INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Worker Exposure to Airborne Contaminants When Using Waste Foundry Sand in the Construction of Road Embankments

Introduction

Sand is a major waste product of the foundry industry. For many years, foundries have advocated the use of waste sand for civil engineering purposes. One such use is in the construction of roadway embankments. It seems to be an ideal solution, one which rids the industry of the protracted problem of dumping the sand on the plant site or at a monofill site and fulfills the Occupational and Safety Health Administration's (OSHA) specifications for limiting worker exposure. It also makes good business sense to "recycle" waste products.

The waste foundry sand is a mixture coming from different processes in the foundry. It can range in size from large coarse waste sand from broken and crushed castings and molding to much finer particulate matter accumulated and captured in baghouses, a device used for air pollution control. These various sand wastes are mixed in order to prevent the finer sand particles from becoming airborne and posing a dust problem either at the plant or the sand monofill.

In 1996, waste sand was used to in the construction of a roadway embankment in northeastern Indiana. Previous investigations of the sand had found that it was safe to use as a construction material and had no detrimental effects. However, several days after the laying and compaction of the sand, tire interaction with the compacted and now dried sand caused the generation of copious black dust clouds that coated the backs of the construction vehicles in a layer of fine black dust.

Concern expressed by the workers breathing the dust is the driving force behind this research. The workers concern in breathing the waste sand dust, knowing it is composed mainly of silica, is silicosis. Thus the aim of this research was to determine whether worker exposure is greater than the current OSHA Permissible Exposure Limit (PEL) for silica and to specify a mixture percentage of fine dust for waste sand that can be used for embankment construction.

Findings

The field experiments took place at the Auburn foundry waste sand monofil during the summer of 1998. Large black dust clouds were generated by moving the sand around on the sand monofil under dry conditions. Area sampling was done using a High Volume Andersen Cascade Impactor, a PM-10 sampler and a Total Suspended Particulate (TSP) sampler. Personal cyclone respirable samplers were worn by personnel at the site to measure worker exposure.

Overall, over 20 samples were taken from the various samplers over two days of sampling. Aerodynamic size distribution and percentage silica content among particles ranging up to 3.3 microns was found using results from the Andersen Impactor. The air sampling showed that a large fraction of the collected dust contained particles within the respirable range of 0.5 to 5.0 microns and indicated that most of the silica obtained was from quartz, with very small amounts of cristobalite and non-detectable levels

of tridymite. The PM-10 sampler measured particles equal to or less than 10 microns in diameter and cumulatively indicated quartz to be the major phase of silica present at approximately 12% by weight. Total dust concentration values obtained from the PM-10 sampler also yielded high values. The total suspended particulate (TSP) sampler measured particles equal to or less than 40 microns in diameter and was used to determine the concentration of sand dust and the silica content for this wider range of particle sizes. Results from the TSP sampler results were similar to those given by the PM-10 sampler. Comparison of the total dust concentration results from the different field samplers showed good agreement. The low percentage of cristobalite and the more dangerous tridymite was constant throughout the samplers. Quartz emerged as the main component of silica present in the dust. Data from the personal cyclone respirable samplers showed that overexposure will not occur during an 8 hour work shift using the waste foundry sand in road embankment construction. Up to an average of 20% by weight of respirable dust such as baghouse hopper dust can be contained in the waste sand and still provide a margin of safety of 2.0 with respect to the OSHA PEL.

Implementation

The recommendations reached in this research indicate that a waste foundry sand material specification would allow up to an average of 20% by weight of respirable dust in the waste sand. Standard safety precautions should be used during the road-laying, including wetting the sand before dumping and compacting, regular wetting of the compacted sand, and initial worker testing using personal respirable samplers to check for overexposure.

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