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The Importance of Technical Experiment in the Teaching Process

Education in Highly Progressive Materials and Technologies

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Abstract

In the 20th century all industrialized countries need to recognize the essential role of theory-based technical education in the efforts of commercial and industrial competitiveness, and its main role in strengthening human potential. As the world's rapidly growing volume of public funds, entered into support-oriented projects in the field of high-tech materials, increasing the responsibility of universities and other research organizations to use them effectively. This is subject to the professional qualifications of investigators of these projects. Currently, composite materials are considered like progressive materials 21st century, they can solve many of the current problems with light, faster and more efficient materials, components and systems. We have to take full advantage of the benefits from the application of composite of materials, not enough for us just the research and development of new products, but we also have other professionally educated successor in the younger generations. And that's why today of great importance also have activities related to education and training.

Die Bedeutung des Technischen Experiments im Unterricht

Bildung in stark progressive Materialien und Technologien

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1 Introduction

Composite materials – they surround us at every step, we use them almost constantly. Their production grows perpetually. The trend of evolution and production of plastics and composite materials in the world is giddy.

Composite materials have gained popularity (despite their generally high cost) in high-performance products such as aerospace components (tails, wings, fuselages, and propellers), boat and scull hulls, and racing car bodies. More mundane uses include fishing rods and storage tanks.

In comparison to common materials used today such as metal and wood, composites can provide a distinct advantage. The primary driver and advantage in the adoption of composites is the lightweight properties. In transportation, less weight equates to more fuel savings and improved acceleration. In sporting equipment, lightweight composites allow for longer drives in golf, faster swings in tennis, and straighter shots in archery.

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While in wind energy, the less a blade weighs the more power the turbine can produce. Besides weight savings, the most important benefits of composites include: non-corrosive, non-conductive, flexible, will not dent, low maintenance, long life, design flexibility.

Although composite materials have certain advantages over conventional materials, composites also have some disadvantages. The common one is the high manufacturing costs. However, as improved manufacturing techniques are developed, it will become possible to produce composite materials at higher volumes and at a lower cost than is now possible.

However the development of teaching of plastics technologies in learning is not as dynamic as the industrial sphere demands from technical vocational schools. Our educational institutions are far at the teaching of these materials – both for theoretical teaching (lack of qualified teachers of practice, outdated textbooks and professional learning materials) and at practical training as well – there is the absence of masters of vocational training with practical skills, specialized classrooms and modern practical teaching and procedures as well.

However, the students were interested in technical fields, it is necessary that during his basic and secondary education gradually develop a positive attitude towards science, which can greatly help the teachers themselves biology, chemistry or physics.

You cannot, however, assume that the company will have enough comprehensively educated people who apply in the field of composite materials. We must reckon with the fact that the field will discover people without eg. deeper knowledge of material science, physics, general chemistry, one must therefore first of all ask the question "Who will educate and train?"

2 Technical experiment

Technical experiment is irreplaceable in laboratory work at universities and in the sphere of industry. It has the most important role in establishing selected value and the measure of its uncertainty. Technical experiment can be divided into these stages:

- preparation (study of alternatives of measurement, selection of the method and measuring device etc.),
- realization of measurement (necessary work for gaining the data in graphical or numerical form),
- evaluation of measurement (enumeration of value of wanted quantity and of the size of its uncertainty, determination of mathematical methods, functional dependence etc.) and
- achieving (protocol about the measurements).

The selected method vacuum bagging of composite materials influences the process of experiment, quality and range of information which we expect from technical experiment.
The experiment is suitable for groups of students in the number of 2-10 members. The time of realization of all experiment is only several hours it is not possible to realize it during one or two lessons. It is possible to realize this experiment also as the half day block, but it is necessary to count with the technological time of polymerization of resin for one or two hours. It is ideal to divide the experiment into two hours sections when you work with the group of four members.

