THE IMPACT OF THERMAL STRESS OF COMPOSITE PANELS USED IN THE AUTOMOTIVE INDUSTRY

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Abstract: *The automotive industry has focused recently on reducing the mass of the car body, but also of other key components. This trend is driven by the need for a small mass to be able to use new engines, especially fully electric ones, therefore finding materials that have certain mechanical and thermal proprieties when under exploitation. Composite panels can easily replace conventional materials, and can bring a plus through the thermal properties they have. The thermal characteristics of the composite materials from which we propose to make an automotive element, were experimentally determined by taking into account several types of fiberglass and carbon based fabrics.*

Keywords: *Composites, thermal stress, automotive industry*

1. INTRODUCTION

Leader companies in the automotive field are using composite materials to reduce weight and also costs. A new application is a heat shield to insulate the fuel tank from the high temperature generated by the engine's exhaust system. The landmark is a laminate made by molding AOC resin (SMC) reinforced with short glass fibers. It was specially made because the shield must benefit from superior mechanical properties, being exposed to high temperatures or corrosion.

The usage of polypropylene (PP) air intake systems for the latest gasoline engines it is said to lead to weight savings of up to 15%, high resistance to mechanical stress, as well as high thermal stability, better acoustic performance.

From this point of view, more and more car manufacturing companies are starting to rethink their product development method. Companies want to reduce the amount of waste through specific measures, which will be applied even during the production of the vehicles and their recovery at the end of the life cycle.

Recycled materials are preferred over new materials if they can be produced at lower costs, and if they maintain their quality characteristics from a tactile and visual point of view, mechanical or thermal resistance. Recycled materials are starting to be used nowadays also in the making of markers that are mounted on the bodywork in visible places of vehicles.

2. TESTING PROCEDURE

To elaborate the samples, during processing, the following must be taken into account:

- The samples must be processed in conditions that do not create a strong increase in heat in the sample (it is recommended to use a cooling liquid). If such a liquid is used, the samples are dried immediately after processing;

- All the processed surfaces of the test piece must be free of processing defects.

If it is not possible to take samples from the finished object, sheets or plates are prepared that reproduce as much as possible the manufacturing method of the considered product.

If the material shows significant differences in the bending characteristics in two main directions, it must be tested in both directions.

A model for making the samples, from a plate of composite material, is presented in the following figures. A 12 mm thick plate was made from composite material reinforced with glass fiber felt.

The measurements were made in order to establish the dependency of the temperature with the energy consumption. The sample was tested using a device used to determine the thermal conductivity coefficient.

The coefficient of thermal conductivity characterizes the property of the materials to conduct the heat flow. The thermal conductivity of solid materials has very different values, depending on the nature and properties of the materials. Moisture greatly increases the thermal conductivity of materials. The thermal conductivity of wet material is higher than the sum of the conductivities of water and dry material. For porous materials, thermal conductivity decreases with increasing porosity (apparent density), tending towards the thermal conductivity of air which is 0.023 [W/(mK)] at temperatures of 20ºC.

Figure 1: Sample while tested

In the figure above we have the image of the sample being situated in the testing device. The sample is located between the two metallic plates of the apparatus (hot plate and cold plate), used to determine the thermal coefficient of the material.

3. TEMPERATURE VARIATIONS ON THE SAMPLE

During the testing, the temperature variation in both plates was recorded. The variation durin testing, as well as the equation determined for the fluctuation is presented in the graph bellow. We used the average temperature drop in each case.

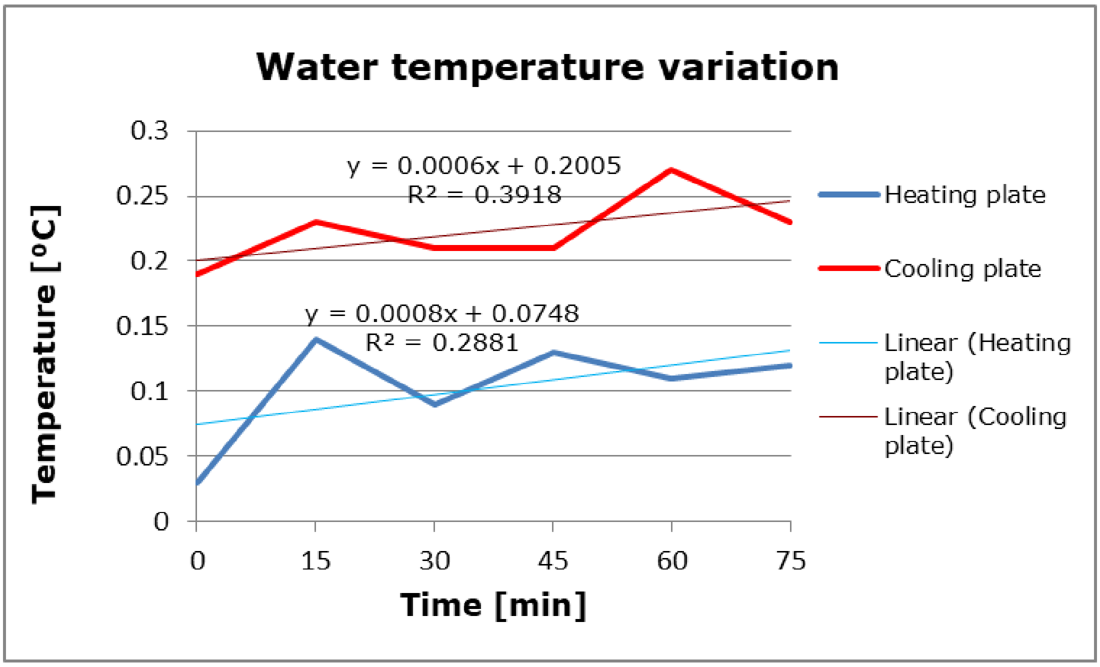

Figure 2: Temperature drop variation for each measurement.

