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Research Article

PHYSICO-CHEMICAL PROPERTIES OF POLYMER COMPOSITES

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ABSTRACT

The article deals with the role of physics in the modern national economy, production and scientific system. A number of issues are considered, such as physics, the subject of the school curriculum, the methodology of teaching physics, the basics of professional training of a physics teacher, the content and tasks of the methodology of teaching physics, the methodology for studying the methodology of teaching physics, the history of the development of methods of teaching physics.

KEYWORDS

Pedagogy, professional training, pedagogical methods, lecture, laboratory classes, education, teaching, methodology of physics, methods, efficiency, assessment, lesson, tournament.

INTRODUCTION

Life is now hard to imagine without polymers. Gadgets, clothes, spare parts and even contact lenses are created from them. And the DNA molecule itself is also a polymer. RBC Trends found out what polymers are and how they are obtained Read more at RBC: What are polymers The word "polymer" comes from the Greek: pollá (many) and méros (part). Polymers are substances that consist of many monomers (structural units). Polymers can be linear, branched, or networked in structure.

The number of monomer units and the molecular weight of each of them affect the properties of the future material. Read more at RBC: The name of the synthetic polymers used in the article: Polyethylene is a thermoplastic polymer of ethylene. Polyurethane - The raw material for this polymer is polyol. It is obtained from crude oil. Polyamide - obtained as a result of the chemical processing of coal, gas and oil.

Polyvinyl chloride (PVC) is a synthetic thermoplastic that is made up of chlorine and ethylene. Bakelite is a reaction product of phenol and formaldehyde under

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pressure at high temperatures. Polystyrene is a material obtained by polymerization of styrene.

Since the change in the economic mechanism, the global polymer industry has set a course for deep integration into the international division of labor in the production of polymers and occupies leading positions in a number of areas. For example, in the production of polyolefins (polyethylene, polypropylene). From the point of view of economic efficiency, the polymer business is aimed at acquiring the most promising Western technologies and depositing them in all production points of the world.

Research methodology. Polymethy methacrylate (plexiglass) is a polymer that transmits light and looks like glass. Polyester fiber - used as a filler in toys, blankets, pillows, furniture. Polypropylene is a solid substance that is obtained as a result of the polymerization of propylene (colorless gas). Polyamides - this group of plastics includes nylon, nylon, and anid. Teflon is a polymer that contains carbon and fluorine (polytetrafluoroethylene).

Polymer composites are made from two or more components. The polymer acts as the main (matrix). Polyacrylamide (PAA) is a white, odorless polymer. Soluble in water, glacial acetic and lactic acids and glycerin, but insoluble in ethanol, methanol and acetone.

Polymer applications Polymers in the oil and gas industry.

Oil and gas is not just a source of fuel for most modes of transport, but also a raw material for chemical production. It is from petroleum products that most types of polymers are created. The obtained polymers are also used in the extraction process itself. Thus, polyacrylamide (PAA) and its derivatives are used to increase productivity and clean pipelines. This technical water-soluble polymer helps to increase the maximum throughput of the oil pipeline and improves the quality of the pumped oil.

It is also used for repair work in wells. In medicine The medical field has long and actively used products made of polymers. Among them: pins, disposable syringes, instruments for surgery, containers for plasma and blood, contact lenses, laboratory glassware, surgical sutures, shoe covers, prostheses, artificial organs, and even polymer nanogels for drug delivery.

The study of the possibilities of polymers does not stop there.

So, students and professors of the National Research Technological University "MISiS" in 2017 decided to improve polyethylene in order to use it as a replacement for bones, joints and muscles. According to scientists, if the idea is finalized, then the shelf life of an implant made of this material will be at least 15 years. Economics of innovation.

Innovations in Injury Prevention: The Latest in Sports Medicine

In the automotive industry, automotive companies use at least 100 types of polymer materials in the production of vehicles. Thus, the wheel covers, instrument panel and some parts of the engine are made of polypropylene.

Seats are made of polyurethane, floor mats are made of polyethylene. There are polyamide in the drive levers, gears, gas tank, battery, fuse cases. The wiring is made of polyvinyl chloride (PVC). This thermoplastic vinyl chloride polymer is familiar to people around the world. Linoleum and stretch ceilings are usually made from it.

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In construction, the construction sector does not lag behind others.

Polymers are used to create electrical structures, cables, wires, pipes, insulating enamels, varnishes, films, nets, fences and protective coatings. Moreover, polymers are added to the composition of reinforced concrete and concrete. This improves the quality of building materials.

