

Study of asbestos fibre levels in and around a brake-lining industry

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In India, out of 673 small-scale and 13 large-scale asbestos-based industries, only 60% industries are in operation. The present report reveals the exposure of commercial asbestos (chrysotile) in the occupational as well as ambient air environment of the brake-lining industry using membrane filter method of Bureau of Indian Standards (BIS). The fibre concentrations in 9 samples collected in the occupational environment was 0.123-0.238 f/cc (mean 0.187 ± 0.03) and that in 6 samples from surrounding ambient air was 0.002-0.007 f/cc (mean 0.004 ± 0.00). All samples showed fibre concentration lower than the threshold limit values (TLVs) prescribed by BIS at 0.5 f/cc. Morphological analysis of samples further under phase contrast and polarized microscopy indicates the presence of chrysotile asbestos, which acts as carcinogen as well as co-carcinogen.

Keywords: Asbestos fibre, Lining industry, Morphological analysis

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Introduction

Asbestos, a fibrous mineral occurring in natural deposits, is available in serpentine and amphibole forms¹. Chrysotile is a fibrous hydrated magnesium silicate mineral $[\text{Mg}_3\text{Si}_2(\text{OH})_4]$, which is being used in about 3000 commercial products² due to its high durability and tensile strength. Exposure to asbestos fibre is now restricted in developed and industrialized countries, while it is mounting in the developing countries². Currently, manufacturing of chrysotile-based products is undertaken in more than 100 countries and production is about 27-30 million tons annually. Brake-linings, asbestos cement sheets and pipes are the major products based on chrysotile fibres, which is imported from Canada, Brazil, Japan, USA, Switzerland, Kazakhstan, Russia, and South Africa etc. Asbestos - based products are manufactured mostly in wet process. During processing, fibres, being small size and lightweight, release into the surrounding environment due to poor handling and control measures and remains suspended for long period. The emission may occur from sources other than operation such as handling and shifting of

the asbestos material, cutting or machining of end products, disposal of wastes etc. The rate of emission may depend on fibre control measures and technology³. Air pollution levels of asbestos are reported to be elevated in the surroundings of asbestos industries⁴. Occupational exposure of asbestos may cause simple inflammatory reactions to bronchogenic carcinoma, asbestosis, lung cancer and mesothelioma⁵. Various health effects in man and laboratory animals have been documented due to chrysotile environmental exposure, which causes asbestos related diseases⁶. In present investigation, an attempt has been made to monitor and assess the asbestos fibre emission sources and its release and magnitude in the occupational as well as surrounding ambient air environment, and to assess health risk burden to the workers as well as surrounding population.

Materials and Methods

Study Site

Asbestos burden in and around the industry was assessed at M/s. Sundaram Brake Linings Limited, TSK Plant-1, Madurai (Tamil Nadu), India, a medium scale industry with 2700 metric tons annual production. The raw material every month used in the manufacturing of brake - linings, clutch-facing and disc pads etc is as follows: asbestos fibre, 84; resin,

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50; friction dust and modifiers, 27; metal powders, 9; fillers, 102; and fibre glass, pigment and others, 23 tons. The locations namely (1) Compounding/Mixing, (2) Pre forming, Curing and Post Curing, and (3) Finishing (U-Line 1/2/3) were selected for occupational environment monitoring and (1) 0.4 km south-west from plant, upwind direction, (2) 0.4 km north-east from plant, downwind direction, and (3) 0.6 km north-east from plant, downwind direction were selected for ambient air environment monitoring respectively.

Manufacturing Process

Compounding, Mixing and Preforming

Raw materials (friction, bonding and filler materials) are mixed for 20-30 min in mixing machine in a requisite proportion to obtain designated chemical composition as per specifications indicated by buyer. The mix is discharged into closed buggies. Based on the product requirement, weighed quantity of mixture in closed buggies is subjected to preforming operation, wherein friction mix is pressed into required shape.

Curing and Post Curing

The preformed friction materials are subjected to requisite heat ($\sim 150^{\circ}\text{C}$) and pressure for 8-12 min in a vertical curing press to get slabs. The slabs are then subjected to post curing in an electrical oven. Curing equipment with fume extractor connected to the roof ventilator.

Finishing Operations

Post cured slabs are subjected to cutting, grinding, drilling, de-dusting and printing operations in the U-Line, which is provided with an exclusive bag dust consisting of pre-collector connected to the dust extractor provided at each operation. The slabs are cut into requisite size as per customer requirement in a slab saw/gang splitter. The cut pieces are then ground both on the inner and outer surfaces, using an inner and outer diameter grinder to obtain the required thickness and to ensure better surface finish. In order to enable fixing of these friction slabs to the brake drums, the ground pieces are drilled in a drilling machine according to product shape and type.