3 Technical school experiment

Technical school experiment is characterized as planned and purposeful mental activity to gather knowledge, which leads to deeper, but also to the general technical understanding. (Kropáč, J., 2004)

Technical experiment in educational terms is also development of individual creative activity of students, development of their logical thinking, acquiring scientific and technical ideas about tested objects, developing positive and realistic attitudes towards technology, detection of physical laws, creating a right relationship to the technical means and the development of communication skills of students. Technical experiment contributes to the acquisition of practical skills and general work habits of students. [HRMO, R., 2009] Students must be regarded technical experiment as a necessary and natural impact their study activities needed to observe chemical and physical phenomena and verified theories and material laws. (Kučerka, D., 2015)

3.1 The use of specific material properties of composite materials in the didactic process

Composite materials comprise a fairly wide range of plastic materials. They have their own characteristics, advantages and disadvantages. Their specifics include the fact that a material is produced at the same time with the product. It was this specific property of composites, which we can effectively use in the didactic process. Currently in the process of making 'own material and own product „receptive teachers can create opportunities for understanding the physical and chemical relationships not only in composite materials sector, but in plastic materials totally.

3.2 Learning equipment

Another "advantage" of composite materials is their relatively modest financial applicability. For the composite product we do not need expensive technological equipment. For production, a structurally simple mould from composite, surface treated wood or metal is necessary. It is also very suitable vacuum pump, (but not absolutely necessary), especially for less manually skilled students. For the advanced learning process (at more complex experiments when the prepregs is used) is the use the furnace with vacuum needed. Learning set for the manufacture of composite materials may be included of the chemical laboratory.

3.3 Materials

A special part of the didactic process is to familiarize with the treated materials. While in conventional plastics we can only see the final product material (granule, plates or profiles), in composites the situation is much more interesting. We can monitor and compare the character reinforcing components, which can be used in various forms and types of materials (glass mats, carbon fabric, roving, chopped strand). Each type of reinforcement has a specific function, it is important to know its function in follow-up process.

Also choice a study of the properties of the used resins is didactic site interesting process. The second essential is polyester resin and epoxy resins are generally basic synthetics resins in composite industry sector. Other types, especially for their difficult processing, availability and handling demanding in terms of safety are not suitable for study purposes.

Special (and didactically very thankful theme) is exploring so pre-impregnated materials - prepregs. An interesting feature of these materials is the fact, that these materials are mostly used in the aircraft industry (for some aircrafts even its use is up to 50 %). Their general disadvantage is their high cost, it is also necessary for their processing to use vacuum and hardening furnace (in the aerospace industry are the autoclaves used). Also, for storage of these materials a freezer box is needed. Therefore, prepregs are more suitable for higher levels of education (high schools or universities).

4 The scope and specification of technical experiment

Scope and subject of specific technical experiment on topic "composites" can be determined by a number of respects, notably by:

- range of lessons,
- the type of professional teaching (composite materials can be used in chemical, plastic, material, artistic, or automotive discipline),
- the quality of laboratory equipment and the school,
- material options,
- the number and composition of students,
- didactic objectives of teacher or school.

5 Technical experiment in terms of the teaching discipline

In the case of chemical fields are experiments conducted to examine the chemistry of reactions. It is possible to monitor the time course of the reaction, the temperature during the polymerization, the effect of reinforcement and fillers on the reaction temperature and the subsequent structural strength. It is easy to follow exothermic polymerization phenomena during process.

In the case of fields of plastic processing (or automobile fields) experiment will focus on the production of a specific technical product. All material elements and manufacturing process will be discussed before production process.
In the case of art and design fields of study the project will be focused to design, shapes, contours and colours of handiwork. We can apply the simple exercise of mixing and casting polyester or epoxy resins. The casting mould can be of various types and shapes (small metal moulds that are used for baking, the casting of various statues and objects). We can use various types of fillers or colour pastes for treatment of casting mix during casting process. When synthetic resins are casted, however, is not found in composite materials - while not applying reinforcing components. Filler modifies mechanical and physical properties, but does not change their properties such as glass, carbon or Kevlar reinforcement. Applying of reinforcing components in the form of woven fabric material achieve specific properties that we can use for production of larger body or real product. (Using this experiment, students observe a significant effect of reinforcement on the strength of material. By this way it is easily possible production of containers, flower pots, holders, and art objects. Imagination has no limits - is necessary only imagination along with creativity in the production process and artistic works. (HRMO, R., 2015)
The main advantage of composites in the learning process is relatively simple possibility of producing simple technical products. Of course, this phase of study of composites should be preceded by phase of simple task described in the preceding lines. Also detailed acquaintance with materials either in theory or practical terms is necessary.
Production of various moulds for either casting or production of specific products from silicone, plaster, wood or composite material can be a separate chapter of the didactic process in modeller and moulders disciplines or in art and design fields.

