CAUSTIC 1 LAD

OPERATING

Prod #2
Caustic 1
B-29

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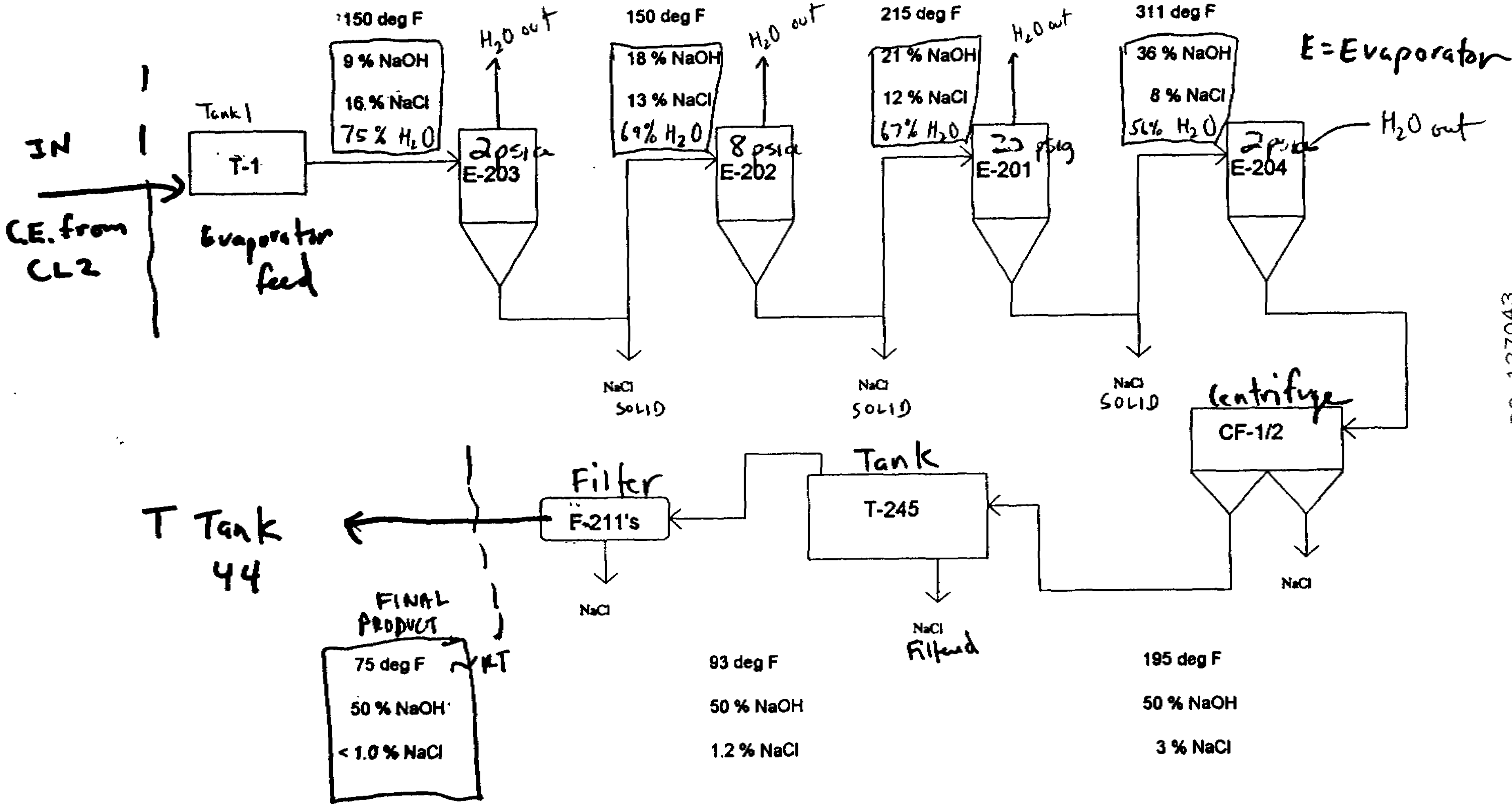
PROCESS

b_p H_2O pure = 212°F

f_p = 32°F



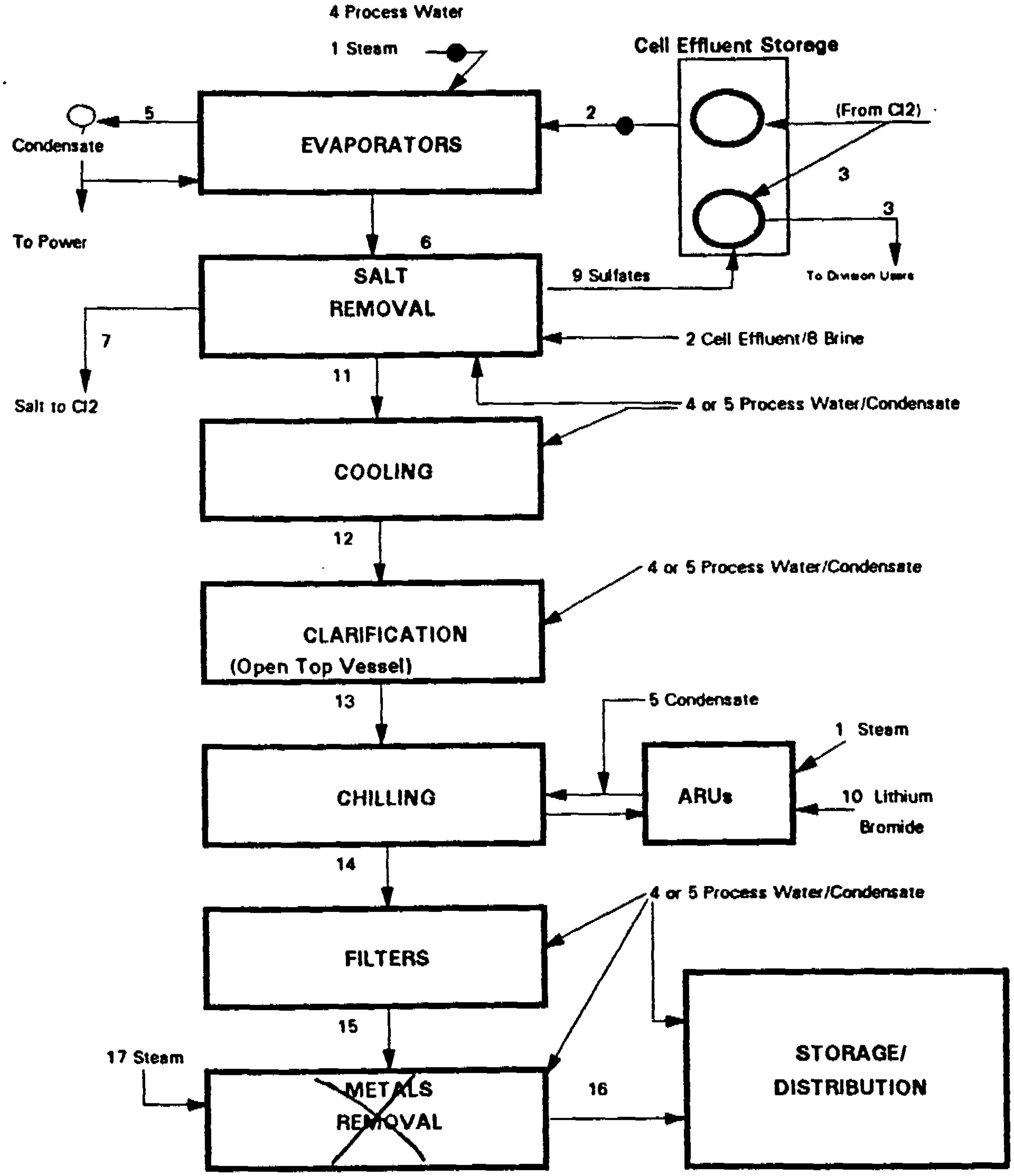
standard atmosphere = 1 atm = 14.7 psia = 760 mm Hg

$P_{gauge} + P_{air} = P_{abs}$

(psig) (psia)

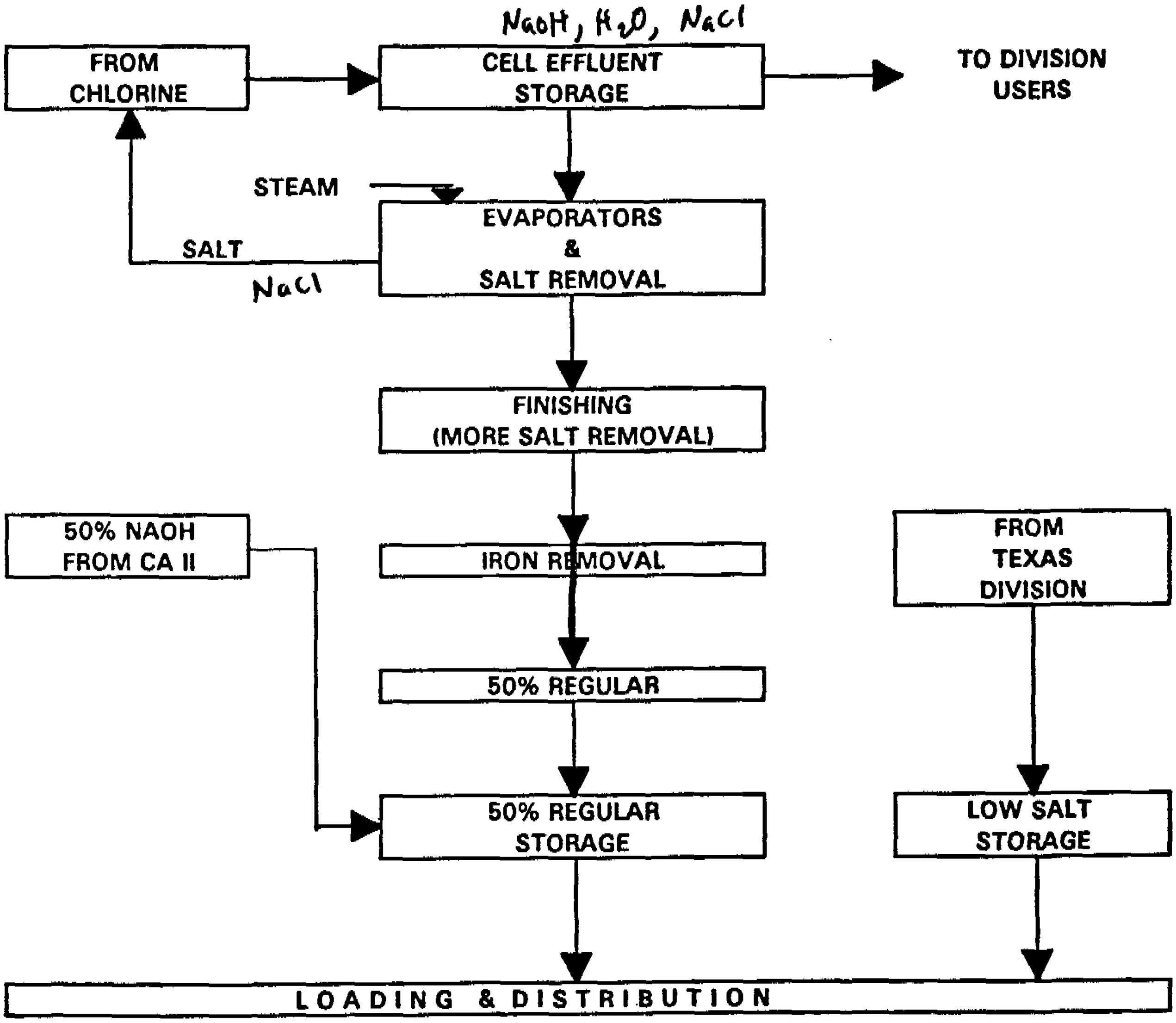
CAUSTIC 1 - LOUISIANA DIVISION

Process Stream Identification



● EBVs (3 Total, 2 on incoming steam (150# and 235#), 1 on feed to evaporators)

LAD CAUSTIC I
BLOCK DIAGRAM



Specific information for various parts of the process is on the Document Management System. A summary of the individual documents is listed below.

Evaporators	414JH03A.DOC
ST-4 Operation	414JH02A.DOC
- Condensate Recovery System	414JH05A.DOC
Salt Removal & Salt Wash Column (D205) Operation	414JH04A.DOC
*Centrifuge And Sulfate Salt Removal	414KH01A.DOC
– Cooling, Settling And Polishing	414KH02A.DOC
ARU Operation	414KH03A.DOC
Sparkler Filter Operation	414KH04A.DOC
Iron Removal System	414KH05A.DOC
Air Compressor Operation	414KH06A.DOC
Strong Cell Effluent Distribution	414DH03A.DOC
Weak Cell Effluent Distribution	414DH02A.DOC
Cell Effluent Storage	414DH04a.XLS 414DH05a.DOC
50% Caustic Storage	414LH01A.DOC
Loading Guide	414MH01A.DOC
Utitities	414DH01A.DOC
Equipment List	414AH01A.DOC

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General Process Description

Cell effluent is pumped into the caustic plant from the chlorine block into cell effluent feed tanks. This cell effluent is then pumped into the evaporators. The function of the evaporator-crystallize is to convert cell effluent to 50% caustic (NaOH, Sodium hydroxide, or caustic soda), salt (Nacl, or sodium chloride), and condensate. The concentration or strengthening of the caustic and concurrent crystallization of salt is accomplished by heating the cell effluent with steam to a temperature sufficient to boil the water from the NaCL-NaOH-H20 solution. Steam energy is conserved by maintaining a vacuum on part of the system. This allows evaporation at lower temperatures. As water is evaporated and the ratio of caustic to water increases, salt crystallizes and settles out of the solution and is separated in the salt removal system.

The heating, evaporation, and partial separation of salt takes place in the evaporators with their associated heat exchangers. Solution from the evaporator body is circulated through the external heat exchangers where steam is applied. As the hot liquid returns from the heat exchanger, & back into the evaporator the water vaporizes and exits at the top of the evaporator body. Crystallized salt settles to the cone bottom and is pumped away. Strong caustic is removed with the slurry or as a separate stream: weak caustic is added in the circulating system.

In the caustic plant we use three evaporators in series to raise the caustic concentration from 8% to 42%. This is known as a triple effect evaporator. A fourth unit, called a flash evaporator, raises the concentration to 50%.

Caustic is forwarded out of the evaporator area into the sulfate removal area. The objective of the sulfate area is to remove all the sulfate from the 50% caustic and in doing so remove the salt from 50% caustic to a level where the sparkler filters can perform their job properly. T-203 receives the 50% caustic containing salt and sulfate from E-204, the evaporators. The clear liquor overflows from T-203 into T-218. The bottom from T-203 is fed to the centrifuge (CF-1) where the salt is clear liquor is fed into T-218 and forwarded on to T-10. The remaining salt and sulfate is removed from CF-1 or 2 and recovered in T-219 where it's mixed with cell effluent or condensate to form a slurry. It is then fed into D-207A salt column. The slurry enters the top of D-207A and salt falls to the bottom of the column while the caustic, cell effluent and sulfate is washed from the salt in counter current fashion to the top of D-207A over flow and into T-246A. It is then pumped to D-205, suction line and from there to the chlorine block. SO_3

The next objective is to cool the 50% caustic, causing the salt to settle out of the caustic and thereby making it possible to feed the sparkler filters with caustic containing approximately 3.0% salt. In doing so the sparkler filters are able to remove the salt from the caustic down to less than 1.0%. Between T-218 and T-10, the heat from the caustic is exchanged. With incoming cell effluent being fed to the third effect evaporator. The heat exchangers used are HE-20A and HE-20B. Caustic is fed in series through the two exchangers, while the cell effluent flows through the exchangers in parallel. This cross exchange of heat provides cooling for the caustic while preheating the cell effluent approximately 13°F for more efficient energy saving during evaporation.

After the caustic is forwarded from T-10 it goes through coolers (HE-204's and HE-205's) to T-245 where the salt settles to the bottom of the tank and the clear liquor overflows to T-236.

(The salt slurry of the T-245 bottoms under flow is fed to CF 1/2 centrifuges.) The caustic is then pumped thru the HE-5 &6s cross exchangers to T-20 where it is cooled by chilled water from ARU units and pumped on to T-28, the salt crystal growth tank. The caustic is pumped out of T-28 into the sparkler filters where the salt is reduced to 1.0% or less. Nickel and copper picked up in the process are also removed by the sparkler filters.

After the caustic leaves the filters, it is forwarded into the iron removal feed tank (T-44). The original objective of iron removal was to reduce the iron content of 50% caustic from approximately 10 PPM to 4 PPM or less. This reduction in iron content was accomplished through the use of etecholytic cells, composed of nickel mesh cathodes and nickel screen anodes. However, today, iron content of the product is generally less than 3 PPM due to improvements in cell operation at Chlorine 1. The iron cells are generally run to further remove nickel & copper. The 50% caustic is preheated, sent through the cells where the iron is removed and then, cooled and transferred to the storage tanks. From the storage tanks, the product is transferred in a safe and timely fashion by way of tank cars, tank trucks, ships, and barges to meet our customers need.

Operating Discipline:	General Process Description
Revisions:	Added HE20A/B description removed reference to flatbed filter and added CF-2 added master list of operating discipline documents.
Developed:	2/17/88 LVT
Revised - Date:	5/93
By:	Ray Brown
Approved:	
Title:	
Date Approved:	
Key Words:	Operating discipline, process description

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Evaporators

1. General Comments

1.1 General

The function of the evaporator-crystallizer (Train 2) section of the Caustic Plant is to convert cell effluent to 50% Caustic (NaOH, sodium hydroxide, or caustic soda), salt (NaCl, or sodium chloride), and condensate.

Feed	Products
NaOH 8.5%-10.5%	50% NaOH with < 3% NaCl in solution
NaCl 17.5%	pure water (condensate) out of
H_2O 76.1%	evaporator section
0.2% impurities	
100.0%	

The concentrating and strengthening of the caustic and concurrent crystallization of salt is accomplished by heating the cell effluent with steam to a temperature sufficient to boil the water from the NaCl - NaOH - H_2O solution through several heaters and crystallizers in series. Steam energy is conserved by maintaining a vacuum on part of the system. This allows evaporation at lower temperatures.

Water will hold in solution approximately 26% salt by weight. When caustic is put into this solution the amount of salt the solution will hold is reduced to the range of 1-3%, depending on the temperature, as the caustic approaches 50% concentration.

As the water is evaporated and the ratio of NaOH (Caustic) to water increases, NaCl (Salt) crystallizes and settles out of the solution and is separated in the salt removal system.

less H_2O → less NaCl in sol'n

The heating, evaporation, and partial removal of salt takes place in evaporators with their associated heat exchangers. Solution from the evaporator body is circulated through the external heat exchanger where steam heat is applied. As the hot liquid returns from the heat exchanger back into the evaporator, the water vaporizes and exits at the top overhead line of the evaporator body. Crystallized salt settles to the cone bottom and is pumped away. Strong caustic is removed with the slurry or as a separate stream; weak caustic is added in the circulating stream.

In the Caustic plant we use three evaporators in series to raise the caustic concentration from 8.5% to 40%. This is known as a triple effect evaporator. A fourth unit, called a double effect (or finishing) evaporator, raises the concentration to 50%. This configuration is known as a triple-double.*

There are several considerations in the design and operation of evaporator that should be understood.

Evaporator Capacity -- depends mainly on (1) the area of heating / condensing surface provided (2) the overall temperature drop between the steam condensing in the first effect heat exchanger and the saturation temperature of the vapors leaving the last effect (3) the overall heat transfer coefficient. (The velocity in the tubes as well as the fouling in the tubes greatly affects the heat transfer coefficient.) A triple effect evaporator requires three times the heat exchanger area as a single effect for each pound of water evaporated.

Evaporator Economy-- the pounds of water evaporated per pound of steam used increases almost threefold by using a triple effect instead of a single. One pound of steam will evaporate approximately 2.2 pounds of water in the triple effect system whereas one pound of steam in a single effect evaporator will evaporate somewhat less than one pound of water. Steam economy justifies the added equipment expense of triple effect evaporation. In our plant, maximum efficiency can be * gained by allowing the triple to concentrate the caustic to the point just below where sulfate salts precipitate out, n 38%.

Vapor Body Size -- the cross sectional area of a vapor body is determined by the allowable velocity of the vapors leaving the evaporator body. If the vapor velocity is too great or the area of the evaporator is too small, a large amount of the boiling liquid will go overhead with the vapors. The height of the vapor space between the boiling liquid and the mesh pad is based on allowing the majority of the liquid droplets that are entrained in the vapor to disengage and fall back into the boiling liquid before they hit the mesh pad.

Lower concentration or lower pressure reduces the boiling temperature, this allows us to use lower pressure steam to effect boiling.

Higher concentration or pressure gives a higher solution temperature, which requires a higher, steam temperature to boil the solution. This requires a greater steam pressure from the preceding vapor body or from incoming steam in order to condense.

Salting or fouling occurs when water is evaporated in the heat exchanger and the salt crystallizes on, the evaporator body walls and within the heat exchanger tubes and heads. Careful design provides adequate flow velocity and pressure to prevent evaporation, or flashing, until solution re-enters the vapor body. Steady operation - (steam temperature, vacuum, levels) - reduce salting.

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Incoming steam temperature is fixed by the set point on the steam desuperheater temperature controllers, which is a function of the condensing pressure of the shell. The boiling temperatures in the third effects are fixed by the amount of vacuum on the third effect vapor bodies. It is this temperature difference between the temperature of steam entering the first effect heater and the saturation temperature of the vapors leaving the third effect (vapors leaving the third effect are superheater as is the case in all the effects) that is the overall temperature difference. Concentrations, pressures, and temperatures, in the triple effect evaporators must then reach an equilibrium according to heat exchanger area and rate of heat transfer for the evaporator heat exchangers.

No single pressure, level, temperature, or density reading can pinpoint the cause of a problem. Readings must usually be observed across an entire triple effect system to locate the source of a problem.

On all of our evaporators, the circulation through the heat exchanger is caused by an in-line axial flow pump. When the circulation is caused by a pump, it is said to be forced circulation. Usually, boiling in the tubes of a caustic evaporator heat exchanger is undesirable, but this is mostly true on heat exchangers that have to condense steam at a high temperature and pressure, which seem more prone to fouling.

The design capacity for the Caustic Plant is 3,500,000 pounds per day. The above rates are based on cell effluent feed being 115 GPL or approximately 9.3%.
- Need to add residence time estimates based on calculations done by J. Harrison.

2.1 Train II Evaporators

2.1.1 First Effect Evaporator

Steam Flow Rate	300-620 M#/hr	This is the normal flow rate of superheated steam going to HE-201 Condensate for de superheating is added before the steam gets to HE-201.
Steam Pressure on HE-201	90-150 PSIG	The pressure controller should be set so that the recorded condensing pressure in HE-201 does not exceed/50 PSIG. Normal operating pressure should run around 118 PSIG.

HE-201 Condensate Flow Rate	1200 GPM	If the steam meter is reading correctly and the steam is being properly de superheated the condensate flow out of HE-201 should be about 900 GPM to / 1200 GMP.
% NaOH	30-40	This is highly dependent on how you operate the flash effect evaporator. 30-38% can be considered a good range for E-201, above 28% may. Result in sulfate salts precipitating out.
Boiling Temperature	280 to 318°F	This will vary with pressure and concentration in E-201, but should not generally be below 295°F or above 320°F.
of caustic ΔT Across HE-201	18°F	This may vary from 7° to 18°F depending on steam rate to HE-201 and concentration in E-201. Values higher than 20° should be cause for concern and may indicate fouling of HE-201 or pump cavitation due to low level in E-201.
Vapor Pressure in E-201	17-20 PSIG	This will vary from 17 PSIG to 20 PSIG during normal operation. Values higher than 20 PSIG would normally indicate fouling of the second effect heater HE-202. Valves below 10 PSIG can be observed at low rates
Pump Out Rate to SC-201	1300 GPM	This rate remains very constant. The slurry removal rate from E-201 can be changed by putting two pumps on line and/or bypassing SC-201.
Level Control E201	59% to 64%	Set at 62%
Feed Rate to E-201	2200 GPM	This rate varies with the action of the E-201 level control valve but averages about 2200 GPM.

MP-201 HE Motor Load	220 Amps	This will vary somewhat with concentration in E-201 and the amount of crystal salt in E-201. A high motor load may also indicate a low level in E-201

2.1.2 Second Effect Evaporator

Vapor Flow Rate to HE-202	340,000 #/hr	The second effect evaporator heater condenses vapors from E-201 at about 300,000 #/hr and from CT-202 overhead at about 40,000 #/hr.
Condensate Flow Rate From HE-202 to CT-205	700 GPM	The indicated flow rate is dependent on the condensing pressure in HE-202. Also, a gradual decrease in this flow rate is on indication of fouling in HE-202 or poor vacuum.
Vapor Pressure in E-202	11" Hg	The normal range is from 9.0 to 17.0 inches Hg vacuum.
Boiling Temperature in E-202	205°F	Normal range is from 205° to 220°F.
ΔT Across HE-202	8-15 °F	A temperature rise of 10°F or greater is an indication of fouling in HE-202.
% NaOH	12-15%	
Pump Out Rate to SC-202	3300 GPM	This should be a fairly steady flow.
E202 Level Control	42% to 47%	Set at 45%
MP-202HE Motor Load	125 AMPS	This is our most dependable indication of fouling in the second effect heater. When the motor load reaches 125 - 130 amps and the E-202 level is okay it is an excellent indication that HE-202 need a shot.

