Thermochimica Acta, 93 (1985) 725-727
Elsevier Science Publishers B.V., Amsterdam

THEMOGRAVIMETRIC METHOD FOR QUANTITATIVE QUALIFICATION OF MOTOR OILS

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ABSTRACT

The application of thermogravimetric curves and their new evaluation method for the quantitative qualification of motor oils are shown. The E^* vs. $(1-x)$ or E^* vs. $1/T$ functions give new informations about the quality of motor oils, their aging and the effects of additives.

INTRODUCTION

Though many kind of possibilities were examined, it can be concluded from the sharp discussions that the kinetic characterization of processes and substances cannot be considered as a solved problem even in the case of chemically homogeneous and simple compounds as $Mg(OH)_2$ or $CaCO_3$. The formal kinetic description in its classical sense is totally hopeless now in the case of overlapping decomposition processes and especially if the chemical composition of the sample is complicated. The dependence of the results of thermoanalytical measurements on the measuring conditions increases the difficulties of the kinetic description. Partly the complex composition partly the problems of the evaluation are the reason why the thermal analysis is a neglected area of the examination of motor oils.

RESULTS AND DISCUSSION

Considering the many-sided experiences gathered in thermoanalysis and in the motor oil examinations, we introduced the following relation for the qualification of motor oils /1,2/:

$$E^* = E_1/R = T_1 \ln (1-x)_1 - \ln (-dx/dT)_1$$

where T_1 is the temperature in K
$(1-x)_1$ the reaction coordinate calculated from the TG curve
$(-dx/dT)_1$ the rate of the weight change

For the qualification of the different motor oils and of the effects during the aging of oils, the differences in the E^* vs. $(1-x)$ or the E^* vs. $1/T$ functions are used and suggested.

As an example of the applicability of the method, we made comparison between the thermal stability of two commercial motor oils. The measurements were made by Paulik-Paulik-Erdey type derivatograph /3/, using 200 mg initial sample weight, 5 K/min heating rate and 30 dm^3/h nitrogen flow. In a series of measurements standard fine and course street dust (AC dust) /4/, as well as SiO_2 with different particle size were added to the oil samples. Table 1 contains the results of measurements as the average ΔE^* absolute difference calculated from the E^* vs. $(1-x)$ functions relating to the measurement using Pt crucible

Proceedings of ICTA 85, Bratislava

without any dust or powder. Table 2 shows the differences for the same measurements calculated from the E^* vs. 1/T functions.

Table 1: Effect of the measuring conditions on ΔE^* results

Measuring Conditions	Type of Commercial Motor Oils	
	A	B
AC fine dust	308.0	105.7
AC coarse dust	64.9	137.5
SiO_2 3 µm	209.4	67.3
SiO_2 25 – 50 µm	480.5	51.7

Table 2: Extent of rotation and displacement to achieve overlapping the E vs. 1/T functions under various conditions

Symbol of samples and measurement	Degree (360 °C)	ΔE^*	°C
A a:b	0	-300	+26
a:c	-22	+900	-23.5
b:c	-18	+950	-152.5
B a:b	-4	0	0
a:c	-4	0	+5.1
b:c	0	0	+5.7

a; with Pt crucible
b; with ceramic crucible with AC coarse dust
c; with ceramic crucible with AC fine dust

It can be stated that using the above presented evaluation method and altering expediently the thermogravimetric measuring conditions, the thermal stability and the sensitivity of motor oils can be quantitatively defected and from this aspect the less sensitive oil has to be qualified as the better one.

Both the E^* vs. (1-x) function and the E^* vs. 1/T function indicate the same oil as less sensitive from the respect of thermal stability.

Beside the qualification of motor oils, this method can be extended towards the rapic and unexpensive study of the additive effectiveness even with 1 % concentration of the additive (Fig. 1). The great sensitivity of thermogravimetric data onto the measuring conditions does not conceal the physical and chemical differences originating from the hydrocarbon group composition and it helps to bring to light the complex interactions of oils and motors during the run.

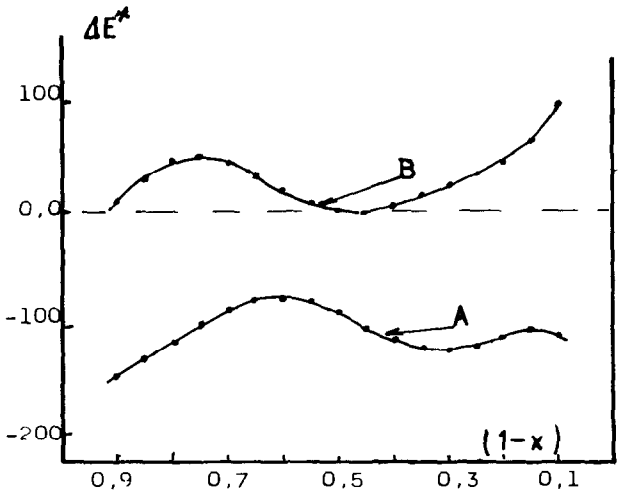

Fig. 1: 1 % more additive into A and B commercial motor oils

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