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MERCURY EMISSIONS INTO THE ATMOSPHERE FROM A CHLOR-ALKALI COMPLEX MEASURED WITH THE LIDAR TECHNIQUE

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Abstract—Data are reported on atmospheric mercury flux measured by a lidar system at a chlor-alkali plant located in central Italy. Two mercury sources were identified over the electrolytic cell rooms. A flux value of 36 g h^{-1} was determined during the daytime while at night the value increase to 56 g h^{-1}. The mercury emitted into the atmosphere was found to be 4 g per 1000 kg of chlorine produced. Atmospheric mercury concentrations were supplemented with some determinations made with the point monitor technique.

Key word index: Mercury, atmosphere, chlor-alkali plant, lidar.

INTRODUCTION

Mercury and its compounds are widely used for industrial and agricultural applications due to the unusual physico-chemical properties of these materials (Nriagu, 1979). One of the principal uses of mercury (which accounts for about 20% of the total consumption) has been in the production of caustic soda and chlorine. The chlor-alkali processes make use of mercury in the simultaneous production of chlorine and caustic soda by electrolysis of brine solution using a flowing cathode of metallic mercury. Twenty years ago it was estimated that 200–250 g of mercury could be lost to the environment for every 1000 kg of chlorine produced.

In the most advanced chlor-alkali installations losses of mercury to the environment should be less than 3 g per 1000 kg of chlorine (Frei and Hutzinger, 1985). Mercury is released into the environment mainly in waste water (a), in the atmosphere (b) and in sludges (c):

(a) Mercury discharged into waste water should not surpass a value of about 1 g per 1000 kg of chlorine produced;
(b) Mercury emitted into the atmosphere (especially from electrolytic cell rooms) should be of the order of 1.5–2 g per 1000 kg of chlorine;
(c) Mercury in sludges, old cell room parts, etc., is not easy to estimate.

In the literature, data are available on mercury discharged into waste water from some chlor-alkali complexes (Renzoni, 1977; El-Rayis *et al.*, 1986), but data on atmospheric mercury are scarce and refer only to the area around the complex (Lindqvist *et al.*, 1991). Rather than dealing with direct measurements of atomic mercury concentration in air, many authors are discussing mercury content in vegetative organisms, used as biological indicators of atmospheric mercury pollution (Wallin, 1976; Lodenius and Herranen, 1981; Lodenius and Tulisalo, 1984; Hynninen and Lodenius, 1986; Gonzales, 1991).

In the present paper we report a study on mercury emission into the atmosphere from a chlor-alkali complex located in central Italy. The chlor-alkali complex of Rosignano Solvay & Cie (Livorno) produces 120,000 tons y^{-1} of chlorine. Consequently, the minimum loss of mercury into the environment should be about 360 kg y^{-1}, if the most modern techniques are applied. From our previous work (Maserti and Ferrara, 1991) mercury discharged to the waste water in the coastal area has been estimated to be of the order of 150–180 kg y^{-1}. Few data are available on mercury concentration in the atmosphere around this chlor-alkali complex (Maserti and Ferrara, 1991), while no information is present on mercury emitted directly into the atmosphere by this complex.

Research on mercury concentrations in plants and lichens collected in this area reveals that atmospheric background values (3–5 ng m^{-3}) are reached within a radius of 4–5 km from the emission point with an asymmetry in the spatial distribution due to the presence of prevailing winds.

In order to evaluate the mercury concentrations in the atmosphere above the complex and the total flux of the metal emitted, a measurement campaign was performed in 1990 using a lidar system developed at the Lund Institute of Technology (Sweden).