RESEARCHES ON ENGINEERING SPARE PARTS MADE OF COMPOSITE MATERIALS, USED FOR INTERIOR FITTING OF CARS

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Abstract: *The paper presents some results of the researches done within a research project funded under the program PNCDI 2007, which aims to achieve a new advanced bio-composite material based on natural fibres with the matrix of polymer or resin modified polypropylene (e.g. acrylic or ethylene oxide), which have applications in obtaining elements used in the interior of the car. Optimal material obtained was "mixture of polypropylene with 5% linen fibre", and the samples were plates with dimensions of 2000 x 1000 x 3 mm.*

Keywords: cars, composite materials, biodegradable materials.

INTRODUCTION

The realization of "light bodies" represents an important objective of this period in implementing innovative products in all industries and, in particular for motor vehicles. European Commission and European Parliament have limited fuel consumption for 2005 to maximum 5 l/100 km, which corresponds to CO_2 emissions of 120 g/km (25% reduction compared to the year 1995), so the choice of materials must be based on economic considerations. In consonance with the global trend of replacing existing materials with new lighter and biodegradable materials as much as possible, our team tries to obtain new biodegradable materials used to made advanced parts of low density (in order to reduce the vehicle weight) such as the door linings, the bumper, the door steps, the radiator shell, the ailerons, the fuel tanks, the plate behind the rear seats etc.. Depending on their destination, these ornaments for cars could be manufactured by resin reinforced with natural fibers. These materials will be very valuable in the future as will ensure achieving of greater fuel economy.

EXPERIMENTAL TESTS PERFORMED WITH PLATES MADE OF COMPOSITE

In accordance with the standards ISO 3795/1989 and STAS 6926/7-89, we manufactured specific parts for interior fittings of the cars, we have studied the possibilities for reinforcement and lining and we determined the burning speed of the materials.
The researches have led to obtain the plates made of the composite material chosen as the best choice (fireproofed PP + 5% linen fibre), using an extruder of type KLEINEWEFERS (Germany) with capacity of 100 kg/h, a calender, a wire puller and a guillotine. Using the six heating areas of the extruder, the granules were preheated to 60^oC and then to a thermal regime of 130-180^oC, and using the seven heating areas on nozzles they were heated to a thermal regime of 165-180^oC. Finally, the composite plates were cut to size of 1000 x 2000 x 3 mm.
The parts were made by vacuum thermoforming on open models and by thermoforming in closed moulds, using models and moulds conformance and compatible with the counter-parts which are mounted inside the car.
Within the laboratories of the company S.C.. AMROM AUTOMOTIVE 2006 S.A. – CESAR DEPARTMENT (partner in the project) there were performed the following tests:

- dimensional checks of the manufactured parts;

- compatibility check of the mounting of parts on the car;
- determination of burning speed of the material used for fitting the car interior experienced.

The parts used for testing were made by two processes:

- vacuum on open model;
- thermoforming in the closed mould.

The parts obtained by vacuum on open model had opened cracks and crevices on the surface. This determine us to abandon this procedure still in the phase of manufacturing the parts.

The thermoformed parts in closed moulds were produced in three variants:

- parts obtained from the original board (single);
- parts obtained from the plate coated with linen mesh, armoured with pieces used for installing the panels on the car;
- parts obtained from board, covered on the outside with PVC film.

For testing and sampling the parts necessary to conduct the tests, there were used the following equipment:

- tools and universal devices for measuring and controlling;
- the control model;
- the combustion chamber, with the size in accordance with the standard ISO 3795-1989, fitted with transparent side windows to visualize the burning evolution of the materials between two marks at the distance of 254 mm. Inside the combustion chamber is mounted a support for the sample made at the dimensions imposed by ISO 3795-1989.
- a device to initiate the combustion using gas (Bunsen bulb);
- a chronometer for timing the combustion of samples between the two marks of the combustion chamber;
- a measuring tape (one meter long) used to measure the samples.

The working conditions for carrying out the experiments were:

- the ambient temperature: + 40^{o}C;
- the atmospheric pressure: 726 mmHg;
- the humidity: 50%.

The test was done as follows:

There were tapped samples of the dimensions imposed by ISO 3795-1989 (five samples of each material which are used in the automotive interior). The samples were conditioned for 24 h at a temperature of 23 ± 2^{o}C and a relative humidity of 50 ± 5%, in accordance with the paragraph 5.3 of ISO 3795/89. These samples were introduced into the combustion chamber and the combustion was initiated by the Bunsen gas bulb maintained under the material at least 30 seconds.

After initiating the flame, for each material it was timed the period of firing between the two marks. The operation was repeated for each material, calculating the combustion rate according to the formula:

$$R = 60\ D/T \qquad (1)$$

with :

R – combustion speed, [mm / min];
D – burning length, [mm];
T – burning time, [sec].

The universal tools (measuring tool, tape measure, micrometer) and the verification and control devices (control model) were used to verify the dimensions of the parts made of the composite material based on polypropylene reinforced with 5% linen fibres.

The data obtained by checking the dimensions of the parts were written on the measuring sheets and then they were used for calculus.

The control model was used to verify the contour of the manufactured parts and to check the fastening and the assembly points.

To check the compatibility of the parts on the car, the parts accepted after checks were sent to the assembly station and there were verified their position on the clamping support, the firm grip, their aspect and functionality on the car.

THE RESULTS OF THE EXPERIMENTS

The tests for measuring the burning speed of the materials used in the interior of the cars provided the results presented in Table 1.

Table 1. The results of the tests for measuring the burning speed

No.	Material	Utilization on the car	Burning speed, [mm/min]		Observations
			Standardised	Determined	
1	Composite based on polypropylene reinforced with 5% linen fibre	Plate behind the rear seats Wheel hub cover Door lining	100	18	It is self-stifle
2	Composite based on polypropylene reinforced with 5% linen fibre, plate coated with linen mesh	Door lining	100	22	Burn with flame

Figure 1 presents different parts obtained from the composite materials studied, used to fitted on the interior of the car.

Fig.1. The parts obtained from the composite materials studied, used to fitted on the interior of the car.

CONCLUSIONS

The experimental researches conducted show that the materials used for manufacturing the parts for the interior of the car shall fulfil both the dimensional regulations according to STAS 6926/7-89, and the regulations for burning speed under the provisions of ISO 3795-1989.
The researches done with parts manufactured by vacuum or thermoforming methods have concluded that the optimal manufacturing method and consistent with this type of material is the process of thermoforming technology.
Following the analysis of the results obtained with biodegradable composite material made within the project, the project team decided that the best choice to be adopted is the composite material made of polypropylene (PP) fireproofed with 5% linen fibre, because it has the smallest burning speed.

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