

OBSERVATIONS OF LINING WEAR

The near absence of free asbestos fiber from lining wear has been reported by Luxon (5) using x-ray diffraction and by Lynch (4) using the TEM. Several authors have suggested that interfacial temperatures during braking could be high enough to decompose the chrysotile asbestos into nonfibrous thermal degradation products. Analytical relationships exist which permit calculation of interfacial temperatures (6). However, several of the significant parameters are difficult to determine accurately for heterogeneous materials such as brake linings. The asbestos crudes (larger fiber bundles) were calculated to reach their rapid decomposition temperature during normal braking at speeds above 56 mph (25 m/s) as an upper bound value and above 18 mph (8 m/s) as a lower bound value. An experimental approach was undertaken to provide closer bounds.

Added insight into the thermal decomposition of asbestos fibers in brake lining wear was attempted by direct visualization of the frictional process. A small laboratory friction test machine was constructed using a thermal shock resistant (Vycor) glass rubbing surface (replacing the conventional cast iron) in which the friction interface was directly viewed with a low power (7-50X) binocular microscope (7). Scaled rubbing velocities were used to compensate for the thermophysical property differences between the glass and cast iron.

Moderate scaled velocities, roughly equivalent to 12 mph (5 m/s), provided a view of intermittently incandescent asbestos crudes. During the initial burnishing operation, resinous material surrounding these asbestos crudes was observed to pyrolyze, producing microbeads of condensation products around the crude. These organic products of resin degradation and the apparently powdered asbestos decomposition products were seen to smear into platelets, often of such size as to be discernible to the unaided eye.

At higher rubbing velocities (over 30 mph, or 13 m/s) the platelets formed a surface char layer under the action of more severe thermal and mechanical action. The larger asbestos crudes then could be seen to glow with apparent depth and for greater time durations, often several seconds.

The actual brake lining contact area was only a few percent

of the total available surface, with contact spots moving in a random manner with time. From these friction visualization studies it appeared that local flash temperatures and severe mechanical action could be major factors in the breakdown of asbestos fibers for most brake usage. Examination of the lining surfaces revealed the presence of nonfibrous magnesium silicate in both crystalline (Forsterite) and amorphous phases. Magnesium silicate is a thermal degradation product of chrysotile asbestos. Forsterite transformations have been reported to occur at 600°C over a period of hours. Differential thermal analysis (DTA) studies in our laboratory indicated this transformation occurs within seconds at 820°C.

Special brake lining formulations were then prepared and tested on the glass visualization apparatus and a Friction Assessment and Screening Test (FAST) machine. (8). Chemical reactions were found to take place at the friction interface, which would require a flash temperature rise of 740°C to initiate when an equivalent of 35 mph (16 m/s) rubbing speed was used on the FAST machine. At this same speed, melting of inorganic lining additives and metal particles confirmed brake flash temperatures up to 980°C.

Based on these findings, it would not appear surprising for few asbestos fibers to be emitted from brakes in normal usage. However, some mechanical removal of fiber appeared possible during the first several brake applications with new linings. Also, high brake temperatures possibly could weaken the organic binders and cause increased fiber emissions.

TEST PROCEDURES

Complete sample collection and examination procedures, along with sample data calculations are included as Appendixes A-D. Briefly, the tests were performed as follows: a new Pinto disc brake assembly was installed on a single station brake dynamometer in a room which was cleaned of extraneous asbestos sources. Air from within the room was blown through a diffuser screen to provide a velocity distribution over the brake which approximated that of vehicle usage. The air stream in front of and behind the brake was sampled isokinetically, using matched 0.45 μ m filters, holders, and air pumps. The system schematic is shown in Fig. 1 and the ac-

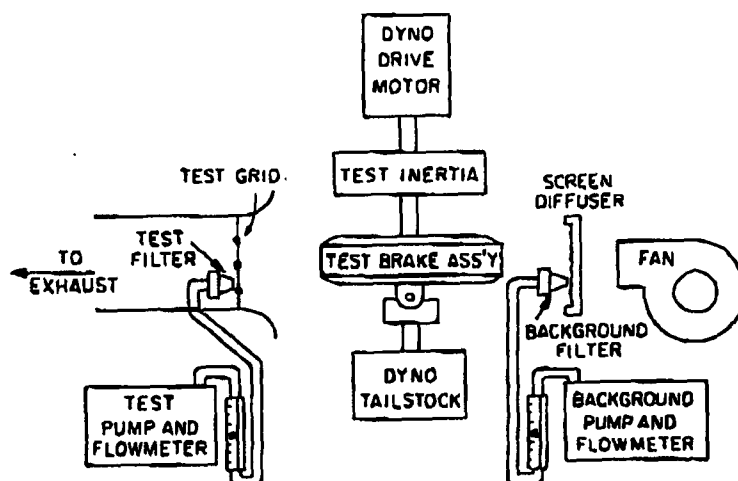


Fig. 1 - Dynamometer test schematic