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REPORT OF THE INITIAL PLANT VISIT TO ALLIED CHEMICAL'S SYNTHETIC FIBERS DIVISION, CHESTERFIELD, VIRGINIA REGARDING THE NEW SOURCE PERFORMANCE STANDARDS FOR THE SYNTHETIC FIBERS INDUSTRY

PURPOSE

This trip was made to gather background information on nylon-6 spinning operations for Phase I of new source performance standards (NSPS) development for synthetic fibers industry.

PLACE AND DATE

Allied Chemical Corporation
Fibers Division

November 27, 1979/Revised version

ATTENDEES

Name	Affiliation
Robert Chase	Allied — Chesterfield Plant Superintendent Environmental Affairs
Wayne Sullivan	Manager — Environmental Services — Fibers Division
Robert Nida	Manager — Environmental Affairs and Employee Relations — Chesterfield
Wayne C. Didden	Supervisor — Spinning Area
Jann C. Henley	State Air Pollution Control Board
Dennis Crumpler	EPA
Robert Zerbonia	PES
Gregory Lathan	PES

DISCUSSION

Dennis Crumpler and Robert Zerbonia provided a detailed description of Phase I objectives in the development of NSPS for the synthetic fibers industry. Allied agreed that nylon-6 is a growth industry. Although no information concerning Allied's plans for capacity expansion was given, they did indicate that any expansion would be on existing equipment. In relation to other fibers the market for nylon-6 seems to be well positioned as far as product lines are concerned. Most of this dependence is due to the physical properties of nylon, but some is also due to cost dependence.

Wayne Sullivan inquired about EPA's definition of volatile organic compound (VOC) and indicated that he did not believe that caprolactam, the major pollutant in the nylon-6 spinning process would fall into this category. He also pointed out that caprolactam was not considered a VOC under the State of Virginia's regulatory definition.

Allied's representatives stated there have been some problems in quantifying the emission from the monomer exhaust stack. At the stack temperature caprolactam is in the solid phase. Caprolactam, $(CH_2)_5CONH$, has a melting point of 69°C (156°F) and a boiling point of 269°C (516°F). If EPA Method 5 is used, and the sample train is heated, then the caprolactam does not appear as a particulate. If the train is not heated, water vapor or droplets cause interference with measuring samples. The caprolactam emissions have not been considered as a VOC, since the State's VOC regulation does not apply to caprolactam emissions.

R.E. Chase provided process diagrams for the spinning of nylon-6 by Allied. After a detailed discussion of nylon-6 spinning, a plant tour of nylon-6 spinning operations was conducted and a subsequent meeting was held to answer any questions that representatives of PES and EPA had concerning the plant tour.

PROCESS DESCRIPTION

Allied Chemical Corporation is the largest producer of nylon-6 in the United States. In 1977 its two nylon-6 manufacturing facilities located in Chesterfield, Virginia, and Columbia, South Carolina, have an annual capacity of 398,000,000 pounds.[1] The Chesterfield plant was constructed in 1954 with a subsequent addition in 1961. The majority of their final product is used in producing tire and rubber goods, carpets, and nylon seat belt yarns.

[1]Chemical Economics Handbook, Nylon Fibers, December 1977 p. 543.4122L

There is no direct spinning of nylon-6 in the Chesterfield plant. Nylon chips (produced at Allied's Columbia and Chesterfield plants) are fed into an extruder and heated to melting. During transfer of the nylon chips to the extruder, a nitrogen atmosphere is maintained. The resulting molten monomer is then pumped through a filtering unit and out a spinnerette head into a quench stack. The physical characteristics of the nylon fibers are critically influenced by the temperature, moisture, and flow rate of the air introduced into the quench stack. Prior to entering the quench stack the air is carefully conditioned for a moisture content and temperature variation of no more than ± 1 percent relative humidity and ± 2°F, respectively, from desired conditions. The temperature gradient within the length of the quench stack is also carefully maintained to ensure proper cooling rate of the filaments. This operation is very critical in determining the physical properites of the nylon fiber. A portion of the quench air is removed at the top of the quench stack near the spinnerette head for monomer recovery and the remaining quench air is removed and exhausted to the atmosphere. The filaments solidify as they travel down the inside of the quench stack. Prior to the winding operation the fibers are lubricated with a mineral oil compound. After winding on spools, the nylon is removed from the wind machines and is further processed (e.g., texturizing). Any scrap nylon is depolymerized back to caprolactam.

CONTROL TECHNOLOGY

Since the residual monomer is extremely soluble in water, nylon chips are treated upstream in a water bath in order to optimize yarn properties before the spinning process begins. There are two major emission points in the spinning of nylon. First, are the exhausts from two ovens which are each used for the cleaning of spinnerettes by burning residual monomer clogging the filament holes of the spinnerette. The second and major emission point is at the spinnerette head near where the molten fibers emerge. Here, the residual monomer is volatilized as the filaments emerge from the spinnerette head — the majority of these emissions being given off in the first foot of the quench stack.

A portion of the quench air laden with caprolactam vapors is removed from the quench stack at the spinnerette head and is sprayed with water to absorb the caprolactam (caprolactam and water are very soluble in one another). This mixture of monomer (both dissolved in water and existing as vapor) and water are pumped into a monomer exhaust tank. Spinning building "A" has two monomer exhaust stacks and spinning building "B" contains five monomer exhaust stacks. The caprolactam-laden washer water is pumped from the monomer exhaust tank through a filter. A portion of this filtered washwater is recycled to the spraying process; the remainder is bled to a caprolactam recovery system.

The previously mentioned concurrent air flow system is employed in the quench stacks as opposed to the more commonly used cross-flow (current) system to cool the fibers as they are extruded through the spinnerette head. This totally enclosed system uses only 10 percent of the quench air necessary in conventional systems, thus reducing monomer emissions significantly.

OBSERVATIONS

Exit stacks from spinning buildings "A" and "B" emitted a white plume of water vapor or steam that tended to dissipate but did leave a detectable trail of organic vapor. Clear blue sky served as the background.

There was no detectable odor in the spinning building observed.

ACTION TO BE TAKEN

Allied agreed to provide PES and EPA with an update of the 1979 State emission registration forms, the results of the emission tests conducted on the monomer stack, and any other process diagrams that would be helpful.

Figure 1. CONFIDENTIAL
QUENCH STACK DIAGRAM

Figure 2. CONFIDENTIAL
SCHEMATIC DIAGRAM - MONOMER EXHAUST FLOW