Lung Contamination Among Foundry Workers

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Summary. Ten iron foundry workers representing typical foundry occupations were examined. The amount of lung contamination was estimated after the workers' thoracic area had been magnetized and the remanent magnetic field measured. Chest radiographs were classified according to the "siderotic", "silicotic", and nonspecific changes found; and the changes were then divided into four categories.

The preliminary results of the electron micrographs indicated that the size and shape of the pollutants varied greatly according to the type of foundry site. In addition, the estimated amount of lung contaminants in the subjects varied between 30 and 600 mg. A good correlation (r=0.86) was obtained between radiological "siderotic" and "silicotic" changes, and the correlation between both of these radiological findings and the measured average permanent magnetic field was rather good (r=0.60). There was no correlation between the estimated exposure (neither length nor magnitude) and the amount of retained lung contaminants, and therefore a balance between retention and clearance seemed to have been achieved. These results indicate that the magnetic measuring method can be used to evaluate the amount of lung contaminants retained by foundry workers.

Key words: Siderosis – Silicosis – Lung contamination – Foundry work

Foundry work forms a rather heterogeneous group with respect to occupational exposure to dust. Studies concerning the respiratory status of foundry workers are numerous; they have primarily concentrated on silicosis or, occasionally, on chronic bronchitis (e.g., Karavä et al., 1976; Mikov, 1974; Gregory, 1970). Several studies have also been made concerning the properties (concentration, chemical composition, and quartz content) of the silica to which workers in iron and steel foundries are exposed (e.g., Siltanen et al., 1976; Koponen et al., 1976; Tossava-
However, the metallic components in foundry dust and their physical properties, e.g., size, shape, and the crystallic structure of metallic aerosols, are poorly known.

The aim of the present investigation was to study ten subjects representing typical foundry conditions and to determine whether the magnetic measuring method (Cohen, 1973; Kalliomäki, 1977) is suitable for estimating the total amount of lung contaminants in foundry workers in vivo.

**Subjects and Exposure**

In this study ten iron foundry workers representing typical foundry occupations were examined. Their length of exposure time to foundry dusts ranged between 24 and 46 years (mean ± S.D. = 33.2 ± 6.8 years). Most of the subjects had worked in foundries where all foundry operations were carried out in the same hall. One of the subjects had been exposed only to core sand dust. The others had had a mixed exposure to sand dust and metal fumes, three of them also to metal dust from grinding operations.

In an earlier study of the metal fumes in foundries (Tossavainen, 1976), the total iron concentrations of dust samples in melting works varied between 10 and 20%. Both Fe$_2$O$_3$ and Fe$_3$O$_4$ were found in these samples. An analysis of electric furnace dust showed the following components: total iron (Fe) 16—36%, Fe$_2$O$_3$ 19—55%, and FeO 4—10% (Campbell and Fullerton, 1962).

During this study transmission and scanning electron micrographs were taken of foundry dusts collected from different work sites. Particle size, shape, agglomeration, and chain forming were especially studied when the samples were analyzed. The metal fume particles collected from the melting process of an iron foundry corresponded to manual arc welding fumes. The particles seemed to be roughly round and they formed small agglomerations and short chains. The particles averaged 0.1 μm in diameter.

Particles from the fettling process in an iron foundry were predominantly about 1 μm in size. Main part of the particles were irregularly shaped, and they did not form agglomerations or chains.

Particles from moulding process were large, about 5—10 μm in diameter. The shape of these particles was also irregular.

A dust survey made of Finnish iron and steel foundries (Siltanen et al., 1976; Koponen et al., 1976) estimated the level of dust exposure in typical foundry occupations. The means of the respirable dust concentrations measured in different foundry work phases of 51 iron foundries varied between 2.6 mg/m$^3$ (core making) and 6.8 mg/m$^3$ (fettling).

The subjects in the present study had a mixed exposure to foundry dusts with different magnetic properties. A rough estimation of their exposure to iron fumes, sand dust, and metal dust was made so that the most dominant component of the exposure could be determined. The classification (Table 1) is only qualitative; it is not based on exact figures of dust concentrations. One of the authors (MK) made the classification using the work history of the subjects and information on the work conditions in the foundries where the subjects worked.