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THE STUDY OF THE PROPERTIES OF POLYMER COMPOSITIONS AND PARTS CREATED ON ITS BASIS FOR THE AUTOMOTIVE INDUSTRY

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ABOUT ARTICLE

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Abstract: The article illustrates the results of laboratory studies of various composite materials for plastic parts of cars, the company "General Motors". As a result, compositions corresponding to the requirements of the GMW standard were obtained. The modes of manufacturing these parts are also recommended.

INTRODUCTION

In previous works [1-5], data were presented on the use of polymer compositions for the automotive industry based on polypropylene and fillers produced by LLC "Uz-Kor Gas Chemical". At this stage of research, it becomes necessary to create compositions for specific details. As a study, plastic parts used for both outside (exterior) and inside (interior) of cars were tested.

Experimental technique. Polypropylene compositions of various types for the automotive industry were selected as studies. The requirements of these brands contain data that the newly created composition must comply with. As an experiment, the following grades of the composition of internal door skins were chosen: grade CW452B –UZ is used for the manufacture of the DUCT-WS Defroster Nozzle part and CW452U-UZ for the RR Door Trim ASM LH/RH part. The brands CEW 670U-UZ (part

FASCIA-RR BPR LWR), and CEW676U-UZ (part FASCIA-RR BPR LWR), vehicles produced by “UZAUTO MOTORS” JSC were used as external plastic parts.

The compositions were made on the basis of polypropylene copolymers produced by the JV LLC "Uz-Kor Gas Chemical", for the possible replacement of other types of polymer. Such a need arose due to the fact that the production of the polymer and the composition from it, as well as the parts from this composition, are located in the same region in the Republic of Uzbekistan.

RESULTS

The performance of the obtained compositions and their comparison with the required data are shown in tables 1-4. For the reliability of the data obtained, the standard average square deviation - σ was calculated. This indicator is calculated on the basis of at least 30 experimental data. Both physical-mechanical and thermophysical parameters of the composition were studied.

The results of laboratory studies of the composition CW452B-UZ

Table 1

Properties	Standard	Required index	CW452 B-UZ	Average. square Deviation σ
Melt Flow Rate, 230/2.16	ISO 1133	14-25	21.9	0,5625
Density, **g/cm³**	ISO1183-A	0.980-1.02	1.018	0,0028
ASH content, **% by mass**	ISO3451-1	13-17	16.2	0,4986
Tensile Modulus, 1 mm/min, MPa	ISO-527-1/2	2100-2700	2246	47,8852
Tensile Stress at Yield, 50 mm/min, MPa	ISO-527-1/2	≥ 26	26,9	0,4342
Notched Charpy Impact Strength at +23 °C, kJ/m²	ISO-179/1EA	≥ 4	4,3	0,169
Notched Charpy Impact Strength at -30 °C, kJ/m²	ISO-179/1EA	≥ 2	2,3	0,0868
Heat Deflection Temperature(1.8MPa)	ISO-75-2	≥ 55	57	0,9745
Mold Shrink after 48 hour, %	ISO-294	0,9-1,2	0,952	-

The results of laboratory studies of the composition CW452U-UZ

Table 2

Properties	Standard	Required index	CW452U-UZ	Average. square Deviation σ
Melt Flow Rate, 230/2.16	ISO 1133	11-23	22,1	0,5796
Density, **g/cm³**	ISO1183-A	0,99-1,06	1,040	0,0035
ASH content, **% by mass**	ISO3451-1	13-22	20,0	0,4347
Flexural Modulus, 1 mm/min, MPa	ISO-178	1500-1900	1734	46.1215
Tensile Modulus, 1 mm/min, MPa	ISO-527-1/2	1600-2000	1837	46,7371
Tensile Stress at Yield, 50 mm/min, MPa	ISO-527-1/2	≥ 17	20,0	0,3986

Notched Charpy Impact Strength at +23 °C, kJ/m²	ISO-179/1EA	≥ 25	33,5	0,1579
Notched Charpy Impact Strength at -30 °C, kJ/m²	ISO-179/1EA	≥ 4	4,5	0,0903
Heat Deflection Temperature(1.8MPa)	ISO-75-2	≥ 50	57,8	0,8739
Mold Shrink after 48 hour, %	ISO-294	0,75-1,05	0,905	-

The data of tables 1-2 show that the mechanical properties, for example, the tensile modulus of CW452B-UZ is 2246 MPa and it is within the required range of 2100-2700 MPa with a standard deviation of 47.8852.