Feed Rate From T-205	3000 GPM	

2.1.3 Third Effect Evaporator

Vapor Flow Rate to HE-203A&B		The third effect evaporator heaters condenses vapors from E-202 & CT-203 overhead & sometimes CT-202 overhead
Condensate Flow Rate from HE-203A&B to CT-1 or eastern cond. header	750 GPM	This rate may vary and depends mostly on the E-202 overhead vapor rate.
Vapor Pressure in E-203	26.4 to 27.4 Hg	This varies from 26.4 to 27.4 Hg vacuum depending on production rates, feed concentration. It is desirable to hold as much vacuum as you can on E-203, to maximize efficiency.
Boiling Temperature	135° to 155°F	This will vary from about 135° 155°F. It is desirable to keep this around 140° F by getting as much vacuum on E-203 as you can.
% NaOH	8-10%	This should run around 11% when the % NaOH is around 9.3% in the feed.
ΔT Across HE-203	5° to 14°F	This will normally run around 8°F and remain fairly constant.
Feed Rate to E-203	3000 GPM	This may vary from 2800 to 3300 GPM depending on concentrations, pressures, and temperatures in the system.
E203 Level Control	39% to 44%	Set at 43%

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Pump Out Rate From E-203 to T-205	2400 GPM	This is controlled by the T-205 LCV. It will normally average around 2400 GPM.
MP-203A HE Motor Load	65 AMPS	This motor load normally runs very steady. A higher load may be an indication of a low level in E-203.
MP-203B Motor Load	65 AMPS	Same as above

2.1.4 Double Effect Evaporator E-204

Steam Flow Rate	125,000 to 150,000 #/hr	This is the normal flow rate of superheated steam to HE-204. Condensate for de superheating is added before steam gets to HE-204. This should be minimized to push as much to the triple as we can to help to increase our efficiency.
Steam Pressure	5 to 17 PSIG	The pressure controller should be set so that the recorded condensing pressure in HE-204 does not exceed 35 PSIG.
HE-204 Condensate Flow Rate	300 GPM	If the steam flow meter is correct and the steam is properly de superheated the flow out should be approximately 300 GPM.
% NaOH	49 - 51%	This depends greatly on the concentration in E-201. It may be desirable to run higher concentrations at times.
Boiling Temperature	185-212°F	This depends greatly on the vacuum of E-204 and concentration but should not generally be below 200 or above 209 °F.

ΔT Across HE-204	18 °F	This will vary from 10° to 14°F depending on steam rate to HE-204 and depending on concentration in E-204. Values higher than 6°F should be cause for concern and may indicate fouling of HE-204 or pump cavitation due to low level in E-204
E204 Level Control	42% To 47%	Set at 45%
Vapor Pressure in E-204	27.5 Hg	This will vary from 26.5" to 28.0" HG during normal operation.
Pump Out Rate to T-203	440 to 570 GPM	This depends on the vacuum on E-204 and concentration in E-201. It generally runs about 440 GPM.
Feed Rate to E-204	800 GPM	Same as above
MP-204HE Motor Load	65 Amps	This depends on concentration and amount of salt in E-204. High amps may indicate excessive salt or low level.

Each evaporator has 2 sets of level transmitter show on T.D.C. Group 1

HS-1518	E201	Slot 1	Switch a tap C flange
	E201	Slot 2	Level control
HS-1001	E202	Slot 3	Switch C west A east
	E202	Slot 4	Level control
HS-1415	E203	Slot 5	Switch C west A east
	E203	Slot 6	Level control
HS-1626	E204	Slot 7	Switch A south C north
	E204	Slot 8	Level control

If the two level transmitters on a evaporator is tracking 10 point difference, the board person will have outside operator flush the level purges to correct the difference or switch to other transmitter to control level in the evaporator.

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3. Trouble Shooting

Many variables affect the operation of the Evaporator System. Among these are temperatures, pressures, levels, flow rates, motor loads, compositions of flowing streams, automatic valve positions, and air signals on automatic controllers. Many of these variables are interdependent. An abnormal value or condition of any of the above variables can adversely affect several of the others. Operators should become familiar with the normal values of the above variables for all of the equipment throughout the evaporator systems.

The following possible abnormal conditions may be accompanied by the indications and problems show below. Also shown are some of the things to check to find the source of the problem.

3.1 Steam rate to first effect heater falling off.

3.1.1 Loss of circulation through the heater would cause a rapid increase in the shell side pressure of the heat exchanger. The automatic pressure controller would throttle the steam flow to the first effect heat exchanger (HE-201). Check to make sure that the circulation pump is running.

3.1.2 The shell side pressure could also increase due to a malfunction in the condensate level control loops. Check the level control valve and controller for proper operation and manual valves for proper position.

3.1.3 A low level in the first effect evaporator body can also cause the first effect heater shell pressure to increase above the pressure set point and make the steam rate fall off. This is because an abnormally low level in the evaporator will cause the circulation pump to cavitate and the circulation rate will be reduced. Check all evaporator level control systems.

3.1.4 If the problems mentioned in the above three paragraphs occur on the second or third effects they will cause the steam rate to fall off on the first effect because of the way the evaporators are connected together in series. An abnormal condition on any of the evaporator bodies will adversely affect the operation of the entire evaporator system.

3.1.5 Fouling of the second effect heater causing the pressure in E-201 to rise to 20 psig. Shoot HE-202 to solve the problem since the TDC will cut steam to keep the pressure below 20 psig.

3.2 Condensate Dumping

3.2.1 Check differential pressure across mesh pad on preceding evaporator. If pressure drop across mesh pad has increased wash the mesh pad. If differential pressure does not decrease after washing mesh pad check to see if automatic valve in mesh pad wash line is opening properly and that manual valves are lined up properly. The increase in process water flow as indicated on the process water meters (group 65) to each mesh can serve to indicate if we are getting enough water flow to the mesh pad wash.

3.2.2 If washing the mesh pad several times does not clear up the problem the bad condensate may be caused by leaking tubes in the evaporator heater. Catch a pint or larger sample of the condensate, cool it to about 25°C and run its conductivity on the portable resistance box conductivity meter that is kept in the control room lab. <u>CAUTION: Hot condensate can cause server and painful burns. Make sure that you can get the sample safely.</u> If the results of running this test confirm the readings on the L & N conductivity recorder controllers we may have some tube leaks in the evaporator heater. Also the mesh pad might have a bad section of mesh or an evaporator & heat exchanger might need a shot.

3.2.3 Bad condensate can also be caused by an abnormally high or abnormally low level in an evaporator body. If the level is too high the boiling caustic solution will be too close to the mesh pad and boiling liquid will splash into the pad and be carried through to the shell side of the next evaporator's heater. If the level is too low we may have very hard flashing of the boiling liquid in the evaporator body. This causes formation of an excessive number of very fine particles of liquid which are carried up with the vapors into the mesh pad, overload the mesh and are carried through to the next evaporator's heater. If you suspect that the level is too high or too low make small adjustments in the evaporator level and see what this does to the condensate quality. You should also wash the mesh pad after the level has lined out at its new set point before concluding what the change in the evaporator level has done to the condensate quality.

3.3 First Effect Evaporator body pressuring up.

3.3.1 The concentration of the product being withdrawn from the flash effect evaporator may be too high. Check for proper operation of the concentration controller on the flash evaporator.

3.3.2 If the pressure build up is rapid the tubes of the second effect heater may be blanked off by a high condensate level. Check the second effect heater's condensate pump and level control valve and controller for proper operation.

3.3.3. Loss of circulation through the second & third effect heater would also cause the first effect evaporator body pressure to increase fairly rapidly. Check to make sure that the circulation pump is running.

3.3.4 A low level in the second effect evaporator body will also cause the pressure in the first effect evaporator to increase. The low level will cause the circulation pump to cavitate. The flow rate through the second effect heater will decrease and the liquid temperature rise through the second effect heater will increase. The temperature difference between the condensing vapors and the liquid being circulated through the second effect heater will decrease and the condensing pressure will increase. Check the second effect evaporator level and adjust as necessary or poor vacuum.

ΔT decreases

3.3.5 The second effect heater is fouled. Shoot with a mini shot.

3.4 Second effect evaporator body pressuring up.

3.4.1 Check third effect heater's condensate pump and condensate level control valve and controller.

3.4.2 Make sure third effect circulation pump CSI are running.

3.4.3 Check for low level in third effect evaporator or poor vacuum.

3.4.4 The third effect heaters may be fouled. Shoot with a mini-shot.

3.5 Excessive vibration and/or high amperage on evaporator circulation pumps.

3.5.1 Check the evaporator level. A low level will cause the pump to cavitate. This will make it draw high amperage and may also cause the pump to vibrate excessively and be very noisy.

3.5.2 If the level in the evaporator is okay the high amperage and noisy operation may be caused by excessive salt build-up in the evaporator & heat exchanger. This can generally be corrected by shooting the heater. Another method that is sometimes successful is to withdraw slurry from the evaporator body at a much greater then normal rate for a short time. This can be done by using two slurry forwarding pumps.

3.6 High mesh pad differential pressure.

A mesh pad differential may sometime show an abnormally high reading without having bad condensate in the next heater. Also the mesh pad showing the high reading may be a third effect mesh pad.

3.6.1 Flush and check the purges.

3.6.2 Wash the mesh pad.

3.6.3 Get the D/P cell checked.

3.7 Losing level in an evaporator body.

3.7.1 Check the level control valve and controller.

3.7.2 Wash the evaporator feed line.

Many problems other than those listed above can arise in the operation of the evaporator systems. It is extremely important that operators be familiar with the normal values of pressures, temperatures, flow rate, concentrations, motor loads and valve positions in order to keep the evaporator systems running smoothly.

P-201 HE Upgrade

The scope of this change involves the upgrade of the P-201HE Morris pump in the first effect evaporator loop. The present pump is rated at 75,000 gpm at 20' of differential at 288 rpm. For the new exchanger, we will need to upgrade the pump to 85,000 gpm at 30' of differential at 366 rpm. To affect this change, we will need to replace the starter in the MCC, replace the motor, replace the coupling, upgrade the gearbox and replace the U-joint. In addition, because of the increased discharge pressure, we will need to replace the flanges on the pump outlet/diffuser inlet to accommodate larger studs. All new equipment is being located in the same place as the old equipment.

The present MP-201HE starter in the 2300V MCC is being replaced with a larger vacuum contact starter. It will be located in the same cubicle as the previous one. In addition, a larger wire is being run from the starter to the motor and the control hardware is being replaced with new equipment. In conjunction with this, the motor is being upgraded from a 1000 hp/1800 rpm motor to a 1500 hp/1800 rpm motor. The field switch is also being replaced to handle the new motor. It will require about 1250 hp during normal operations. This about equal to 275 A (330 A at full load).

The spare gearbox was modified to increase the output speed of the shaft from 288 rpm to 366 rpm. Thus, CA2 will no longer have a gearbox identical to ours. However, most of the parts in the gearbox will be identical, so the spare could be changed from one configuration to another in less than 24 hours if either ours or CA2's gearbox wrecks.

Because of the increase in horsepower of the motor, the connections between the motor and the gearbox and between the gearbox and the impeller are being upgraded. The U-joint is being upgraded to Zurn model U3350ST U-joint. The coupling between the motor and the gearbox was upgraded to a Series 52 size 500 Thomas flexible disc pack coupling.

The old pump discharge flanges were sized to accommodate 60 X 7/8" studs. For the increased pumping requirements, we were required to change the backing flanges to accommodate 44 X 1 1/8" studs. This required cutting off the old flanges and replacing them with welded split ring backing flanges. Because of the split ring design, the weld seams MUST be located 90 degrees from one another. This must be checked every time the bolts are removed from the flanges.

Operationally, the pump will run the same as it did before the upgrade. The only exception is increased power requirement of the motor. The motor should normally run between 260-280 A, with a full load at 330 A.

The instrumentation for the pump, bearing housing and gearbox will stay the same as for the old pump configuration. For the motor, a Multi-lin was added to monitor the amps and the temperature of the motor. This unit performs the same function as the overloads and dash pots present in the old system, which it replaces.

HE-201 D Replacement

The scope of change involves the replacement of HE-201 C with a new larger exchanger. Other than the vessel itself and the addition of instrumentation, other aspects of the system are unchanged.

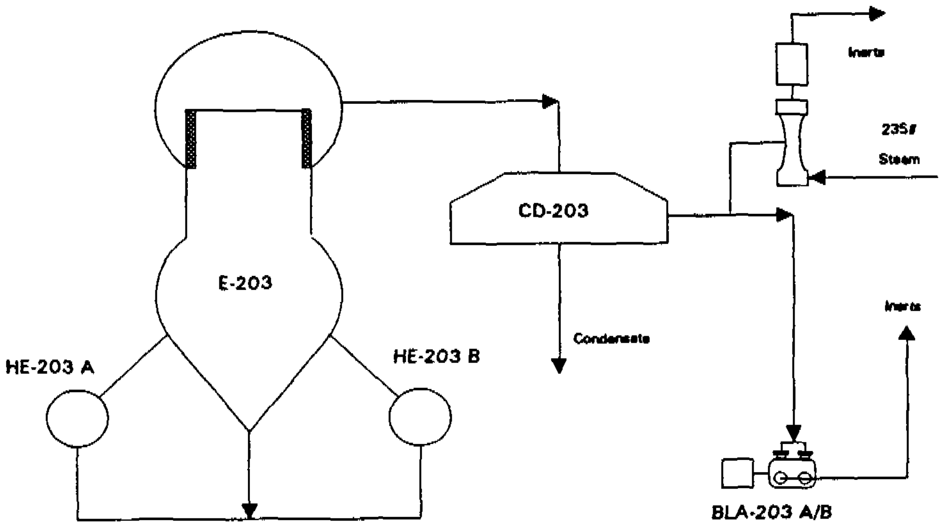
The new exchanger has the same diameter as the old exchanger, but due to a change in the design of the steam distribution system and baffles, it has 68 more tubes than the old exchanger. It also has 51% more surface area than HE-201C originally had, due mostly to the increased length (22' vs. 30'). This should allow us to be able to use more steam, assuming the remainder of the evaporator system can handle the capacity increase. It will be able to pull 650Mlbs/hr from ST4 at 150# of back pressure.

The condensate system is virtually unchanged. One exception to this is the addition of a second level transmitter in the condensate sump. A second exception to this is the installation of a temperature probe in the condensate drain out the sump. This will be used to monitor the temperature of the condensate out HE-201D during cold starts. One other change on the condensate/steam side involves the placement of four skin temperature probes on the shell of HE-201, under the insulation (a WOW suggestion from Donald Yelverton). These will also be used during start-up along with the condensate temperature to monitor the heating rate in HE-201D.

On the caustic side, there are only instrumentation differences between the old and new system. We have added pressure transmitters on the tube side inlet and outlet. This will give us the capability to monitor any changes in the pressure drop across the tube side. This will be a helpful tool to use when trying to determine when to shoot the evaporators.

J-203 Steam Jet (Hogging Jet)

The scope of this change involves the addition of a steam jet ejector to the BLA-203 suction piping. Currently it takes about 6 hours to get to full vacuum on the triple after breaking the vacuum. With the installation of the ejector as specified, we should be able to pull a rough vacuum in about 1 hour, and then use the vacuum pumps to pull down to a deep vacuum an hour later. The ejector will use about 5000 lb. of 235# steam. The installation of the ejector includes a double block and bleed, and a steam trap on the steam side; and a double block and bleed on the process side. It will be located on the southeast corner of the E-203 structure. The exhaust will be sent through a muffler and then to the atmosphere.



DO 127067
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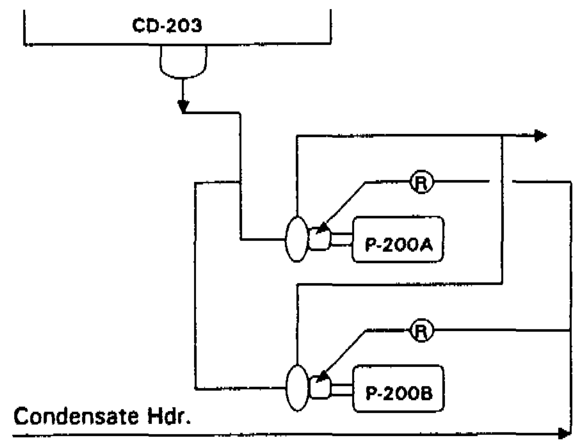
P-200 A/B Packing Flush

The scope of this project involves the installation of permanent piping to allow for an external condensate flush to the packing on P-200 A/B.

Currently, the packing is flushed with water piped from a discharge bypass line. This arrangement ideally suited for pumping cool condensate; for the flush fluid should be at least 50 ° F below its boiling point. However, in this situation, because of the low pressures involved, the fluid is condensate near its boiling point. In addition, as the net positive suction head available (NPSHA) of the pump reaches the net positive suction head required (NPSHR), cavitation occurs, causing the flow and the pressure out the pump to drop. This results in a reduction and eventual loss of packing flush flow. In this instance, air may begin to leak in through the packing, and lead to a complete loss of flow.



New Packing Flush Arrangement - External Flush

Adding an external flush to the packing will allow for a constant, flow of cool condensate to the packing, regardless of the suctions conditions of the pump. The piping can tie into the closest condensate header available, and shall be piped to both P-200 A & B utilizing individual rotameters and valves. According to Durco, this should help our situation. If we still cannot get out of CD-203 at high vacuum, we will seek ways to increase the NPSHA.

DO 127068
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P-201 HE
Operating Parameters

Motor
- 1500 HP Siemens
- 1738 RPM
- 329 AMPS full load
- 240 AMPS normal load
- 190 AMPS startup (CE / H20)

Pump
- 54 inch impeller
- 330 RPM
- 85,000 GPM recirculation rate

Gear Reducer
- Lufkin speed reducer
- 1738 input RPM
- 330 output RPM
- 2.4 application factor
- 5.27:1 Ratio

Oil pressure switch on speed reducer
- 18 PI normal run
- 15 PSI low pressure alarm
- 10 PSI trips motor

Shaft from speed reducer to pump shaft is a zurn universal drive shaft.

Coupling between motor and speed reducer is a Thomas disc pack flexible coupling.

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5. Equipment Description

Item No.	Pump	Motor
P-201HE	Morris 330 RPM Direct drive (Watson universal drive shaft) (Lufkin speed reducer)	Siemans 1500
P-202HE	Bingham 44 1/2" impeller 330 RPM 76,000 GPM Belt Drive	General Electric 800 HP 900 RPM
P-203 HEA&B	Bingham 34 1/2" impeller 392 RPM 34,000 gpm	General Electric 400 HP 900 RPM
P-204 HE	Bingham 24" impeller 895 RPM 25,000 GPM	500 HP

Item No.	Mfg.	Tube Size	Overall Size	No. of Tubes
HE-201D	NOOTER	30' x 1 1/2" OD 7.9 ft/sec velocity	10'10" x 51'6"	2,684
HE-202	CB&I	25'11-7/8"x 1 1/2" OD 8.1 ft/sec velocity	8'2" x 33'5"	2,040
HE-204A&B	CB&I	25'11-7/8"x 1 1/2" OD 7.7 ft/sec velocity	8'2" x 33'5"	965
HE204B	Ohmsted	16-0 x 1 1/2 8.2 ft/sec velocity	7'0 x 25' 7 1/2"	1404

Mesh Pads			
DME-201	York 931	6" Thickness	Ni Mesh
DME-201B	Koch 9310	8" Thickness	Ni Mesh
E-202	York 939	12" Monel	Atomizing Wash, Hard Wash
E-203	You 318H(M)	12" Monel	Atomizing Wash, Hard Wash
E-204	Koch 9310	12" Nickel	Hard Wash

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Final Effect Evaporator: Concentration Control

The scope of this project involves the implementation of a concentration control scheme on our final effect evaporator, E-204. This will involve the addition of one pressure transmitter below the mesh pad, the replacement of a thermocouple with an RTD and a temperature transmitter. No additional modification will be made in the field. See the diagram below for a sketch of the process.

← operators

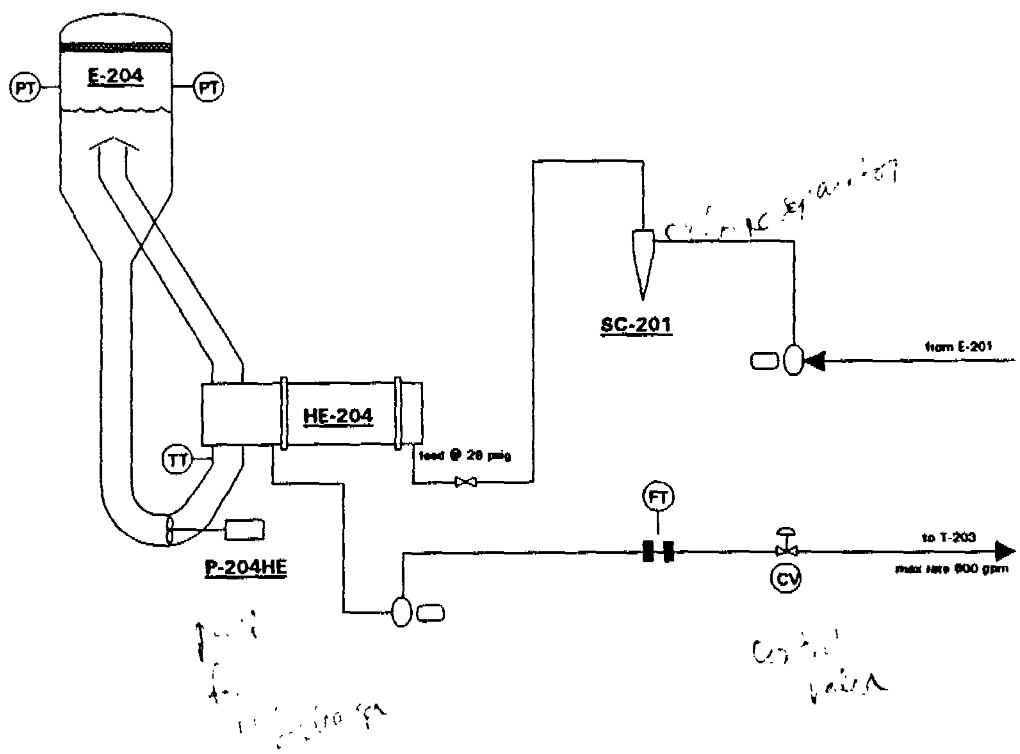
operating specialist

Presently, our concentration control is a manual operation. The OS's catch and run samples of the caustic exiting E-204 every two hours; the SOS's then adjust the flow out E-204 appropriately.

Senior operating specialist

The new control scheme will use a correlation on the Micro VAX to calculate a concentration based on the temperature and pressure in the evaporator, input a flow set point on the TDC, and allow the TDC to control the flow out of E-204. The correlation will be one based on data obtained from the plant (temperature, pressure and concentration), and will be similar to one used successfully at CA2 on their final effect evaporator. In addition, the control scheme will include an auto-stroke sequence, where the FCV out E-204 will be moved to the full open position for a few seconds every 6 hours. This can be changed as necessary.

Eventually, we hope to reduce the sampling frequency from six times per shift to twice per shift (similar to CA2's).



DO 127071
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Operating Discipline:	Evaporators
Revisions:	Updated target operating parameters added mesh descriptions.
Developed:	
Revised - Date:	5/27/93 6/23/93 1/6/94
By:	Ray Brown / Glenda Townsend / Brian Pankow
Approved:	Sam Boudreaux
Title:	Evaporators
Date Approved:	1/7/94
Key Words:	Operating Discipline, Evaporators, Equipment

Salt Removal and D-205 Salt Column Operation

I. Introduction

As water is removed from the cell effluent in the evaporators, the salt in the cell effluent crystallizes and forms a salt slurry. This takes place because the solubility of salt in a caustic solution decreases as the percent caustic increases. The purpose of the salt removal system is to separate this solid salt from the caustic solution and to wash this salt until less than .5% NaOH appears in the under flow of the salt column so that it can be reused by the Chlorine Plant. Any caustic that is not removed from the salt slurry is lost production for our plant.

II. Equipment Description

A. Cyclones

Cyclones (SC-211, SC-212, SC 201B) are used to separate the salt slurry from the clear caustic solution.

1. How a Cyclone Works

a. The slurry is pumped at a high pressure into the tangential nozzle entering the cyclone.

b. Because the slurry enters tangentially and at high pressures, the slurry is forced by the circular walls of the cyclone to rotate very fast around in circles. This circular motion develops centrifugal forces on the slurry. The solid salt has a higher density (is heavier) than the NaOH solution and therefore is driven toward the outside wall and downward. The clear caustic moves inward and upward toward the liquid discharge at the top of the cyclone. See diagram on the next page.

2. SC-201B/CS-211

The slurry from E-201 is pumped to SC-201B or SC-211. The liquid caustic goes to E-204. The salt drops out of the bottom of SC-201B or SC-211 into T-204.

