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PROGRAM TO ESTABLISH THE NATURE OF PARTICULATE EMISSIONS
FROM BRAKE LINING WEAR

Introduction

The wearing down of brake lining on vehicles can result in the emission of wear dust into the atmosphere. About 100 g of chrysotile asbestos per year are worn from the linings of the average car. This amounts to about 11,000 tons per year in the United States, concentrated in regions of high vehicle population density. The total quantity of wear debris, including the other constituents besides asbestos, may amount to $1 \frac{1}{2}$ to $1 \frac{2}{3}$ times this amount. This quantity is small relative to other particulate emissions attributable to vehicles: exhaust particulates (400,000 ton per year) and tire-tread wear (700,000 tons per year). However, since asbestos fiber has been implicated as a carcinogen, the potential hazard from brake lining wear debris could be disproportionate to its quantity. There are many questions regarding the disposition, properties, and physiological effects of brake lining wear debris about which we have little information. Some of these areas where knowledge is lacking are listed below. The object of the program outlined herein is to answer some of these questions in order to form a rational basis for judging the extent to which brake lining wear products might be considered a community health hazard.

Information Which is Lacking

1. Some of the wear products from brake lining accumulates on wheel parts and, in the case of drum brakes, some is retained within the drum. The fraction which is emitted to the atmosphere is not known.
2. Some of the emitted wear products will settle quickly and some may remain airborne. The settling characteristics and particle size distribution of emitted wear products is not known.
3. The fibrous asbestos particles in wear dust could be particularly

hazardous as a carcinogen. Although there is an indication in the literature that less than 1% of the wear dust is fibrous asbestos (the remainder of the asbestos having been decomposed to non-fibrous dust) there is some controversy on this point. Furthermore, the number of fibers, rather than the weight, may be more significant. The number of fibers per unit weight of wear products and their size distribution are not known.

4. The organic ingredient in brake lining could, upon pyrolysis at the friction interface, produce carcinogenic compounds. It is not known whether such compounds are present in wear debris, and if so, if they would promote a carcinogenic reaction in the lungs.

5. The long term physiological effect of decomposed asbestos dust is not known. The only biological study of this material found in the literature indicates that calcined asbestos has produced acute toxic effects when injected in massive doses into animals. The amount of decomposed asbestos which could be distributed to the atmosphere from brake lining wear is unlikely to be great enough to cause any such acute effect in the population. No information has been found relating to its long term carcinogenic potential.

Experimental Program

Brake lining wear debris will be collected during controlled stops on a brake dynamometer. The test cycle will be selected to correspond to moderate braking conditions, say a deceleration rate of 8 to 10 ft/sec² from 40 or 50 mi/hr. Experiments will be done with both disc brakes and drum brakes with the wheel in place and with realistic air flow over the brake. This test may be combined with other dynamometer tests of brake lining performance. Measurements will be made of brake lining weight loss due to wear, and the following samples will be collected during multiple dynamometer stops:

1. Total wear debris collected on the wheel and in the drum will be measured for a determination of the fraction emitted to the air.

2. Dynamometer will be used to collect some of the dust which settles within a short distance of the source on clean sheets of paper to get some idea of the portion of the emitted dust which settles quickly. The quantity of dust collected in this sample is expected to be very small, and perhaps not measurable, since a total of only a gram or two of wear dust will be generated per day of testing.

3. Samples of airborne dust will be collected on a 0.2 micron membrane filter at the perimeter of the field over which settled samples are obtained. The air samples will be located at a position indicated by a light beam to have a high concentration of dust and at a distance from the brake such that the air velocity has diminished somewhat. Preliminary experiments will be necessary to develop effective and meaningful sampling techniques and to determine how much sample can be collected per stop. It is possible that several days of dynamometer testing will be required to collect sufficient sample.

The samples collected on the membrane filter and the settled samples will be examined by electron microscope to determine the particle size distribution and the number of fibers per unit weight of each fraction.

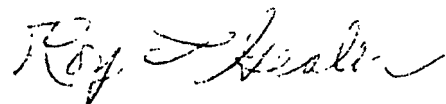
An attempt will be made to analyze extracts of wear dust for carcinogenic organic compounds, such as benz(a)pyrene. The quantities of sample are expected to be small, so that this measurement may not be practical. The most likely source of sample for this analysis will probably be the material collected on the wheel parts, since only a small fraction of the air-emitted dust will be collected. Liquid-solid or liquid-liquid chromatography will be employed for the analysis.

To ensure that the measured fraction of worn lining which is emitted to the atmosphere is realistic, measurements could be made of the amount of brake lining wear debris accumulated on the wheels and in the drums of vehicles brought in to dealers for their first brake relining, and the amounts collected compared to the amount of lining worn away. This will be done only if the results of

the laboratory measurements indicate that this refinement is warranted.

The program outlined above is expected to give some indication of the possible community hazard from wear dust. If the physical and chemical tests suggest that such a hazard might exist a program may be considered to collect enough sample for biological studies. The kind of animal test and the laboratory to do it would be established by consultation with an expert in the field, e.g., I. J. Selikoff of Mt. Sinai Hospital in New York.

The execution of the proposed experiments will require a cooperative effort among the Chemical Engineering Department; the Mechanical Research Department, for the brake dynamometer set-up and for sampling assistance; the Technical Services Department, for particle analysis and analysis for organic carcinogens; and the Chemistry Department, for assistance in establishing sampling techniques. It is expected that no more than about 2 man-months of effort will be required to complete the described sample collection and physical and chemical analyses of wear dust.



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