Interoffice Communication

To John Friend

From R. W. Churns

Date March 15, 1978

Subject Split HCl Feed to Oxy - Revised Design

The attached replaces the revised Class "A" Process Design dated January 11, 1978. It incorporates recommendations made in the review meeting held January 25, 1978.

RW Churns

R. W. Churns
Senior Process Engineer
Chemicals Division
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dm
Enc
CC:
JADe:JRH:HDG:GLF:JOG:
DG:RWE:ROW:DEB:GJF:RAR

File A27.1

CLASS "A" PROCESS DESIGN
SPLIT HCl FEED TO OXY
VCM PLANT

October 21, 1977
Revised January 11, 1978
Revised March 15, 1978

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SPLIT HCl FEED TO OXY

VCM PLANT

RWC-dm
*Revised 1/11/78
+Revised 3/15/78

PROBLEM DESCRIPTION

SPLIT HCl FEED TO OXY

VCM PLANT

The major by-product from the oxychlorination reaction is ethyl chloride. The ethyl chloride make consumes between 1.8 and 3.8 percent of the ethylene and HCl feed to oxychlorination, depending on the type and age of the oxychlorination catalyst and reactor operation. The ethyl chloride yield loss can be reduced by lowering the HCl concentration in the first oxychlorination reactor. Shell Oil Company has demonstrated that the ethyl chloride loss can be reduced by 0.5 to 0.8 percent by splitting the HCl feed between the first and second oxychlorination reactors, rather than feeding all the HCl to the first reactor as in the conventional Stauffer oxychlorination process. By splitting the HCl feed, the HCl concentration in the first reactor is reduced. The proposed control valve loop will add up to 30 percent of the total HCl feed directly to the second reactor.

In the oxychlorination reaction, the unreacted HCl in the first reactor acts as a diluent and suppresses the flammability of the air and ethylene mixture. Shell calculates that the gas mixture in the first reactor may become flammable if the HCl split to the second reactor is greater than 40 percent. Therefore, instrumentation will be installed to limit the HCl flow split when it approaches 40 percent. In addition, a small computer will be installed to continuously monitor the flammability of the first reactor. Both the HCl flow limiting system and the computer will have redundant inputs to minimize the flammability hazard resulting from a malfunction of one input loop.

At present, the reaction load carried by each reactor is adjusted where possible to prevent one reactor's catalyst from decaying appreciably before the other reactors. By splitting the HCl flow, the reaction load of the first two reactors can be better controlled and the catalyst run life may be extended.

If the pressure differential across the first oxychlorination reactor is unexpectedly increased by ethylene or air contamination, the plant may have to shut down immediately and recharge the reactor. By having the option to feed HCl directly to the second reactor, the reaction load and pressure drop of the first reactor can be greatly reduced, allowing the plant to continue operation while the shutdown work is organized. Although the plant would be operating at reduced rates, the resulting loss in production may be less than the loss resulting from an emergency shutdown and catalyst recharge operation.

RWC-1km
10/25/77

PROCESS DESCRIPTION

SPLIT HCl FEED TO OXY

VCM PLANT

Piping Revisions

A new monel line will be installed to carry HCl from the acetylene hydrogenators to the inlet of the second stage oxychlorination reactor, R-302. This stream will be ratio flow controlled so that 30 percent of the total HCl to oxy will go to R-302.

Shutdown System

The present oxy shutdown system will be revised so that, if the HCl to R-302 is greater than 40 percent of the total HCl flow, the HCl flow to R-302 will stop. The HCl to R-302 will be blocked in on instrument air failure and pullbutton emergency stop.

Computer

The proposed computer is an Interdata 8/16 with 65K bytes of memory, dual floppy disc drives, and a 30-character per second typer. It provides 16 digital input and output lines, 16 differential or 32 single ended analog inputs, and four analog outputs. The analog inputs can be strapped to allow input of any of the standard instrumentation signals, and the analog outputs can be similarly strapped and have an output capability of 5 ma. Vendor literature on the computer is attached.

The computer will take the air, ethylene, HCl and steam flows, and the air, ethylene, HCl, and reactor inlet and outlet temperatures and calculate an overall heat and material balance for oxy and heat and material balances for each reactor. This calculation will be made at least every five seconds. The computer will calculate and record the approach to flammability for the R-301 inlet and outlet and the R-302 inlet and will cause an alarm to be sounded if the approach to flammability exceeds 95 percent. A high approach to flammability shutdown will not be provided at this time.

Explosive Limit

With a 30 percent HCl split (5.4 percent O_2), the oxy system will operate closer to the explosive limit than with a 0 percent HCl split (4.5 percent O_2) at the R-301 inlet. Under normal conditions (109 psig and 120°C), neither of these points will be within the explosive limit (see the attached explosibility chart). The only other potentially hazardous spot is the R-301 outlet if reaction is lost. The computer will cause an alarm in this case.

RWC-lkm
10/25/77
Revised 3/15/78

WORK LIST

SPLIT HCl FEED TO OXY

VCM PLANT

1. The computer is to be shipped from the manufacturer to Ponca City for checkout and programming by Central Computer Department personnel. The computer will then be shipped to Lake Charles and be installed in the chief operator's office.

2. Install and insulate 6-XH-301-H-A20-1 including the flow control valve and orifice from the new six-inch valve upstream from PRC-216B valve to the new six-inch valve on the line from R-301 to R-302 upstream from the air addition point.

3. Install flow transmittee FT-320 (2 d/p cells with a high select relay) in the field and flow ratio recorder controller FRRC-320 in the oxy section of the control room. Connect the output from FRC-312 transmitter to this controller.

4. Install a shutdown solenoid at FRRC-320 valve. Hook this into the existing oxy shutdown system. This valve is to fail closed on instrument failure and/or activation of the emergency pull button.

5. Install pressure switch PS-320 on the ratio output from FRRC-320. This signal is to alarm at 35 percent HCl to R-302 close FRRC-320 at 40 percent HCl to R-302.