A study of the thermophysical properties of the CW452U-UZ grade shows that the bending temperature (at a load of 1.8 MPa) is 57.8°C with a standard deviation of 0.8739. This indicator is within the required range (more than 50 °C). Similarly, the trend is observed for all other indicators of the studied compositions.

Tables 3, 4 present the same indicators for the compositions used from the outside of the car, as a bumper.

The results of laboratory studies of the composition CEW-670-UZ

Table 3

Properties	Standard	Required index	CEW-670-UZ	Average. square Deviation σ
Melt Flow Rate, 230/2.16	ISO 1133	33-38	34.1	0,6314
Density, **g/cm³**	ISO1183-A	0.94-0.99	0.983	0,0037
ASH content, **% by mass**	ISO3451-1	10-14	13.2	0,3726
Flexural Modulus, 1 mm/min, MPa	ISO-178	1550-1850	1692	46.7159
Tensile Modulus, 1 mm/min, MPa	ISO-527-1/2	1550-1850	1692	46,9697
Tensile Stress at Yield, 50 mm/min, MPa	ISO-527-1/2	≥ 13	18.6	0,4046
Notched Charpy Impact Strength at +23 °C, kJ/m²	ISO-179/1EA	≥ 50	52.9	0,1634
Notched Charpy Impact Strength at -30 °C, kJ/m²	ISO-179/1EA	≥ 5	5.7	0,09104
Heat Deflection Temperature(1.8MPa)	ISO-75-2	≥ +50	54.5	0,7996
Mold Shrink after 48 hour, %	ISO-294	0.525 -0.675	0.577	-

The results of laboratory studies of the composition CEW 676U-UZ

Table 4

Properties	Standard	Required index	CEW677U-UZ	Average. square Deviation σ
Melt Flow Rate, 230/2.16	ISO 1133	33-38	34.5	0,6256
Density, **g/cm³**	ISO1183-A	0.94-0.99	0.984	0,0041
ASH content, **% by mass**	ISO3451-1	10-14	13.5	0,3865
Flexural Modulus, 1 mm/min, MPa	ISO-178	1550-1850	1676	46.8465
Tensile Modulus, 1 mm/min, MPa	ISO-527-1/2	1550-1850	1705	46,7471

Tensile Stress at Yield, 50 mm/min, MPa	ISO-527-1/2	≥ 13	18.8	0,3896
Notched Charpy Impact Strength at +23 °C, kJ/m²	ISO-179/1EA	≥ 50	53.2	0,1725
Notched Charpy Impact Strength at -30 °C, kJ/m²	ISO-179/1EA	≥ 5	5.7	0,0897
Heat Deflection Temperature(1.8MPa)	ISO-75-2	≥ +50	55	0,8016
Mold Shrink after 48 hour, %	ISO-294	0.525 -0.675	0.580	-

Higher demands are placed on the bumper of a car, for example, high impact resistance. For example, such notched Charpy impact strength is 53.2 kJ/m2 at σ=0.1725, where this value should be greater than 50 kJ/m2.

In general, the data of tables 1-4 indicate that the performance of the resulting compositions meets the requirements of GENERAL MOTORS.

Subsequently, parts were made from these compositions, which were produced in industrial injection machines under standard conditions. Table 5 shows the conditions for obtaining parts in injection machines.

Processing guide of parts in injection machine.

Table 5

Drying Temperature	C^0	80
Drying Time	hour	2
Minimum Moisture Content	%	0.01
Melt Temperature	C^0	210 ~ 240
Cylinder Temperature	C^0	180 ~ 200
Rear	C^0	190 ~ 210
Front	C^0	210
Nozzle Temperature	C^0	220
Mold Temperature	C^0	40 ~ 70
Back Pressure	kg/cm2	300 ~ 600
Screw Speed	rpm	30 ~ 60

It should be noted that the mode of casting samples does not differ from the mode when using polypropylene compositions used previously.

