OPERATING MANUAL

OLD UNIT PVC REACTORS

ABERDEEN, MISSISSIPPI

I. INTRODUCTION

A. Operator Responsibilities

The purpose of this plant is to safely and economically convert vinyl chloride monomer (VCM) into a usable form of polyvinyl chloride (PVC). This is accomplished by a batch process in which VCM, water, initiator and colloid solution are charged into the reactor and under carefully controlled conditions PVC with the desired physical properties is produced. This chemical reaction, which changes VCM to PVC is called polymerization. PVC leaves the reactor in slurry form and is dried to product specification by centrifuging and drying with hot air.

The operator helps fulfill the plant's purpose by making sure that quality production is obtained from his equipment without endangering himself, his fellow workers, or his equipment. The operator is able to attain his goals in safety, job performance, and efficient operation through a training period, on the job experience, and passing written and field examinations.

The operator fulfills his responsibilities by:

1. Demonstrating understanding of how his equipment functions.
2. Being able to explain what role each piece of equipment plays in the process.
3. Keeping a close and regular check on equipment.
4. Being able to demonstrate troubleshooting and corrective measures.
5. Keeping his area of responsibility safe and clean.

I. INTRODUCTION (CONTINUED)

A. Operator Responsibilities (Continued)

6. Keeping complete and accurate records.
7. Reporting process or equipment problems to his supervisor promptly.

This operating manual will cover the normal responsibilities and duties of the old reactor unit lead and "A" operators. Each phase of the production method will be covered. In addition to normal operating methods it will also discuss operations under abnormal and emergency conditions. The operator must be prepared to meet these situations with temporary measures until the abnormal condition is corrected or the emergency crisis ceases to exist.

Safety takes second place to no other plant activity. The safety of the plant personnel and equipment is to be carefully considered before any job is started. The Conoco safety slogan "Our work is never so urgent or important that we cannot take time to do it safely" is an idea that can help make the work area safer for everyone when it is put into practice. Each operator is responsible for compliance to all plant safety rules as stated in the plant safety rulebook and for reporting any infractions of these rules by other personnel in their units. This includes keeping himself safe by following the VCM safety rules and wearing proper protective equipment as required.

Preventing the loss of raw materials and product in the area where he works is another responsibility of the operator. Each operator is

I. <u>INTRODUCTION (CONTINUED)</u>

A. <u>Operator Responsibilities (Continued)</u>

responsible for doing his job and producing resin without losing any raw materials or resin or, if product loss is absolutely necessary, by doing the job in a manner that minimizes such losses. Any loss of material, whether resin, VCM, or other raw materials, must be reported promptly by the operator to his Supervisor and corrective steps will be taken as soon as possible. Awareness of this problem, planning jobs before performing them, reporting losses that occur, and being careful when handling raw materials, will improve the plant vinyl efficiency and make the plant operation more profitable.

Any loss of VCM from any process equipment or piping requires special attention by the operator. VCM emissions are regulated by regulations from the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA), because it is a suspected carcinogen (cancer causing agent). VCM losses must also be minimized because it is extremely flammable. The operator is responsible for stopping any VCM leak that he is aware of (including water leaks that have VCM in the water). If the operator cannot stop the leak himself, he must notify his Supervisor immediately. <u>Any</u> relief valve discharge, whether major or minor, from a piece of equipment that processes VCM is reportable to government agencies, and must be reported to a Supervisor immediately. Also, <u>any</u> VCM

I. INTRODUCTION (CONTINUED)

A. Operator Responsibilities (Continued)

discharge which exceeds one pound of VCM is reportable to government agencies within a few hours of its occurrence and must be reported to a Supervisor and to the Operations Supervisor immediately (this includes releases due to "O" ring failures and other miscellaneous losses of VCM).

Another important responsibility of each operator is energy efficiency in his operating area. Plant operating costs are heavily affected by energy usage and cost, and inefficent operation of process equipment is very unprofitable. The operator must be aware of the equipment that must be run to do his job and is responsible for shutting down energy using equipment that is not needed. Prompt reporting of steam leaks is also expected of each operator to reduce energy losses. The operator is responsible for notifying his Supervisor if a steam leak cannot be stopped, and the Supervisor will see that a work order is written and that the leak is tagged. Some other examples of energy inefficiencies that should be watched for and corrected include air leaks (write maintenance work orders to repair), steam tracing on in above freezing weather conditions, automatic cooling tower fan controls not running in automatic, an excessive number of cooling tower pumps running, recovery system pumps left running, aeration on to empty blend tanks, and dryers left running when there is no feed to them. The lead and "A" operators in the

I. INTRODUCTION (CONTINUED)

A. Operator Responsibilities (Continued)

affected area must be aware of such unprofitable energy usage and are responsible for correcting these and similar situations to minimize energy losses.

Good communication is one of the most important keys to effective and efficient plant operation. However, effective communication is not easily attainable. It must be worked toward on a day-to-day basis by each person involved and affected. The operator is responsible for keeping his Supervisor and affected co-workers informed of operating or mechanical problems in his area. The operator must also pass on pertinent information to his shift relief, in detail, so that plant operation can continue smoothly from shift to shift. Communications between the lead and "A" operators are most important and are essential to good plant operations. The lead operator initiates and coordinates "A" operator actions, and then the "A" operator must communicate back to the lead operator that the action has been completed as instructed.

Good housekeeping is also an important responsibility of each operator. It requires careful attention for safety reasons and for maintaining good working conditions. Cleaning up after a job is finished is the responsibility of the person doing the job. A job is not considered completed until all materials are picked up and properly stored.

I. INTRODUCTION (CONTINUED)

B. Process Information

1. Vinyl Chloride Monomer

Vinyl chloride monomer (VCM), also called vinyl chloride or vinyl, is the principal raw material used in the manufacture of polyvinyl chloride (PVC). It is a colorless, sweet-smelling gas at room temperature and pressure and may be condensed to a colorless liquid under moderate pressures (50-100 psig). It is an extremely flammable gas that emits highly toxic fumes (carbon monoxide and hydrogen chloride, an acid-gas) when burned. Exposure to VCM is regulated by the EPA (Environmental Protection Agency) and OSHA (Occupational Safety & Health Administration) because it is a suspected cancer causing agent. Vinyl chloride liquid is lighter than water and the vapor is heavier than air. Liquid VCM will float on top of water in pressurized tanks, but the water will be saturated with VCM and is an exposure hazard. VCM vapors will collect in low spots and in the bottom of open tanks and sewers since it is heavier than air. This will be further discussed under VCM safety (below).

a. Manufacture and Use

Vinyl chloride is made from ethylene and chlorine. Ethylene is made from ethane and propane [that comes primarily from natural gas as LPG (liquified petroleum gas)] or from naptha (a refinery petroleum cut that is lighter than gasoline). In an ethylene plant, the ethane, propane, or naptha is "cracked" at temperatures from 1500°F to 2000°F breaking the raw mate-

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

1. Vinyl Chloride Monomer (Continued)

a. Manufacture and Use (Continued)

rials into many chemical gaseous products, and ethylene is the primary product that is distilled from the resulting gases.

Ethylene is a highly versatile gas that is reacted with other chemicals to make chemicals such as ethylene glycol (anti-freeze), polyethylene (plastics), and vinyl chloride. A vinyl chloride plant reacts ethylene with chlorine (which is made in electrolytic cells in a chlorine plant from very salty water known as "brine") to make ethylene dichloride which is then "cracked" at 800-900^{o}F. Vinyl chloride is distilled from the resulting gases and is compressed and condensed (liquified) for shipment to PVC makers.

The primary industrial use of vinyl chloride at the present time is for manufacture of PVC. Vinyl was used in the past as a propellant in aerosol cans, but government regulations on VCM halted its use.

Most of the VCM that comes into this plant comes in tank cars from Conoco's VCM plant in Westlake, Louisiana. VCM also occasionally comes from PPG in Lake Charles, Louisiana, B. F. Goodrich in Calvert City, Kentucky, or from Uniroyal in Geismar, Louisiana. VCM tank cars typically hold 175,000

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

1. Vinyl Chloride Monomer (Continued)

a. Manufacture and Use (Continued)

pounds of VCM (about 23,000 gallons of liquid) and are unloaded into the tank farm sphere by the yard department as VCM is used by the reactor units.

b. Safety

Vinyl chloride is a hazardous chemical because it is highly flammable and because it is a suspected cancer causing agent.

Vinyl chloride mixes with air (oxygen) to form a very flammable and potentially explosive mixture. The explosive range for vinyl chloride is 3.6 to 33.0 percent or 36,000 to 330,000 ppm. Whenever vinyl is mixed with air in that range, it can ignite if there is an ignition source (spark, welding, static electricity, and other similar sources). VCM and oxygen burn and emit fumes which are highly toxic, including hydrogen chloride gas and other very dangerous chemicals.

Tests have shown that VCM may be linked to acroosteolysis, which is a bone finger disease, and to angiosarcoma, which is a rare form of liver cancer. Acroosteolysis can be prevented by avoiding or preventing direct contact with high concentrations of VCM. VCM was linked to this disease when a high percentage of workers who cleaned reactor internals over long periods of time without adequate protection were shown to

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

1. Vinyl Chloride Monomer (Continued)

b. Safety (Continued)

have a higher incidence of the disease. The direct contact with dried PVC resin product is not considered toxic because of the very low levels of VCM contained in the resin (less than 10 ppm).

Angiosarcoma was linked to VCM by ~~some~~ studies ~~that~~ showing ~~showed~~ that workers ~~who were~~ exposed to breathing high levels of VCM for many years had a higher incidence of this rare form of liver cancer. The EPA and OSHA have regulations on VCM which must be followed by plant personnel. The plant has taken extensive measures to eliminate exposure of plant personnel to VCM. All safety rules concerning VCM must be followed by all employees while on the job, and are listed in the current Safety Rulebook or in the Engineering and Work Practices Control Plan. If any problem concerning VCM exposure develops that is not specifically covered by these rules, consult your Supervisor. Every employee is expected to control his exposure to VCM or other potentially hazardous chemicals used in the process in accordance with plant safety standards. It is important to use sound materials handling practices when using ~~the~~ these chemicals to minimize the potential for skin and respiratory contact. This

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

1. Vinyl Chloride Monomer (Continued)

b. Safety (Continued)

includes respiratory protection, safe work practices, protective clothing and the like.