Packing

The finished friction linings are passed between two brushes to remove dust (de-dusting) that would have deposited during the finishing operations. As per the customer requirement, the required characters are printed on the linings along with identification code

either using pad printing or ink jet-printing machine. The products are tested for their dimensions as well as visual defects and processed for packing.

Fibre Monitoring, Sampling Devices and Methodology

Asbestos sampling was done according to the standard procedure of Bureau of Indian Standard - 11450⁷. Air monitoring for asbestos was done by using 25 mm diam ester cellulose filter (0.8-1.2 μm pore size) at constant flow rate, 1/min. Sampler Model XX5700000 and Low Volume Vacuum/ Pressure Pump Model XX 5600002 attached with filter holder (cowl) MAWP 025AC (Millipore Corporation, USA) were used for the collection of air samples. In both the cases, filter holders were kept in downward position during sampling to avoid the contamination of heavy particles on filters⁸.

Sample Transportation, Preparation and Analysis

The collected samples were stored in upward position with sealed boxes and transferred to the laboratory for further analysis as per acetone triacitin technique⁷. The mounted samples were analyzed for the presence of asbestos fibre at a magnification of 400X by using phase contrast microscope. Asbestos fibres ($>5\mu\text{m}$ length, $< 3\mu\text{m}$ diam, and length to diam ratio 3:1) were considered for counting and scanned under the phase contrast microscope (LABROX, Germany)^{7,9}.

Results and Discussion

The asbestos fibre concentrations were measured in the occupational environment (Table 1) and in the ambient air environment (Table 2) because asbestos mainly presents risk in air borne condition. Occupational exposure of asbestos fibres causes serious health effects on the population living near the sources¹⁰. The processing for manufacturing of asbestos-based products increases the air pollution levels in the areas surrounded by the asbestos-based industries^{4, 11} and health risk to the workers. In India, an estimated 100000 people are exposed to asbestos at work place¹². The people residing in the vicinity of the asbestos-based industries may be exposed to higher levels of asbestos fibre concentration³. Exposure of asbestos fibres mainly concerned to lung diseases such as asbestosis, pleural and peritoneal mesothelioma, and bronchogenic carcinomas, which are more common in the population living near to the asbestos-based industries¹³. Chrysotile is a convicted mass killer¹⁴. Exposure levels of asbestos in the air are 0.000001-0.0001 fibres/ml air and are generally

Table 1 — Concentration of asbestos fibres in the occupational environment

Sl No.	Location	Sample	Date and time h	Concentration, f/cc
1	Compounding/ mixing	A	August 9, 2002 10:05 – 11:05	0.123
		B	August 9, 2002 13:05 – 14:05	0.164
		C	August 10, 2002 17:00 – 18:00	0.189
2	Preforming, Curing and post curing	A	August 9, 2002 10:55 – 11:55	0.238
		B	August 9, 2002 12:55 – 13:55	0.181
		C	August 10, 2002 17:30 – 18:30	0.197
3	Finishing (U Line 1/2/3)	A	August 9, 2002 10:25 – 11:25	0.201
		B	August 9, 2002 13:00 – 14:00	0.222
		C	August 10, 2002 17:30 – 18:30	0.173

Table 2 — Concentration of asbestos fibres in the ambient environment

Sl No.	Location	Sample	Date and time, h	Concentration, f/cc
1	0.4 km SW from plant, upwind direction	A	August 9, 2002 13:45 – 14:45	0.002
		B	August 10, 2002 08:25 – 09:25	0.003
2	0.4 km NE from plant, downwind direction	A	August 9, 2002 13:45 – 14:45	0.006
		B	August 10, 2002 08:25 – 09:25	0.007
3	0.6 km NE from plant, downwind direction	A	August 10, 2002 15:00 – 09:00	0.006
		B	August 10, 2002 16:00 – 17:15	0.005

highest in cities and industrial areas¹⁵. The present study shows that the concentration of asbestos in the range of 0.123 to 0.238 f/cc (mean 0.187 ± 0.03) in the occupational environment and 0.002 to 0.007 f/cc (mean 0.004 ± 0.00) in the ambient air environment, is less than the proposed prescribed threshold limit (0.5 f/cc as per BIS) and more than that of International Standard (0.1 f/cc). The collected filter containing fibres, analyzed by phase contrast microscopy, were found to be of chrysotile variety (white asbestos). The low level of asbestos concentration for long-term can register bioaccumulation and bio-persistence in the environment.

Conclusions

The observations reveal that the chrysotile asbestos is emitted in the occupational as well as ambient environment during the manufacturing of asbestos-based products including brake-lining.

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