RESEARCH ON NEW MANUFACTURING TECHNOLOGIES OF RUBBER MATERIALS WITH AUTOMATIC INDUSTRY APPLICATIONS

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ABSTRACT: The composite material is an assembly consisting of two or more bodies, with different structure and properties which, by combining the individual qualities of the components, form a heterogeneous material with improved overall performance. The concept of composite material (matrix + reinforcement) appeared in the early 50's, with synthetic laminated materials. The development of science and technology has determined the design of new composites based on traditional materials, the discovery of new materials and reinforcements, the development of the shape and distribution of reinforcements, their adaptation to the technological requirements imposed on the material.
Keywords: composite materials, reinforcement, rubber matrix, properties, experimental methods, polymers, fillers.

INTRODUCTION

Composite materials today meet a number of requirements: high mechanical strength, high wear resistance, high temperatures and aggressive environments. These properties result from the advantageous combination of the properties of several materials in the matrix and in the reinforcement.

The evolution of composite materials has not been marked by economic crises over the years, but rather has been a factor of continuous progress in the development of new products and new technologies, to overcome certain limits of human knowledge. [1]

Composite materials are very good examples of how modern technologies have forced the creation of new materials and how new materials have revolutionized the technique.

In the economic struggle for performance, the quality-price-performance ratios offered by composite materials cannot be neglected. In synthesis, composite materials have the following advantages:

-possibilities to adapt the material to the operation of the part;

-optimization of weight, residual stresses, surface quality and other parameters for the chosen technological solutions (selection of matrix and reinforcement materials, geometry determination, optimal sizing, modern processing procedures);

-possibility to make multifunctional parts that simplify the shape of the mechanisms and allows the increase of performances (small specific weights without affecting the mechanical properties)

Composite materials must ensure the establishment of interface and sometimes even crystallographic connections. The evolution of achievements in the field of composite materials, increases progressively, with the need to use them in various fields such as: automotive industry, aerospace industry, naval industry, sports materials industry, energy, construction, medicine, etc. [2]

Unlike traditional materials, composite materials are created so that their properties are perfected based on the characteristics of the component materials used in the new composite material. Thus, in the field in which their use is desired, composite materials must meet certain required properties.

The ascending use is due to their characteristics, superior to those of classical materials, reduced energy consumption necessary to obtain them, increased resistance to corrosion, breakage, wear, high temperatures, low densities, controllable thermal conductivity, good deformability, dimensional stability, low thermal expansion, impact resistance, etc.

The properties of traditional materials (metals, ceramics, and polymers) can be improved by fiber reinforcement. Composite materials can be reinforced with short fibers, long fibers, continuous fibers or fabrics to improve mechanical properties, because the fibers take over a large part of the stress, thus increasing the strength of the material or structure. The type of fabric used in the composite material is very important because each fabric has different properties, for example, carbon fiber fabric has excellent electrical properties and is used in the civil and military aircraft construction industry, fiberglass fabric, having good anticorrosive properties and resistance to humidity, it is used in the construction of maritime ships, aramid fabric having anti-shock properties, it is used in military applications.

Such fiber-reinforced composite materials have replaced conventional materials, such as wood, steel in a variety of applications. The matrix is the second basic element of composite materials, due to the very good mechanical, chemical and electrical characteristics, epoxy systems are the most used materials in the class of thermoset polymeric materials. The properties of the solid polymer largely depend on the curing agent used, because its type and the volume ratio of mixture between resin and hardener affect the viscosity in the pre-polymer state so it affects the machinability or maneuverability in the stage of effective placement of components in molds.[3,4]

The field of composite materials is still new, especially in terms of its explosive development being marked by the deficiencies of mathematical models associated with the description of the properties of these materials. Researchers in the field of composite materials face difficulties regarding the combinations of matrix-reinforcement elements, training recipes and training techniques, each of these elements having a major impact on the final properties of the formed materials.

Polymeric materials have been used since prehistoric times. While natural polymers retain their intrinsic importance, today's synthetic materials are mostly used. The first man-made polymers were produced in the second half of the 19th century formed by the chemical modification of natural materials. [5]

Polymers and reinforced plastics are used in various important applications, from household items to aerospace products. Polymers have a wide range of physical and mechanical properties that are suitable for a large number of technical applications.

