5.19 AP42 Reference 20

SYNTHETIC FIBERS
AP-42 Section 5.19
Reference Number
25

Pullman Kellogg
Division of Pullman Incorporated

Houston, Texas 77084
Telephone (713) 492-2500

28 November 1978

US. EPA, OAQPS, ESED, CPB, CAS
Room 730 Mutual Building (MD-13)
Research Triangle Park,
North Carolina 27711

Attention: Mr. M. R. Clowers

Dear Mike:

Attached is a trip report containing the non-confidential data supplied by Allied Chemical regarding VOC emissions from their manufacture of Urea-formaldehyde Resins and Nylon 6. This information has been revised based on a review by Mr. R. L. Fawcett of Allied.

The supplemental data requested during the meeting was also supplied by Mr. Fawcett in his November 21 letter. I have also included that information in the trip report.

The following caprolactam vapor pressure data was also provided:

$$\log_e P = 18.86 - (6670/T)$$

P = vapor pressure mm Hg
T = temperature, ^{o} Kelvin

Very truly yours,

PULLMAN KELLOGG
a Division of Pullman Incorporated

E. L. Bechstein

ELB:sk
Attachment
cc: Mr. R. L. Fawcett - Allied Chemical
w/Attachment

TRIP REPORT: Allied Chemical
Morristown, New Jersey

Nylon 6 and Urea-Formaldehyde Resins

24 October 1978

The following personnel were in attendance:

Allied Chemical

R. L. Fawcett	Manager, Corp. Pollution Control
W. L. Sullivan	Fibers Division Manager, Pollution Control
R. E. Chase	Environmental Manager, Chesterfield Plant
W. L. Boyer	Senior Environmental Engineer, Columbia Plant
D. R. Fitts	Manager, Environmental Services, Specialty Chemicals Division
R. H. Wholf	Manager, Environmental Services, Toledo Works

Pullman Kellogg

E. L. Bechstein
D. K. Webber

EPA

M. R. Clower

REVISED 27 November 1978

Allied Chemical has two plants engaged in the manufacture of Nylon 6 and one plant engaged in the manufacture of Urea-Formaldehyde Resins. A description of the process and storage facilities by Allied Chemical including notes taken by Pullman Kellogg follows.

1. Columbia South Carolina Plant

In this plant Allied polymerizes caprolactam to Nylon 6 and then spins fiber producing continuous apparel yarn and staple. A quantity of merchant chip is produced. Also Nylon 6 chip from other Allied facilities is spun. Both batch and continuous polymerization is practiced. Some staple fiber is spun directly from reactor melt. However, the majority of the fiber is spun from remelted chips produced in a separate operation. Unreacted Caprolactam from chip purification and exhaust scrubbers is collected as a dilute solution in water and concentrated for subsequent reprocession at another site.

A. Process Description

1) Storage

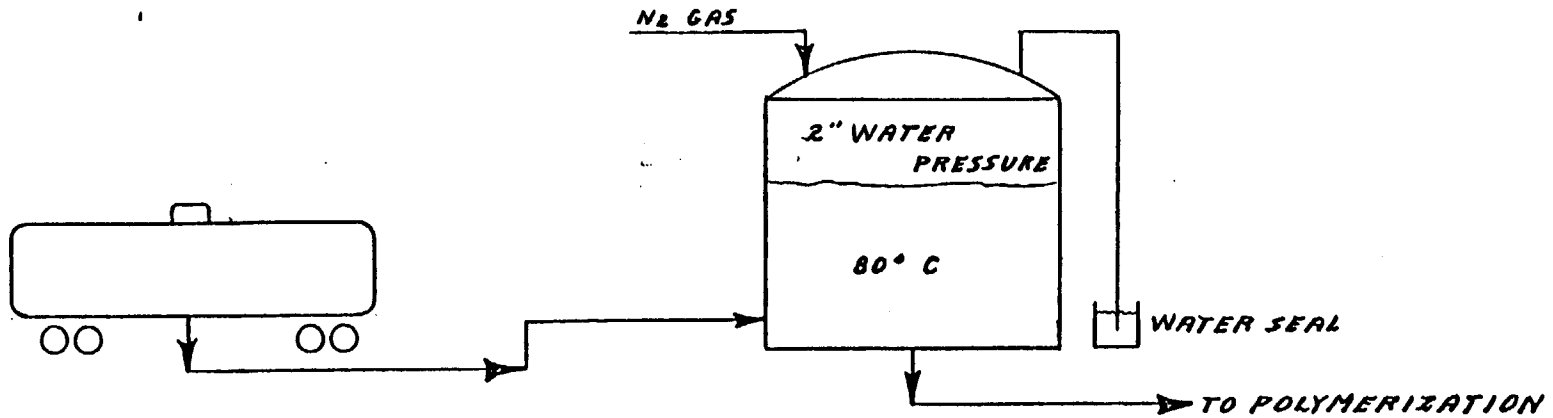
Caprolactam is produced by Allied Chemical Corporation at Hopewell, Virginia and delivered by rail tank car to the Columbia Plant as a lactam-water solution. Supplemental delivery by tank truck is used to provide return tankage to Hopewell from Columbia for recovered, concentrated, lactam-water solutions for purification and reuse. Figure 1 shows the storage and delivery system.

Rail delivered lactam is stored in a large tank under a nitrogen blanket to prevent oxidation. As lactam is withdrawn pressure is maintained by admission of nitrogen. As lactam is added the displaced nitrogen gas containing lactam is bubbled through a water seal tank where the lactam is absorbed by the water. No significant emission occurs.

AFELY TODAY

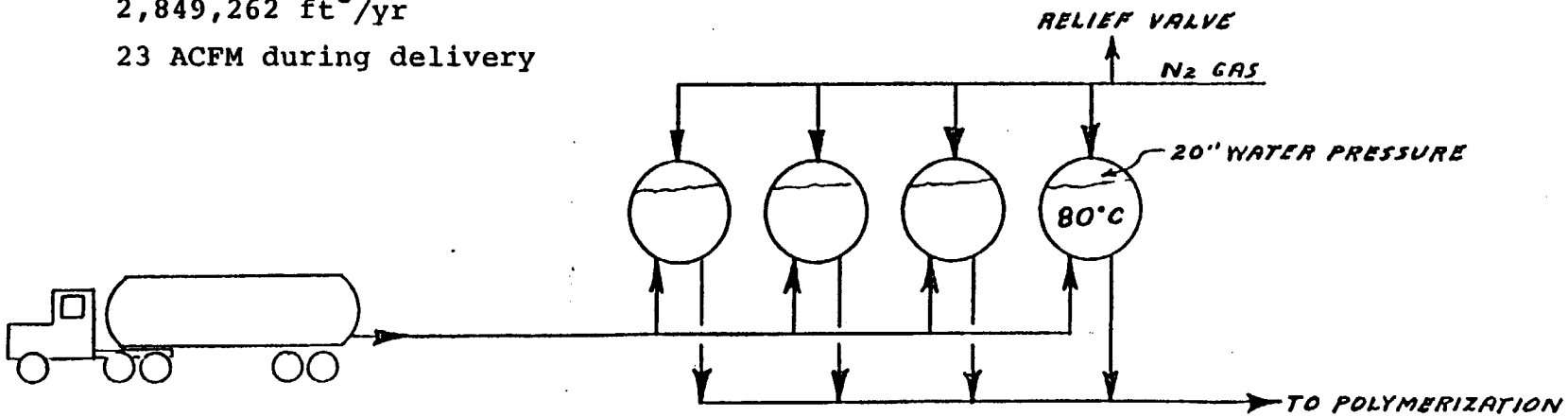
FIGURE 1

Nylon 6 Manufacture



2,849,262 ft^3/yr

23 ACFM during delivery



458,488 ft^3/yr

16 ACFM during delivery

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FRACTIONS ± DECIMALS ± ANGLES ±

Allied Chemical FIBERS DIVISION
Columbia, South Carolina

PLANT
JOB NO.
DASH
BLDG.

CAPROLACTAM DELIVERY & STORAGE

SCALE

DWN	CHK'D	ENGR	APP	DATE
TGR		CSW		

SK—6110

Trailer delivered lactam is stored in four horizontal tanks. A similar nitrogen blanket is maintained but displaced nitrogen gas is vented to the atmosphere. An average annual emission rate of 5480 lb/hr was estimated for the horizontal tanks.

2) Batch Polymerization (See Figure 2)
Lactam is weighted into tanks. Various additives are prepared and added to the lactam. The mix is then charged to an autoclave. The polymerization proceeds and evolved water and monomer are condensed and recovered in a closed system for recovery and reuse. No significant emissions arise from the polymerization step.

The molten nylon 6 is extruded into a water quench batch. Monomer vapors evolved are collected at the extrusion die heads by an exhaust system. Steam is admitted to the exhaust system to prevent crystallization. The air/steam/lactam mixture is passed through a wet scrubber containing mist eliminators. A water stream is sprayed on the mist eliminators to collect the lactam. The lactam water solution is recovered for purification and reuse. These are points O, P, Q, and R in Figure 2.

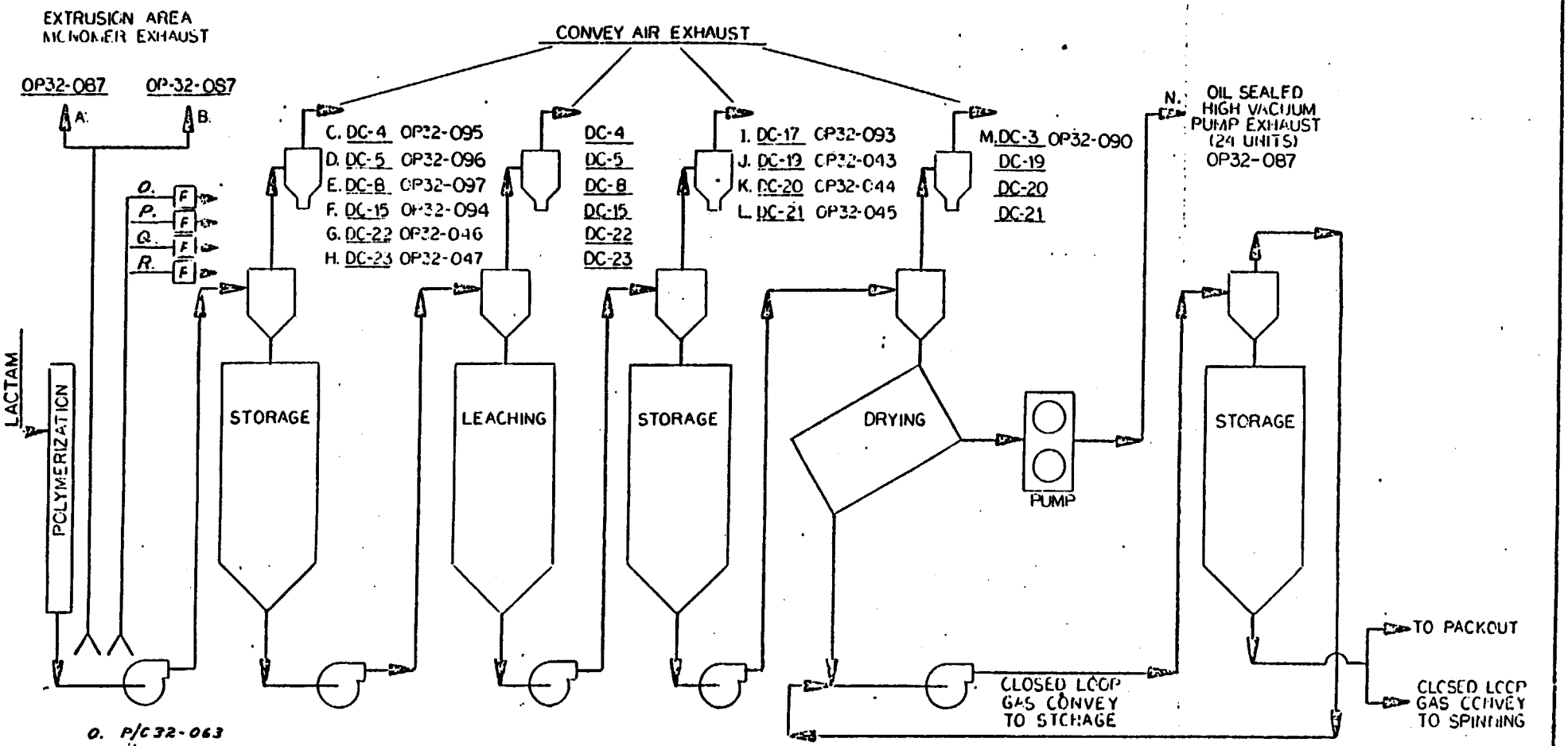
Sampling of the scrubber inlet and outlet air stream indicated an estimated annual lactam vapor flowrate of 64,308 lb/yr at the scrubber inlet and 3,353 lb/yr at the scrubber outlet. The total flow rate for points O, P, and Q (point R is not yet installed) is 12,000 ACFM. No other VOC were detected.