In the food industry Polymers in the food industry must comply with certain hygiene requirements. They should not affect the organoleptic properties of products (taste, color, smell), and also contain toxic components. Polymers are used not only in the production of equipment for the food industry, but also in packaging materials. Equipment. For example, in the canning and dairy industries, the links of conveyor belts are made of polyamides or high-density polyethylene. And in order to prevent raw materials and semi-finished products from sticking to the surface of the equipment, special polymer coatings are applied to metal structures. polymer packaging. It allows you to store millions of tons of agricultural products and food in stores. So, disposable multilayer films keep food 20% longer without the addition of preservatives.

Results and its discussion. Properties of polymers Impact resistance.

In terms of their ability to withstand mechanical stress, polymers are in no way inferior to some metals. Therefore, polymers are used to create car bumpers, protective covers and more. Plasticity and elasticity. This property is possessed, for example, by natural and synthetic rubbers. That is why they are used to create car tires, hoses, wire and cable sheaths, shoe soles, balloons and more. reflectivity. Thanks to this property, special reflective films are created from polymers. Usually they are used to indicate objects in the dark. For example, reflective materials are used in the organization of traffic, the creation of billboards and banners. Electrical insulation. Polymers are dielectrics (they do not allow electricity to pass through them). They can be used not only as insulating materials in electrical equipment, but also in the manufacture of tool handles for working with conductive parts.

Natural polymers are found everywhere. They are macromolecules created by nature itself without human intervention. Let's give some examples. Polysaccharides. This large group of natural polymers includes starch and cellulose. They differ from each other in their properties. So, starch is easily soluble in water and can be eaten. Cellulose does not dissolve in water. It is commonly used in the manufacture of paper and textile fibers. Proteins (proteins) are a natural polymer that consists of amino acids.

It is protein that is responsible for the growth, structure and development of a living organism.

Nucleic acids. Nucleic (DNA) and ribonucleic acids (RNA) contain all the information about a person: from diseases to talents. Natural rubber. It is a plastic and viscous polymer found in the sap of rubber plants. Green economy Scientists have found a way to produce vanillin from plastic Synthetic Until the 19th century, natural polymers were enough for industry.

But over time, due to a lack of resources, there was a need for other materials. So, in 1909, the American chemist Leo Baekeland tried to find a replacement for natural shellac (resin). But in the end, the experiments helped him create a material called Bakelite. It was obtained by the reaction of phenol and formaldehyde under pressure at high temperatures. It was with this discovery that the era of synthetic materials began. In chemical laboratories, the development of new types

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of polymers began. Read more at RBC: Before the Second World War, several countries (England, Germany and the USA) started the production of synthetic rubber.

At the same time, the development of polystyrene, polyvinyl chloride, polymethyl methacrylate began.

In the 1950s, scientists created polyester fiber and the production of fabrics based on it began. At the same time, polypropylene and low-density polyethylene appeared. Then polyurethanes were launched into mass production.

In the 1960s–1970s, polyamides were synthesized.

Read more at RBC: How polymers are produced Polymers are produced in two ways: polymerization and polycondensation. Each has its own characteristics. Polymerization is a process in which monomers are combined into chains and held together by chemical bonds. Polymerization produces polystyrene, chloroprene and butadiene rubbers, Teflon, polypropylene, polyethylene. "Polymers are produced by the reaction of combining monomers. In simple terms, these are beads, where beads are monomers. When obtaining polymers, the composition does not change. That is, what atoms were in the substance, these remain. Only their number changes. And depending on the number of monomers, their properties change", Read more on RBC:

During polycondensation, in addition to the polymer, a low molecular weight substance (water, alcohol, hydrogen chloride) is also formed.

In the process of polycondensation, lavsan, polypeptides, phenol-formaldehyde resins are formed. But capron, for example, can be obtained in two ways at once. Polymers and Plastics: What's the Difference Often, the word "polymer" is used as a synonym for the concept of "plastic". But it's not. Plastic is just one type of polymer. Many types of plastics are synthesized from petroleum or hydrocarbon oil. More than 380 million tons of plastic are produced annually in the world. And about 8 million tons of items made of this material enter the World Ocean every year: bottles, bags, fishing nets. According to environmentalists, it was the plastics manufacturing process that created the global waste crisis.

Environmentalists are concerned not only about the amount of emissions, but also about the process of creating such materials.

According to Greenpeace, during oil and gas production, a lot of toxic substances are released into the air and water. More than 170 chemicals used in the extraction of raw materials for plastics cause a variety of diseases, from cancer to a weakened immune system. Green Economy How Much Plastic Decays and Is It Efficient to Recycle The Future of Polymers. In the future, the world will not be able to get away from polymers, experts are sure. Every year they will take on new forms. "Green" polymers are already beginning to come to the fore.

