TEMPERATURE BEHAVIOR OF LAMINATED COMPOSITE MATERIALS CONTAINING TEXTILE WASTE

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Abstract. *Composite materials are new materials class, which is growing rapidly due to their special properties and so because of their use. Following the technological process in the textile industry, resulting more waste, in order to capitalize on their part, are made of composite laminates containing textile waste. This paper represents the starting point for the study of the temperature behavior of these composite materials laminated.*

Keywords: *composites, textile waste, temperature.*

1. INTRODUCTION

Composite materials are defined as systems of solids, deformable macroscopic scale achieved through a combination of several materials [1]. There are several variants of the definition of composite materials. The most comprehensive, best characterize their nature is given by P. Mallick, "A composite is a combination of two or more different materials in chemical terms, with an interface between them. Constituent materials retain their separate identity (at least at the macroscopic level) in the composite, however, their combination generates all the different properties and characteristics of the material component. "

Major advantage of composite materials, which consists of the modulation properties and thus to obtain a wide variety of materials, whose use can be extended in almost all fields of technical activity [2].

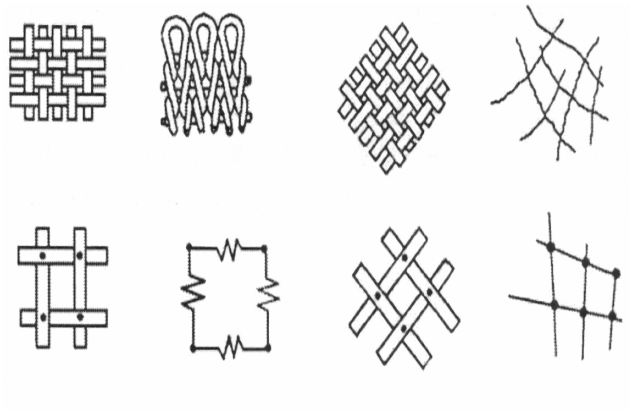

Figure 1 - Textile Structures

The development of textile technologies in the processes of weaving, knitting, sewing, layers of materials are obtained with an architecture in which fiber orientation can be in any direction, not only plan. As well known technological processes, to correlate the last two images in textile products, are braided and woven fabrics obtained, which can be strengthened by needlepunching-mechanical, or chemical processes by applying a binder.

Due to the nature of three-dimensional fiber architecture of the structures obtained is less inclined to delamination and impact resistance to increase significantly. In particular knitted products obtained in the 3D state offers an alternative to laminated plates, the great deformability, the possibility of ventilation - air permeability and good low-cost price. As a 3D knit geometric forms, were studied variants and hexagonal diamond. And additional wires are used to ensure contact between the layers [3].

Figure 2 - Cross section of the direction of rows in knit sandwich

We know two kinds of fiber:
• Natural: Wood (classical cellulose), non-wood (cellulose, hemp, jute, etc.). Main constituents of the plant cellulose fibers (60 ... 80%), hemicellulose (12 .... 23%) and lignin (1 .... 20%). Increasing the length of natural fibers, eg fibers recovered from waste in, from 6 to 12 mm led to a 20% improvement in tensile strength and 100% increase in impact resistance, with the polipropilena/20% composite.

Thus, the waste fiber the preliminary processing, carding and spinning have been tested as reinforcement material in low density polyethylene and polyethylene recovered, resulting in an improvement of elastic properties, the flexural modulus, elongation at break decreased, while maintaining the mechanical strength between the same limits. Vegetable fibers were tested as well as biodegradable matrices reinforcements, for example, starch cellulose fibers, leading to improved mechanical properties and increase the transfer of water temperature and decrease in permeability [2].

• Chemical: artificial (viscose), synthetic organic (polyolefins, polyamides, PAN, etc..), inorganic (glass, ceramic, metal). The major disadvantage of using synthetic fibers that it shows they are not hydrated and does not fibrillates. High strength polyamide fibers is due largely hydrogen bonds of macromolecules. For the production of carbon fiber composites subject of our study were used [9.10]:

a) The fibrous material:

- characteristics of demineralized natural cellulose blown presented in (Table 1).
- carbon fiber with the following characteristics (Tab.2).

b) The auxiliary and additive materials were used:

- romacril ECHP with 45% dry;
- colloidal silica with n = 1.2 gacm ³
- PPE (Polyamide-polyamine-epichlorohydrin) with a concentration of 0.7%;
- ammonium polyacrylate concentration of 11.4%;
- poly aluminum
- antifoam: glanopon 150 g

Table 1. Natural features blown cellulose

Characteristic	STAS	Value
Tear index	Min 105	114.5
Ash, %	-	0.75
Elongation, %	Min 3.1	2.33
Breaking length, m	Min 8000	8152
Conductivity	-	74.7
pH aqueous extract	-	8.5
Humidity, %	Max 40	37.1

Sheets were run on a Rapid Köthen apparatus, the composition of 0.05% and a constant grammage 120g/ cm². Processing and drying the sheets were made from textile fabrics. Calendering was performed on laboratory facility, working schedule is t = 74 ° C, P = 30kN / m, no. footprint = 3. Passing through the grille was made between two carrier sheets.