Fiber-reinforced polymers have become some of the most important materials for engineering applications, due to their high specific rigidity, fatigue performance, good chemical and thermal resistance, as well as low costs. Due to their advantages, fiber-reinforced composites are now increasingly used to replace traditional metal materials and widely used in aircraft construction, marine, industry, apparatus, automotive structures, sports equipment, land transport, construction and so on.

The research conducted internationally and nationally for various structures of laminated composite materials reinforced with fiberglass, carbon, Kevlar has focused on the study of the effects of fiber orientation and positioning of the sheets on the mechanical characteristics of these materials, for different load combinations. Also, studies were performed regarding the determination of their rigidity, elasticity, but also of other mechanical properties of these materials. Carbon fiber reinforced composites have excellent mechanical properties, but suffer from brittleness. Self-reinforcing polypropylene hybridization (APRS) is a promising strategy to improve the ductility of carbon fiber reinforced polypropylene. [6]

In hybrid composites, the layers may include two or more fibers, for example, glass fiber carbon fiber or aramid fiber glass fiber and so on. Hybrid composites provide extensive control over the rigidity of materials over strength but also over costs. The transition to a low mass of conjugated structures with a high rigidity and which have a good durability to fatigue and corrosion resistance led to the transition from metal structures to composite structures.

This brings a new concern related to the certification of new components as failure mechanisms and durability requirements of composite materials that differ significantly from those of conventional materials such as metals. In the formation of composites, an important aspect of the combination of matrix and reinforcement is the formation of a chemical bond. Technological additions act as a catalyst, accelerator, fire retardant, protection against ultraviolet rays, etc. Composite materials are part of the "new materials" category and are designed to meet the following requirements:

- resistance to the action of chemical agents;
- corrosion resistance;
- mechanical strength and rigidity;
-resistance to variable demands;
- resistance to shock and wear;
- dimensional stability;
- low weight.

1. Types of products that can be made of composite materials with rubber matrix

Since the beginning of the industrial age, steel and cast iron have been the "heart" of progress in the main industrial sectors. While in developed countries there is already a long-term trend of reducing demand for products from material-intensive industries, as well as a decline in the intensity of raw materials used, low consumption of materials is becoming an essential element of manufacturing technologies in these countries. The need for lighter, stronger and more durable materials is evident. There is a high problem with the high energy consumption incorporated in these materials, but also with their sometimes too high price. Lately, the idea of extending the use of composite materials in the sense of their application for new subassemblies in the automotive industry has emerged.

The car manufacturing industry is the largest consumer of materials in the economy. This industry uses and integrates the products obtained in almost all modern industries: metallurgy, chemistry, electronics, textiles, etc. being the main consumer for most of these industries. During operation, motor vehicles are a major consumer of petroleum products and industrial fluids.

Thus, technical progress, competition in this field and the requirements imposed on vehicles require knowledge of material properties, development of new materials, new processing technologies. In the current stage of development of the world economy based on the laws of the market economy, the correct choice and use of materials and processes for their processing must be done according to scientific rigor, in order to meet increasing demands. [7, 8]

In design, the optimal choice of materials is made according to the conditions of use, the existing requirements, the processing processes, the shape, dimensions and performance of the products, the regulations in force and last but not least the cost. The choice of materials and their processing processes is a difficult but very important stage for the performance and cost of the product. The choice is based on the promotion of cheap and easy to purchase materials, the optimal use of technological properties. At present, the share in the car manufacturing industry has metallic materials, but forecasts show that these materials will be replaced by composite materials.

The replacement of metal materials used so far in the automotive industry has led to increased service life, increased noise and vibration absorption for exterior and intercompartmental insulation of vehicles and to take the kinetic energy of shocks in the event of accidents. In the field of car rims, it is expected to use composite materials that ensure greater flexibility and strength in terms of reducing the inertia corresponding to the high speeds with which the wheels of high-performance cars generally run. It is also worth mentioning the use of state-of-the-art composite technology in the field of braking systems made of ceramic materials on active surfaces by the manufacturers MERCEDES BENZ, PORSCHE, FERRARI. [9]

The constructive improvement of the subassemblies of the classic vehicles is related to the use of some materials with superior qualities and to the extension of the actuation by means of the electronic equipments ensuring the continuous control of the operation of all the components. To a very large extent, safety in operation is conditioned by three factors: the constructive conception of the materials used and the electronic control. It is found that with each generation of vehicles increases the volume of plastics reinforced with carbon fiber and composite materials simultaneously with the spectacular evolution of the quality of these materials.