Plastics, or plastics, are materials based on synthetic or natural high-molecular compounds. Plastics (Figure1) based on synthetic polymers have received exceptionally wide use.

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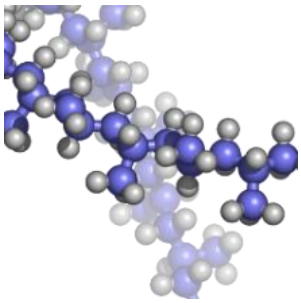

Figure1. a. Plastic **b. Plastic and properties**

Polymerization (other Greek πολυμερής - consisting of many parts) is the process of formation of a high molecular weight substance (polymer) by repeatedly attaching molecules of a low molecular weight substance (monomer, oligomer) to active centers in a growing polymer molecule. The monomer molecule, which is part of the polymer, forms the so-called monomeric (structural) unit. The elemental composition (molecular formulas) of the monomer and polymer is approximately the same.

Typically, monomers are compounds containing multiple bonds or cyclic fragments that can open up and form new bonds with other molecules, providing chain growth.

The polymerization process consists in the fact that the same monomer is attached to the monomer unit, another of the same monomer is attached to this unit, and so on. We can consider this process as a random event: attachment occurs with a certain probability and, therefore, does not occur with a probability , since the sum of the probabilities of opposite events is equal to one [a consequence of the theorem of adding the probabilities of two incompatible events]. Since each subsequent addition occurs independently of the previous ones, the probability of the formation of a molecule containing monomers is calculated by the formula

$$P(n) = \underbrace{p \cdot p \cdot \ldots \cdot p}_{n\ раз} \cdot q = p^n \cdot q = p^n (1-p).$$

Features of polymers. Special mechanical properties: elasticity – ability to high reversible deformations at a relatively light load (rubbers);

low fragility of glassy and crystalline polymers (plastics, organic glass);

ability of macromolecules to orientation under the influence directional mechanical field (used when fiber production and films).

Features of polymer solutions: high solution viscosity at low polymer concentration;

The dissolution of the polymer occurs through the swelling stage.

Special chemical properties: the ability to dramatically change one's physical

- mechanical properties under the influence of small amounts of reagent (vulcanization of rubber,

leather tanning and etc.).

The special properties of polymers are explained not only by the great molecular weight, but and the fact that macromolecules have a chain structure and have flexibility.

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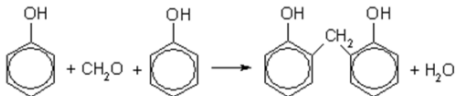
Classification of polymers. According to their chemical composition, all polymers are divided into organic, organoelement, inorganic. Organoelement polymers. They contain in the main chains of organic radicals, inorganic atoms (Si, Ti, Al), matching with organic radicals. They don't exist in nature. Artificially derived representative — organosilicon compounds. It should be noted that often in technical materials use combinations of different groups of polymers. This composite materials (for example, fiberglass). Based on the shape of their macromolecules, polymers are divided into linear, branched (special case - star-shaped), ribbon, flat, comb-shaped, polymer mesh and so on.

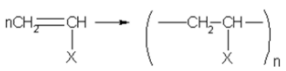
Polymers are classified by polarity (affecting solubility in various liquids). Polymers whose units have significant polarity are called hydrophilic or polar. Polymers with non-polar units - non-polar, hydrophobic. Polymers containing both polar and and non-polar units are called amphiphilic. Homopolymers, each unit of which contains both polar, yes and non-polar large groups, proposed to be called amphiphilic homopolymers.

In relation to to heating, polymers are divided into thermoplastic and thermosetting. Thermoplastic polymers (polyethylene, polypropylene, polystyrene) soften when heated, even melt and when cooled they harden. This the process is reversible. Thermosetting polymers, when heated, undergo irreversible chemical destruction without melting. Thermosetting polymer molecules have nonlinear structure obtained by stitching (for example, vulcanization) of chain polymer molecules. The elastic properties of thermosetting polymers are higher how in thermoplastics.

Phenol - formaldehyde resin is a thermosetting polymer that obtained by the polycondensation reaction of phenol with formaldehyde in presence of acids. Phenol-formaldehyde resins are used as the basis for various composite materials, which also include fillers, hardeners and other components. Products from such materials are durable and have good dielectric properties properties.



