FILE NAME: Allied Signal Bendix (ASB)

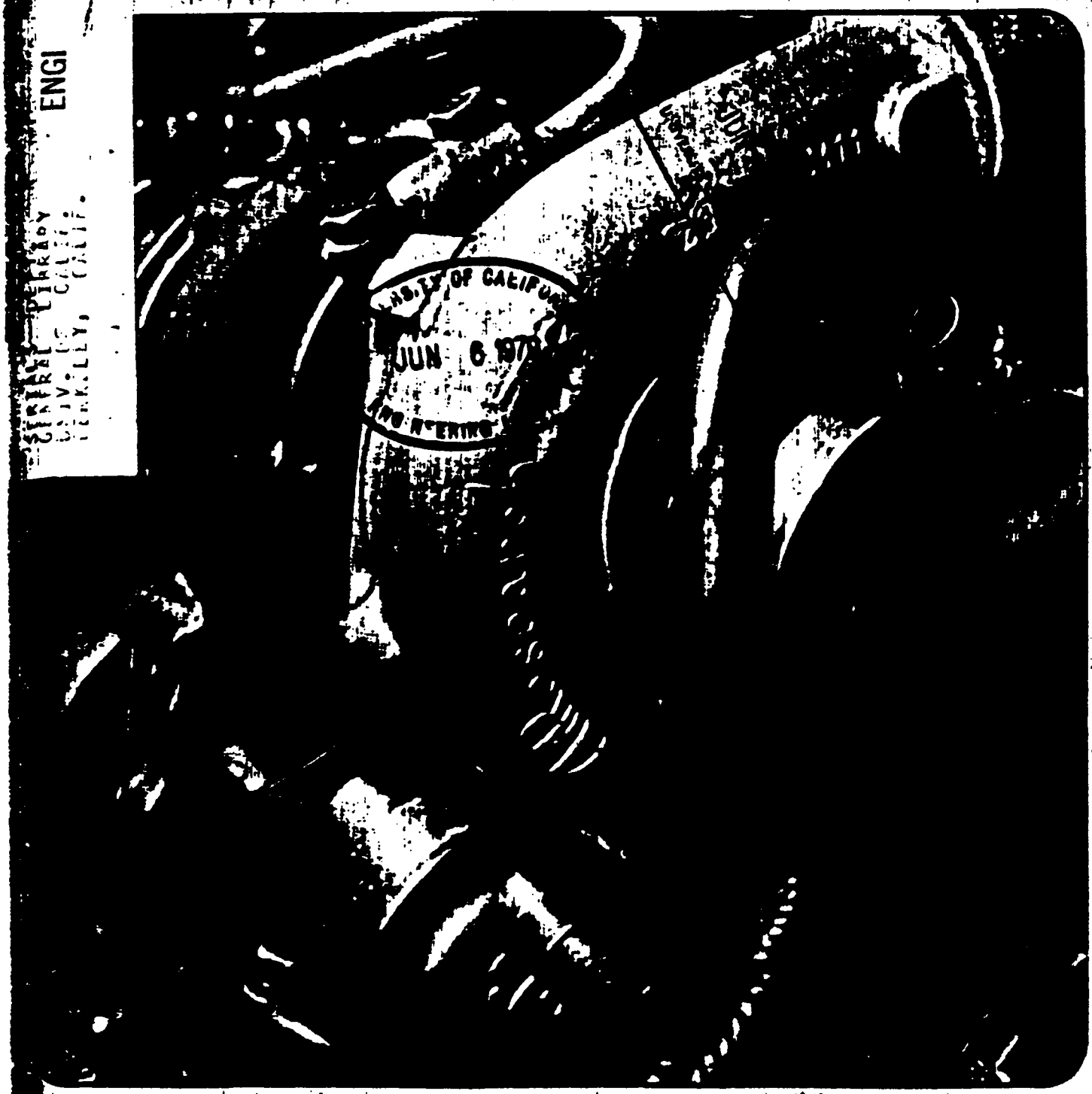
DATE: 1979 June

DOC#: ASB207

DOCUMENT DESCRIPTION: Journal Article - Automotive Engineering

automotive engineering

JUNE 1979



Future Turbochargers • Aer namics • Airbag Gas Generants

Designers can affect frictional coefficients of brake and clutch linings by blending ingredients in their binders.

