

FLAME RETARDED, REINFORCED POLYPROPYLENE TECHNICAL FIBRES

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Abstract

A new simple method has been elaborated for increasing the strength of oriented polypropylene fibres by additives. The principle of the process is the incorporation of inorganic fillers (such as talc or CaCO_3) into polypropylene matrix material in a manner that allows maintaining the stretch ability of the fibre formed in this way.

A new halogen free additive system has been developed which contains reactive P, N, Si and Zn derivatives that react with each other in the production line forming a flame retarded polypropylene fibre by reactive extrusion. The influence of the additive system under combustion is based on the formation of a closed intumescent surface layer, that hinders the heat and flammable material transport.

Keywords: reinforced polypropylene, filler, surfactants, flame retardants, fibers.

1. Introduction

The role of woven and non-woven technical fabrics in the textile industry of the world is increasing. The proportion of polypropylene consumption among the raw materials of these products is increasing similarly. Beyond the economic and technical reasons, in this growth environmental protection plays a pronounced role, since the wide use of polyolefins makes recycling much easier [1].

The field of application of polypropylene was extended by the use of different additives. The lifetime was increased by stabilizers, and the titre of fibres improved by peroxides applied in the course of production of the raw materials.

The common additives of polypropylene fibres, however, are not appropriate for improving the two important features: the tensile strength and the flame resistance.

We place a special emphasis on the improvement of these properties, because of this challenge.

2. Reinforced Polypropylene Fibres, the MODYLENE Principle

The final tenacity of polypropylene fibres is determined by the orientation formed in the course of the stretching step of production, but this degree of orientation is far from theoretical [2].

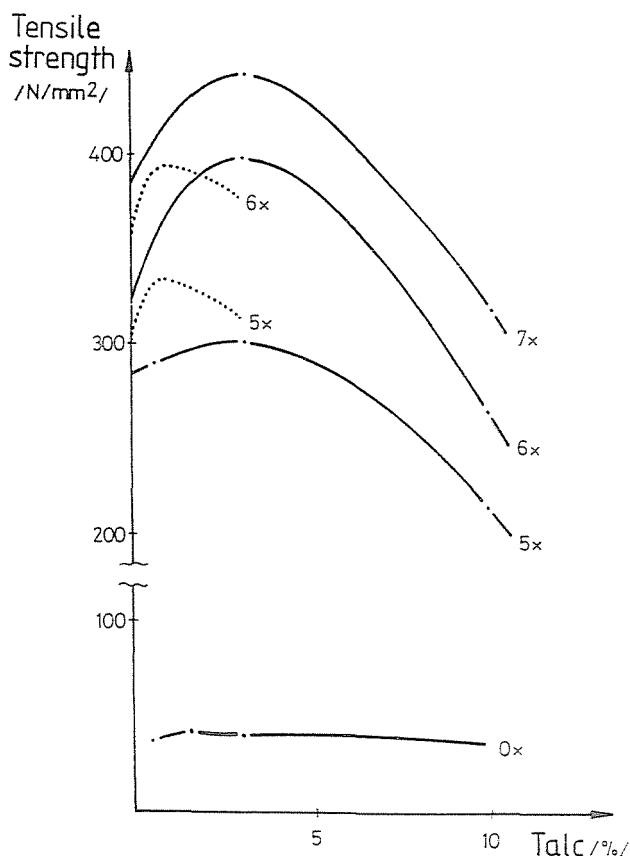


Fig. 1. Tensile strength of oriented staple fibres versus composition and stretching ratio. ·····: Polypropylene + Talc; - · - · - · - ·: Polypropylene + Talc + modified interphase

A simple new method has been elaborated at our Department for increasing the strength of oriented polypropylene fibres by additives. The principle of the process is the incorporation of inorganic fillers (such as talc or CaCO_3) into polypropylene matrix material in such a manner that allows of maintaining the stretch ability of the fibre formed in this way. The process, based on a world-wide patented principle, has been industrialized at Tisza Chemical Works (TVK Rt.) [3].

The tensile strength of polypropylene can be increased by addition of unmodified fillers up to a low filler ratio, as it is shown in *Fig. 1*, but the maximum degree of stretching decreases simultaneously. Consequently, the resulting tensile strength of filled and oriented fibres is lower than that of unmodified polypropylene fibres.

Application of a surfactant as interfacial additive and elastomer interlayer around the filler particles allowed us to achieve a reinforcing effect even at higher degrees of orientation [4] – [6]. An improvement of 25% in tensile strength of polypropylene fibre has been achieved in this way. New reactive interfacial additives have been prepared and applied for further improvement of the interfacial interaction between the polypropylene and filler phase.

The following formulas are characteristic examples of the new additives, which react with polypropylene chains by radical addition and with the surface of filler particles by acid-base reaction.

The modification described above results in increased elastic recovery, improved control of fibrillation and decreased dust formation during twisting of the fibres as well. The modified fibre forming grade is commercialized under the trade name MODYLEN 5112 by TVK Rt.

