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Promising processing technologies of glass-filled polyurethane materials

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Abstract. The review of modern methods of glass-filled polyurethane materials processing is presented. A possibility to use of glass-filled PU in the manufacture of interior parts with different surface textures (instrument panels, door trim, armrests) has been revealed.

1. Introduction

A hundreds of brands of elastic and rigid gas-filled materials are produced on the basis of synthetic resins, rubbers and high-molecular compounds, which are used in all industries and construction. At present, a large number of studies on the development of new polyurethane compositions (PU) were investigated due to a decrease in their cost, simplification of technologies, reduction of toxicity in production, and the possibility of operating in a wide temperature range. It is possible to vary the properties of the obtained PU in a wide range due to the large number of initial components [1-7].

2. Body text

Currently, the following technologies are used for the manufacture of glass-filled polyurethanes [8] (Table 1): Long Fiber Injection Molding (LFI); Fiber Composite Spraying (FCS); Reinforced Reaction Injection Molding (RRIM); Structural Reaktion Injection Molding (SRIM); Resin Transfer Molding (RTM).

Table 1. Description of production methods for glass-filled PU

Method	Basic operations	Advantages
LFI	cutting of fibers, mixing components, stitching fibers and pouring them into the into the socket of the disclosed forms; finishing the product	minimum waste; possibility of combining with cellular cardboard; variable content of fibers and their length; technologies for obtaining the outer surface (staining in the form, film and textile materials)
FCS	cutting of fibers, mixing components, spraying polyurethane, introducing of fibers from the outside into the spray jet and applying separate layers; curing the coating in air; final processing	only the lower half of the form is necessary, the form carrier is not needed; the form can be made of artificial resin (low temperature and mechanical stress); suitable for small batches and large molded products; very high flexural modulus, low mass; structural construction with variable layer

		thickness and its types (monolithic, foamed, filled, unfilled); variable content of fibers and their length; technologies for obtaining the outer surface (staining in the form, film, textiles)
RRIM	polyol with pre-mixed fiber is mixed with isocyanate in the mixing head, poured into the form and there reacts; finishing of products	short cycle times due to high activity components; amenable to spraying surface; high temperature resistance; excellent impact strength
SRIM	before forming and cutting the glassmat.; manual planting; pouring into an open form, followed by pressing; finishing of products	purposeful orientation of fibers for high freedom at adjustment of durability parameters; simple changeover-flexible and low-cost technology; high mechanical properties
SCS	spraying by the reaction mixture of the upper and lower sides of the pre-assembled "sandwich" (fibers, remote glassmats); laying in the form; finishing of products	very light products with high flexural rigidity are produced when using cellular cardboard or similar materia, low consumption of polyurethane due to uniform stitching.
RTM	cutting glassmat; laying in the form by hand; fill in a closed form, where necessary, with vacuum support; finishing of products	targeted orientation of fibers (insoluble binder); high mechanical performance; higher fiber content (up to 70%)

Due to the development of tools for mechanization and automation of labor, cheaper hardware and software tools, LFI and FCS technologies produced by glass-fiber PU [2–8] are widely used in mechanical engineering.

The physical-mechanical and operational properties of glass-filled PU products manufactured according to LFI and FCS technologies were studied [2-7]. Tested two types of samples of glass-fiber PU, manufactured by LFI technology. The first sample consisted of: the front layer - polyurethane film; reinforcing layer (frame) - glass-filled rigid polyurethane; intermediate (connecting) layer - semi-rigid PU. The second sample is glass-filled rigid polyurethane. A sample of glass-fiber PU, made by FCS technology, was a rigid polyurethane.

The results of studies of physico-mechanical and operational properties of glass-filled PU, are presented in tables 2 - 3.

Table 2. Physico-mechanical and performance properties of products from glass-fiber PU obtained by LFI technology

Name of the indicator	Test result		
	Material 1	Material 2	Material 3
Frost resistance	No change in appearance	No change in appearance	No change in appearance
Impact resistance at low temperature: impact with a ball weighing 883 g from a height of 0,724 m immediately after the frost test	Sample №1 No destruction of products: cracks, through holes, chips. Sample # 2 is cracked	No destruction of products: cracks, through holes, chips	No destruction of products: cracks, through holes, chips
Impact resistance at low temperature: impact by	No destruction of products: cracks,	-	-

a 225 g ball from a height of 0.400 m immediately after the frost test	through holes, chips		
Heat resistance (change in the geometric dimensions of the part,%)	0,09 (no peeling and swelling of the face coating)	0,06 (no peeling and swelling of the face coating)	0,04 (no peeling and swelling of the face coating)
Apparent density, kg / м^2	1036,71	1116,52	535,80
The level of odor, points, not more	2,0 (allowed to use)	-	-
Breaking stress, MPa -in tension	32	47	11,5
Breaking stress, MPa - in bending	45	90	19
Oil-benzine resistance	The lack of stratification and dissolved samples	The lack of stratification and dissolved samples	The lack of stratification and dissolved samples
Material resistance to temperature: +100 ºC for 12 h; +45 ºC for 16 h; -40 ºC for 8 h	-	Lack of detachment of the facial layer, changes in appearance, deformation, delamination	Lack of detachment of the facial layer, changes in appearance, deformation, delamination
Heat conductivity coefficient, W/ (m*K)	-	-	0,148

Table 3. Physico-mechanical and performance properties of products from glass-fiber PU obtained by FCS technology

Indicator	Value	Method
Breaking stress at bending, MPa	49,4	GOST 18564-73 [8]
Shore D hardness	60-69	GOST 24621-91 [9]

3. Conclusions

The test results revealed high values of the physicomechanical and operational properties of glass-filled PU. The results obtained allow us to recommend the use of glass-filled PU as an alternative to traditional fiberglass materials in the production of interior parts with different surface textures (dashboards, door panels, armrests) [10].

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