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Recent Achievements and Research Initiated in the Swedish Plastics and Rubber Industry

by Anders Englund* and Bo Holmberg†

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The improvement in exposure conditions in the Swedish vinyl chloride producing industry is reported. The article comments on the technology and control methods by which the vinyl chloride concentration has been lowered to less than 1 ppm vinyl chloride. Two epidemiological retrospective cohort studies are presently under way on workers in PVC-utilizing industries and in the rubber industry.

In the spring of 1974 a search for cases of liver tumors led to the detection of two cases of angiosarcoma of the liver among workers in the vinyl chloride/poly(vinyl chloride) (VC/PVC) industry (*1*).‡ Since then, an epidemiological survey reported in this symposium (*2*) has been performed without revealing any excess cancers of other sites.

Until April 1974, the official permissible concentration for VC was 500 ppm time-weighted average (TWA) although the VC/PVC producing industry with certainty normally did not exceed 100 ppm during the last few years. In April 1974 a temporary permissible concentration was set at an 8-hr TWA of 20 ppm with 50 ppm as a ceiling value. In the autumn of 1974, a low value was discussed among experts, but the Swedish company did not agree upon the technological and economical feasibility of a low-risk-standard around 1 ppm. In October 1974, however, 1 ppm TWA for VC was settled with a ceiling value of 5 ppm as a 15-min average. The impossibility of such a low value has been argued not only in Sweden but also in other countries. A look at the efforts in work hygiene in the factory is, however, encouraging.

The factory was erected at Stockvik, northern Sweden, in 1945 and produced VC monomer as well as PVC resin until 1968/1969, when monomer production was halted. At the same time the standard of work hygiene was partly improved. The factory today employs around 100 workers in PVC production, and the company concerned is one of two existing companies in Scandinavia. The production capacity in this particular plant was around 6×10^7 kg PVC in 1975.

Table 1 (*3*) shows the arithmetic means of dose measurements in the Stockvik plant during 1974–1975. The mean values as well as the highest and lowest measured values decrease markedly with time and with the improvement of work hygiene technology. As soon as mid-1975, half a year before time demanded, the company was able to achieve the permissible concentrations.

What kinds of control are maintained on the exposure levels and by what means were the concentrations lowered? Air samples are automatically taken at 28 fixed sampling sites (Fig. 1). The air sample is fed into a centrally located analysis apparatus during 24 sec. A sample is taken at a particular sampling site every 15 min. Gas chromatographic analyses on hydrocarbons are performed automatically and

* Landsorganizationen i Sverige, Barnhusgatan 18, S–105 53 Stockholm, Sweden.

† Section of Occupational Toxicology, Department of Occupational Health, National Board of Occupational Safety and Health, Fack, S–100 26 Stockholm, Sweden.

‡ On March 20, 1976 a third man died at the age of 64 in a hemangiosarcoma of the liver. He was employed as an autoclave operator from 1947 to 1968, when he left the company. Since 1973 he was granted sick pension due to angina pectoris. The tumor disease was asymptomatic until one month prior to the death.

Table 1. VC dose measurements at the Stockvik PVC production plant.[a]

	VC, ppm						
	April–June 1974	July–Sept. 1974	Oct.–Dec. 1974	Jan.–March 1975	April–June 1975	July–Sept. 1975	Oct.–Dec. 1975
Arithmetic mean	12.2	7.7	3.4	1.3	1.1	0.7	0.6
Highest value	106	29.5	13.9	4.8	3.0	4.5	10.5
Lowest value	1.3	2.6	0.4	0.1	0.2	0.1	0.1
Percentage employees exposed to less than 1 ppm	0	0	3	26	74	89	100
No. of measurements	42	29	32	40	46	40	46

[a] Data of Norgren (*3*).

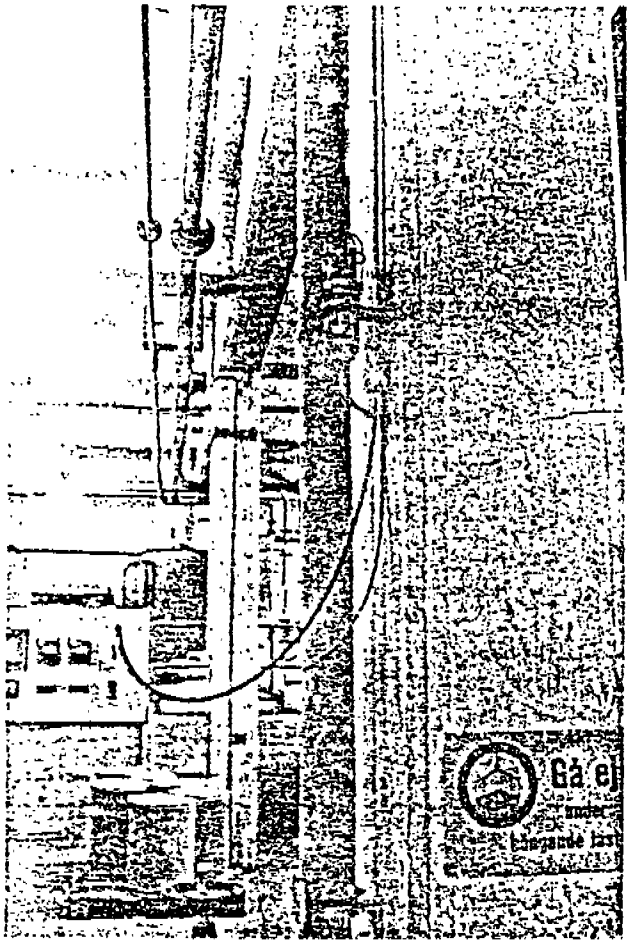


FIGURE 1. Stationary sampling unit with warning lamp in a PVC producing department.

recorded. Should the content of VC/hydrocarbon in the air sample exceed 5 ppm, a warning lamp at the sampling site turns on to warn the workers (Fig. 1).

