

# Carbon tetrachloride content of chlorine-bleach-containing household products and implications for their use

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## ABSTRACT

It was recently shown that a substantial amount of carbon tetrachloride (CCl<sub>4</sub>) is formed in chlorine-bleach-containing household products as a result of reactions of sodium hypochlorite with organic product components. Use of these household products results in elevated indoor air CCl<sub>4</sub> concentrations. CCl<sub>4</sub> in several chlorine-bleach-containing household products (plain, n=9; fragranced, n=4; and surfactant-added, n=29) from Europe and North America were measured in the present study. CCl<sub>4</sub> concentrations ranged between 0.01 and 169 mg/L (23.2±44.3 mg/L, average±SD) and concentrations were the lowest in plain bleach, slightly higher in fragranced products and the highest in the surfactant-added products. Indoor air concentrations from the household use of bleach products (i.e., bathroom, kitchen, and hallway cleaning) were estimated using a simple box model. Estimated indoor air concentrations ranged between 0.30 and 1124 (82±194, average±SD) µg/m<sup>3</sup>, indicating substantial increases compared to background (0.27 µg/m<sup>3</sup>).

Eventually, the majority of CCl<sub>4</sub> in chlorine-bleach-containing household products is emitted to the atmosphere. Global annual CCl<sub>4</sub> emissions from the use of chlorine-bleach-containing household products were estimated using the concentrations measured in this study and an average per capita consumption of 1 kg/year. Since the shares of product types (i.e., plain or surfactant added) were not known, emissions were estimated for two extreme cases: (i) plain bleach having the minimum CCl<sub>4</sub> concentration, (ii) surfactant-added bleach having the maximum CCl<sub>4</sub> concentration. For these cases global annual CCl<sub>4</sub> emissions ranged between 0.06 and 1230 tons. CCl<sub>4</sub> emissions from 14 European countries with a population of ~600 million and known country specific per capita household bleach consumptions were also estimated. Annual European CCl<sub>4</sub> emissions ranged between 0.02 and 493 tons. Per capita household bleach consumptions are highly variable, ranging between 0.22-11.8 kg/year, and generally it is > 3 kg/year. This suggests that the global average per capita household bleach consumption may be higher than 1 kg/year and as a result global CCl<sub>4</sub> emissions may be underestimated. Although the estimated global emissions are highly uncertain due to lack of detailed information on product type and usage amounts, the results of the present study indicated that household chlorine bleach use is an ongoing source of CCl<sub>4</sub> emitting appreciable amounts to the atmosphere.

**Keywords:** Chlorine bleach; carbon tetrachloride; global emissions.