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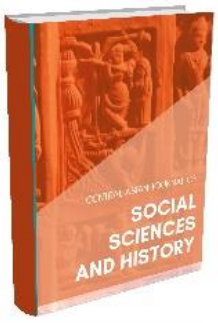

Processing of Secondary Polymer Raw Materials and PVC Compositions to Create a Technology for Manufacturing Shoe Sole

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Annotation:
In the article analyzed sources of formation of wastes of high-molecular materials. The physical and chemical properties of plastics are revealed. Particular attention is paid to composite materials. PVC soles are characterized. PVC is often used to make shoe soles due to a number of advantageous characteristics.

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Currently, one of the most important tasks in the field of environmental protection (EP) is the improvement of the waste management system. In this regard, the most important task of any state in the field of waste management is to create mechanisms aimed at environmental safety, economical use of raw materials, materials, energy and other resources, as well as the creation and implementation of low-waste and waste-free technologies.

The history of the discovery of polyvinyl chloride is very interesting and, at the same time, dramatic. It was opened and safely forgotten, then reopened. And so several times. As a result, this rather simple compound has four creators, and recognition came to him a century later [1-3].

It has long been known that scientists or researchers, when they invent something new (device or material), are driven not at all by considerations of convenience and economy, but by the desire to learn or create something new at a higher level. The same was true of the French chemist and mining engineer Regnault , who was the first to obtain polyvinyl chloride. This happened in 1835, when Henri Victor Regnault was working in Giessen , in the laboratory of Justus von Liebigs . In a solution

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containing vinyl chloride, which was kept for several days in a test tube on a windowsill, significant changes occurred: a white powder formed. Most likely, this was facilitated by sunlight, which reacted with the solution. Regnault continued his tests in Lyon (France). He tried to carry out various experiments with the resulting powder, but he could not cause any additional reaction or dissolve it . As a result, the scientist, having recorded and published his observations, no longer began to deal with this randomly obtained substance. Thus, Henri Victor Regnault first received polyvinyl chloride, without knowing it.

For the first time, the product of polymerization of vinyl chloride was studied in more detail in 1878, but the results of these studies did not become the property of industry. It happened only in the next century [4-8].

In 1912, a new search began for opportunities for the industrial production of polyvinyl chloride (PVC). Scientist Fritz Klatte , an employee of the German chemical firm Greishain Electron, combined acetylene with hydrogen chloride and put the resulting solution on a shelf. After a short period of time, he saw a precipitate that had fallen out. Since chemistry, at that time, already knew enough about the structure of the substance, the scientist realized that it was a polymer (vinyl chloride). In 1913, Fritz Klatte was the first to obtain a patent for the production of polyvinyl chloride (PVC). He expects PVC to be used instead of celluloid, since PVC is difficult to ignite compared to it. The outbreak of the First World War prevented Fritz Klatte from studying in more detail the properties of PVC and the possibilities of its application, production was frozen . Despite this, Klatte is deservedly considered the founder of the industrial production of polyvinyl chloride.

Polyvinyl chloride is one of the largest and most widely used synthetic polymers, which is largely due to its high mechanical strength, chemical resistance in various environments, high elasticity, incombustibility (which is due to the content of up to 56.8% combined chlorine), good electrical and thermal insulation properties, relatively low cost of raw materials, the possibility of varying properties over a wide range .

Products made of plasticized PVC from these compositions, as a rule, are homogeneous in structure, which determines the uniformity of properties over their cross section. Meanwhile, during operation, their surface layers are mainly exposed to external influences. This is especially evident in the example of products subjected to intense surface wear: linoleums, shoe soles, etc. The low wear resistance of PVC compounds does not provide the possibility of their use in the production of soft, elastic products used in friction-rolling and friction-sliding units , for example, tires for children's bicycles [9-11].

One of the cardinal ways to solve the problem of creating polymer composite materials with a controlled set of properties is the chemical modification of the polymer base (grafting of monomers onto PVC, grafting of vinyl chloride onto other polymers). However, under conditions of work for a specific consumer and often the release of relatively small batches of material, this way is not always economically justified (requires special reactor equipment, environmental issues, etc.). In this regard, the development of methods for increasing the wear resistance of PVC-based materials during their processing is of great importance. An effective way to partially solve the problem of increasing the wear resistance of products made of polymeric materials is to control the composition and structure of their surface layer. There are known works on surface treatment of finished products made of polymers by chlorination, impregnation with reactive oligomers /8/, metallization, etc. However, the objects of

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impregnation were mainly products made of unplasticized PVC. It should be noted that these methods of surface hardening of plastic products are very laborious, cumbersome and inefficient .

