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Report of the Initial Plant Visit to Tennessee Eastman Company Synthetic Fibers Manufacturing Kingsport, Tennessee Regarding the Development of New Source Performance Standards for the Synthetic Fibers Industry

I. Purpose

Report of the initial plant visit to the Tennessee Eastman Company's Synthetic Fibers Division in Kingsport, Tennessee, regarding the New Source Performance Standards (NSPS) for the Synthetic Fibers Industry.

II. Place and Date

Tennessee Eastman Company
Synthetic Fibers Manufacturing
Kingsport, Tennessee
December 13, 1979/Revised Version, No. 3

III. Attendees

Attendees	Affiliation
Dennis Crumpler	EPA
Robert Zerbonia	PES
Greg Lathan	PES
Rhonda Carpenter	Tennessee Eastman
Wayne Bridges	Tennessee Eastman
Lynn Perry	Tennessee Eastman
C. A. Shaffer	Tennessee Eastman
R. W. Burow	Tennessee Eastman
S. A. Wood	Tennessee Eastman

IV. Discussion

Tennessee Eastman manufactures three synthetic fibers: cellulose acetate - both cigarette filtration tow and continuous filament cellulose acetate yarn, polyester - both continuous filament yarn and staple and tow, and modacrylic.

Prior to the plant tour, a meeting was held with the Tennessee Eastman personnel and the EPA/PES project team. Dennis Crumpler (EPA) opened with an explanation of Phase I of the New Source Performance Standards (NSPS). Robert Zerbonia followed with a detailed description of Phase I, outlining its major purposes.

Tennessee Eastman (TE) personnel agreed that cellulose acetate and polyester fiber production are growth industries; although no information concerning TE's plans for capacity expansion were given. They did indicate that some expansion could be effected on existing equipment through debottlenecking of process lines now running at near capacity. R. Zerbonia noted that one literature source referred to a swing capacity between modacrylic and cellulose acetate fibers spinning facilities. TE personnel stated that such a switch in spinning facilities would require significant modification to existing equipment in order to convert from one fiber to another. A time frame of one year was given as an estimate of the time required to make the necessary conversion. TE stated that air flow patterns are very critical in both processes.

Questions were asked concerning the residual solvent content of the fibers after spinning. TE personnel state that the filter tow process fiber has 10-15 lbs. solvent per 100 lbs. dry fiber. Cellulose acetate yarn has 18-19 lbs. per 100 lbs.

Concerning the residual monomer content of the spinning of modacrylic fibers. TE stated that about 20 ppm of AN is in the fiber polymer. Residual monomer in polyester polymer is considered negligible.

TE presented a variety of flow diagrams showing the processes at the plant. These are presented in Appendix A.

Concerning solvent recovery, TE stated that the plant uses both wet scrubbing and carbon adsorption to recover the acetone solvent. TE has 12 carbon beds used in combination. Continuous monitors are used to measure the acetone concentration of the exit gas although these monitors are not always reliable. The recovery efficiency for all acetone processes combined varies from 92 to 94 percent on a monthly basis.

1. <u>Cellulose Acetate</u>

A. Cigarette Filtration Tow Staple Manufacturing Process

The cellulose acetate filter tow manufacturing process at Tennessee Eastman is illustrated in Figure 1.

High alpha-content cellulose is acetylated. Sheets of cellulose are dried, shredded, and blended with a moragueous swelling agent (acetic acid). Sufficient time (1-5 hours) is given to allow the cellulose sheets to absorb water and acetic acid. To the cellulose suspension, an esterfication catalyst is added (sulfuric acid) and then acetic anhydride as an acetylating agent. After reaching the triacetate state there is a homogenous solution, from which the triacetate can be precipitated. A corresponding amount of water and sulfuric acid is added to the triacetate solution to initiate the hydrolysis. When hydrolysis has progressed sufficiently, the cellulose acetate is precipitated by adding water.

Figure 1

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Dried cellulose acetate flakes are stored and dissolved in acetone and a pigment is added. Dissolving occurs in a closed agitated mixer. The resulting batches are blended, filtered, and sent through a metering pump which provides a constant flow of the dope to the spinnerett head.