WORK SAFELY TODAY

FIGURE 2

Nylon 6 Manufacture

PROCESS PERMIT o/p 32-087



REVISED -- 9-5-70

Allied Chemical

FIBERS DIVISION
ALLIED CHEMICAL CORPORATION
COLUMBIA, S. C.

PLANT
JOB NO.
DASH
BLDG.

BATCH POLYMERIZATION

SCALE

DWN	CHK'D	ENGR	APP	DATE
ESH		HWC		

SK-5790

Point A and B of Figure 2 are an exhaust collection system stacks for air used to remove quench water from polymer strands. These stacks have been sampled and calculations show an estimated 14,016 lb/yr of lactam vapor emitted at 130°F. Total flow rate for points A and B is 7180 ACFM.

After pelletization, the nylon 6 chips are leached with hot water to remove unreacted caprolactam and oligomers dryed in a closed loop circulating nitrogen dryer, and stored. No significant organic emission streams are produced during these operations. Some fugitive emissions occur as a result of nitrogen leakage in the drying system.

3) Staple, Continuous Polymerization, Spinning and Processing (See Figure 3)

Caprolactam and other additives are continuously fed to a closed system of vessels to produce a continuous stream of molten nylon 6 without emissions to the atmosphere.

The molten nylon 6 directly from the continuous polymerization unit and additional molten nylon 6 from remelted chips is extruded through holes in steel plates to form filaments. During the extrusion and air quenching process lactam vapor is removed by a monomer exhaust system. The exhaust system collects the lactam vapor from around the filaments and a water spray is admitted to the collection system to

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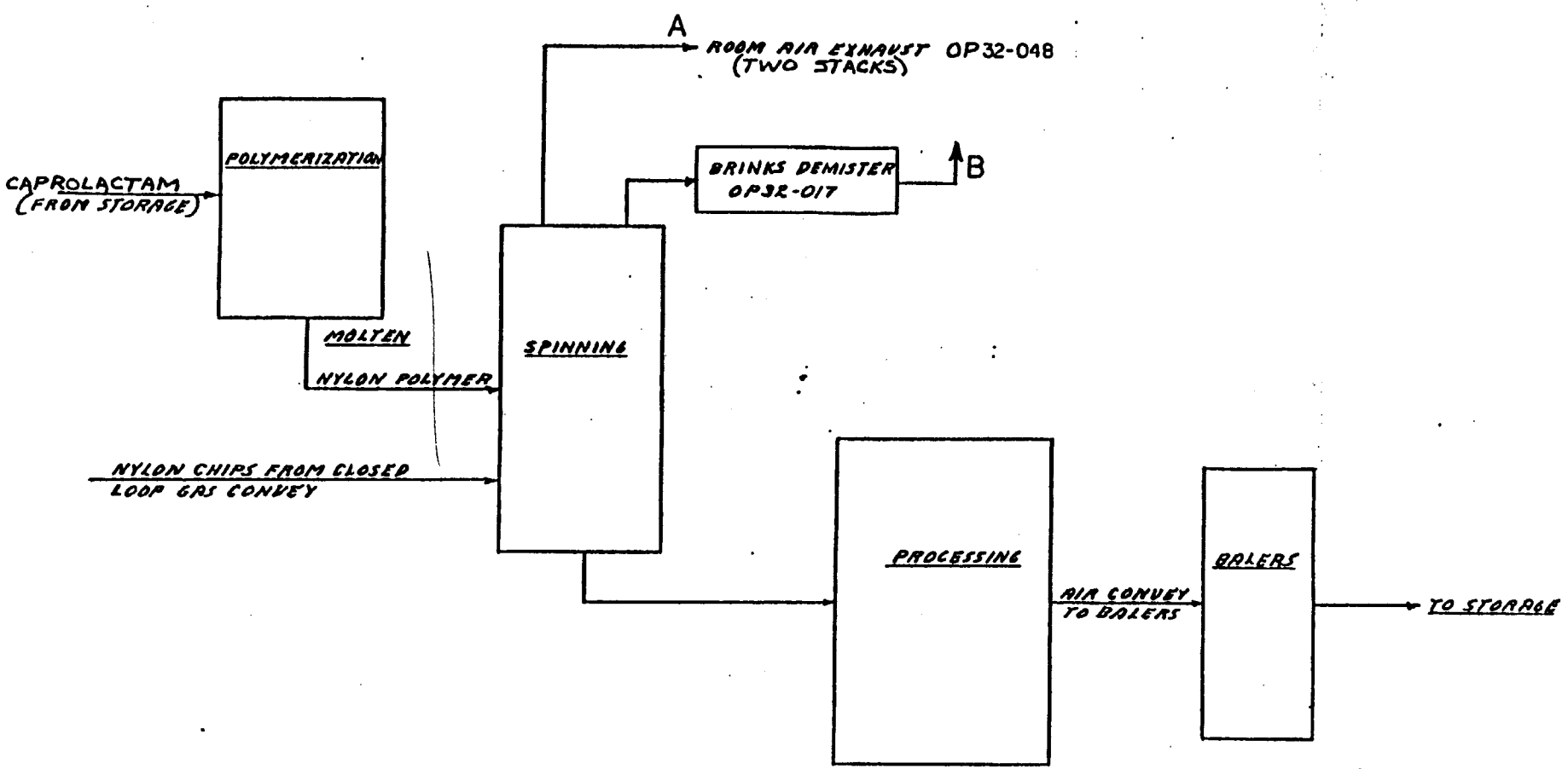
Figure 3

Nylon 6 Manufacture PROCESS PERMIT OP32-088



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Allied Chemical

FIBERS DIVISION
ALLIED CHEMICAL CORPORATION
COLUMBIA, S. C.

PLANT
JOB NO.
DASH
BLDG.

STAPLE POLYMERIZATION SPINNING & PROCESSING

SCALE

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SK—5791

prevent crystallization. The lactam/water/air mixture is passed through a 5 element Brinks demister (wet filter) where the lactam-water is removed and collected for recovery, purification, and reuse. Lactam vapors not collected by the monomer exhaust system is collected outside the spin stack door from the room air by another exhaust system and is exhausted directly to the atmosphere.

Sampling of the Brinks demister system inlet and outlet air streams yielded an estimated annual lactam vapor flowrate of 259,471 lb/yr at the Brinks unit inlet and 1,927 lb/yr at its outlet. Temperatures are 120°F at the inlet and 115°F at the outlet. Flow rate to the Brinks demister is 2086 ACFM.
Sampling of the room air exhaust system yielded an estimated annual lactam vapor flowrate of ~~83,220~~ 170 lb/yr at 100°F in 64,758 ACFM. No other VOC emissions were detected.
The nylon 6 fiber is drawn, crimped, cut, and baled for sale. No significant VOC emissions result from these operations.

4) Apparel Fiber Spinning and Processing (See Figure 4)
Nylon 6 chips are remelted and extruded through holes in steel plates to form molten filaments. During the extrusion and air quenching process lactam vapor is removed from around the molten nylon 6 by a monomer exhaust system and vented to the atmosphere.

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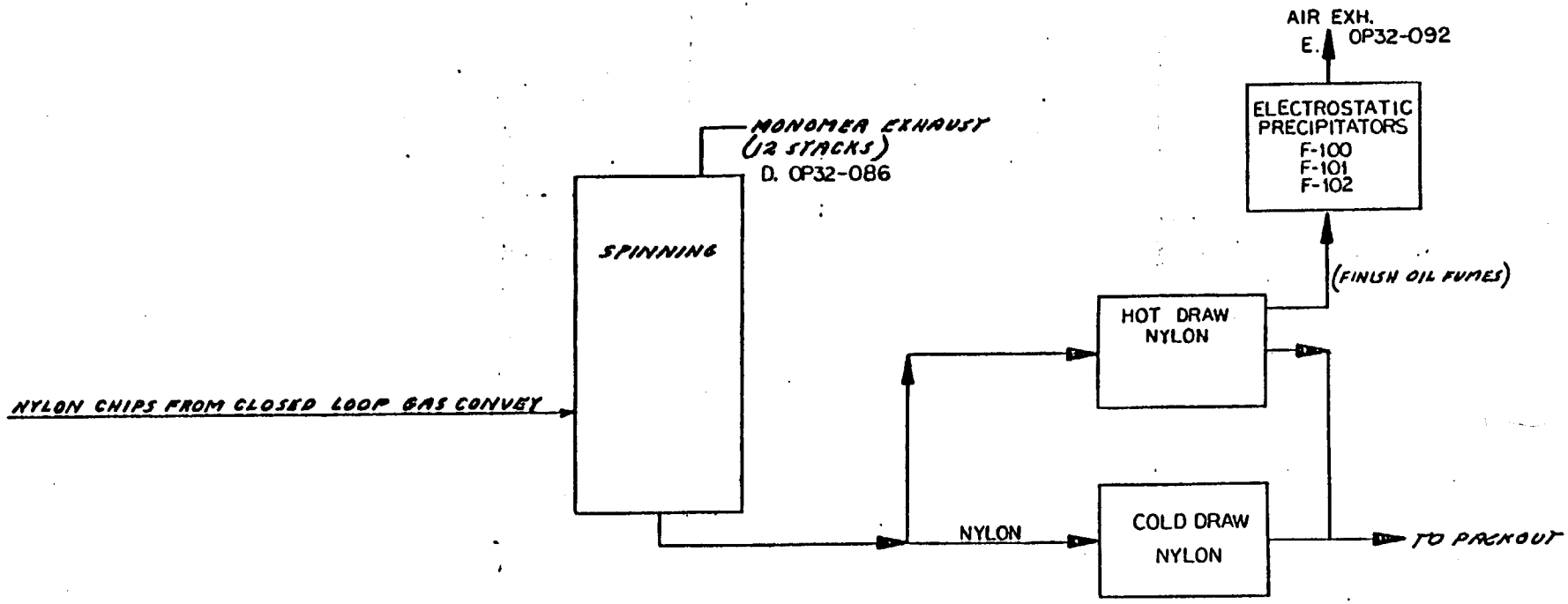
FIGURE 4

Nylon 6 Manufacture

PROCESS PERMIT O/P32-086



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Allied Chemical

FIBERS DIVISION
ALLIED CHEMICAL CORPORATION
COLUMBIA, S. C.

PLANT
JOB NO.
DASH
BLDG

APPAREL SPIN. & PROCESS

SCALE

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SK—5789

Based on stack sampling an estimated annual lactam vapor emission rate of 141,649 lb/yr was obtained. Exhaust air flow rate is 47,554 ACFM at 120°F. No other VOC was detected.

The nylon 6 filaments are wound onto sleeves, then drawtwisted to approximately 3.5 times their original length. The drawn yarn is wound onto bobbins for pack-out into cartons for sale. No significant VOC emissions result from these operations. However, a "smoke" emission of finish oils results from the hot draw operation. Electrostatic precipitators are utilized yielding essentially 100% abatement of this emission. The finish oil is collected at an average annual rate of 1,022 lb/yr. 10,000 ACFM of air is treated.

5) Aqueous Dilute Caprolactam Reconcentration
Dilute aqueous caprolactam solutions are collected and concentrated to 50% strength by multiple effect evaporators and distillation. Less than 100 lb/yr of VOC emissions result from this operation.

B. VOC Emission
VOC emissions reported are included in process descriptions. Most emissions, excepting for storage and the batch reactor vent are dilute caprolactam vapor contained in large volumes of air.

C. VOC Emission Control Devices.
Four approaches were reported:

1) A Wet Scrubber is used to control the emissions from batch polymerization water quench bath exhaust. A 94.8% efficiency is shown.

2) A Brinks Demister is used to control the exhaust stream from filament air quench exhaust in staple manufacture. This unit achieves 99.3% efficiency. It was reported that utilization of this type is not feasible for all varieties of Nylon 6 filaments. Rapid plugage by certain fiber additives was cited as a major problem
3) Underwater pelletization is utilized presently on one continuous polymerization line to manufacture chips. This approach eliminates the need for a water quench bath exhaust. This approach is feasible only in conjunction with continuous polymerization and thus is not applicable to high tenacity fiber manufacture which can only be made via batch polymerization.
4) Electrostatic precipitators are used to control "smoke" (probably not VOC) emissions from heat stretching operations.