The following items warrant particular emphasis and explanation concerning VCM exposures:

(1) Breathing protection must be worn in any area where the VCM concentration is greater than 1 ppm, as follows:

a. 1-10 ppm: VCM canister mask or air line respirator.

b. 10-1000 ppm: Air line respirator.

c. Above 1000 ppm or unknown concentration: Self-contained breathing equipment (Scott Air Pack).

(2) The Honeywell continuous monitor alarm goes off in the control room when the VCM concentration at any of the 40 monitoring points exceeds 3 ppm and the field alarm beacons also come on at 3 ppm. Whenever the lights come on, employees are required to either leave the area or put on a respirator. The lead operator will notify the "A" operator upon acknowledging the control room alarm, and will tell him the location and concentration of VCM at the site of the alarm. The "A" operator is then responsible for making sure all employees that are not wearing proper respiratory equipment clear the affected area. Personnel who have a need to work in an area where a warning light is flashing are responsible for wearing proper respiratory equipment.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

1. Vinyl Chloride Monomer (Continued)

b. Safety (Continued)

(3) The fixed point monitor computer records the hourly averaged levels of VCM for each Honeywell continuous monitor point and gives a report at the end of each shift. If the computer malfunction alarm comes on, the lead operators must record the VCM concentration at each monitoring point hourly on the continuous monitoring log sheet. An instrument maintenance work order should be filled out and turned in to repair the computer as soon as possible.

The computer also monitors the individual Honeywell points for EPA leaks. A "leak" is defined as three successive readings of 5 ppm VCM or more at any given fixed point. An alarm will go off in the control room and the lead operator that acknowledges the alarm must fill out a leak report form and have the "A" operator put on proper respiratory equipment and identify the source of the leak. Each leak will be given a successive number by the computer to enable the leak to be kept up with until it is fixed. If the leak is at the tank farm, the lead operator will notify the yard operator, who must put on proper respiratory protection and

I. <u>INTRODUCTION (CONTINUED)</u>

B. <u>Process Information (Continued)</u>

1. <u>Vinyl Chloride Monomer (Continued)</u>

b. <u>Safety (Continued)</u>

identify the source of the leak.

<u>NOTE:</u> A VCM canister mask must be worn as the minimum protection in VCM leak detection operations. If the leak is 10.0 ppm or more as shown on the printout in the control room, an air-line respirator must be used when looking for the leak. The operator will use a properly operating HNU as a guide for what type of respiratory protection to use once he is in the field. Proper operation of the HNU must be verified before leaving the control room. The HNU can be tested using any organic vapors such as liquid paper or liquid paper thinner fumes, or cigarette, tobacco or lighter fluid f~~l~~umes.

(4) Air line respirators, disposable coveralls, and rubber gloves must be worn when changing VCM filters or water filters that contain VCM (such as recovery seal water or scrubber water).

(5) When VCM can be smelled by the human nose, the concentration is generally greater than 200 ppm. Thus, when an operator smells VCM an air line respirator or Scott Air Pack is a minimum requirement for breathing protection.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

1. Vinyl Chloride Monomer (Continued)

b. Safety (Continued)

The operator must evacuate the area and obtain proper respiratory protection before re-entering the area. Continued breathing of high concentrations of VCM can cause dizziness, tingling sensations on various body parts, unconsciousness, and can be fatal. Whenever VCM is detected in high concentrations, a serious fire hazard may be present.

(6) Air line respirators are required for personnel who are on top of any large blend tank containing slurry and may be necessary on top of the small tanks if high residual slurry has been added and was just put on "aeration."

(7) VCM canister masks are to be kept in the immediate area of each operating unit. Shift personnel who work in each area are responsible for knowing the location of the masks and for informing their Shift Supervisor if they use the next to the last one at any storage point. Shift Supervisors are responsible for notifying Safety Personnel about where the canisters came from, collecting them, and seeing that they are put in the control room or at the emergency equipment station.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

1. Vinyl Chloride Monomer (Continued)

b. Safety (Continued)

(8) Protective rubber gloves must be worn when cleaning culls from dump Sweco screen~~ers~~s.

(9) Air line respirators are required when any pipe or line that has contained VCM is broken or blanked (even if the line or vessel has been evacuated and/or steam stripped).

(10) Special precautions should be taken before going into low lying areas, sewers, or areas like the 500 series activators pit. VCM is heavier than air and will ~~and will~~ collect in low lying non-aerated placed and the oxygen level may not be adequate for life support. A man-hole watch must be present before entering such areas and the pit, sewer, or area to be entered must be sniffed with a HNU meter prior to entry.

(11) Entry of any vessel or piece of equipment requires an authorized entry permit and check ~~-sheet~~ sheet. The Shift Supervisor is the only shift worker who can authorize an entry permit.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

1. Vinyl Chloride Monomer (Continued)

b. Safety (Continued)

(12) Air line respirators which have been used during a shift must be put into a receptacle for used respirators whenever they are no longer needed or at the end of a work period.

(13) After a Scott Air Pack is used it must be brought to the emergency equipment station for service. Safety personnel must be notified as soon as the emergency conditions have been corrected so the air pack can be serviced and returned to its normal storage location.

I. <u>INTRODUCTION (CONTINUED)</u>

B. <u>Process Information (Continued)</u>

2. <u>Poly Vinyl Chloride</u>

Poly Vinyl Chloride resin (PVC) is a dry granular white powder ~~is~~ used to make various products including pipe, siding, wire and cable insulation, wall covering, car tops, seat covers, phonograph records, and other plastic products. It is a polymerized hydrocarbon made from vinyl chloride monomer (VCM). PVC is the second largest volume plastic sold in the United States, behind polyethylene. About 6 billion pounds of PVC are produced in the United States yearly and current U.S. plant capacity is 9 billion pounds. PVC resins produced today are very stable and without sunlight and heat will not environmentally degrade for hundreds of years. At elevated temperatures, however, PVC becomes unstable, begins to lose its physical properties, and becomes discolored.

a. <u>Manufacture</u>

PVC is produced by the polymerization of vinyl chloride monomer. Vinyl chloride is placed in the presence of very unstable free radical initiators. These initiators (commonly called catalysts in this plant) break down upon heating, forming free radicals which react with the monomer.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

a. Manufacture (Continued)

The free radicals activate the monomer molecule and it then combines with another monomer molecule, which then combines with another, etc., until very long chains of the monomer are put together or "polymerized". The "length" of the PVC chains (called the molecular weight) determines the viscosity or resin type. The reaction is highly exothemic, which means heat is produced from the reaction. One of the primary factors in producing PVC commercially is control of the heat released by the reaction. The polymerization reaction is ended by adding a killing agent. Any monomer left after killing is then recovered and the PVC is further processed until product specifications are met.

There are four processes used to polymerize VCM to PVC:

(1) Bulk or mass polymerization - VCM and initiator are put into a reactor and a very high purity PVC is produced since there are no other additives. This process is not very prevalent but is gaining in importance because it produces a very uniform particle size resin. The disadvantages of this process are high reactor pressures and reactor heat transfer control.

(2) Solution polymerization - In this process, monomer is polymerized in a solution containing other ingredients. This is used by only one U. S. manufacturer to

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

a. Manufacture (Continued)

make a copolymer of vinyl acetate and vinyl chloride for a specialized application.

(3) Suspension Polymerization - VCM is suspended in water and suspending agent is used to stabilize the VCM droplets by coating them. The amount of suspending agent and agitation mode determine the resin particle size. The water surrounding the particles facilitates heat transfer control. Disadvantages of this process are impurities in the resin from the suspending agent and investment in equipment and energy to remove the water from the resin.

(4) Emulsion Polymerization - VCM is polymerized in water using an emulsifying agent. This produces a very fine particle size resin which is then dried for use in plastisols and paints.

The Aberdeen Chemical Plant produces PVC using a batch suspension process in which VCM, water, suspending agent, and initiator are put into a reactor, controlled at between 115-155°F, and approximately 80% of the VCM in the reactor is converted to PVC. The plant reactor area has four 18,000 gallon reactors, four 22,000 gallon reactors and two 32,000 gallon reactors.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

a. Manufacture (Continued)

The PVC leaves the reactors in a slurry form (mixed with water) and most of the water is removed with centrifuges in the dryer area. Further drying occurs by mixing hot air with the resin in either the fluid bed dryer or one of the seven rotary dryers. If there were no VCM or resin losses, every pound of VCM polymerized should produce a pound of PVC. The plant efficiency usually is about 98 percent, meaning that two pounds of resin or VCM are lost for every 100 pounds of VCM brought into the plant (or 20,000 pounds lost out of every million pounds of VCM).

NOTE: If 20,000 pounds of material are lost per day at a typical price of about 20¢ per pound, then the plant would lose $4,000 per day due to efficiency losses. This emphasizes the importance of minimizing resin and VCM losses in the reactor and dryer areas.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

b. Phases of Reactor and Dryer Operation

The phases of reactor operation at the Aberdeen plant and a brief description of each phase follows:

(1) Evacuation - Steam ejectors are used to remove most of the air from the reactor. Too much air left in the reactor will cause safety and quality problems. Reactor evacuation requires 5-10 minutes depending on which evacuation system is used and the size of the reactor being evacuated.

(2) Charge - Water, colloid, and VCM are charged into the reactor using an automatic charge sequencing system. Chain transfer agents, where required, and initiator (catalyst) are charged into the reactor by the field operator. Reactor charge takes about 10-15 minutes.