Cellulose acetate dope enters the spinnerette and the extruded filaments are quenched by air from the scrubber - all cellulose acetate is produced by dry spinning. The solvent evaporates and is recovered, leaving a filament of cellulose acetate. Acetone laden air exiting from the quench stack is sent to a cold H_2O scrubber and recycled to the quench stack. This quench air is conditioned for humidity and temperature. Cellulose acetate filaments travel down the quench stack. Since cigarette tow is used for filtering, the holes in the spinnerette are smaller and more numerous than those for yarn or fabric. The post-spinning treatment of the fiber consists of lubrication, crimping and drying. Fugitive emissions (acetone) are emitted as the filaments travel to the crimping operation. Emissions from the drying process are sent to carbon beds where acetone recovery takes place. These carbon beds recover 92-95% of the acetone released at the drying stage. The carbon beds are continuously monitored; but as mentioned earlier, these monitors are not always reliable. Table 1 indicates the sources and quantities of pollutants in Figure 1.

B. Cellulose Acetate yarn manufacturing process

Eastman Kodak's cellulose acetate yarn process is illustrated in Figure 2 with the major emission points labeled by large lettered arrows. Table 2 quantifies these emissions.

In the cellulose acetate yarn process both continuous and batch cellulose acetate processes are employed. The spinning process is essentially the same as in the cigarette tow process. Post-spinning treatment varies. The cellulose acetate filament is wound on packages. If desired, a twist is put into the filament and the fiber is subsequently wound on cores and packaged for shipment. If a twist is not desired, the yarn is sent to beaming operations and subsequently packaged for shipment.

2. The Verel (modacrylic) manufacturing process

The "Verel" modacrylic polymer is a mixture of two different polymers - a co-polymer of acrylonitrile (AN) and vinylidere chloride (VCl_2) and a homo-polymer of N-isopropylacrylamide.

Polymer powder is stored in silos prior to fiber production. When needed the polymer powder is dissolved in acetone spin solvent, filtered and dry spun. Figure 3 is a schematic showing dry spinning, fiber washing and finishing for Verel. Filtered dope is extruded from spinneretts vertically downward into enclosed cabinets. Acetone solvent evaporates into a stream of hot dry air and the

Table 1. **FILTER PRODUCTS DIVISION PROCESS EMISSION SOURCES**

Process Emission Source No.	Description	Stack Height (ft)	Stack Diameter (ft)	Velocity (ft/sec)	VOC Concentration (wt ppm)	Average Emissions (lbs/yr)	Hours of Operation/Day	Control Methods
• B-62-1	Fugitive VOC Emissions from Bldg.'s 62 and 62A	-	-	-	-	4.4×10^4 Acetone	24	None*
• B-69-2	Fugitive VOC Emissions from Bldg. 69	-	-	-	-	3.4×10^4 Acetone	24	None*
• B-74-1	Fugitive VOC Emissions from Bldg. 74	-	-	-	-	4.4×10^4 Acetone	24	None*
B-80-1	Vent from Mineral Oil Storage Tanks	-	-	-	-	Less than 1.0 Oil	24	None
B-80-2	Vent from Storage Tanks Greater than 10,000 Gallons	-	-	-	-	1.6×10^3 Acetone	24	None
B-80-3	Fugitive VOC Emissions from Bldg. 80 Tank Farm	-	-	-	-	1.0×10^3 Acetone	24	Tanks are Vented to Carbon Beds
B-85-1	Exhaust from Carbon Beds Nos. 4, 5, and 6	20	3.0	59.1	246	2.66×10^5 Acetone	24	Source is a Control Device*
B-85-2	Vent from 750 Gallon Tank Type Dumpster	-	-	-	-	Less than 1.0 Oil	24	None
B-85-3	Vent from Lubricant Batch Mix Tanks	20	0.5	0.57	3.3	1.0 Oil	8	None
• B-85-4	Fugitive VOC Emissions from Bldg. 85	-	-	-	-	3.3×10^4 Acetone	24	None*
• B-97-1	Fugitive VOC Emissions from Bldg. 97	-	-	-	-	8.1×10^5 Acetone	24	None*
→ B-125-1	Vent from Second Stage of Filter Tow Dryers	90	2.5	3.4	3600	1.14×10^5 Acetone	24	None
• B-125-2 •	Fugitive VOC Emissions from Bldg. 125	-	-	-	-	1.0×10^7 Acetone	24	None
B-125A-2	Vent from 750 Gallon Tank Type Dumpster	-	-	-	-	Less than 1.0 Oil	24	None
→ B-125A-3	Vent from Second Stage of Filter Tow Dryers	85	5.0	1.2	2000	1.08×10^5 Acetone	24	None
• B-125A-4 •	Fugitive VOC Emissions from Bldg. 125A	-	-	-	-	8.1×10^6 Acetone	24	None
• B-126-1	Fugitive VOC Emissions from Bldg. 126	-	-	-	-	9.0×10^4 Acetone	24	Tanks are Vented to Water Scrubber which Connects to Carbon Bed.
B-127-1	Exhaust from Carbon Beds Nos. 1, 2, and 3	85	3.0	38	999	6.8×10^5 Acetone	24	Source is a Control Device*