6 Technical experiment in terms of monitoring specific material properties

By hand lamination and subsequent vacuum process we can easily produce rectangular or square size samples as necessary. The samples will be used in the testing process and for observation of various interesting phenomena. Here are a few simple tests proposals:

- Comparing of composite beams by various material composition.

The beams are made to size 250x25x optional thickness in mm according standard ISO 527). Beams will be made e.g. from one type of epoxy resin, but will be reinforced by various types of reinforcement - eg. glass fabric or carbon fabric. The carbon reinforced beams during bending have clearly visible higher flexural strength compared with the reinforced glass beams. Also reducing of weight of carbon reinforced beams is possible to observe!

- Tests with Kevlar fabrics.

Kevlar is generally very resistant fabric against breakdown. Excellent comparison of thin plates reinforced with Kevlar against glass reinforced plates. The Kevlar plates clearly show higher resistance to penetration of a foreign body. (example from practice - Kevlar vests and helmets in military industry).

- The effect of sandwich structures.

If between fabric is core material (lightweight porous material which has a considerably greater thickness than fabrics) added a sandwich structure is created, which has a much higher torsion rigidity than composite monolith consisting only from fabrics.

- The effect of increasing strength using unidirectional fabrics.

In case, if we put unidirectional fabric in one direction only (into named basic direction), in this direction will have material a much higher strength than in a direction perpendicular to the basic direction. Destructive testing can follows.

- Tests of burning material.

Generally organic material such as glass has a greater flame resistance such as synthetic reinforcement like carbon or Kevlar. The possibility of comparisons, but special devices or laboratory is needed.

- The using of alternative reinforcement.

We can use alternative reinforcing from natural materials such as jute, flax, hemp or cork as core material.

7 Technical experiment in terms of monitoring specific physical processes and phenomena

Except to observing the chemical reaction of polymerization of synthetic resin as the main plot of composites production can be observed several other phenomena and properties of materials.

- Material viscosity

During the experiment, students have a real opportunity to examine and assess the viscosity of the liquid (resin) and its impact on the processability and final characteristics of the product.

- Separation process

During manufacture of the product is required separation of moulds. Therefore, awareness of the needs and the application of this process help students understand the separation process.

- Vacuum process

Also vacuum degassing process helps students become familiar with practical principles of vacuum.

- Temperature

Students are observing effect and development of the temperature during the polymerization of the product. Technologically recommended temperature generally leads to good results.

- Establishing and measuring

When preparing material for the production of either product samples or simple tests samples students are using knowledge of physical units of weight, length and volume. They use knowledge practically - they measure, weigh and dose.

8 CONCLUSIONS

Educational programs should be designed to reflect the efforts of key scientific and engineering trends and efforts to ensure coevolution of technology and human potential. [HRMO, R., 2005]

As required equipment before own training in composite materials is the knowledge of the latest knowledge of science and the latest engineering technology (the ability to turn knowledge into the practice in materials engineering, mechanics, physics, or materials science).

In the 20th century all industrialized countries need to recognize the essential role of theory-based technical education in the efforts of commercial and industrial competitiveness, and its main role in strengthening human potential. As the world's rapidly growing volume of public funds, entered into support-oriented projects in the field of composite materials, increasing the responsibility of universities and other research organizations to use them effectively. This is subject to the professional qualifications of investigators of these projects.

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