Phenol Concentrations in the Air from Disinfection Solutions

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Received for publication 9 August 1971

Phenol concentrations in the air near phenol disinfectant solutions were measured. The concentration of phenol was not excessive, except for hot solutions with which exposure would normally be for a very short time. Adverse physiological reactions may occur at air levels below the threshold limit values which may be especially hazardous to those persons exposed to organisms causing respiratory diseases.

Phenol is the disinfectant of choice in many laboratories, especially those working with mycobacteria. Pipettes and other glassware are frequently immersed in a 5% phenol solution before autoclaving. Phenol is a highly toxic chemical, and in concentrated form it will cause nonhealing chemical burns and is readily absorbed through skin, mucous membranes, and gastrointestinal and respiratory tracts (3). Acute exposure to its vapors may cause a number of severe acute or chronic symptoms, depending on concentration of the vapor and length of exposure (3). Persons exposed to phenol vapors frequently develop allergic sensitivities. Phenol is shown to inhibit ciliary movement and may induce tumors in mouse skin (2).

The threshold limit valves (TLV) are 5 ppm or 19 mg/m³ as indicated by the hygiene guide of the American Industrial Hygiene Association (1). However, Stern (4) reported U.S.S.R. air quality criteria indicating adverse human reflex response to as low as 0.015 mg/m³ of phenol.

To determine the degree of phenol vapor exposure received by workers in our laboratory, the concentration of phenol in air close to open pans (920 cm² surface area) containing 1 liter of 5% phenol solution was measured. Samples were collected in a bubbler sample (Ace Glass, Inc., cat. no. 7530-10). Airflow was controlled by limiting orifices of appropriate size. Sodium hydroxide (0.1) in distilled water was used as the collecting medium. The sample was quantitatively analyzed by a modified 4-amino antipyrine method by using premeasured reagents obtained from the Hach Chemical Co., Ames, Iowa. In our studies, interfering substances were not present. Samples were read in a Coleman Junior spectrophotometer calibrated with standard phenol solutions.

To maintain the temperature of the pan of phenol solution, it was placed in a thermostatically controlled water bath. Duplicate samples were collected at each time and at least three trials were made at each temperature and distance from the pan. It was found that, at 25°C and 30 cm above the solution, the phenol concentration in air was only 3.8 mg/m³; when the temperature was raised to 37°C, the concentration was almost six times as high. At 1 m from the solution, the concentration was 4.8, 12.0, and 21.0 mg/m³ of air at solution temperatures of 37, 40, and 45°C, respectively (Table 1).

Glassware in a pan of phenol solution should be autoclaved before the glassware is cleaned. With the methods outlined above, the average phenol concentration found in the air from 1 through 4 min after opening an autoclave containing a pan of 5% phenol solution is shown in Table 2. The samplers were located at a position to simulate the face of a person opening the door of the autoclave. The average phenol concentration was 190 mg/m³ during the first minute but rapidly decreased to 20 mg/m³ during the fourth minute. One set of determinations was obtained by sampling the air 0.5 m above a pan containing 1 liter of hot autoclaved phenol solution. This air contained 600 mg/m³ during the first 10 sec after removal of the pan lid.

There is a considerable discrepancy on what may constitute hazardous levels of phenol in the air; however, the TLV are not exceeded except at a relatively close distance to the source or when the solutions are hot. Intermittent exposure at these levels may, however, favor the development of allergic reactions.

The most significant effect of the phenol exposure is the fact that phenol being an inhibitor of ciliary action may reduce this natural defensive
Table 1. Phenol concentration in the air above a 5% solution of phenol

| Temp (°C) | Distance (cm) above solution | Amt (mg) of phenol/m³ of air |
|-----------|------------------------------|-----------------------------|
| 25        | 30                           | 3.8                         |
| 37        | 30                           | 22.5                        |
| 37        | 100*                         | 4.8                         |
| 40        | 100*                         | 12.6                        |
| 45        | 100*                         | 21.0                        |

* Distance measured at a 45° angle from solution surface.

Exposure can be reduced by good laboratory ventilation, directing airflow over pans of phenol away from personnel, and the use of exhaust hoods at autoclave openings and over open pans of phenol. Respiratory protection is advisable for persons working with hot phenol solutions. Other contact with phenol should be reduced to a minimum to lessen total exposure.

Table 2. Phenol concentrations in the air after opening the door of an autoclave containing 1 liter of 5% phenol solution

| Time (min) | Amt (mg) of phenol/m³ of air |
|------------|-----------------------------|
| 1          | 190                         |
| 2          | 34                          |
| 3          | 34                          |
| 4          | 20                          |

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