

The Use of Methylcyclopentadienyl Manganese Tricarbonyl (MMT) as Gasoline Additive and Its Effects on Manganese (Mn) and Lead (Pb) Concentrations in Air and Soils in the Accra – Tema Metropolis

Saforo-Baah, Joanitta

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ABSTRACT

Methylcyclopentadienylmanganese tricarbonyl (MMT) is an organometallic derivative of manganese (Mn), which has been used since 2004 in gasoline as an octane enhancer in Ghana. It was used after the ban of the use, marketing and sale of tetraethyl lead as gasoline additive by the Government of Ghana by a legislative instrument (LI 1732). The combustion of MMT leads to the emission of Mn particles which has health effects when inhaled. A baseline study carried out by Tema Oil Refinery's (TOR) in 2005 by a research group established that Mn concentrations in the respirable range were within international standards. Studies were conducted to measure Mn and residual Lead concentrations in the air and soil along some major roads in the Accra-Tema metropolis and to examine their relationship with meteorological data and traffic density. Four study sites namely Tema, Nungua Police Barrier, Shangri-La and Circle were chosen due to their traffic densities. Mn and Pb in the coarse and fine particulates were sampled continuously (24 h/day) over a period of 6 months using a Dichotomous sampler. Soil samples were also taken from the sites. Analyses of air and soil samples for Mn were done by Instrumental Neutron Activation Analysis (INAA) and that of Pb was done with Atomic Absorption Spectrophotometer (AAS). Metal analysis of both fine and coarse particulates indicated that Mn levels were increasing gradually while lead concentrations were decreasing. Soil concentrations for Mn and Pb were found to be variable. Manganese concentrations ranged from 65 to 2587 mg/kg and that of lead ranged from 4.89 to 88.91mg/kg. Particulate matter concentrations over the entire study period ranged from 12.55 $\mu\text{g}/\text{m}^3$ to 5145.58 $\mu\text{g}/\text{m}^3$. Field studies showed that pedestrians and hawkers who sell their wares along the major roads and streets were at high risk of respiratory diseases since they were exposed to high levels of contaminated particulate matter. A higher percentage of females were involved in the sale of various items along road ways (i.e. 52% females and 48% males). Thus for the people involved in such activities, more women may experience illnesses relating to inhalation of particulate matter and hazardous and toxic metals. Comparing the concentration of Mn in the baseline study by Tema Oil

Refinery (TOR) in 2005 with that of this study showed marked increase in the Mn concentration levels. Geometric mean of Mn in the respirable range ($0.032 \mu\text{g}/\text{m}^3$) was higher compared to that of the baseline study which was $0.021 \mu\text{g}/\text{m}^3$. The geometric mean was however well within the tolerable daily intake (TDI) proposed by health Canada, World Health Organization (WHO), and USEPA standards. Multiple regression analysis showed that there was a significant correlation between manganese no fine particulates and humidity in dry season. Lead on coarse particulates also showed significant correlation against wind speed and lead on fine particulates showed significant correlation against rainfall and wind speed in the rainy season. In the dry season, there were significant correlations between lead on fine particulates and wind speed, and lead on coarse particulates and humidity. Since there was an increment in the manganese concentrations in this study as compared to the baseline study it is important that further monitoring on Mn concentrations in ambient air is carried out nationwide.

SUPERVISOR

Dr. Nyarko, Elvis