3. SC-212/CS-201B

The slurry from E-202 is pumped to SC-212 or as a backup SC-201B. The salt from the bottoms of SC-201B or SC-212 also enters T-204 and the liquid overhead is the feed to E-201.

4. SC-201B Special Nots

SC- 201B was installed in December of 1993 replacing SC-201. It is intended it be a spare for either SC-211 or SC-212. For SC-211 it is piped directly into the line and can be swapped from SC-211 to SC-201B on line. If a failure in SC-212 occurs, SC-201B can be placed into the hole where SC-212 presently resides, SPECIAL NOTE: The apex/vortex finder from SC-212 need to be installed into SC-201B to handle the system from E-202. It is designed to fit in the hole utilizing the spool piece on the under flow of SC-201B and the apex/vortex finders for both cyclones are interchangeable. For a swap back to the E-201 feed (i.e. SC-211 side) the apex/vortex finders need to be swapped back.

T204 hot salt setting tank for Caustic 1.

Salt and Caustic enters T-204 from E-203 slurry pumps, SC-202 or SC-212 bottoms, SC-201 or SC-211 bottoms and D-205 overflow. The pump outrate from the bottom of T-204 should be determined by the salt bed level in T-204. Concentration of NaOH out the bottom should be between 17% to 20% and salt settle volume should be 60% to 70% with over flow into T-205 clear liquor. T-204 is a cone shape vessel with a covered top, 22' diameter at top and 29' high. Carbon steel with alloy 200 clad. The bottoms are fed to the salt column D-205 by P-204TA or P-204TB at the average rate of 1200 GPM. At 600,000 steam rate on the evaporators.

T-205 Pump Back Line Controller

The new T-205 pump back controller has been installed. It is accessible on group #32. The flow of caustic into the pumpback line can be controlled in either of three modes. The first is manual, where the position of the valve can be manually set by the operator. The second is automatic, where the operator inputs a flow set point, and the controller keeps the flow at the desired level. The third is computer, where the computer maximizes the flow from T-205 to T-1 trying to bring the level down to 50%.

Manual Mode

During normal running time, the level in T-205 is controlled at 55% by throttling the flow to T-205 from E-203. Nothing is sent to T-1 or T-2 via the pumpback line. The pumpback controller should be set on manual with the valve closed.

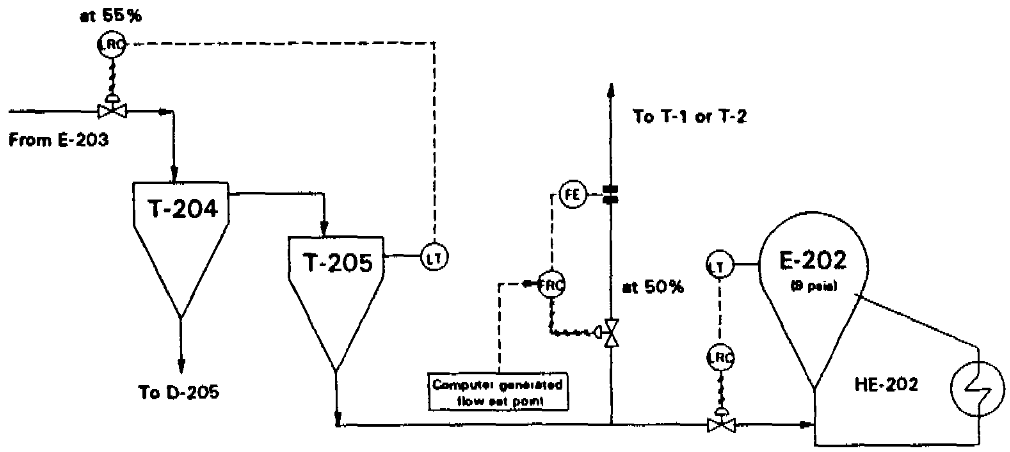
Automatic Mode

If we wish to increase the strength of the CE in the T-2, the controller mode should be set on automatic and a flow set point input to control the T-205 flow to T-2.

Computer Mode

During a shot, salt is removed from the system through D-205. To maximize the efficiency of the shot, we will maximize the process water flow through the system by maximizing the flow to T-1 or T-2. To do this, we will either make into T-205 at max. flow or draw out of T-205 at max. flow. This is done by allowing two valves to try to control the level in T-205 at the same time. The make-up valve will control at 55% (as it normally does), and the draw off valve will control at 50% (using the microvax). With these valves fighting each other, either one will always be open 100%. See the diagram to further describe the system.

The controller should be set on computer control whenever we need to utilize the pumpback line during a shot.



DO 127076
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Since this new system, there may still be a few bugs.

First of all, watch the controller to make sure that it is tuned. Bad turning could be a problem both in automatic or computer control. Call Brian if there are any problems.

Second of all, there could be a problem with the response of the controller. If it is set too slow, it may not open fast enough when set on computer, either allowing T-205 to fill up or taking too long to get a substantial flow to T-1 or T-2. If this is a problem, set the controller on manual and slowly open the valve to 100%. Once 100% is reached, put it on computer.

Finally, the difference in the two set points may be too small. The current delta is set at 5%. If during a shot we do not notice that one of the two valves is not open 100%, let me or Vernon know so we can increment as needed.

T-205 - E-202 Feed tank

T-205 receives it's level from the overflow of T-204 and is level controlled by the flow from E-203 slurry to T-204. The bottoms are pumped to E-202 or T1 or T2 while we are shooting evaporators. The slurry to E-202 should only have a trace of salt in the samples. If more then a trance of salt in T-205, T-204, is overflowing salt and T-204 bottom flow will have to be increased.

T-205 is a cone shape tank with a covered top 21'3" diameter top 15'7" height made of carbon steel, alloy 265 clad.

III. Salt Column Operation

D-205 Salt Column

1. Introduction

When water is evaporated from chlorine cell effluent, the solubility of sodium chloride decreases. This causes the precipitation of salt crystals in the evaporator at the approximate rate of two pounds of salt for every pound of sodium hydroxide processed. The use of salt columns is one method of removing the solid salt from the evaporators.

The original conception of salt columns was conceived and developed at the Western Division in California. This was reported at the 1960 and 1962 Caustic Conferences and is patented under Dow patent No. 3,278,275, 10/11/66, R. D. Barnard & K. H. Mayer. These original columns had a series of trays in them but in the mid 1960's, the Inorganic Process Research Department at Texas developed the columns as used today without trays. Various studies and improvements since then have been made both by the Louisiana and Texas Divisions.

2. Theory

Salt wash columns can be described as a counter current, moving bed separator. The feed is a slurry containing approximately 20% NaOH in the solution and approximately 50% by settled volume solids. This slurry enters the column through a distributor at the top of the vessel. Wash water, normally condensate, is introduced in the lower section of the vessel through a sparger arrangement. The solids from the feed form a moving bed, with a definite interface and are washed relatively free of NaOH. This washed slurry is withdrawn from the bottom of the vessel through a cone bottom and should be 0.4 to 0.8% NaOH in the clears and approximately 75% by settled volume solids.

The overflow of the column is collected in a launder around the top of the vessel. This should be an essentially solids-free solution that is slightly diluted from the approximate 20% NaOH feed.

3. Design

The salt column vessel is essentially a tank with a cone bottom. The sides are 20 feet on the straight side and the bottom is a 18.'9" cone. The overflow nozzle to accept the overflow. The diameter of the vessel is 16 feed by the solids load the column is designed for.

Both Louisiana and Texas research have found the through-put, as defined as pounds of solids per square feet of column area per minute (lbs./ft2/min.), is a critical parameter. The salt settling rate affects the optimum through-put and is controlled by the particle size. The higher the settling rate, the greater the optimum through-put. Data indicates a through-put of 16-18 pounds/ft.2/min. is desirable. The design of the column must be based on this parameter, as once the column is built there is no practical way to change the through-put. The typical diameter is from 12 to 16 feet. The original columns built feel somewhat short of this through-put and are of larger diameter.

The spargers introducing the wash water are generally of two designs; radial and circumferential. The ring type circumferential spargers do not obstruct flow and are particularly helpful in keeping solids from building up on the cone. The radial spargers are used to insure an even distribution of wash over the cross-section area. Sparger design is one of the most significant factors in preventing channeling.

The feed distributor is located at the top of the column and can either be a through arrangement with slots cut in the bottom or simply a tee with the outlets horizontal. Both systems are in use and seem to be satisfactory.

In some columns, particularly at Louisiana and O.C.D., a channel breaker has been placed in the lower section of the columns. This is an inverted cone of smaller diameter than the vessel, centered in the vessel. It is sometimes referred to as a "Chinese Hat". Its use is debatable and not all the data involving it is understood.

IV. Materials of Construction

The material of construction of the salt columns is primarily carbon steel. This is acceptable as the Caustic concentration is less than 20% and the temperature of the feed and overflow is 90 °C but the temperature drops considerably below the bed level. In D-205 column, a nickel cone has been used on the bottom of the vessel to help combat the pitting corrosion. This nickel / carbon steel interface, however, promotes galvanic corrosion and Cathodic protection is necessary. The feed distributor is usually fabricated from nickel to prevent corrosion. It has small supporting members and is particularly vulnerable and would cause a shutdown if dislodged from its support.

V. Instrumentation

Instrumentation of a salt column is important for successful operation. The interface or bed level must be known and controlled. There are two common ways of detecting the bed level. A system of using a dip leg from the top of the column is sometimes used. Small amounts of water and air are purged down the dip pipe and the resulting pressure is recorded using a standard differential pressure cell. The most reliable and common method consists of a series of thermocouples measuring a temperature profile vertically in the column. An abrupt change in temperature between two points is the result of the lower temperature point being in the bed of salt.

The flow of condensate to each sparger has a flow recorder-controller. This under flow slurry line also has a condensate wash line that is flow recorded-controlled to maintain a pumpable slurry.

Magnetic flow recorders are normally used on the feed slurry lines and the under flow slurry. Orifice meters suffice for the clear overflow and condensate washes. No direct control of the feed or overflow is used as this is determined by the rate the evaporators are run and consequently the amount of solids formed.

VI. Operations

Controlling the operation of the salt column is accomplished by using two data points. First, the bed level must be maintained at a constant level, usually near the top of the vessel. This is accomplished by controlling the brine carrier flow, removing more or less to lower or raise the level. Experimentation or trial-and-error is the best way to determine at what level the bed should be maintained in a specific column.

Second, the clear liquid from the under flow slurry should be analyzed for NAOH on a routine basis, twice a shift for example. This result is used to adjust the water flow to the spargers. How much change and in which sparger is a decision that must be made on experience.

Usually the radial spargers will affect the quality of the under flow more than the circumferential spargers. The distribution should be as follows:
Bottom Sparger: 7.1%
Third Sparger: 21.4%
Second Sparger: 47.6%
Top Sparger: 23.8%

The total flow is set according to the steam rate, at about 338 gpm at 620 mlbs/hr ST-4 steam to HE-201. This is done using the Micro VAX reading the steam rate and then setting the sparger rate set points on the TDC.

If the system is on computer control, it can be put on auto or manual and adjusting flows as necessary. Auto controls each specific sparger flow, manual sets a valve position.

In the past, brine was used as the sparger liquid, however, sever corrosion occurred at the bottom of the column due to the presence of oxygen in the brine. Currently, condensate from HE-208 is used.

If the under flow caustic concentration cannot be controlled by adjusting the sparger flows, channeling is probably occurring. This can be corrected by "shocking" the column. This is done by momentarily stopping the feed and opening all the spargers or levitate it and allow the solids to resettle, filling any channels.

A material balance around the column is helpful in determining the condition of the column. This can be accomplished by careful analysis of the feed, overflow, and underflow, including the solids concentration in each. From the analytical data plus the flow rates, the material balance can be calculated. The ratio of wash water to NaC1 removed or water added to the evaporator divided by NaC1 removed should be 0.2 or less.

VII. Maintenance

The most common problem other than operational problems is with the spargers. They are prone to becoming plugged or in some cases broken. This usually can only be fixed during a shutdown.

If the water used for washing in the spargers is not deserted, serious corrosion to the vessel walls will occur. Deep pitting resulting in leaks in the walls occurs, and down time to patch is a result.

A preventive maintenance program for the instrumentation is a large contribution to successful operation. The instrument package is quite large on a salt column and can easily be neglected. The importance of knowing the data for operations cannot be overemphasized.

VIII. Trouble Shooting

There are many variables which affect the proper operation of the salt column. The symptom of almost all of these problems is the same.

A. Problem: Caustic in D-205 bottoms is greater than 1%

1. Cause: Level of salt bed is either too high or too low.

Solution: If the d/p cell level indication is questionable, the level can be checked by temp probes shown on CRT or PIC.

2. Cause: Salt bed caking up in some places causing channels to form in the salt.

   Solution: Channeling can either be caused by the temperature of the condensate being too low or the wash rate being too low or high sulfates in the feed. If channeling in column is suspected, run the column with a high wash rate (≈.4) until this problem is corrected. Two hours should be sufficient time to correct the problem with 105°F. condensate.

3. Cause: Improper water distribution to the sparger rings is also a problem with the column. The top ring is either open too much or not enough.

   Solution: Make sure column is on computer control.

4. Cause: The settled volume in the feed from T-204 may be too low.

   Solution: If the feed is lower than 60-80% SV NaC1 lower the feed rate to the column.

5. Cause: NaOH concentration in the feed from T-204 is too high.

   Solution: Cut back on cyclone bottoms.

May 6, 1993

To: Operations

RE: Time delay on D-207A level control

The time delay on D-207A level control was changed from 60.68 seconds to 0.0 seconds. This time delay affects not only D-207A control but CPE pH reading. Both are controlled from box 22 slot 2. Once the time delay was initiated the pH reading on CPE outfall fell to normal readings; thus resolving the pH problem. Keep an eye on D-207A to see how this change affects the column control. Maybe this has something to do with the persistent problems in D-207A.

Jeff Harrison

Operating Discipline:	Salt Removal and D-205 Salt Column Operation
Revisions:	Adopted Texas Caustic 1 information for columns added SC-211/212 references
Developed:	5/25/93
Revised - Date:	5/25/93 & 1/5/94
By:	Ray Brown, Jeff Harrison
Approved:	Sam Boudreaux
Title:	Salt Removal and D-205 Salt Column Operation
Date Approved:	1/7/94
Key Words:	Operating Discipline, Evaporators, Salt Removal, D-205

Condensate Recovery System

N:\BRIAN\

A. General Description

During evaporation, entrained caustic and salt are removed from the overhead vapor stream by either internal or external mesh pads on each of the evaporators. This vapor is then condensed in heat exchangers connected to the overhead vapor lines. The condensate streams from each of the heat exchangers (and the 3rd and 4th effect surface condensers) are recovered and either returned to the power plants for boiler feed or used internally to the plant for salt removal (washing) and for salt column operation. Generally, the condensate recovery is 2 lbs condensate for each lb of steam used (8 lbs condensate per lb of caustic produced). Typical return rates to power are 2100 to 2800 gpm. Refer to the diagram on the last page for an overview of the system.

Condensate is recovered out of each heat exchanger and surface condenser in the evaporator area. Each exchanger or condensate tank outlet has a conductivity probe which will test the condensate for the presence of caustic. Based on the reading, the condensate will either be sent to Power (or CT-1) if good or be sent to the flume if bad (or if real bad will dump to T48). If a probe appears to be operating unreasonably, we can use a hand held conductivity meter to check condensate and determine if the condensate is good or bad, and if the micro mhos meter is working properly.

B Condensate Return To Power

The Caustic plant has 2 lines which return condensate back to the power plant. One line comes off CT-1 and the other directly from the heaters and in line condensate tanks.

<u>CT-1</u>: P-201 CTA&B pump condensate from CT-1 to Power I. These pumps also feed both the Sundyne pumps P-201 CTD&E and the 6" condensate line to the finishing end. CT-1 is level controlled and has two conductivity meters on the pump discharge line. CT-1 gets condensate from CD-203, CD-204 and a control loop on the 2nd deck of E-204 west side. This line makes-up the level into CT-1 from the header to Power 1 off CT-203 to keep the level above 50%. The flow on the line to Power 1 from CT-1 is shown on TDC group 57, FR 1351.

<u>Hot Condensate to Power:</u> The other line (east line) comes out of CT-203A and is pumped directly to Power 1. CT-203A receives condensate from the good condensate headers off of the following condensate tanks:

1. CT-202A

2. CT-205
3. CP-204A
4. CD-204
5. HE-203A
6. HE-203B

The total flow for this line to Power 1 is shown on TDC group 7, F1 1876... This line is pressure controlled or is on TDC group 7, PRC 1878.

C. High Pressure

Hot and cool condensate system in the caustic plant is set up on 2 headers fed off P201 CTD and P201 CTE. These headers are cross tied on the discharges of the Sundyne pumps.

The high pressure hot condensate header is used for the steam desuperheaters in the evaporators.

The high pressure, cool condensate header come off the Sundyne pump through the HE-209 tube and shell exchanger. The condensate on the shell is cooled to between 110° and 125° by river water on the tubes. The river water is manually adjusted in the field to control the temperature of the condensate. The pressure is controlled on TDC Group 8, PRC 1401 with the set point at about 200 psig and by manual bypass on the pressure control loop in the field. The cool condensate is used for the following .

1. Purges on circulation pumps in evaporators.
2. ANSI pump purges through out plant
3. For washing cross exchangers
4. For washing some slurry lines
5. Hot condensate drops in finishing area of plant
6. Liquid ring vacuum pump rings seal water
7. Instrument purges
8. E-201 and E-204 overhead desuperheaters

During Plant outage this system can be switched from condensate to process water by switching air operated valves from condensate to water at I beam north of Sundyne pumps.

D. Low Pressure Cool Condensate

The low pressure cool condensate uses bad condensate from CD-203, HE-203A, HE-203B, CT-202 and CT-203. In all cases, it must be manually routed into this header and sent to HE-208 where it is cooled to about 115°F using river water.

Because of the location of the take-off from HE-203B (before the LCV), extra care must be taken when starting up so that a level may be built in CP-203B. It is suggested that the valve remain closed until we are running before routing any bad condensate to HE-208 for HE-203B.

The low pressure cool condensate is mostly used in the salt columns, D-205 and D-205 for sparger flow. It is also used for CF condensate washes, DME-201 and DME-1B demister washes. The demister washes for E-203 and E-202 can be on either this header or the process water header.

D. Good and Bad Condensate

We have conductivity meters for each heater and condensate tank on the board, north end of the control room. These control on auto to keep the condensate going to power good by dumping bad condensate from each heater or surface condenser into the bad header, HE-208 or the flume.

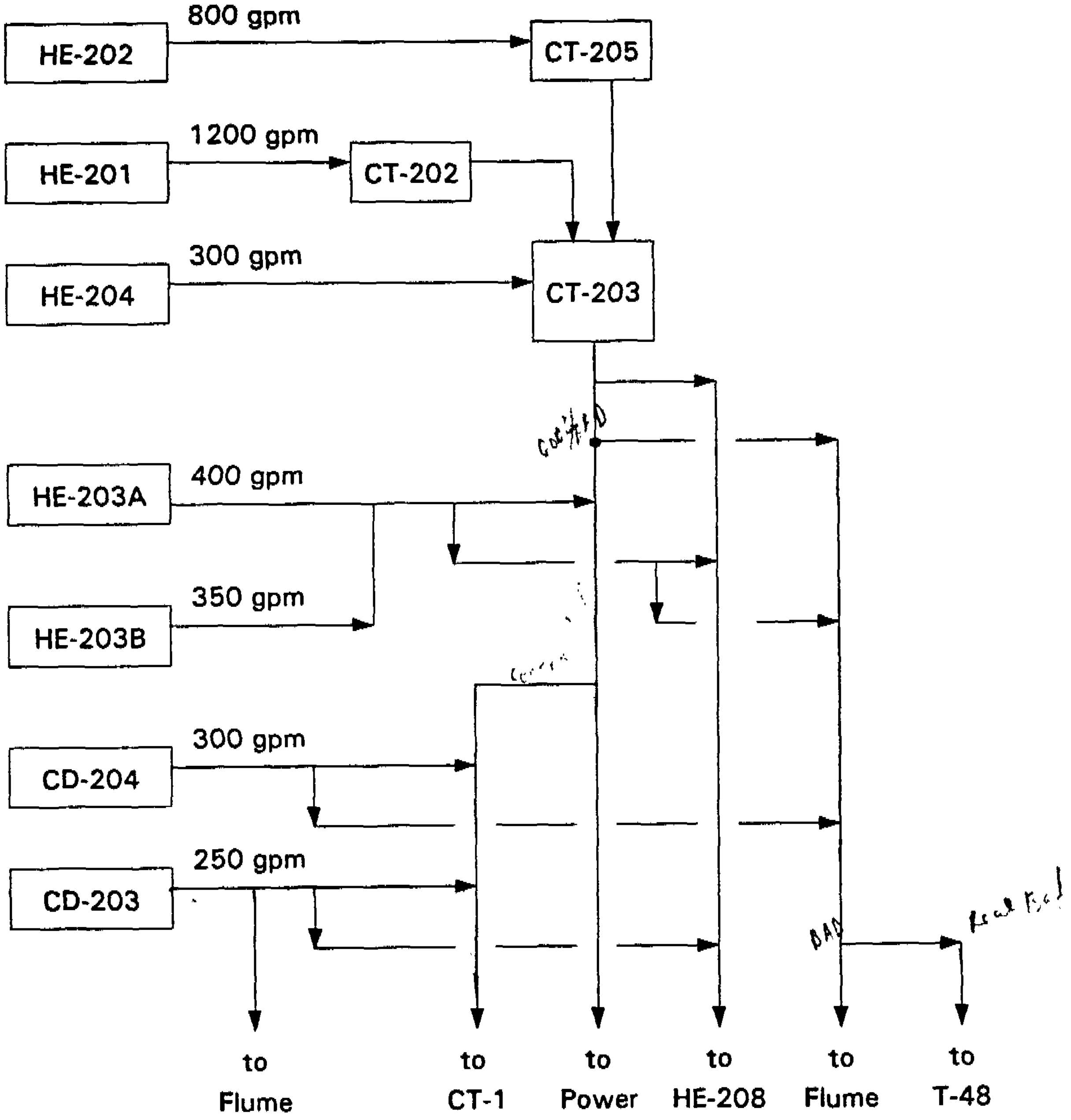
The location of the meters and set points are shown in the table below:

CT-1	10 set point to dump
CT-2	10 set point to dump
Train 2 Line	10 set point to dump
Train 2 Backup	10 set point to dump
CD-203	15 set point to dump
CD-203 H1	Shows real high conductivity
HE-201	10 set point to dump.
HE-202	25 set point to dump
HE-203A	10 set point to dump
HE-203B	10 set point to dump
CD-204A	10 set point to dump
CP-204A	13 set point to dump
CT-203A	10 set point to dump
CT-203A Backup	10 set point to dump

Bad condensate is generally sent to the flume, where the excess alkalinity is neutralized. When this is not possible, it is sent to T-2.

Each of these meters can be set on auto, dump or manual, but most of the time they are set on auto except when they keep going from bad to good, then they are set to dump to keep the alarm off. The conductivity of each heater or surface condenser is also shown on TDC groups 91, 107 and 108.

Caustic 1 Condensate System



DO 127091
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Operating Discipline:	Condensate Recovery System
Revisions:	
Developed:	Ray Brown
Revised - Date:	1/5/94
By:	Brian Pankow
Approved:	Sam Boudreaux
Title:	Condensate Recovery System
Date Approved:	1/7/94
Key Words:	Operating Discipline, Evaporators, Condensate

DO 127093
CONFIDENTIAL

Centrifuges and Sulfate Salt Removal

A. Introduction

The objective of the sulfate removal system is to remove all sulfate from the 50% caustic and in doing so the remove the salt from the 50% caustic to a level so that our polishing filters can perform properly.

B. Description and Process Equipment

General - The sulfate removal system consists basically of tanks T-203, T-218/228, T-219/229; T-246; D-207 salt column; two bird centrifuges, CF-1/2; and pumps P-203TA&B, P-218TA&B, P-219TA&B, P-207DE&DD and P-246TC&TD

T-203 receives the 50% caustic containing sulfate and salt from E-204. The clear liquor over from T-203 goes to T-218/228. The bottoms from T-203 is fed to the bird centrifuges. The bird centrifuge uses centrifugal force to separate the caustic from the salt. The clear liquor is removed from one end of the centrifuge and the salt cake at the other end. The clear liquor falls into T-218/T-228 where it is also pumped to T-10. The salt cake falls directly into T-219/229 with a cell effluent wash. The salt slurry enters the top of D-207 and the salt falls to the bottom of the column while the caustic, cell effluent and sulfate is washed from the salt in counter current fashion on over the top of D-207 and into T-246 where it is pumped then to T-2 and out of the caustic block. The salt that falls to the bottom of D-207 is virtually caustic free and it is then pumped to the Chlorine Plant.

During normal operation of sulfate removal the following are the average flows and level set points.

1. Feed out of T-203 bottoms ranges from 120 -160 GPM to the centrifuge. Try to achieve 50-70% S.V.
2. Feed out of T-245 bottoms ranges from 50 - 100 GPM to the centrifuge. Try to achieve 50 - 60% S.V.
3. Level setpoint at 35% on T-218/228.
4. Flow to T-10 out of T-218/229 375 GPM average.
5. Level setpoint at 30% on T-219/229.
6. Flow to D-207 out of T-219/229 310 GPM average.
7. Level setpoint for D-207A 30%.
8. Bottom flow out of D-207A 75GPM average.
9. Bottom temperature of D-207A should he equal to sparge water temperature. Usually 105°F - See group 8.