*Improved Control Methods Being Actively Investigated

Table 1. FILTER PRODUCTS DIVISION PROCESS EMISSION SOURCES (Continued)

Process Emission Source No.	Description	Stack Height (ft)	Stack Diameter (ft)	Velocity (ft/sec)	VOC Concentration (wt ppm)	Average Emissions (lbs/yr)	Hours of Operation/Day	Control Methods
B-127-2	Exhaust from Carbon Beds Nos. 7 and 8	85	2.5	41	1121	5.76×10^5 Acetone	24	Source is a Control Device*
B-127-3	Fugitive VOC Emissions from Bldg. 127	-	-	-	-	5.7×10^5 Acetone	24	None*
B-176-1	Fugitive VOC Emissions from Bldg. 176	-	-	-	-	7.54×10^3 Acetone	24	None
B-178-1	Exhaust from Carbon Beds A, B, C, and D	100	3.3 x 2.0	41.2	1050	7.36×10^5 Acetone	24	Source is a Control Device*
B-178-2	Fugitive VOC Emissions from Bldg.'s 178 and 178A	-	-	-	-	1.4×10^5 Acetone	24	None*
B-249-1	Fugitive VOC Emissions from Bldg. 249	-	-	-	-	9.4×10^5 Acetone	24	None*
B-254-1	Vent from Acetone-Air Scrubber	80	1.5	17	3900	3.05×10^5 Acetone	24	Source is a Control Device
B-254-2	Fugitive VOC Emissions from Bldg. 254	-	-	-	-	7.8×10^5 Acetone	24	None*

*Improved Control Methods Being Actively Investigated

Figure 2.

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Table 2. PROCESS EMISSION DATA

Emission Point	Emission Type	Average lb/hr	Tons/Yr.	Stack Height Above Grade, Ft.	Diameter Ft.	Exit Velocity Ft/Sec	Runtime Hrs/Day	Control Method
-1 A	Polymer Dust	0.001	0.004	48	0.29	3.8	24	None
-3 B	Burned Polymer	0.11	0.161	80	2.00	44.0	8	None
-1 C	Burned Polymer	1.10	1.606	80	1.67	63.0	8	Scrubber
-6 D	Lubricant	0.48	2.102	72	0.83	50.0	24	None
-2 E	Lubricant, Fiber	0.04	0.175	80	1.20	20.0	24	None
-4 F	Lubricant, Fiber	0.02	0.088	80	0.85	20.0	24	None
-5 G	Lubricant, Fiber	0.06	0.263	80	0.63 x 0.47	17.0	24	None
C-1 H	Fiber, Acetone	6.00	26.28	60	5.00	108	24	Scrubber
A-1 I1	Acetone Vapor	270	1182.6	Fugitive			24	None
A-1 I2	CO, CO_2, Acetone	50.15	219.66	80	3.00	57	24	Carbon Bed
3 J	Acetone Vapor	670	2934.6	Fugitive			24	None
2 K	Acetone Vapor	640	2803.2	Fugitive			24	None
1 L	Lubricant	0.11	0.482	100	0.94	42	24	None
1 M	Lubricant	0.01	0.044	75	1.70	27	24	None
2 N	Lubricant	0.01	0.044	75	1.70	27	24	None
1 O	Lubricant	0.02	0.088	75	1.70	34	24	None
-1 P	Lubricant	0.14	0.613	75	1.80	20	24	None

Figure 3.