Against the background of the need for a sustainable resource of raw materials, as well as environmental problems caused by plastics and metals, which are difficult to degrade, car manufacturers are always looking for new materials, especially composites, with low impact on the environment, which after the end of the life cycle, they should be easily recyclable and biodegradable, ensuring the same performances, but to be produced in the most ecological way possible. In search of solutions, science and industry in turn have considered new materials. Large companies in the automotive industry such as Volkswagen, Audi, BMW, Opel, Ford use composite materials. [10]

Ecological design is a methodology used for product design that aims to reduce their footprint on the environment but while maintaining a level of performance and similar functionality. Industrial developments and standardization of the life cycle analysis methodology are the factors that contribute to the development of ecological design. The environment occupies a very important place in society. At the same time, ecological catastrophes and findings such as depletion of natural resources have led to public awareness of the impact of products and services on the environment. Therefore, these new behaviors contribute to the appearance on the market of "green products". The origin of these acts is related to the notion of sustainable development, first appeared in an official report in 1987. In addition to the concern for resources left to future generations, this concept is represented as the intersection of three spheres that designate the environment, society and the economy. Ecological design can be defined by considering the environment in the design stage of a product, to reduce its impact on the environment throughout its life cycle while maintaining the identical quality performance and functions of the product or service offered. One possibility to develop eco-design is to use the Life Cycle Analysis (LCA) methodology as described in international standards.

Composite materials in the future will have more and more an important part in the execution of important, light weight parts, specific to engine parts, but also transmission, suspension. For some structural elements in the construction of motor vehicles, some mixed metal-plastic laminates will be used, also called "sandwich" type (simple or multilayer). These laminates are composed of a plastic material between two metal layers (steel or aluminum), the lamination being made hot, under pressure. They are intended to replace steel, being in competition with aluminum, because they represent a combination between the low weight of the plastic material (polypropylene or polyethylene) and the strength, the rigidity of the respective steel and aluminum. A weight reduction of 50% can be obtained, for an increase of the laminate thickness by 10%. It has good anticorrosive and thermal insulation properties, resistance to heat, chemicals or petroleum products but also a price reduction of 2 ... 3 times compared to steel.

Analyzing the implications of replacing metals with such materials it should be mentioned that the advantage is not only to reduce weight, but often to equal or superior operation. A very important issue is the rational use of raw materials. And from this point of view, it is necessary to reduce the mass of the car, in order to reduce the consumption of materials and increase the percentage of its recyclable mass. [11]

Currently about 75% of the car's mass is recyclable (5.4% non-ferrous materials: 3% Al, 0.4% Cu, Zn, 2% electrical equipment; 70.1% ferrous materials: 13% cast iron, 13% forged , 39% sheet metal, 5.1% mechanical equipment). Remains unrecovered (residues): 24.5% materials: 8.5% plastics, 3.5% glass, 1% textiles, 0.5% paper, 2.8% others, 3% electrical equipment, 4% rubber, 1 % oil and grease.

It is expected that by 2030 about 90% of the mass of cars (those that go out of operation on the mentioned date) will be recyclable and for the new designed ones the percentage will be 95%. In the longer term, it is expected that 100% of the car's mass will be recyclable. Composite materials prove to be competitive both in terms of price and the possibilities of successfully replacing and / or completing traditional materials (metal, ceramics, glass). Research in order to use composite materials aims not only to replace these traditional materials but also specific applications due to the particular properties they present. In determining the physical properties of composite materials, the law of mixtures is used, written in general form:

$$Pc = \sum Pi\ Wi;$$

Pc = properties of the composite material;

Pi = properties of components;

Wi = volume fraction of components.

