NON-CONFIDENTIAL

REPORT OF THE INITIAL PLANT VISIT TO MONSANTO COMPANY'S PLANT IN DECATUR, ALABAMA REGARDING DEVELOPMENT OF NEW SOURCE PERFORMANCE STANDARDS FOR THE SYNTHETIC FIBERS INDUSTRY

I. PURPOSE

The purpose of the plant visit was to obtain process, operating, cost, and emissions data regarding the wet spun acrylic fibers segment of the synthetic fibers industry. The information obtained will serve as background data in the development of "New Source Performance Standards" (NSPS) for the synthetic fibers industry.

II. PLACE AND DATE

Monsanto Company
Acrylic Fiber Plant
Decatur, Alabama

April 1, 1980/Revised Version

III. ATTENDEES

Name	Affiliation
Dennis Crumpler	EPA, CPB
Roy Manley	PES, Inc.
Greg Lathan	PES, Inc.
Robert Zerbonia	PES, Inc.
Lee O. Chambers	Monsanto
Jim Forthman	Monsanto
Dale Kline	Monsanto
Rudy Kucera	Monsanto
Bill Matthews	Monsanto
Ray Smiley	Monsanto
James Vaughan	Monsanto

IV. DISCUSSION

Prior to the plant tour, a meeting was held among various Monsanto personnel and the EPA/PES project team. Mr. W.L. Matthews, Monsanto Environmental Affairs Representative, opened the meeting with a discussion of the objectives of the EPA/PES information gathering effort. Robert Zerbonia provided a general overview of the objectives and purposes of the information gathering program and its overall relationship to New Source Performance Standard (NSPS) development.

Mr. Matthews noted that considerable information regarding the Decatur plant is available in two previous EPA related-studies: The Emission, Process, and Control Technology Study of the ABS/SAN, Acrylic Fiber, and NBR Industries conducted by Pullman-Kellogg (April 20, 1979) and Development Document for Effluent Limitation Guidelines and New Source Performance Standards for the Synthetic Resins Segment of the Point Source Category, EPA-440/1-74-010a (March 1974). Mr. Matthews next provided a detailed review of the agenda, previously sent to Monsanto. The agenda contained numerous questions concerning the Monsanto acrylic fiber process. A copy of the agenda along with the information and data provided by Monsanto is contained in Appendix A. The topics of discussion on the agenda that required detailed examination are discussed below:

In response to item #10 on the agenda, Monsanto provided a process flow diagram depicting the operation of the acrylic fiber plant. The diagrams illustrate the processing steps and stages used in production of acrylic fibers (Figure 1).

In response to item #20, Mr. Matthews stated that Monsanto has made a determination of solvent loss for the entire dope preparation stage, which includes several process steps. At this time, Mr. Matthews presented a series of baseline data regarding solvent losses for the various production stages of their acrylic fiber plants. Mr. Matthews noted that these figures were from a Monsanto in-house determination and are based on limited data. The values reflect calculations based on vapor pressures, on design of equipment, and in some cases on actual measurements (Table 1).

After a thorough discussion of items included in the agenda, Monsanto indicated that if an NSPS was promulgated for wet-spun acrylic fibers, they would rather go to a water absorption (scrubbing) instead of carbon adsorption air pollution control system. Monsanto felt that recovering the solvent twice (first by steaming the carbon bed to remove the VOCs and subsequent distillation of the VOCs to separate out the DMAc) would not be economically feasible. The high boiling point of DMAc (167°C) would require more energy to remove and distill the solvent. Also, Monsanto stated that their in-house experience with carbon adsorption has been technically negative. They stated that regeneration of the carbon bed would be quite costly since the solvent has a high boiling point requiring more than usual quantities of steam. It was also noted that because of the gas volumes involved, tremendous amounts of carbon would be required to maintain the beds (past experience has shown significant carbon losses during regeneration). It was also noted that the high cost of energy would make carbon adsorption less desirable than wet-scrubbing since carbon adsorption requires steam stripping and distillation where scrubbing requires only distillation.

Dennis Crumpler (EPA) asked representatives from Monsanto whether they had attempted to enclose the spinning area more effectively (i.e., making the ventilation area smaller around the process line) since his previous visit connected with the Pullman-Kellogg study in the summer of

Figure 1. Process Flow Diagram

CONFIDENTIAL

Material Claimed Confidential
By Company And Therefore
Deleted From Inclusion
In The Public Record

TABLE 1

Monsanto Baseline Data

Process Stage	Solvent Loss (lbs solvent/1000 lbs fiber)
Dope Preparation	
Polymer/Solvent Mixing	---
Polymer/Solvent Dissolving	---
Dope Filtering	---
TOTAL	0.478
Spinning*	
Extrusion	---
Washing	---
Drawing	---
Finishing, Etc.	---
Drying	---
TOTAL	
Plant 1**	86.724
Plant 2***	6.453
Average (weighted)	20
Cutting and Bailing	
Stress Relieving	---
Recrimping	---
Cutting	---
Bailing	---
TOTAL	4.576

* These emissions were measured out the stack.