As the temperature in each plate varies, we find a variation in the energy consumption for each measurement(Figure 3), as well as for the heat flow. In our case, the fluctuation can be given by the temperature of the cold water, as well as the flow of air near the installation.

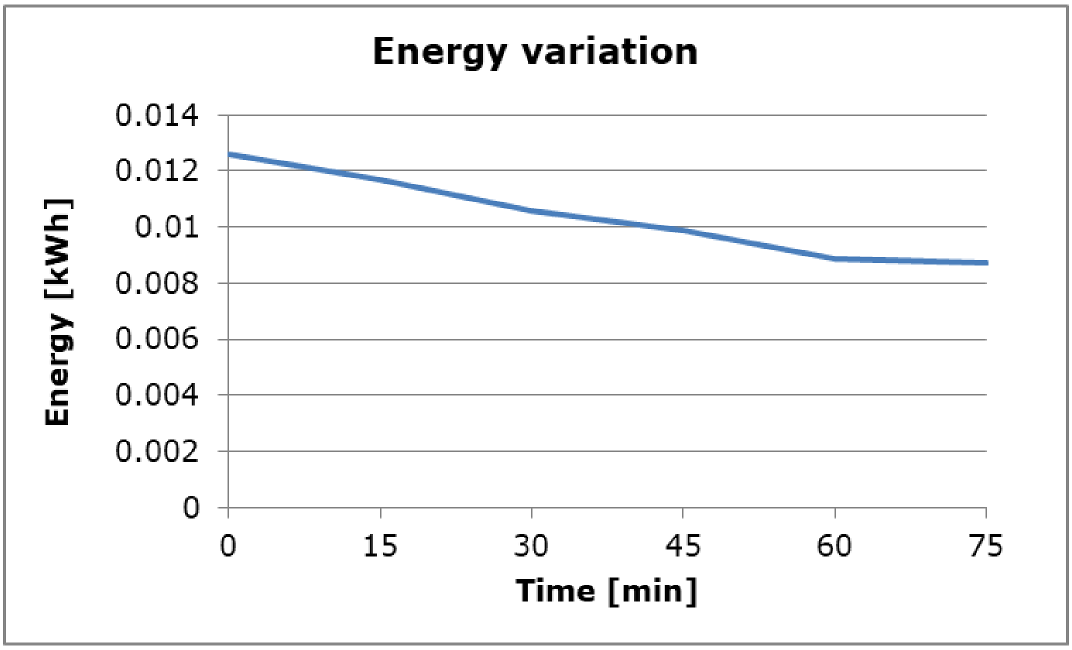

Figure 3: Energy variation for each measurement.

In figure 4 we have the unitary heat flow for each measurement. We recorded a drop in the flow as the temperature in the plate stabilized.

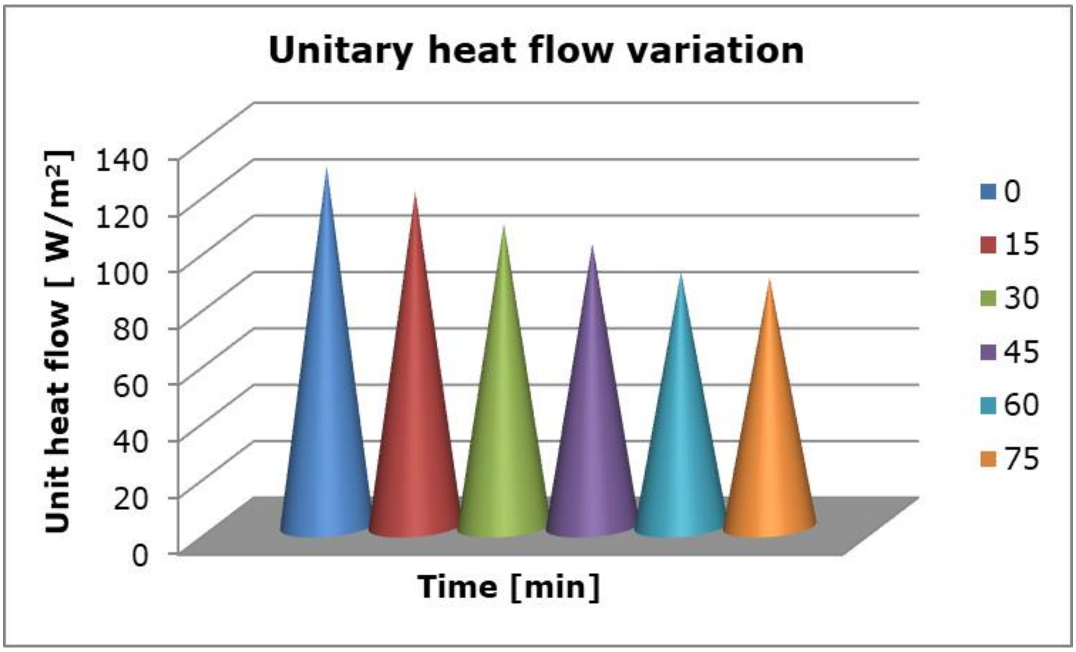

Figure 4: Unitary heat flow variation for each measurement.

4. CONCLUSIONS

According to the obtained results, the chosen material can be used in structures and besides it's mechanical proprieties that can replace some conventional materials, it also register thermal proprieties, being superior to metallic material in this case.

We can also consider changing some of the structure elements with composites based on fiber glass in order to also increase the thermal proprieties of the replaced element.

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