(3) Polymerization - This is the time from initiator addition until most of the VCM has been converted to resin. Steam is added to the reactor jacket for the first hour of polymerization to heat the reactor contents to the desired polymerization temperature. At run temperature

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

b. Phases of Reactor and Dryer Operation (Continued)

(3) Polymerization (Continued)

the reaction begins to generate its own heat as the liquid VCM is polymerized to PVC, ~~resin.~~ This heat is removed by cooling water in the reactor jacket and condenser. Reaction times vary depending on the weather and cooling water temperatures. Generally, polymerization requires five to seven hours, except in the 32,000 gallon reactors where 3 to 4 hours is usually required.

(4) Recovery - The reaction is killed when it has reached the desired conversion, and then the un-reacted VCM must be removed from the reactor. A compressor-vacuum pump system pulls the vaporized VCM from the reactor ~~and~~ while steam is added to the bottom of the reactor. The steam rises through the PVC and water slurry to "strip" the un-reacted VCM from the reaction mass. Recovery requires about 55-65 minutes for the small reactors and 75-90 minutes for the extra large reactors.

(5) Dump - After recovery is complete, the water and PVC mixture (called "slurry") is gravity drained from the reactor through a screener, and is pumped to slurry holding tanks called blend tanks. The dryer operation

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

b. Phases of Reactor and Dryer Operation (Continued)

(5) Dump (Continued)
begins at the slurry blend tanks. Reactor dump requires about 20-25 minutes except in the large reactors where it takes about 30-35 minutes.

(6) Clean and Rinse - After dumping, the reactor shell and condenser are either chemically washed or are rinsed with water according to an established schedule. This cleans the reactor internals which is very important to heat transfer control and to resin quality. Chemical washing, and reactor rinsing each require about 20 minutes.

(7) Swirl - The reactor is filled with water which is agitated to further clean the reactor. This is also set up on a schedule according to the reactor cleanliness required to make a specified product. Reactor swirl takes 10-20 minutes depending on whether a half swirl or full swirl is required.

After reactor cleaning is completed, the reactor is ready to be evacuated and charged. The total batch cycle usually requires about 7 to 8 hours.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

b. Phases of Reactor and Dryer Operation (Continued)

The phases of dryer operation at Aberdeen and a brief description of each phase follows:

(1) Blend Tanks - The blend tank system provides storage for slurry between the reactors and dryers. It consists of tanks and the associated slurry pumps which transfer slurry as needed to feed the centrifuges. Tank agitation is provided by air injected into the bottom of each tank that also strips VCM out of the slurry. In the larger blend tanks, several reactor batches can be dumped and blended together, giving a more consistent and uniform product.

(2) Centrifuges - The dryer centrifuges are fed slurry that contains 60 to 70 percent water and concentrates the slurry into a wet cake, containing 20 to 25 percent water. After removing most of the water, the centrifuge feeds wet cake into either a rotary dryer or the fluid bed dryer. This reduction in water shortens the drying time in the hot air dryers resulting in less energy used.

(3) Dryers - The plant employs two different type of dryers to dry the wet cake from the centrifuges. Both types

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

b. Phases of Reactor and Dryer Operation (Continued)

(3) Dryers (Continued)

use hot air mixing with the wet cake to dry the wet cake to a product containing 0.15 to 0.25 percent water.

~~(3) Dryers (Continued)~~

The rotary dryers utilize an exhaust fan that pulls air through a gas-fired burner and through the rotating dryer. The wet cake drops into the dryer from the centrifuge and is dried as it mixes with the hot air and is swept through the dryer. The air and resin are separated in a filter (dust collector) and then the resin is screened to remove any oversize particles before being transferred to the product silos.

The fluid bed dryer has two sections and a common exhaust fan pulls air through the gas-fired burner for each section. Additional heat is provided in the first section by circulating water that is heated by direct steam injection. Wet cake is fed into the first section (backmix section) from the centrifuge where it is "fluidized" and dried to about one percent moisture. It then flows into the second section (plug flow section) where it is dried to product specification. The resin overflows a weir at the fluid bed discharge and drops

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

b. Phases of Reactor and Dryer Operation (Continued)

(3) Dryers (Continued)

through a screener into the transfer system. Resin in the exhaust air from the fluid bed passes through a cyclone and water scrubber system where the resin ~~is~~ is removed from the air and recycled ~~removed and~~ recycled into the bed or back to the slurry blend tanks.

(4) Resin Transfer System - Two types of transfer systems are used in the plant to transfer dry resin from the dryers to the product silos. The fluid bed dryer and two of the rotary dryers have a continuous pneumatic transfer system that utilize rotary valves which feed the resin into lines that are pressurized with air from a blower. The air then transfers the resin to the proper destination. The five remaining dryers each feed individual activators, which fill to a certain level with resin, then are automatically pressurized with air and the resin is blown to the silos. The air is cut off automatically when the activator is emptied and the activator is refilled to start another load.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

b. Phases of Reactor and Dryer Operation (Continued)

(5) Silos - Resin is loaded into railcars, trucks or is bagged for shipment from the silos. The vinyl department is responsible for bagging operations and the yard department loads trucks and railcars.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

c. Miscellaneous Raw Materials and Additives

Some of the raw materials and additives used in making PVC in the Aberdeen vinyl department and a brief description of each follows:

(1) Water - The process water used by the plant is pumped from wells that are on the plant premises. Process water is used as reactor charge water and rinse water, rinse water for process lines, high pressure service water (HPSW) and mechanical seal purge water (MSPW), water for making up methocel and chemical wash solutions, and is used for numerous other plant activities. Well water also feeds the cooling towers which supply reactor and process cooling water. City water is the back-up for the process water systems and is used as needed for process water as the demand for well water exceeds the supply.

(2) Methocel - The suspending agent or colloid changed into the reactors is a solution of Methocel* and water. Methocel* is a granular white powder that comes into the plant in 50 pound bags. Its chemical name is hydroxypropyl methylcellulose. A 1.5% solution is made up for charging into the reactors.

*Registered Trademark

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

c. Miscellaneous Raw Materials and Additives (Continued)

(2) Methocel (Continued)

The colloid or suspending agent solution is referred to by plant personnel as methocel or PVA, and will be referred to in this manual as methocel. PVA (poly vinyl alcohol) can be used as a suspending agent for VCM polymerization but is not currently used in this plant. The amount of methocel charged into the reactor is one of the biggest factor affecting the resin particle size. Too much methocel will cause small (fine) particles to be formed in the reaction. Not enough methocel will cause large (coarse) particles to be formed. Methocel solution makeup is also very important and very critical for consistently producing good resin particle size.

NOTE: Dust masks must be worn while handling the Methocel* powder. This is to prevent inhalation of the fines (dust) from the Methocel*.

(3) Initiator - The initiator charged in the reactors decomposes at reactor temperature and reacts with the monomer causing the monomer to become reactive and start long chains of polymer (polymerization). Initiators used by the plant are generally peroxydicarbonates and peroxyesters, and come into the plant in one gallon

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

c. Miscellaneous Raw Materials and Additives (Continued)

(3) Initiator (Continued)

plastic bottles. They are very unstable and must be kept below 10^{o}F. Heat or impact can cause the material to decompose rapidly and explode. Plastic disposable gloves must be worn when handling initiator bottles or cases. Initiators are commonly called catalysts by plant personnel and will be hereafter referred to as catalysts in this manual to facilitate better communications. Catalysts decompose faster or slower according to temperature and usually only one type of catalyst is charged into a reactor. However, some of the resins are made at an "in between" temperature where one type of catalyst is too fast and the next higher type is too slow. Dual catalysts or two types of catalyst are charged for these resins and one catalyst controls the "front end" or first few hours of the reaction and the other catalyst controls the "back end" or last few hours of the reaction. Whether a catalyst reacts fast or slow is temperature dependent, for example, L-223 reactsfaster the last few hours with 5385 resin, but with 5305 resin polymerized at a higher temperature, it is a "front end" catalyst, reacting faster in the first few hours.

I. <u>INTRODUCTION (CONTINUED)</u>

B. <u>Process Information (Continued)</u>

2. <u>Poly Vinyl Chloride (Continued)</u>

c. <u>Miscellaneous Raw Materials and Additives (Continued)</u>

(4) Chain Transfer Agents (CTA) - The use of chain transfer agents allows lower molecular weight (smaller chain length) PVC to be made at lower temperatures and pressures. The CTA reacts with the polymer chain causing it to stop growing before it reaches the normal length. This gives chains that shorter than normal and results in lower molecular weight resins. 5265 and 5305 are made using the chain transfer agent 2-ethylhexaldehyde. It comes into the plant as a clear liquid in 55 gallon drums and has an irritating odor that will not easily wash off of skin or out of clothing, so direct contact with it should be avoided.

(5) <u>Odorless Mineral Spirits (OMS)</u> - Odorless mineral spirts are charged into reactors with some products to lower the dry time, which is a measure of plasticizer absorption. It comes into the plant in 55 gallon drums and is a clear liquid. Chemically, OMS is a refinery cut of hydrocarbons.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

c. Miscellaneous Raw Materials and Additives (Continued)

(6) Alpha-methylstyrene (AMS) - AMS is used to kill or terminate the PVC polymerization. It reacts with the reactivegrowing polymer chains in the reactor and deactivates them, ending the reaction. It is a clear liquid that comes into the plant in 55 gallon drums. It will irritate or burn the skin and should be immediately washed or flushed off of the skin if contacted. Plastic gloves must be used when killing reactors to avoid contact with AMS. The amount of AMS put into the reactor is critical. Some residual AMS is apparently carried over into the recovery system during reactor recovery and stays with the recovered VCM (RVCM) that is charged into subsequent reactor batches. Too much AMS in the RVCM will inhibitor slow down the polymerization and may cause erratic particle size. On the other hand, too little AMS put intoa reactor will not entirely kill the reaction and some of the RVCM will still contain reactive monomer molecules which will react in the recovery system, recovered receivers, or in VCM charge lines, causing troublesome polymer buildup problems.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

c. Miscellaneous Raw Materials and Additives (Continued)

(7) Naugard - Naugard 492 is an antioxidant which is added to the resin to give it improved heat stability. As mentioned previously, PVC degrades and discolors at elevated temperatures which is partially due to impurities in the resin such as catalyst residue. An antioxidant is a material that reacts with the impurities in the resin and prevent resin degradation. Naugard is a very viscous light yellow liquid and comes into the plant in 55 gallon drums. It is chemically a blend of a substitutive phenol and an organic phosphite which may cause skin irritation if direct contact is not avoided.