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10. D-207 sparger set points.

E-204	Total	Bot	3rd	2nd	Top
up to 250	75	11	23	26	15
250-300	80	12	24	28	16
300-350	85	13	26	30	17
350-400	90	14	27	32	18
400-450	95	14	29	33	19
450-500	100	15	30	35	20
500-550	105	16	32	37	21
550-600	110	17	33	39	22

11. Level set point at 50% on T-246A.
12. Flow from T-246A is 250 GPM to T2. Be sure T-219/229 level switch is set on the tank which is recieving the salt from the centrifuge being fed from T-203.
13. CE or Cond flow into each - shell 45 GPM Min. Max 80.
14. CE or Cond flow to each - chute 15-20 GPM Min. Max 60.

T-203, Hot Salt Settler

The hot caustic from E-204 is pumped to T-203 with the flow being controlled by the E-204 K.R.C. control valve. This valve is controlled by the concentration control program on E-204 and flow to T-203 is adjusted to meet a concentration set point in E-204. Increased flow will lower the concentration and visa revsa typical flow to T-203 ranges from 350 - 500 GPM with 600 M#/HR steam on the plant.

T-203 Hot Salt Settler Discription.

20' Diameter 27' 10" height
cone shape carbon steel
alloy clad nickel weir 10" deep
6" over flow to trench system with high level probe
8" overflow from bottom of weir into T-218
4" suction at cone bottom to P-203TA&TB feed to T-203 out of E-204 400 to 570 150 GPM out bottom to bird centrifuge.
250 to 420 GPM overflow into T-218 these rates are at 600 steam rate on evaporator.

A salt bed is maintained in the column and usually occupies 40% of the total capaity. As the salt settles out to the bottom of the column, it is pumped to the centrifuge. If the column is operating properly, this flow should be about 50-70% settled volume salt. Adjusting the amount of settled volume salt I.E. increasing the flow will decrease the settled volume. With the salt settling to the bottom of the column, clear caustic should be overflowing into the weir of the tank. An analysis of the stream should show no settled volume salt.

T2-4 Hot Salt Discription

CF-1/2 - Bird Centrifuges

CF-1 & CF2 are a 36" X 72" solid bowl continuous feed centrifuge. This machine takes the salt slurry from T-203 Bottoms and further separ ates the salts and sulfates from the 50% caustic. The bottom flow from T-245 is pumped to CF-1 or CF-2. The caustic and salt slurry enter CF-1 or CF-2 and are separated by centrifugal force. These two streams fall into two hoppers directly below the centrifuge, where they then gravity feed to two (2) holding thanks. Cell effluent or condensate is added to the outside of the bowl on the salt end of CF-1/2 and to the salt hopper to pervent a salt buildup at these two (2) points. The addition of the cell effluent to the bowl is critical in that a salt buildup around the outside of the bowl will result in the motor turning the bowl pulling too many AMPS, thus tripping the machine. It should also be added here that a buildup of salt inside the bowl will result in the machine being highly torqued, again possibly tripping the machine. Both torque and AMPS on CF-1 or CF-2 are monitored in the control room. On TDC group 19&20.

Alarms and trips: On scan north end of control room.

- LO Torque - Alarms as machine approaches maximum torque capacity.
- LO HI Torque - Shuts down feed to CF-1 or CF-2; machine continues to run.
- HI HI Torque - Shuts off feed and trips the machine.

CF-1/2 are also vibration monitored on TDC groups 80 - 81 for CF-1 and CF-2 respectively. The south vertical vibration probes are the probes that are alarmed. A normal range of vibration is 2-8 mils. The alarm print is set at 12 ,mils and the centrifuges should be washed if this alarm is realized. Follow procedure for normal centrifuge washes or slow roll centrifuge washes. Both procedures are on the document range.

Oil Mist Lubrication System:
The main roller bearings are lubricated from the lubrimist oil system. Mobilube SHC-629 is the oil used in this misting process. The air pressure should be regulated between 18-20 lbs. At the field station there is a red light for malfunction and a green light for okay. In the control room the scam alarm on the northeast panel warns of high/low mist flow and high/low oil level. At each misting drop on CF-1/2 there are petcocks that should be bled down each shift to eliminate any accumulated oil. Regal 220 is the lubricant for the gear unit, while lubriplate grease no. 1242 is used in the thrust, trunion and conveyor bearing.

Sulphate pruge: CF-1 and CF-2 Bird centrifuge, continuous solid bowl

Size:	36" X 72"
Feed rate:	130 - 200 GPM, 200 Optimun, 300 Max
Solid salt in feed:	35%
Temperature of feed:	200 degrees F
Pool depth:	1inch
Beach Angle:	10 degrees
Conveyor lead:	12", double, left hand

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Gear Unit:	40/1
Drive Speed:	1200 rmp
Main bearing lube:	Circulating system
Salt slurry:	30 gpm, sent to Cell Effluent users

Collection Tanks for CF-1 & CF-2

T-218-T-228 -T-219 and T-229 description 6' diameter 8' height closed top except for chute from bird centrifuge T-218 and T-228 have clear liquior and T-219 and T-229 has salt and condensate carrier. Each tank has level purges and T-218 and T-228 has common suction to P-218TA or TB and T-219 and T-229 has common suction to P-219TA or TB.

There are condensate tie ins on the bottoms of T-219/229 salt collection tanks. Purpose of these tie ins is to allow operations the capability to wash salt cake out of these vessels. See Sulfate Start-Up Procedure (413KB01A.DOC).

D-207 Sulfate Salt Column

T-219 or T-229 feeds this column from CF-1 or CF-2. The salt is washed with four sparger rings and the sulfates are washed over head into T-246 which is pumped to T-2 then to C.E. users. The salt is pumped out the bottom of column and returned to CL_2 by the D-205 pumps. We have temp probes every foot in this column to show where the interface is in it.

7' 6 7/16" cone shape bottom
13' 11 3/4" high sides
21' 5 3/16" height
9 foot dia.
4 sparger rings

D-207 salt bed is controlled by one of two level meters on groups 16 & 17 in the TDC. The bed level should remain between 30 & 40%. This is to prevent salt overflow to T-246. The bottoms flow should be < 1.0% NAHO. The spargers are computer controlled on the TDC, taking ratios of the total sparger flow-proportional to E-204 forwarding rate and calculations set points for each sparger. Equations are as follows: (A chart of the distribution is shown in the description section)

Total = 35 + (0.01) x (E-204 Forwarding Rate)
Bottom = 2.485 + (0.0071) x (E-204 Forwarding Rate)
3 RD = 7.490 + (0.0214) x (E-204 Forwarding Rate)
2ND = 16.66 + (0.0476) x (E-204 Forwarding Rate)
Top = 8.33 + (0.0238) x (E-204 Forwarding Rate)

If the forwarding rate out of E-204 is less than 250 GPM, the computer will automatically assume it is 250 GPM and calculate the sparger distribution as shown on the chart. This is to prevent a low flow situation in the column.

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% NAOH IN C.E. VS % NACL AT SATURATION

% NAOH	% NACL @ SATURATION
7.0	20.40-20.32
7.2	20.24-20.16
7.4	20.08-20.00
7.6	19.92-18.84
7.8	19.76-19.68
8.0	19.60-19.52
8.2	19.44-19.36
8.4	19.28-19.20
8.6	19.12-19.04
8.8	18.96-18.88
9.0	18.80-18.72
9.2	18.64-18.56
9.4	18.48-18.40
9.6	18.32-18.24
9.8	18.16-18.08
10.0	18.00

Operating Discipline:	
Revisions:	5/93 - Removed references to flat bed filters updated operating parameters to current values referenced E-204 concentration control for flow control to T-203 10/93 - Changed some operation parameter on the description. Added sparge distribution chart and computer control logic. Added centrifuge vibration alarm data.
Developed:	
Revised - Date:	5/93 10/93
By:	Ray Brown / Glenda Townsend / Jeff Harrison
Approved:	Sam Boudreaux
Title:	Centrifuges and Sulfate Salt Removal
Date Approved:	1/7/94
Key Words:	Operating Disipline, Finishing, sulfate removal, centrifuges

Cooling, Settling and Polishing

Introduction

The objective of this system is to cool the 50% caustic, causing the salt to settle out of the caustic and thereby making it possible to feed the polishing filters with caustic containing approximately 1.3% salt. In doing so the polishing filters are able to remove the salt from the caustic down to less than 1.0%, thereby meeting the sales specification of 1.0%. The caustic leaving the sulfate removal area typically has a salt content of 2-3%.

The reduction of the salt is accomplished using holding and surge tanks, heat exchangers, settling tanks and a salt crystal growth tank, as well as pumps and other related equipment.

As a typical caustic-salt solution is cooled, the salt in the solution becomes less soluble. At 150 °F, a caustic solution could contain as much as 2.0% soluble salt while at 80 °F, this number would decrease to almost 1.0% salt. For this reason the caustic leaving the sulfate area goes through successive cooling and separation stages in order to remove the excess salt from the caustic solution.

These stages consist of the following equipment:

1. Pre-coolers (HE-20A&B).
2. Coolers (HE-205A/B/C/D & HE-204A/B & HE-15A/B)
3. Clarifier / settling tanks. (T-245, T-10, T-20)
4. Cooling / Cross exchangers (HE-222A, HE-4A/B, HE5A/5, HE-6A/B)
5. Caustic chillers (HE-206A/B, HE6C/D/E/F)
6. Sparkler filters (F-211A/B/C/D/E/F)

The coolers and chillers are shell and tube heat exchangers which serve to lower the temperature of the caustic passing through them. The clarifier and filters are both separation processes in which some portion of the salt is removed from the 50% caustic. Each of these processes are discussed in further detail in the operating discipline section covering each.

A. Pre Coolers - HE20A&B

Description: Hot caustic from T-218/228 is sent to T-10 via the HE-20A/B exchangers. The precoolers are shell and tube exchangers through which the caustic flows in series and is cooled by cell effluent to the evaporators flowing in parallel. Caustic enters the exchangers at 180 °F and exits at 148 °F. Cell effluent enters at 135 °F and exits @ 148 °F. This increase in cell effluent temperature has a substantial favorable impact on evaporation energy requirements. The precoolers should have preferrance over the coolers when there is excess cooling capacity.

Precoolers can be washed automatically by using the Modicom or manually in the field. The wash is triggered by a high level reading in T-218/28

B. T-10 and Forwarding Pumps to Cooling Area

T-10 is a 20' diameter and 32' high carbon steel feed tank for the cooling area of the plant. T-10 is fed from the overflow of T-203 and the two bird centrifuges. The level is on the T.D.C. group 22 LRC-7003 and is controlled by the amount recycled off the coolers and amount going to T-245. T-10 temperature out of tank is 144° shown on T.D.C. group 40 TR-3012.

The coolers are fed by either P-210TC or P-210TD out of T-10. Production spec. on this process tank is 49.0% to 51.0% caustic.

C. Booster Pump

Booster pumps on the coolers are tied into pump trips on Modicon meter page 18.

P-205D trips when pressure exceeds 190#
P-205C trips when pressure exceeds 210#
P-205A trips when pressure exceeds 225#
This will prevent over pressing the system.

Instrumentation is located on groups 44 and 39 on the TDC.

HE20A&B Description	24" Diameter X 215 5/8" length
Carbon steel shell	Tubes = 16' X 1"
Nickel Tubes	Area = 1100sq. ft.
Nickel-clad heads	
150 PSIG - Shell	
300 PSIG - Tubes	

D. Caustic Cooling (Primary Coolers- HE204A/B - HE-205 A/B/C/D & HE-15)

Description: The caustic coolers, also commonly referred to as the primary exchanges, consist of 8 shell and tube heat exchangers: HE-204A&B and HE-205A/B/C/D&HE-15A/B.. Caustic feeds the exchangers from T-10, passes through the tubes of the 2 pace exchangers and is cooled by river water passing through the shell side on 6 of the 8 exdrangers, excluding HE-15A/B. The last two exchangers HE-15A/B (short-term coolers) utilize spent chilled water from the chillers and are utilized only in the summer months due to a lighter heat load. The caustic flow to the exchangers are controlled by the recycle and the forwarding control valves. The control valves react to the level in T-10, the recycle on cascade and the forwarding valve on automatic. In this scenario, the flow through the coolers is maximized with same recycle. This control aids in shorter wash frequencies (lighter tube velocity), cooler feed from T-10 (recycle some cooled caustic) and eliminates back pressure on the system. Three booster pumps are located in the system P-205HEA/HEC/HED. The booster pumps help maintain flow as the salt fouls the tubes. P-205HEA feeds HE-205A, P-205 HEC feeds HE-205C and P- 205HED feed HE-205D and also feeds HE-15A/B when on-line in the summer.

The exiting temperature of the caustic is controlled at 95°F by the amount of river water fed to HE-205D and the spent chilled water to HE-15A/B during the summer when on-line. This river water fed to the other exchanger, is controlled manually. As the caustic is cooled in the exchangers, a scale forms on the walls of the tubes. This scale forms on the walls of the tubes. This scale-up causes a decrease in heat transferred across the tubes and more cooling medium (river water/spent chilled water) must be used to maintain the caustic outlet temperature at 95°F. At some point as fouling increase the control valve for the river water and/or the control valve for the spent chilled water will be open 100% and the outlet temperature will begin to rise above 95°F. At this time the caustic flow must be stopped and the coolers washed with hot condensate to remove the salt scale from the walls of the tubes.

The caustic coolers are washed by shutting off the caustic forwarding valve out of T-10 and adding condensate the coolers. The condensate dissolves the salt off the tube walls as it flows through the coolers. As the condensate flow through the coolers, it pushes the 50% caustic in front of it. When the condensate leaves the final cooler, the flow is routed to T-1. This point can be determined by measuring the temperature of the liquid. As the condensate dissolves the salt, it increases in temperature due to the heat of dilution. This temperature spike can be used to determine the caustic to condensate shift. The temperature will then quickly drop off and approach the river water temperature. This temperature will be lower than the previous caustic temperature because the water is less viscous and has an increased heat transfer rate. These temperature profiles can be used to efficiently wash the coolers by optimizing the times for swapping valves thereby reducing caustic losses to T-1, reducing caustic dilution, and reducing the amount of condensate used during a wash. All these factors will improve plant operating efficiencies. See Cooler Wash HE-204A/B, HE-205A/B/C/D&HE-15A/B procedure on document manage. The procedure describes steps for manual and automatic washes.

May 19, 1993

To: Caustic Personnel

Re: New control scheme for coolers

The following is a proposal for a new control scheme for the primary coolers. This experimental project would be implemented after the start up of the new spent chilled water coolers (HE-15A/B). The scope of the project has two following objectives: 1) Eliminate the potential for over-pressuring the system, 2) maximizing the recycle to T-10, providing higher velocity in the first six exchangers and potentially decreasing the current wash frequency.

See the attached flow sheet the upcoming description. First of all, we have always had the potential to over pressure our primary cooling system. This is due to the exchangers running in series with three pumps running. Pressure in a system in series is cumulative and as we begin to foul the tubes the pressure begins to increase. Currently this is one indication to wash the coolers. The proposal suggests taking the third booster pump (P-205HED) off line and running the HE-205's in parallel. Coupled with the new six inch line to T-245 and the exchangers running in parallel, there should be no need to run the third pump to maintain the same flowrate. This has been reviewed with process engineering with confidence to test this theory on an experimental basis. For the experiment we will monitor Temp out of the exchangers and Press off the P-10 pump, P-204HEA pump and the pressure out of HE-205D.

In order to maximize the recycle to T-10 we will utilize two reverse acting control valves. The first valve (recycle) will have a higher setpoint than the feed forward valve to T-245. Therefore, the recycle will remain 100% open allowing as much flow as possible back to T-10. The outlet control valve to T-245 will still maintain a setpoint of 35% level in T-10. With a maximum flow of 800 gpm through the coolers, our forwarding rate will still be the plant running rates (app. 450 gpm) with the balance recycling to T-10. This will increase the velocity through the coolers. This technology is currently being used in Germany and has shown success (i.e. decreases wash frequency). The outlet temperature will be controlled by the spent chilled water control valve feeding the last two coolers (HE-15A/B).

As mentioned before, this project will be on an experimental basis. All of the piping and valves exist to perform the necessary alterations. Initially, we should try the project on an incremental basis, i.e. start the recycle at a slow rate and increase will maintaining control of outlet variables. If you have any questions or concerns contact me.

Jeff Harrison
x8075

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Caustic Communiqué
To: Caustic
From: Vernon Darling, ph:8035
Date: June 11, 1992
Subject: Caustic System T-10 Coolers TDC Control

What is the control scheme?
The cooler scheme involves two valves which control the level in T-10. The recycle valve is controlled by LRC-70034; the forwarding valve is controlled by LRC-31053. Both valves control T-10 level.

Where are the controllers located?
Both controllers are on the TDC.

How is T-10 level controlled?
Controller Actions -

The two level controller action are opposite. The recycle valve closes to decrease level, while the forwarding flow valve opens to decrease T-10 level. When the level goes too high (above the LRC-31053 SP), TDC increases the forwarding flow. If the level continues 10% higher (above the LRC-70034 SP), TDC decreases the recycle flow which will effectively raise the pressure and send more forwarding flow.

Setpoint Offset -
The recycle level setpoint is automatically set 10% above the forwarding flow level setpoint. For instance, if the operator sets the forwarding flow level setpoint = 50%; then the recycle level setpoint will automatically be set = 60%. This configuration will maximize the recycle flowrate which should help the cooling.

How does the operator interface with this system?
The TDC should normally be set as follows:

LRC-70034 in CAS mode
LRC-31053 in A mode
T-10 level SP is set with LRC-31053

The operator can change the mode of T-10 level controller LRC-70034 to:

1. CAS (Cascade Mode) Recycle level control is active; gets remote level SP from LRC-31053 = and adds 10%.
2. M (Manual Mode) Recycle level control is not used; TDC is using local valve % SP

The operator can change the mode of T-10 level controller LRC-31053 to:

1. A (Automatic Mode) Forwarding level control is active; uses local level SP from LRC-31053.
2. M (Manual Mode) Forwarding level control is not used; TDC is using local valve % SP.

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Target Temperatures and Operating Parameters

Coolers
Outlet temp of each exchanger.
Group 40 on T.D.C.

HE 204A	114°	(112-115° Target)
HE 204B	113°	
HE 205A	106°	(100-105° Target)
HE 205B	102°	
HE 205C	99°	(95°F Target)
HE 205D	95°	

During normal operating conditions in the cooling and chilling area of the plant the controls on the T.D.C. should be set by the board person as per following list.

Group 22 T.D.C. Coolers

1.	LRC	7003	T-10 level	40%
2.	T.R.C.	7030	HE-205 D temperature	95%
3.	FRC	7010	Flow thru coolers	700 GPM average
4.	FR	7003	T-10 to T-245	450 GPM average
5.	PI	31200	HE-205 pressure to T-245 - 228	

Group 21 TDC Chillers

1.	LR	7000	T-20 level	68%
2.	TI	3120	T-20 temperature	92°
3.	TRC	7142	HE-6 temperature out	70° average
4.	TRC	7146	HE-206B temperature out	75° average
5.	FRC	7104	Flow thru chillers	480 GPM average
6.	FRC	7105	T-20 to T-28 flow	420 GPM average
7.	TI	7137	T-20 recycle temp	70° average

Other controls for cooling & chilling are on these groups on the T.D.C.

Group	68	ARU-204 controls
Group	69	ARU-205 controls
Group	70	ARU-204 and 205 and chill water from T-11

These are covered in ARU operating procedure and T-11 and chill water pump procedure.
Group 40 shows the temperature of each cooler.

Equipment

HE-204A/B, HE-205 A/B/C/D Description
106 Nickel tubes (per unit) - 1.25" OD x 16 BWG x 16', 1 9/16" pitch Carbon steel shell (Ni clad shell on tube side)

4 - with twisted tapes	(6" pitch)	2 pass
tube velocity:		2.46 - 3.38 ft/sec
2 - without twisted tapes		6 pass
tube velocity:		7.38 - 10.15 ft/sec
Total cooling area:		3042 sq ft
Cooling range:		140 - 95 degrees F
Caustic flow range :		400 - 700 gpm
Wash fluid:		condensate
Wash frequency		6 hours
Wash duration:		6-10 minutes
Wash rate:		275 gpm (estimate)
Reason for wash:		Heat transfer
Caustic downgraded:		5000 lb/day (estimate)
Wash sent to:		Cell effluent users

River water silt build-up on shell side must be removed bi-annually by acidizing with inhibited HCL and HF. This problem would be eliminated by use of a different cooling medium such as process water or ARU chilled water.

As an alternative to washing, quick "shots" of condensate are sometimes used to restore heat transfer lost due to salt precipitation. In this case the diluted caustic is sent down line rather than downgraded. The frequency of shots is grater (3-4 hours) but the duration is less (2-3 minutes).

July 20, 1993

To: Charles Jackson

cc: Brian Pankow
Rick Lemelle
Tony Spears

Re: Asset Utilization Project -- Chiller De bottlenecking

Prior to the June 1993 shutdown, an investigation was sparked to determine why the chilled water capability was limited. The main concern for the limitation was due to the fact that Caustic I was experiencing all time high rates. We realized the chilling system would not suffice; and we would have to cut rates as the summer temperatures grew hotter. Therefore, we experimented and performed calculations to determine why the capability was unreasonably low for the existing piping system. Both prior to and during the shutdown, several items of interest were found and corrected. These include piping modifications, feed and return valve operation and the commissioning of two new primary coolers (utilizing spent chilled water). Combining all of the changes gave the chillers a 50% increase in total chilling capability. As a result we have achieved total asset utilization of the ARU's. At present, Caustic I achieves 7.37 MM BTU/hr versus 4.93 MM BTU/hr before asset utilization was achieved. We believe that these changes have allowed Caustic I to continue its present capability of 3.80 MM LB of production per day throughout the summer.

Initially, a 4" line was investigated by looking at pressure drop across several key locations. This data reconfirmed calculations and intuition that the flow through the chillers was low. Initially, we believed that the line was plugged with silt from a previous operation with river water. However, there proved to be no line limitations related to plugging. Therefore, we decided to replace a section of the 4" feed line from the 6" West header with a 6" line. When the 4" line was removed from the header, we discovered the problem. It appeared that a field cut made into the 6" West header was 2" too small. This 'limiting orifice' was the reason for the low flow to the two chillers, HE-206C/D. The 4" line was replaced with a 6" line and a proper flange was installed on the West header. This change removed much of the flow limitation.

After this problem was discovered, we decided to check the other two feed lines off the West header. Although no similar problems were found, another interesting bottleneck was corrected. A piece of a check valve was found wedged in the port connecting the feed line to the West header. This was promptly removed.

In addition to reevaluating the piping to the six chillers from the two ARU's, we also looked to increase our versatility of the feed/return valves. In the past, two of the six chillers were fed and returned from the West header (ARU-204), and the other 4 chillers were fed and returned from the East header (ARU-205). Opening all of the valves allowed us to feed/return all six chillers from both headers simultaneously, maximizing the flow through the chilling system.

Finally, two new spent chilled water coolers were put on line. The additional heat load from the two coolers absorbed a great majority of the increased asset utilization of the ARU's. Without the above mentioned changes, the spent chilled water coolers would have 'robbed' necessary chilling capability from the chillers.

Following are four cases demonstrating the chilling capability prior to and after the asset utilization project. In the four cases, enthalpy is compared to the maximum average production rate.

Case 1
Before any changes were made the chillers were responsible for achieving a delta T of 22 degrees in early June. At this demand, the chillers were removing 4.93 MM BTU/hr and enabled Caustic I to obtain a maximum average production of 3.4 MM LB/day.

Case 2
In late August the chillers would be responsible for achieving a delta T of 25 degrees. With no changes, the chillers would be only capable of removing 4.93 MM BTU/hr, thus limiting the daily maximum average production rate to 2.99 MM LB/day.

Case 3
After the feed/return headers were re configured, the chillers were then capable of removing 5.93 MM BTU/hr. This would allow Caustic I to maintain a maximum average production rate of 3.59 MM LB/day in August.

Case 4
Combining Case 3 with the two new spent chilled water coolers, the chilled water system is capable of achieving a total delta T of 29 degrees. This demand correlates to 7.37 MM BTU/hr heat removed and a maximum average production rate of 3.85 MM LB/day. This change in combination with a chilled water flow increase, allowed Caustic I to take advantage of total asset utilization of the ARU's.

In summary, the piping and valving changes (low cost) have removed a pre-existing bottleneck in the chilling system. Without these changes, Caustic I would have to remain at a maximum average production rate of 2.99 MM LB/day during hot summer months.

Those accredited to this project are myself, Brian Pankow and the two shift supervisors, Rick Lemelle and Tony Spears. If any further questions or concerns are realized, feel free to contact me at extension 8075.

Jeff Harrison
Development Engineer
Caustic I

NOTE: An attached plot demonstrates the chilled water capability as the changes were implemented.