6. Install pneumatic to current relays on the following flow signals:

   a. FRC-303 - Air to R-301
   b. FR-304 - Steam from S-301
   c. FRC-306 - Air to R-302
   d. FR-307 - Steam from S-302
   e. FRC-308 - Air to R-303
   f. FR-309 - Steam from S-303
   g. FRC-302 - HCl to Oxy
   h. FRRC-313 - Ethylene to R-301
   i. FRRC-320 - HCl to R-302

   Connect the electronic signals to the appropriate analog input points on the new oxy minicomputer.

7. Install dual thermocouples in the following existing thermowells:

   a. TR-302-1 - R-301 Inlet
   b. TR-304-1 - R-302 Inlet
   c. TR-305-1 - R-303 Inlet

   Connect the existing lead wire to the appropriate thermocouple. Run lead wires from each thermocouple to the appropriate analog input point on the new oxy minicomputer.

8. Connect the appropriate minicomputer analog output points to recorder UR-321:

   a. UR-321 Red - R-301 Inlet Approach to Flammability
   b. UR-321 Blue - R-301 Outlet Approach to Flammability
   c. UR-321 Green - R-302 Inlet Approach to Flammability

   High flammability alum UA-321 is to alarm if any point exceeds 95 percent flammability.

9. Install a fourth thermocouple in the existing thermowell in the southwest quadrant of R-301, R-302, and R-303. This couple is to measure the temperature as deep in the reactor as possible. Run lead wires to the appropriate analog input on the new oxy minicomputer.

10. Revise the air-to-ethylene ratio computer and shut down as follows:

    a. Change the bellows on the Foxboro Model 556 pneumatic analog computer to a Model 80 with a scaling factor of 3.500. This can be done off line with a spare computer.

    b. The air flow signal from FRC-303 should be fed to the "A" port and the ethylene flow signal from FRRC-313 to the "C" port.

    c. Set PS-315, PdHA-311, and PdLA-313 as follows:

Item	Function	Air-to-Ethylene Molar Ratio	Set Point
PS-315	High Air-to-Ethylene Ratio Shutdown	1.3	11.2 psi Rising
PdHA-311	High Air-to-Ethylene Ratio Alarm	1.1	8.9 psi Rising
PdLA-313	Low-Air-to-Ethylene Ratio Alarm	0.6	4.8 psi Falling

    d. Remove the existing manual loading station which puts an artificial signal on PS-315 for maintenance bypass.

RWC-dm
Revised 1/11/78
Revised 3/16/78

OXY SHUTDOWN SYSTEM REVISIONS

SPLIT HCl FEED TO OXY

VCM PLANT

The potential for explosive mixtures to form in oxy has been evaluated, and changes to the oxy shutdown system are proposed. Material balances have been prepared using the original flow rates as proposed by Stauffer, flows rates as the plant presently operates, and flow rates that would be experienced with HCl split 70 percent to R-301 and 30 percent to R-302.

The restrictions for the oxy shutdown proposals are represented in Figure 2. Point A represents R-301 inlet concentrations under present operating conditions. Points A through F are the normal operating conditions for each reactor's inlet and outlet stream with the split HCl feed.

As with the present oxy flow rates, the inlet feed to R-301 is the only stream that could potentially reach explosive oxygen concentrations. If at normal R-301 split HCl feed conditions the air rate increases to 1.54 times the ethylene flow rate, the feed reaches the explosive region as shown by Point I. When the HCl flow to R-301 drops to 56 percent of normal total HCl to oxy (that is, the total HCl flow falls to 80 percent of normal with 70 percent of the total HCl going to R-301), the feed concentration will go from Point A to Point G. With air increasing, Point J is reached and the feed to R-301 approaches the explosive level at 1.33 air-to-ethylene ratio. This leads to the selection of 80 percent of normal HCl flow as the low shutdown point and a high air-to-ethylene ratio shutdown of 1.30 with a high ratio alarm set at 1.10.

The other situation considered was the air-to-ethylene shutdown requirements with the present low HCl shutdown remaining at 55 percent of normal. If the HCl flow drops to 55 percent of normal and the air and ethylene feeds remain at normal rates, the mixture is at Point H. Point K shows that, at this HCl flow rate, the air-to-ethylene ratio must be greater than 1.13 for the R-301 feed concentrations to be explosive.

The segment from A to M to N shows that, under low ethylene flow conditions, the feed mixture never reaches the oxygen concentration required to make the inlet stream explosive. The present 55 percent of normal etylene flow shutdown point will provide adequate protection.

Figures 3 and 4 show the shutdown points under current operating conditions and original design conditions, respectively.

The air-to-ethylene ratios are taken with the existing Foxboro Model 556 pneumatic analog computer. It is necessary to change the bellows on the existing unit to a Model 80 with a scaling factor of 3.500. This change can be done off-stream with a spare computer. With these conditions, the output from FRC-303 should be fed to "A" port and FRRC-313 to "C" port. The output from "B" port goes to PS-315, PdHA-311, and PdLA-313. These should be as follows:

Item	Air-to-Ethylene Ratio	Set Point
PS-315	1.3	11.2 psi Rising
PdHA-311	1.1	8.9 psi Rising
PdLA-313	0.6	4.8 psi Falling

Presently, PS-315, the high ratio shutdown, is set at 6.00 psi falling signal. To bypass this shutdown for maintenance, a manual loading station is used to place an artificial signal above 12 psi on PS-315. Since PS-315 will now be set at 11.2 rising signal, the signal to PS-315 should be vented to bypass the high ratio shutdown without shutting down oxy. The manual loading station is no longer necessary and should be removed.

OPERATING PROCEDURE

SPLIT HCl FEED TO OXY

VCM PLANT

General

The split HCl system has been piloted by Stauffer and is in operation at Shell's VCM plant. Its purpose is to improve yields by reducing ethyl chloride formation. It also improves oxy run length by reducing the flow through and thus the pressure drop across R-301. Because of the lower R-301 flow, the R-301 hot spot temperature is more difficult to control. For this reason, splitting of the HCl is not done until the fifth month of an oxy catalyst run when the catalyst has begun to deactivate. This design consists of piping and instrumentation revisions and the computer. The computer only monitors the oxy system and calculates the approach to flammability. It does not have control or shutdown features.

Specific Steps

Start up oxy in the normal manner.

Make sure the computer is operating.