The work environment in the PVC plant was improved by application of already known ventilation technology and by closing the process cycle by recirculation of VC. The general ventilation was improved by an increase in air inflow and outflow. The impact of an increased general ventilation was further enhanced by a stabilization of the air flow by air jet streams. (Fig. 2) At the point where leakage occurred, special ventilation was arranged in order to take care of leaking monomers (Fig. 3). In the autoclave area, a mobile ventilation unit can be transferred to a site where a local leak-

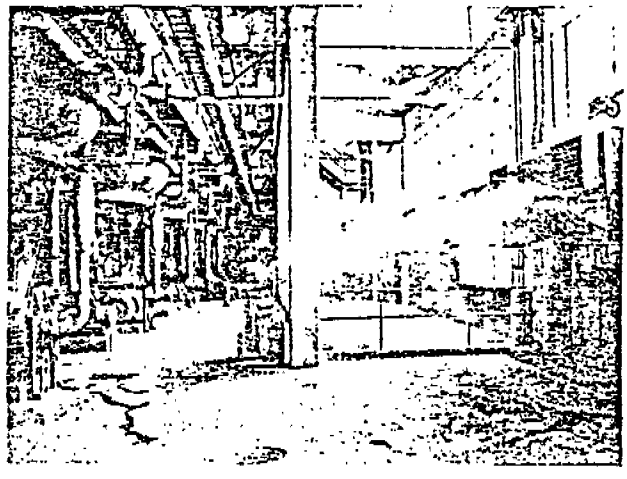


FIGURE 2. Ventilation equipment with air inflow at window wall. Air exhaust behind the autoclaves, the bottoms of which are seen to the left. Jet streams from the roof to the left of the pillar stabilizes air stream as seen by smoke indicator.

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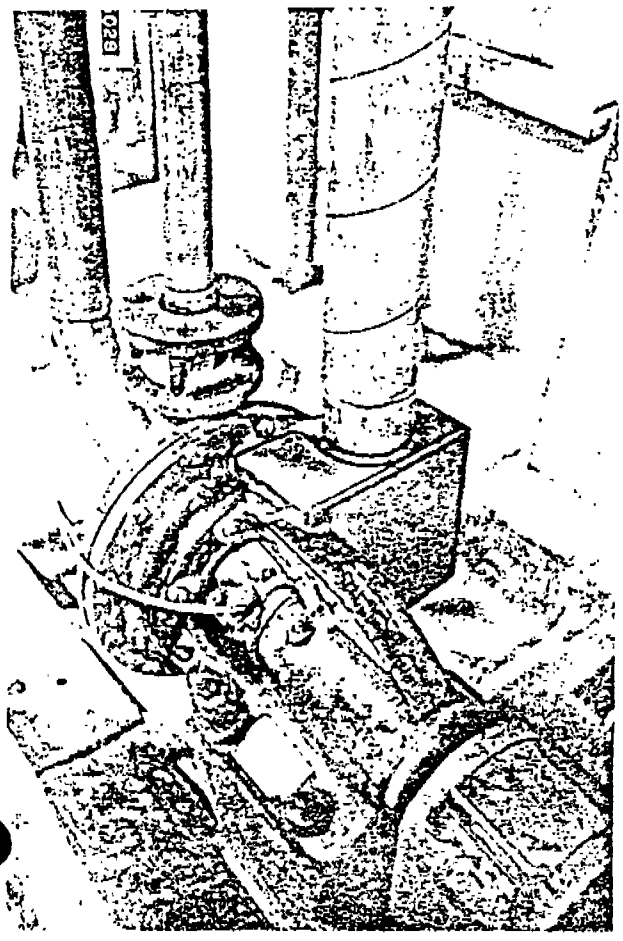


FIGURE 3. At some points of leakage, special ventilator equipment was designed. The picture shows such equipment at a tube joint.

age has been detected. Before a worker enters an autoclave, fresh air is blown into the autoclave. Workers must wear masks during autoclave cleaning. The financial investment for work hygiene improvements in the Stockvik plant was around 20 million Swedish Crs. (approx. $4.5 million).

The conclusions to be drawn from the Swedish VC/PVC experience are that the technological and economical considerations initially expressed by industry are not always valid and that setting a low occupational health standard may govern the technological development.

Industries engaged in fabrication of PVC, which employ between 3500 and 5000 workers have had a better start for improvement of their work hygiene as far as exposure to VC monomer is concerned. Improvements have been made by improving ventilation in fabrication and by modifying the PVC resin production process in PVC manufacture so as to leave less residual VC monomers in the resin. This last effort is ongoing and the goal is to produce a resin with less than 0.001% residual monomer. Measurements of TWA dose in four major companies investigated, which produce carpet material, textile fabrics, food packaging, plastic film and tubing, do not normally exceed 0.1 ppm today.

An epidemiological retrospective cohort study is presently under way. A total of about 2100 workers will be checked with the cancer registry and with the national registry for causes of death. The reason for making a survey in the fabricator industries is to evaluate the possible risk for excess cancer due to past exposure, which certainly has been higher than today's, but has certainly not been as high as in the PVC production plant.

In the rubber industry an epidemiological study on possible health hazards among Swedish rubber workers has been begun. Two major Swedish rubber companies are included in the study on a cooperative basis. The trade union, the companies, and the National Board of Occupational Safety and Health are all involved. The population at risk is now estimated to be around 5000, with at least 700 workmen from weighing and compounding departments.

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