2. Chesterfield Virginia Plant

In this plant Allied polymerizes caprolactam to Nylon 6 and spins heavy denier (840+) fiber for industrial, tire and carpet applications. Merchant chip is also produced. Continuous polymerization is utilized. Also small quantities of special or low volume Nylon 6 products are produced in chip form by batch polymerization.

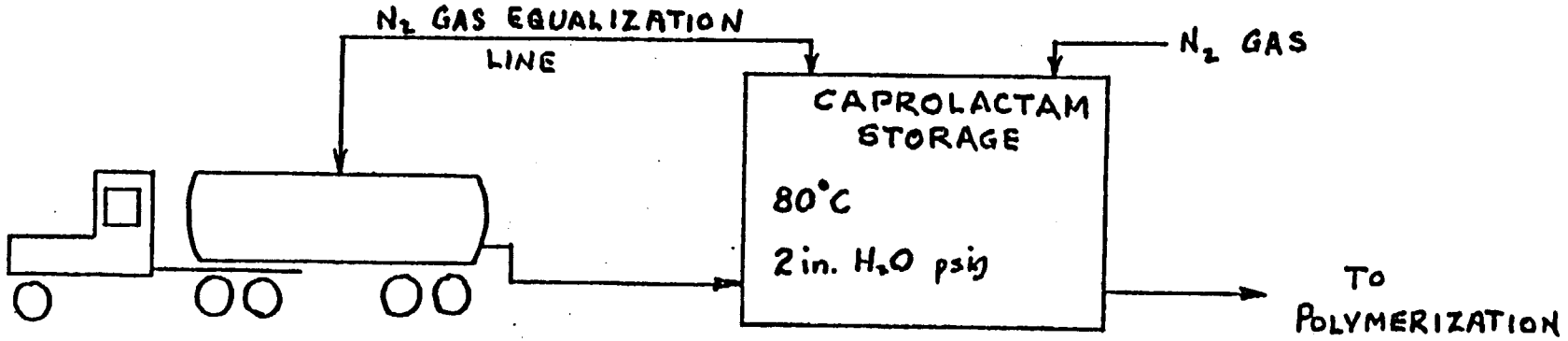
A. Process Descrpition

1) Storage (See Figure 5)

Caprolactam is produced by Allied Chemical Corporation at Hopewell Chemical Plant in Hopewell, Virigina and delivered by tank truck to the Chesterfield Plant. Recovered and concentrated lactam-water solutions are returned to Hopewell Plant for purification and reuse.

FIGURE 5

Nylon 6 Manufacture



CHESTERFIELD PLANT

CAPROLACTAM STORAGE & DELIVERY

SK-1 10-4-78 REC

Lactam is stored in large tanks under a nitrogen gas blanket to prevent oxidation. As lactam is withdrawn from the tanks, pressure is maintained by admission of nitrogen gas. As lactam is added, the displaced nitrogen gas is returned to the tanker as a means of equalizing pressures. Hence no emissions result.

2) Continuous Polymerization (See Figure 6)

Lactam is pumped into multi-stage continuous polymerization systems to produce molten Nylon 6 polymer, This material is then extruded through a die to form heavy strands which are quench in water, cut into pellets and put into a slurry with water and leached of residual monomer.

The wet chips are dryed under an inert atmosphere and conditioned to a precise moisture content. The chips are then stored for ultimate conveying to the spinning process.

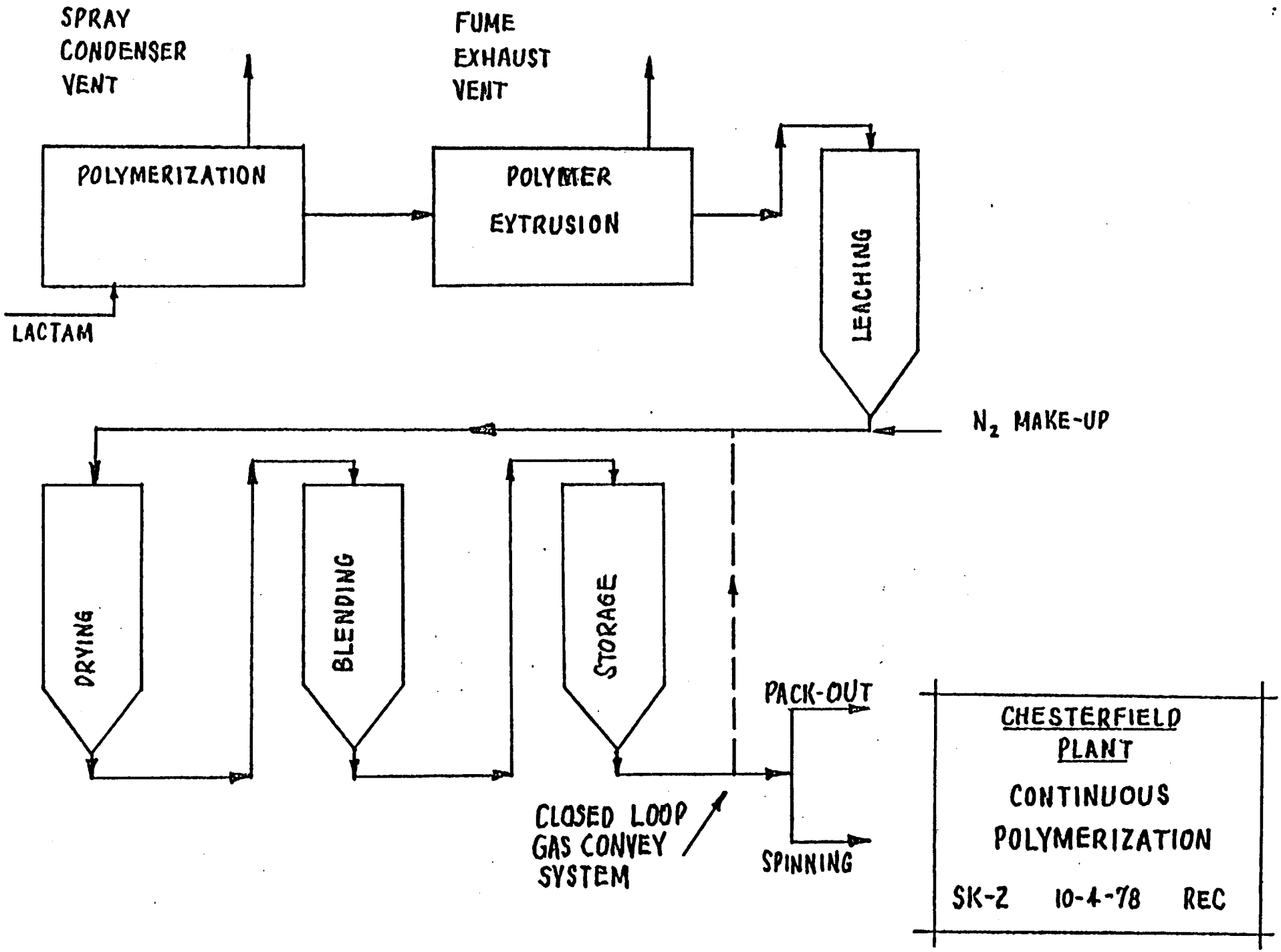
Inert gas, nitrogen, is used to blanket polymerization kettles to prevent oxidation and to control polymerization rate. The blanketing gas is washed through a spray condenser and bubbled through seal pots before exhausting to the atmosphere. Lactam discharged from this source is estimated to 5000 lb/yr after the seal pots in 300 CFM of nitrogen.

Vapors are produced as the molten nylon is extruded through the die into the quench bath. These vapors are collected in hoods and exhausted to the atmosphere. The estimated amount of lactam from this source is 34,700 lb/year in 3065 CFM of air. No other VOC are present.

Leaching, drying and storage of the chips results in no significant VOC emissions.

FIGURE 6

Nylon 6 Manufacture



3) Batch Polymerization (See Figure 7)
Caprolactam and additives are pumped into a batch kettle for polymerization. The mass in the kettle is cooked until the desired molecular weight is achieved. The molten polymer in the kettle is extruded through a die to form strands, quenched in water, cut into pellets and packed out in containers as an intermediate product.

The containers are then dumped into a washing and drying bin where unreacted monomer is removed and reclaimed. The same vessel then serves as a dryer with hot, conditioned nitrogen gas as the drying medium. At the end of the drying cycle, the nylon chips are stored in packout containers for future use.

Emissions from the polymerization kettle are vented to the atmosphere. A rough estimate of the emission rate is 300 lb/yr of Lactam in 15 CFM of nitrogen.
packaging results in no significant VOC emissions.

4) Nylon 6 Yarn Production (See Figure 8)
Nylon 6 chips are remelted and extruded through a multihole spinnerette to form molten filaments. During the extrusion and air quenching process, lactam vapor is removed and vented to the atmosphere. Extrapolation of data taken on a few stacks shows that an estimated 655,000 lb/year of lactam is emitted at 120 ^{o}F in an exhaust flow rate of 9800 CFM.

5) Concentration of Caprolactam: Solution obtained in the leaching step is concentrated by evaporation and returned for further purification at the Hopewell monomer plant. Less than 100 lb/yr of VOC emissions result from this operation.

B. VOC Data

VOC data is included in process descriptions.

FIGURE 7

Nylon 6 Manufacture

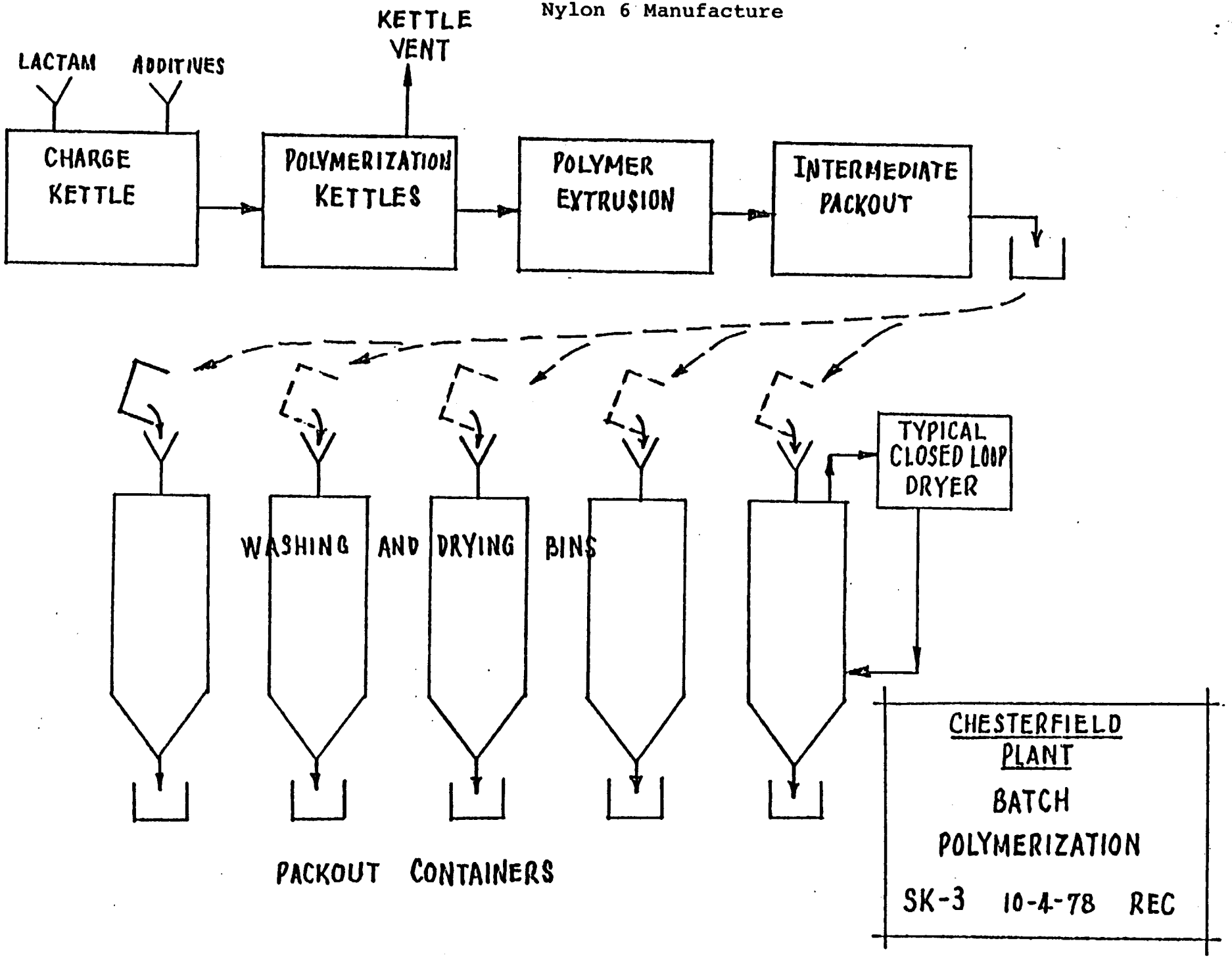
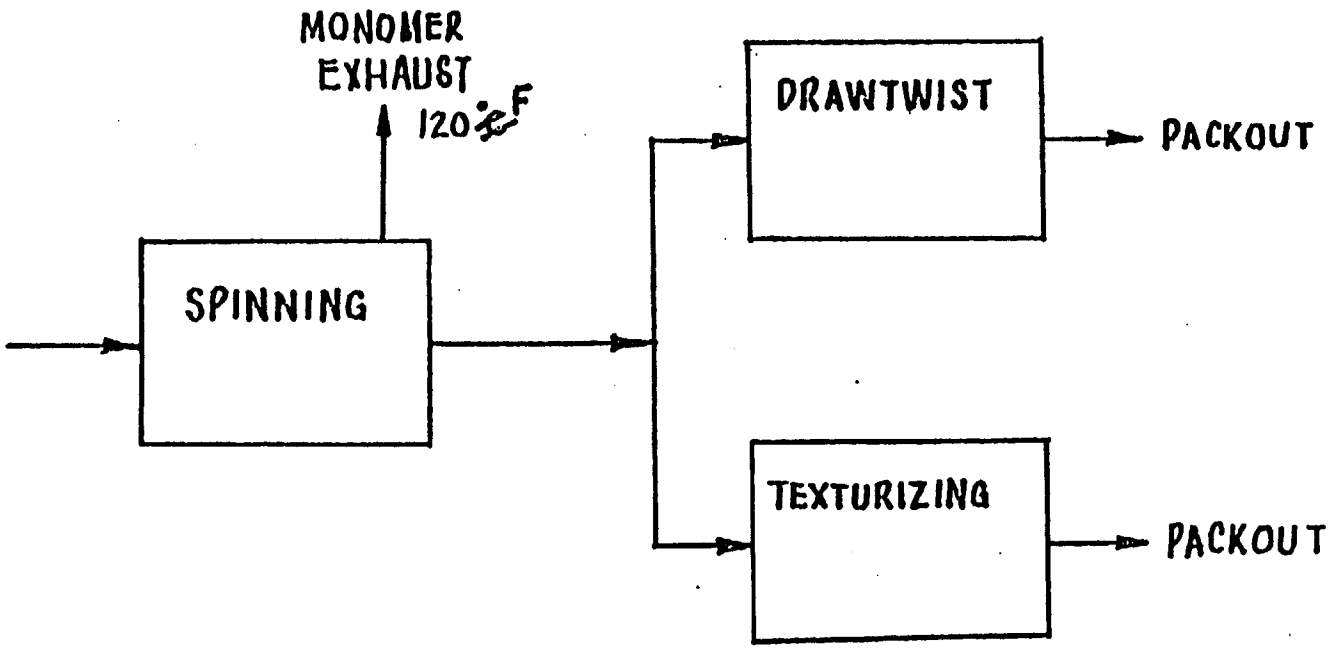