Friction modifiers tailor brake a

New requirements for friction lining materials exist because of the elimination of asbestos in brake and clutch compositions and the use of small pads for downsized and compact cars. Semimetallic compositions generally need some friction modifiers to reduce squeal and wear and produce friction characteristics that are less temperature-dependent. Research on solid friction control additivies at Dow Corning has produced new technology by which friction and wear properties can be tailored to specific requirements.

Friction modifiers

Friction modifier additives are synergistic blends of temperature-stable materials which can be incorporated into various compositions to provide specific friction, wear, and load-carrying properties. Concentrations of one to six weight percent can reduce noise levels and dependence of friction on speed and temperature.

Additives, such as cashew resin or graphite, have been used for many years to control friction properties in brake and clutch compositions. Friction composites are composed of a balanced mixture of resin plus additives and generally contain over a dozen ingredients to achieve desired characteristics. In Europe MoS_2 (molybdenum disulfide) has been utilized as a friction modifier for harder brake pad compositions. Comparisons were made between MoS_2 and a composition termed by Dow Corning "Friction Modifier A".

Phenolic resin compositions

Phenolic resins are the most common organic binders used in friction composites. Compositions of phenolics with high loading of MoS_2 powder and Friction Modifier "A" were tested using an Alpha LFW-1 friction and wear testing machine.

Phenolic resin by itself does not have the best lubricating properties. Addition of MoS_2 or Friction Modififer "A" provided a reduction in wear and friction. Generally, the phenolic resin with Friction Modifier "A" gave lower initial coefficients of friction and wear values as compared to an equivalent weight concentration of MoS_2. Coefficient of friction for the Friction Modifier "A" formulation changed less with time than the base resin or MoS_2 composition.

Additional tests at a lower load of 13.6 kg and higher speeds revealed that formulations with Friction Modifier "A" gave a more constant coefficient of friction with changes in speed, load, and time. At higher speeds and lower loads, no difference in wear was apparent between MoS_2 and Friction Modifier "A", but wear was significantly lower than the base resin.

Compositions

Three different brake compositions were categorized as follows:

- *Class A*—High in asbestos and organic components
- *Class B*—Less asbestos and organic components plus some inorganic components
- *Class C*—Semi-metallic nonasbestos composite
- *Class C prototype*—Semi-metallic nonasbestos composite with 10% Friction Modifier "A".

Table 1 lists the different characteristics of the three classes. The brake compositions were tested on the LFW-1 test machine.

The results of the testing are listed in Table 2. Good correlation between the LFW-1 tests and the general characteristics provided for each of the classes was obtained. Complete correlation existed for the wear of the brake composite and the metal mate, and very close correlation existed with noise and friction properties at low and high temperatures.

Class C, which produced the

and clutch characteristics

Table 1 — General Properties of Brake Linings

Characteristic	High Organic Class A	Medium Organic Class B	Low Organic No Asbestos Class C
Fade	Poor	Good	Excellent
Wear	Excellent	Good	Fair
Friction: Cold	Highest	Lower	High + Stab.
Hot	Lowest	Higher	High + Stab.
Noise	None	Little	Lots
Compressibility	Lots	Some	Little
Metal Mate	No scoring	Some scoring	Lots of scoring
Duty For Use	Standard	Medium heavy	Heavy

Table 2 — LFW-1 Results at 27.3 kg Load at Variable Speeds (Step Change)

