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THERMOANALYTICAL INVESTIGATIONS OF TECHNICAL PRODUCTS IN THE AUTOMOBILE INDUSTRY

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ABSTRACT

Thermoanalytical techniques are becoming more and more widely used in the car industry. The sample preparation is usually simple and the measuring and evaluation times normally short. Compared with other methods one measurement provides a great deal of information. All these reasons guarantee Thermal Analysis a large industrial application in the future. Using typical examples of applications in the motor-car industry, the efficiency and versatility of TA-techniques is discussed.

INTRODUCTION

In the car industry TA is applied both in production and research laboratories. In both cases the operator commonly faces these typical difficulties: -

- samples are usually not pure single component materials.
- their composition is not constant but within set limits.
- essential components are often only present in low concentrations.

Thermal Analysis can be successfully applied in the following areas: Quality control, safety, error location, optimizing processes, quality statistics and in research and development generally.

Measurements must often be made with high sensitivity and reproducibility under non-ideal operating conditions and under time pressure. Here the main advantages offered by Thermal Analysis are: -

- easy and quick sample preparation
- short measuring times
- automatic test run
- simple evaluation

In many cases where the precise chemical make-up or reaction mechanism is not totally understood, useful results can also be obtained.

When a car runs, high temperatures, high temperature gradients and frequent quick temperature changes occur. Therefore, measurements must be made over a continuous temperature range.

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EXPERIMENTAL RESULTS

DSC measurement on lubricating oil

Lubricating oils are used in all engines and gearboxes, so studies of the ageing processes are made to give a quality prognosis. Four samples of the same oil, after covering different distances were measured by DSC under static oxygen. Increased mileage results in decreased oxidation resistance, as shown by the lower extrapolated onset temperatures.

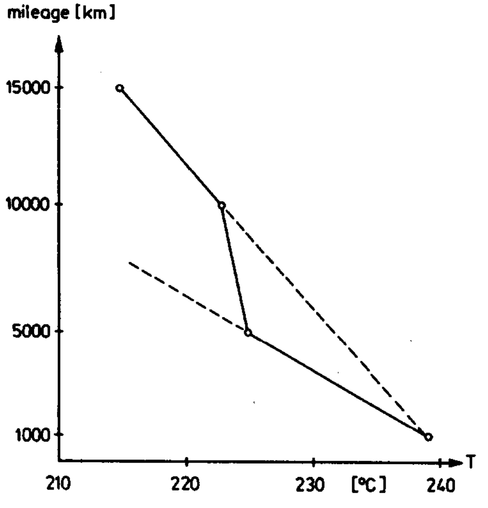

Fig. 1. Correlation between the onset temperatures of the first DSC peak, and the mileage of the motor oils

The sharp step in the curve of km versus onset temperature may be due to a quality decrease in the oil after a certain number of kilometers. Further work may provide a correlation between onset temperature and oil quality.

Fault diagnosis for rubber gaskets

A shipment of sealing rings showed inadequate resistance to cold. Curve II below shows the glass transition between -22,6 and -12,3°C. A replacement shipment of new material is considerably improved, a reduction in elasticity here occurs at T < -35°C.

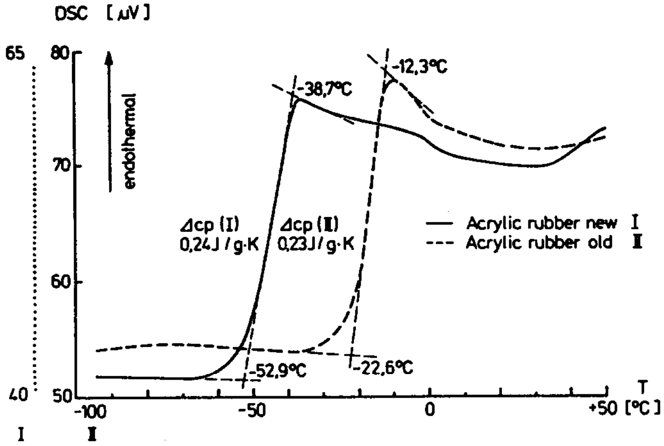

Fig. 2. Cold resistance of rubber gaskets

Quality control of brake hoses

Brake hoses from the same producer, but from different shipments, were measured with an STA 409. The hoses have three layers: rubber - fabric - rubber. The outer rubber layer is of chlorinated natural rubber (polychloroprene $-CH_2-\underset{H}{C}=\underset{Cl}{C}-CH_2-$, neoprene), the portion measured.