Make sure the HCl line to R-302 is not blocked in.

Input the S-309 HCl strength to the computer using the teletype.

When oxy is lined out at the desired rates, gradually cut HCl into R-302. Take about an hour to switch 30 percent of the total HCl into R-302. Watch the percent flammability at the R-301 inlet (UR-321 red pen). If it exceeds 80 percent, back off on the HCl to R-302.

When the lab reports a new value for S-309 HCl strength, input it to the computer using the teletype. The computer will then output an oxy material balance.

If any trouble occurs, especially high percent flammability on the R-301 inlet, back off on the HCl to R-302. The shutdown system is set up to stop HCl flow to R-302 on low total HCl flow.

On a planned shutdown, gradually cut the HCl out of R-302. Then shut down in the normal manner.

RWC-lkm
3/16/78

CONOCO

ENGINEERING CENTER

PONCA CITY, OKLAHOMA

SPECIFICATION SHEET

FLOW INSTRUMENTS

AFE NO 8267
DATE 10-13-77 W O NO
MADE BY RWC INQ. NO
APP'D BY GSF REQ NO
B M NO P O NO

PLANT VCM PLANT PROJECT SPLIT HCl FEED TO OXY

1	TAG NO	FRRC-320			
2	SERVICE	HCl FLOW TO R-302			
3					
4	INSTRUMENT, TYPE	dP CELL (1)			
5	LOCATION	LOCAL			
6	ELEMENT TYPE	ORIFICE			
7	LOCATION	6-XH-301-H-A20-1			
8	LINE SIZE, IN. / SCHEDULE	6 / 10			
9	BORE, IN	3.666			
10	RANGE, IN H_2O	100			
11	METER FACTOR	2500 LB/HR			
12	VALVE TYPE	PLUG (2)			
13					
14	LOCATION	6-XH-301-A20-1			
15	MATERIAL	NICKEL			
16	BODY SIZE / PORT SIZE	3" / 3"			
17	PLUG FORM	PLUG (2)			
18	ΔP MIN / NOR / MAX	10 / 15 / 60			
19	CALC Cv / VALVE Cv	153 / 216			
20	AIR TO OPEN OR CLOSE	OPEN			
21	MAX SHUTOFF ΔP	120			
22	FLUID	HCl VAPOR			
23	TEMPERATURE °F	259			
24	PRESSURE PSIG	109			
25	°API (M W)	(36.47)			
26	SP GR AT STD. COND	—			
27	SP GR AT P & T	—			
28	CP/CV AT T & P / COMPRESSIBILITY	1.29 / 0.982			
29	VISCOSITY AT P & T	0.0185			
30	RATE NORMAL	16615			
31	RATE MAX / MIN	32362 / 5540			
32	NOTES				

(1) TWO dP CELLS WITH COMMON ORIFICE

(2) DURCO MODEL 411 PLUG VALVE
QUADRAPOWER MODEL 60 SPRING DIAPHRAGM ACTUATOR
HONEYWELL VALVE POSITIONER WITH GAGES.

CCR 000037575

REV 2 : 3- -78
REV 1 : 1-6-78

SHEET 1 OF 1 REV 2

CENTRAL ENGINEERING DEPARTMENT

PONCA CITY, OKLAHOMA

SPECIFICATION SHEET

INDICATORS, RECORDERS, CONTROLLERS

AFE NO 8267
DATE 10-14-77 W O NO
MADE BY RWC ENG NO
APP'D BY GJF REQ NO
B M NO P O NO

PLANT VCM PLANT PROJECT SPLIT HCl FEED TO OXY

		ITEM NO	FRRC-320	UR-321		
		SERVICE	HCl FLOW TO R-302	OXY EXPLOSIBILITY		
RECEIVER		INDICATOR OR RECORDER	RECORDER	RECORDER		
		INPUT SIGNAL PNEU - ELEC	PNEU	ELEC		
		LOCATION YARD - PANEL	PANEL	PANEL		
		MOUNTING YOKE - FLUSH				
		NO OF PENS OR POINTERS	2 (1)	3		
		CHART SIZE - CIRCULAR - STRIP	STRIP	STRIP		
		CHART RANGE	0-10 √	0-100		
		CHART NUMBER				
		CHART FACTOR	2500 LB/HR	1 % EXPLOSIVE		
		CHART DRIVE MECH ELEC	ELEC	ELEC		
		SCALE RANGE	0-10 √	0-100		
		CALIBRATED ACCURACY	± 1%	± 1%		
		SENSITIVITY				
		REPEATABILITY				
CONTROLLER		CONTROLLER LOCATION	BOARD			
		CONTROLLER ACTION INPUT	3-15 PSI			
		CONTROLLER ACTION OUTPUT	3-15 PSI			
		PROP BAND PER CENT	✓			
		AUTOMATIC RESET	✓			
		DERIVATIVE	✓			
		CASCADE RESET BY	✓			
		REPEATABILITY				
		SENSITIVITY				
		ACCESSORIES				
		MANUFACTURER				
		MODEL NO				
		PRICE				

GENERAL SPECIFICATIONS

RECORDER INK SUPPLY CAPILLARY WITH 6 MONTHS MIN SUPPLY

ALL CONTROL STATIONS SHALL HAVE A VALVE POSITION INDICATOR AUTOMATIC-MANUAL SWITCH AND DIRECT - REVERSE SWITCH

ELECTRONIC INSTRUMENTS SHALL HAVE A SOLID STATE SYSTEM

ELECTRIC CHART DRIVE 115 VOLT 60 CYCLE SYNCHRONOUS MOTOR

CCR 000037576

MECH CHART DRIVE 24 HOUR SPRING WIND

PROPORTIONAL BAND COMPLETELY ADJUSTABLE

INSTR ELEC CLASSIFICATION IS CLASS 1 GROUP D DIVISION 2 UNLESS OTHERWISE NOTED

(1) CONTROL PEN IS HCl FLOW TO R-302. RECORDED (SECOND) PEN IS RATIO OF HCl FLOW TO R-302 TO TOTAL HCl FLOW.

