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SELF-HEATING OF VEGETABLE OIL, DETERMINED WITH A Q 1500 D DERIVATOGRAPH

L. Beda and *K. Mórotz-Cecei*

FIRE PROTECTION DEPARTMENT, YBL MIKLÓS POLYTECHNIC BUDAPEST 70, PF. 117, 1442, HUNGARY

The self-heating of rape-seed oil was studied. The starting point of self-heating was determined from the DTA curves relating to different ambient temperatures. The asymptote was found at about 72°C.

It is well known that self-heating can start in vegetable oils under certain circumstances. Self-heating is the process of an increase in temperature of a material without the acquisition of heat from its surroundings [1]. The fundamental factors of self-heating are:

1. A spontaneous exothermic process.

2. The rate of heat generation per heat dissipation is more than 1. This means a large specific surface area.

In the case of vegetable oils, the spontaneous exothermic process involves two stages. The first stage is oxygen adsorption. The second stage is a chemical reaction, the oxidation of unsaturated bonds. The iodine value is a measure of unsaturation, and it has been observed that there is some correlation between the iodine value and the susceptibility to self-heating. Since there is no quantitative measure of the latter property, the relationship is only approximate [2].

The self-heating of a system does not necessarily result from the spontaneous exothermic process itself. It is indispensable for a temperature increase that the heat must be generated more rapidly than it is transferred to the surroundings.

This phenomenon takes place when the oxidation surface is much larger than the heat-transferring surface. Such circumstances arise, for example when fibrous or porous materials are impregnated with oil. Thus, a small amount of perlite impregnated with rape-seed oil ignites due to self-heating. We therefore studied the self-heating process and its features.

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The iodine value [3] was found to be 136. This value indicates a high susceptibility to self-heating.

Two types of specimens were tested, liquid rape-seed oil, and the same oil on perlite.

A study was made of the influence of the ambient temperature on the self-heating process. Other factors were held constant.

The experiments were carried out with a Q 1500 D Derivatograph in static air. The sample size was 500.0 mg in each experiment.

Preliminary experiments were performed in order to determine the lowest temperature at which self-heating occurs within a reasonable period of time. Therefore, the sample was heated at a low heating rate of 0.6 deg/min.

The behaviour of the samples differed. The DTA curve of the oil alone showed no peaks. However, in the case of oil on perlite, an exothermic DTA peak appeared at 75°. Consequently, the following measurements were performed at constant ambient temperatures of 80, 90, 100, 125 and 150° while the TG, DTG and DTA curves were recorded. During the measuring period, no changes were observed in the TG and DTG curves, but exothermic DTA peaks were found (Fig. 1). The peaks varied with the ambient temperature. The starting-point of self-heating (t_o) was determined from the DTA curves relating to the different ambient temperatures (T_o).

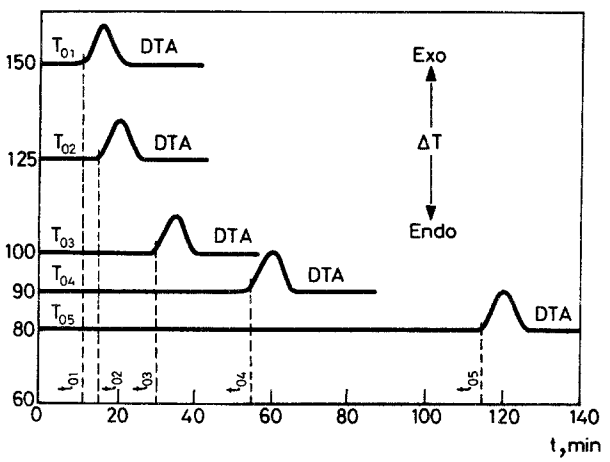

Fig. 1 Isothermic DTA peaks shift depending on temperature

The higher T_o, the shorter the period up to the appearance of peaks. The correlation between the starting-point of self-heating and T_o [Fig. 2] was approximately fitted by equation

$$t_o = \frac{1}{1.16 \cdot 10^{-3} T_o - 8.37 \cdot 10^{-2}}$$

where t_o = starting-point of self-heating [min], T_o = constant ambient temperature [°].

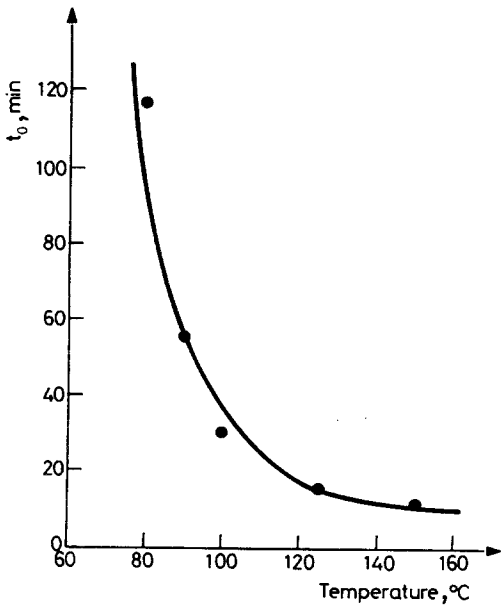

Fig. 2 Starting point of self heating *vs.* temperature

The asymptote of the hyperbole is 72°. This means that the starting point of self-heating goes to infinity as T_o tends downwards to 72°. The calculated and measured data are in good correspondence, as the following table shows.

Table 1

Ambient temperature, T_o °C	Calculated time, t_o min	Measured time, t_o min
80	110	116
90	48	55
100	31	30
125	16	15
150	11	11.5

Conclusions

These experiments confirm that the self-heating of oils can take place on a support with a large specific surface area. The starting-point of self-heating depends on the ambient temperature. An increase of the ambient temperature promotes oxidation of the unsaturated bonds in the oil molecules. Under the given experimental conditions, the exothermic processes accelerated at about 72°. Due to the increasing reaction rate, the temperature of the material rose.

A Q 1500 D Derivatograph is suitable for the observation of self-heating. In materials susceptible to self-heating because of the chemical structure, conditions that lead to self-ignition were clearly distinguishable with the Derivatograph.

References

1 Fire protection hadbook (1474 edition), NFPA, Boston, 1980.
2 H. J. Yallop: Fire investigation, Alan Clift Associates, Solihull England, 1984.
3 E. Schulek and Z. Szabó, A kvantitativ analitikai kémia elvi alapjai és módszerei, Tankönyv Kiadó, Budapest 1973.

Zusammenfassung – Es wurde die Selbsterhitzung von Rapskernöl untersucht. Mittels DTA-Kurven für verschiedene Umgebungstemperaturen werde der Beginn der Selbsterhitzung bestimmt. Es wurde eine Asymptote bei 72°C gefunden.