Cobalt Exposures Enhanced by Synthetic Coolants?

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The University of Washington Department of Environmental Health's Field Research and Consultation Group was asked to investigate a carbide-tip saw blade manufacturing plant after three workers evaluated at the Harbor view Occupational Medicine Clinic were diagnosed with possible hard metal lung disease resulting from occupational exposure. Hard metal lung disease is associated with the production and shaping of tungsten carbide materials. Tungsten carbide consists of tungsten and carbon with cobalt as a binder. Cobalt is the suspected causative agent in the disease. The mix of tungsten, carbon and cobalt depends upon the product's desired hardness and physical characteristics. The manufacturing process at this plant required grinding tungsten carbide material containing less than 10% cobalt. The process uses coolants to remove heat at the grinding surface and to control dust generation.

The majority of coolant falls from the grinding surface into a collection trough for circulation; however, a very small portion becomes airborne as a fine mist. It has been reported that cobalt can be dissolved or leached by the coolant in tungsten carbide grinding processes, resulting in workplace exposures to cobalt when coolant mist is generated. The workplace evaluation included air monitoring to evaluate ambient airborne tungsten and cobalt levels throughout the plant.

Table 1 Air Samples In the Plant

Operation / Location	Cobalt (mg/m3)	Tungsten (mg/m)
boring mill	<0.004	<0.02
Gumming	<0.004	<0.02
surface grinder	<0.004	<0.02
hammering	<0.004	<0.02
brazing	<0.008	<0.02
wet grinder	0.055	0.69
Table by		
wet grinder	**0.043**	**0.41**
dry grinder	0.021	0.71
PEL	0.1	5.0

Tungsten levels were less than 10% of the current Permissible Exposure Limit (PEL) of 5.0 mgjm3 set under the Washington Industrial Safety and Health Act (WISHA). Airborne cobalt levels were low in cutout; gumming, brazing and hammering work areas (below .008 mgjm3). Grinding area air levels were near or above 50% of the PEL, the level at which corrective action is recommended (Table 1). Area and personal sampling over six shifts indicate that the grinders daily exposures were consistent and not anomalous events. At this facility, field observation confirmed the effectiveness of the "wet grinding" process in suppressing airborne tungsten carbide dust. However, cobalt concentrations in the coolant were found to increase as the day's work progressed and frequently reached levels of500mg/ ml (micrograms per milliliter) coolant or greater at each grinding station.

Cobalt can appear in tungsten carbide particles or "grinding fines" suspended in the coolant as well as being dissolved and incorporated into the coolant. Separating these two forms of cobalt (suspended *from dissolved)* by filtration indicated that the majority of the cobalt found in used coolant was in the dissolved form. Further laboratory testing indicated that cobalt leaching continues as long as the grinding fines remain in the coolant. For example, increases of 5-fold (12 to 50 mg/ml) in dissolved cobalt were noted over a 60-minute interval. The concentration of cobalt dissolved in coolant further increased as more grinding fines were added addition of slightly more than 5 grams of tungsten carbide dust to 500ml of the coolant used at this plant produced 300 mg/ml concentrations of dissolved cobalt. Thus, the fraction of cobalt in solution and the overall cobalt content of used coolant will increase continually during use or during idle periods following use. These laboratory findings suggest that coolant droplets will constitute a potentially hazardous exposure if cobalt levels become sufficiently high. Was this an example or is cobalt leaching a common occurrence in carbide grinding operations? The Field Group obtained new and used coolant samples from nine local businesses that performed grinding of tungsten carbide. Cobalt concentration in used coolant samples ranged from 1 to 2100 mg/ml. There was no apparent relationship between cobalt coolant concentration and either the estimated number of tips ground or the duration of coolant use. The data indicates that uptake of cobalt into coolants is highly variable, and probably depends on specific ingredients in the coolant formulation. Currently, the chemical properties of various coolants are under investigation in order to identify chemical constituents that promote or retard leaching. It has been suggested, for example, that chemical components functioning as hard water stabilizers, corrosion inhibitors or biocides lead to substantial leaching of cobalt binder from the carbide material. In laboratory experiments, the presence of an as- yet-unidentified compound containing cobalt and an organic complexing agent has been detected.

This result may explain why one coolant dissolves cobalt from tungsten carbide dust much more readily than another coolant. The possible formation of a complexed form of cobalt in coolant solutions could also affect the toxicity of the cobalt itself. Exposure to a more biologically available or active chemical form of cobalt would be expected to be more hazardous to workers than would exposures to the equivalent amount of cobalt in carbide dust.

The goal of these efforts is to evaluate and ultimately make recommendations concerning the use of specific chemicals or coolant formulations. As an interim measure, identification of coolants that appear unlikely to concentrate dissolved cobalt will help tungsten carbide manufacturers minimize the possibility of cobalt intoxication of workers. In general, suggested industrial hygiene solutions regarding exposure to cobalt in the workplace include substitution of a less hazardous substance, engineering controls (such as local exhaust ventilation) and/or administrative controls (such as rotation of workers). In this case substitution of non-leaching coolant was the method of choice.

This article supplied by Stanley S. *Niemiec, Forest Products Department, Oregon State University, Forest Research Laboratory, Corvallis, Or 97331-5709.*

Recommendations by Mr. Niemiec:

- Isolate machinery from workers.
- Adequately ventilate machinery to an outside source.
- Provide high efficiency respirators to workers coupled with a respirator education program.
- For personal protection wear gloves while working with carbide.
- Wash hands before eating or smoking.
- Contact saw supplier to see what's available in non-leaching cobalt coolants.

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