Table 3. Characteristics of carbon fiber.

Characteristic	Value
Number filaments	12000-15000 (12K-15K)
Filament diameter	9-15
Humidity (EN-STAS 7691-82)	7-9
Appearance – color	Brown or black
Density, kg/m³	1350
Carbon content, %	91-95
Ash, %	0.04
Surface area, m²/Kg	$(3\text{-}4.5)10^5$
Electrical resistance, Ω cm (la 20ºC)	0.06-1.3
Moisture absorption, % la 20ºC şi 65% UR	3.7
Thermal conductivity, W/mK	16.8
Coefficient of thermal expansion, grd^{-1}	$0.6\text{-}29*10^{-6}$

Resulting sheets were tested to determine:

• Filter by determining the permeability properties in air, according to STAS 4749-55;

• insulating properties by determining the coefficient of thermal conductivity;

• Electrical characteristics namely relative permittivity, dielectric loss factor and dielectric strength.

2. DETERMINATION OF HEAT IN COMPOSITE MATERIALS BY ENDURANCE BY TWO CRITERIA FOR TEST

Criterion weight loss

The main steps of determining the temperature index - IT by the criterion of mass loss:

- mass loss was calculated with the equation:

$$p = \frac{m_0 - m_1}{m_0} \cdot 100 \quad , (\%) \qquad (1)$$

where: p (%) - weight loss (%); m_0 - initial sample weight, non-irradiated, (g); m_1 - irradiated sample weight (g). After reaching the limit test results were centralized and mass loss values for each temperature separately. If the value exceeds the mass loss limit according to IEC 216 -2, while the failure is determined as follows:

♣ Determine the mass loss per hour in the last cycle of aging:

$$\frac{p_m - p_{m-1}}{t_m - t_{m-1}} = p_x \qquad (2)$$

Where: p_m - mass loss exceeded the limit (%); p_{m-1} - his

previous weight loss p_m (%); t_m - time (hours)'s appropriate p_m; p_x - mass loss per hour. In the last cycle (%)

♣ Determine the number of hours corresponding value ($p_m - p_{m-1}$) that exceed the limit on the mass loss by simple rule of three

$$\frac{p_l - p_{m-1}}{p_x} = t_x \quad (3)$$

Where: t_x - number of hours that exceed the limit and mass loss.
Determine the appropriate time limit value:

$$t_l = t_{m-1} + t_x \quad (4)$$

The criterion of breakdown voltage
The test is performed according to STAS 10242/1-75 5.2
After the test specimen thickness is measured at the point of breakdown, with an external micrometer. Dielectric strength is determined using the formula:

$$E_{str} = \frac{U_{str}}{d} \quad (5)$$

where: U_{str} - Breakdown voltage (kV), d-piercing occurs where the specimen thickness (mm).

3. AGING AGENTS OF PULP

A number of factors influence the degradation of cellulose, the most important of which proved to be: temperature, humidity, oxygen [7].

Action temperature

It was found from experiments that the rate of degradation increases with aging temperature. Representing the speed variation with temperature for a given initial moisture sheet was acquired in a straight line. Influence of temperature on the degradation rate can be expressed in general by the Arrhenius equation:

$$\ln k\eta = -\frac{E}{RT} + \ln k\eta_0 \quad , \quad (6)$$

where: $k\eta$ is the speed of degradation, T is absolute temperature, $k\eta_0$ is a constant, E is the activation energy of degradation reaction considered (approx. 20Kcal/mol).
Insulation life of their operating temperature can be represented graphically and calculated with his relationship Montsinger: $T = A \cdot e^{-Bt}$, (7)
where: T - life in years t - temperature and C, A and B - constants of the materials. Relationship refers to Class A insulation, exposed to thermal stresses in oil.

Sizes were measured at constant: 7.15 * 10^4 for A and B. Considering t = 0.088 for 105 ° resulting service life T = 7 years. As of end-life criterion was considered insulation destruction by loss of the initial mechanical properties. If temperature increases with t = 8 ° C, reaching an initial reduction of insulation life, t, half, while if Δt decrease of 8 ° C doubles the life 2T .
The equation was extended to dielectric materials in class B and H, with some changes on the value of the constant B. It was found that temperatures are characteristic of insulating materials in classes A, B and H, while maintaining their employment during T = 7 years, after Montsinger are equal to 105 °C, 125 °C respectively 180 ° C.

