Fibre Chemistry, Vol. 27, No. 4, 1995

GLASS-FILLED POLYPROPYLENE FOR FABRICATION OF AUTOMOBILE RADIATOR TANKS

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UDC 678.742.3.06

One of the leading foreign manufacturers of auto radiators, Societa Sofica (France), began in 1968 to manufacture automobile radiators with upper and lower tanks made of modified polyamide 66 (GFPA-66). Contemporary radiator design includes such polyamide tanks molded together with the connecting pieces. Such radiators are used in almost all modern automobiles, including models VAZ 2108 and 2109. Special brands of polyamide 66 are manufactured for these purposes by the foreign firms BASF, Rhone-Poulenc, Akzo Plastics, and others; Karbolit Orekhovo-Zuevsk Industrial Association produces polyamide PA-66-LTO-SV 30 according to USSR Technical Specification TU 6-05-211-1404−85.

On the other hand, the domestic plastics industry is more oriented toward production of polyolefins with respect to production volume and prospects for growth. For this reason, it was interesting to investigate the possibility of using domestic glass-filled polypropylene (GFPP) of the Armlen PP SV 30 type in these articles. It is manufactured on the industrial scale by Poliplastik Scientific and Industrial Co. (Moscow) according to TU 6-05-11378612-11−92.

It was found that GFPP is superior to GFPA-66 with respect to processability in processing by injection molding and the resistance of the articles to cracking. In addition, polypropylene is resistant to the components of antifreeze of the "Tosol" type (water, mono- and diethylene glycols), while polyamide 66 is not resistant both with respect to swelling and with respect to chemical degradation. These processes lead to gradual worsening of the resistance of the material to aggressive media. They are especially accelerated with an increase in the temperature.

It should be noted that GFPA-66 in the initial state has better physicomechanical indexes than GFPP (Table 1). However, the strength properties of polyamides (in contrast to polypropylene) change markedly with an increase in the moisture content of the ambient air or medium. When the humidity of the air increases from 0 to 50%, the equilibrium bending strength of polyamide PA-66-LTO-SV 30 decreases by 1.25 times, and the rigidity (bending modulus of elasticity) decreases by 1.33 times. With respect to the thermal stability, GFPA-66 (250°C) is initially better than GFPP (165°C). However, since "Tosol" antifreeze boils intensely at a temperature above 125°C, polypropylene's thermal stability of 160°C is higher than necessary.

GFPP and GFPA-66 were comparatively tested for stability in antifreeze ("Tosol A40" at high temperature and "Tosol A60" at low temperature) on standard samples both fabricated by injection molding and cut from cast radiator tanks.

Prolonged holding of samples in the shape of standard paddles (type 2 according to GOST 11262−80) in antifreeze showed that the shape of the materials is preserved in the temperature range from −60 to 125°C. After holding in antifreeze for 300 h at 120°C, the degree of swelling is equal to 0.36% for GFPP and 10.4% for GFPA-66. The width of GFPP-0 and GFPA-66 paddles increased by 4.2%, the thickness increased by 6.6%, and the length increased by 0.32%. The difference in shrinkage was due to orientation of the glass fibres and led to the appearance of additional residual stresses. The tensile strength preservation coefficient in these conditions was 74% for GFPP and 38% for GFPA-66. The rigidity of the polyamide decreased relatively sharply, while it decreased much less for polypropylene. This difference in the change in the strength properties is due to the fact that both swelling and thermal aging play a role in the first case, and thermal aging alone is involved in the second case.

In view of the high degree of swelling of GFPA-66 in antifreeze, we can also conclude that radiator tanks slowly pass the harmful components of antifreeze due to diffusion through the walls with subsequent entry into the passenger compartment of the automobile when the hot engine is operating.

Scientific−Research Institute of Automotive Materials, Moscow. Translated from Khimicheskie Volokna, No. 4, pp. 49-50, July-August, 1995.

0015-0541/95/2704-0280$12.50

TABLE 1. Results of Tests of Materials for Resistance to "Tosol" Antifreeze

Material	Temperature and holding time in antifreeze	Degree of swelling, % (GOST 12020—72)	Tensile modulus of elasticity, MPa (GOST 9550—81)	Charpy impact viscosity, kJ/m²		Wick thermostability, $P = 1$ kg (GOST 15065—60)
				at 20°C	at −50°C	
Glass-filled polyamide 66	Starting material	–	8750	49,4	28,4	250
	125°C, 48 h	12,0	3370	54,2	25,2	230
	−60°C, 72 h	0,1	8960	26,0	20,4	245
Glass-filled polypropylene	Starting material	–	5210	20,4	19,4	165
	125°C, 48 h	0,7	4280	11,9	13,5	166
	−60°C, 72 h	0,1	5830	16,7	16,7	167

During prolonged holding in hot antifreeze (90°C), the impact viscosity of GFPA-66 initially increases due to the strong swelling of the material and then gradually decreases due to chemical degradation and continued swelling.

At negative temperatures (below −60°C), the strength indexes of GFPP change less than those of GFPA-66 during holding in antifreeze (that is, the cold resistance is better).

The use of special additives such as stabilizers in the formula for GFPA-66 for radiator tanks does not in principle give the polyamide absolute resistance to antifreeze of the "Tosol" type but only decreases the rate of chemical and physical reactions.

The important possibility of using an alternative construction material for fabrication of plastic automobile radiator tanks was thus demonstrated. Glass-filled polypropylene of the Armlen PP SV 30 type can be used. Use of this material for radiator tanks increases the quality of the articles, saves on expensive brass, solder, and other materials, and decreases the raw material consumption standards by 20% when replacing GFPA-66. GFPP does not require prolonged drying before processing, so that it is easier to respect molding regimes, fewer technological rejects are formed, and the problem of utilization of technological processing wastes is solved more easily than with GFPA-66.