NOTES UA-321 IS COMMON HIGH EXPLOSIBILITY ALARM FOR ALL 3 POINTS ON UR-321

REV 2 : 5-8-78
REV 1 : 1-6-78

SUPPLIER TO COMPLETE FORM BY FURNISHING INFORMATION FOR BLANK SPACES

SHEET 1 OF 1 REV 2

ENGINEERING CENTER
PONCA CITY, OKLAHOMA
SPECIFICATION SHEET
THERMOCOUPLES AND WELLS

AFE NO 8267
DATE 1-6-78 W O NO
MADE BY RWE INQ NO
APP'D BY GSF REQ NO
B M NO P O NO

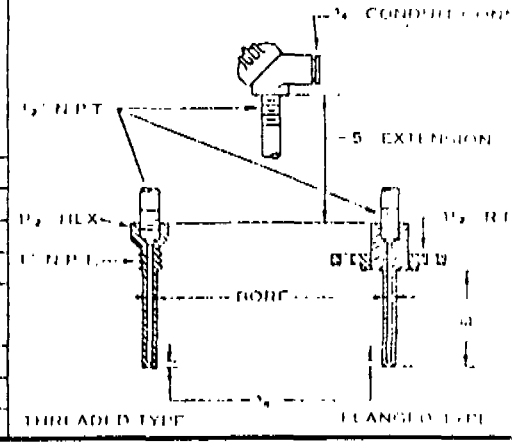
UNIT VCM PLANT PROJECT SPLIT HCL FEED TO OXY

	TR-302-1 TR-304-1 TR-305-1	TR-302-12 TR-304-12 TR-305-12
TYPE SINGLE DUPLEX	DUPLEX	SINGLE
TYPE OF WIRE	J	J
WIRE SIZE	14 GAUGE	14 GAUGE
INSULATOR MATERIAL	CERAMIC	CERAMIC
NO HOLES IN INSULATOR		
INSULATOR SIZE		
	TWO THERMOCOUPLES IN EXISTING WELL - ONE SIGNAL TO TR - ONE SIGNAL TO COMPUTER	ADD 4TH COUPLE TO EXISTING WELL - RUN SIGNAL TO COMPUTE
MODEL NO		
TYPE THD FLGD	EXISTING	EXISTING
FLANGE RATING	"	"
LENGTH BELOW THD OR FLG'D	"	"
WELL MATERIAL	"	"
FLANGE MATERIAL	"	"
WELL BORE	"	"
MODEL NO	"	"
MANUFACTURER		
UNIT PRICE		