In the case of mechanical properties, this equation must include parameters that take into account the particle size of the filler, the orientation, the packaging geometry, the specific interactions between the matrix and the filler and the effects along the interface. For these reasons, the physical and chemical properties of composites cannot be described by a single equation. An "easy" material used for a long time and with developed technology, is aluminum. Die-cast, it is used for engine blocks and housings, in which are incorporated (by direct casting or pressing), bushings cast iron or aluminum guide (abrasion resistant, with high silicon content). A greater success is also that of the solidification controlled by locally controlled cooling which allows the influence of the properties in such a way that the different distribution of the mass and the different cooling speeds do not lead to inhomogeneities of structure and resistance. A car body thus made has a weight about 20% lower. The energy consumed in the process is higher, but the additional costs are offset by cheaper recycling of the material. Another easy material is magnesium used especially in the automotive industry for the gearbox housing and the intake block, for steering components, supports, rims. Fiberglass, carbon fiber, etc. are also used.

2. The influence of the properties of composite materials on their fields of use

At present there are many materials used by contemporary industry. Each of them has properties specific to the field of use. We are currently working on obtaining materials with superior characteristics to the existing ones, but it is known that we do not have universal materials that meet all the requirements, so the problem of engineers is to find the right material in the right place. Of course they are materials with phenomenal properties, such as nanomaterials, but industrially, these materials do not multiply due to the technological complexity of production. It is known that in the construction of cars there is a tendency to use materials that have high performance physical-mechanical properties, and on the other hand these materials in terms of cost are cheap. From these materials we can specify the plastics, which have obtained a wide spread in different fields being characterized both by their low cost and by the efficient technologies of obtaining, as well as the field of use. At the same time, a rather progressive direction for obtaining construction materials is composites, which combine in them a whole series of sometimes contradictory properties. The problem of composites is more appropriate, because they have a well-exposed theoretical and technologically feasible support. [12]

The properties of composite materials are based on the transfer of stress from the ductile matrix to the hard fiber. The matrix fulfills two roles, on the one hand, ensures the transfer of mechanical stresses to the fibers, on the other hand, allows the incorporation of fibers. The elongation difference between the fiber and the matrix represents the lever through which the load is transferred, which results from the different modulus of elasticity of the components. Depending on the field of use, composite materials are applied in aerospace construction.

Here the carbon-carbon and ceramic-ceramic composites behave very well due to the very good resistance to compression, fatigue, wear, thermal shocks, they have a chemical and biological inertia. Due to these characteristics, composites produce aircraft engines, thermal protection elements of the rocket body, aircraft braking systems, etc. [13]

Most car manufacturers use polymer composite materials with exceptional results. Composites with plastic matrices reinforced with fiberglass, boron, carbon, Kevlar, or metal carbides have a wide application in body construction, containers, tanks, parts with complex configuration, clamping, cages for bearings, gears, etc. . Composites with metal matrices reinforced with boron fibers, glass, carbon, and carbon-carbon composites, ceramic-ceramic are used to make heat engines, break discs for cars, etc. Fiberglass has a great use in this field in the production of high speed telecommunication cables for remote data transmission. Composites of telephone cables are also made of composites, as well as a large number of parts in the structure of telecommunications devices. Prostheses are built from these materials, which must meet a large number of biochemical requirements.

3. Analysis of the effects produced by the composition of composite materials on their use properties

Structural analysis is an extremely important operation and has applications in most industrial fields, both in aviation and in vehicle design. Stress and deformation maps obtained from structural analyzes have an important role in the design and integration of composite quality monitoring systems. The use of composite materials has seen a great development in recent years when a new generation of materials has been developed, namely, smart materials. Knowing the behavior of composites in different loading conditions both statically and dynamically offers valuable results for design engineers in the aerospace industry who aim to develop ultra-lightweight materials with high rigidity. The aerospace industry usually works with structures with special requirements, such as minimum mass and resistance to a large number of tests.

In order to reduce the consumption of time and financial resources, engineers in the aerospace industry have adopted the design based on structural analysis. This involves the use of the finite element calculation method which has become one of the most useful engineering tools.