** This plant accounts for 16 percent of fiber production.

*** This plant accounts for 84 percent of fiber production.

1978. At that time, Monsanto was using duct cloth to cover the wash lines and spinning areas. Monsanto stated that they had curtains on the machines presently and that they also had some prototype lucite-enclosed spinning areas which were being tested. Monsanto also said they had made three major advances in their ventilation system since the Pullman-Kellogg visit:

1) More effectively enclosed the spinning machines
2) Balanced the spinning room air flow
3) Increased the concentration of the solvent by reducing the air flow.

Present capacity is 325 M lbs/year. In 1964 and 1965, the spinning and polymer area was doubled, but this was the last major expansion. Most increases in capacity since this doubling of equipment have been achieved through bottlenecking and upgrading of equipment.

Monsanto was asked what effect escalating oil prices would have on acrylic fiber production since the acrylic fiber industry's raw materials are almost completely derived from petrochemicals, and how this raw material tie would affect acrylic fiber markets and cost in comparison to other fiber types. Monsanto personnel stated that its production raw material costs are indirectly tied to crude oil prices. Further discussion between PES and Monsanto led to the topic of acrylic fiber cost curves which vary significantly from other true synthetic fibers which are also tied to petrochemicals. It was noted that in recent years the cost curve for nylon fibers has been somewhat steeper than that of acrylic fibers; therefore, acrylic is theoretically becoming more economically competitive with nylon in certain market areas. Nylon is directly tied to the production of benzene, which is also used for unleaded gasoline; acrylic fibers production is tied to the production of propylene which is a petroleum by-product pyrolysis operation. Acrylic fibers do not compete with benzene demand. It is of general industry opinion that acrylic fibers have a stable market (specific market segments) and are considered a mature product line.

In the early 70's, approximately 50 percent of Monsanto's Decatur plant production went into carpeting and approximately 50 percent went to the apparel industry. Presently, 95 percent of Monsanto's Decatur acrylic fiber production goes into the apparel market (mainly sweaters, coats, and other winter wear) and only 5 percent is made into carpeting.

Monsanto representatives also claimed that due to the devaluation of the dollar, a greater portion of recent sales is overseas, but they did not expect this trend to continue.

V. PROCESS DESCRIPTION

Monsanto's acrylic fibers plant at Decatur, Alabama, has a name plate capacity of 325 million pounds per year of acrylic fibers. Monsanto produces three major types of acrylic polymer which include an "acrylic" copolymer mix of acrylonitrile (AN) and vinyl acetate (VA); an "acrylic" copolymer mix of AN, VA, and vinyl bromide (VBr) and a "modacrylic" copolymer mix of AN, VBr, and vinylidene chloride. Polymerization

process steps are described in the Pullman-Kellogg Study Report of April 1978, and the Pullman-Kellogg plant trip report of July 17, 1978.

Monsanto utilizes a wet spinning process to form the acrylic fibers. In the Monsanto process, dry polymer is dissolved in the spinning solvent (dimethylacetamide) to form a solution of honey-like consistency called dope. A filtration step employing plate and frame filter presses is used to remove trace impurities from the dope prior to the spinning operation. The dope is extruded through a spinneret into a spinning bath. The bath contains solvent diluted with water such that it causes the fibers to coagulate at the proper rate. The composition of the spinning bath does vary with such factors as fiber denier. The main feature of the wet spinning process is the mass transfer of solvent; precipitation or coagulation ensues by diffusion of the solvent out of the fiber into the bath, and by diffusion of the water into the fiber. In the process a highly swollen gel thread results at first, which has to be densified in the post-treatment of the fibers. Post treatment endows the fiber material with the technological properties needed for downstream processing and with the textile properties required for end use. The Monsanto fiber processing stages include: washing, drawing, finishing, dyeing, drying, crimping, stress relieving, recrimping, cutting, and baling.

Solvent Manufacturing Unit - Makeup solvent required by the process is prepared at the plant site in a separate manufacturing facility. Acetic acid is reacted with dimethylamine to form dimethylacetamide (DMAc).

VOC (Solvent) Emissions - See Table 1.

Solvent Recovery - Monsanto's wet spinning fiber plant is equipped with a solvent recovery system to recover dimethylacetamide from the solvent/water stream from the spinning, washing, and drawing stages. Distillation operations are used to separate water from solvent in the recovery system. Water is recycled to spinning operations and solvent is recycled to dope preparation.

Solvent recovery system vent streams were identified; however, no figures were furnished for DMAc losses. These numbers are available in the Pullman-Kellogg plant trip report (July 17, 1978) and in the August 11, 1978, letter to Mr. W.M. Talbert (P-K) from R.J. Kucera (Monsanto).