GENERAL

THERMOCOUPLE HEAD CASE TO BE WEATHERTIGHT CAST ALUMINUM, GASKETED WITH SCREW ON COVER CHAINED TO HEAD

EXPANSION ½ STD WT STEEL NIPPLE



CCR 000037577

REV 1: 3-8-78

REFER TO COMPLETE FORM BY THOMPSON'S FOR INFORMATION FOR BLANK SPACES

SHEET 1 OF 1 REV 1

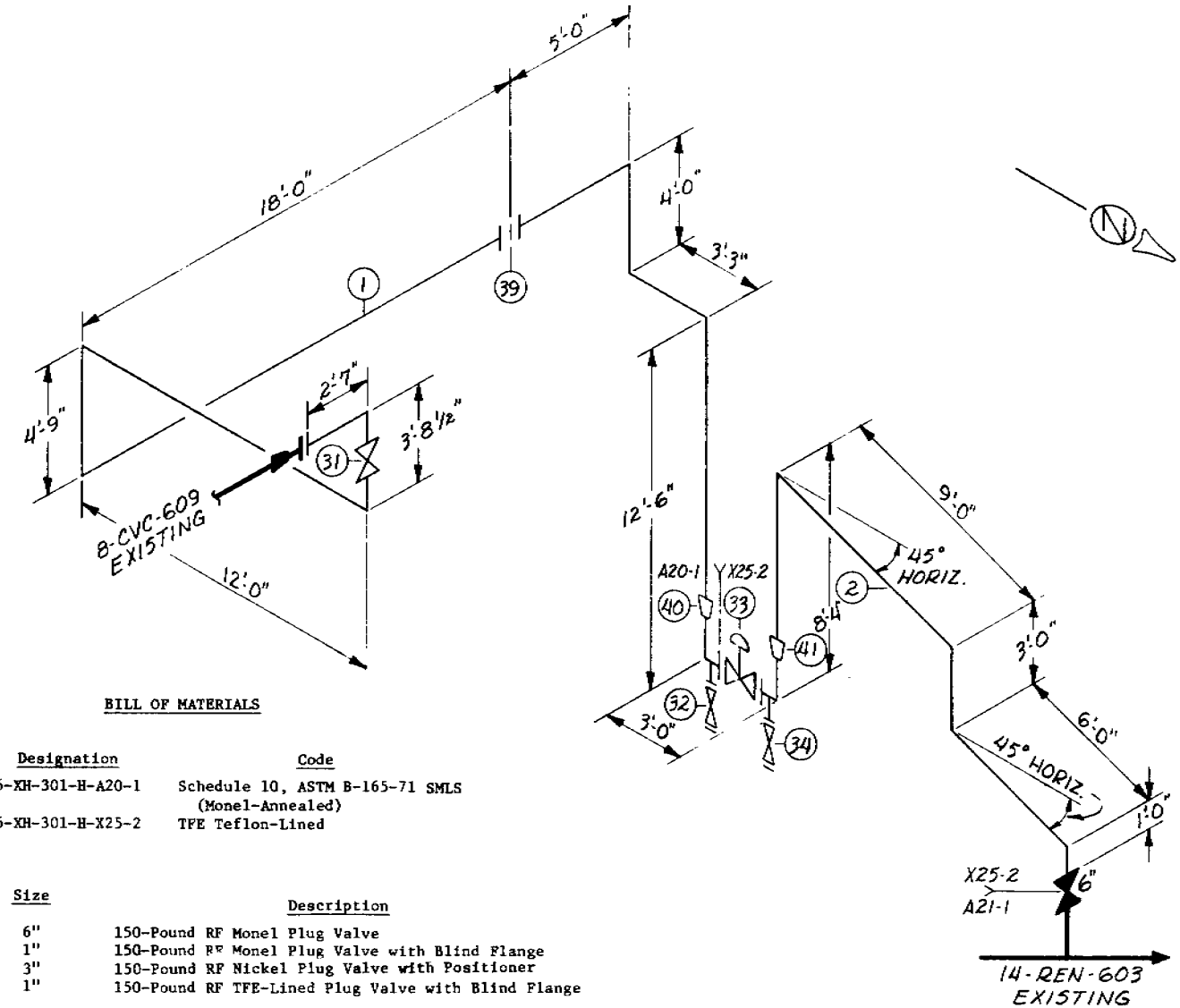
REV 1-6-78 Rev 1

PROCESS PIPING SCHEDULE
PROCESS ENGINEERING DEPARTMENT

Date 10-14-77 Made By RWC
Project SPLIT H2 FEED TO OXY
Plant VCM PLANT

Line Designation	Service From	Service To	V L	Flow Rate Lb/Hr (Hot BPSD)	Normal °F	Normal PSIG	At T and P Lb/CF (Sp Gr)	At T and P Visc Cp	Press Drop PSI/100'	Velocity Ft/Sec	Remarks
6-XH-301-H-A20-1	8"CUC-609	FRRC-320	V	16615	260	95	0.527	0.01	0.32	40	30% OF HCl TO R-302
6-XH-301-H-X-25-2	FRRC-320	14"REN-603	V	16615	260	95	0.527	0.01	0.32	40	TFE

CCR 000037578



LEGEND:

——— New

━━━ Existing

BILL OF MATERIALS

Pipe

Item	Designation	Code
1	6-XH-301-H-A20-1	Schedule 10, ASTM B-165-71 SMLS (Monel-Annealed)
2	6-XH-301-H-X25-2	TFE Teflon-Lined

Valves

Item	Size	Description
31	6"	150-Pound RF Monel Plug Valve
32	1"	150-Pound RF Monel Plug Valve with Blind Flange
33	3"	150-Pound RF Nickel Plug Valve with Positioner
34	1"	150-Pound RF TFE-Lined Plug Valve with Blind Flange

Miscellaneous

Item	Size	Description
39	Two at 6"	300-Pound Monel Orifice Flanges
40	6" x 3"	Monel Eccentric Weld Reducer
41	6" x 3"	TFE-Lined Eccentric Weld Reducer

PIPING ISOMETRIC
6-XH-301-H-A20-1
SPLIT HCl FEED TO OXY
VCM PLANT

Sheet 1 of 1 Rev. 1

Drawing No. SD-2556-77-1-B

COMPUTER PROGRAM DESCRIPTION

SPLIT HCl FEED TO OXY

VCM PLANT

The purpose of the computer program is to simulate the stream compositions of the oxychlorination reactor section. The program inputs the inlet stream's temperature; each reactor's outlet temperature; the outlet HCl strength; the percent of differential pressure readings for air, HCl, and ethylene; and the steam produced by each reactor. With this information, the program calculates an overall heat and material balance for the primary oxy reactor suite and heat and material balances for each reactor every five seconds.

From the material balance the program calculates oxygen concentrations at the R-301 inlet and outlet and R-302 inlet. The oxygen concentration required for a flammable mixture is only dependant on temperature (not composition). This concentration is 7.0 mol percent at 130°C (R-301 inlet), 4.6 mol percent at 250°C (R-301 outlet), and 5.6 mol percent at 210°C (R-302 inlet). The approach to flammability (actual percent O_2 devided by percent O_2 at flammability) is calculated and outputted for the above three points. An alarm (not part of the computer) will be sounded if the approach to flammability exceeds 95 percent at any location.

RAR-lkm
1/11/78
Revised 3/16/78

TABLE III
MATERIAL BALANCE
SPLIT HCl FEED TO OXY
VCM PLANT

Proposed Operations
30% HCl to R-302

Component	STREAM, POUND MOLS/HOUR											
	Ethylene Feed	HCl to R-301	Air to R-301	R-301 Feed	R-301 Effluent	HCl to R-302	Air to R-302	R-302 Feed	R-302 Effluent	Air to R-303	R-303 Feed	R-303 Effluent
Ethylene	816.90	0.10	-	817.00	593.95	0.04	-	593.95	318.67	-	318.67	61.32
HCl	-	1,060.47	-	1,060.47	624.07	454.49	-	1,078.56	539.53	-	539.53	35.70
Oxygen	-	-	136.53	136.53	17.21	-	141.78	158.99	25.84	145.38	171.22	19.22
Nitrogen	-	-	506.95	506.95	506.95	-	526.43	1,033.38	1,033.38	539.79	1,573.17	1,573.17
Argon	-	-	6.45	6.45	6.45	-	6.70	13.15	13.15	6.88	20.03	20.03
Water	-	-	15.44	15.44	235.25	-	16.03	251.28	522.77	16.43	539.20	792.97
CO and CO_2	-	-	-	-	12.04	-	-	12.04	26.92	-	26.92	40.82
EDC	-	-	-	-	204.06	-	-	204.06	456.11	-	456.11	691.70
VCM	-	0.36	-	0.36	0.52	0.15	-	0.67	0.87	-	0.87	1.06
Light Ends	6.57	2.00	-	8.57	18.23	0.85	-	19.08	31.01	-	31.01	39.41
Heavy Ends	-	-	-	-	3.02	-	-	3.02	6.75	-	6.75	10.24
Total Mols/Hour	823.47	1,062.93	665.37	2,551.77	2,221.75	455.53	690.94	3,368.22	2,975.00	708.48	3,683.48	3,288.39
Pounds/Hour	23,009	38,770	19,105	80,884	80,884	16,615	19,389	117,338	117,338	20,342	137,657	137,657
Molecular Weight	27.94	36.47	28.71	31.70	36.41	36.47	28.71	34.84	39.44	28.71	37.37	41.86
Temperature, °C	126	126	143	130	245	126	143	210	216	143	205	225
Pressure, psig	248	121	117	109	102	121	117	102	95.2	117	95	72.1
Mol % O_2	0	0	20.5	5.4	0.8	0	20.5	4.7	0.9	20.5	4.6	0.6
Mol % Ethylene	99.2	0	0	32.0	26.7	0	0	17.6	10.7	0	8.7	1.7

