NON-CONFIDENTIAL
REPORT OF THE INITIAL PLANT VISIT
TO AVTEX FIBERS, INCORPORATED
RAYON FIBER DIVISION
FRONT ROYAL, VIRGINIA
REGARDING DEVELOPMENT OF NEW SOURCE PERFORMANCE STANDARDS
FOR THE MAN-MADE FIBERS INDUSTRY

I. PURPOSE

Report of the Initial Plant Visit to the Avtex Rayon Fiber Plant in Front Royal, Virginia, regarding the New Source Performance Standards (NSPS) for the Man-Made Fibers Industry.

II. PLACE AND DATE

Avtex Fibers, Incorporated
Rayon Fiber Division
Front Royal, Virginia

January 15, 1980/Revised Version

III. ATTENDEES

Name	Affiliation
Dennis Crumpler	EPA
James C. Berry	EPA
Robert Zerbonia	PES, Incorporated
Greg Lathan	PES, Incorporated
John C. Doherty	Virginia State Air Pollution Agency
Nick Kappel	Virginia State Air Pollution Agency
Herbert S. Hall	Avtex
John Cosgrove	Avtex
Robert M. Biggs, Jr.	Avtex
Roger Strelow	Leva, Hawes, et. al. (Avtex representative)
Robert S. Taylor	Leva, Hawes, et. al. (Avtex representative)

IV. DISCUSSION

Members of the EPA/PES project team gave a brief description of the Phase I objectives in the development of New Source Performance Standards (NSPS) for the synthetic fibers industry.

During the discussion regarding applicability of NSPS to only new or significantly modified sources, Herbert Hall stated that it is highly unlikely that any new rayon plants will be built in the near future (the next five years).

Mr. Hall then commented on the recent articles in various textile bulletins and reports claiming that Avtex has scheduled a 100 million pound expansion of its staple capacity, costing approximately $50 million, to be completed by early 1981. Hall clarified these reports and stated that this was not an expansion of capacity but only restoration and replacement of existing facilities. He also strongly indicated that there would be no new rayon manufacturing facilities (new plants) built in the free world in the forseeable future. Factors which prohibit the construction of new rayon plants are the high capital cost of building new rayon facilities (approximately $2 to $3/annual pound) as well as rising raw material costs (e.g., CS_2 is expected to increase from $200/ton to $275/ton by the end of 1980). The rising cost of energy was also cited as a deterrent to building new facilities. Mr. Hall also added that the new technology being developed for rayon fiber production is now in the laboratory stage and is not expected to come on stream for several years. He also noted that the new process does not involve the use of CS_2.

Questions arose concerning what is considered a new source. Technicalities dealing with expansion of existing facilities which would then be regulated under NSPS modification and reconstruction clauses were discussed.

Next, Dr. John Cosgrove gave a description of the viscose rayon manufacturing process (details can be found in the following section). Following the process description, discussion turned to review of CS_2 and H_2S emissions and control techniques. Avtex presently does not recover any CS_2 or H_2S (approximately 15 to 20 percent of the CS_2 on a sulfur basis is converted to H_2S in by-product reactions). Although the internal environment of the plant is controlled through ventilation systems, the collected pollutants are exhausted to the atmosphere uncontrolled.

Technical personnel at Avtex stated that their Front Royal plant had made attempts in the past, all with negative results, to recover CS_2 through carbon adsorption systems. They found that recovery of

CS_2 (and H_2S) was both economically and technically impossible. Numerous examples of unsuccessful CS_2 recovery systems, attempted in European rayon manufacturing facilities, were cited. Sateri, a Finnish rayon manufacturer, was found to have the most efficient CS_2 carbon absorption recovery system, of the plants investigated by Avtex. This facility reclaims about 25 percent of all CS_2 used in the process.

Although there is no recovery system for CS_2 or H_2S at Avtex, a study performed by TRC (Research Corporation of New England) found no detectable CS_2 or H_2S beyond the fence which encloses the area surrounding the Front Royal Plant. In the area of the plant CS_2 levels of 1 to 2ppb were found. TRC also reported that the sulfur-like odor evident in Front Royal was not due to CS_2 or H_2S emissions; the substance which causes this odor has not yet been qualified or quantified.

Dr. John Cosgrove then described the rayon yarn manufacturing process-specific details of his discussion are included below with information received on the plant tour which followed the meeting.