Characteristic	Class A	Class B	Class C	Class C + 10% Friction Modifier "A"
Wear (General Rating)	Excellent	Good	Fair	———
LFW-1 on blocks, mg	189	351	587	490
Friction-Cold (General Rating)	Highest	Lower	High and Stable	———
LFW-1, μ(T °C) at 2000 rpm	0.38 (49)	0.22 (38)	0.46-0.39 (55)	0.27-0.30 (55)
Hot (General Rating)	Lowest	Higher	High and Stable	———
LFW-1, μ(T °C)				
@ 1200 rpm	0.30 (107)	0.28 (82)	0.38 (143)	0.35 (150)
@ 1000 rpm	0.33 (115)	0.38 (232)	———	
Noise (General Rating)	None	Little	Lots	———
LFW-1	Very slight at one speed	None	Some at several speeds	None
Metal Mate (General Rating)	No scoring	Some scoring	Medium-heavy scoring	———
LFW-1 Test ring, mg loss	13	236	634	270

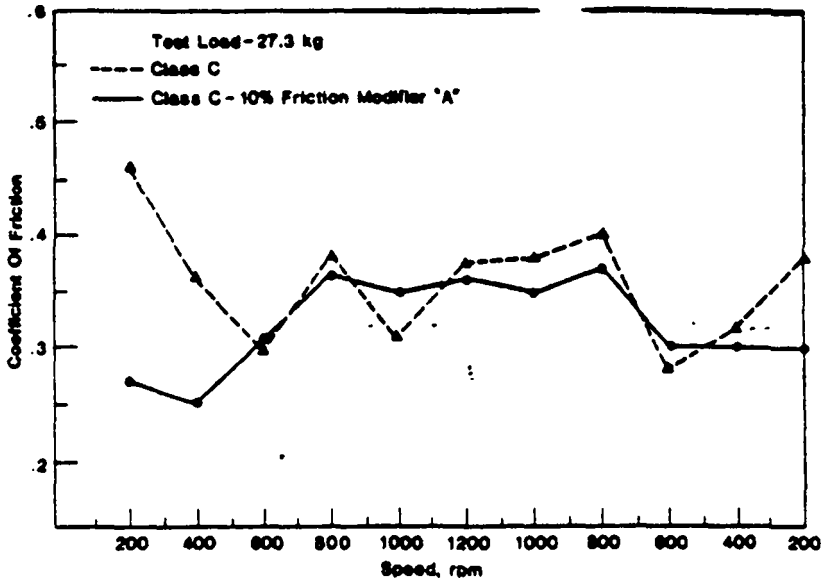


Fig. 1—LFW-1 Coefficient of friction vs. speed.

most noise, also gave the most stable frictional properties with speed and temperature as shown in Fig. 1. More consistent coefficient of friction properties were obtained from the Class C prototype between 600 and 1200 rpm. Class C prototype produced less noise than the standard Class C brake pad. The difference between the maximum and minimum coefficient of friction was less with the prototype containing Friction Modifier "A" than standard Class C material.

Desirable characteristics of Class B (lower wear, less noise, and a more constant coefficient of friction) may be achieved through use of the 10% Friction Modifier "A" composition. It must be noted that this percentage should not be considered as the amount necessary for other compositions.

Commercial applications

New technology for these new friction modifiers was first developed in Dow Corning's Munich Research and Development Laboratory. The first commercial evaluation and successes were in European brake pads.

Friction Modifier "A" has been used in the brake pads of a large European car for several years. The performance of the brake pad with the new friction modifier was compared with another composition containing MoS_2. Comparisons made on a dynamometer showed the following advantages over the MoS_2 composition:

- lower noise level
- less dependence of friction coefficient on temperature
- decreased wear of the brake pad (30% increase in lifetime)
- decreased wear of the metal disc.

Since the initial usage in Europe, other European brake and clutch material manufacturers have evaluated these new friction modifiers. They have generally found them equal or superior to MoS_2, but they do not always provide the same characteristics since different materials are used in each formulation.

In the U.S.A. a number of brake and clutch friction material manufacturers have already evaluated the friction modifiers. Some have found that in semi-metallic brake pads without asbestos, these new additives can reduce noise, wear, and fade. In some cases, no improvement was found. ▲

Based on SAE paper 790717, "Controlled Friction Additives for Brake Pads and Clutches," by **Harry M. Schiefer** and **George V. Kubczak**, Dow Corning Corp.