(8) Nitric Oxide - Nitric Oxide (NO) is used as an emergency reactor killing agent. The mechanism of reaction termination is similar to AMS. It is stored in pressured cylinders and is a yellowish-brown vapor when emitted to atmosphere. NO is very dangerous to breathe and Scott Air Paks must be worn while using it.

(9) Antifoam (Bubble Breaker) - DF-160 LC is an antifoam that is used in the reactors during recovery to reduce reactor foaming. It is important that the antifoam be

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

c. Miscellaneous and Raw Materials and Additives (Continued)

(9) Bubble Breaker (Continued)

be added to every reactor batch to prevent resin carryover into the recovery systems. DF-160-LC is a mixture of various oils and is a light tan colored liquid that comes into the plant in 55 gallon drums.

(10) Hydroquione - Hydroquinone is an antioxidant and polymerization inhibitor. It will react with reactive monomer molecules and deactivate them, keeping them from polymerizing in lines and vessels. Hydroquione is a light tan powder that is made up with water as a 5% solution and added to the recovery system seal water. The powder comes into the plant in 100 pound fiber drums and should be kept dry.

(11) Calcium Stearate - Calcium stearate is a material used to reduce torque on the bird centrifuges, reduce static on the dried resin, and to increase resin bulk density. Calcium stearate also helps resin customers process the resin easier and is especially desired by customers that make PVC siding.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

B. Poly Vinyl Chloride (Continued)

c. Miscellaneous Raw Materials and Additives (Continued)

(11) Calcium Stearate (Continued)

Chemically, the material is a neutralized dispersion of calcium stearate in water and comes into the plant as a white liquid in 55 gallon drums. Calcium stearate solution will freeze below 40°F and will not go back into solution, so it must be stored in a warm place.

(12) Glycerine - Glycerine is added to some resins in the dryer area to reduce static on the dried resin. Static makes the resin cling together due to electrical charges and it will not easily flow. Glycerine comes to the plant in 55 gallon drums as a clear liquid. Its chemical name is glycerol. A 10% solution of glycerine in water is made up by the dryer operators and is sprayed as a fine mist on some resins as they leave the rotary dryers.

(13) Caustic - A caustic solution is used to chemically wash the reactors according to a set schedule and procedure. The reactors are then rinsed for an extended period of time and very little if any caustic should remain in the reactor. Caustic is a solution of sodium

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

c. Miscellaneous Raw Materials and Additives (Continued)

(13) Caustic (Continued)

hydroxide (NaOH) which is brought into the plant in bulk as 50% caustic and is diluted to 22% caustic by the compound department. Further dilution may occur in the vinyl chem wash tank prior to reactor cleaning. Caustic very is dangerous and will cause severe burns if it contacts the skin. Caustic will cause coarse batches if it gets into a reactor. If may also in increase the pH of the resin to unacceptable levels and cause discoloration of the resin.

d. Resin Quality and Uses

Several types of resins are produced in the Aberdeen Chemical Plant vinyl department. The molecular weight of the resin, which is indicated by the viscosity of the resin solution, determines the resin type. There are five types produced at the present time. In order of increasing viscosity, they are:

(1) 5265 - Used for injection molding (pipe fittings, such as valves, couplings, and tees). The low molecular weight (viscosity) gives better and faster flow which allows the molds to be filled more easily.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(2) 5305 - Used in calendering, where resin films are made between heated rollers. Examples of calendered PVC include wall covering, seat covers, and plastic wrappers that go around grocery and drug products.

(3) 5385 - Used for pipe, for PVC siding and for general extrusion applications.

(4) 5425 - Used for wire and cable insulation.

(5) 5465 - Used for wire and cable insulation and in various specialty applications.

The middle two numbers of each type of resin indicate the specific viscosity (e.g., 15385 has a specific viscosity of 0.38). The viscosity measured in the plant is inherent viscosity, which is not the same as the specific viscosity.

Most of the PVC made in this plant used to be pipe grade resin. About 40% of all PVC made in the U.S. in 1981 went into PVC pipe. Generally, pipe grade resin is easy to make and low quality (Type III) 5385 can be sold to pipe customers quite easily. The PVC marketplace is becoming more and more deversified, however, as more uses are found for the plastic. The monetary rewards and profits are also appealing in these other markets. This requires much stricter quality control and more attention to keeping the resin quality within the

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

quality specifications. Pressure is being applied by the market place as more non-5385 resins are required which causes more emphasis on making good quality resin because there are very few outlets for low quality non-5385 resin. The most important factor to making good quality resin consistently is for each step of the production process to be done the same way by every operator every time. Each quality parameter is affected by some process variable in the reactors or dryers. It is important for each operator to know how each production step affects resin quality and for operating procedures to be followed consistently. Consistent resin quality is one of the most important factors customers look for as they buy resin and try to use it to make finished products for the market place.

Each of the resin quality parameters, how it is tested and what process variable(s) affects it is listed below. The resin specification sheet gives the specifications for each type resin (Figure 3 in the Appendix). Some customers are even more specific, and resin specs tighter than the published ones sometimes must be met. The spec sheets show the quality specifications for the various types of resin that

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

d. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

are prime grade such as type I, type III, BC, and S. BC stands for "Blendable into Compound" and this resin can sometimes be used in the compound department for rigid (dry blend) or flexible (compound) applications. "S" stands for siding which has special specifications for contamination and bulk density. The spec sheet shown in the Appendix does not show 5265 specifications, which are the same as 5305 except for viscosity. 5265 must have a 0.66-0.71 inherent viscosity.

Most of the quality tests are conducted on dryer "regular" samples, which are samples taken off the dryers by the dryer "A" operator for every reactor batch dumped into the blend tanks. The regular samples show blended results from the blend tanks but will give indications of quality problems according to the trend of each parameter. The problem can then usually be resolved before a result is out of specification.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(1) Viscosity - Resin viscosity is a measure of the resin molecular weight. The higher the reactor run temperature the faster the monomer will react, causing shorter chains of polymer and a lower molecular weight (viscosity) resin. Thus, reactor run temperature should be lowered to produce higher viscosity resin and raised to produce lower viscosity resin.

NOTE: The vapor pressure of VCM is dependent on temperature; therefore, the reactor temperature will determine the reactor pressure. Raising the reactor run temperature will raise the run pressure and lowering the run temperature will lower the run pressure.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(1) Viscosity (Continued)

Generally, for each one degree Farenheit rise in temperature, there will be a two psig rise in reactor pressure. Relief valves on the small reactors start relieving at 185 psig and at 205 psig on the extra large reactors. These maximum pressures limit the reactor run temperatures in the plant's reactors.

The viscosity of the resin is a measure of how fast it will flow when put in solution. Solutions of shorter chains will flow with less resistance than solutions of longer chains, thus the viscosity of lower molecular weight resins is lower. The Instrument Development Lab puts the resin in solution and measures the solution viscosity in an apparatus called a viscometer. Viscosity specs range from .66 inherent viscosity for 5265 resin to 1.14 inherent viscosity for 5465 resin.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(1) Viscosity (Continued)

Resin viscosity is ~~tested~~ measured daily ~~off~~ from sample taken from the dryers by testing one sample from the dryer regulars for each product dried, and is tested daily on ~~every~~ each reactor from the residual samples taken by the reactor "A" operator when the reactor is dumped. Viscosity tests are very sensitive and time consuming. A single sample takes three hours to test for viscosity.

(2) Particle Size Distribution - Dried resin is put into a set of screens with an antistatic agent, shaken for a given length of time, and then the amount of resin on each screen is weighed. Typically, the specs are that less than 20% of the resin ~~can~~ must go through the 140 mesh screen with less than 5% being on the pan (which is under the 200 mesh screen).

In addition, all railcars and many truck shipments are tested for viscosity.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(2) Particle Size Distribution (Continued)

No new ¶ On 5305 and 5265 resins, 25% is the maximum through the 140 mesh screen, and resins for compound and dry blend can exceed the ~~usual~~ normal specifications per values given on the spec sheets. The maxium amount on the 40 mesh screen is 0.1% for all resins. Typically, the internal specs are that any result over 10% on the 60 mesh screen (which is under the 40 mesh screen) or over 18% through the 140 mesh screen requires rechecking, ~~extra~~ resampling, and possible corrective action.

Resin particle size distribution affects compound processing and bulk handling properties. Fine particles produce dusting problems both in bulk handling and in processing. ~~Fine particles are also responsible for uneven absorption of plasticizer during dry blending.~~ On the other hand, oversize (coarse) particles may not process properly ~~and may cause~~ causing gels or fish eyes in the finished product because they do not absorb ~~their share~~ an equal amount of plasticizer during dry blending. New ¶ Particle size is primarily controlled by the amount of methocel charged into each batch.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(2) Particle Size Distribution (Continued)

No new ¶ For this reason methocel makeup is very important because the methocel batch concentration will also affect particle size. Methocel concentration must be 1.4-1.6% solids when tested according to both the scope test and the oven test in the QC lab. Methocel with less than 1.4% solids should never be charged, as coarse batches may result. ~~Numerous~~ Other things which ~~also~~ affect particle size distribution ~~as follows~~ are:

(a) Catalyst Loadings and Polymerization Times - Generally, the longer a batch runs, the more the chance of it going coarse. Guidelines are set up on each product for how long it can run before killing it (see Polymerization Operating Procedures). Batches with excessive catalyst loadings that are killed early because of temperature or pressure runaway will generally be fine ~~and~~ but should ~~be dumped separate if possible.~~ be able to blend off if dumped into the extra large blend tanks (502 or 747).