Manufacturing Process

Wood cellulose (usually derived from spruce, hemlock, or pine trees) are purified and formed into large white sheets of pulp that look like blotting paper. Two grades of pulp are purchased by Avtex. The first has a cellulose purity of about 93 percent and is used to produce high tenacity staple or any rayon product in which Avtex is not interested in maximizing strength. The second is a pulp that has a purity of approximately 98 percent which is derived from southern pine trees. It is used in producing tire and industrial yarns and the high "wet modulus" type of staple where strength is maximized. The bales of pulp are conveyed to the "soda" room where they are immersed in a "soda press" which contains a concentrated solution of caustic soda (NaOH). The objective here is to wet the cellulose and also to dissolve out some of the impurities that are left in the pulp. It is allowed to steep for a period of time. At the end of that period, the NaOH drains from the press and, a large ram pushes the cellulose sheets forward and presses the NaOH out of the sheets to a desired concentration. At this point, the sheets contain a known ratio of NaOH to cellulose. These sheets are then pushed into a large grinder where they are ground into small particles called cellulose crumbs. After grinding, these crumbs are poured into large cans and transferred to the mercerizing cellar where the reaction between the NaOH and cellulose is allowed to go to completion. This process actually lowers the degree of polymerization of the pulp to a desired point. When the "aging" of the cellulose crumbs is completed, they are poured into a mechanical churn, a vacuum is drawn, and the CS_2 is added.

Cellulose is then added to the churn. A xanthation reaction is then allowed to go to completion. At the end of this period, the crumbs are converted to alkali xanthated cellulose. A charge of NaOH and H_2O are then added to the churn. The resulting slurry is transferred to the mixing tanks containing caustic soda and mixed. Viscosity measurements are run on the viscose solution that is formed to make sure that it is in the specified range that is desired. The viscose solution is then pumped into an aging cellar and stored. The solution is filtered upon completion of aging through a plate frame filter press where any foreign material or undissolved cellulose is filtered out. The filtered viscose solution is then pumped to a spinning tank and put under a very high vacuum to remove any air bubbles that may have been trapped in mixing or pumping. An air bubble can block a spinning jet hole or cause an inflated filament or broken filament, all of which produce defects in the fiber.

The viscose is then pumped to a spinneret which is immersed in a sulfuric acid bath. The sulfuric acid neutralizes the sodium hydroxide and precipitates one filament from each hole in the spinneret head. Due to the extreme corrosive properties of the spinning bath, the spinneret heads or jets are made of platnium. These filaments are brought out of solution and stretched between wheels. The purpose of stretching is to align the cellulose molecules to give the filaments more strength. The sulfuric acid is continously recycled - a portion of the acid bath is evaporated leaving Na_2SO_4 crystals.

In box filament yarn production, a small spinning jet is used, and the filaments are collected in a spinning box which forms the yarn into cakes containing several thousand yards. Staple production uses large spinning jets with many more holes than filament yarn jets. Spun fibers are collected together into a continuous rope or tow; however, both begin as spun filament.

The continuous rayon filament spinning area is enclosed by plexiglass walls. A very effective ventilation system draws off the CS_2 and H_2S released in the spinning bath. The rayon staple spinning process was not as well enclosed because more handling of the filaments was required when breakage of the "tow" occurred due to the design of the spinning bath process line.

The subsequent filament and staple texturizing operations are very similar. In rayon staple production, the tow is cut into short uniform lengths by a cutting machine. After the cutting operation, the staple is formed into a mat or blanket of fiber. Next, the washing operations begin. In the first wash section, the spin bath chemicals are removed. The staple mat is washed with a solution where any by-product sulfur is removed from the staple fiber. A subsequent water wash is employed to remove any residual washing solution retained from the desulfurizing operations. Finally, the blanket is washed with water to reomove the acid in the previous washing step. Finish or lubricant is added to the staple mat and it is then torn apart by a beater and fed into a dryer. The dry staple is finally baled in lots by a bale press.

The rayon filament texturizing operation is essentially the same until the drying process is completed. After drying, the yarn is wound on cones or beams for shipment.

Emissions

The majority of the emissions in rayon staple and fiber production originate from the spinning process. A schematic diagram for both rayon staple and fiber production was provided that illustrates the major emission points in the process. Qualified and quantified source emission data was also supplied.

Figure 1. VISCOSE PRODUCTION

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Figure 2. RAYON FILAMENT PRODUCTION

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Figure 3. RAYON STAPLE PRODUCTION

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Table 1. EMISSIONS FROM RAYON STAPLE MANUFACTURE

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Table 2. EMISSIONS FROM RAYON FIBER MANUFACTURE

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