RWC-1km
10/25/77

TABLE IV
MATERIAL BALANCE
SPLIT HCl FEED TO OXY
VCM PLANT

Current Operating Conditions
0% HCl to R-302

Component	Ethylene Feed	HCl to R-301	Air to R-301	R-301 Feed	R-301 Effluent	HCl to R-302	Air to R-302	R-302 Feed	R-302 Effluent	Air to R-303	R-303 Feed	R-303 Effluent
	STREAM, POUND MOLS/HOUR											
Ethylene	816.90	0.14	-	817.04	593.99	-	-	593.99	318.67	-	318.67	61.32
HCl	-	1,514.96	-	1,514.96	1,078.56	-	-	1,078.56	539.53	-	539.53	35.70
Oxygen	-	-	136.53	136.53	17.21	-	141.78	158.99	25.84	145.38	171.22	19.22
Nitrogen	-	-	506.95	506.95	506.95	-	526.43	1,033.38	1,033.38	539.79	1,573.17	1,573.17
Argon	-	-	6.45	6.45	6.45	-	6.70	13.15	13.15	6.88	20.03	20.03
Water	-	-	15.44	15.44	235.75	-	16.03	251.28	522.77	16.43	539.20	792.97
CO and CO_2	-	-	-	-	12.04	-	-	12.04	26.92	-	26.92	40.82
EDC	-	-	-	-	204.06	-	-	204.06	456.11	-	456.11	691.70
VCM	-	0.51	-	0.51	0.67	-	-	0.67	0.87	-	0.87	1.06
Light Ends	6.57	2.85	-	9.42	19.08	-	-	19.08	31.01	-	31.01	39.41
Heavy Ends	-	-	-	-	3.02	-	-	3.02	6.75	-	6.75	10.24
Total Mols/Hour	823.47	1,518.46	665.37	3,007.30	2,677.28	0	690.94	3,368.22	2,975.00	708.48	3,683.48	3,288.39
Pounds/Hour	23,009	55,385	19,105	97,499	97,499	0	19,839	117,338	117,338	20,342	137,657	137,657
Molecular Weight	27.94	36.47	28.71	32.42	36.42	-	28.71	34.84	39.44	28.71	37.37	41.86
Temperature, °C	126	126	143	129	238	-	143	207	216	143	205	225
Pressure, psig	248	121	117	109	99	-	117	99	92	117	92	68
Mol % O_2	0	0	20.5	4.5	0.6	0	20.5	4.7	0.9	20.5	4.6	0.6
Mol % Ethylene	99.2	0	0	27.2	22.2	0	0	17.6	10.7	0	8.7	1.9

RWC-lkm
10/25/77

TABLE V
MATERIAL BALANCE
SPLIT HCl FEED TO OXY
VCM PLANT

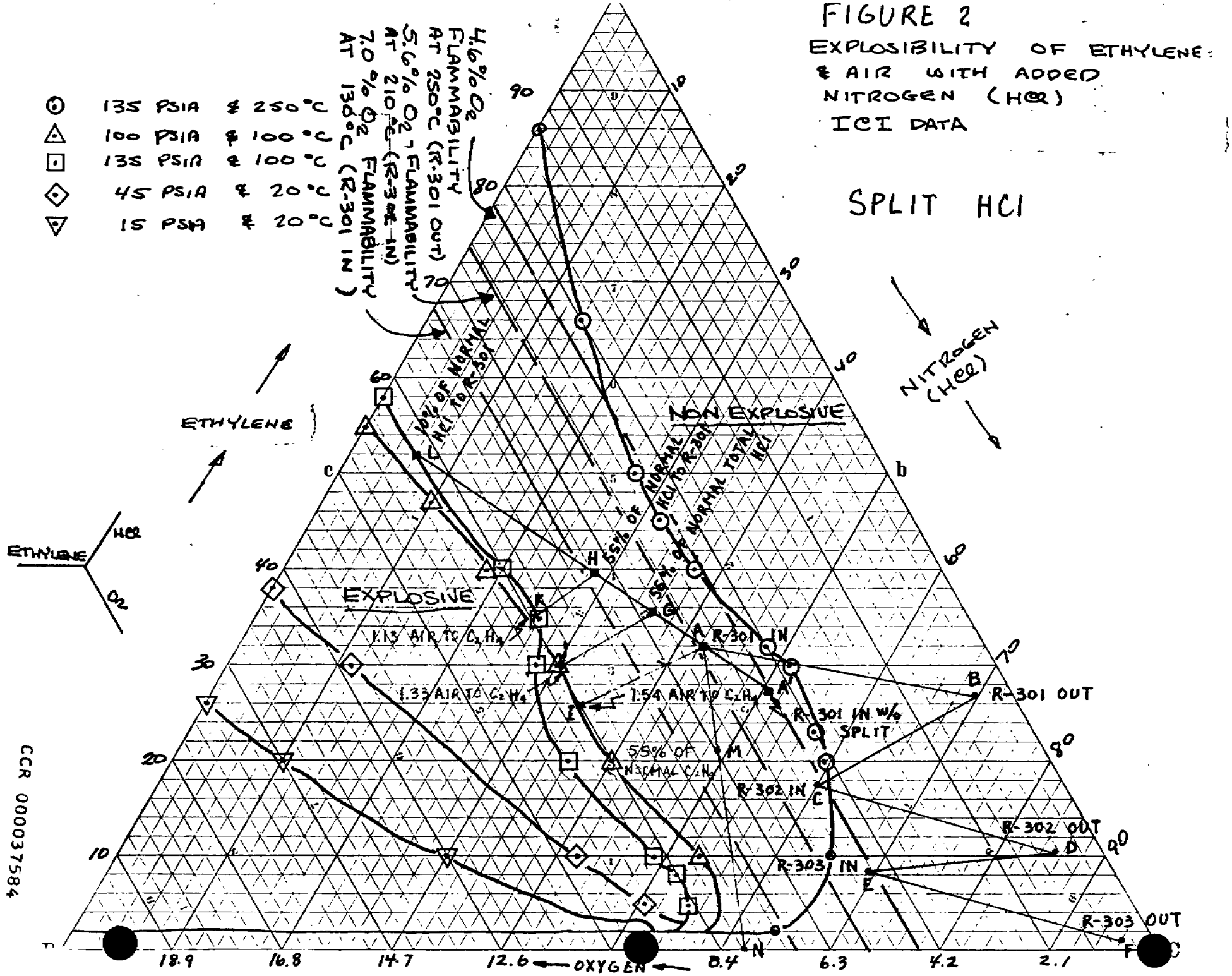
Original Stauffer Design
0% HCl to R-302

