Our interest in this problem has been stimulated by many results obtained in sampling gases from welding atmospheres in industry. We could not find significant concentrations of nitrogen dioxide or total gaseous oxides (nitrates) in these atmospheres even during extended welding periods (several hours). This is also confirmed by the recent United States Maritime study reported by Dreessen and associates [5] and by Wade, Elkins and Ruotolo.[2]

An important aspect of ventilation which enters into this problem is the recirculation devices used for removing welding fume. According to theoretical calculations, dangerous concentrations of nitrogen dioxide might result if high concentrations of nitric oxide were present, since only particulate matter and not gases would be removed. Field samples taken with recirculation under such conditions, however, have not indicated abnormal or unhygienic concentrations of nitrogen dioxide.

The purpose of this study, therefore, was to determine factors influencing concentrations of nitrogen oxides in the breathing zone of the welding arc and to determine whether recirculation appreciably increased the amounts of nitrogen dioxide present.

We are in agreement with Elkins as to the toxicological factors discussed by him and concur in the opinion that nitrogen dioxide is the most toxic member of the nitrogen oxides. Since welding exposures to these oxides are common, it is important to study actual welding atmosphere with respect to oxide of nitrogen conditions.

EXPERIMENTAL PROCEDURE

The nitrogen oxide reactions that may develop during arc welding were investigated in a series of experiments as detailed in table 1. Bare and coated electrode resistance welding was performed at different voltages, currents and other conditions. Studies were made in a 1,200 cu. ft. (34 cu. M.) cabinet in which the air could be recirculated continually. Welding was done for one hour periods and oxide and fume concentrations were collected during this period and, in most cases, for two hours following welding. Coated and bare 5/32 in. (4 mm.) rods were welded to a low carbon steel plate in beads. The bare rods were General Electric arc welding electrodes (type F) for welding mild steel in all positions. These electrodes complied with the American Welding Society's specifications for filler metal class E-4511. The recommended current was straight polarity 125-175 am. and 13-16 v., but our welding machine set at 70 v. resulted in average values of 125 am. and 25 v. The coated rods were products of the Hollup Corporation, Chicago, type B (American Welding Society's specifications E-6010). The recommended current was reversed polarity 110-165 am. and 24-27 v. The generator set at 65 v. resulted in an average welding value of 120 am. and 30 v. In runs 4 through 6 the voltage was raised to 40 with 150 am. In experiments in which it was desired to remove the welding fumes near the arc (without loss of welding gases), an M.S.A. welding fume exhauster was employed. This unit has an average exhaust rate of 60 cu. ft. (1.7 cu. M.) per minute which also contributed to recirculation of cabinet air. The cabinet air was recirculated approximately 25 times per hour; thus adequate mixing was insured.

Gas samples were taken at breathing level through the cabinet's exterior at approximately 4½ ft. (123 cm.) from the floor level. Iron fume was removed from the gas sample inlet by a 5 in. (12.5 cm.) calcium chloride drying tube filled with loose absorbent cotton to remove the bulk of the fume. We observed that if the iron fume was not substantially removed, considerable interference appeared with the phenoldisulfonic acid nitrate method.

5. Dreessen, W. C., and others: Health of Arc Welders in Steel Ship Construction, Public Health Bulletin 298, Federal Security Agency, United States Public Health Service, 1947.