Computer aided design (CAD- Computer aided design) and Computer aided engineering (CAE-Computer aided engineering) are considered tools that have a considerable impact on the design, processing and lifespan of composite structures. After the improvement in both data integrity and analysis accuracy, they motivated design engineers to adopt CAE and CAD as the main tools in order to reduce prototype production and experimental testing to demonstrate design concepts. [14]

In the manufacture of composite materials, the application of computer-aided design and engineering tools includes the design and analysis of finite elements (FEA), the execution of virtual prototyping sketches and the control of processing processes including the control of robots and optimization processes. CAD and CAE applications include design rules that are in accordance with design norms and standards.

The purpose of these tools is to reduce the time and costs for making a new product. The use of specific design software and structural analysis leads to the minimization of design errors due to the human factor.

4. Methodologies for selection of composite materials with rubber matrix for the realization of different types of products

The functional quality of a composite structure means the expression of the degree of utility of that structure, insofar as by all its technical-functional, psycho-sensory and economic characteristics, it satisfies the need for which it was created to respect the restrictions imposed by the general interests of society on socio-economic efficiency, protection of the natural and social environment. Quality also represents the technical level of structures / components, because a structure with low technical performance cannot be considered as quality.

For the appreciation or evaluation of the quality, in practice the quality parameters are used.

These are quantitative or qualitative properties used to highlight the quality requirements imposed on products and / or their components. Usually, in the industrial field, a series of quality parameters are used, such as technical, economic parameters, etc. [15, 16]

The technical parameters refer to the intrinsic characteristics of the structure, meant to satisfy to a certain degree a utility. In general, these parameters can be measured directly or indirectly with sufficient accuracy by technical means. Among the more semi-significant technical parameters, the geometric or dimensional precision of the respective structure / component and the kinematic or movement precision have a special importance. The economic parameters represent the economic aspects of the production and use of the structures. These are expressed by a series of specific indicators, such as the cost of production, the price, maintenance costs, yield, and the degree of value of the raw materials. [17]

The analysis of the quality of the functioning of a structure / component is an essential activity within the quality assurance cycle, at the level of industrial companies. The quality analysis activity involves the analysis of an inadequate current state in order to identify ways to intervene in order to reach an acceptable, better future state. Solving these problems involves going through a universal cycle shown in Fig. 4.1

During these processes there may be some errors that must be avoided, the wrong proposal of the problem to be solved and the rapid application of a solution that proves over time that it is not the optimal one. It is well known that metal alloys and composite materials can be considered orthotropic materials. Consequently, a series of experimental methods are needed to be able to provide information about the state of stresses and their deformations as well as highlighting the mechanisms of failure of structures.

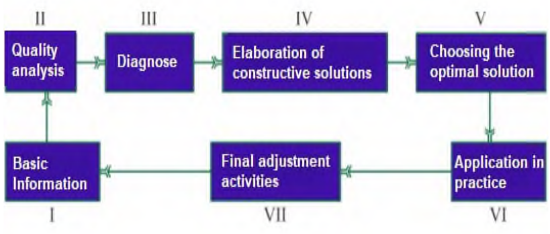

Fig.1 Universal cycle of functional quality assurance

This information can be provided both from the surface of the specimens and from their volume.

In this sense, the most used (and most accessible) experimental methods acquire information only from the surface of a structure. [18]

Of course, some more special and expensive experimental methods are able to provide information inside the structures, but in industrial practice they operate with a wide variety of investigation techniques and combinations of them, of which the most used, are:

-electro-resistive tensometry;
-photoelastic methods;
- Moire’s method;
-thermographic methods;
-radiographic methods;
-ultrasonic methods;
-acoustic emission method;
-metal image correlation method (VIC - Video Image Correlation).

All these techniques and methods can be applied to perform determinations and analyzes on structures made of metallic and composite materials, taking into account certain constructive features of the material, structures, related to orthotropy, inhomogeneity and rigidity, which require appropriate adjustments, both in terms of regarding the use of the proper experimental method, as well as in the interpretation of the measurement results.