FIGURE 8

Nylon 6 Manufacture



CHESTERFIELD
PLANT

SPINNING &
YARN PROCESSING

SK-4 10-4-78 REC

C. VOC Emission Control Devices

This plant is largely uncontrolled. The only control device reported is a spray condenser on the reactor vent stream from the continuous polymerizer.

II. Urea-Formaldehyde Resins

Allied produces urea-formaldehyde molding powders in its Toledo, Ohio unit. No urea-formaldehyde syrup is produced in this facility. Four identical dryers are utilized.

A. Process Description

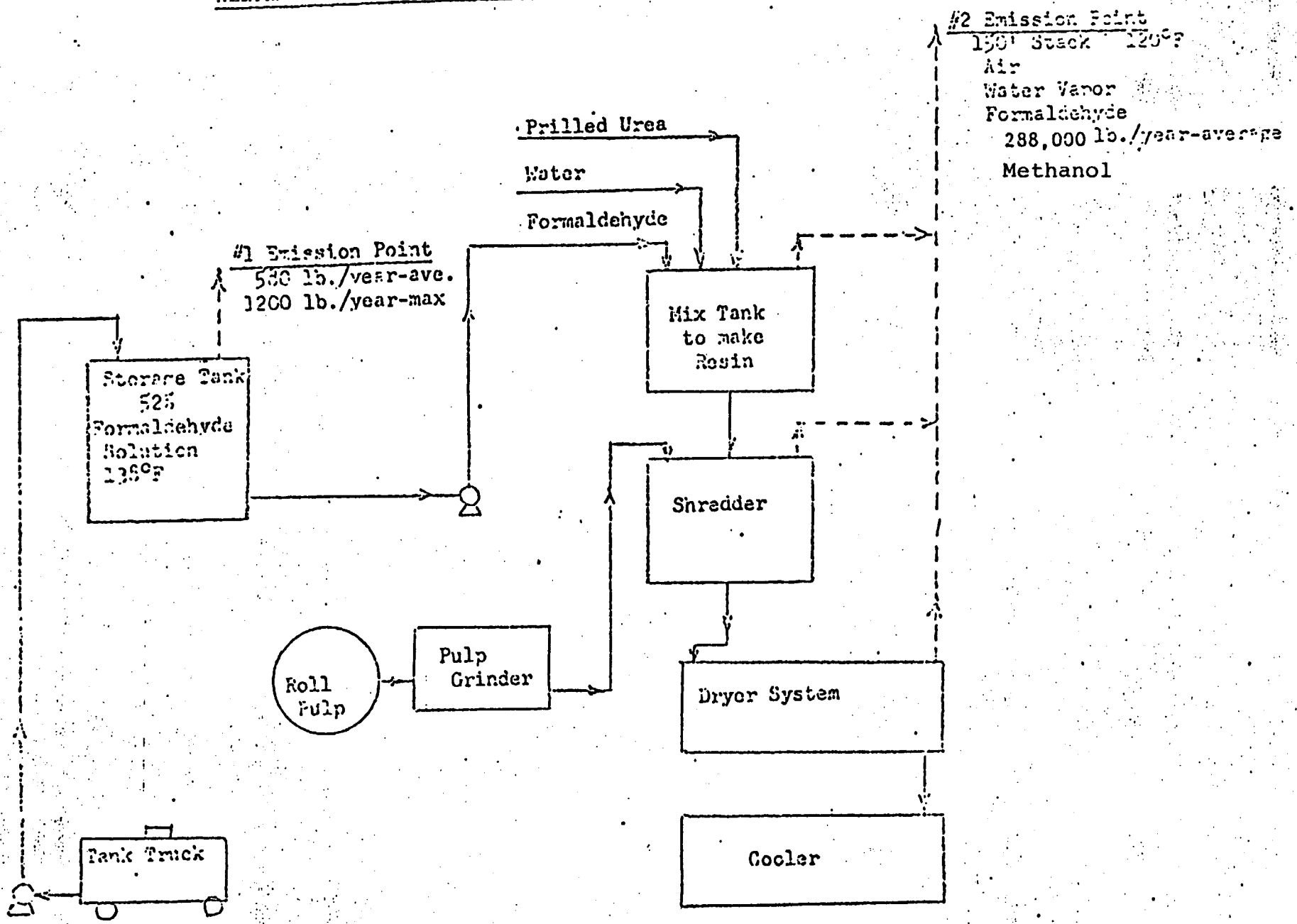
Formaldehyde solution (52%) is received by tank trucks and transferred to a heated, insulated, vertical, atmospheric storage tank maintained at 138°F. Prilled urea, water, 52% formaldehyde, and hexamethylenetetramine are added to one of four available mix tanks and the resultant solution reacted to form a urea-formaldehyde resin solution in water. The reacted resin is pumped to one of seven available shredders where, depending on formulation requirements for various types and colors, a quantity of chemicals, pigments and cellulose pulp is mixed until a uniform wet slurry is obtained. The wet slurry obtained from the shredder is transferred to the hot air dryers where the product is fed at uniform blanket thickness through the dryers via a continuous perforated belt. Four complete dryer systems are available. The dried product is cooled, ground to a powder, and packaged.

B. VOC Emissions

Four VOC emission points are shown in Figure 9, combined into two exhaust points, storage tank vent and main stack.

FIGURE 9
Urea-Formaldehyde Polymer Emissions

ALLIED CHEMICAL TOLEDO PLANT



1. Formaldehyde storage. Formaldehyde vapor is emitted at an average annual rate of 580 lb/yr. The emission results from vapor displacement during tank filling. The formaldehyde concentration is estimated to be 297 ppm (volume basis) based on equilibrium vapor pressure at 138°F storage temperature.
2. Dryer Exhaust. Emission during drying of residual formaldehyde and methanol contained in the resin is the largest VOC emission source. The following are estimated average annual emissions:

Component	lb/hr	wt %	lb/yr
Air	125,000	96.24	-
Water vapor	4,800	3.70	-
Formaldehyde	48	.037	288,000
Methanol	36	.028	216,000

NOTES

a) Air flowrate is based on blower capacity
b) Formaldehyde data is based on stack gas measurements
c) Methanol emissions calculated by material balance based on specification for methanol content in purchased formaldehyde of 0.5-1.0% (0.75% ave.)
d) 40 percent water in dryer feed
e) 250 days/yr operation - 24 hrs/day

3. Reactor manhole vent exhaust. This picks up any formaldehyde vapor from the reactor manhole. No concentration or flowrate data was available for this source. It is estimated to be less than 1 lb/hr for all reactors.
4. Shredder Area Exhaust. This picks up any formaldehyde vapors from the shredder area. No concentration or flowrate data was available for this source. It is estimated to be less than 1 lb/hr for all shredders.

C. VOC Emission Control Devices

While this is an uncontrolled plant, a major process change was made in 1974 that reduced formaldehyde emissions from the dryers by approximately 85% [1] versus an objective of 75%. The modification was made in response to an abatement order from the Toledo Pollution Control Agency and was accepted by the Agency as an acceptable alternative to installation of an emission control system. Reaction process changes to further reduce formaldehyde emissions is not consider feasible by Allied.

Note: (1) Actual average test results for twelve months of 1977 and first four months of 1978.

REVISED (New input) 27 November 1978

Capacities in conf. file

Light Denoi

Attachment 1

Sept 12, 78

ALLIED CHEMICAL CORPORATION

FIBERS DIVISION

COLUMBIA PLANT

(interchange between 2 plants so totals do not prove)

CAPROLACTAM EMISSION

FROM NYLON 6

POLYMERIZATION AND FIBER PRODUCTION

Brink's demister does not work for all the products - low M.W. polymer buildup & additives

- efficient when clean

- solvent cleaning - recycle - system - enters into whole process

BNB
9/12/78

SK-6110

(2)

CAPROLACTAM

DELIVERY AND STORAGE

Caprolactam is produced by Allied Chemical Corporation at Hopewell, Virginia and delivered by rail tank car to the Columbia Plant. Supplemental delivery by tank truck is used to provide return tankage to Hopewell from Columbia for recovered, concentrated, lactam-water solutions for purification and reuse.

Rail delivered lactam is stored in a large tank under a nitrogen blanket to prevent oxidation. As lactam is withdrawn pressure is maintained by admission of nitrogen. As lactam is added the displaced nitrogen gas containing lactam is bubbled through a water seal tank where the lactam is absorbed by the water.

Trailer delivered lactam is stored in four horizontal tanks. A similar nitrogen blanket is maintained but displaced nitrogen gas is vented to the atmosphere.

→ MW=113 pvenRT

Annual flow of lactam from the relief valve from the horizontal storage tanks is calculated to be 5480 lb/year. ↗

Annualized caprolactam received is submitted under separate cover to maintain confidentiality.

Flows are on conf. page.

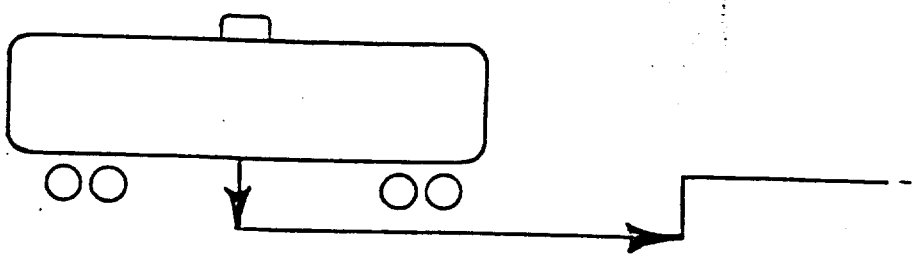
No Breathy loss
- water jackets &
Al. tops
80°C - heating coils
- so B.L. should be neg.