These samples were heated in dynamic nitrogen atmosphere until constant weight, first plasticisers are released, then the polymer decomposes. An oxygen atmosphere is then introduced, non-volatile oxidisable components burn, e.g. carbon black.

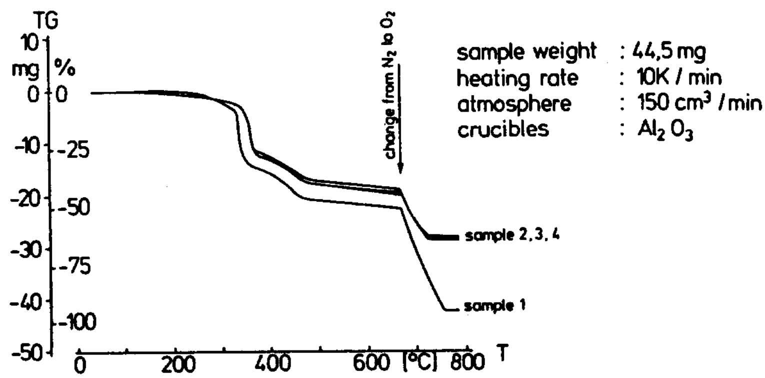

Fig. 3. Comparison of TG curves for four brake hose samples

A clear difference can be seen between sample 1 and the others due to different plasticiser and carbon contents.

Degree of vulcanisation using DMTA

With DMTA the sample is clamped at both ends and deformed via a vibrator with constant amplitude and frequency. From the required power and the known geometry of the sample the dynamic Young's Modulus E' is calculated; from the phase shift, damping (Tan δ) is calculated. This technique detects all motional transitions and usually provides a most sensitive means of studying glass and secondary transitions, and of quantitatively determining the effects of phase type and morphology on properties.

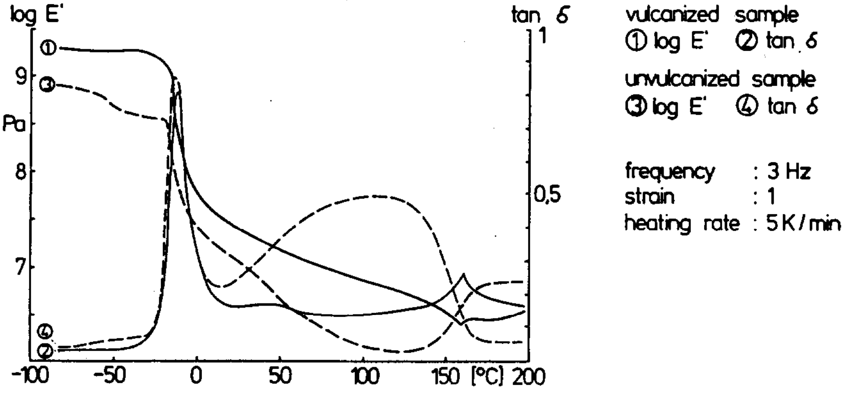

Fig. 4. Comparison of vulcanized and unvulcanized rubber samples

Fig. 4 shows very clearly the different levels of vulcanisation in good and bad samples of rubber from rubber - metal bonded components used in car suspension units.

CONCLUSION

These few, but very varied examples demonstrate the wide and exciting scope for TA in the car industry. Continued development, particularly wider use of computers for easier operation and evaluation of data ensure that TA will grow rapidly in this area.

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