Polyethylene (Figure 2) (-CH2-CH2-)n is one of the simplest polymers. His molecular weight ranges from 20 thousand to 3 million in A -depending on method of receipt. Polyethylene - a transparent thermoplastic material with high chemical resistance, poor heat conduction and electricity. It is used for insulating electrical wires, making transparent films and household items. As a result of polymerization V Asymmetric carbon atoms appear on the main chain, which differ in the position of the connected with them groups X relative to the main chains. There are isotactic and syndiotactic and atactic polymers. IN in isotactic polymers, the substituents are located strictly on one side OT main chain, in syndiotactic polymers - alternately different sides of the chain, and in atactic - chaotically on one side or the other of chains. In the first two cases, the polymer is said to have a stereoregular structure. Isotactic polymers have particularly valuable physical properties-mechanical properties.



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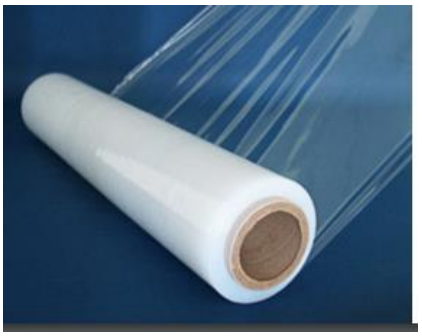

Figure 2. Polyethylene

Polyvinyl (Figure 3) chloride (PVC, vinyl, polyvinyl chloride, winnol, corvic, sikron, Westolite, Hostalite, Jeon, Sumilite, Lukovil, Nippeon, Helvik, Norvik and etc.) is a white plastic, thermoplastic polymer vinyl chloride. Polyvinyl chloride (PVC) is used for the production of pipes, sheets, films, polyvinyl chloride fiber, shoe plastic compounds, polyvinyl chloride foam, linoleum, furniture edges, etc. Also The scope of application of PVC is the production of gramophone records, a wide range of range of profiles for the manufacture of windows and doors, corrugated pipes for electrical insulation of wires and cables.

Polyvinyl has a high chemical resistance to mineral oils, alkalis and many types of acids, as well as o solvents. Polyvinyl chloride is not burns in air, but at the same time has low frost resistance (about minus 15 °C). Heat resistance is up to plus 65 °C. Temperature indicators can be easily modified by making composite material with different composition under the necessary conditions. Chemical formula polyvinyl chloride [-CH2-CHCl-]n

Figure 3. Polyvinyl

Rubbers. Natural rubber – natural high molecular weight unsaturated hydrocarbon composition (C5H8)n, where n = 1000 - 3000. It has been established that that this polymer consists of repeating units of 1,4-cis-isoprene and has stereoregular structure.

Butadiene rubber is produced in two types: stereoregular and non-stereoregular. Butadiene rubber, stereoregular, in mainly used in the manufacture of tires, which wear resistance is significantly higher than tires from natural rubbers.

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Butadiene rubber (Figure 4) non-stereoregular is used for production, e.g. ebonite, alkali- and acid-resistant rubber. Styrene butadiene rubber is used in production of rubber shoes, car tires and conveyor belts, and is characterized by increased wear resistance.

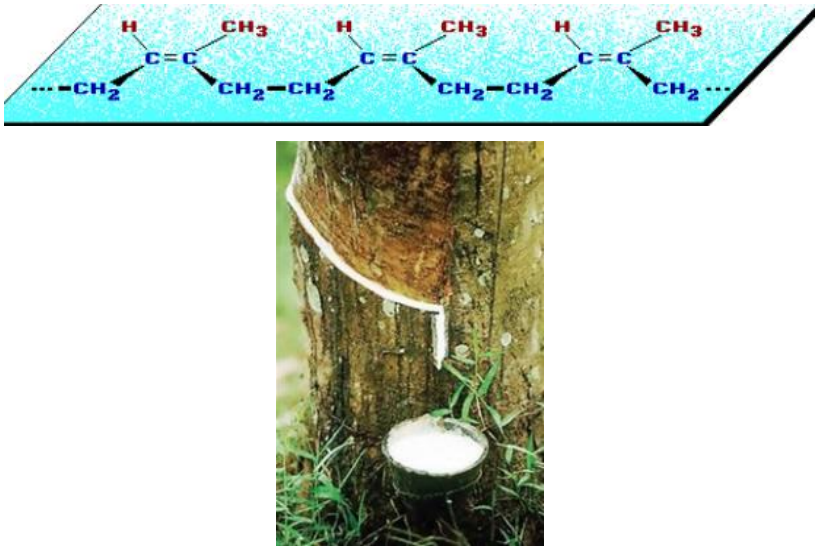

Figure 4. Butadiene rubber

CONCLUSIONS

And so, polymers are used in all spheres of the national economy. It is impossible to imagine our life without polymers.

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