Thermochimica Acta, 93 (1985) 225-228
Elsevier Science Publishers B.V., Amsterdam

THERMOANALYTICAL INVESTIGATION OF SILICON RUBBER SYSTEMS II. DEGRADATION KINETIC OF ELASTOSIL E 4

G.Liptay, J.Nagy, A.Borbély-Kuszmann, Technical University
Budapest, Hungary
J.Ch. Weis, Wacker-Chemie GmbH
Munich, GFR

ABSTRACT

We intended to establish the factors playing role at the thermodegradation process of silicon rubber. The effect of the different components was observed by the isotherm-thermogravimetric analysis. Our experimental results were supported also by mathematical analysis.

INTRODUCTION

The heat resistance is a very important factor at the technical application of silicon rubber [1]. The isotherm-thermogravimetric analysis is an outstanding method qualifying this feature of silicon elastomers. The characteristic thermostability or instability of the products are resulted by the same properties of the components forming the silicon rubber (caoutchuc type, filler quality, quenching agent e.t.) and by the technology of the production. In our work we intended to analyse the thermostability on the basis of this property of the different components.

MEASURING METHODS

Silicon elastomer (Type Elastosil E 4 produced by Wacker Chemie GmbH) its different components and systems mixing up from the two or three former ones were investigated by the method of isotherm-thermogravimetric analysis.

Investigated products:

1. Silicon polymer: FD 80(Wacker Chemie GmbH)
2. Plasticizer: "Weichmacher 100" (Wacker Chemie GmbH)
3. Filler: HDK V 15 (Wacker Chemie GmbH)
4. Filler: R 972 (Wacker Chemie GmbH)
5. System A: Silicon polymer FD 80 and filler HDK V 15
6. System B: Silicon polymer FD 80 and filler R 972
7. System C: Silicon polymer FD 80, filler HDK V 15 and plasti-

---

Proceedings of ICTA 85, Bratislava

cizer Weichmacher 100

8. System D: Silicon polymer FD 80, filler R 972 and platicizer Weichmacher 100.

All the patterns were examined by a reconstructed analytical balance at 160, 180, 200, 220 °C temperatures. The investigation run always lasted for 24 hours.

RESULTS AND DISCUSSION

The experimental data of the weight loss (values in weight percentage) were plotted against time (time values in hour). The isothermal degradation curves seemed to consist of two elementary parts. The first part is characteristic for the evaporation of volatile products, the second one represents the thermodegradation process. The evaporation and the thermodegradation, respectively, were possible to characterize according to the theory of reaction kinetic as a process of first order [2]. We calculated the reaction rate constant for the two part processes (k_e, k_d) in the cases of the all distinct components and of the systems A, B, C, D respectively. The activation enthalpy and enthropy were got from the Eyring equation. The "half-life time" values ($t_{1/2}$) were determined too.

Table 1.

k (hour^{-1})	160 °C		180 °C		200 °C		220 °C	
t (hour)	k	$t_{1/2}$	k	$t_{1/2}$	k	$t_{1/2}$	k	$t_{1/2}$
FD 80								
k_e	0.41	1.70	0.41	1.70	0.36	1.87	0.16	12.5
k_d	$3.0.10^{-4}$	2310	$3.5.10^{-4}$	1980	$4.0.10^{-4}$	1732	$4.6.10^{-1}$	1507
Li 100								
k_e	0.60	1.16	0.55	1.26	0.50	1.40	0.40	1.73
k_d	$3.0.10^{-4}$	2310	$5.0.10^{-4}$	1386	$1.6.10^{-3}$	433	$2.8.10^{-3}$	243

The data of Table 1 represent similar trends of change in the case of both components. Our isotherm-thermogravimetric measurements proved that the weight loss of the fillers (V 15 and R-972, respectively) was negligible.

The constants (ΔH^+, ΔS^+ and ΔG^+) of Eyring equation were calculated by the least square method from the data of Table 1. The appropriate values were listed in Table 2.

Table 2.

	ΔH^{+} kJmol^{-1}	ΔS^{+} Jmol^{-1}K^{-1}	ΔG^{+} kJmol^{-1}
FD 80	12.3	-268.7	139.4
M 100	69.6	-153.6	142.3

The small activation enthalpy of FD 80 silicon polymer was in connection with the building of a cyclic complex intermedier by hydrogen bridges. It was proved by the great negative value of activation enthropy. The M 100 plasticizer had a chemical structure of other type and in this case was only a slight possibility to occur such an intermedier product during the thermodegradation. This supposition was proved also by the activation enthropy value. For systems C and D we established that the all-over weight loss was higher value than in the case of FD 80.

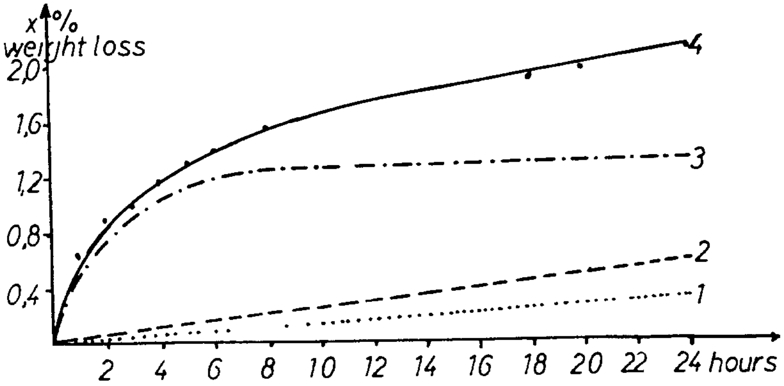

Fig 1

The rate of the evaporation and of the thermodegradation, respectively increased according to the simple addition rule (Fig.1). It was proved also by mathematical analysis, that the all-over weight loss (curve 4) was to be obtained from the evaporation weight loss (curve 1,2) and from the thermodegradation weight loss of the two components (curve 3). The measured values corresponded to the values obtained by mathematical analysis (curve 4).

REFERENCES

1 G. Liptay, L. Ligethy, J. Nagy, Thermal Analysis, Proc. 6th Int. Conference on Thermal Analysis, Birkhauser Verlag, Basel-Boston-Stuttgart, 1980. Vol. I. pp 477-482
2 G. Liptay, J. Nagy, J.Ch. Weis, A. Borbély-Kuszmann, Thermochimica Acta 1985. in press