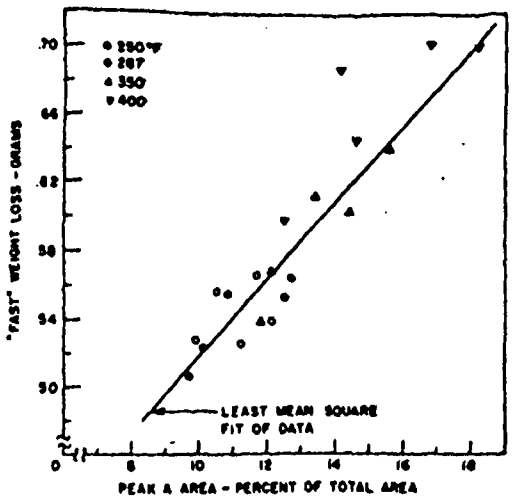

Fig. 11 - Correlation between area of Peak A and FAST weight loss

The first 20 minutes of the test results are shown in Fig. 10 for all the cure conditions studied. These curves are arranged in order of the sample's "index of cure," as defined in the preceding section. A systematic change in shape with increasing index of cure is readily apparent. The amount of change between cure conditions from the steplike shape of the 250 F cure sample friction traces to the sloping shape of the 400 F cure sample friction traces is qualitatively consistent with the values of the index of cure noted on each curve.

CURE AGENT CONCENTRATION EFFECTS - Friction and wear variations due to varying the cure agent concentration in the material were small compared to the effects of cure time and temperature.

In general, those samples cured at 250, 300, or 350 F had slightly decreased wear with excess hexa (20%) when compared with the low hexa samples (10%). At the 400 F cure, the increased hexa had a slightly detrimental effect, and the wear rate was greater than for the low hexa samples. The 15% hexa level wear results generally fell between the 10% and 20% results and were qualitatively consistent with the results of the first group of samples.

The friction differences between the low and high hexa samples were greatest for the low temperature cures where the high hexa (20%) samples had slightly lower friction than the low hexa samples. This effect occurred for about the first 30 minutes of the test, after which there were no effects clearly attributable to hexa level.

These friction and wear results are consistent with known vehicle performance: that is, the cure effects upon friction rapidly diminish with use, while the effects on wear affect the lining for a much longer time.

INTERRELATIONSHIP BETWEEN FAST AND PGC

As previously shown, both the FAST friction and wear data and the PGC peak A area show systematic changes with increasing degree of cure. To demonstrate the relationship between the chemical cure variations as detected by PGC and the functional variations in the form of FAST results, the area of peak A is shown in Fig. 11 plotted against FAST total sample weight loss. The solid line represents the linear fit to the data which provides a correlation coefficient of 0.93. The mean error from the linear fit is 3.23%, with the maximum deviation of 10% occurring for the 4 hr 400 F cure.

These results illustrate that chemical changes detectable by PGC are functionally significant, at least, in the system investigated in this study. For this resin system, variations in the curing conditions produced a corresponding variation in the FAST wear. That is, increasing the cure results in an increase of both the phenol peak area and wear. This provides important support for the use of these two methods for both quality assurance and laboratory testing.

SUMMARY AND CONCLUSIONS

An oil-modified, phenolic resin-asbestos system was used to study the chemical and functional responses to variations in cure conditions. Five cure times at each of four cure temperatures were investigated using pyrolytic gas chromatography (PGC) and the friction assessment screening test (FAST).

The PGC results show a systematic variation with changes in cure time and temperature.

The FAST friction and wear results show a systematic variation with cure time and temperature consistent with the PGC response.

For this resin system, a linear relationship exists between the area of the phenol peak, as determined by PGC, and the wear determined by the FAST procedure.

A chemical kinetic model is postulated which relates the concentration of phenol produced on pyrolysis to a function of cure time and temperature. The model accurately fits the actual phenol concentration as determined by PGC.

An index of cure is defined which reduces the curing conditions to a single parameter consistent with the functional test.

Variations in cure agent concentration influence the PGC and FAST responses, but in a more complex manner than the cure time and temperature variations studied.

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