VI. PLANT TOUR

The dry polymer (AN) is blended with solvent (DMAc) and delusterants in the mixing stage. The dry polymer is fed into a mixing area to form a slurry (partially dissolved polymer plus solvent). All instrumentation and controls are located in a room below the mixing area. This slurry is pumped to a heater to complete the polymer dissolving. (Sampling of the slurry is performed for production testing and sampling records.) The slurry is pumped to heaters; as heat is applied, the polymer goes into solution. The polymer is fed into large holding tanks. A rupture

disc and vent pipe is installed on top of each tank to prevent potentially dangerous pressure buildup. The dope is then pumped to filter presses. A duct over the presses vents vapor to the roof.

Following the filter presses, dope is pumped through a final, small filter. The dissolved and filtered polymer is then pumped through spinneret jets into a coagulation bath. The coagulation bath is drained to the solvent recovery area. A counter-current water wash flows down a slight slope built into the wash area, and toward the coagulation bath. This wash water is essentially solvent free as it first flows over the moving fiber, but gains in solvent concentration as it moves toward and into the coagulation or spin bath. This spin bath mixture is drained continuously and piped to the solvent recovery area.

The tow bundles then proceed along the line to the finish area. Typically, this is a bath of lubricants and anti-static agents. Following the finish application, the tow is passed over steam-heated rollers. The steam and vapor released at these points is collected by integral vent slots in the spinning, washing, and drawing equipment. These vents collect into a large duct which leads to the roof and atmospheric venting.

Monsanto also has a prototype spinning line enclosed with flexible lucite covers. The enclosed area includes spinning machines, the spin bath and subsequent washing, finishing, and drafting operations. The relatively tight enclosures are being used to measure the effect on controlled air flow in this area.

After the drawing (drafting), fiber leaves the main process line equipment and is fed to a crimping machine. The fiber at this point is dry to the touch. The crimping involves heating the fiber and pressing the fiber tightly against itself, to form wrinkled or crimped fiber. A vacuum duct is installed at the exit of the crimper to cool the fiber and vent the removed vapor to the roof. A conveyor then transports and loads the tow into carts for temporary holding and movement to subsequent processing.

The fiber in the carts is transported to a large heated and pressurized vessel. This process is termed stress relieving. The heated and pressurized air and vapors are vented to the roof. Next, the fiber is put through a recrimping process, since the stress relieving removed most of the earlier induced crimp. As in the earlier crimping stage, vacuum ducts are installed at the crimper box and underneath the conveyor to cool the fiber and to remove most of the residual vapor. These ducts are vented to the roof. A small portion of the unrecrimped continuous tow is baled for shipment at this stage, although most of the tow is carried to the fiber-cutting stage. A tamper presses the loose staple into a bale, which is automatically weighed, bound, labeled, and covered with plastic wrap. These bales are removed from the area by fork lift and transported to storage or shipping.

Outside Building. Visible on the roof of the building are a large number of assorted fans, vents, blowers, large ventilation systems, etc.

VII. FINAL DISCUSSION

After completing the plant tour, a short question and answer session was held between representatives of EPA and Monsanto.

Monsanto was asked if sliding glass enclosures would affect their manufacturing process. They indicated that sliding glass enclosures would cause lacing problems with the tow.

Representatives of EPA asked what portions of their manufacturing line were vented to the two large stacks on their facility. Total spinning capacity is vented through the two stacks.

VIII. ACTION TO BE TAKEN

Monsanto agreed to consider PES's request for the following data:

1) Engineering data on flow rates and concentrations in the spinning area.

2) Roof plan of Monsanto's Decatur plant.

3) Cost and economic data requested in question #58.

PES agreed to send Bill Matthews a copy of the Phase I Source Category Survey Report.