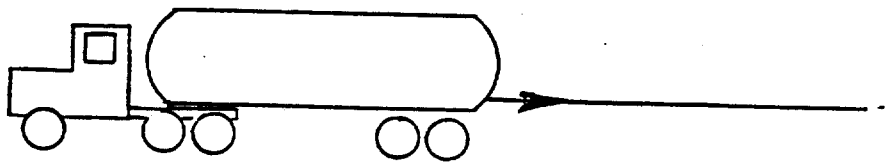
- Need V.P. curve for caprolactam

- est. of N_2 flow

WORK SAFELY TODAY

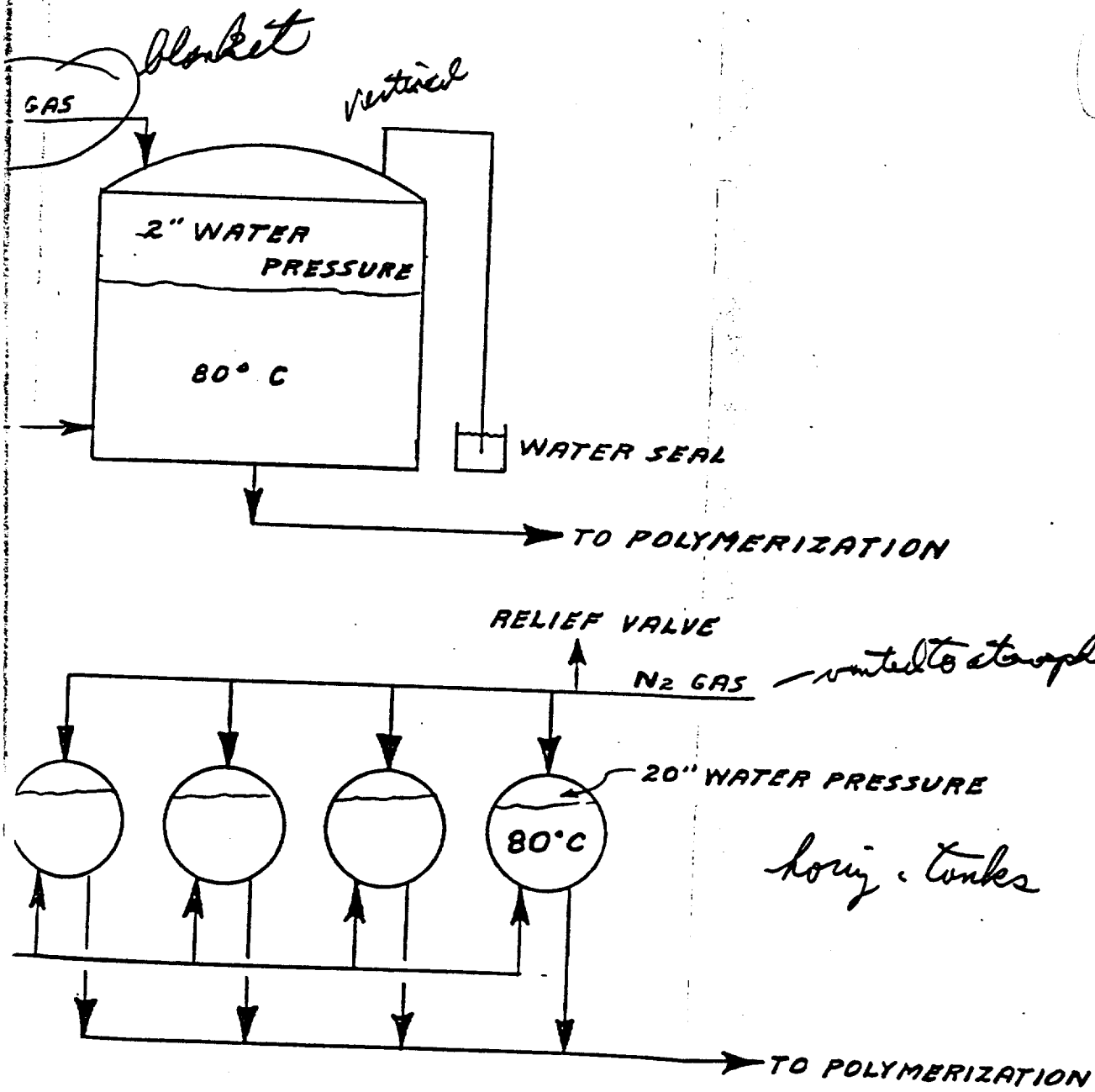
N2 S





Allied Chemical

Columbia, South



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PLANT
JOB NO.
DASH
BLDG.

CAPROLACTAM DELIVERY & STORAGE

SCALE

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SK—6110

SK-5790

BATCH POLYMERIZATION

Lactam is weighed into tanks. Various additives are prepared and added to the lactam. The mix is then charged to an autoclave. The polymerization proceeds and evolved water and monomer are condensed and recovered in a closed system for recovery and reuse.

The molten nylon 6 is extruded into a water quench bath. Monomer fumes evolved are collected at the extrusion die heads by a vacuum duct system. Steam is admitted to the duct system to prevent crystallization. The air/steam/lactam mixture is passed through a wet scrubber containing mist eliminators. A water stream is sprayed on the mist eliminators to collect the lactam. The lactam water solution is recovered for purification and reuse. These are points O, P, Q, & R. The vacuum collection system was sampled and calculations show that 60,955 lb/year of lactam could be collected at 90° F. The exhaust from a scrubber was sampled and calculations show that a total of ~~3353~~ 8353 lb/year of lactam could be emitted at 82° F.

Points A & B are a vacuum collection system used to remove quench water from polymer strands. These stacks have been sampled and calculations show that 14,016 lb/year of lactam could be emitted at 130° F.

After pellatization the nylon 6 chips are leached with hot water, dried, and stored.

Annualized batch polymer production is submitted under separate cover to maintain confidentiality.

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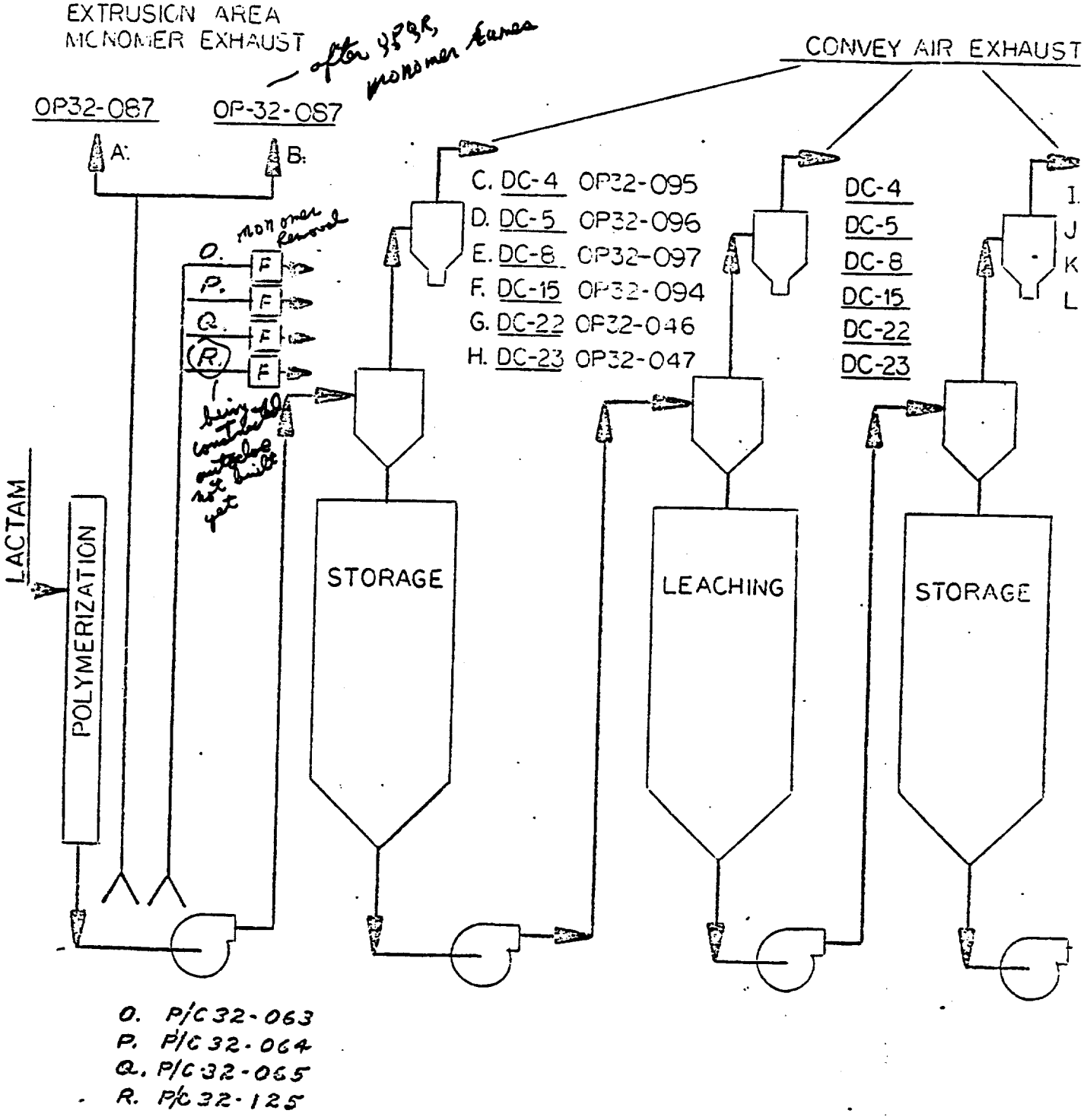


Allied Chemical

FIBERS

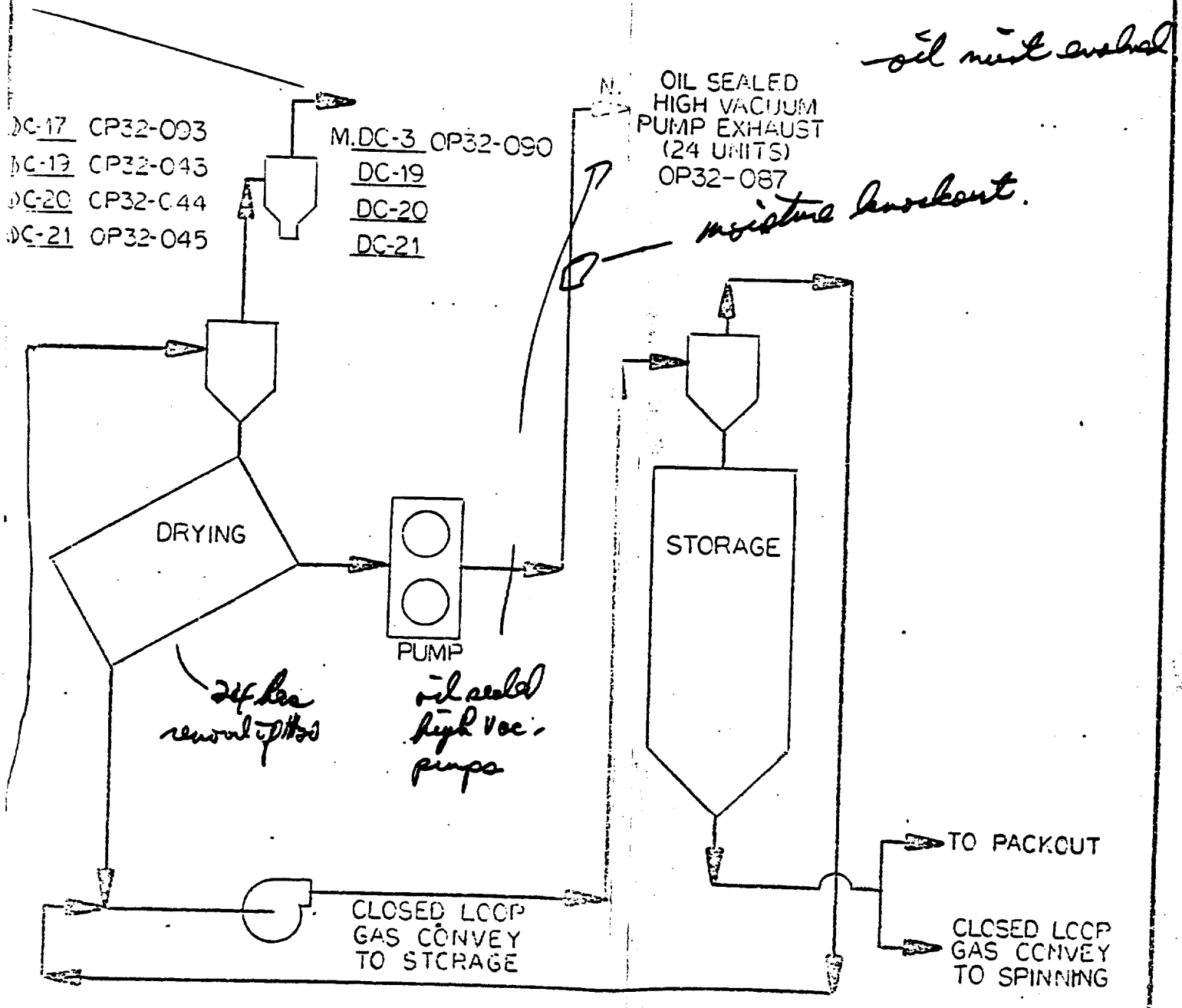
ALLIED CHEM

COLL

HERCULENE® 77161 DRAFTING FILM

DC = Dust collectors

PROCESS PERMIT o/p 32-087



REVISED -- 9-5-78

DIVISION CORPORATION A. S. C.	PLANT JOB NO. DASH BLDG	BATCH POLYMERIZATION		SCALE
		DWN: ESH	CHK'D	ENGR: WWC
		APP	DATE	SK—5790

SK-5789

APPAREL

FIBER SPINNING AND PROCESSING

2.