5. Analysis of the way in which the structure of composite materials influences their properties

Among the polymer composites that fall into the subgroup of batch polymers (fig. 5.1), a special interest is the composite materials with dispersed fillings and the composites with fibrous fillings (reinforcement). Composites with dispersed fillers (charged plastics) are compositions composed of polymers and filler or charge materials. The polymers used in the manufacture of this type of material can be thermoreactive (phenolformaldehyde resins, carbonyl, epoxy, unsaturated polyester, etc.) or thermoplastic (polyamides, polyolefins, polyvinyl chloride, polysulfones, polycarbonates, etc.). As dispersed fillers can be used: sand, quartz, diatoms, silica (powder, colloidal, airgel), kaolin, mica, silicates (sodium, potassium, aluminum), talc, calcium metasilicate, asbestos, flakes, microspheres hollow or solid, granules), limestone, ground chalk, precipitated calcium carbonate, metal oxides (zinc, aluminum, titanium, manganese), barium sulphate, silicon carbide, carbon black, wood flour, ground bark , lignin, etc., if they have a submillimeter dimension. The main types of charged polymers are included in fig. 5.1.

From a theoretical point of view, the associations that can be made between different polymers and the wide range of fillers are infinite. In practice, however, although numerous, the polymer-filler associations are limited. Among the thermoplastic polymers for the processing of which fillers can be introduced, the most important are: polyolefins, polyamides, ABS polymers, polyesters, polycarbonates, PVC. The way in which the fillers influence the characteristics of these polymers depends on the nature of the polymer, the nature and proportion of the filler, the conditions for obtaining and processing the mixtures.

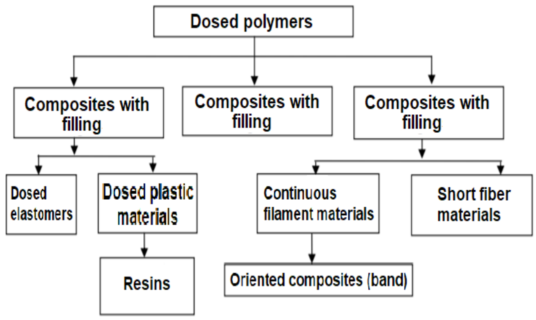

Fig. 2 The main types of polymeric composites in the subgroup of charged polymers.

Usually, the processing of thermoplastic polymers does not require fillers, their introduction being made either to reduce the cost price and improve the machinability, or to modify, within certain limits, the physical-mechanical properties of these polymers. Studies have shown that, in the case of all mixtures consisting of thermoplastic polymers and fillers, apart from the nature and proportion of the components in the system, the characteristics obtained are also determined by:

-form and size of the filling material particles;

-degree of distribution of the particles of the filling material in phases (polymer matrix);

-the adhesion of the polymer to the filling material;

Usually, with the reduction of the particle size of the filling material, the physical-mechanical properties of the mixtures containing them are improved. Due to these findings, for the charging of thermoplastic polymers, very finely divided filling materials are preferred, which also ensure an improvement of the surface characteristics and the optical properties of the products. However, increasing the degree of grinding of fillers causes them to become more expensive. In order to obtain good physical-mechanical properties of the products from thermoplastic polymers that contain dispersed filling materials, it is necessary a uniform distribution of them in the polymer mass. A good adhesion of the polymer to the filler material and the ability to moisten the filler by the polymer allow to obtain compositions with a high content of addition and with acceptable physical-mechanical properties. [19]

Because the vast majority of fillers are lyophilic, they are difficult to disperse in the mass of polymers, they are not wetted by them, and the polymer-filler adhesion is low. These inconveniences can be alleviated by resorting to a surface treatment of the fillers, carried out by:

-chemical interaction of fillers with compounds that possess functional groups;

-chemical absorption on the surface of the particles of the filling material of some modifying agents;

-coating the filler particles with a suitable coupling agent.

These processes are generally laborious and cause an increase in the cost of fillers, but offer the possibility of considerably increasing the content of fillers in mixtures, without worsening their characteristics. In recent years, more and more macromolecular compounds are being used to change the surface of fillers. This can be done in two ways:

- polymerization of some monomers on the surface of the filling material;
- coating the particles of the filling materials with a polymer layer.