APPENDIX A

Plant Survey Agenda

CONFIDENTIAL

CONFIDENTIAL

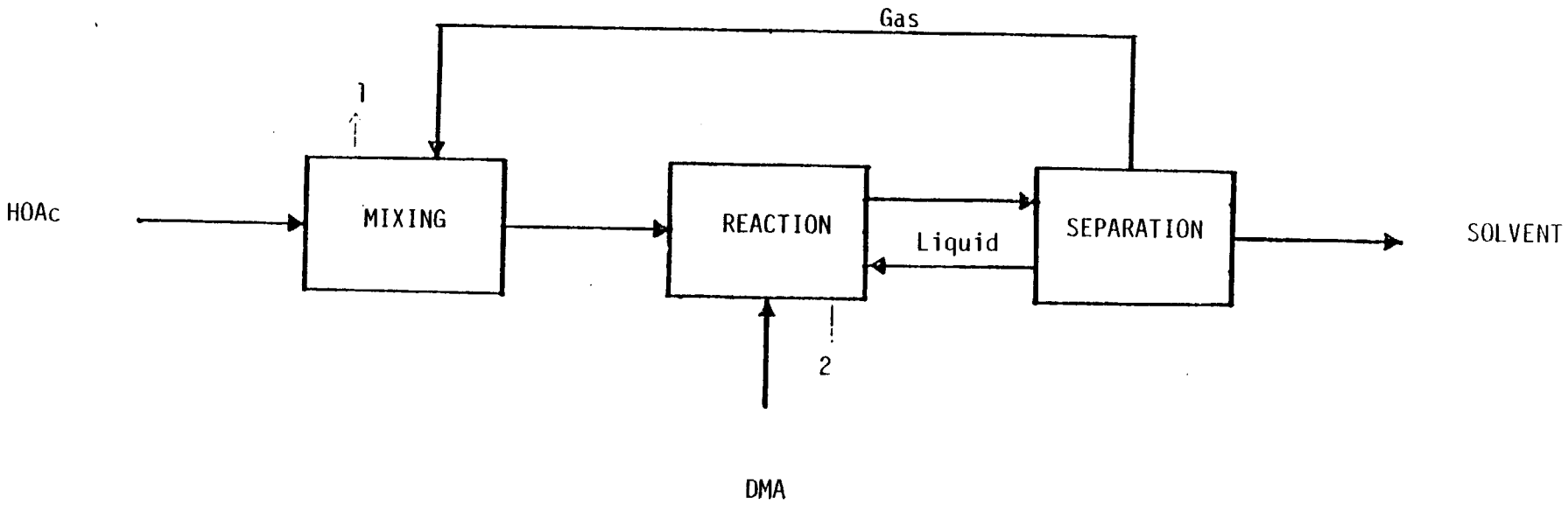
Material Claimed Confidential By Company And Therefore Deleted From Inclusion In The Public Record

Figure 1. PROCESS FLOW DIAGRAM

CONFIDENTIAL

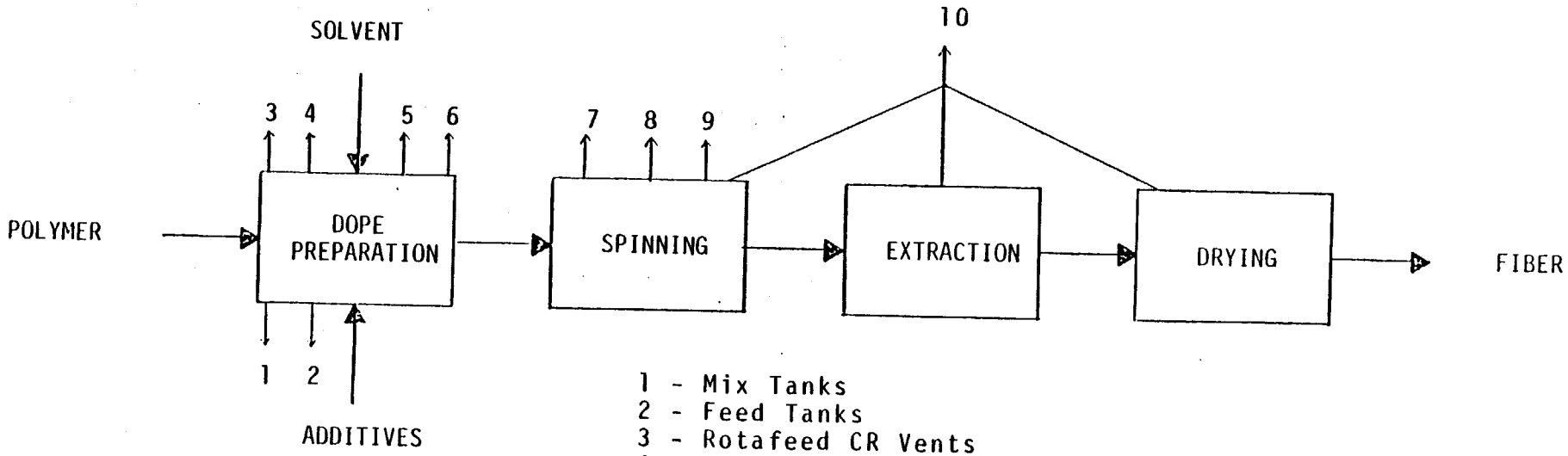
Material Claimed Confidential
By Company And Therefore
Deleted From Inclusion
In The Public Record