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C. Clarifier - T-245 Salt Separator

Description: As the caustic is cooled by the primary exchangers, the solubility of the salt in the caustic decreases and salt crystals begin to form. This solution is then fed to the clarifier so that the newly formed crystals can settle out of the caustic. The clarifier is large to allow an extended residence time (approximately 20 hours) for the crystals to thoroughly settle since the viscosity of the solution is increased at the reduced temperature. The settler has a weir to allow the clear liquor to overflow to a catch tank where it is pumped to the chilling area. The salt slurry from the bottom of the clarifier is pumped back to the centrifuge where the salt and caustic in the slurry can be separated. The bottoms can also be pumped directly to T-2 when the centrifuge is not in operation.

Feed to the clarifier is controlled by the level controller on T-10 or by manually setting the flow control, but usually the former. The level of the catch tank is also controlled. The under flow from the clarifier is controlled such that the settled volume of salt in the slurry is maintained between 40 and 60%. If the settled volume is greater than 60% the under flow must be increased and decreased for less than 40%.

Manufacturer - Dorr Oliver

Diameter:	65 feet
Height:	16 feet
Depth of feed well:	6 feet
Speed of rake rotation:	0.11 rpm
Operating temperature	92 to 95° F
Solid salt in feed:	5 %
Solid salt in overflow:	0%
Solid salt in bottoms:	40-90%
Bottoms flowrate:	75-125 gpm
Clarifier bottoms pumped to:	Centrifuge

Although the weir salts up, this tank has been almost trouble free since 1979 when the rake got stuck. Weir salt is washed out during shutdowns.

DO 127111
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D. Cooling/Cross - Exchangers - Secondary Cooling (HE-222A, HE-4 A/B, HE-5 A/B, HE-6A/B)

Description: As the caustic leaves the clarifier through T-236 it must be further cooled so that the salt in solution will continue to crystallize. At the same time it is advantageous from an energy viewpoint to use the heat from this stream to the benefit of the plant. As seen later, the feed to storage via iron removal must be heated. Therefore this stream can be cross-exchanged with the flow from the settlers so that heat is transferred from the warmer stream to the cooler stream. Six shell-and-tube heat exchangers with 2 passes each are used for this transfer. They are HE-4A&B, HE-5A&B, and HE-6A&B. They are arranged in two sets: HE-4A, 5A & 6A and HE-4B, 5B & 6B and HE-222A, such that either or both of the sets may be bypassed as requirements demand. The caustic stream on the tube side of the cross-exchangers is fed from the T-236 pumps and flow into T-20. This flow is controlled by the level in the feed tank. The caustic stream on the shell side of the exchangers is fed from T-44, is flow controlled, and proceeds to the iron removal system.

Operating Parameters / Equipment Descriptions
HE 4/5/6 A/B

48 Nickel tubes (per unit) - 1.25" OD x 16 BWG x 12', 1 9/16" pitch Carbon steel shell (Ni clad shell on tube side)

6 - without twisted tapes	6 pass
tube velocity:	8.15 - 11.21 ft/sec
Cooling range, tube side:	100 - 95°F
Shell side:	75 - 85 °F
Flow	400 to 450 gpm
Total exchange area:	1014 sq ft
Wash fluid:	Condensate
Wash Frequency:	1-2/week
Wash rate:	200 gpm (estimated)
Reason for wash	Heat transfer & delta P
Caustic downgraded:	Minimal
Wash sent to:	C.E. users
TDC control groups	24 + 43

DO 127112
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T-20 and Forwarding Pumps to Chilling Area

T-20 is a 24' diameter and 32' high carbon steel feed tank for the chilling area of the plant. T-20 collects its level from the overflow of T-245 into T-236 which is cross exchanged with feed to iron removal to cool it before going to T-20. The level is controlled by the amount of recycle back to T-20 and amount of caustic to T-28 at 40% level on TDC group 21 or 24 LR 7100. The temperature out of T-20 is 92°F. going to the chillers. TDC group 21 T1 - 3120. The chillers are fed with either P-20TA or P20TB out of T-20 production spec on this process tank is 49.0% to 51.0% caustic.

HE-222A

HE-222A is a tube and shell exchanger with caustic from T-44 on the shell and caustic flow thru the tubes to cool caustic from T-236 going to T-20. The same as the other cross exchanger used for T-236 to T-20.

HE-222A Description
Carbon steel shell 24" diameter.
106 Nickel tubes 1 1/4" x 16'
N1 clad heads and entry box on tube side 508 square foot area - 2 pass on tube side over all length is 22'

The heat exchanger needs to be periodically washed on tube side to remove salt buildup. The wash is triggered by a high level in T-236. Washing the exchanger can be done automatically on the Modicom or manually in the field.

E. Caustic Chillers - HE206 A/B & HE6 C/D/E/F

Description: The final step in lowering the temperature of the 50% caustic occurs in the caustic chillers, commonly refereed to as secondary exchangers. Sales specifications for 50% caustic demand that the salt concentration be less than 1.00% while the plant goal is that the caustic be less than 0.98%.

The caustic leaving the clarifier usually contains about 1.20% salt at a temperature of 95 °F. Most of this salt is in solution. To enhance the crystallization of this salt, the temperature of the caustic must be lowered to 72°F. A portion of this temperature drop takes place in the cross exchangers, but the temperature is lowered to its final temperature in the chillers.

The chillers consist of six shell-and tube heat exchangers labeled HE-206A&B, and HE-6C,D,E&F. Each of the exchangers contain two passes with caustic passing through the tubes and chilled water passing on the shell side. The exchangers are organized in pairs such that any pair of exchanger can be bypassed for cleaning or maintenance. One inline pump between large and small exchanger. (See chiller diagram for further flow details.)

The chilled water used to cool the caustic can come from one of two sources. River water can be used when the temperature of the water is below 55°F. Should this temperature be exceeded, the chilled water is supplied by absorption refrigeration units (See ARU section), ARU-204 and ARU-205. Under normal conditions, ARU-204 would supply water for HE-206A&B, while ARU-205 would supply water for HE-6C,D,E&F (See following page). The inlet/outlet chilled water HCL valves were altered in 1993 to allow both ARU's to feed all the exchangers via east/west headers and the return can be routed the same way Each ARU feeds into a holding tank. The chilled water flow from this tank is controlled by the temperature of the caustic leaving the exchangers.

DO 127114
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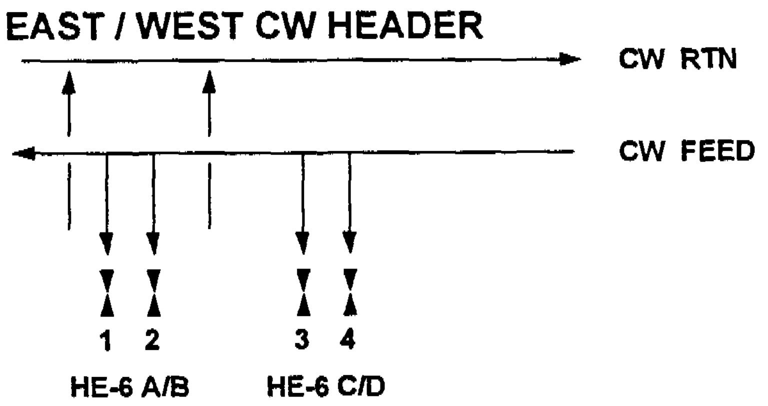
June 10, 1992

To: Caustic Operations
Re: Change to West Header (CW) valve operation

Much effort has been put into determining why the flow is restricted through the big chillers (HE-206A/B). Several experiments were simulated, while the plant was down, to pinpoint the cause of the restrictions. There were two scenarios found. One was on the 4" feed(CW) line to HE-206B in which a 2.5-3" opening for the 4" pipe was found. This has been corrected and the 4" pipe replaced with a 6" pipe. The other scenario increased the flow rate by almost double when all of the inlet and outlet valves were opened allowing the flow the go everywhere at once. With this in mind, the reverse acting EBV's on the inlet and outlet to HE-6C/D/E/F were altered to operate independent of one another. This will also provide greater flexibility when operating the chilling section of the plant. See drawing...



The valves 1,2,3,4 should all be in the open position. This will allow the maximum amount of flow to the chillers. If too much cooling is realized, then close the HE-6s as needed.

Thanks - Jeff

414kh02a.doc

DO 127115
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Equipment Description

HE-206 A/B
106 Nickel tubes (per unit) - 1.25" OD x 16 BWG x 16', 1 9/16" pitch Carbon steel shell (Ni clad shell on tube side)

2- with twisted tapes (8" pitch)	2 pass
tube velocity	2.46 - 3.38 ft/sec

HE 6 C/D/E/E/F
48 Nickel tubes (per unit) - 1.25" 0D x 16 BWG x 12', 1 9/16' pitch Carbon steel shell (Ni clad shell on tube side)

4- with twisted tapes (8" pitch)	2 pass
tube velocity:	2.72 - 3.74 ft/sec
Total cooling area:	1690 sq ft
Salt in inlet:	1.18% - 1.20%
Cooling range:	91 - 70°F
Caustic flow range:	400 -500 gpm
Wash fluid:	Condensate
Wash frequency :	24 hour
Wash rate:	375 gpm (estimated)
Reason for wash:	Heat transfer
Caustic downgraded:	5000 lb/day (estimated)
Wash sent to:	C.E. users
TDC Control Groups	68-69-70

ARU solution solidification due to overcompensation for swings in cooling load may be eliminated by an insulated buffer tank than contains enough chilled water to absorb shocks to the system.

F. ARUs (See Operating Discipline Specific to ARUs)

G. Polishing Filters - (See Operating Discipline Specific to Sparkler Filters)

Operating Discipline:

Revisions: Combined Pre-cooling, Cooling, cross-exchanger and chilling information and added HE-15 A/B information and HE-222A.

Developed:

Revised - Date: 5/93 - 1/4/94

By: Ray Brown / Richard Rolke / Jeff Harrison

Approved: Sam Boudreaux

Title: Cooling, Settling and Polishing

Date Approved: 1/7/94

Key Words: Operating Discipline, Finishing, Cooling, Chilling

DO 127117
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ARUs (ARU-204, ARU - 205)

Machine Description:

Basic Cycle

The ARU consists of 4 chambers: The Evaporator, The Absorber, The Generator, and The Condenser.

In the evaporator, water is sprayed on the surface of the tubes in the bundle in which the chilled water flows. Because this chamber is operated under high vacuum, the water which is sprayed on the tubes evaporates at a temperature lower than the temperature of the in-coming chilled water. Therefore, heat from the chilled water is used to evaporate the spray water, which lowers the temperature of the chilled water. NOTE: Solution is LiBr (Lithium Bromide).

The water vapor produced is carried over to the second unit, the absorber. In the absorber, a strong solution is sprayed into the water vapor carried over. The solution absorbs the water vapor, distilling the solution. River water flows through the tube bundle in this chamber to cool the solution, allowing the solution to absorb the water vapor more easily.

The solution is pumped to the generator which operates under less vacuum than the absorber and evaporator. There, low pressure steam heats the solution, evaporating water out of the solution, making the solution strong again. The strong solution is then gravity fed to the absorber. The weak solution from the generator is pre-heated by the hot, strong solution from the generator in a heat exchanger.

The water vapor removed from the solution is condensed by the river water in the condenser chamber. The river tower water used is that which previously passed through the absorber. The condensed water returns to the evaporator to being the cycle again.

Some by-passes which act automatically to protect the unit are also on the unit. An overflow for the hot solution to go directly to the absorber from the generator is included in order to reduce the chance of solution crystallization in the heat exchanger. When the solution begins to become too concentrated, the solution in the generator will usually begin to rise and overflow into this pipe. When the cycle guard valve is open, refrigerant water is sent to the absorber from the refrigerant pump to dilute the solution. When the low level valve is open, solution from the solution pump is sent to the evaporator to raise the level of the evaporator.

Control

Basic Scheme - The chilled water outlet temperature is controlled by the flow rate of steam. In addition, steam pressure is controlled.

Additional Control -

Cycle-Guard-- To prevent the solution from becoming over-concentrated, (i.e. crystallization of the LiBr solution) the unit is equipped with a device which transfers refrigerant to the solution in the absorber. It is activated by any of three switches;

1) A high refrigerant level switch corresponding to a concentration of about 59.5 wt %
2) A high refrigerant level at about 57 wt% in series with a low temperature switch,
3) A high refrigerant level switch at about 55 wt% in series with a lower temperature thermoswitch.

This control scheme assumes that a high level of water on the refrigerant side indicates a lack of water on the absorber side and, therefore, a high concentration.

Low Level Control -- To prevent the evaporator from running dry, a low level control valve will activate upon low refrigerant level to send solution from the absorber solution pump to the evaporator.

(Low Temperature Cutout -- To protect the unit from serious damage due to solution freezing, a low refrigerant sump temperature from a thermocouple will shut the unit down. This should be set for about 48°F.

Operating Parameters:

ARU 204 Group 68

TRC 3187	River Water Inlet Temp. - 102°
TR 3190	Chill H20 Inlet Temp - 56°
TRC 3189	Chill H20 Outlet Temp 48°
PRC 3181	Steam pressure 12 PSI
TRC 3186	Desuperheater Temp 262°
TRC 7116 HE 206B	Caustic outlet temp. 73° to 75°

ARU 205 Group 69

TRC 3177	River water inlet temp - 100°
TR 3180	Chill water inlet temp - 55°
TRC 3179	Chill water outlet temp - 51°
PRC 31	Steam pressure 15PSI
TRC 3176	Desuperheater Temp. - 262
TRC 7142	HE6 Caustic outlet temp 68.5 to 70.7

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Group 70

FR 2394	AUR 205 Chill H_2O Flow - 675 GPM
FR 2395	ARU 204 Chill H_2O Flow - 675 GPM
P.I. 3188	ARU 205 Solution Pump Pressure - 7.90
P.I. 3191	ARU 204 Solution Pump Pressure - 1307

The upper shell, which operates at 4 in. mercury, contains the generator and condenser sections. In the generator, water is vaporized from the solution to make the solution strong. In the condenser, cooling is used to condense the vapor to liquid.

There is a solution heat exchanger to heat the weak solution removed from the absorber using the relatively hot, strong solution from the generator.

Two hermetic pumps are used to circulate the solution and refrigerant. The pumps have no pump seals or external seal water system. Lubrication and cooling of the solution pump is accomplished by lithium bromide solution. The refrigerant pump is lubricated and cooled by refrigerant water. Pump motors are operated on 3 phase, 60 hertz power at 460 volts. Bearing inspection is recommended every 6 years.

A control panel includes an elapsed time indicator, multi-tap control voltage transformer, machine pump starters, pump overload protection, fused disconnect, and a panel door which shuts the unit off when opened.

The evaporator, absorber, and condenser circuits are designed for a working pressure of 150 PSIG. The steam generator is designed for 15 PSIG.

The generator tube bundles are u-tube, secured at only one end. Other tube bundles are of straight tubes. The evaporator tubes sheets, like all other, are carbon steel, and the tubes are 3/4 in OD and the tube walls are .049" thick, 20 gauge 90-10 copper-nickel. The tube in the absorber, evaporator, and condenser are all 18 gauge 90-10 copper-nickel.

The evaporator, condenser, absorber and generator have removable head covers. The tubes are rolled in the tube sheet and are individually replaceable. The header box is made of carbon steel.

Equipment Description

Design Condition:

Condition	ARU-204	ARU-205
Capacity	600 Tons	300 Tons
Chilled Water Inlet Temp.	52 Deg F.	53 Deg F
Chilled Water Outlet Temp.	42 Deg F.	42 Deg F.
Chilled Water Flow	1800 GPM	720 GPM
Steam Pressure	12 PSIG	14 PSIG
Steam Temperature	250 Deg F.	250 Deg F.
Solution Pump Pressure	8.0 PSIG	8.0 PSIG
Solution Pump Temp.		
Refrigerant from generator to evaporator.	112 Deg F.	112 Deg F.
LIBR from Generator to Absorber	120 Deg F.	120 Deg F.
LIBR from Absorber	107 Deg F.	107 Deg F.
River water flows	2000 GPM	1000 GPM

Start-Up and Shut-Down Units

DO 127122
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Operating Discipline:	
Revisions:	
Developed:	Ray Brown
Revised - Date:	1/5/94
By:	Jeff Harrison
Approved:	Sam Boudreaux
Title:	ARUs (ARU-204, ARU-205)
Date Approved:	1/7/94
Key Words:	Operating Discipline, Finishing, ARUs, Chilling

Sparkler Filters & T-28

Description:

The caustic that has been cooled to 70 deg F by the secondary exchangers contains small salt crystals. The caustic stream is pumped into T-28, where the crystals are allowed to grow. From T-28, the caustic is pumped through the sparkler filter system where these small salt crystals can be removed from the solution. Solution leaving this system must have a salt content of 1.00 % or less before it can be sold.

There are six sparkler filters in the filter system, F-211A,B,C,D,E&F each filter contains 30 monel plates (leaves) which are covered with polypropylene bags. These bags serve as the filter media. Caustic is pumped into the filter housing, through the filter bag, into the monel plate, and is discharged through a manifold running along the bottom of the filter. In this manner, salt builds up on the outside of the filter bags. As this salt cake thickens, the differential pressure across the face of the bags increases causing the shell pressure of the filter to increase. When the shell pressure reaches 60 PSIG, the feed is terminated and the filter goes through a sluice, or wash cycle. The salt is washed from the bag with condensate streams from a sluice header which travels the length of the filter. At the completion of the wash, the filter cycle resumes.

Equipment / Operating Parameters

Number of filter leaves:

F-21A/B/C/D	30 Filter Plates
F-211E/F	27 Filter Leaves

60 PSI Trips The Filter Sluice or 15 a hour cycle time

Caustic Filter Feed Temperature: 70 F

Filter Feed Pumps: P-28TF A/B Max. Flow - 1200GPM

Filter Feed Flows: 125 - 150 GPM Normal Flow
175 GPM Maximum Flow

Caustic Feed: 1.5% Salt

Filter Discharge: Below 1.0% Salt

Pressure Filters: Six sparkler horizontal retractable tank, vertical plate, wetcake discharge self cleaning filters.

Diameter:	72 inches
Length:	18 feet
Filter area:	1110 sq ft (per filter)
Cake capacity:	231.25 cu ft (per filter)
No. bags:	30 (per filter)
Filter cloth material:	poly pro renforce felt
Inlet temperature to filters:	70 degrees F
Inlet flowrate:	175 gpm maximum
Salt in feed:	1.3%
Salt in outlet:	less than 1.0 %
Process control:	Modicon logic

Operating problems: The filters require a lot of attention. If not maintained, they will cause problems. What about Texas' new filter material?

T-28

T-28 Ageing Tank: The caustic is aged before filtering at about 70° F, although the temperature sometimes gets as high as 75° F due to reciculation pumping. The tank does not require periodic clean-out.

Diameter:	40 feet
Height:	40 feet
Tank recirculation:	400 gpm
Level control:	80 - 85 % for maximum crystal growth
Residence time:	At 75% level (12 hours)

Operating Conditions

Caustic

Temperature - 72°F

Pressure - 45 psig

Max Flow - 125 gpm

Inlet salt - 1.5%

Outlet salt - 1.00 or less

Condensate

Flow - 265 GPM

Pressure - 150 psig

Filter Design Conditions

Temperature - 650°F

Pressure - 100 psig

Modicon Change To Trip A Filter After A 15 Hour Cycle

Within the next two weeks, there will be a change made to the MODICON filter control. This change will add an automatic sluice after a filter has run a 15-hour cycle. This modification will help prevent damage to our filters. When a filter runs an excessively long cycle, there is a potential for salt bridging, bad damage, and filter leaf damage. On May 16, 1993, F-211 B ran a 28-hour cycle. As a result of this lengthy cycle, salt bridging occurred on the filter leaves and the filter cycles began to decrease. Prior to May 16, F-211B was running 15 hour cycles. After the 28 hour cycle, the filter began averaging 3 hours cycles. This is illustrated in the graph that accompanies this memo. Although our goal is to maximize filter run cycles, we do not want to do so at the expense of filter damage. The MODICON programmers are also adding logic to prevent more than two filters to be sluicing at the same time.

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Instrumentation

1. Flow recorder controller on each filter feed line.

2. Pressure recorder on F-211A, F-2211B, F-211C, F-211D, F-211E & F-211F

3. Temperature recorder on F-211A, F-211B, F-211C, F-211D, F-211E & F211F

4. T-28 temperature.

5. Level indicator on air knock out pot.

6. Alarms

    a. Fill up malfunction on F-211A, F-211B, F-211C, F-211D, F-211E & F211F. This alarm will activate if the filter does not fill up in 12 minutes.

    b. Clear up alarm on F-211A, F-211B, F-211C, F-211D, F-211E & F211F.

    c. Blow back malfunction.

    d. Run time alarm = 15 hrs

    e. Pressure trip = 60 psig

Operating Discipline:

Revisions: Added F-211 E/F information

Developed:

Revised - Date: 5/93 - 1/5/94

By: Ray Brown / Jeff Harrison

Approved: Sam Boudreaux

Title: Sparkler Filters & T-28

Date Approved: 1/7/94

Key Words: Operating Discipline, Finishing, Filters, T-28

Iron Removal System

Description:

NOTE: Iron Removal is presently down since 3/93. An experiment is running to prove elimination.

The objective of this system is to remove magnetic metal contaminants from the caustic. Iron, nickel and copper are the primary metals removed. The reduction in metals is accomplished through the use of electrolytic cells, composed of nickel mesh cathodes and nickel screen anodes. The caustic from the filters is preheated by cross-exchanging it with the cooler cross-exchangers and with the caustic stream exiting iron removal itself. (HE-222A to HE-4/5/6A/B to HE-222C)

The final temperature necessary for iron removal operation is achieved in HE-223 using 235 psig steam. Once the metals are removed product is cooled via HE-222C and HE-206 C/D prior to storage and distribution.

Description of Equipment HE-222C

HE-222C is a plate and frame heat exchanger used to cross exchange the feed stream to the cells with the product stream from the cells. Caustic enters the system at 75 deg F. and must be heated to 200 deg. F before being fed to the cells. The caustic leaving the cells at 200 deg. F must then be cooled back to 100 deg. F or less so that the caustic does not pick up any excess iron in the carbon steel piping in the storage area. HE-222C crosses these two streams, minimizing the amount of steam needed by HE-223 to heat the caustic.

HE-222C

Plate & Frame Cross Exchanger: Recovers heat from the hot caustic returning from the iron cells.

224 Nickel plates

Cooling range,	hot side:	195 - 130 degrees F
	cold side:	85 - 175 degrees F
Total exchange area:		2209 sq ft

HE-223

The caustic going to the iron cells must be heated to 200 deg F in order to receive the maximum efficiency from the cells. Any heat required is supplied by HE-223. The 235# steam flow to the exchanger is controlled by the temperature of the outlet caustic stream. HE-223 is a 4 pass shell and tube heat exchanger with the caustic stream on the tube side while the steam passes on the shell side. The condensate from HE-223 blows back to T-217, the condensate catch tank which is located just west of ARU-205.

50 Nickel tubes - 1.25" 0D x 16 BWG x 16', 1 9/16" pitch Carbon steel shell (Ni clad shell on tube side)

Number of Passes	Four
Tube velocity:	10.43 - 14.34 ft/sec
Cooling area:	250 sq ft
Heating range:	175 - 200 degrees F
Caustic flow range:	400 - 550 gpm

Iron Cell Rectifiers - R-201 A/B/C

Power to the iron cells is supplied by three (3) water cooled silicone rectifiers denoted R-201A, B & C. These rectifiers convert 480 V. AC current to 30 V. DC. The normal output of the rectifiers is 25 V. at 1750 AMPS. Each rectifier can be controlled locally or in the control room as control panels are at both locations. The local - remote switch is located on the rectifier control panel. All panels contain on-off switches, volt and AMP meters, and indicator lights. In addition, the panel in the control room has a power start which provides a means of varying the power output of the rectifier and a reset switch. An air purge is located on each rectifier to prevent damage which could be caused by corrosive acid and caustic vapors. For this reason the doors on the rectifiers should stay tightly coles at all times.

Alarms:
Blown fuse alarm - The blown fuse alarm and light indicator that a diode circuit has shorted. This may linit the capacity of the rectifier, but it can be operated.
Rectifier trip alarm - This alarm will activate whenever the unit trips or is intentionally shut down.

C-501A&B / C-502A&B / C-503A&B

High-Low AMPS alarm - This alarm will activate whenever the amperage exceeds the limits set on the AMP meter. Loss of current to the cells will cause the iron collected on the cathodes to reenter the caustic. This can be avoided if current is restored immediately.

Low Cooling water flow alarm - This alarm activates when the pressure drops on the cooling water line to the rectifier. Water is used to cool the diode bank and the transformer. If cooling water flow is not maintained the unit will overheat and trip. Flushing of the strainer on the cooling water line will normally restore pressure.

Diode and transformer high temperature alarm - These alarms activate when the unit begins to overheat; they also shut the unit down.

Iron Cells - C-501 A&B, C-502 A&B, C-503 A&B

Iron Cell Description

Each cell body is 4' 3" wide, 7' 2 3/8" long and 4" high. It is made of carbon steel with two drains in bottom and overflow flange and is hypalon lined. There is 5 baffles, 6 cathodes and 12 anodes.