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resulting fiber "rope" is passed over takeup rolls before washing. After the wash, product fiber is crimped, dried, cut, baled and stored prior to shipping. Acetone evaporated at spinning is recovered from the spinning cabinet air via a water scrubber system. Major acetone losses occur from the rope as it is guided, the bath (wash), and crimping and drying. The volatized acetone from these operations are sent to scrubbers. Activated carbon beds are used to recover acetone from storage vent tanks.

Precautions are taken to keep below the lower explosive limit (LEL) for acetone in the spinning and finishing areas. For specific details on emission rates, see Table 2. [These carbon beds are continuously monitored for acetone; but as previously mentioned, monitors are not always reliable.]

3. Polyester manufacturing process

At Tennessee Eastman Kodel polyester filament yarn and staple are usually manufactured by direct melt spinning. Eastman produces their own DMT from raw materials. The major polymerization by-product is ethylene glycol with smaller amounts of methanol. The ethylene glycol and methanol are condensed and transferred to storage tanks.

A. Staple Polyester - Confidential

B. Partially oriented yarn process

As in the polyester staple operation, the TPA polymer is extruded and distributed to filtering cabinets. The molten polymer is extruded through a spinnerette head (containing a smaller number of holes than tow spinnerette heads) and emerges into a quench stack in the spinnerette. The air quenching system is similar to the one in staple manufacture. Finish oil is applied after the filaments join to form a fiber. It is then wound on spools for shipment. An additional draw texturing operation may be performed after winding - the fiber is then wound on packages again for shipment. Figure 6 illustrates the POY process and Table 3 quantifies and types the emissions.

Figure 5.

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Figure 6

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Table 3. Kodel Fiber Division

Process Emissions Sources

Source	Description	Stack Height Feet	Stack Diameter Feet	Stack Volume Flow Ft^3/Sec*	Stack Velocity Ft/Sec	Stack Temp. ^oF	Particulate Total For Source Lbs/Hr	Control Device
B-226-1	Dryer Exhaust Vents**	78	4	408	37	140	1.72	None
B-226-2A	Apron Tow Cooling***	70	3	157	23	109	4.96	None
B-226-3A	Steam Tube Exhausts**	63	1.5	109	19	122	1.48	None
B-226-5	— Lubricant Booth Exhaust —	63	1x2	30	18	76	0.85	None
B-226B-1	Waste Fiber Dryer	30	2	83	29	180	0.003	None
B-226B-2	Dryer Exhaust Vents***	72	3	2405	53	119	7.92	None
B-226B-5	— Lubricant Booth Exhaust —	63	1.25x1.25	46	42	94	0.23	None
B-227-1	Parts Cleaning Exhaust***	30	1.3	446	30	95	1.736	None
	Salt Baths (cleaning)	30	1.66	78	37	95	0.157	None

*70^oF 1 Atmosphere

**Four Stacks - conditions listed for one stack.

***Eight Stacks - conditions listed for one stack.

APPENDIX A

SYNTHETIC FIBER PROCESS

INFORMATION

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Figure 1. FLOW CHART FOR FILTER TOW MANUFACTURING

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Figure 2. PARTIALLY ORIENTED YARN PROCESS

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Figure 3. ACETATE YARN PROCESS

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Figure 4. FILTER TOW PROCESS

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Figure 5. VEREL PROCESS

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Figure 6. POLYESTER EXTRUSION OPERATION (14-6)

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Figure 7. HIGH TENACITY T-2 YARN PROCESSING LINE

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APPENDIX B

Plant Survey Agenda

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