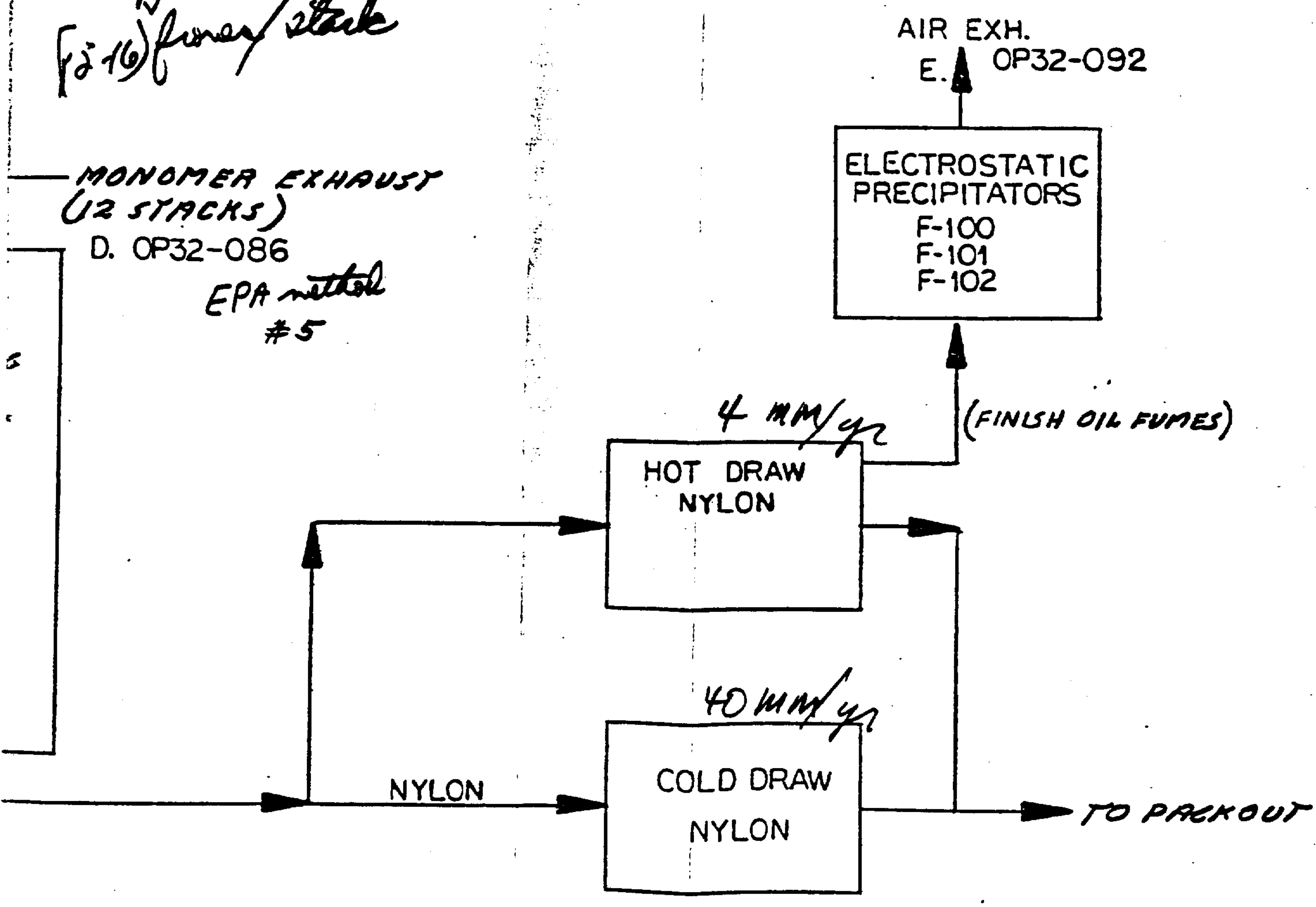
Nylon 6 chips are remelted and extruded through holes in steel plates to form molten filaments. During the extrusion and air quenching process lactam is removed from around the molten nylon by a monomer exhaust system and vented to the atmosphere. The stacks have been sampled and calculations show that 141,649 lb/year of lactam could be emitted at 120°F.

The nylon filaments are wound onto sleeves, then drawtwisted to approximately 3.5 times their original length. The drawn yarn is wound onto bobbins for pack-out into cartons for sale.

Annualized apparel fiber production is submitted under separate cover to maintain confidentiality.

PROCESS PERMIT O/P32-086

VAPOR



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DIMENSIONS ARE IN INCHES
TOLERANCES

FRACTIONS	DECIMALS	ANGLES
±	±	±

REVISED 9-5-78

VISION
CORPORATION
S. C.

PLANT
JOB NO.
DASH
BLDG

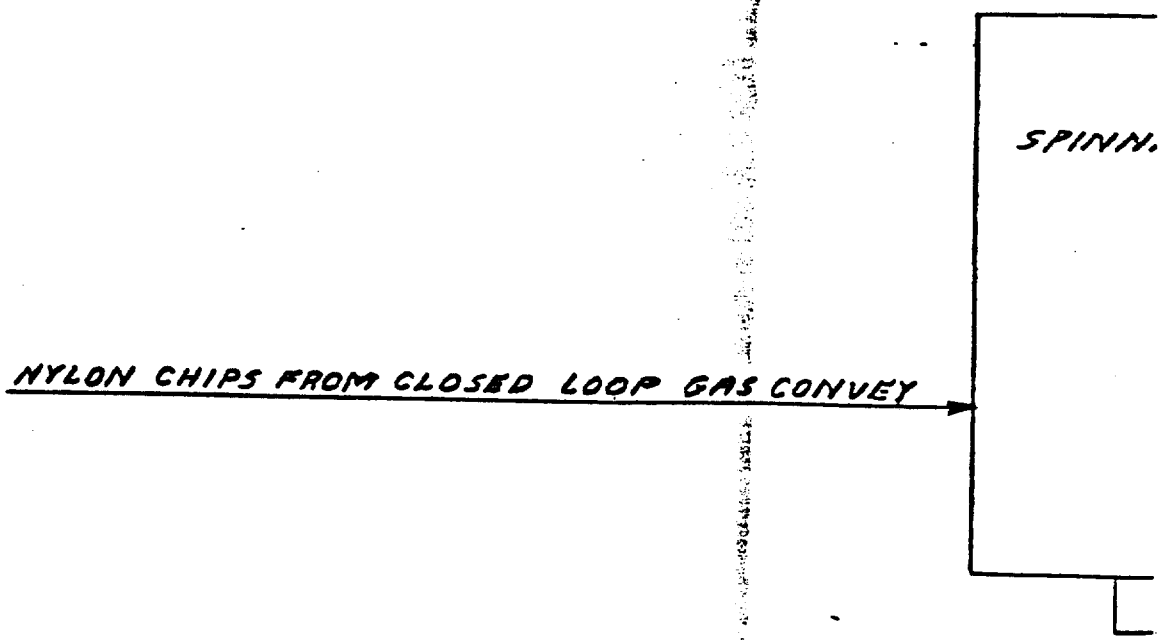
APPAREL SPIN. & PROCESS

SCALE

T.G.A. DWN | CHK'D | JMM ENGR | APP | DATE

SK—5789

WORK SAFELY TODAY



Allied Chemical

FIBERS

ALLIED CHEMIC

COLUM

SK-5791

STAPLE

POLYMERIZATION, SPINNING, AND PROCESSING

Caprolactam and other additives are continuously fed to a closed system of vessels to produce a continuous stream of molten nylon 6 without emissions to the atmosphere.

The molten nylon 6 from the continuous polymerization unit and molten nylon 6 from remelted chips is extruded through holes in steel plates to form filaments. During the extrusion and air quenching process lactam is removed by a monomer exhaust system. The vacuum system collects the lactam from around the filaments and a water spray is admitted to the collection system to prevent crystallization. The lactam/water/air mixture is passed through a 5 element Brinks demister (wet filter) where the lactam-water is removed and collected for recovery, purification, and reuse. Lactam not collected by the monomer exhaust system is collected outside the spin stack door from the room air by another vacuum system and is exhausted directly to the atmosphere.

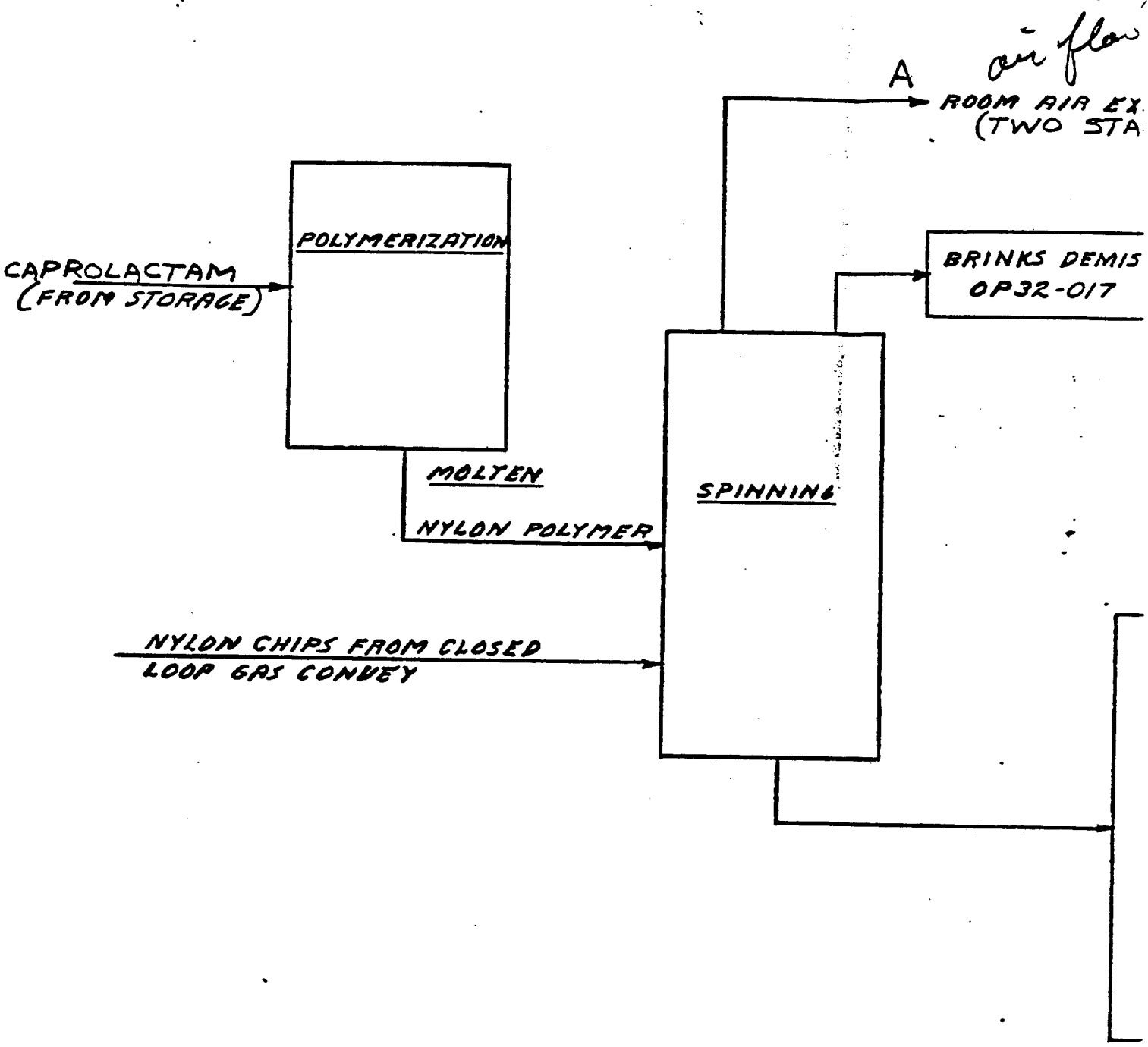
The collection system prior to the Brinks demister was sampled and is calculated to collect 257,544 lb/year of lactam at about 120°F. The Brinks demister exhaust was sampled and it is calculated that 1927 lb/year of lactam could be emitted at 115°F.