Figure 2. SOLVENT MANUFACTURING UNIT FUNCTIONAL BLOCK DIAGRAM



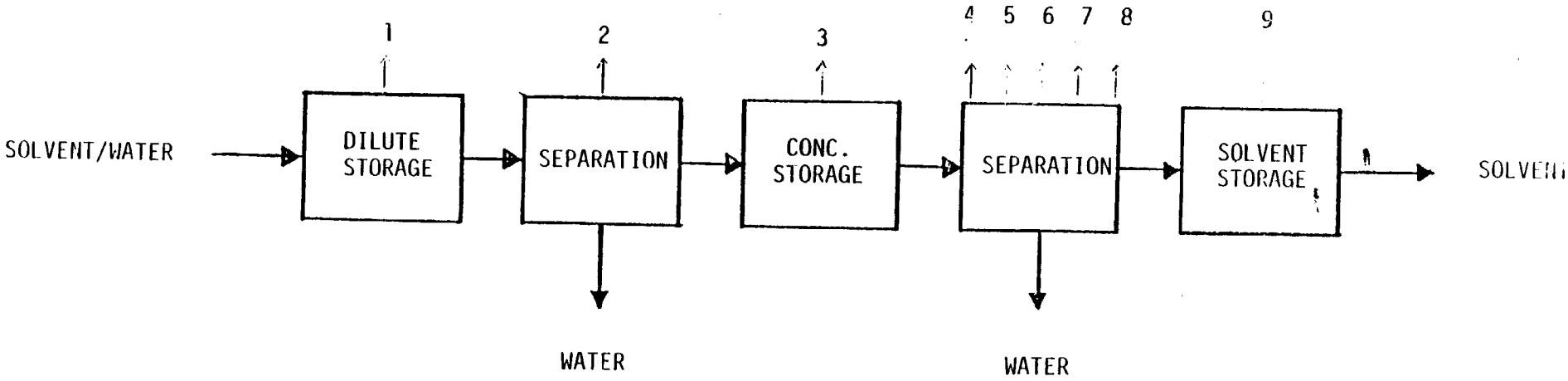
1 - Scrubber Vent
2 - Heels Column Feed Tank Vent

Figure 3. DOPE PREPARATION & SPINNING UNIT FUNCTIONAL BLOCK DIAGRAM



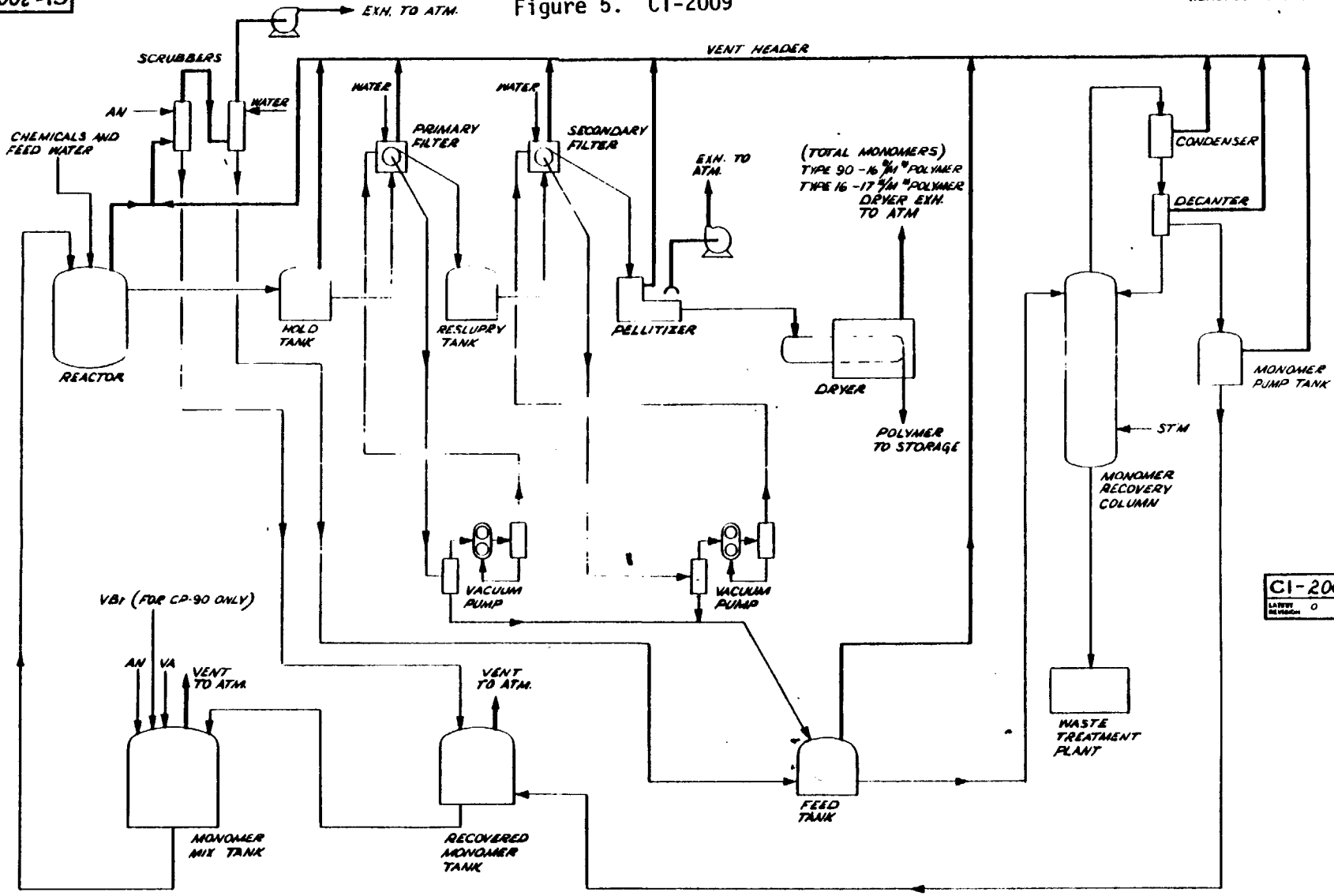
1 - Mix Tanks
2 - Feed Tanks
3 - Rotafeed CR Vents
4 - Slurry Tank Vents
5 - Area Exhaust Fans
6 - Filter Press Exhaust Fans
7 - Jet Bath Vents
8 - Dilute CR Tank Vents
9 - Conc. CR Tank Vents
10 - Spinning Machine Vents