(b) Amount of RVCM Charged - When a 50% RVCM batch is charged, 5 gallons less methocel should be charged.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(2) Particle Size Distribution (Continued)

(f) Impurities in the RVCM - Too much AMS, CTA, or other impurities in the RVCM may cause erratic particle size. 5265 and 5305 resins charged with CTA must be charged with no RVCM due to ~~its~~ the affect of the CTA in the RVCM on resin particle size.

(g) Water to Monomer Ratio - Higher water to monomer ratios (~~amount~~ weight of water divided by ~~amount~~ weight of total VCM charged) give "tighter" particle size distributions (less through the 140 mesh screen and less on the 40 and 60 mesh screens) while lower water to monomer ratios will give "flatter" particle size distributions. This is inversely proportional to increasing ~~production~~ productivity as higher water to monomer ratios give good quality but low production, and lower water to monomer ratios give higher production but the resin has a more spread out particle size distribution.

(h) H over T (H/T) - The height of liquid in the reactor (H) divided by diameter of the reactor (T) is also a controlling factor in particle size distribution. Changing batch size (which changes "H") can therefore affect particle size.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(2) Particle Size Distribution (Continued)

(i) Agitation - Reactor agitation is very important to particle size. This is measured by the power to volume ratio in the reactor. Agitator blade size and configuration will determine the motor horsepower put into the reactor, which is divided by the total liquid volume in gallons to calculate the ratio. Higher power to volume ratios give tighter particle size distribution but involve using more energy to make the resin.

(j) Baffles - Size, configuration, and number of baffles in the reactor will ~~also~~ affect resin particle size.

(k) [See back of sheet]

Resin particle size is tested off the dryers for every batch that is dumped into the blend tanks as a dryer regular sample by the dryer "A" operator. If particle size begins to shift (get finer or coarser), slurry samples off of the reactors may be caught as each reactor is dumped and the slurry ~~may~~ can be dried in the lab and tested for particle size.

A new method of testing particle size is being used by the lab using the Leeds and Northrup (L & N) Microtrac Analyzer. This machine, called the "L & N", uses a laser to record the size of resin particles passed through a cell and gives a printout that may be related

(k) Chem Wash left in the reactor - ~~[illegible]~~ The chem wash (caustic) destroys the effectiveness of the methocel and will cause a batch to go coarse if it is left in the reactor. ~~This can sometimes happen when a condenser is partially plugged and chem wash is not rinsed out of the tube~~ Correct rinsing of the reactor is important to flushing all the chem wash out of the reactor and maintaining consistent particle size.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(2) Particle Size Distribution (Continued)

to screen particle size distribution. The L & N result utilizes three numbers, showing the micron size that 20% of the sample is less than, showing the median particle size (50% micron size), and showing the micron size that 80% of the sample if less than. Typically, the 20% value ~~should~~ must be ~~less~~ greater than 100 microns, the 50% value should be about 140-150 microns, and the 80% value should be less than 240 microns. L & N samples are taken by the reactor "A" operator on each reactor as it dumps, and are analyzed by the lab once per shift and printed out to the vinyl control room for analysis.

(3) Bulk Density - Bulk density is the weight of dry resin per some given volume. It can be measured as pounds per cubic foot or as grams per cubic centimeter. The lab pours the resin into a small container with an anti-static agent ~~(except on 5385 resin where calcium stearate is the antistat)~~ and weighs the container to give a measure of the bulk density. It is reported in grams per cubic centimeter (to convert g/cc to lb/cu. ft., multiply by 62.4).

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(3) Bulk Density (Continued)

No new ¶ Conoco resin specs run from 27-39 lb/cu. ft. or .438 to .624 g/cc, depending on the type of resin. Lower molecular weight resins will generally pack better and give higher bulk densities. New ¶ The spherical shape and particle size distribution of the resin will affect the resin bulk density, which ~~is~~ gives a measure of how closely the resin particles will pack and how much void space is around the particles. The bulk density is sometimes an indicator of the resin viscosity, but this is not always true and may give misleading results.

The bulk density is important to customers because higher bulk densities allow maximum compounding and processing rates. Additives such as calcium stearate are used to make resin bulk densities higher. Some customers also require that a fluff test be run. This is important because of high processing rates required for some uses such as siding. The resin is mixed or fluffed in a blender and then the bulk density is remeasured in the lab. The amount of calcium stearate in the resin also affects the results of the fluff test.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(3) Bulk Density (Continued)

Bulk density is sampled on the dryer regular sample taken by the dryer "A" operator for every reactor batch that is dumped. Fluff tests are run ON ~~out of~~ every 5385 blend tank every shift on special fluff test samples taken by the dryer "A" operator. A Low bulk density or fluff test result ~~s~~ may require that additional calcium stearate be added to the blend tanks.

(4) Dry Time - The dry time is a measure of how long it will take a given amount of resin to absorb a given amount of plasticizer. This is important to the customer because it affects the processing time. The more absorbent the resin is, the shorter the dry time. New ¶ Dry time is measured on a machine in the lab called a Brabender Torque Rheometer using a "sigma" head which mixes the plasticizer and resin. One customer, Southwire, requires a special dry time test on 5425 resin that has no numerical testing results. The resin is either "OK", "Marginal", or "Wet", according to how it "cakes" together or flows when mixed with plasticizer with a mixing blade.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(4) Dry Time (Continued)

The resin dry time is ~~affected~~ determined by the reactor pressure drop allowed before killing the reactor. As the batch pressure drops, the outside or "crust" of the resin particles contracts and hardens, allowing less plasticizer absorption after longer pressure drops. To lower the dry time, a shorter or small pressure drop is required, and longer or larger pressure drops will give higher dry times. The amount of "back end" catalyst when using dual catalysts also affects dry times because too much "back end" catalyst causes a faster reaction and faster pressure drop at the end of the batch.

Dry time is sampled by the dryer "A" operator on dryer regular samples which come off of each reactor batch dumped.

(5) Gels - Gels are hard resin particles which will not absorb plasticizer. In a finished ~~article~~ plastic product they may be observed as small spots or windows. They degrade and discolor more than the surrounding resin because of the plasticizer deficiency. Newitt The lab tests for gels by milling out a sheet of resin that is plasticized, then observing for "holes" or spots in the sheet over a lighted box.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(5) Gels (Continued)

No new P

The gel rating is given according to how many holes are counted, for example, 1-4 holes is given a 1 gel rating, 5-9 holes is a 2 gel, and 10-13 holes is a 3 gel, etc. A three or less gel rating is Type I resin (except on 5265 and 5305 where gels are not counted).

Reactor cleanliness is the main factor affecting gels. Polymer buildup on reactor internals will go through several batches and then "flake off" into a batch being produced and will ~~make~~ cause gels. Reactor chem washing, rinsing, and swirling is used to keep the reactor internals clean. The frequency or length of time on these may need to be increased if gels become a problem. Another problem may be that the reactor and condenser sprayheads are not functioning properly. These are pipes that extend into the reactor and ~~have a flat washer attached near the end to cause an even~~ that are designed to evenly spread~~ing~~ or "spray~~ing~~" ~~of~~ the chem wash or water onto the reactor condenser or walls. The sprayhead pattern can be visually checked through the reactor manway during rinse to verify that the sprayhead is working properly.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(5) Gels (Continued)

Resin or impurities that are charged into the reactor with raw materials will also cause gels. The charge filters on the raw materials (water, or fresh or recovered VCM) can be changed out, if needed, to prevent gels in the resin. Resin gels are checked off the dryer on the dryer regular sample taken by the dryer "A" operator. If there is a problem with gels, a gallon slurry sample may be required to be taken by the reactor "A" operator when dumping ~~a~~ each reactor to have the lab dry the slurry and check for gels from ~~a~~ each specific reactor.

(6) Color - The color of the resin gives a measure of the heat ~~stability~~ history and thermal properties of the resin. At elevated temperatures PVC is inherently unstable and will have discoloration, increased melting viscosity, embrittlement, sticking, and loss of HCl (which will damage process equipment). ~~The resin customer has to mix expensive heat stabilizers with the resin to process it into a finished product.~~ Customers desire resin with good ~~stability~~ color to reduce ~~their operating costs and~~ color matching problems and to give the finished product consistant outward opperance and color.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(6) Color (Continued)

The lab measures color on a Gardner Colorimeter which gives a "L", "~~A~~ a", and "~~B~~ b" value for the resin sample. They have the following meanings:

(a) "L" - White (high value) vs. Gray-Black (low value)

(b) "~~A~~ a" - Red (high value) vs Green (low value)

(c) "~~B~~ b" - Yellow (high value) vs. Blue (low value)

High "L" values are desirable and the "~~A~~ a" and "~~B~~ b" values should be between the respective red and green or yellow and blue ends of the ranges. The spec sheet gives the acceptable results for each resin type.

The color of the resin is controlled by reactor stripping conditions when recovering a reactor and by the amount of antioxidant added to the reactor. Naugard is presently used as the antioxidant and is added when killing a reactor, which is just before reactor recovery begins. The operator must be sure that the proper amount of Naugard is added to each batch to keep the color and heat stability within specifications. New HP Stripping temperature and the length of time the batch is held at high temperatures affects color and heat stability because of the amount of heat the resin is subjected to.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(6) Color (Continued)

No new HP

Stripping conditions are set up that will allow the resin to remain within specifications, but the stripping procedures must be closely followed or the batch will become discolored. New HP The vinyl department normally goes by the "~~B~~b" color value to determine whether the resin is within specification. Usually, if the "~~B~~b" value is good, the "L" and "~~A~~a" value will also be within specification. If the color results are out of specification more Naugard may be added to subsequent batches to give lower color results so that the high color material can be blended off in the large blend tanks. The reactor temperature controllers may also need to be checked and any malfunctions repaired by instrument maintenance if color results are high. New HP Resin color may also be affected by the dryers if the resin is allowed to stay in contact with high temperatures for extended periods. A good example of this is that when resin backs up in a dust collector. It may become discolored if it is not transferred out or if the heat is not shut off quickly. The dryer inlet temperatures must also be watched closely to keep resin color within specification.