The room air exhaust system was sampled and it is calculated that 83,220 lb/year of lactam could be emitted at 100° F.

The nylon fiber is drawn, crimped, cut, and baled for sale.

Annualized polymer and fiber production is submitted under separate cover to maintain confidentiality.

WORK SAFELY TODAY



Allied Chemical

FIBERS DI

ALLIED CHEMICAL

COLUMBIA

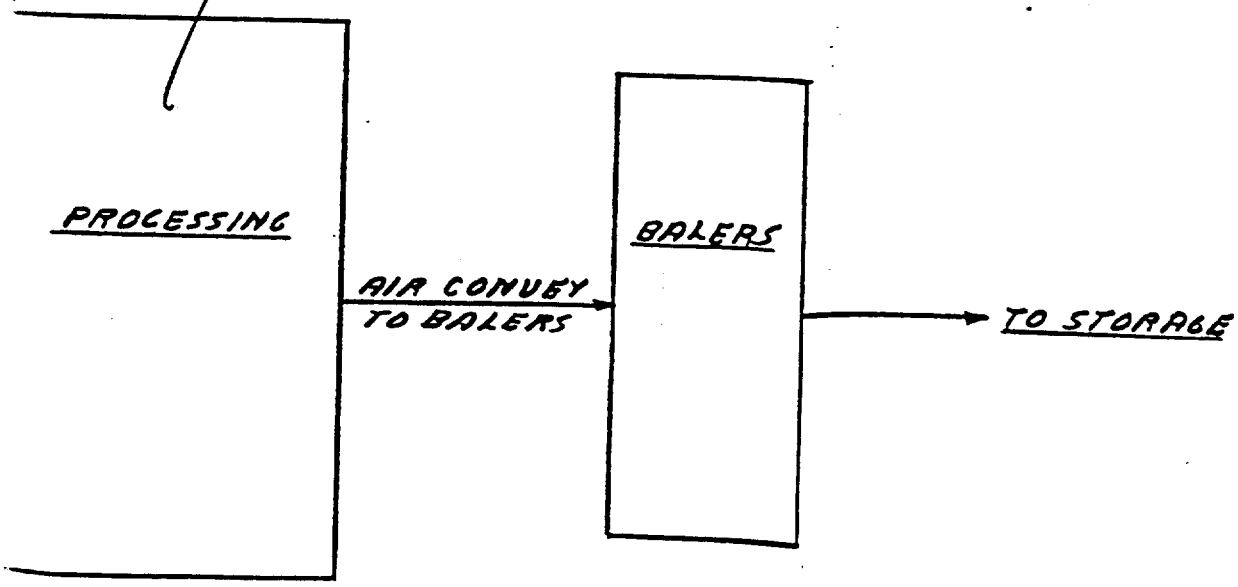
PROCESS PERMIT OP32-088

'AUST OP32-048
KS)

air flow ?

ER → B

tow stretching
crimping
- fiber, heat set - crimp.



REVISED 9-5-78

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
FRACTIONS ± DECIMALS ± ANGLES ±

VISION
CORPORATION
S. C.

PLANT
JOB NO.
DASH
BLDG.

STAPLE POLYMERIZATION SPINNING & PROCESSING

SCALE

T.G.B. DWN CHK'D JMM ENGR APP DATE

SK—5791

Capacity in conf. file

Attachment 2

OCTOBER 6, 1978

ALLIED CHEMICAL CORPORATION
FIBERS DIVISION
CHESTERFIELD PLANT

CAPROLACTAM EMISSION
FROM NYLON 6
POLYMERIZATION AND FIBER PRODUCTION

No trend in industry toward batch or cont.,

&

Can't make high class tenacity yarn
w continuous.

* (this is why have batch & cont.)

(2)

ALLIED CHEMICAL CORPORATION

FIBERS DIVISION

CHESTERFIELD PLANT

CAPROLACTAM EMISSION

FROM NYLON 6

POLYMERIZATION AND FIBER PRODUCTION

8

2

REC
10/6/78

SK-1

CAPROLACTAM

DELIVERY AND STORAGE

heavy denier 1000 and above 840 & lower (tire yarns)

Caprolactam is produced by Allied Chemical Corporation at Hopewell Chemical Plant in Hopewell, Virginia and delivered by tank truck to Chesterfield Plant. Recovered and concentrated lactam-water solutions are returned to Hopewell Plant for purification and reuse.

Lactam is stored in large tanks under a nitrogen gas blanket to prevent oxidation. As lactam is withdrawn from the tanks, pressure is maintained by admission of nitrogen gas. As lactam is added, the displaced nitrogen gas is returned to the tanker as a means of equalizing pressures.

Annualized caprolactam received is submitted under separate cover to maintain confidentiality.

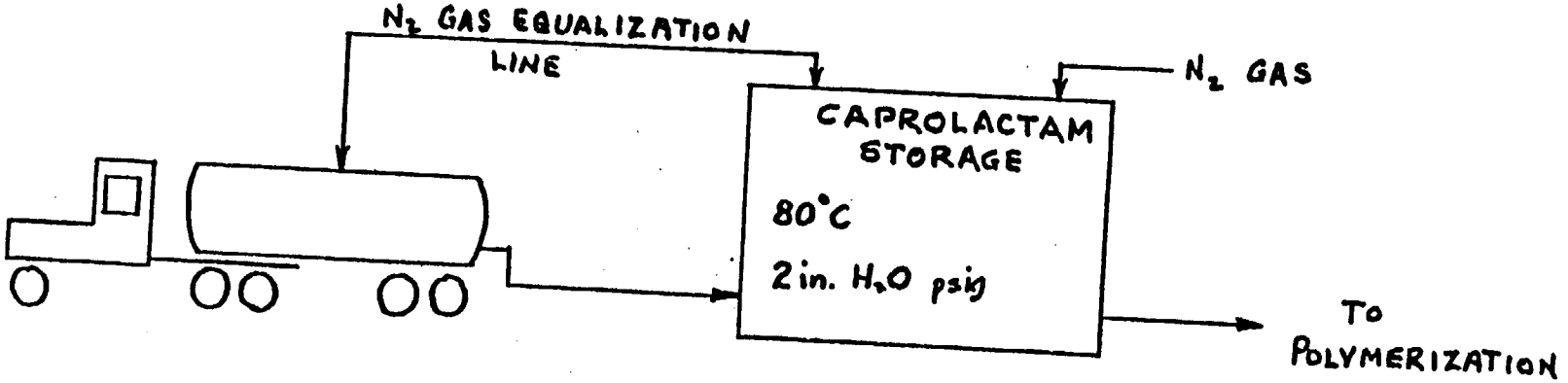
cont. → spun - goes out as yarn

less products

tire yarn {840 / 1260}

Carpet yarns { 1200 - 4000

many variations to satisfy custom



Keep O_2 out.

CHESTERFIELD PLANT		
CAPROLACTAM STORAGE & DELIVERY		
SK-1	10-4-78	REC

SK-2

polymer trains
4 large
1 small

CONTINUOUS POLYMERIZATION

Lactam is pumped into multi-stage continuous polymerization systems to produce molten nylon 6 polymer. This material is then extruded through a die to form heavy strands which are quenched in water, cut into pellets and put into a slurry with water. The quench and slurry waters along with leaching water used to remove the unreacted 10-15% monomer are collected, concentrated to recover lactam and recycled to the leaching step.

The wet chips are dryed under an inert atmosphere and conditioned to a precise moisture content. The chips are then stored for ultimate conveying to the spinning process.

Inert gas, nitrogen, is used to blanket polymerization kettles to prevent oxidation and to control polymerization rate. The blanketing gas is washed through a spray condenser and bubbled through seal pots before exhausting to the atmpsphere. Lactam discharged from this source is estimated to be 5000 lb/year.

Fumes are produced as the molten nylon is extruded through the die into the quench both. ~~These vapors are collected in hoods and exhausted to the~~ atmosphere. The estimated amount of lactam from this source is 22,000 lb/year.

?

considering capture control in future,

Cont. leaching sys.

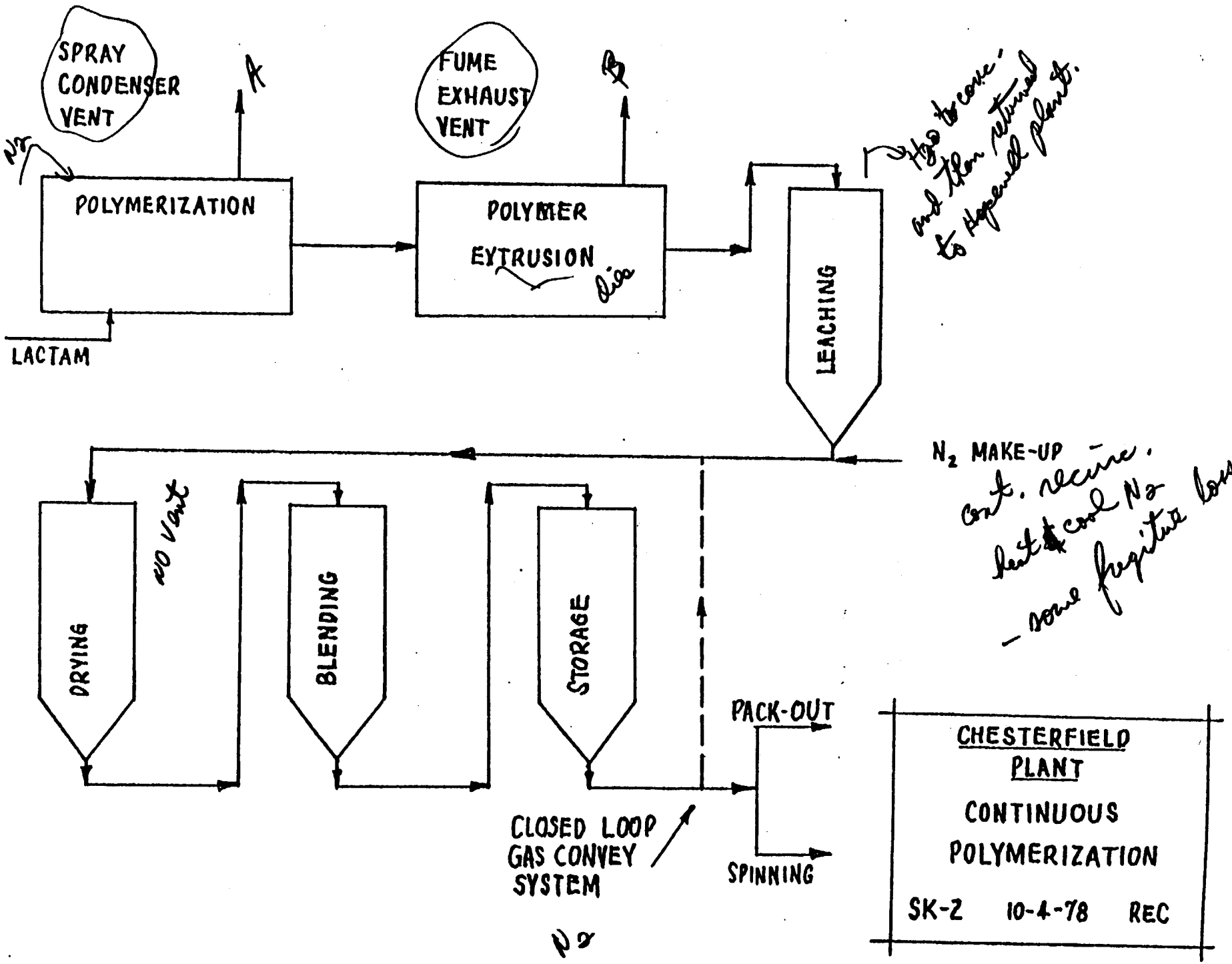
monomer back to Hydrocell to purify,

[Gas convey is N_2 — closed loop]

— cont. to chip & also cont. to fiber?