Humidity Action

It is driven by a simple law, namely: the speed of thermal degradation of the layer is proportional to its water content. This can be expressed by a relationship of the form: $\lg k\eta = \lg \alpha + \beta H$, where: $k\eta$ is the speed of degradation, H is humidity paper, α, β are constant. This relationship was verified experimentally [7] under certain conditions, namely: temperature between 100 and 130 º C and humidity of the layer between 0.6 to 4%.

Influence of humidity H is characterized by constant whose value has been determined almost equal to 0.4[3, 4].

Action oxygen

Oxygen dissolved in the oil and the air layer directly influence on accelerating its aging [7]. Oxygen is harmful especially in the presence of moisture. Direct action of oxygen is manifested in cells open to air free, oil-filled, sheet moisture content of 0.3-0.5% for ages about 2.5-3 times faster than closed cell under vacuum or under nitrogen and for the same moisture content and temperature of 90 ° C, 100 ° C and 115 ° C.

Tests to determine the reaction temperature

Reaction temperature was performed on polymer composite materials which are a result of these tests will determine the temperature index, the composite material used to classify a certain class studied in isolation.

Determine IT

To estimate the temperature index for fiber-based composite materials copoliamidice / carbon samples impregnated with melamine resin Remisol respectively were thermally aged to reach the criterion of degradation at temperatures of 120 ° C, 140 º C and 160 º C. Aging cycles for these temperatures were 160 ° C - 3 days to 140 º C - 7 days and 120 º C - 14 days. Due to the porous structure of these composite fibers, the breakdown voltage was applied, it was found that the material does not resist. Breakdown voltage values obtained were inconclusive and

could not calculate the statistical temperature index as the criterion of degradation was obtained (threshold value) before 100 hours - the minimum number allowed is 100 hours. Fiber composite samples were subjected to thermal aging and test temperature was determined IT index, either by mass loss. To estimate the temperature index mass loss criterion for polymeric composite materials based on polyamide and polypropylene, the samples were thermally aged to reach the criterion of degradation, at temperatures of 120 ° C, 140 ° C and 160 ° C. Aging cycles for these temperatures were 160 ° C - 3 days to 140 ° C - 7 days and 120 ° C - 14 days. Aging temperatures and cycles were chosen according to IEC 216-4. For breakdown voltage are introduced by four discs of 10 cm in diameter and are removed from the oven after the same cycles as the loss of mass. Tested in transformer oil in the air because it presents difficulties: flashover and excessive carbonization.

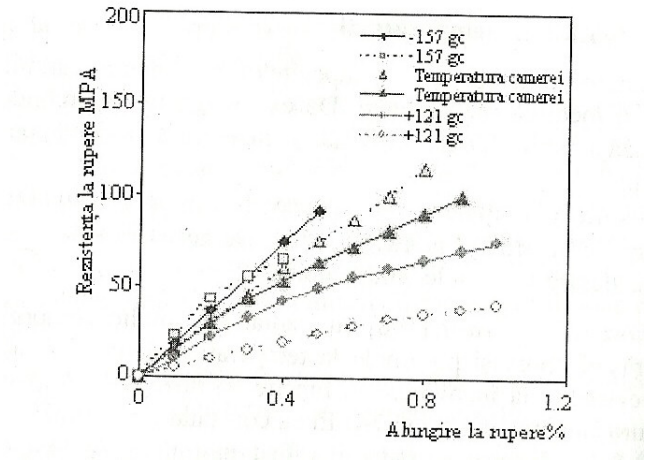

Fig. 3 - Curves of tensile strength - elongation, a function of temperature

Tests to determine the water absorption

These tests were conducted on polymer composite materials because they do not disperse in water. Attempts were made by weighing the samples immediately after they were removed from the oven and then after they have been left for 3 hours in the air. The effect of humidity on fibrous composites was determined by conditioning samples and determination of dielectric characteristics before and after conditioning [8].

4. CONCLUSIONS

Due to the type of fiber used is absolutely necessary to know the behavior of materials obtained both humidity and temperature viscosity. It was found from experiments that the rate of degradation increases with aging temperature and humidity is influenced directly proportional.

Also it was found that temperatures are characteristic of insulating materials in classes A, B and H, while maintaining their employment during T = 7 years (after Montsinger) are equal to 105 °C, 125 ° C respectively 180 ° C.

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