I. <u>INTRODUCTION (CONTINUED)</u>

B. <u>Process Information (Continued)</u>

2. <u>Poly Vinyl Chloride (Continued)</u>

d. <u>Resin Quality and Uses (Continued)</u>

(6) <u>Color (Continued)</u>

Color results are run off the dryers on every dryer regular sample taken by the dryer "A" operator. If the "~~B~~b" value is too high, further sampling may be required to determine if the slurry from the reactor had a high color or if the dryers caused the bad result. This can be checked by drying a slurry sample in the lab and running the color test. The sample would be taken by the reactor "A" operator when the reactor is dumped.

(7) <u>Heat Stability</u> - Resin heat stability tests are run by the development lab once per week off of random dryer regular samples from each product produced. A strip of plasticized resin is put into a Metr~~o~~astat oven and the strip feeds out of the oven, allowing a progressive heating of the strip from one end to the other. This is then compared to standard control resins to determine if heat stability is equivalent to the standard. A heat stability value of 3.0 means the tested resin was the same as the control resin, while a value of more than three indicates that heat stability is worse than the control and values less than 3.0 indicate resin that is better than the control resin.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(7) Heat Stability (Continued)

Resin heat stability is affected by the same parameters that affect resin color ~~and~~ Bad heat stability gives resin customers burned products which cannot be reground, and causes the addition of extra heat stabilizers which are expensive and affect the customer's operating cost. ~~the same type of problems that come from off color resin.~~ The heat stability may be affected more by the heat history of the resin, which will include temperature peaks during polymerization or heat kicks or runaway at the end of the polymerization time. These problems can usually be controlled by ~~the altering reactor catalyst loadings or improving heat transfer to the reactor~~ changing the reactor catalyst loadings or improving heat transfer to the reactor cooling water (i.e., more flow, cooler water, or cleaner condensers).

(8) Contamination - Contamination in the resin can be any small pieces of foreign matter or may be particles of burnt resin. These particles will not absorb plasticizer or fuse and will appear as black "specs" in a finished vinyl article. This is objectionable from an appearance standpoint and can also lead to weakening of the finished product.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Qualtiy and Uses (Continued)

(8) Contamination (Continued)

No new ¶ For instance, in wire and cable insulation, the burnt resin particle will be highly conductive and may lead to spark failures when the cable is tested. New ¶ Contamination is tested every two hours off of each dryer (except on some products where it may be required every hour as specified by the Supervisor) and guidelines are set up for what procedures to take if the contamination level is out of spec. Contamination results are reported as black contamination and brown contamination. The internal specification for brown contamination is a maximum of 100 except on certain customers such as Southwire where brown contamination is more critical (brown contamination maximums are not shown on the spec sheet). The lab tests for contamination by putting a resin sample in a soap solution and the heavier brown and black particles will settle to the bottom and can be counted.

Another method of checking the contamination is by spreading a sample ~~over a small conveyor belt and counting~~ on a small vibrating trough and counting the contaminated particles as the ~~belt slowly turns.~~ resin moves down the trough. This test is required for ~~wire and cable customers~~ Southwire.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(8) Contamination (Continued)

Contamination is usually ~~controlled by~~ a measure of dryer cleanliness. The rotary dryers will have some resin particles build up on the baffles and the inlet portion of the dryer and as these "flake" off, resin discolor and contamination is caused.

Going into and cleaning the dryer will usually clean up the contamination. Occasionally the contamination may come from the reactors, which may be determined by using contamination tests on a slurry sample after it is dried in the lab. The source of contamination must then be isolated and the contamination can be stopped. ~~[illegible]~~ Resin in the chem wash that is left in the reactors ~~[illegible]~~ is one source of ~~[illegible]~~ reactor contamination. This usually causes "brown" contamination.

(9) Moisture - Moisture in the resin comes from water that is not removed from the wet cake in the dryers. The moisture specification for all the resins produced ~~in~~ is 0.30 percent, maximum, as measured on a resin sample by the Anacon moisture analyzer. The analyzer uses infrared light to determine the moisture content of the resin. Moisture content can also be determined by drying a weighed resin sample in an oven and then reweighing it after completely drying.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(9) Moisture (Continued)

No new ¶ The internal vinyl department resin spec may vary from season to season. In the winter, the spec must be lowered to insure that moisture levels are very low in the resin product.

Moisture in the product causes several problems for the customer. ~~The customer buys resin at about 20¢ per pound which is an expensive price to pay for water. A railcar of resin at 0.3% moisture will contain about 500 pounds or 60 gallons of water at a price of about $100 and the customer does not receive 500 pounds of resin that was paid for.~~ Excessive moisture in the product ~~also~~ causes resin transfer problems in the customer's transfer systems. The moisture in a railcar will tend to migrate to the bottom of the compartment, causing unloading problems because the wet resin will not flow. In winter conditions, ~~that~~ moisture is an even bigger problem because the resin can freeze and the railcar will not unload. ~~Finally~~ Moisture mixed with the other raw materials when ~~it~~ the resin is processed can also cause porosity or various other processing problems in the finished product.

DTH 000094337

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(9) Moisture (Continued)

Moisture in the resin is sampled every two hours off of every dryer that is running. If the moisture result is above the maximum limit, the dryer conditions must be adjusted to make the resin more dry ~~dryer~~ and the resin from the dryer must be resampled in one hour. If a moisture problem continues for more than 4 hours on one dryer, the lead operator ~~will~~ must notify the Shift Supervisor and follow his instructions for correcting the problem.

(10) Residual VCM - The residual VCM maximum on all resin~~s~~ produced is 10 ppm. Residual VCM is tested by the Instrument ~~QC~~ Development lab on all shipments and is tested off of the dryers on every "regular" sample for 5265 and 5305. The specification of 10 ppm is set by industry standards ~~EPA and OSHA regulations~~ because excessive VCM in the resin may be hazardous to human health and the environment. Excessive VCM in the product can also cause problems for the resin customer because when the resin is heated, the VCM may form gaseous bubbles giving impurities in the finished product and may give off hydrogen chloride acid-gas ~~hydrochloric acid~~ which will damage process equipment.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

d. Resin Quality and Uses (Continued)

(10) Residual VCM (Continued)

The residual VCM content in the resin is controlled by reactor recovery and stripping conditions, and by blend tank aeration. The plant has established Reactor stripping conditions ~~are set up~~ ~~which~~ that will give acceptable amounts of VCM in the slurry that is dumped from the reactors. The EPA has set a limit on the amount of residual VCM that can be contained in the slurry, which must be less than 400 ppm averaged over all the batches dumped in a 24 hour period.

Lack of compliance to this regulation could lead to fines or plant shutdown, so stripping according to the established procedures is essential. A sample for residual VCM must be taken off of every batch dumped from the reactors to comply with government regulations. Lengthy aeration times are necessary in the blend tanks on some resins such as 5265 and 5305 which ~~tend to be~~ are harder to strip. These resins must be dumped into separate blend tanks and aerated for a given length of time prior to drying the slurry so that the 10ppm residual VCM requirement for the dried resin can be met.

I. INTRODUCTION (CONTINUED)

B. Process Information (Continued)

2. Poly Vinyl Chloride (Continued)

(11) Volume Resistivity - Volume resistivity tests are run once per month on 5425 and 5465 to check the electrical properties of the resins. The tests are run by the Development Lab and the resins are compared to a previously run control resin. Impurities of any type in the resin can affect the volume resistivity and too much or too little of the additives will also affect it. The volume resistivity is important to electrical customers in wire and cable applications where resin is used to insulate electrical wires and cables.

Copy Perm

III. OPERATING PROCEDURES

A. Reactor Evacuation

General Information

Evacuation of the reactor is required prior to charging in order to remove as much of the air (inerts) as possible. Air is introduced into the reactor during previous phases of the reactor batch cycle since dump, rinse, and chem wash require that the reactor be vented to the atmosphere.

Proper reactor evacuation is extremely important. Some of the problems that can occur if too much air is left in the reactor prior to charge include:

1. A buildup of excess pressure in the reactor during charge.
2. An explosive mixture can be created as VCM is put into the reactor that already contains oxygen from the air. Any spark source, such as static, could then create a catastrophic situation.
3. Poor temperature control during polymerization because of inerts blanketing the condenser and impairing proper heat transfer.
4. The production of off-grade PVC or a coarse batch.
5. A buildup of excess pressure in the recovery system as the inerts are vented into that system.

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

General Information (Continued)

Evacuation is accomplished using one of the two available two-stage steam jet ejector systems. Evacuation is controlled by the lead operator from the control panel. The "A" operator must check on the evacuation jets and valves, if needed, and confirm that the reactor is evacuated to the correct vacuum during evacuation.

Procedure

1. Prior to evacuating, the lead operator should start filling out the Large Reactor Batch Sheet (Figure 2) for the reactor to be evacuated. The following items should be completed:

   Reactor: Write the reactor number on the sheet. The "batch number" may also be recorded which increases by one every time that particular reactor is to be charged (e.g.,if reactor 743 had batch number 522 the last time it was charged, the next time that 743 is charged if would be batch number 523).

   Type: Write the resin type to be charged (e.g.,5385).

   Date: Write the current date. Note that the period from midnight to 7 A.M. is considered to have the previous day's date because the vinyl department "day" is from 7 A.M. one morning to 7 A.M. the following morning (e.g.,at 5:00 A.M. on 2/23/82, the date recorded on the batch sheet should be 2/22/82).