Figure 4. SOLVENT RECOVERY UNIT FUNCTIONAL BLOCK DIAGRAM



1 - Atmospheric Vents
2 - Vacuum Jet Vents
3 - Atmospheric Vents
4 - DMA Removal Column Vent
5 - DMA Bottoms Tank Vent
6 - Column I Heater/Cond. Vent
7 - Pan Dryer Manway
8 - Pan Dryer Overflow
9 - Atmospheric Vents

Figure 5. C1-2009



PROJ	REV	ZONE	DESCRIPTION	PROJ	REV	ZONE	DESCRIPTION	REFERENCE DRAWINGS

MONSANTO TEXTILES COMPANY
AREA 309 / 319 N/S POLYMER
TYP. CP-16, 90 POLYMER PLT.
ENVIRONMENTAL PROT. AGENCY - STUDY
SCALE - NONE | SITE DECATUR
FUNC. CLASS | PROJECT | C1-2009

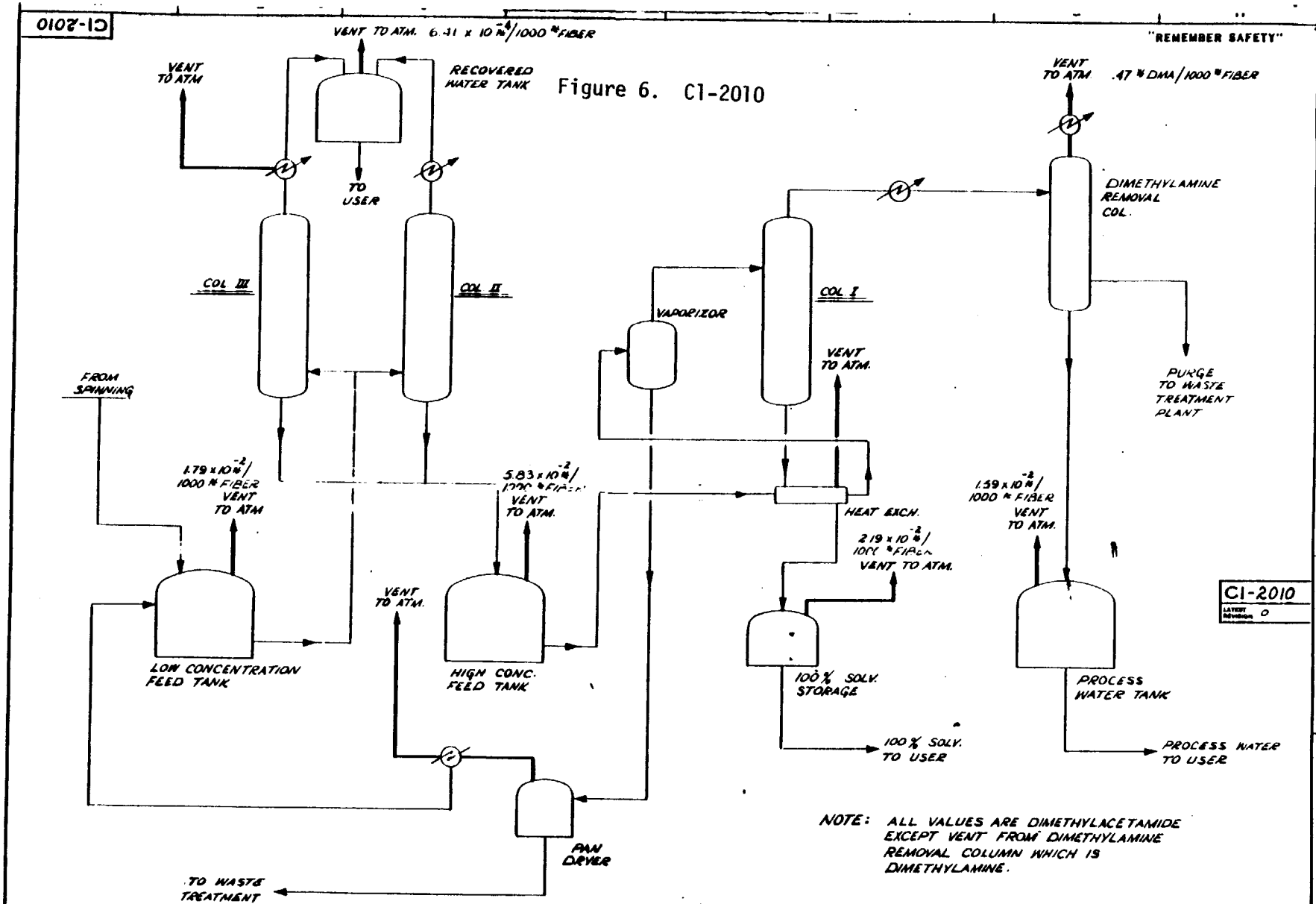
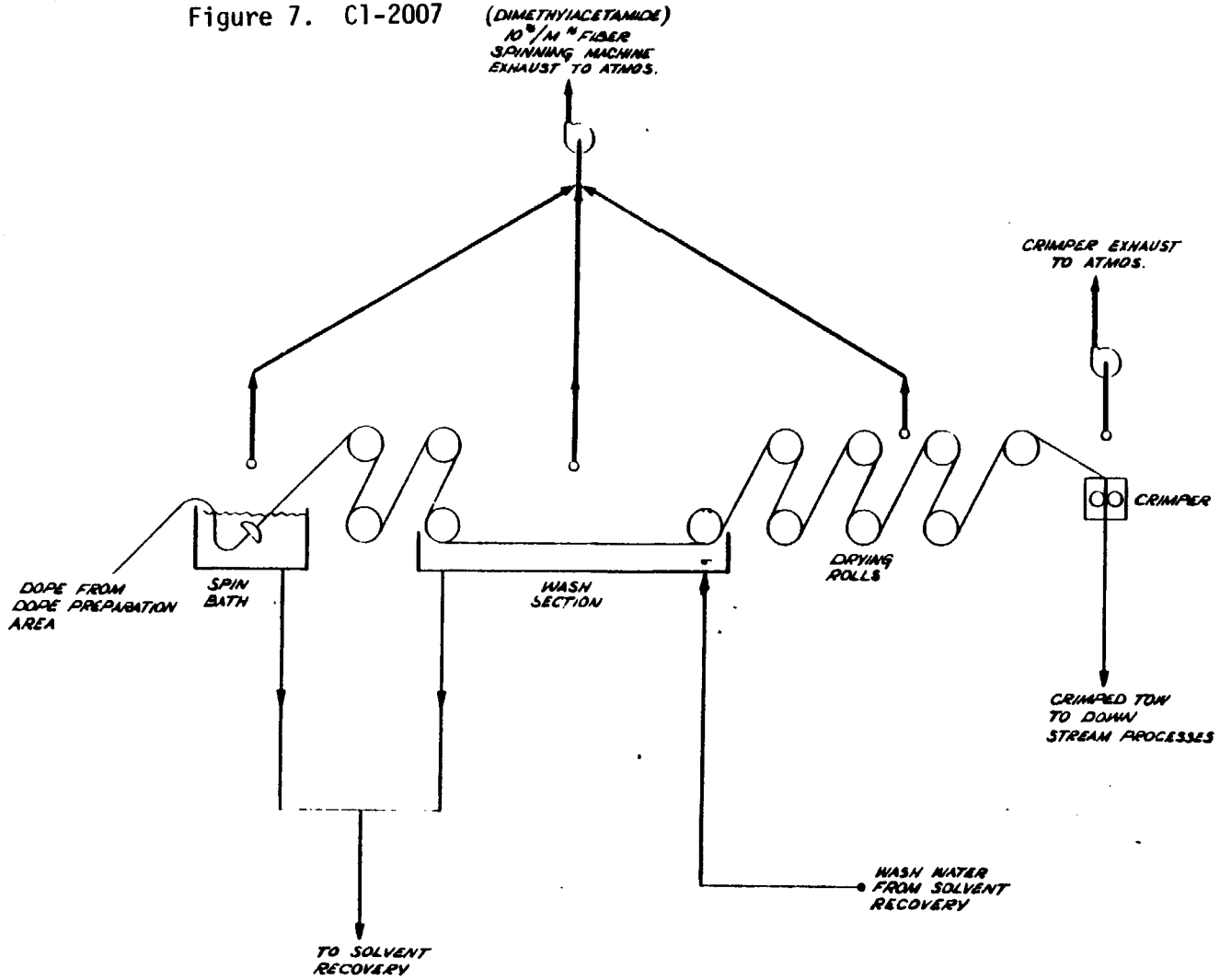