As a result of the current passing through the caustic in the iron cells, some hydrogen gas is produced. Most of the gas bubbles out of the caustic to the atmosphere. In addition, the turbulence of the caustic through the cells results in a fine caustic mist above the cells. For these two (2) reasons, the cells have hoods which vent the mists and gases into a venturi scrubber, VS-1. The venture creates as vacuum on the vent line which draws the hydrogen and caustic into the liquid stream. The caustic is absorbed by the water cycled through the scrubber system while the hydrogen is safely expelled through an air vent about thirty (30) feet above ground level. To prevent a caustic buildup in the scrubber, the water is partially drained and replenished periodically.

V.S. 1 Design Parameters

Fiber glass tank 6' diameter and 7' 4 1/4 high 34" water level MP 201 water recirculation pump which washes the caustic out. The water level is maintained by a purge flow in the scrubber. The pump and level is checked on finishing area round sheet.

HE-206 C&D

The final step in iron removal are the coolers, HE-206 C&D. Caustic leaving the system going to storage must be cooled to less than 11° F so that no iron is absorbed from the carbon steel piping in the storage area. These coolers are six pass shell and tube exchanger river water flowing on the shell side. The system has a back flush which should be used periodically to wash out any river silt which may have settled in the exchangers.

HE-206 C&D

Final Coolers: Cool the caustic so that it can be safely stored in carbon steel tanks T-21 or T-22.

106 Nickel tubes (per unit) - 1.25" 0D x 16 BWG x 16', 1 9/16" pitch Carbon steel shell (Ni clad shell on tube side)

2- without twisted tapes	6 pass
tube velocity:	7.38 - 10.15 ft/sec
Cooling area:	1014 sq ft
Heating range:	130 - 100 degrees F
Caustic flow range:	400 - 550 gpm

DO 127135
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Operating Discipline:	
Revisions:	5/93 - Updated operating parameters referenced HE-222A 1/5/94 - Added note of potential Iron Cell Removal.
Developed:	
Revised - Date:	5/93 - 1/5/94
By:	Ray Brown / Jeff Harrison
Approved:	Sam Boudreaux
Title:	Iron Removal System
Date Approved:	1/7/94
Key Words:	Operating Discipline, Finishing, Iron Removal

Air Compressor Operation

Plant Air Compressor - AC301 (42)

Design Conditions:

Maximum pressure capacity 2500 scfm at 125 psig.
Air discharge temperature 95 deg F.
Cooling water flow 71 gpm at 80 deg F to compressor
Bearing oil pressure 20 to 30 psig.
Bearing oil temperature feed 100 to 110 deg F.
Oil cooler water requirements 20 gpm at 80 deg F.

Motor:

Horsepower 350
Voltage 2300

General Description:

The centac consists of an air compressor that is motor driven. The compressor and motor are connected by a flexible coupling and the entire unit is mounted on a common base plate.

The compressor is a three (3) stage, three shaft speed unit. Each compressor stage consists of an impeller mounted on a shaft and is enclosed within a common casing of cast iron. Each shaft contains an integral pinion gear which varies in size, resulting in three (3) different speeds of the stages when driven by a common bull gear. The bull gear is driven by the main motor driver. An inter cooler is located between each stage and an after cooler after the last stage. After each cooler, a moisture separator is provided to remove condensate from the air stream resulting from cooling.

Air enters the casing through an axial inlet connected to the first stage impeller, is increased in pressure by the centrifugal action of the impeller, and the velocity reduction in the diffuser following the impeller. The air then passes through the inter cooler and separate or to the next stage impeller.

Inlet air filter is a high efficiency, two stage unit designed to remove 97% of all particles larger then one (1) micon. The first stage filter element is removable for cleaning without shutting down the compressor.

Seals - The shaft seals behind each impeller are the floating carbon ring type. A seal air system is provided to supply air to the seals, assuring that lube oil is not drawn in past the seals into the air system.

Control Modes - The control console has provision for "Modulating"

Control Operation - The operator may select either "Modulating" control or "Unload" by positioning the "Operating Mode Selector" switch on the front of the console.

Modulating Control:

This type of control maintains discharge pressure at the operating point by throttling the inlet valve, thereby reducing air flow through the compressor, and if necessary modulates the compressor blow-off valve, to bleed off excess air.

Pressure controller continuously detects the deviation between the discharge pressure and the discharge pressure set point. The outlet of the pressure controller goes to both the blow-off and inlet valves. At a 3 pound output the valve will be wide open and at 10 pounds the valve will be closed. The inlet valve will go fully closed to fully open with a signal of 7 pounds to 15 pounds. NOTE: However, this inlet valve will never go completely closed.

Unload:

When the operating mode selector switch is in the unload position causing the blow-off valve to open completely. When the selector switch is turned to the unload position from modulate, the pressure in the compressor discharge line will fail very rapidly when the blow-off valve opens. To prevent the surge sensing pressure switch from sounding the alarm, this switch is automatically deactivated by the selector switch.

Alarm and Trips

The control console will automatically unload and shutdown the compressor when any of the protective devices are actuated.

When the exception of the surge control which unloads the compressor only. In addition and audio alarm will sound a panel light will come on to indicate which device activated the alarm.

Protective devices are as follows:

Low oil pressure switch - 8#
High oil temperature switch - 125 deg F
Low oil temperature switch - 65 deg F
High discharge air temperature switch - 115 deg F
Vibration trips:
First stage - 1.10 mils
Second stage - 1.05 mils
Third stage - 1.00 mils
Compressor surge switch (Alarm and unload only, will not shut down)
Alarm clearing procedure:

If one of the four protective devices cause the compressor to shut down, the operator should proceed as follows:

Push the alarm silence button to silence the horn.

The alarm indication lights will indicate which device caused the shutdown, a light on the face of the vibration monitor will indicate which probe caused the shutdown. The "low oil pressure" light should always come on with shutdown. If low oil pressure is not the cause, another light will also be on, indicating the reason for shutdown.

When the cause has been corrected, the compressor may be restarted by pushing the system reset button and then the start button.

Operation

Start-up:

Turn on unit air supply.

"Power On" is indicated by a panel light.

Set control selector to the desired operating mode. Unit will run unloaded regardless of switch position for a period of time dictated by a time delay.

Turn on power to the panel.

Pre-lube oil pump will start as indicated by a panel light.
Oil and air cooling water solenoid valves will open.
Push the lamp test and alarm silence button.

Push the system reset button. The low oil pressure, high oil temperature, high discharge air temperature and surge lights will go out.

High /Low oil temperature must be above 65° to start. If not start oil heater.

Push "Start" Button:

Pre-lube oil pump light will go out and pump will stop when main oil pump takes over. If main oil pump falls to function or if oil pressure doesn't increase sufficiently within approximately 10 seconds, a time delay relay will operate to shut the seconds, a time delay will operate to shut the compressor down, sound the audio alarm, and light the "Low Oil Pressure" light.

Time delay relay also delays loading the compressor if the selector should be in the "Modulate" position. Loading is normally delayed for about 10 second until the motor is to speed.

Compressor is now operating:

During operation, the "Operating Mode" selector switch may be switched to any position without shutting down the compressor. The compressor will automatically unload when it shuts down.

Stopping:

To stop the compressor, push the stop button. As the oil pressure falls, the low oil pressure light will come on and sound alarm. The pre-lube pump will automatically start, after the alarm sounds, the pre-lube oil pump should be permitted to operate for approximately 20 minutes to insure proper cooling of bearings. To stop pre-lube pump and close cooling water solenoid valve, turn off power to panel.

Lubrication System

The system can operate under varying conditions and has the necessary instrumentation to protect the compressor at all time.

During normal operation the main oil pump, which is driven by the bull gear shaft, supplies oil to the system. The oil, after leaving the pump, passes through a cooler and filter. The water flow to the cooler should be adjusted so that the oil leaves the cooler at the recommended temperature. The filter has throw away type treated paper elements of 10 micron capability. The control valve should be adjusted so that the pressure gauge on the control panel indicates the recommended pressure.

When starting the unit, the motor driven pre-lube oil pump starts when the control panel is energized. The pre-lube pump supplies oil to the system at a reduced pressure which is sufficient to prime the system, including the main oil pump, and close the permissive start switch. The internal relief valve on the pre-lube pump is set to maintain the oil pressure so that the pre-lube pump will not shut itself off at the compressor starts and the main oil pump develops pressure, the pre-lube pump is shut off by pressure switch set to open at 25 psi. If this does not occur within 10 seconds after the motor is started, the unit will trip.

Should the oil pressure in the system fall below 8 psi during operation, pressure switch will trip the unit and start the pre-lube pump for the shut down cycle. The pre-lube oil pump will continue to run until the power to the control panel is turned off.

Two temperature switches are provided downstream of the cooler. The high oil temperature switch is set to open at the specified maximum allowable oil temperature (125 deg. F). The opening of this switch lights the alarm light, sounds the horn and trips the unit. This switch protects against the loss of cooling waster. Switch is set to open at a temperature below 65 deg. F. The opening of this switch lights the light, sounds the horn and does not allow the unit to be started. This is the low oil temperature switch.

Check valve for pre-lube pump is on discharge. Both pumps are provided with a filter and a check valve. The filter is of the screen mesh type. The check valves prevent the back flow of oil.

There is a oil heater on the oil reservoir which is used to heat up oil during cold weather or if compressor trips and the oil temp gets too cool. The heater is controlled by on and off switch on east side of compressor.

Building 2901
April 19, 1993

Mr. Glen Easterly
SGS Control Service, Inc.
6624 Langley Dr.
Baton Rouge, LA 70809

cc: Glenda Townsend
Rick Lemelle
Tony Spears
Cliff Hood

MANUAL GAUGING OF CAUSTIC TANK FARM TANKS BY SGS

Effective immediately, surveyors monitoring the marine storage tanks at the Caustic Plant, will no longer need a plant escort to gauge tanks manually. They still will not be able to operate valves or equipment in the area, Caustic Plant employees will be doing this part of the loading procedure.

The safety equipment required to enter the Caustic area at the marine storage area are monogoggles, hard hat, respirator and rubber boots.

Prior to entering the area, contact should be made with the Caustic Plant control room to verify it is safe to enter the area and to let someone know that a surveyor will be in our area. At time it may be necessary to accompany the surveyor, if he/she is new or unfamiliar with the area or tank, if the control room operator or shift supervisor thinks there is a safety related problem or when the tank is on recirculation and needs to be gauged.

If you have questions concerning this letter or its contents, please call me Sam Boudreaux, at 353-5710 or Cliff Hood at 353-8550.

Sam Boudreaux
Caustic Plant Technologist

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414kh06a.doc

Operating Discipline:	Air Compressor Operation
Revisions:	
Developed:	
Revised - Date:	5/93
By:	Ray Brown
Approved:	Sam Boudreaux
Title:	Air Compressor Operation
Date Approved:	1/7/94
Key Words:	Operating Discipline, Finishing, Air Compressor, AC-301

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WEAK CELL EFFLUENT STORAGE AND DISTRIBUTION OPERATING DISCIPLINE

WEAK CELL EFFLUENT STORAGE AND DISTRIBUTION:

The Caustic plant is the division distributor of cell effluent. Weak cell effluent is received from Chlorine and CA-II through the trench liqueur line and stored in the c.e. distribution tank, T-2. Cell effluent is then distributed to all the division users through the Glycol, eastern, and western users lines.

Cl_2

Chlorine and CA-II send weak cell effluent through the 10" trench liqueur line to the Caustic block where it is stored for distribution in T-2. This flow normally averages 900 gpm. The NaOH concentration in this stream can vary depending on several factors at both plants. Concentration in the flow coming from Chlorine normally averages 8.00% but can vary depending on cell diaphragm condition, electrical load, and hypo/iron content. The concentration of the cell effluent coming from CA-II averages less than 7.00%. This is because CA-II sends cell startup c.e. stored in D-301 and D-316A and sulfate purge from the caustic plant. SO_3 sulfate

SO_2 sulfite

The Caustic plant also sends several streams to T-2. The sulfate purge made up of D-207 overflows, & filter sluices, are all pumped to this tank.

T-2 is the primary weak cell effluent storage tank. When Glycol I is down for maintenance, the division demand may not keep up with the amount of weak c.e. being sent to the tank. In this case T-3 and T-109 can be used for additional weak c.e. storage.

Weak cell is distributed through out the division. The users include Glycol I, Solvents, CPE, Utilities, R & D, Vinyl II, LHC II, LHC III, Environmental Operations, and Methanes. The Caustic plant has sole responsibility in supplying cell effluent to the division.

Glycol I takes over 95% of the cell effluent distributed through the division by the Caustic Plant. Glycol I uses the cell effluent to control the amount of TOD levels being discharged out of the reactors and sent to environmental operations for treatment. Swings in the cell effluent concentration being sent to them will cause swings in the TOD levels which causes upsets at environmental operations due to sick bugs. This can lead to Glycol I having to run at reduced rates for weeks while the bugs get replenished. Any substantial swing in cell effluent concentration should be immediately forwarded to Glycol I so they can take proper steps to reduce the impact. The c.e. out analyzer should be used to monitor trends in the concentration. The C.E. concentration will be determined based on PO and caustic production requirements.. If the concentration gets below, the minimum target Glycol should be notified and steps should be taken to raise the concentration.

CELL EFFLUENT USERS

GLYCOL I:

Cell effluent is used in the production of propylene oxide. The cell effluent is fed directly into the reactors with no holding tank. Glycol can not run without a constant supply of cell effluent.

Max. flow: 2050 gpm 2.5MM lbs./day

SOLVENTS/EDC I:

Cell effluent is used for division canal for PH control, acid scrubbing, and Cl_2 scrubbing. The solvents vents can be scrubbed at Glycol I. The division canal PH control system can only be supplied with c. e. by direct pipeline.

Max. flow: 2000 gpm Normal flow: 150 gpm

VINYL II:

Vinyl II has 3 primary uses for cell effluent:

1. Neutralization and caustic cracking in Oxy-EDC
2. Neutralization in the ecology area
3. Non-routine neutralization in the HCl dump scrubber (Used only during plant trips)

Both option 1 & 2 can be supplied through a 125,000 gallon storage tank which contains about 15 hrs worth of cell effluent at normal operating rates. Option 3 can only be supplied through direct pipeline.

Max. flow: 2500 gpm Normal flow: 200 gpm

LHC III:

Cell effluent is used primarily for removing acid gases in a cracked gas scrubber column. LHC III has a 14,150 gal storage tank (127,000 lbs of NaOH). This tank can hold 14 hrs. of cell effluent while running at normal rates.

Max. flow: 250 gpm Normal flow: 180 gpm

ENVIRONMENTAL OPERATIONS:

Cell effluent is used to control PH in the water plant and incinerator. A 20,000 gallon c.e. storage tank does service the entire block .
Max. flow: 75 gpm   Normal flow: 7 gpm

METHANES:

Cell effluent is used for scrubbing chlorine in a THROX unit and PH control in an air stream. Methanes can only be supplied via pipeline with a maximum run time of 2 hrs. without c.e. supply.
Maximum flow: 200 gpm Normal flow: 60 gpm

CPE:

Cell effluent is used to scrub chlorine vapors from the reactors. CPE has a 400 gallon storage tank. CPE only uses c.e. sporadically and can go several days without needing more cell effluent if their tank is full.
Normal flow: 2 gpm avg.

UTILITIES: (water treatment)

Cell effluent is used to neutralize a waste acid coming from a regeneration unit. This is a batch type process. Cell effluent is needed upon demand because there is no c.e. storage tank at utilities.
Normal Flow: 2 gpm avg.

LHC II:

Cell effluent is not being used at LHC II now. Cell effluent was used to remove acid gas(CO_2 & H_2S) form the cracked gas before the gas goes to the purification area of the plant. A 14,000 gallon c.e. storage tank can hold enough c.e. for 12 hrs. of normal run time.
Normal flow: 0 gpm

R & D:

Cell effluent is used to neutralize an acid stream from the CPE pilot plant. Cell effluent is only used periodically and there is no storage tank.

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Normal flow: 1.2 gpm avg.

CELL EFFLUENT USERS

10" GLYCOL LINE:	GLYCOL I - NO TANK
6" EASTERN USERS LINE:	EDC I - TANK SOLVENTS - NO TANK CPE - TANK UTILITIES - NO TANK R & D - NO TANK
8" WESTERN USERS LINE:	VINYL II - TANK LHC II - TANK LHC III - TANK ENVIRONMENTAL OPER. - TANK METHANES - NO TANK

STRONG CELL EFFLUENT STORAGE
AND DISTRIBUTION

weak CE ↓% NaOH

CELL EFFLUENT PRODUCTION DESCRIPTION:

Strong CE ↑% NaH

Cell effluent is produced at the Chlorine plant in 5 rectifiers(circuits) each with 4 series. Brine (NaCl & H_2O) is fed into the circuits and electrically charged. The brine molecules are broken up into Chlorine, Sodium Hydroxide & Hydrogen($2NaCl + 2H_2O \rightarrow Cl_2 + 2NaOH + H_2$). At full load, 267MW, Chlorine can produce 6.4 MM lbs. of NaOH per day. Each rectifier has a capacity of 1.28 MM lbs. NaOH/day. Chlorine and caustic load can be cut by dropping a rectifier off line(50MW drop) or cutting load across all the rectifiers. Cutting load reduces the percent caustic in the cell effluent while dropping a circuit off line reduces cell effluent volume.

Strong cell effluent(high % of NaOH) is sent to the caustic plant in the 16" line(strong line) and weak or out of spec. cell effluent is sent in the 10" or trench liqueur line from the Chlorine and CA-II plants. The strong line contains the cell effluent used to feed the evaporators. The trench liqueur line contains cell effluent with low NaOH concentrations, and high iron or hypo's due to circuit startups or poor performing cells.

brine = saltwater = $NaCl + H_2O$

NaCl

$2NaCl + 2H_2O \rightarrow Cl_2 + 2NaOH + H_2$

(salt) + (water) = acid + base

$NaCl + H_2O = HCl + NaOH$

$2NaCl + 2H_2O \rightarrow 2HCl + 2NaOH$

$2e^-$

$2H^+ + 2e^- + 2Cl^-$ ions in water

(gaseous)

$H_2\uparrow + Cl_2\uparrow + 2e^-$

STRONG CELL EFFLUENT STORAGE & DISTRIBUTION:

Strong cell effluent coming from Chlorine and/or CA-II is used to feed the evaporators. When Chlorine is at maximum rates, this flow can be over 3900 gpm. The strong cell effluent NaOH concentration can vary from 8.25% to 10.0% depending on Chlorine's electrical load, cell diaphragm quality, or the number of circuits that are on line. The cell effluent coming into the block is sent to T-1, the evaporator feed tank, at approximately 140F. A bypass loop around T-1 allows some cell effluent to be diverted around the tank and is fed directly into the evaporator feed pumps. This limits the amount heat the cell effluent will loose before reaching the evaporators. The cell effluent is then heated from 140F to 147F in the precoolers(HE-20A/B) by cross exchanging it with hot 50% caustic coming out of the centrifuges. *It is very important that as much heat as possible is recovered by the cell effluent since each degree rise in c.e. temperature relates into $10,000/yr in steam savings.* From here the c.e. is fed into the evaporators through HE-203A and B.

NaCl

Cell effluent is analyzed for NaOH concentration, salt, iron, sulfates and hypo chlorites. The samples are taken off the meter runs on the strong and weak lines. % NaOH or GPLs (13.2 GPL = 1.0%) in the streams are measured once a shift with a grab sample, continuously estimated using an electronic analyzer, and measured on a 24 hr average using a compositor. Compositors are located on the strong c.e. line, evaporator feed line, and the c.e to the users. Continuous electronic analyzers are on the strong c.e. in, the evaporator feed, and the c.e. to the users lines. Both salt and iron are measured once a shift with a grab sample. Sulfates are measured once a shift. Excess sulfates in the cell effluent (>900ppm) causes heat exchanger fouling, decreases the time between evaporator shots, and shortens filter cycle times. This is because sulfate salt crystal are smaller and finer than normal salt crystals.

Strong cell effluent is stored in T-1, T-1A, T-2A, T-3, and T-109. Maximum strong cell effluent storage is approximately 12 MM lbs. 2 MM lbs. is the minimum inventory that has to be kept in storage. At the caustic plant with a minimum combined level in T-1A & 2A This inventory must be kept in case the Chlorine plant has to trip all five circuits and scrub the chlorine gas immediately. Cell effluent in T-1A and T-2A would be pumped back to Chlorine in the 16" line.

Fe^{2+} iron II — SO_4^{2-} sulfate ion

Fe^{3+} iron III — SO_3^{2-} sulfite ion

ClO_2^- chlorite ion

ClO_3^- chlorate ion

ClO_4^- perchlorate ion

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$HClO_2$ hypochlorite

CELL EFFLUENT STORAGE

TANK	SERVICE	SIZE	CONC.	#NaOH/ft	TOTAL NaOH		BOTTOM	TOP	STOR. HEIGHT	S.G.	#/GAL	#/FT3
CAUSTIC:												
T-1	STRONG C.E.	70' X 40'	9.00%	26,119	1,014,181		1' 4"	40' 2"	38.83	1.2085	0.907753	6.790199
T-2	WEAK C.E.	70' X 40'	7.00%	20,146	782,281		1' 4"	40' 2"	38.83	1.1985	0.700188	5.237565
T-1A	STRONG C.E.	140' X 32'	9.00%	104,474	3,186,457		1' 8"	31' 10"	30.5	1.2085	0.907753	6.790199
T-2A	STRONG C.E.	140' X 32'	9.00%	104,474	3,204,218		1' 8"	32'	30.67	1.2085	0.907753	6.790199
T-3	STRONG/WEAK C.E.	80' X 40'	9.00%	34,114	1,370,358		0	40' 2"	40.17	1.2085	0.907753	6.790199
TOTAL					9,557,494							
T-109	STRONG/WEAK C.E.	125' X 40'	8.50%	78,659	2,772,731		2' 10"	42' 10"	35.25	1.2085	0.857322	6.412966
				78,659	3,067,702	*			39	1.2085	0.857322	6.412966
MAX. C.E. STORAGE					12,330,225							
CHLOR-ALKALI II:												
D-301		100' X 32'	9.00%	53,303	1,599,092		32'	2'	30	1.2085	0.907753	6.790199
D-316A		65' X 40'	4.50%	11,107	422,048	**	40'	2'	38	1.192	0.447679	3.348745
TOTAL					2,021,140							
TOTAL DIVISION C.E. STORAGE					14,351,365							

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SPECIFIC GRAVITY CALCULATED @ 104 F

* STORAGE AT MAXIMUM LEVEL ABOVE ENGINEERING STANDARD

** AFTER TK REPAIRS ARE DONE

50% CAUSTIC STORAGE

TANK	SIZE	#NaOH/ft	TOTAL STORAGE		STORAGE MINUS TANK HEEL	BOTTOM	TOP	STOR. HEIGHT	#/GAL	#/FT3
CAUSTIC:										
T-46	40' X 40'	59,240	2,418,783		2,300,302	43' 2"	3' 4"	40.83	6.305403	47.16587
T-47	40' X 32'	59,240	1,885,620		1,767,139	35' 1"	3' 4"	31.83	6.305403	47.16587
T-49	40' X 40'	59,240	2,418,783		2,300,302	43' 2"	3' 4"	40.83	6.305403	47.16587
T-104	80' X 24'	236,961	5,668,114		5,431,153	26' 11"	3'	23.92	6.305403	47.16587
T-105	80' X 24'	236,961	5,668,114		5,431,153	26' 9"	2' 10"	23.92	6.305403	47.16587
T-106	80' X 24'	236,961	5,668,114		5,431,153	26' 9"	2' 10"	23.92	6.305403	47.16587
T-108	160' X 24'	947,845	22,672,458		20,776,767	27' 10"	3' 11"	23.92	6.305403	47.16587
T-110	125' X 40'	578,519	16,678,697	#	15,521,660	45' 2"	4' 1"	28.83	6.305403	47.16587
		578,519	*18,512,602*	*	*17,355,564*			*32.00*	6.305403	47.16587
T-111	150' X 28'	833,067	22,559,457		20,893,323	32' 8"	4' 7"	27.08	6.305403	47.16587
TOTAL			**85,638,140**		**79,852,952**					
T-109	125' X 40'	578,519	16,678,697	#	15,521,660	42' 11"	2' 10"	28.83	6.305403	47.16587
		578,519	*18,512,602*	*	*17,355,564*			*32.00*	6.305403	47.16587
WITH T-109			**102,316,837**		**95,374,611**					
CA-II:										
D-316B	65' X 40'	156,431	5,873,220			40'	2' 6"	37.55	6.305403	47.16587
D-316C	65' X 40'	156,431	5,873,220			40'	2' 6"	37.55	6.305403	47.16587
TOTAL			**11,746,440**							

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STORAGE CAPACITY LIMITED DUE TO SOIL SHEAR STRESSES
** T-104, 105, & 106 HAVE 1' MIN. TANK HEEL
*** T-46, 47, 49, 108, 109, 110, & 111 HAVE 2' MIN. TANK HEEL
SPECIFIC GRAVITY CALCULATED @ 104 F
* STORAGE AT MAXIMUM LEVEL ABOVE ENGINEERING STANDARD; NOT INCLUDED IN TOTAL

R. Rolke 8/92

414LH01A.XLS Print Date:1/18/94

AREA
1,256
1,256
1,256
5,024
5,024
5,024
20,096
12,266
12,266
17,663
12,266
12,266
3,317
3,317

CAUSTIC PLANT LOADING GUIDE

1. General Description

1.1 Introduction

Dow's future, and ours, depends on our ability to serve customers. We all are part of the sales force of the corporation. The method with which we "package" our product relates to safety and quality. The analysis of our shipments reflects our quality. The prompt and timely loading of product is quantity. This section of the manual is specifically related to the administration of loading and shipping, including accountability, and the physical transfer from Finished Product Storage to a carrier will be covered.