Starting from the last process, it was concluded that good physical-mechanical properties and an improvement of the machinability of composite materials can be obtained by the direct introduction into the system of macromolecular compatibility agents. In the vast majority of cases for the processing of charged thermoplastic materials, the techniques used in the case of thermoplastic polymers are used, the construction of the equipment used being special. The range of products that can be made of charged thermoplastics covers all areas of use that characterize unloaded plastics.

6. Theoretical and experimental possibilities to improve the properties of rubber matrix composite materials

Fisher introduced for the first time the dynamic vulcanization of rubber dispersed in thermoplastic material (TPV). After some time, the Qur'an and its collaborators developed this dynamic vulcanization technique, and Ismaeil Ghasemi showed that this process optimizes properties such as high temperature resistance, oil resistance, breaking strength, etc.

It was found that by dynamic vulcanization and compatibility, ethylene-propylene-terpolymer (EPDM) rubber particles disperse more easily in the mixture, making it possible to develop new and innovative materials and techniques capable of eliminating waste.

The possibility of reintroducing waste into the production process, without negatively influencing the quality of composites, leads to a reduction in the cost price of products from the entire industry and consumer goods. The composite material, based on polypropylene (PP), rubber - EPDM, compatibilizer polypropylene grafted with maleic anhydride (PP-g-MA) and crosslinking agents, is intended for the manufacture of products for example for the footwear industry, such as: soles , heels, fringes, etc. And consumer goods. Realization and experimentation of dynamically vulcanized polymer composites based on PP, rubber - EPDM, compatibilizer - PPg-MA and crosslinking agent ensure quality performance, greening the technology to obtain them, to meet current quality and aesthetic requirements. Dynamically vulcanized polymer composites based on plastomer / elastomer (PP / EPDM) have been tested and characterized from a physicomechanical point of view (according to the standards in force) and structurally by appropriate techniques. The preparation of composites based on

PP and EPDM rubber, compatible with PP-g-MA were performed on a double-screw extruder-granulator and the parameters are kept constant until the mixture becomes homogeneous. The mixture is granulated through a thin-threaded mold, cooled in a water bath with a drawbar that directs the material into the hot air drying chamber and is then packaged for transport. Then the obtained granules are prepared by mixing technique, on a mixer type Plastic Corder Brabender - 350 E Germany, with crosslinking agent (PD, mixing time 3-5 min.) At the mixing speed of 280 rpm, the temperatures in the three zones: 165/175/175 ° C, air cooling.

After this process, the polymer composites obtained are introduced into molds, depending on the samples used for the physical-mechanical characterization, for the finished products, using an electrically heated press. [20]

Differential calorimetric analysis (DSC) measurements were performed in a temperature range of 120 ° C-190 ° C. In general, the values of the melting temperature in the thermograms reflect minor changes in the samples compared to the PP thermogram, this being the basic material in which the other components are distributed. The experiments show the technology of making dynamically vulcanized polymeric composites based on polypropylene and EPDM rubber, compatible with PP-gMA and crosslinking agents - PD, using specific processing techniques, physically-mechanically tested according to current standards and characterized by electron microscopy scanning (SEM) and differential thermal analysis (DSC). From the scanning electron microscopy it is observed that the sample is characterized by a homogeneous dispersion of vulcanized EPDM rubber given by the presence of the compatibilizer, which demonstrates a processing at the optimal technological parameters of dynamically vulcanized polymer composites based on EPDM and PP rubber. The data from the DSC analysis show the same appearance of the samples containing EPDM, PP-g-MA and that the temperatures are slightly decreasing compared to the PP sample. The thermograms of the samples demonstrate the presence of EPDM and PP-gMA, respectively, by decreasing by about 15 ° C, a change that shows that the two components change the viscosity of the composition. Experimental data of polymer composites based on PP / EPDM / PP-g-MA / PD demonstrate the possibility of application in the footwear and consumer goods industry. [21,22,23]

CONCLUSIONS

The research is based on the analysis of a considerable number of studies carried out in this direction and on the study of specialized works in the field. The aim is to analyze the elastic properties of laminated sheets with different fabrics and matrices made of three different types of epoxy resins. Starting from the main purpose of the study, a program of documentation, training and testing of materials and interpretation of experimental data was followed.

