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THERMAL STABILITY AND VOLATILITY OF POLYMER LIGHT STABILIZERS

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INTRODUCTION

The application of polymer stabilizers requires a preceding comprehensive analysis of their properties. Besides of the knowledge of an intrinsic efficiency of the stabilizers which is determined by their chemical structure, it is very important to know their thermal stability, volatility, compatibility and extractibility from polymer[1-4].

The long-term efficiency of the light stabilizers in polymers can rapidly decrease especially due to their volatility and loss from polymers during processing at higher temperatures[1,2].

In the present paper the thermal stability of some polymer light stabilizers was determined by thermogravimetry and DTA.

EXPERIMENTAL

Materials. The investigated polymer light stabilizers were: Tinuvin 770 [bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate], Tinuvin 144 [2-butyl-2-(3,5-di-tert-butyl-4-hydroxybenzyl)-bis(1,2,2,6,6-pentamethyl-4-piperidyl)propandionate], Cyasorb UV 531 [2-hydroxy-4-n-octyloxybenzophenone], Tinuvin 327 [2-(2'-hydroxy-3',5'-di-tert-butylphenyl)-5-chlorobenzotriazole], Irgastab 2002 [bis(ethyl-3,5-di-tert-butyl-4-hydroxybenzyl)phosphonate nickel], Tinuvin 622 [poly-{1-(2-ethylenyl)-2,2,6,6-tetramethyl-4-piperidylbutandionate}], Chimassorb 944 [oligomeric 2,2,6,6-tetramethyl-4-piperidylamino-substituted triazine]. Compounds 38 (higher molecular weight stabilizer of piperazine type)[5], 47a (oligomeric 2,2,6,6-tetramethyl-4-piperidylamino-substituted light stabilizer)[6] and 64 (oligomeric 7,15-diazadispiro 5,1,5,3 hexadecane-15-yl-substituted light stabilizer)[7], were laboratory prepared

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samples at the Polymer Institute, Bratislava. The mixtures some of these additives (10 % of w.) with isotactic polypropylene-TATREN (Slovnaft, Bratislava) were studied, too.

Equipments. The nonisothermal measurements have been carried out on the Derivatograph-Q, 1500 D, MOM-Hungary. The samples of initial weight 100 mg were heated in the air at the rate 5°/min. Isothermal measurements were performed on a Perkin-Elmer TGS-1B thermobalance.

RESULTS AND DISCUSSION

In the Table 1a there are summarized the main data from the TG, DTG and DTA curves for pure light stabilizers. It can be seen (Fig. 1), that thermal stability of individual compounds depends not only on their molecular weight but also on their chemical structure. The sequence of stability of investigated compounds estimated according to temperature of initial weight loss is (Table 1a) Chimassorb 944 > Tinuvin 622 > Cyasorb UV 531 > Compound 38 > Tinuvin 144 > Tinuvin 770 > Tinuvin 327 > Compound 64 > Compound 47a > Irgastab 2002. As for the molecular weight, it decreases in the order: Chimassorb 944 > Tinuvin 622 > Compound 64 > Compound 47a > Compound 38 > Tinuvin 144 > Irgastab 2002 > Tinuvin 770 > Tinuvin 327 > Cyasorb UV 531. (The molecular weight from 500 to 600 was the upper limit for low-molecular photostabilizers). Irgastab 2002 and compounds 47a and 64 belong to the least stable even though their molecular weight is higher than molecular weight of e.g. Cyasorb UV 531. This inconsistency may be explained by simultaneous destruction of stabilizer with formation of low-molecular and more volatile compounds. It may be also the reason why compounds 47a and 64 show lower photostabilizing efficiency when processed in polypropylene at higher temperatures.

On the Fig. 2 there are shown isothermal TG curves at the temperature 493 K, which corresponds to technological conditions of thermal processing of polypropylene. The similar tendency of thermal stability as from nonisothermal curves may be seen.

It was expected that all examined photostabilizers may perform also the stabilizing effect in thermooxidation of polymers. It follows from the Table 1b that especially Chimassorb 944 and Tinuvin 327 are good thermooxidative inhibitors at higher temperatures.