1.2 Loading Day

As the majority of scheduling problems are involved with railroad tank cars, and because the final RR "pull" form the Division occurs at 1800 hours; the Loading Day in the Caustic Plant is considered to be from 0600 hours to 0600 hours the following day. To permit proper scheduling of production, loading sequence and manpower, all Shipping Instructions, or telephoned data must be received by the Caustic Plant by 1430 (afternoon mail delivery) preceding the desired "Loading Day" as herein defined.

1.3 Shipping Instructions

The loading and shipping of caustic is initiated by an order, or release, from a customer to Dow Sales. The sales office communicates the request to Shipping Co-ordination at Louisiana by teletype. Shipping Co-ordination prepares a form "Shipping Instructions", "SI", and teletypes two copies to Caustic. The information is sufficient to complete the order except the carrier number.

Upon receipt of the "SI", Caustic either files it by the week and date of loading when sufficient time is given to schedule; or it is immediately scheduled for loading on form L-41-1, "Loading Schedule and Log", when the loading must take place during the current week.

Filing of "SI" will either be by Loading Date or on one of the three clip boards labeled "Yesterday", "Today", and "Tomorrow".

At appropriate times, as outlined in paragraphs following, data will be written on the "SI" including:

1) the carrier number and 2) the analysis of the product.

1.4 "Loading Schedule and Log", Form L-41-1.

Each day prior to 1500 hours, a "Loading Schedule and Log" is prepared for the next day's loading by the OS in the Lab.

All carrier numbers and estimated weights must be recorded for use on the Daily Production Report by Lab personnel.

1.5 Carrier Numbers

The carrier numbers for the "Loading Schedule and Log" are obtained from Shipping Coordination on the afternoon before their scheduled loading day. They are recorded on the "Product Shipping Schedule". The second copy of the "Product Shipping Schedule" should be sent to the control room. These steps should be taken prior to 1600 hours each day by Lab.

1.6 Estimated Weights

At 0730 every work day, a check by Lab personnel shall be made to determine the actual loading status. Those cars loaded on "Yesterday's" production day (prior to the 0600 tank gauging) shall be clearly identified.

The carrier shall be transposed from the white work sheet (carbon copy) to the blue record sheet (original) of the "Loading Schedule and Log" as well as the determination of the Estimated Weight of product loaded.

For cars loaded ahead, (those having no "SI"), a sheet of paper shall be used to match the car number, estimated weight, grade, date loaded and analysis until released for shipment. These steps shall be clip board filed as "Loaded Ahead".

1.7 Analysis See Lotting Procedure

Lab personnel reports an analysis for each car shipped. The analysis can be either a tank sample. This analysis is recorded on the appropriate "SI"

For advance loaded cars it shall be kept on the same paper matching car numbers.

The analyses are to be reported to the Shipping Coordinator by 1000 each work day for cars shipped the previous day.

1.8 Daily Production Report

The "Production Report" may be completed using the estimated weights shown on the "Loading Schedule and Log", Form L-41-1. The "Loading Schedule and Log" should be given to the secretary by 1000 hours each work day.

1.9 Tank Trucks

Tank trucks cause the following exceptions to the above paragraphs.

1.9.1 Seals are used with thank trucks.

1.9.2 The actual solution weight is taken from the truck scale at the rear entrance to the plant. Therefore, it is not necessary to estimate any weights.

1.10 Barges cause the following exceptions and new procedures to the above paragraphs.

1.10.1 No seals are used with barges.

1.10.2 It is necessary to gauge a tank before loading and after loading. <u>No other use of the tank is allowed during loading except by permission of Plant Superintendent or his designee.</u> The gauge differences are used to calculate the actual loaded weight; therefore, no estimated weight is determined. Gauge readings will be recorded on the "Loading Schedule and Log".

1.11 Ships

Ships are handled in the same manner as barges.

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From: LARNDC::TOWNSEND "Glenda Townsend, Prod. Supervisor, Caustic 1, (504)389-1594" 22-May-1991 15:00:18.71
To: @Tank Clean.dis
CC:
Subj: Terminal Tank Cleaning For Caustic Products

As of May 20, 1991 we have gotten approval to bring 20% caustic generated during tank cleaning of caustic tanks back from Dow leased terminals as feed for the Glycol 1 plant. Since this material will be used to feed the T-2 tank at the Caustic plant where it is then subsequently fed to the Glycol 1 plant, this material will not be considered hazardous waste. Any residue left in the tank car after the liquid is removed by the Caustic plant will be disposed of as all others hazardous wastes generated in their cleaning operation.

Prior to each shipment the Caustic plant needs to verify that the product can be sent to the T-2 feed to Glycol 1. If product cannot be sent to Glycol 1 as feed and therefore must be recycled into the Caustic Plant, then this material will need to be shipped as hazardous waste and special re-evaluation must be done to determine status according to our environmental permit and disposal of outside generated hazardous waste. If product can not be sent to T-2 and Glycol 1 as feed, at no time should this 20% material be brought back into the division without clearance and approval from environmental services and the division legal department.

Approval to the above procedures given by Paul Borke (LAD legal department) and Jill McCullough (Environmental Services).

Glenda Townsend
Production Supervisor
Caustic 1
5/22/91

Building 2901
April 19,1993

Mr. Glen Easterly
SGS Control Service, Inc.
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cc: Glenda Townsend
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Tony Spears
Cliff Hood

MANUAL GAUGING OF CAUSTIC TANK FARM TANKS BY SGS

Effective immediately, surveyors monitoring the marine storage tanks at the Caustic Plant, will no longer need a plant escort to gauge tanks manually. They still will not be able to operate valves or equipment in the area, Caustic Plant employees will be doing this part of the loading procedure.

The safety equipment required to enter the Caustic area at the marine storage area are monogoggles, hard hat, respirator and rubber boots.

Prior to entering the area, contact should be made with the Caustic Plant control room to verify it is safe to enter and to let someone know that a surveyor will be in our area. At time it may be necessary to accompany the surveyor, if he/she is new or unfamiliar with the area or tank, if the control room operator or shift supervisor thinks there is a safety related problem or when the tank is on recirculation and needs to be gauged.

If you have questions concerning this letter or its contents, please call me Sam Boudreaux, at 353-5710 or Cliff Hood at 353-8550.

Sam Boudreaux
Caustic Plant Technologist

DO 127161
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Operating Discipline:

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Revised - Date: Cliff Hood

By:

Approved: Sam Boudreaux

Title: Caustic Plant Loading Guide

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UTILITIES

I. Water

A. River Water

River water is that unclarified, untreated water which is pumped directly out of the Mississippi River into the intake canal. This may also be referred to as cooling water or raw water. This water is used in the block for cooling purposes. We have two sets of pumps on this system, those on the southwest corner of the block and those on the south side of block 28 on the canal. There are acreens on the inlet to each of these sump pits. These screens should be checked at least once each shift and washed if necessary.

1. Block 28

We have four vertical Peerless pumps on the canal. They furnish water to BE-201, BE-204, HE-208, HE-209, ARU-204 , ARU-205, HE-204, HE-205, and HE-224. There is also a jumper into the low head water header. There are strainers in the suction lines to these pumps. These need to be cleaned periodically. The water pressure to the packing of the Peerless pumps should be at least five pounds higher than the pump discharge pressure. To start a pump, check oil level, make sure packing water is on, open discharge valve and push start buttons. To shutdown, just push stop button. The discharge valve is normally left open.

B. Process Water

Process water, also know as treated water, is that water supplied by the water treating plant which has been treated and clarified. In the Caustic Plant it is piped to hose stations, some process lines and miscellaneous other places. This water is <u>not</u> suitable for drinking. We have two lines coming into the block, a ten inch header and a six inch header. These lines are tied together inside the block, therefore, the flows on both lines will rise and fall at the same rate.

C. Potable Water

This is the water supplied by the water treating plant that has been treated and made suitable for drinking. This water is used on all safety showers and eyewashes, lavatories, commodes and drinking fountains. This water should <u>never</u> be tied into any process line or cross tied with the process water system.

D. Possible Malfunctions

1. Low river water pressure. Check screens.

2. Low heat transfer on heat exchangers. Backflush exchanger to remove accumulated trash. Clean strainer in line to heat exchanger.

3. Caustic in process water line. Check all places where water is tied into caustic lines. Double block and bleed. Open bleeds in area where caustic is to flush it out of lines.

II. Condensate System

A. Recovery System

The condensate recovery system is necessary to recover condensate of sufficient purity for power house boiler feed. Condensate is collected in CT-1 from Train I, Train II, Iron Removal and ARU-201. From CT-1 it is pumped to power, the condensate purge system and to the filter sluice. There is a conductivity cell on the line to power. This is usually set on ten micro mhos. If the conductivity goes above this the condensate will automatically dump to the flume. Care should be used when working around condensate as it is hot enough to cause burns.

B. Purge System

Condensate is used internally on our purge system. This is used for instrument purges, pump packing, pump seals and to dynamites in purification. Two Sundyne pumps, P-201CTD and 101CTE, pump hot condensate to HE-209 where it is cooled to 100°F for purge use. There is a pressure controller on the inlet to HE-209. This should be set on 150#.

C. Possible Malfunctions

Low condensate purge pressure. Check Sundyne pumps for proper operation, make sure they have a flow to them. Check set point on pressure controller and check pressure control valve.

III. Electrical Distribution System

A. General Information

Electrical power comes to the Caustic Plant from two 2400 volt feeder lines which enter the block on the outer east corner near Train II. These feeder lines have two switches near ground level on supporting poles. One switch is designated for each feeder. The switch on the east pole is on feeder line L-61. The switch on the west pole is on feeder line L-31. These switches on the poles are not to be touched unless instructed.

The east 2400 volt feeder, L-61, supplies power to transformers T-130, T-131, T-200 and to 2400 volt motors on P-203HEA, P-201HE and P-1HE. The west feeder, L-31, supplies 2400 volt power to transformers T-132, T-133, T-201 and 2400 volt motors on P-203HEB, P-202HE, F-201FA, F-201FB, P-205TA, P-205TB, P-202SEA and P-202SEB.

Transformers T-130, T-131, T-132 and T-133 are 750KVA transformers located on the east side of the control room. They supply 440 volt power to motor control centers 140, 141, 142 and 143. Transformers T-200 and T-201 are 1000 KVA transformers located on the south side of the control room. These transformers supply power to motor control centers 200 and 201.

B. Lighting

The source of our plant lighting is divided between the two 2400 volt feeders so that a loss of one feeder results in the loss of lighting in different portions of the plant. To make the plant more safe during failures on either feeder, switches were installed on the motor control centers which will enable the entire plant to be lighted from one feeder.

Feeder L-31 which supplies the power to motor control centers 142 and 143 lights the cell effluent, evaporator I, filter, control room and iron removal areas. Feeder L-61 which supplies power to motor control centers 140 and 200 lights the evaporator II, purification, storage, loading, warehouse and office areas.

The emergency switches for lighting have been installed in the following locations:

1. The north end of MCC-143.
2. The north end of MCC-142.
3. The south end of MCC-140.
4. The west end of MCC-200.

When both feeders are energized, the switches in their normal position are with the handles in the up position. When a feeder losses power, power for lighting is obtained by throwing the switch on the respective motor control center to the emergency position with the handle in the down position.

The following defines the switch to be used when power fails to these motor control centers.

1. MCC-140 supplies power to purification, storage, loading, warehouse, and office areas. Loss of power, throw switch in down position. Source from MCC-143.

2. MCC-142 supplies power to cell effluent and evaporator I areas. Loss of power to MCC-142, throw switch in down position. Source from MCC-140.

3. MCC-143 supplies power to centrifuge, filter, control room and iron removal areas. Loss of power to MCC-143, throw switch in down position. Source from MCC-141.

4. MCC-200 supplies power to evaporator II area. Loss of power to MCC-200, throw switch in down position. Source from MCC-201.

C. Description of Equipment

The metal clad fused disconnects are designed for protection of 2400 volt, three phase (delta-delta), sixty cycle power transformers. The fuse rating is 300 amperes for the 750 KVA transformers and 400 amperes for the 1000 KVA transformers. These fuses are capable of interrupting 150,000 KVA symmetrical and 60,000 amperes RMS a symmetrical and has standard speed time-current characteristics. Construction in NEMA type 4 for outdoor Gulf Coast Chemical Plant.

The motor control centers supplied by the Square D Company are standard motor control centers of NEMA-Type 1 construction. The supply for the motor control centers is 1000/1150 KVA, 2400 volt delta primary, 480 volt delta secondary transformer. The incoming line is a 1600 ampere bus duct connected directly to the main bus in the motor control center. The main horizontal three phase bus has a minimum current carrying capacity of 1500 amperes. The wiring shall be Class I, Type B with two overload relays per starter.

The 1000 KVA Uptegraff transforms are three phase, 60-cycle, 55/65° Centigrade rise, oil insulated, self-cooled with provisions for future forced air cooling. Primary voltage is 2400-volt delta with a 480-volt secondary. The transformer is constructed in accordance with ASA standard C57.12.

Item	Manufacturer	Comments
Disconnect (4)	E.E.E.	Metal clad fused disconnect. One for each of the four 750 KVA Westinghouse transformers.
Disconnect (2)	E.E.E.	Metal clad fused disconnect. One for each of the two 1000 KVA UPTEGRAFF transformers.
MCC 140	G.E.	Motor control center.
MCC 140A	G.E.	Extension to MCC 140.
MCC 141	G.E.	Motor control center.
MCC 142	G.E.	Motor control center.
MCC 142A	G.E.	Extension to MCC 142.
MCC 143	G.E.	Motor control center.
MCC 200	Square D	Motor control center.
MCC 201A	Square D	Extension to MCC 201.
MCC 201	Square D	Motor control center.
MCC 201B	Square D	Extension to MCC 201.
2400 V Motor Starter	Square D	Starter for 200 & 300 HP Bingham Pump motors.
T-130	Westinghouse	750 KVA Transformer.
T-131	Westinghouse	750 KVA Transformer.
T-132	Westinghouse	750 KVA Transformer
T-133	Westinghouse	750 KVA Transformer
T-200	UPTEGRAFF	1000 KVA Transformer
T-201	UPTEGRAFF	1000 KVA Transformer

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Item	Function
Disconnect (4)	Disconnect between 2400 V source coming from underground feeder to existing 750 KVA Westinghouse transformers (back of control room 2903).
Disconnect (2)	Disconnect between 2400 V source coming from underground feeder to new 1000 KVA UPTEGRAFF transformers. (south side of control room 2903).
MCC 140	Motor Control Center
MCC 140A	Extension to MCC 140
MCC 141	Motor control center
MCC 141	Motor control center
MCC 142A	Extension to MCC 142.
MCC 143	Motor control center
MCC 200	Motor control center
MCC 200A	Extension to MCC 200
MCC 201	Motor control center
MCC 201A	Extension to MCC 201
T-130	Supplies 440 volt power to MCC 140
T-131	Supplies 440 volt power to MCC 141
T-132	Supplies 440 volt power to MCC 143
T-200	Supplies 440 volt power to MCC 200
T-201	Supplies 440 volt power to MCC 201

Electrical Distribution System

General Information:

Electric power comes to the Caustic Plant by two 2400 volts lines (L31 and L61) which enter the block at the southeast corner near the evaporators on a three pole structure called the service entrance structure. A switch operator is provided at ground level to open or close the switch associated with each feeder. The operator in the east pole is labeled "L61" and controls the switch for L61. The operator on the west pole and labeled "L31" controls the switch for L31. A third switch operator located on the center pole and labeled "TIE" controls the TIE switch. The Tie switch is opened and closed by the utilities distribution department.

Communications and TDC operator stations back up power is provided by a 120 volt battery bank. The battery is located in a room in the south-east corner of the control room. A combination inverter/battery charger (UPS) in the control room. A combination inverter/battery charger (UPS) in the control room (East of MCC 201) converts the DC power of the battery bank to a square-wave A-C power suitable for the P.A. system and the TDC OP. stations in the block. This system will automatically come into use if all power which normally supplies the P.A. system and the TDC OP stations is lost. Sufficient energy is stored in the batteries to last two hours. Great care must be taken before other loads are added on to the inverter/battery system. Since the output of the inverter is a square wave not all electrical devices can be operated on this voltage source. Also overloading the inverter can result in reduction in voltage to all loads.

L61 supplies power through two sets of 2400 volt fuses. One set of fuses are on the north side of the service entrance structure and serve transformers T-61-2, a 750KVA transformer and 2400 volt motors MP-203HEA MP-201HE, MP-202SEA, MP-204HE PD-205 and MP-205TA. The second set of fuses serve transformer T-61-1, a 2000 KVA transformer.

L31 supplies power through one set of 2400 fuses to T-31-1, a 1500 KVA transformer and T-31-2, a 1000KVA transformer and 2400 volt motor power to MP-202SEB, MP-205TB, MP-202HE, MP-203HEB, PD-206 and AC-301.

T-61-1 supplies 480 volt feed for MCC 301, 302, 200, 200 AUX. and CF-1. It is located on the east side of the control room and is the southern most transformer.

T-61-2 supplies 480 volt feed for MCC 305. It is located on the east side of the control room and is the northern most transformer.

T-31-1 supplies 480 volt feed for MCC 201, 202 and 202 AUX.. It is located on the east side of the control room and is the third transformer from the north.

T-31-2 supplies 480 volt feed for MCC 303 and 304. It is located on the east side of the control room and is the second transformer from the north.

Lighting - the source of our plant lighting is from MCC 200 on feeder L61 and this feeds all lighting in the block. If L61 feeder trips, there is a starter on MCC 202 exactly like the one on MCC 200 that will supply light power. To switch the load from MCC 200 to MCC 202 there is a switch located just to the east of the south exit door that will have to be switched to the one marked L31. The starter on MCC 202 should be in the "ON" position and the H-O-A switch on the door should be in "AUTO".

The 2400 volt starters in the switch house provide protection for the 2400 volt to 480 volt power transformers. The fuse rating is 325 AMP for T-31-2, 450 AMP for T-31-1 and 250 AMP for T-61-2. T-61-1 has an unfused disconnect switch. The fuses for the 2000 KVA transformer are mounted on the service entrance structure.

MCC 304 and 305 are general electric model 8000 units with cable to the transformer. MCC 201 is square D class 8998 with cable to the transformer. MCC 200 AUX and MCC 201 AUX are square D class 8998 and are cable connected to their respective transformers. MCC 301, 302 and 303 are general electric 7700 line with some sections new GE 8000 line tied with buss to them and are cable connected to the distribution panel attached to the east side of the transformer T-61-1

Operating Discipline:

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By: Ray Brown

Approved: Sam Boudreaux

Title: Utilities

Date Approved: 1/7/94

Key Words:

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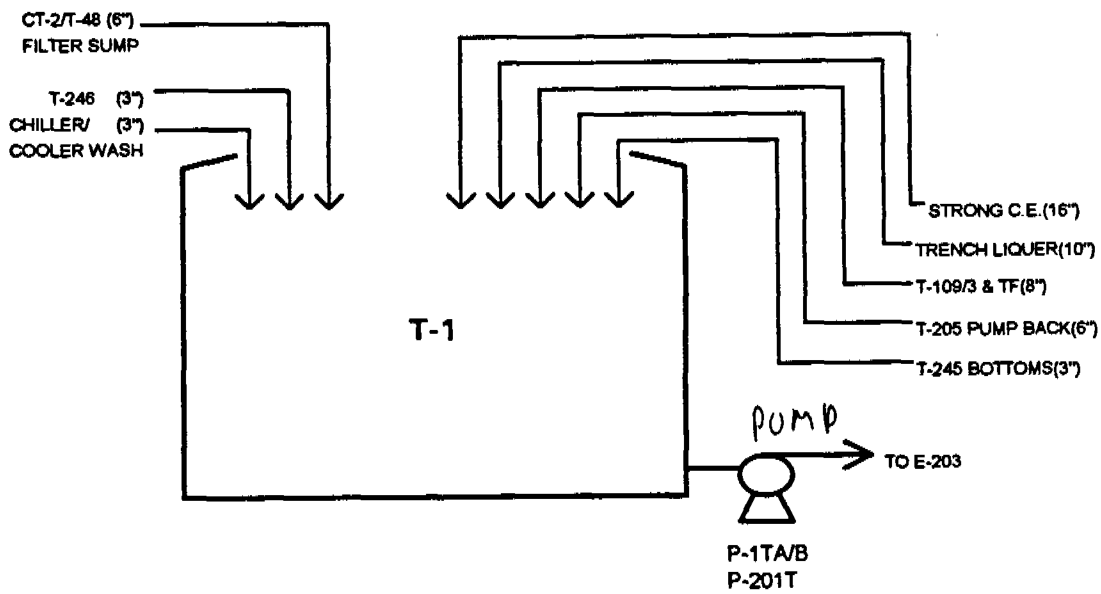
CELL EFFLUENT EVAPORATOR FEED TANK

T-1



TANK CONTENTS: CELL EFFLUENT(9.25% NaOH, 17.0% NaCl, & 73.75% H_2O)

CONCENTRATION RANGE: 8.5% - 10.0% NaOH TEMPERATURE: 135F

TANK DIMENSIONS: 70' X 40'

CAPACITY: 1,146,650 GALLONS 1,014,181 lbs. OF CELL EFFLUENT

28,786 Gal/ft. 26,119 lbs. NaOH/ft.

EMPTY MANUAL: 40' 2" FULL MANUAL: 1' 4"

NORMAL OPERATING LEVELS: 40% - 70%(191" TO 335")

MINIMUM OPERATING LEVEL NEEDED TO PUMP: 60" (5')

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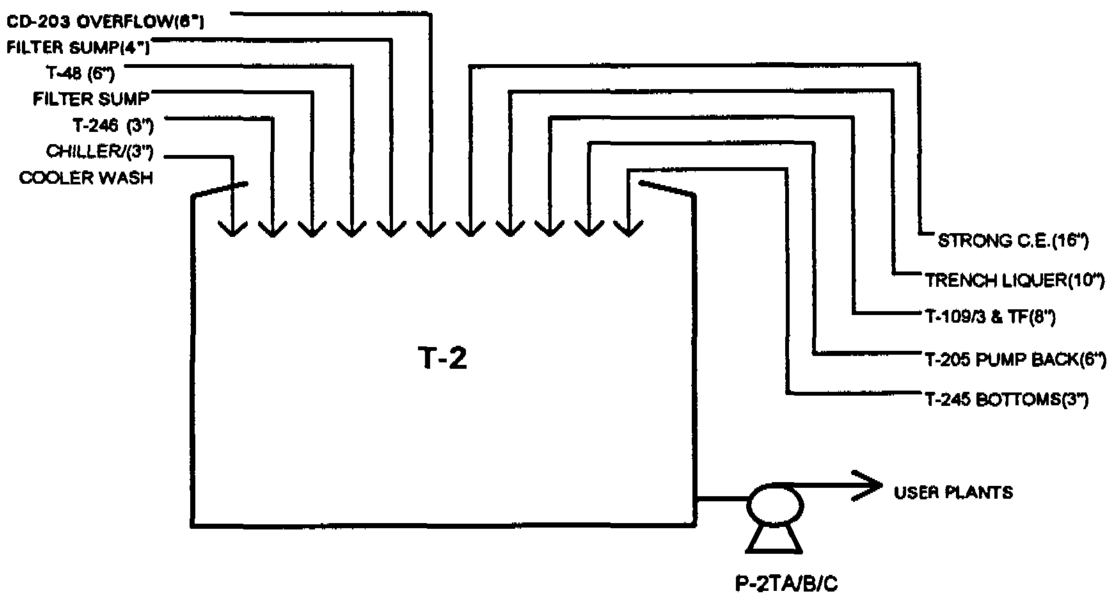
CELL EFFLUENT USERS STORAGE TANK

T-2



TANK CONTENTS: CELL EFFLUENT(7.0% NaOH, 17.0% NaCl, & 76.0% H_2O)

CONCENTRATION RANGE: 7.0% - 8.5% NaOH TEMPERATURE: 135F

TANK DIMENSIONS: 70' X 40'

CAPACITY: 1,146,650 GALLONS 782,281 lbs. OF CELL EFFLUENT

28,786 Gal/ft. 20,146 lbs. NaOH/ft.