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

Procedure (Continued)

Water Counts:	Record the formula amount of water counts to be charged **and the charge water temperature.**
Methocel, gallons and inches:	Record the formula amount of Methocel and inches of Methocel to be charged.
VCM, Counts:	Record the formula amount of total VCM to be charged into the reactor.
RVCM, % and Counts:	Write the % of the recovered VCM charge tank(s) and counts of RVCM to be charged.
Catalyst, gallons and type:	Record the amount and type of catalyst(s) to be used.

NOTE: Several things should be considered before the amount of catalyst to be charged is decided upon. The lead operator has the responsibility of seeing that the reactors are turned around as efficiently as possible and that catalyst loadings are decided upon which will give needed production with minimum downtime. The following should be taken into account:

a. Run time and catalyst loading of the previous batch.

b. Reactor spacing - i.e., if catalyst is increased will the shorter poly time be negated by waiting on recovery?

c. Outside weather conditions and projected conditions during the batch - i.e., will the sun probably be coming up to warm the weather up after the batch is charged?

d. **Resin particle size.**

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

Procedure (Continued)

NOTE: (Continued)

d. (Continued)

Shorter poly times usually cause slightly finer resin and longer poly times usually cause slightly coarser resin. If the particle size is close to out of specificaiton, a change in catalyst loading may not be advisable.

If the lead operator thinks that a change in catalyst loading should be made, he is responsible for contacting and consulting with the shift supervisor and then making the change if the supervisor approves it.

Run Temp.: Set the temperature setpoint on the reactor temperature controller to the specified temperature for the product to be changed in that reactor. Record that temperature on the batch sheet.

what was actual

Run Pressure: Record the pressure that the reactor should run (according to previous batches).

Typical run temperatures and pressures are as follows:

Product	Run Temp., °F	Run Pressure, psig
5265	150-152	~150
5305	143-145	~135
5385	130-135	~120
5425	123-127	~ 100
5465	116-120	90-95

FIB

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

Procedure (Continued)

2. When the reactor is okay for charge and there are no major problems known on raw materials to be charged, the lead operator will record the time and his initial in the appropriate blank on the large reactor batch sheet. One important consideration is to make sure the reactor is empty by re-checking for flow through the bullseye with the reactor sewer valve open and checking the reactor agitator amps. The lead will then record the precharge amps on the large reactor batch sheet. If there is any question about whether the reactor is empty, the lead will contact the "A" operator and have him check the bullseye in the field.

3. The lead operator puts the interlock mode selector on "evacuation" for the reactor to be evacuated and make sure all the reactor valves are closed. The only valves on the reactor that should be able to open in this mode are the condenser valve, the evacuation valve, and the jacket steam valve. All valve lights should be showing ~~either open or~~ closed with no double indications. The lead will put any light that does not work on the panel light list or contact the shift supervisor if an "E" work order is required.

4. The lead operator tells the reactor "A" operator via radio that the reactor is ready to put under evacuation and specifies the reactor, product, and catalyst loading to be charged- e.g., "D-300 is ready for evacuation, 5385, five gallons of L-223 catalyst".

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

Procedure (Continued)

5. The "A" operator responds and tells the lead which evacuation system (big or little "jet") to use, depending on what he is doing and how long it will take him to get to the top of the reactors.

   Energy conservation is very important for the "A" to consider here because steam will be wasted if the big jet is used and the reactor is pulled down to a vacuum several minutes before the "A" operator gets there to check vacuum. Also, note that reactor evacuation and charge takes priority over most other "A" operator jobs. The big evacuation system will pull the reactor to a vacuum in about half the time that the little evacuation system will.

   How decide?

   If D-700 is being charged, the big evacuation system will automatically be used.

   T/F

6. The lead operator opens the condenser valve and evacuation valve on the reactor to be evacuated.

7. The lead operator opens the valves on the appropriate evacuation system which has been chosen for that reactor in step (5), as follows:

   Little Evacuation System:

   a. Open CV-151 which is between the reactor evacuation header and the two primary evacuation jets for the system.

   b. Open CV-152 which opens the steam for the two primary evacuation jets and the two secondary evacuation jets in the system (one actuated valve).

   How many in little?

   M/C

DTH 000094346

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

Procedure (Continued)

Big Evacuation System:

a. Open CV-133 which is between the reactor evacuation header and the primary evacuation jet for the system.

b. Open CV-131 which opens a steam valve going into each of the two jets (primary and secondary).

8. When the valves in step 7 are opened, the lead will check on the camera to see that the jets came on.

9. The lead operator will open the emergency cooling water valve which supplies cooling water to the reactor oondenser.

NOTE: In cold weather, cooling water on the condenser will lower the reactor temperature significantly, causing long heat-up times. Under these conditions, the emergency cooling water should be shut off as soon as the reactor temperature starts falling (this takes about 30 seconds to a minute). However, the emergency cooling must always be turned on initially during evacuation.

List valves opened Evac

10. The lead operator will open the steam to the jacket valve on the reactor being evacuated. This begins heating-up the reactor shell and helps reduce polymerization heat-up time.

11. The lead operator will record the time the evacuation started on the batch sheet.

12. The reactor "A" operator will proceed to the top of the reactors and will check the reactor vacuum on the reactor mercury monometer using the following procedures:

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

Procedure (Continued)

a. Check the pressure gauge on the reactor and make sure it is showing a vacuum. If pressure is on the reactor and the valve to the manometer is opened, the mercury in the manometer can be blown out and will have to be refilled.

b. Open the valve at the manometer for the reactor that is being evacuated.

c. Watch the mercury level and when it reaches 28.5 inches of mercury notify the lead operator - e.g., "28.5 on D-300".

d. Close the valve at the manometer once the proper vacuum has been reached.

13. The lead operator checks the vacuum on the reactor from the control room reactor pressure indicator when notified by the "A" that a 28.5 inch vacuum has been obtained. If the pressure indicator shows the incorrect pressure, the lead will have the "A" recheck the vacuum and notify the shift supervisor if there is a further problem.

14. When a 28.5 inch vacuum has been obtained per both the reactor mercury manometer and the control room reactor pressure indicator, the lead will shut the condenser and evacuation valves on the reactor (this can be done by going to the charge mode on the reactor).

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

Procedure (Continued)

15. The lead operator must then close the reactor emergency cooling water valve. He will then scan the reactor control panel and make sure all valves show closed except the steam to the jacket valve.

16. The lead operator then closes the evacuation system off that was started in step 7, by closing either CV-133 and CV-131 or CV-151 and CV-152. ORDER of steps

17. Evacuation is now complete and the reactor is ready for breaking vacuum.

18. The lead will record the time the evacuation is completed on the batch sheet and record the vacuum attained.

Troubleshooting

1. One problem that commonly occurs is that one or more of the actuated valves will not open. This is evidenced by the jets not coming on or by the pressure on the reactor not falling after the jets are on. If either of these conditions occur, the following procedure will be followed:

   a. The lead operator will have the "A" check the valves in the field by specifying which valve is the problem (if he can tell from the control panel).

   b. The "A" operator will then check the valve in the field and if it is working improperly will follow the steps given in the "Actuated and Automatic Valves" section (Section Q) of this manual and try to get the valve to open.

III. OPERATING PROCEDURES (Continued)

A. Reactor Evacuation (Continued)

Troubleshooting

2. If all the valves are working and the reactor will not evacuate, check the plant steam pressure. It should run between 140-145 psig. If it is low, there may not be enough pressure to evacuate a reactor. If steam pressure is low, contact the supervisor for priorities on what to use steam for. If the steam pressure is below 125 psig, the leads should start cutting back on steam usage immediately because of the possibility of rupturing boiler tubes, and the supervisor should then be contacted and made aware of the situation.

Coupling messed up

3. If the reactor will not evacuate at all and all the evacuation system valves are open, a valve on the reactor may be open that should not be open. This may include the vent valves, the evacuation valve on another reactor, or the recovery valve on the selected reactor. The lead operator should have the "A" operator check for open valves and if none can be found, contact the supervisor or chief lead operator. The lead may be able to narrow down the cause of the problem by closing the selected evacuation and condenser valves and having the evacuation header pressure checked in the field. This will tell whether the problem is on the selected reactor or if it is in the evacuation header and jets. Another possibility is that the reactor could be evacuating but the indicator in the control room may have malfunctioned. This can be checked by pressure gauges in the field.

III. <u>OPERATING PROCEDURES</u> (Continued)

A. <u>Reactor Evacuation</u> (Continued)

<u>Troubleshooting</u>

4. If the reactor will evacuate partially but not reach a 28.5 inch vacuum, the problem could again be that there are valves open or partially open to the atmosphere on either the selected reactor or another reactor. Another possibility is that water may have been left in the reactor and as a vacuum is pulled, the water will evaporate, filling the reactor vapor space and preventing complete evacuation. This can be checked by redraining the reactor.

   Other problem areas to check if the reactor will not evacuate to 28.5 inches of mercury are the catalyst injection valve and the Christmas tree valves on top of the reactor. If these are cracked or left open, a 28.5 inch evacuation may not be attainable.

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves

General Information

Actuated and automatic are used throughout the reactor and dryer units as control valves. These valves may be operated remotely from the control panel in the control room or from switches or controllers in the field.

Actuated valves are valves that have air actuators on them which open or close the valve according to an air signal from a solenoid valve. The valves have one of two general types of actuators on them, either an actuator that is spring loaded or one that uses air to drive the piston in the actuator both ways (open or closed). The non-spring loaded types are most common in this plant. The solenoid valve opens or closes according to the electrical signal from the control valve switch and either allows air to enter or exit the actuator and change the valve position.

Actuated valves have limit switches on them that use magnets to give an electrical signal telling if the valve is open or closed. Two types of limit switches are used. Reed* limit switches use small horseshoe magnets mounted on the actuator that must come very close to the Reed switch to actuate the electrical signal.

*Registered Trademark

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

General Information (Continued)

The signal will give an open or closed indication according to the position of the actuated valve. Go* limit switches use a circular disc on the actuator. Part of the disc is magnetic and when it comes close the the Go* switch an electrical signal is given, indicating the position of the actuated valve.

