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Efficacy of water suppression method for controlling the emissions of submicron particles at a quarry, Boksburg, South Africa.



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RESEARCH REPORT ABSTRACT

by

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A research report submitted in the Faculty of Health Sciences, University of the Witwatersrand in Johannesburg in partial fulfilment of the requirements for the degree of Master of Science in Medicine: Exposure Science

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Abstract

Background: Respiratory diseases has contributed 70% to worldwide occupational disease mortality in all industrial sectors since over a decade ago. Pneumoconioses occur as a result of accumulation of dust in the lungs. Silicosis, one of the most common forms of pneumoconioses, presents in three different forms namely acute, accelerated, and chronic silicosis. Quarrying and open cast mining are responsible for different workplace hazards including noise, trauma, vibration, ultraviolet radiation, and dust exposure, which may cause silicosis. Lung deposition of particulate matter depend on the particulate matter surface characteristics, aerodynamic size, and weight. Quarrying and stone crushing activities are associated with high levels of crystalline silica release. Water suppression has been proven to effectively control dust in mining and construction industries, but not enough attention has been paid on effects of water suppression on fine particulate matter.

Purpose: To evaluate efficacy of water suppression as a dust control measure for submicron particles for the primary, secondary and tertiary treatment processes during the production of stone aggregates in a quarry.

Methods: In this cross-sectional study data was collected using a Nanozen dust sampling device to monitor dust emissions in 0.300µm to 10.658µm bin sizes across 4 different sampling points namely primary, secondary, tertiary treatment area, and office complex at a quarry in Boksburg, South Africa. In the primary treatment area big rocks are crushed into 150mm smaller rock without dust suppression, the secondary area breaks them further into 57mm stones with water supperssion applied, and tertiary breaks them into 19mm and smaller stone products under further water suppression conditions. Primary treatment area and office complex were sampled as dry areas, while secondary and tertiary treatment areas were sampled as water suppression areas. Data was analysed based on mass and number concentrations for different bin sizes, and comparisons were made between dry and wet areas. The effect of water treatment (suppression) on submicron bin ranges (0.300-0.915µm) in terms of mass concentration and number concentration was analysed to determine its efficacy in reducing dust emissions in this range.

Results: The total average mass concentration of 460.2 µg/m^3 (±486.3) was emitted from the primary area without dust suppression with average of 2.22E+08 (±136958.7) number

concentration. This was reduced to 6.02µg/m^3 and 60.9 million (±552879) mass and number concentration respectively in secondary treatment area with water suppression. In tertiary area emissions were 10.52µg/m^3 and 54.8 million particles/cm^3 (±828126) respectively for mass and number concentrations following further water suppression, while in office area (no water suppression) 6.07µg/m^3 and 44.4 million/cm^3 mass and number concentrations were recorded respectively.

Conclusions & Recommendations: Data showed reduction of emissions between primary and secondary area by 98.7% (mass concentration) and 72.5% (number concentration). Further treatment in tertiary treatment showed a further decrease in total average number concentration compared to secondary treatment. Emissions at the office block as a control site were consistent with emissions from secondary and tertiary treatment areas, demonstrating possible dispersion by wind. Water suppression was demonstrated to be effective against particle bin sizes larger than 1 micron, with progressively less effect on submicron particles as they became smaller. More research is recommended on suppression of submicron dust particulate matter emission and consideration of number concentration as a key dose matrix to determine exposure.

Keywords: *water suppression, particulate matter, submicron particles, quarrying, silicosis.*