EMPTY MANUAL: 40' 2" FULL MANUAL: 1' 4"

NORMAL OPERATING LEVELS: 40% - 70%(191" TO 335")

MINIMUM OPERATING LEVEL NEEDED TO PUMP: 60" (5')

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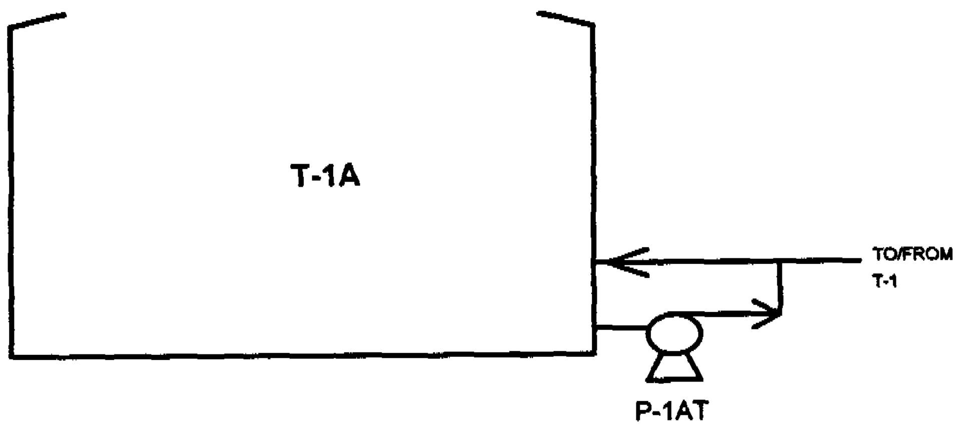
CELL EFFLUENT STORAGE TANK

T-1A



TANK CONTENTS: CELL EFFLUENT (9.00% NaOH, 17.0% NaCl, & 74.0% H_2O)

TANK DIMENSION: 140' X 32'

CAPACITY: 3,684,660 GALLONS 3,186,457 lbs. OF CELL EFFLUENT

115,150 gal/ft. 104,474 lbs. NaOH/ft.

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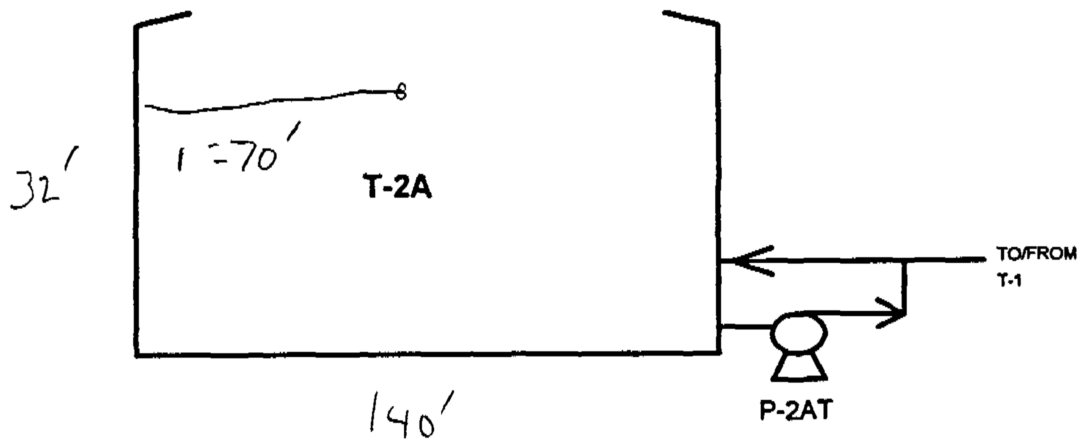
CELL EFFLUENT STORAGE TANK

T-2A



TANK CONTENTS: CELL EFFLUENT (9.0% NaOH, 17.0% NaCl, & 74.0% H_2O)

TANK DIMENSION: 140' X 32'

CAPACITY: 3,684,660 GALLONS EFFLUENT

115,150 gal/ft.

surface area

3,204,218 lbs. OF CELL

104,474 lbs. NaOH/ft.

$\frac{\text{mass}}{\text{length}}$

$V = \pi R^2$

$= \pi (70)^2$

$=$

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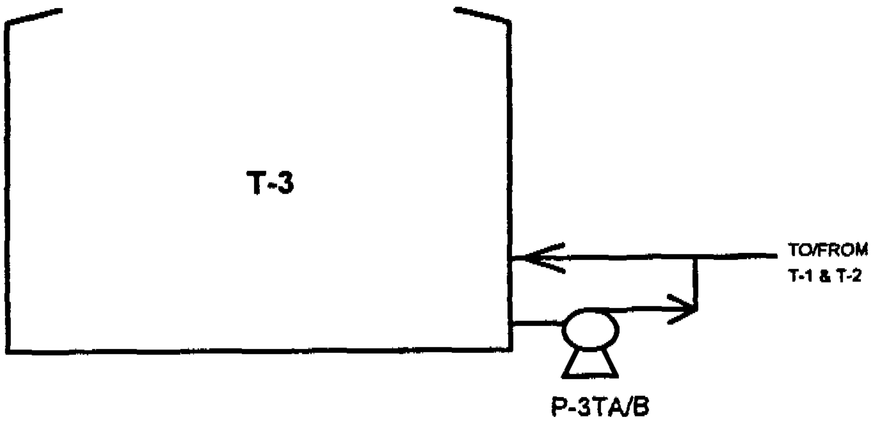
CELL EFFLUENT STORAGE TANK

T-3



TANK CONTENTS: CELL EFFLUENT (9.00% NaOH, 17.0% NaCl, & 74.0% H_2O)

TANK DIMENSION: 80' X 40'

CAPACITY: 1,504,000 GALLONS 1,370,358 lbs. OF CELL EFFLUENT

37,600 gal/ft. 34,114 lbs. NaOH/ft.

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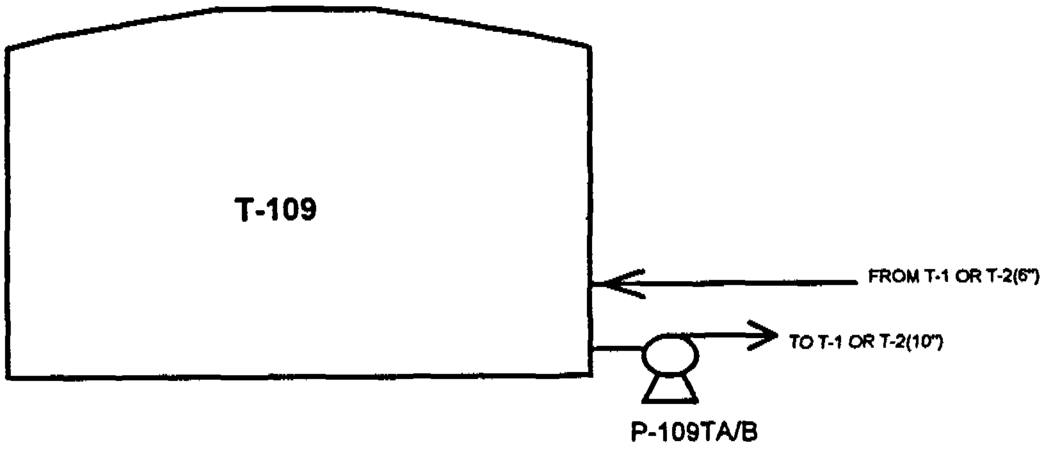
CELL EFFLUENT STORAGE TANK

T-109



TANK CONTENTS: CELL EFFLUENT (8.50% NaOH, 17.0% NaCl, & 74.0% H_2O)

TANK DIMENSION: 125' X 40'

CAPACITY: 2,753,800 GALLONS 2,772,731 lbs. OF CELL EFFLUENT

91,800 gal/ft. 78,659 lbs. NaOH/ft.

MAXIMUM TANK LEVEL WITH CELL EFFLUENT: **35.25 ft** OR **424 inches**

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Heat Exchangers

Description	Vessel Name	# Of Tubes	Tube Size	Overall Size	Material of Construction
HE203B	3rd Eff Hte	965	25' 11 7/8" x 1 1/2 OD	8' 2" x 3 3' 5"	Carbon Steel Shell, Nickel, Tubes & Heads
HE206C	NAOH Cooler	300 PSIG 106	16' x 1 1/4"	24" x 215 5/8"	Carbon Steel Shell, Nickel Tubes, Solid NI 200 Heads
HE206D	NAOH Cooler	106	16' x 1 1/4"	24" x 215 5/8"	Carbon Steel Shell, Nickel Tubes, Solid NI 200 Heads
HE208	Cond Cooler	100 PSIG 434	16' x 3/4"	2' x 2 5' 6"	Carbon Steel Shell, B-111 Admiralty Tubes & Tube Sheet
HE209	Cond Cooler	200 PSIG 790	16' x 3/4"	2' 6 3/4" x 23'0 3/4"	Carbon Steel Shell Steel Outside, Cooper Nickel Inside Tubes
CD204A	Condenser	150 PSIG Tube 28 Vac Shell 4606	3/4' x 14'	82' x 92' x 186"	Carbon Steel Shell, 90-10 CU NI Tubes
HE204	Heat Exch	1404	16'0 x 1'2	7' x 25' 7 1/2"	Carbon Steel Shell, Nickel Tubes and Head
HE-204A-1	NAOH Cooler	106	150 PSGI Shell 16' x 1 1/4"	24" x 215 5/8"	Carbon Steel Shell, Nickel Tubes, Solid NI 200 Heads
HE204B	NAOH Cooler	106	150 PSIG Shell 16' x 1 1/4"	300 PSIG Tubes 24" x 215 5/8"	Nickel Tube Sheet, Nickel Clad Heads, Solid NI 200 Heads
HE205A	NAOH Cooler	106	150 PSIG Shell 16' x 1 1/4"	24" x 215 5/8"	Solid NI 200 Heads

Heat Exchangers

Description	Vessel Name	# Of Tubes	Tube Size	Overall Size	Material of Construction
HE205B	NAOH Cooler	106	150 PSIG Shell 16' x 1 1/4"	24" x 215 5/8"	Carbon Steel Shell, NI 200 Tubes, NI 200 Heads
HE205C	NAOH Cooler	106	150 PSIG Shell 16' x 1 1/4"	24" x 215 5/8"	Carbon Steel Shell, NI 200 Tubes, NI 200 Heads
HE205D	NAOH Cooler	106	150 PSIG Shell 16' x 1 1/4"	24" x 215 5/8"	Carbon Steel Shell, NI 200 Tubes, NI 200 Heads
HE206A	NAOH Chiller	106	150 PSIG Shell 16' x 1 1/4"	24" x 215 5/8"	Nickel Tubes, Nickel Clad Heads, Carbon Steel Shell
HE206B	NAOH Chiller	106	150 PSIG Shell 16' x 1 1/4"	24" x 215 5/8"	Nickel Tubes, Nickel Clad Heads, Carbon Steel Shell
HE223	Steam Heater	300 PSIG 50	1 1/4" x 16'	1'4 x 19' 6 1/16"	Carbon Steel Shell, Nickel Tubes, Solid NI Heads
HE203A	3rd Eff Htr	965	25' 11 7/8" x 1 1/2 OD	8' 2" x 33' 5"	Carbon Steel Shell, Nickel Tubes and Heads
HE202	2nd Eff Htr	2040	25' 11 7/8" x 1 1/2 OD	8' 2" x 33' 5"	Carbon Steel Shell, Nickel Tubes and Heads
HE20A	Pre Cooler	150 PSI Shell 300 PSIG Tubes 268	16' x 1"	24" x 215 5/8"	Carbon Steel Shell, Nickel Tubes, Nickel Clad Heads
HE20B	Pre Cooler	150 PSI Shell 300 PSIG Tubes 268	16' x 1"	24" x 215 5/8"	Carbon Steel Shell, Nickel Tubes, Nickel Clad Heads

Heat Exchangers

Description	Vessel Name	# Of Tubes	Tube Size	Overall Size	Material of Construction
HE4A	I.R Cross Exchanger	150 PSIG 48	1 1/4" x 12'	16" x 13' 10"	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE4B	I.R Cross Exchanger	150 PSIG 48	1 1/4" x 12'	16" x 13' 10"	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE5A	I.R Cross Exchanger	150 PSIG 48	1 1/4" x 12'	16" x 13' 10"	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE5B	I.R Cross Exchanger	150 PSIG 48	1 1/4" x 12'	16" x 13' 10"	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE6A	I.R Cross Exchanger	150 PSIG 48	1 1/4" x 12'	16" x 13' 10"	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE6B	I.R Cross Exchanger	150 PSIG 48	1 1/4" x 12'	16" x 13' 10"	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE6C	Small Chiller	150 PSIG 48	1 1/4" x 12'	16" x 13' 10"	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE6E	Small Chiller	150 PSIG 48	1 1/4" x 12'	16" x 13' 10"'	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE6F	Small Chiller	150 PSIG	1 1/4" x 12'	16" x 13' 10"	Carbon Steel Shell Nickel Tubes & Tube Sheet, Clad Heads
HE222	I.R. Plate & Frame	150 PISG 272		111' 7/8 x 84 1/4 x 37 1/2	Carbon Steel Frame Nickel Plates

Heat Exchangers

Description	Vessel Name	# Of Tubes	Tube Size	Overall Size	Material of Construction
HE206C	I.R. Cooler to Storage	150 PISG 106	16' x 1 1/4"	24" x 215 5/8"	Carbon Steel Shell, Nickel Tubes, NI Clad Heads
HE206D	I.R. Cooler to Storage	150 PSI 106	16' x 1 1/4"	24" x 215 5/8"	Carbon Steel Shell, Nickel Tubes & Sheet, Nickel Clad Heads
HE201	Heater 1st Effect	2684	30' x 1 1/2"		Carbon Steel Shell, Nickel Tubes and Nickel Inlet & Outlet
CD203	E203 Surface Condenser	125 PSIG 8062	7/8 x 39'3 1/4"	15' x 48' x 12' 6 1/4"	Carbon Steel 90-10 CU NI Tubes
HE15A	Coolers	150 PSIG 106	1 1/4" x 16'	24" x 22'	Carbon Steel Shell, NI Tubes and Clad Head & Entry
HE15B	Coolers	150 PSIG 106	1 1/4" x 16'	24" x 22'	Carbon Steel Shell, NI Tubes and Clad Head
HE222A	Cross Exchangers	150 PSIG 106	1 1/4" x 16'	24" x 22'	Carbon Steel Shell, NI Tubes and Clad Head

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Vessels

Vessel No	Vessel Name	Mesh Type	Dia Ht	Bottom Manual	Full Manual	Material of Construction
E-202	2nd Eff Evp	Monel	30' x 47' 1 1/32"			Carbon Steel Nickel Clad
E203	3rd Eff Evp	Monel	36' 8 7/8 x 84' 11 11/16"			Carbon Steel Nickel Clad
E201	Evaporator		19'8 x 33' 0 3/4"			Carbon Steel Nickel Clad
T-246B	Sulfate Tank		60" x 8' 0			Nickel 200
DME-1B	Demister	NI-200	15 PSIG 12 x 20' 2"			Carbon Steel
D-201ME	Demister	NI-200	15 PSIG 12' x 16'			Carbon Steel
T203	Liq Tank		20' x 27' 10" Cone Shape			Carbon Steel Nickel Clad Nickel Weir
CT1	Cond Storage Tank		10' x 12'			Carbon Steel, Epoxy Liner
T10	Storage Tank		20' x 32' Covered Top	33' 9"	4' - 2"	NI Clad

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Vessels

Vessel No	Vessel Name	Mesh Type	Dia Ht	Bottom Manual	Full Manual	Material of Construction
T29	Storage Tank		30' x 30' Covered Top	34' 6"	4' 3"	NI Clad
CP204	Cond Drum		100 PSIG 4' x 7'			Carbon Steel
T-3	CE Storage		80' x 40' Open Top	40' 2"	0"	Carbon Steel Epoxy Lined
T-2A	CE Storage		140' x 32' Open Top	32'	1' 8"	Carbon Steel Epoxy Lined
T1A	CE Storage		140' x 32' Open Top	31' 10"	1' 8"	Carbon Steel Epoxy Lined
T1	CE Storage		70' x 40' Open Top	40' 2"	1' 4"	Carbon Steel Epoxy Lined
T2	CE Storage		70' x 40' Open Top	40' 1"	1' 4"	Carbon Steel Epoxy Lined
T-104	Storage Tank		80' x 24' Covered Top	26' 11	3' 2"	Carbon Steel Epoxy Lined
T-105	Storage Tank		80' x 24' Covered Top	26' 9"	3' 2"	Carbon Steel Epoxy Lined
T-106	Storage Tank		80' x 24' Covered Top	26' 9"	3' 2"	Carbon Steel Epoxy Lined

Vessels

Vessel No	Vessel Name	Mesh Type	Dia Ht	Bottom Manual	Full Manual	Material of Construction
T-108	Storage Tank		160' x 24' Covered Top	27' 10"	4' 5"	Carbon Steel Epoxy Lined
T-109	Storage Tank		125' x 40' Covered Top	42' 10"	14' 10"	Carbon steel Epoxy Lined
T110	Storage Tank		125' x 40' Covered Top	45' 0"	17' 0"	Carbon Steel Epoxy Lined
T111	Storage Tank		150' x 28' Covered Top	32' 8"	5' 2"	Carbon Steel Epoxy Lined
T47	Caustic Storage		40' x 32' Covered Top	35' 4"	3' 4"	Nickel
T-21	Caustic Tank		40' x 40' Covered Top	43' 4"	3' 8"	Carbon Steel Epoxy Lined
T22	Storage Tank		40' x 40' Covered Top	43' 1"	3' 8"	Carbon Steel Epoxy Lined
T28	Storage Tank		40' x 40' Covered Top	43' 2"	3' 8"	Carbon Steel Epoxy Lined
T44	Storage Tank		40' x 24' Covered Top	26' 1"	2' 1"	Carbon Steel Epoxy Lined
T46	Storage Tank		40' x 40' Covered Top	43' 2"	3' 4"	Carbon Steel Epoxy Lined

Vessels

Vessel No	Vessel Name	Mesh Type	Dia Ht	Bottom Manual	Full Manual	Material of Construction
T48	Sump Storage Tank		40' x 40' Covered Top	43' 2"	3' 4"	Carbon Steel Epoxy Lined
T49	Storage Tank		40' x 40' Covered Top	43' 2"	3' 4"	Carbon Steel Epoxy Lined
T214A	Caustic Tank		96" x 8'			Nickel 200
T216	Spent Acid		7' x 10'			Fiberglass
T-245	Clarifier		65' x 16" Open Top	24' 0' From Top Hand Rail	8' 8"	Carbon Steel
T-236	Storage Tank		10' x 10' Closed Top			Carbon Steel
T-11	Water Storage		14'0 x 16'0 Closed Top			Carbon Steel
T-20	Chiller Tank		24' x 32' Closed Top	32' 6"	1' 5"	Carbon Steel, Epoxy Lined
T-218	Cf Surge Tank		6'0 x 8'0' Closed Top Except for Chute			Monel 400

Vessels

Vessel No	Vessel Name	Mesh Type	Dia Ht	Bottom Manual	Full Manual	Material of Construction
T-219	Cf SurgeTank		6'0 x 8'0' Closed Top Except for Chute			Monel 400
T-228	Cf Surge Tank		6'0 x 8'0' Closed Top Except for Chute			Monel 400
T-229	Cf Surge Tank		6'0 x 8'0' Closed Top Except for Chute			Monel 400
T204	Hot Salt Settler	Cone Shape	22'0" x 29' 0" Covered Top			Carbon Steel Alley 200 Cladding
T205	E202 Feed Tank	Cone Shape	21' 3" x 15' 7"			Carbon Steel Alloy 265 Cladding
D205	Salt Column	13' 9" Cone Shape Bottom	16' x 41' 9"			Carbon Steel & Nickel Cone
D207	Sulfate Column	7' 6 7/16 Cone Shape Bottom	9' x 13' 11 3/4"			Monel
CT205	Condensate Tank	100 PSIG	7' 6" x 14' 7 1/2"			Carbon Steel
CT202A	Condensate Tank	150 PSIG	10' x 14'			Carbon Steel
CT2	Bad Condensate Tank	100 PSIG	6' 1" x 9' 5 9/16"			Carbon Steel

Vessels

Vessel No	Vessel Name	Mesh Type	Dia Ht	Bottom Manual	Full Manual	Material of Construction
CT203A	Condensate Tank	63 PSIG	14' x 28'			Carbon Steel
T217	Condensate Tank		48" x 3' 10" Covered Top			Carbon Steel
VS 1	Venturi Scrubber		72" x 7' 4 1/4"			Fiberglass
T12	Tank Farm Sumps Storage		14' x 16'			Carbon Steel
AD301 AD302	Air Dryers		18" x 48 1/4" x 56 1/16" Assembly			Carbon Steel
ST 37	Air Surge Tank		30" x 8'			Carbon Steel
D211	Filter Blow Back Air Tank	150 PSIG	18" x 4'			Carbon Steel
T75	Safety Shower Storage Tank		6' x 6' Covered Top			Carbon Steel
E204	Flash Evaporator	NI-200 Mesh	29' x 36'			Carbon Steel 200 Nickel Clad
T30	Storage Tank		20' 0" x 32' 0" Covered Top			Carbon Steel Nickel Clad

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Pumps

Equipment No	Equipment Name	Drive MFG	Motor HP or Impeller	RPM	Rec 1 GPM	Material of Construction
BLA-204A	Liquid Ring Vacuum Pump		Pull Vacuum on System			Carbon Steel
BLA-204B	Liquid Ring Vacuum Pump		Pull Vacuum on System			Carbon Steel
P204HE	E204 Recirculation Pump	Direct Drive Bingham Pump	30"	892	25,000	Nickel
MP204HE	Motor	Louis Allis	500 HP	892		
P201HE	E201 Recirculation Pump	Morris Pump	54"	280	75,000	Nickel
MP201HE	Motor	Direct Drive Watson Universal Drive Shaft Lufkin Speed Reducer Siemans	1500 H.P.	1780	85,000	
P202HE	E202 Recirculation Pump	Belt Drive Bingham Pump	44 1/2	295	68,000	Nickel
MP202HE	Motor	General Electric	800 HP	900		
P203HEB	E203 Recirculation Pump	Bingham Pump	34 1/2"	392	34,000	Nickel

Pumps

Equipment No	Equipment Name	Drive MFG	Motor HP or Impeller	RPM	Rec 1 GPM	Material of Construction
MP203HEB	Motor	Belt Drive General Electric	300HP	1135		
P203HEA	E203 Recirculation Pump	Bingham Pump	34 1/2"	392	34,000	
MP203HEA	Motor	Siemans Allis	400HP	1885		

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Miscellaneous

Equipment No	Equipment Name	Drive MFG	Motor HP or Impeller	RPM	Rec 1 GPM	Material of Construction
SC201B SC211	Cyclone	150 PSIG Removed Salt From E201 Slurry to E204	26" x 116" 20.5" x 94.54"			Nickel
SC212 SC201B	Cyclone	150 PSIG Removed Salt From E202 Slurry to E201	26" x 116"			Nickel
CF-1	Centrifuge Bird		36" x 72"			Nickel
CF-2	Centrifuge Bird		36" x 72"			Nickel
AC301	Air Compressor					See Mfg Instruction
ARU204	Abortion Refrigeration Unit		600 Ton			See Mfg. Instruction
ARU205	Abortion Refrigeration Unit		300 Ton			See Mfg. Instruction
F211A	Sparkler Filters	100 PSIG	72 3/4" x 17' 11"			Carbon Steel, Nickel Leaves
F211B	Sparkler Filters	100 PSIG	72 3/4" x 17' 11"			Carbon Steel, Nickel Leaves

Miscellaneous

Equipment No	Equipment Name	Drive MFG	Motor HP or Impeller	RPM	Rec 1 GPM	Material of Construction
F211C	Sparkler Filters	100 PSIG	72 3/4" x 17' 11"			Carbon Steel, Nickel Leaves
F211D	Sparkler Filters	100 PSIG	72 3/4" x 17' 11"			Carbon Steel, Nickel Leaves
F211E	Sparkler Filters	100 PSIG	72 3/4" x 17' 11"			Carbon Steel, Nickel Leaves
F211F	Sparkler Filters	100 PSIG	72 3/4" x 17' 11"			Carbon Steel, Nickel Leaves
R501	Water Cooled Rectifier	Input 480V Output 200-2000A @ 1.5-30 VDC Silicon Rectifier	Cabinet 72' x 62' x 56'			Steel
R502	Water Cooled Rectifier	Input 480V Output 200-2000A @ 1.5-30 VDC Silicon Rectifier	Cabinet 72' x 62' x 56'			Steel
R503	Water Cooled Rectifier	Input 480V Output 200-2000A @ 1.5-30 VDC Silicon Rectifier	Cabinet 72' x 62' x 56'			Steel
C501 A&B	Iron Cell		4' 3" x 7' 2 3/8" x 4' High			Carbon Steel, Hypalon Lined
C502 A&B	Iron cell		4' 3" x 7' 2 3/8" x 4' High			Carbon Steel, Hypalon Lined
C503 A&B	Iron cell		4' 3" x 7' 2 3/8" x 4' High			Carbon Steel, Hypalon Lined

Miscellaneous

Equipment No	Equipment Name	Drive MFG	Motor HP or Impeller	RPM	Rec 1 GPM	Material of Construction
T46 Filter LFW #2	Loading Filter		20" x 84"			Carbon Steel Epoxy Lined
T49 Filter LFE #1	Loading Filter		20" x 84"			Carbon Steel Epoxy Lined