Automatic valves are control valves that open or close as a flow, pressure, level, or temperture gets closer to or deviates from a manually adjustable set value (setpoint). For instance, if the reactor temperature setpoint is 130°F, the automatic cooling water valves will open as the reactor temperature rises to and above 130°F. At a few degrees Farenheit above 130°F, the valves will normally be wide open, allowing full cooling water flow to the reactor jacket and condenser. Then as the temperature of the reactor drops due to the cooling water flow, the automatic valves will begin to close and will try to control the reactor temperature at the setpoint (130°F). If the temperature should fall much below 130°F, the valves will completely close, allowing the reactor to heat back up to the 130°F setpoint. The automatic valve controller will normally have an automatic and manual mode. In the manual mode, the valve can be manually opened or closed as much as desired from a positioner on the controller.

* Registered Trademark

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

General Information (Continued)

Many of the actuated and automatic valves have oilers in the air line to the actuator or control mechanism. The oil allows the parts of the solenoid valves and actuators to work and fit together properly without excessive wear that destroys the equipment, causing costly repairs. Keeping the oilers properly filled is the "A" operator's responsibility. ~~for~~ on the valves in his unit. The oiler should not be allowed to run empty, as this will cause valve malfunctions. When filled, the oiler should be filled about one inch from the top. An oiler needs filling if it has less than one inch of oil in the oiler. Oil cans are located strategically throughout the unit ~~allowing~~ providing easy and fast availability when needed. These oil cans are checked weekly (or more often as needed) and kept filled by maintenance personnel. Oil cans that are empty should be reported to the Maintenance Superintendent. Also, any oiler that does not work properly, is broken, or cannot be unscrewed for filling must be reported on a maintenance work-order so that the problem can be corrected.

The following section will give troubleshooting procedures that can be used for actuated and automatic valves. These procedures and steps should be implemented if a valve will not operate

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

General Information (Continued)

properly from the control panel. The lead operator and "A" operator should both be familiar with these procedures and may sometimes be called on to use them very proficiently and quickly, depending upon the situation. The lead operator is also responsible for noting any abnormalities with panel lights or switches and if the "A" operator cannot correct the problem in the field, he must report the problem to the supervisor or note it on the panel light list that instrument maintenance is to work on during the week. The item will also be signed off as each panel light is repaired by maintenance personnel.

NOTE: A copy of the panel light list should be made weekly by the Operations Supervisor and sent to the Vinyl Operations Superintendent, the Maintenance Superintendent, and the I & E Supervisor. This will show progress being made on panel light maintenance.

Actuated Valve Troubleshooting

1. If an actuated valves does not give a light on the control panel in either the open or closed position, the lead operator will have the "A" operator check the position of the

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

Actuated Valve Troublshooting (Continued)

valve. The "A" operator will visually check the valve stem and actuator position and will notify the lead operator which position (open or closed) the valve is in. If the valve is closed or open but not showing a light on the switch, the "A" operator will inspect the limit switch. If magnets are broken or have been removed, either replace the magnet or write a work order to repair the magnet. If the magnets are in place and in good shape, the limit switch may need repairing (write an appropriate work order or place the light on the panel light list).

2. If the lead operator opens or closes a valve but it will not give the proper indication, he will have the "A" operator check the valve in the field while he continues to try to operate the valve from the switch. The "A" operator will visually check the valve stem and actuator position and will notify the lead operator which position (open or closed) the valve is in.

If the valve is in the correct position, the "A" operator will check the limit switch as given in Item 1 (above), and make repairs or have the switch (or magnets) repaired by maintenance as needed. The "A" operator will also check the oiler level

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

Actuated Valve Troubleshooting (Continued)

for the valve and fill it if needed.

NOTE: Automatic safety systems based on valve positions can be overridden or bypassed if the valve is in the desired position by attaching a magnet to a limit switch as long as the valve is constantly attended while the safety system is bypassed. Some operations in the unit (such as charging VCM) cannot proceed until a valve or set of valves is open (or closed). These can be overridden to maintain operations but the "A" operator must remain at the valve for the entire time the valve safety system is bypassed.

3. If the valve is in the undesired position (open or closed), per the "A" operator's visual check, the "A" operator must attempt to manually override the valve by pushing the solenoid valve manual override button.

If the valve goes to the desired position (open or closed) when the override button is pushed, the valve will probably need to be held in that position for a given time period. The "A"

III. <u>OPERATING PROCEDURES (CONTINUED)</u>

V. <u>Actuated and Automatic Valves (Continued)</u>

<u>Actuated Valve Troubleshooting (Continued)</u>

operator can accomplish this by closing the air supply to the valve and releasing the override button. One of three things will happen.

a. The valve will remain in the desired position. This is desirable for a given length of time. When the valve needs to be returned to its original position, open the air valve and the valve should return to its original position. If it does not, override the solenoid again and go though the procedure to change the valve position. If the valve will not operate properly from the panel, the valve oiler may need to be filled. If the oiler has the correct oil level, write a maintenance work order to change out the solenoid valve.

b. The valve will go back to the undesired position. This may indicate that the valve is the spring loaded type which will go back to the original position when air pressure fails. Find an object that can be used to "jam" the valve in the desired position (without tearing it up) and override the valve again to get in in the desired position.

III. <u>OPERATING PROCEDURES (CONTINUED)</u>

V. <u>Actuated and Automatic Valves (Continued)</u>

<u>Actuated Valve Troubleshooting (Continued)</u>

Jam the valve while it is in the desired position to keep it there.

<u>NOTE:</u> Be very careful whem jamming a valve manually. Watch your fingers and hands, being careful not to get them caught or pinched. Very serious injury can result from having a finger caught by a limit switch magnet or by the movable parts of the actuator or valve stem.

When the valve needs to be returned to its original position, remove the jam (<u>carefully</u>). If the valve will not properly operate from the panel, check the valve oiler for the oil level and fill if needed. If the oiler is properly operating, write a work order on the solenoid valve.

c. The valve will go partially back to the undesired position. There may be enough air left between the air valve and the actuator to move it back to an "in between" position (or even back to the undesired position). Find an object

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

Actuated Valve Troubleshooting (Continued)

to jam the valve with long enough to bleed off the air while the override is released (see Safety NOTE under 3b, above). This will leave the valve in the desired position even after the jam is removed. To return the valve to its original position, reopen the air supply valve. If the valve sill not properly operate from the panel, check the valve oiler for the oil level and fill if needed. If the oiler is properly operating, write a work order on the solenoid valve.

4. If the valve wil not operate when the override button is pushed the following problems may be responsible:

   a. The air supply valve to the actuated valve may be closed. Check the valve position and open and close it to verify its proper operation.

   b. The air supply line may be broken, disconnected, or leaking. This is usually evidenced by an air leak around the air valve, solenoid valve, or actuator. Repair the line if possible by tightening or reconnecting the fittings, or have maintenance repair the air piping or tubing. If the valve operation is needed immediately try to hold the tubing or piping up to the proper solenoid connection long enough to operate the valve.

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

Actuated Valve Troubleshooting (Continued)

c. In freezing weather, water may get in the solenoid and freeze, hampering valve operation. Thaw a the ice in solenoid by blowing steam on it.

d. The air pressure to the valve (or reactor unit) may be low. Pressures below 60 psig will not operate most of the valves in the reactor units. Notify the Shift Supervisor and cut back on air usage in the unit where possible.

e. The air line or tubing may be plugged with foreign matter. Clear the line or tubing by disconnecting it and blowing out the plug or have maintenance clear the line, if needed.

In any of these cases the valve may be able to be opened or assisted in opening by manually turning the valve or actuator stem using available hand tools (if the actuator is not spring loaded). This may be necessary if repairs or other steps cannot be delayed and the valve must be operated immediately.

In all cases where any operator must work with or check an actuated valve in the field, he must check the oil level and limit switch for abnormalities. A problem overlooked

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

Actuated Valve Troubleshooting (Continued)

in these areas may re-occur at a more critical time and the operator should try to avert such situations by watching and checking for problems and correcting them (filling oilers or writing work orders on magnets and limit switches) as they are noticed.

To isolate an actuated valve, the operator must close the air supply to the valve and [redacted] push the override to make sure it stays in the desired position or have the lead operator try to operate the valve from the panel and make sure it stays in the desired position. The operator will then tag the air supply valve with a "DO NOT OPERATE" tag.

Automatic Valve Troubleshooting

1. When an automatic valve malfunctions, the lead operator and/or "A" operator must first check the valve position. The lead operator can check the valve position per the needle that indicates valve position on the panel if it is a panel operated valve. This indication may not always be correct, however, and should be field verified by the "A" operator.

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

Automatic Valve Troubleshooting (Continued)

2. Once the valve position is checked, the valve may need to be manually stroked ~~closed~~ open or closed. This can be done for panel operated valves by placing the controller in the manual mode and turning the valve positioner to open or close the valve. This can also be used to verify proper operation of the valve. If the valve will not respond to manual positioner operation, have the "A" operator check the air lines to the the valve and make sure that the valves are open and the lines are not plugged.

3. If the automatic valve is field controlled, after checking the valve position the operator should move the setpoint to verify proper operation of the valve. ~~It~~ The valve should either open or close to try to move the operating variable (flow, temperature, etc.) closer to the setpoint. If the valve will not respond to setpoint changes ~~[illegible]~~, check the air supply and/or write a work order as needed to repair the controller.

4. Another problem with automatic valves is often that the instrument measuring the operating parameter (pressure, temperature, flow, etc.) is malfunctioning. For instance, a flow

III. OPERATING PROCEDURES (CONTINUED)

V. Actuated and Automatic Valves (Continued)

Automatic Valve Troubleshooting (Continued)

controller indicator may show 0 gpm ~~but~~ when the control valve is open and and pressures are correct on the line. This may indicate that there is flow in the line and the flow indicator needs repairing (write an instrument maintenance work order).