Batch to chips
Cont. to fiber Columbia
cont. to chip.

5


SPRAY CONDENSER VENT
FUME EXHAUST VENT
POLYMERIZATION
POLYMER EXTRUSION
LEACHING
LACTAM
DRYING
BLENDING
STORAGE
PACK-OUT
SPINNING
CLOSED LOOP GAS CONVEY SYSTEM
CHESTERFIELD PLANT
CONTINUOUS POLYMERIZATION
SK-2 10-4-78 REC

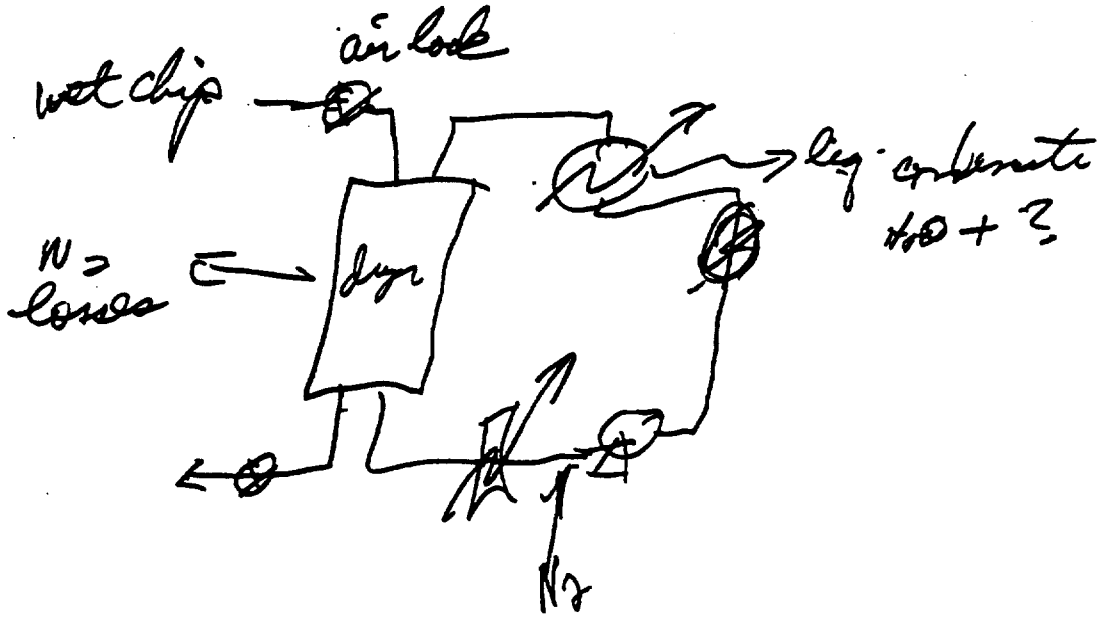
BATCH POLYMERIZATION molding polymers

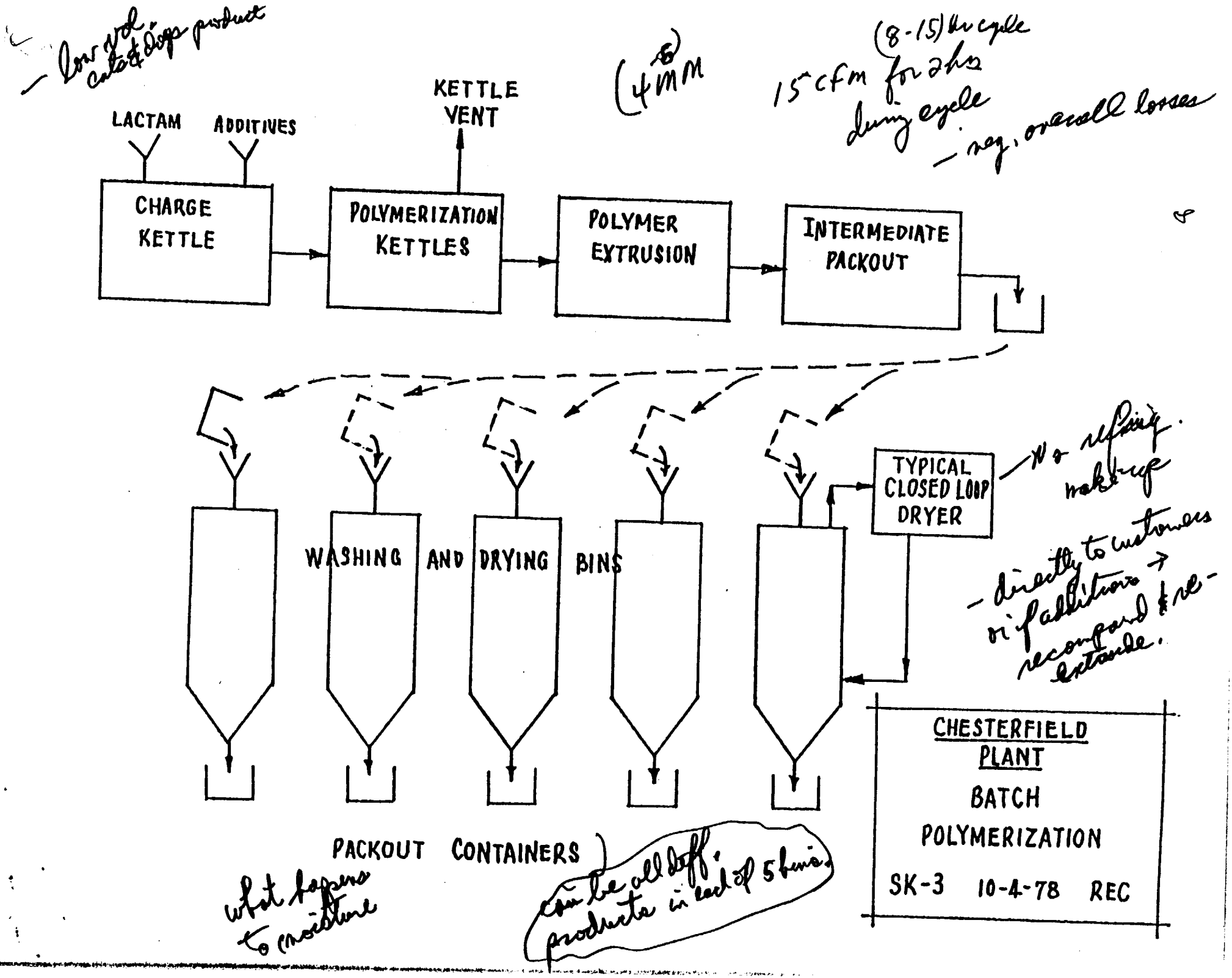
Caprolactam and additives are pumped into a batch kettle for polymerization. The mass in the kettle is cooked until the desired molecular weight is achieved. The molten polymer in the kettle is extruded through a die to form strands, quenched in water, cut into pellets and packed out in containers as an intermediate product.

The containers are then dumped into a washing and drying bin where unreacted monomer is removed and reclaimed. The same vessel then serves as a dryer with hot, conditioned nitrogen gas as the drying medium. At the end of the drying cycle, the nylon chips are stored in packout containers for future use.

Emissions from the polymerization kettle are vented to the atmosphere. The composition and amount are unknown.

"small amount" - Engineering group




LACTAM
ADDITIVES
KETTLE VENT
CHARGE KETTLE
POLYMERIZATION KETTLES
POLYMER EXTRUSION
INTERMEDIATE PACKOUT
TYPICAL CLOSED LOOP DRYER
WASHING AND DRYING BINS
PACKOUT CONTAINERS
CHESTERFIELD PLANT
BATCH POLYMERIZATION
SK-3 10-4-78 REC

NYLON YARN PRODUCTION

Nylon 6 chips are remelted and extruded through a multi-hole spinnerette to form molten filaments. During the extrusion and air quenching process, lactam monomer is removed and vented to the atmosphere. Extrapolation of data taken on a few stacks shows that approximately 655,000 lb/year of lactam could be emitted at 120 F.

proposed to be controlled.

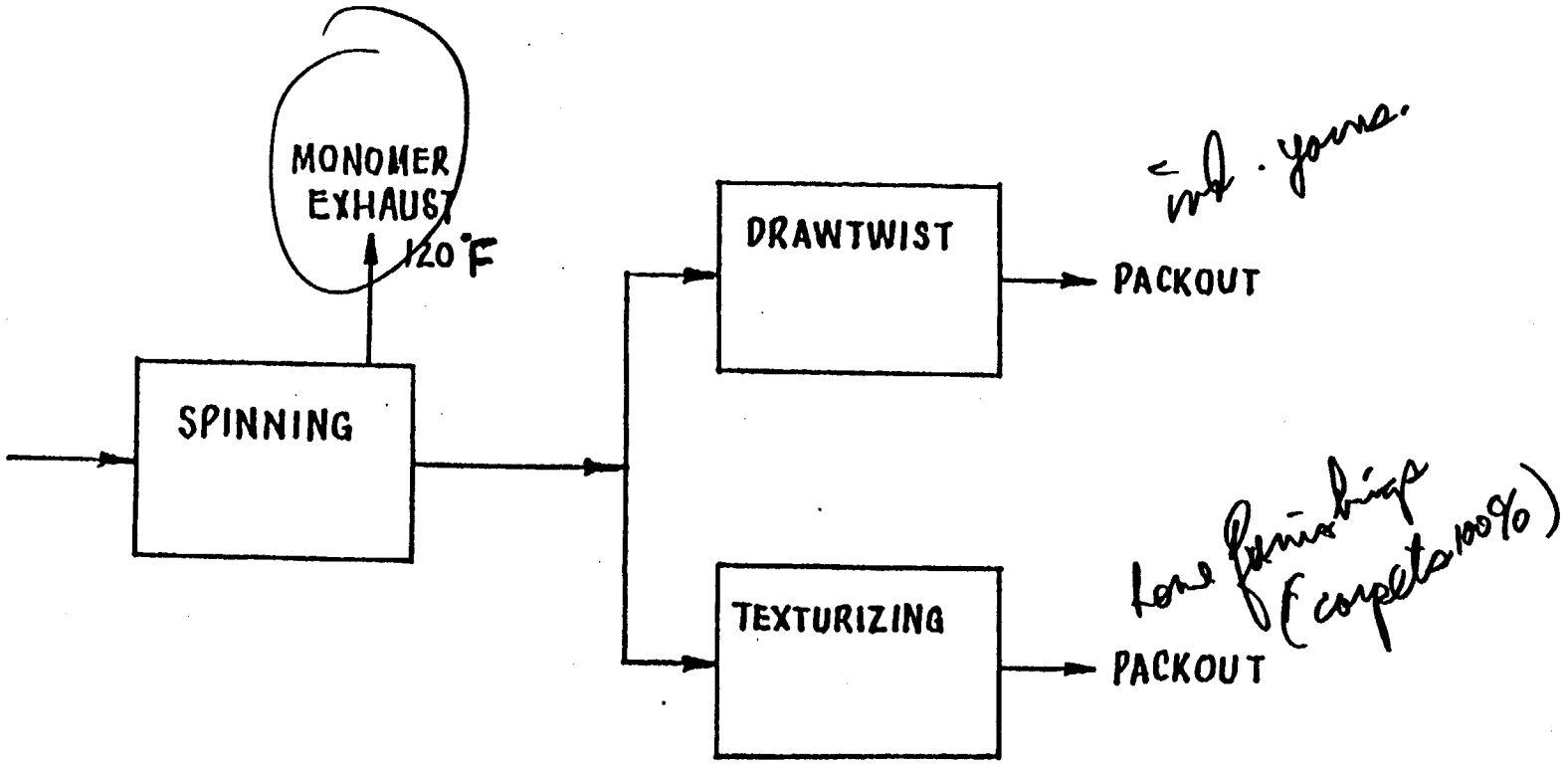
chilling, adsorption, Brinks demister

I.E.R.L. - possible for investigation

- all subj. to problems

→ (they feel that their work will come thru)

- roll of filter → change to



CHESTERFIELD PLANT

SPINNING & YARN PROCESSING

SK-4 10-4-78 REC