Polyvinyl chloride is a polymerization product of vinyl chloride . During polymerization, linear slightly branched (branching of macromolecules is 2–5 per 1000 carbon atoms of the main chain) macromolecules with an elementary link in the form of a flat zigzag are formed.

The nature of the bonds between the elementary units allows several options for constructing a molecular chain, which in practice, during the industrial production of polyvinyl chloride, leads to low regularity (syndiotacticity) of its macromolecules: in one macromolecule, several options for the bonds of elementary units are realized at once, regular sequences of elementary units are not created and industrial samples have a low degree of crystallinity [12-15].

An important characteristic that determines the fundamental possibility of recycling PVC waste (allowable processing time, service life of the recycled material or product), as well as the need for additional strengthening of the stabilizing group, is the thermal stability time .

Based on polyvinyl chloride (PVC), more than 3,000 types of composite materials and products are used in the electrical, light, food, automotive industries, mechanical engineering, shipbuilding, in the production of building materials, medical equipment, etc., due to its unique physical and mechanical, dielectric and other operational properties.

However, at present, the use of PVC is gradually limited, which is primarily due to environmental problems that arise during the operation of products, their disposal and recycling. During the aging of PVC-based polymers, along with the loss of physical and mechanical properties, a negative impact on the environment and humans is observed, due to the processes of PVC dehydrochlorination , which increase at a temperature of 50-80 ° C (highly toxic chlorine -containing polyaromatic compounds are formed).

This determines the relevance of the problem of developing safe technologies for the disposal and processing of waste products containing PVC.

The main methods of recycling waste polymer materials include:

- thermal decomposition in an inert atmosphere (pyrolysis);
- incineration;
- decomposition to obtain initial low molecular weight compounds (depolymerization);
- recycling (injection molding, extrusion, pressing, etc.).

The most difficult issues are the disposal of a mixture of polymer waste containing, along with PVC, polyolefins (polyethylene, polypropylene), polystyrene, polyurethanes, polyamides, etc.

An analysis of the existing technologies for the neutralization of a mixture of polymeric wastes allows us to conclude that it is expedient to use thermal processing based on degradation processes in an inert atmosphere [16-17].

During the pyrolysis of polymers, gases are formed, some of which are capable of condensing to form high-calorie liquid fuels, non- condensable gases containing methane and hydrogen, which have a high calorific value, and carbonizate , which can be used in technological processes. The high energy

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potential of pyrolysis gases allows the recycling process to be carried out in an autothermal mode [18-22].

The thermal degradation of polyolefins, polystyrenes, polyamides has been studied quite well, and the temperature range for their processing has been established - 400 - 500 °C.

It should be noted that PVC soles are very wear-resistant, strong, do not deform and do not slip. Very easy to manufacture, and it is easy to add various impurities and plasticizers to the composition, so virtually any elasticity can be achieved. The oil resistant material makes it ideal for safety footwear .

Often used in children's shoes. PVC is a very heavy material and shoes are appropriate. Despite the good shock-absorbing properties, it is difficult to walk a lot and for a long time in these shoes, the legs get tired. Over time, plasticizers evaporate, and the sole loses its elasticity and begins to crack. Considering that a product usually spends some time before being sold in warehouses or on store shelves, it may happen that the consumer receives a product that has already lost some of its positive qualities.

PVC is not frost -resistant and can burst at -20 degrees. The material is very poorly glued to the top of genuine leather shoes, so it is often used on leatherette shoes.

PVC is often used to make shoe soles due to a number of advantageous characteristics. It is elastic and lightweight, demonstrates incredible strength with repeated bending, and has a high level of electrical insulation. Designers are increasingly opting for PVC soles due to their multi-coloured nature. When carrying out additional processing, the PVC sole can acquire any shade of the color spectrum. What the sole will turn out depends directly on the wishes of the designer. Most often, PVC is used to make spring and summer shoes for everyday wear.

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