Component	STREAM POUND MOLS/HOUR											
	Ethylene Feed	HCl to R-301	Air to R-301	R-301 Feed	R-301 Effluent	HCl to R-301	Air to R-302	R-302 Feed	R-302 Effluent	Air to R-303	R-303 Feed	R-303 Effluent
Ethylene	646.0	-	-	646.0	403.1	-	-	403.1	190.6	-	190.6	38.8
HCl	-	1,211.8	-	1,211.8	732.9	-	-	732.9	313.9	-	311.9	14.6
Oxygen	-	-	151.2	151.2	15.5	-	151.2	166.7	48.0	75.6	123.6	38.8
Nitrogen	-	-	569.0	569.0	569.0	-	569.0	1,138.0	1,138.0	284.5	1,422.5	1,422.5
Water	-	-	-	-	253.8	-	-	253.8	468.9	-	468.9	-
CO and CO_2	-	-	-	-	9.3	-	-	9.3	17.5	-	17.5	-
EDC	-	-	-	-	225.9	-	-	225.9	423.5	-	423.5	564.7
Light Ends	-	-	-	-	4.9	-	-	4.9	9.1	-	9.1	12.1
Heavy Ends	-	-	-	-	7.4	-	-	7.4	14.0	-	14.0	18.8
Total Mols/Hour	646.0	1,211.8	720.2	2,578.0	2,221.8	0	720.2	2,942.0	2,623.5	360.1	2,983.6	2,758.8
Pounds/Hour	18,088	44,182	20,770	83,089	83,086	0	20,770	103,857	103,741	10,385	114,126	114,159
Molecular Weight	28.00	36.46	28.8	32.2	37.4	-	28.8	35.3	39.5	28.8	38.3	41.5
Temperature, °C	134	138	105	135	-	-	105	220	-	105	220	220
Pressure, psig	195	95	120	95	-	-	120	82	-	120	73	64
Mol % O_2	-	0	21.0	5.9	0.7	0	21.0	5.7	1.8	21.0	4.1	1.4
Mol % Ethylene	100.0	0	0	25.1	18.1	0	0	13.7	7.3	0	6.4	1.4