Figure 6. C1-2010

"REMEMBER SAFETY"

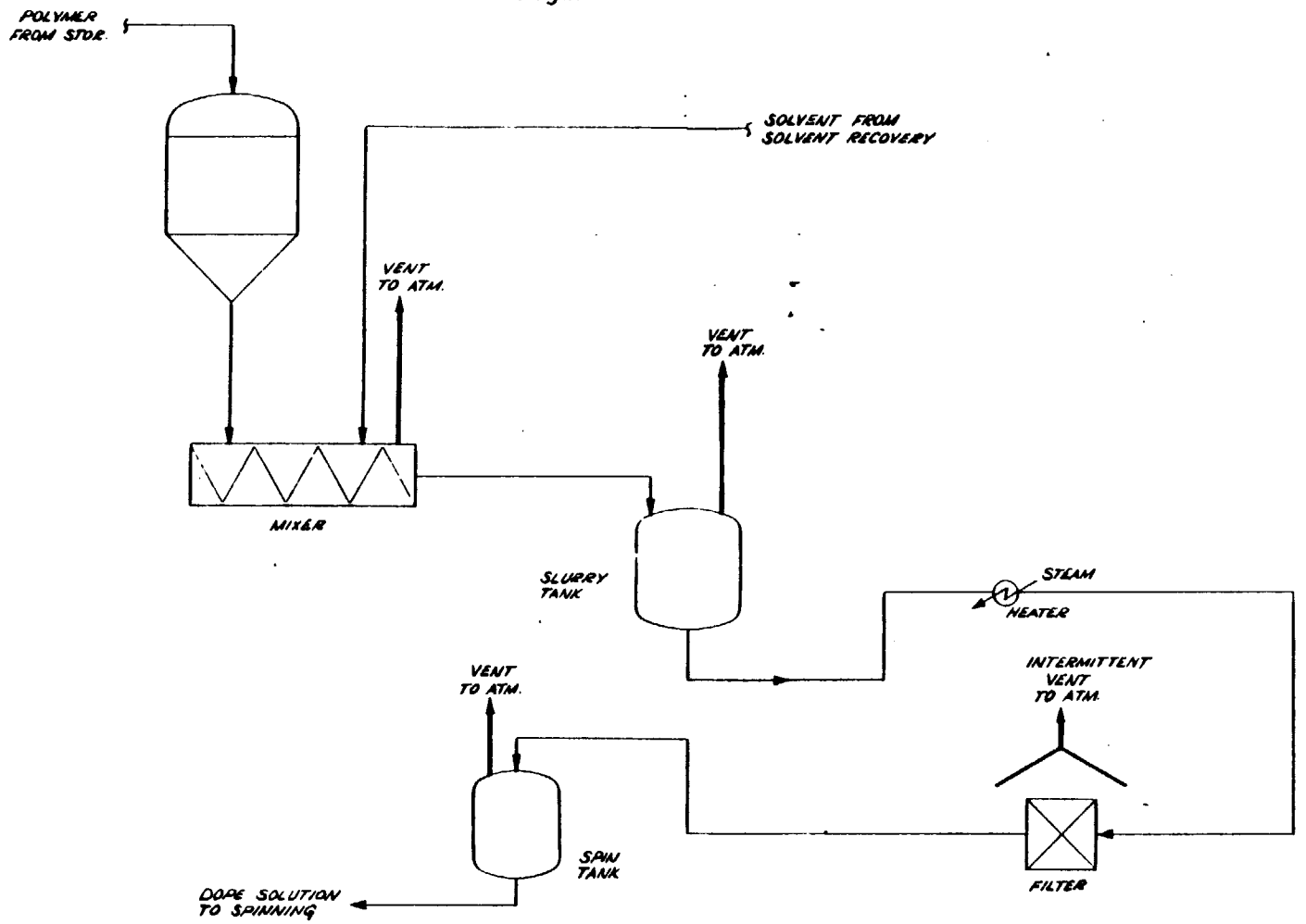
Figure 7. CI-2007



CI-2007

MONSANTO TEXTILES COMPANY
AREA 305/341 N/S SPINN.
TYPICAL SPINN. MACHINE
ENVIRONMENTAL PROT. AGENCY-STUDY
SCALE - NONE
CI-2007

Figure 8. C1-2011



C1-2011

"REMEMBER SAFETY"

MONSANTO TEXTILES COMPANY
AREA 304/340 N/S DOPE PREP
TYP. DOPE PREP PLT
ENVIRONMENT PROT. AGENCY-STUDY
C1-2011