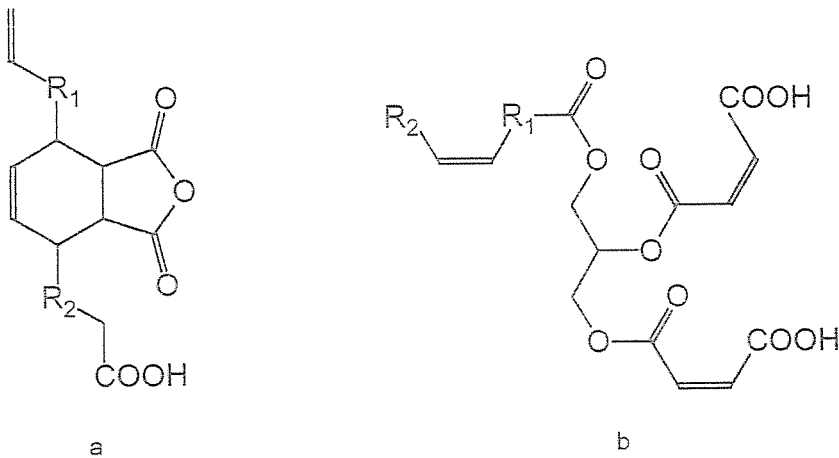


Fig. 2. Formule of phtalic anhydride derivative (a) and unsaturated dicarboxylic acid (b)

3. Flame Retarded Polypropylene Technical Fabrics, the TIPOFREN Principle

Fire proofing is an essential requirement nowadays in several engineering fields of application. Impregnation of the fabric with flame retarding liquid or introduction of halogen-containing additives into the polyolefin matrix are not appropriate solutions since the lack of permanence in the former case and formation of harmful and polluting combustion products in the latter case are not acceptable.

A new halogen free additive system has been developed at our Department, which contains reactive P, N, Si and Zn derivatives that react with each other in the production line forming a flame retarded polypropylene fibre forming grade by reactive extrusion. The influence of the additive system under combustion is based on the formation of a closed intumescent surface layer, that hinders heat and flammable material transport.

The effects of flame retardants expressed by Oxygen Index values are plotted against the amount of the two main components of the flame retarded system in *Fig. 2*. The bigger this values, the more pronounced the fire proofing effect. When Si and Zn derivatives are applied in the additive system, the achievement of the strictest V0 flame resistance rating requires the introduction of the two main components only in a proportion of 21% [8].

Both staple fibres and extruded filaments have been produced from the flame retarded PP.

The properties of the fibres are summarized in *Table 1*.

Table 1. Properties of extruded filaments and staple fibres

Sample	Stretch <i>X</i>	Titre [g/1000 m]	Tenacity [N/tex]	Elongation at break %
H536 staple fibres	1	3672	0.038	391
	6	629.4	0.236	16
Tipofren staple fibres	1	3894	0.021	92
	5	1142	0.074	
Tipplen H536 extruded filaments	5	108.6	0.142	54
	6	45.6	0.324	46
	7	42.0	0.557	38
	8	34.6	1.101	28
Tipofren H389 extruded filaments	5	42.9	0.142	37
	6	40.2	0.139	27
	7	36.0	0.181	21
	8	22.6	0.314	15

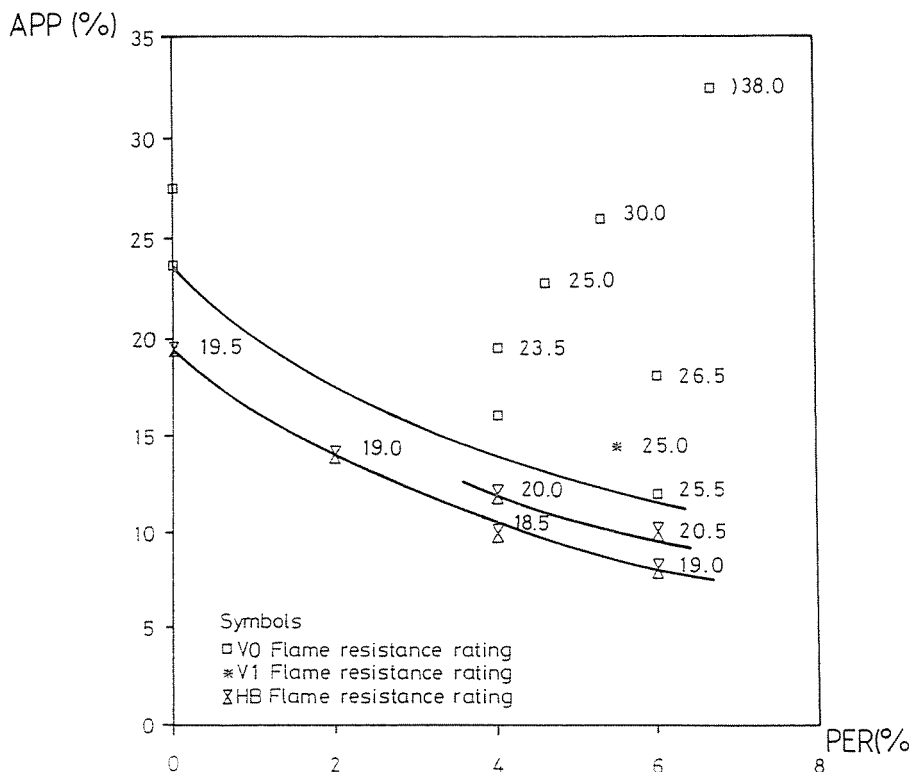


Fig. 3. Flame retardance rating and Oxygen Index of polypropylene loaded with different amounts of ammonium-polyphosphate (APP) and pentaerythritol (PER) (The values of symbols express the Oxygen Index).

The flame resistance rating of fabrics made of the modified fibres attains the V0 rate which is characteristic of self extinguished materials.

The flame retarded polypropylene fibre forming material, patented and industrialized in cooperation with Tisza Chemical Works (TVK Rt.), is commercialized under the trade name TIPOFREN H 389 [9].

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