The results of testing parts from the test samples are presented in tables 6-9. The General Motors standards for these tests do not require the calculation of standard deviations σ. These results are arithmetic mean based on 5 trials.

Parts Test Performance "DUCT-WS Defroster Nozzle"

Table 6

Name of the property	Test methods	Standard spec.	Test results
Optics / Surface / Color / Appearance	GMW 14162	No visible tracks of cracking or pin holes	No visible tracks of cracking or pin holes
Chemical resistance	GMW 14334	Rating 1	1
Fogging	GMW 3235	2mg	1.7
Odor	GMW 3205	Min. Rating 6	6
Flammability	GMW 3232	Max 100mm/min	55
Thermal oxidation Stability	GMW 14651	There are no visible tracks of local discoloration and/or crumbling	There are no visible tracks of local discoloration and/or crumbling

Parts Test Performance "RR Door Trim ASM LH/RH"

Table 7

Name of the property	Test methods	Standard spec.	Test results
Optics / Surface / Color / Appearance	GMW 14162	$\Delta L \leq 0.3$	$\Delta L = 0.2$
Chemical resistance	GMW 14334	Rating 1	1
Fogging	GMW 3235	2mg	1.8
Odor	GMW 3205	Min. Rating 6	6
Flammability	GMW 3232	Max 100mm/min	65
Thermal oxidation Stability	GMW 14651	There are no visible tracks of local discoloration and/or crumbling	There are no visible tracks of local discoloration and/or crumbling
Internal Emissions	GMW 8081	≤ 0.5	0.3

The results of studies of door trim obtained from the composition show that the optical properties of the RR Door Trim ASM LH/RH parts meet the requirement of the standard and the ΔL of the obtained part is 0.2 with the requirement $\Delta L \leq 0.3$. Compliance of the indicators of the obtained parts with the standard is observed in all test methods.

Tables 8 and 9 provide test data for automotive bumpers.

FASCIA-RR BPR Parts Test Performance

Table 8

Name of the property	Test methods	Standard spec.	Test results
Optics / Surface / Color / Appearance	GMW 14162	Нет видимых следов растрескивания или штифтовых отверстий	Нет видимых следов растрескивания или штифтовых отверстий
Chemical resistance	GMW 14334	Rating 1	1
Fogging	GMW 3235	2mg	1.5
Odor	GMW 3205	Min. Rating 6	6

Flammability	GMW 3232	Max 100mm/min	65
Thermal oxidation Stability	GMW 14651	There are no visible tracks of local discoloration and/or crumbling	There are no visible tracks of local discoloration and/or crumbling

Показатели испытания деталей " FASCIA-RR BPR LWR"

Table 9

Name of the property	Test methods	Standard spec.	Test results
Optics / Surface / Color / Appearance	GMW 14162	$\Delta L \leq 0.3$	$\Delta L = 0.2$
Chemical resistance	GMW 14334	Rating 1	1
Fogging	GMW 3235	2mg	1.6
Odor	GMW 3205	Min. Rating 6	6
Flammability	GMW 3232	Max 100mm/min	69
Thermal oxidation Stability	GMW 14651	There are no visible tracks of local discoloration and/or crumbling	There are no visible tracks of local discoloration and/or crumbling
Internal Emissions	GMW 8081	≤ 0.5	0.3

For example, oxidation resistance in FASCIA-RR BUMPER and FASCIA-RR BUMPER LOWER parts comply with the GMW 14651 standard. A study of such an important indicator as flammability shows that for FASCIA-RR parts BPR LWR is 69 at a maximum allowable 100 mm/min.

CONCLUSIONS

The study of polymer compositions based on polypropylene "Uz-Kor Gas Chemical" showed that the standard deviation of the data obtained is within the requirements of the GM standard.

Recommended modes for obtaining details from these compositions are provided.

Testing of door skins and bumpers from these compositions showed that the parts obtained from this composition have the necessary properties.

Thus, based on the results of the work carried out, it can be concluded that the developed samples of the polypropylene composition based on the product of the LLC "Uz-Kor Gas Chemical" company, and the parts cast on their basis, meet the requirements set by JSC UzAuto Motors.

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