SAMPLE a/	M_w	$T_{(in)}$ [K]	$T_{(v\ max)}$ [K]	$T_{(1)}$ [K]	$T_{(2)}$ [K]
Cyasorb UV 531	310	571	624	322	617
Tinuvin 327	358	564	607	415	607
Tinuvin 770	481	565	599	352	594
Irgastab 2002	683	464	584	453-473	556
Tinuvin 144	685	568	603	411	611
Compound <u>38</u>	1230	570	608	317-319	617
Compound <u>47a</u>	2150	471	645	330-335	606
Compound-<u>64</u>	2190	513	631	354-359	628
Tinuvin 622	3600	579	613	396-400	624
Chimassorb 944	4600	625	686	413-453	678
b/					
IPP-TATREN		603	681	422	628
IPP + Tinuvin 622		603	680	428	634
IPP + Cyasorb UV 531		604	691	422	631
IPP + Tinuvin 327		615	694	422	645
IPP + Chimassorb 944		628	696	423	655

Table 1: The main data of thermal stability of stabilizing systems determined by thermogravimetry and DTA /M(w) is the average number molecular weight for polymer light stabilizers, T(in) is the initial temperature of decomposition, T(v max) is the temperature of decomposition at the maximum rate, T(1) is the temperature of DTA(endo) peak, T(2) is the temperature of DTA(exo) peak/

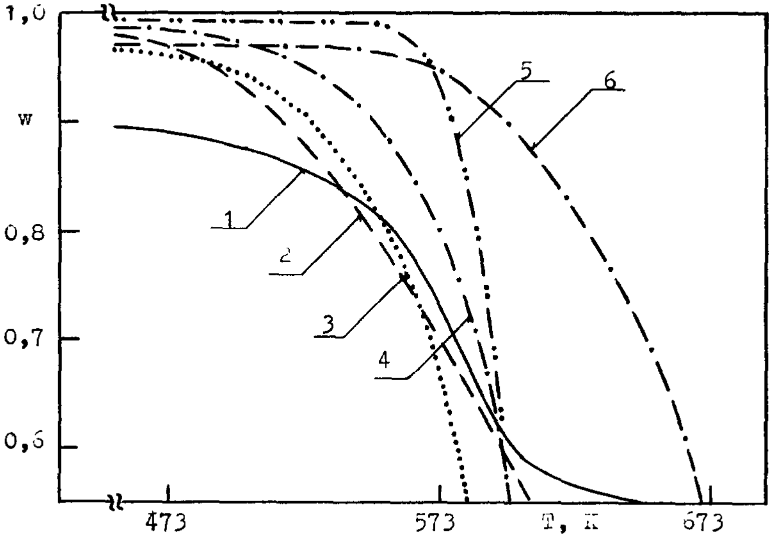

Fig. 1 The nonisothermal TG curves of some polymer light stabilizers. 1 - Irgastab, 2- Compd. <u>64</u>, 3 - Tinuvin 327, 4 - Cyasorb UV 531, 5 - Tinuvin 622, 6 - Chimassorb 944 (w is the relative weight of sample)

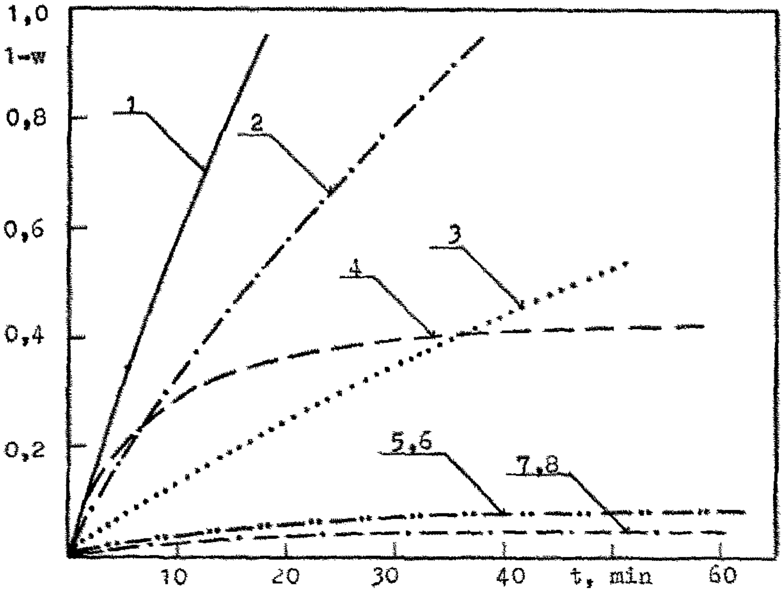

Fig. 2 The time dependence of the relative weight loss (1-x) of polymer light stabilizers at 493 K
1 - Tinuvin 327, 2 - Cyasorb UV 531, 3 - Tinuvin 770, 4 - Compd. 47a, 5 - Tinuvin 144, 6 - Compd. 38, 7 - Tinuvin 622, 8 - Chimassorb 944

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