RAR-1km
1/11/78

FIGURE 2

EXPLOSIBILITY OF ETHYLENE & AIR WITH ADDED NITROGEN (HCl) ICI DATA



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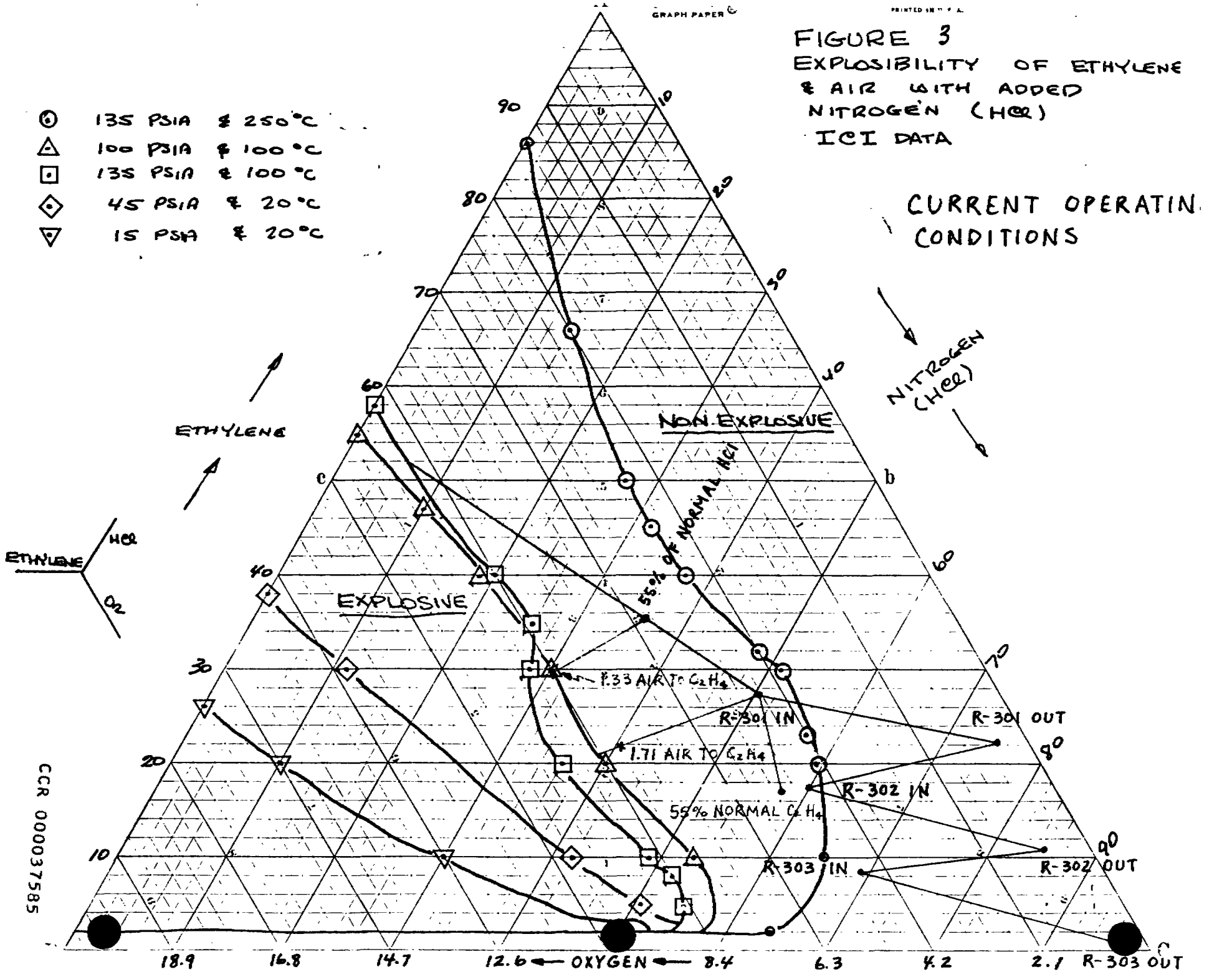
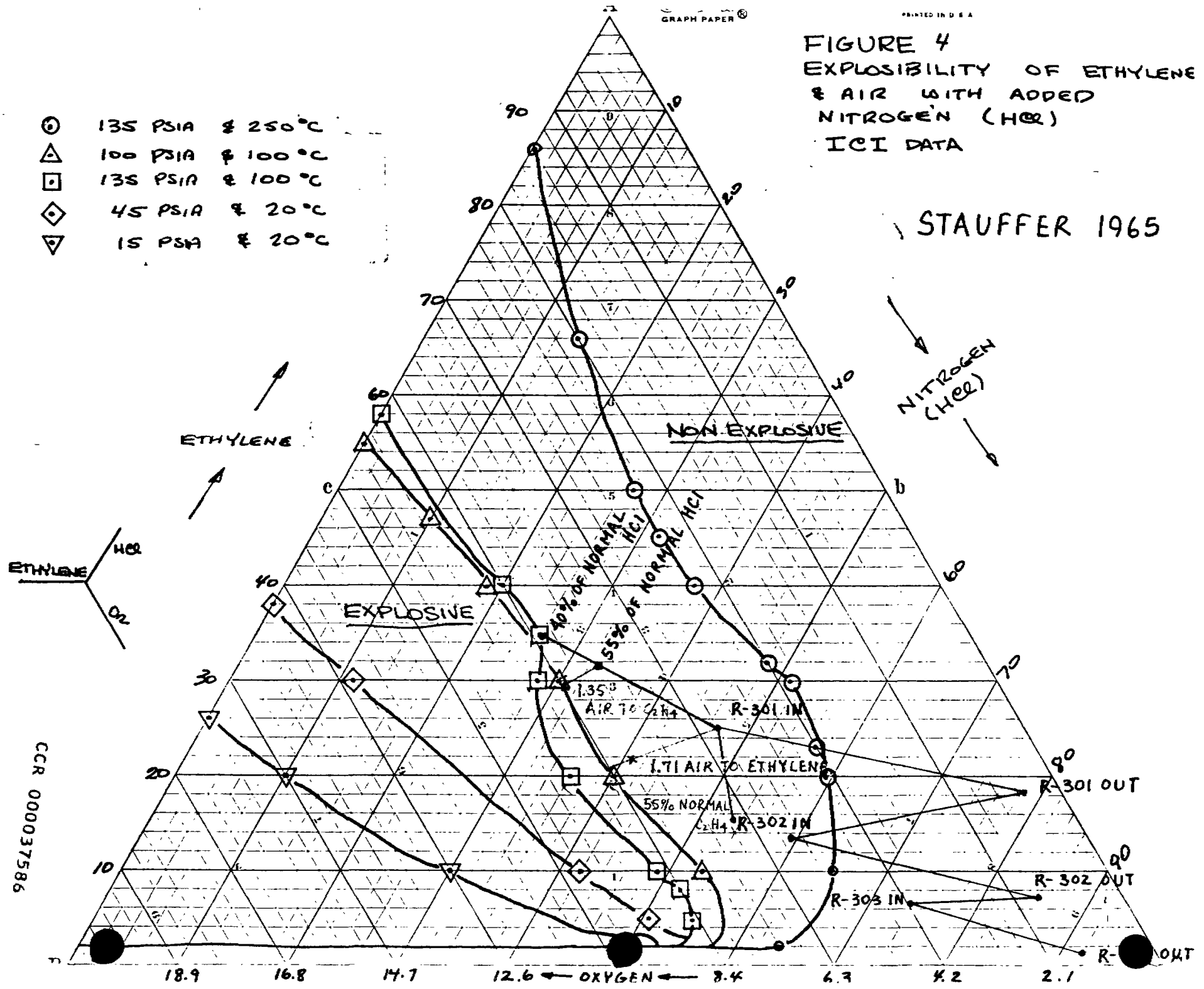

GRAPH PAPER
FIGURE 3
EXPLOSIBILITY OF ETHYLENE & AIR WITH ADDED NITROGEN (HCR)
ICI DATA
135 PSIA & 250°C
100 PSIA & 100°C
135 PSIA & 100°C
45 PSIA & 20°C
15 PSIA & 20°C
CURRENT OPERATIN CONDITIONS
NITROGEN (HCR)
ETHYLENE
NON EXPLOSIVE
EXPLOSIVE
55% OF NORMAL HCI
ETHYLENE
HCR
O2
1.33 AIR TO C2H4
1.71 AIR TO C2H4
R-301 IN
R-301 OUT
R-302 IN
R-302 OUT
R-303 IN
R-303 OUT
55% NORMAL C2H4
18.9
16.8
14.7
12.6 ← OXYGEN ← 8.4
6.3
4.2
2.1
CCR 000037585


GRAPH PAPER
PRINTED IN U.S.A.
FIGURE 4
EXPLOSIBILITY OF ETHYLENE & AIR WITH ADDED NITROGEN (HCl)
ICI DATA
STAUFFER 1965
135 PSIA & 250°C
100 PSIA & 100°C
135 PSIA & 100°C
45 PSIA & 20°C
15 PSIA & 20°C
NITROGEN (HCl)
ETHYLENE
NON EXPLOSIVE
EXPLOSIVE
ETHYLENE
HCl
O2
40% OF NORMAL HCl
55% OF NORMAL HCl
1.35 AIR TO C2H4
1.71 AIR TO ETHYLENE
55% NORMAL C2H4
R-301 IN
R-301 OUT
R-302 IN
R-302 OUT
R-303 IN
R-
OUT
CCR 000037586
18.9
16.8
14.7
12.6 ← OXYGEN ← 8.4
6.3
4.2
2.1