Mechanical tensile tests for specimens were analyzed in order to acquire data that would allow both the comparative analysis of their elastic properties (when reinforced with the same type of fabric) and the comparative analysis of different materials.

In the case of composites reinforced with fabrics there are many approaches regarding the theoretical determination of the values of elastic constants, most of them taking into account certain geometric characteristics of fabrics: fiber bundle dimensions, fiber bundle shape, fiber bundle ripple factor.

For future studies are interesting (from the perspective of completing the information presented):

- testing composite materials reinforced with fabrics and epoxy matrix (laminated) for thermal behavior: specific heat (DSC) and determining the degree of thermal expansion (TMA);

- performing mechanical tests of laminates to determine the bending properties;

- formation of new composite materials reinforced with the same fabrics and other types of epoxy matrices;

- analysis of the elastic properties (tensile) of special composites made of only two sheets (with the same orientations of the fiber bundles or with different orientations thereof) to better understand the proposed mechanisms to explain the different behavior of materials made and tested in the present study;

- from the design perspective, it would also be interesting to study the mechanical behavior (traction) of special composites made of two layers of reinforcement (two sheets) reinforced with different fabrics;

- for dynamic stress tests it is necessary a careful analysis of the maximum and minimum values of the load on a cycle so that they fall within the elastic response range of the material (very narrow as shown for both sheets and laminates) ;

- finding a software solution for exact identification of the load corresponding to the exit from the first level of elasticity for the correct definition of the fatigue test conditions (at this moment the data returned by the machine after static and dynamic tests are different due to the fact that they are used two different software applications);

- finding a viable solution in terms of video monitoring of mechanical tests to identify critical moments;

- finding a technical solution for inspecting the quality of materials before and after testing to validate various assumptions related to failure mechanisms.

The goal for future composites is to present a mix of innovative short-term practical applications as well as ideas to inspire new solutions to present and future challenges in their design.

It can be stated that at the level of industrial companies, the analysis of the quality of operation is a very important activity within the quality assurance cycle. In conclusion, we summarize that composite materials have a number of advantages over classical materials:

-resistance to oxidation, corrosion the biological factor of microorganisms;

-dimensional stability at temperature variation, expansion is reduced by the presence of fibers and the existence of interferences that behave as thermal barriers;

-resistance to friction, as it is known that the intensity of the friction process can be diminished by lubricating or hardening the coupled surfaces, so composites were designed to withstand both variants, in the first case metal composites are made, where the metal matrix makes the load-bearing , and the dispersed fibers, non-metallic, behave as lubricants;

-very low coefficient of expansion compared to metals;

- durable in operation, for example, 5 kg of steel can be replaced, at an equal duration of operation, with 1 kg of Kevlar (light composite material, polymer fiber);

-chemical stability and high temperature resistance: teflon, Kevlar and hyphil fibers keep their properties up to 500 º C, and ceramic ones - up to 1400 º C;

-extremely low density, composite materials with resins reinforced with boron, silicon or carbon fiber have a density of 2kg / dm3, and those reinforced with fiberglass are about 80% lighter than steel;

-traction resistant, composite materials with whiskers are 5 to 30 times stronger than the material of which the matrix is composed;

-the production of composites consumes less energy than the production of steel, aluminum and copper, and the processing facilities are not so expensive, because the composites can be easily made by rolling, spraying, extrusion, injection, etc.

As concerning the study regarding the quality of operation, it can be observed, at the level of industrial companies from all over the world, a preoccupation in the direction of developing analysis methods that would lead to the optimization of the constructive solutions of the composite structures.

Unlike the methods of analysis of structural defects which are of an experimental nature, these methods have more of a statistical-probabilistic aspect and involve a series of diagrams, correlation tables but also simple mathematical calculations meant to avoid defects. The working principle is to find optimal solutions that keep the structures at an optimal efficiency throughout their life. That the applied methods have a real effect, at economic level, it is followed throughout the processes in which the structure is involved, that the quality parameters indicated by international standards are found in the value range accepted and mentioned in the technical documentation of that structure. Also, the knowledge of the quality parameters as well as of the methods of analysis of the functioning quality constitutes a real advantage in the design of some structures with a life as long as possible.

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