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## Technology of separation and recycling of waste the polymer-containing paper for obtaining heat insulation materials

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In modern conditions of intensive industrial development, one of the most important problems is the processing and utilization of household and industrial waste and protection of the environment from polymer contamination with waste paper and the rational use of forest resources of wood and paper. In this regard, it is important to develop and widely implement environmentally closed technological cycles of enterprises, design of equipment and technology for processing waste paper containing polymers, including Tetrapack packaging, with reuse of recycled cellulose and polymers.

A separate type of waste generated in the home and in industry is the waste of paper wallpaper, which contains various polymer coatings, of which 5 -10% of this product falls into the waste generated in production and everyday life. Waste wallpaper with a polymer coating, including polyvinyl chloride (PVC), is formed in accordance with the technological regulations of these industries. The amount of such wallpaper waste in Ukraine exceeds 5 - 8 million rolls or 250 thousand tons per year. Disposable household packaging for juices, water and other beverages made of multilayer cardboard and polyethylene, such as Tetrapack, also ends up in waste. For processing and separation of this waste polymer-containing paper is not yet environmentally friendly, dry separation technology, it falls into the waste, the amount of which exceeds 50 million / ton per year. According to the production technology, these paper-based wastes are made of natural cellulose and synthetic polymers. The high mass content of 5% to 60% of polymers in such waste paper makes it difficult to dispose of such waste by incineration, due to the fact that as a result a large number of harmful chemical compounds of pyrolysis of polymers: chlorine, hydrogen chloride, organic substances, including dioxins. The existing technology of water separation of paper from polymer films is a highly expensive and non-environmentally friendly method, because it requires a lot of water and creates secondary liquid waste, which also needs to be disposed of.

Thus, the development of anhydrous technology and equipment for the processing of such waste paper waste with the separation of polymers from the paper base-cellulose is of practical interest. Our proposed technology of dry separation of waste paper (polymer-containing wallpaper) and polymers, incl. packaging type "Tetrapack", allows with an efficiency of 85-95% to separate and recycle cellulose and polymers. In addition, it makes this recycling process environmentally friendly without the generation of secondary waste, simple and cost-effective for small businesses with high added value, and will additionally save forests from destruction when processing them into new paper - pulp-containing products.

In the course of the research, ecological, resource-saving technology and equipment for processing and reuse of industrial and household waste were developed, namely, waste paper, including polymer-containing wallpaper and Tetrapack packaging with a polymer coating, and obtaining separated cellulose fibers as a result of separated fibers. ecowool) and crushed polymers. To do this, we, together with the Ivano-Frankivsk company MPP "Imex", created industrial equipment - a universal 5-stage crusher and separator (DS-150 "IMEX"). Used for the technology of dry mechanical separation, separation of the paper base of waste paper from polymer PVC or PE coating (including "Tetrapack"), which is shown in Fig.1. It made it possible to completely separate 85-95% of the polymer from waste paper, and to obtain, at the same time, 90-95% pure cellulose and polymers. Additionally, we have developed a universal method for recycling-reuse of 90-95% of the obtained separated waste of pure expanded cellulose-ecowool, which provides their comprehensive utilization within one modern industrial complex of small enterprises and environmental safety of production as a whole, free of harmful gaseous and dusty emissions into the atmosphere and wastewater into rivers and lakes.

The validity and reliability of scientific results will be ensured by the use of modern physico-chemical research methods and physico-mechanical methods - grinding and separation, determination of strength, hardness, elasticity and resistance to rupture of insulating building materials containing waste. Physical and chemical methods of waste analysis, methods of gravimetric and spectral analysis, microscopy, infrared spectroscopy, methods of differential thermal analysis will be used to study the degree of purification of the obtained products.



Fig.1. Photo of universal crusher separation type DS-150 "IMEX", for separation of polymer-containing waste paper (wallpaper, packaging) to obtain two fractions: 1- loose cellulose-ecowool, as a heat-insulating material for insulation of residential premises in construction, and 2 - fractions of crushed polymers of PE, PVC ..

The study explored the possibility of creating and using new innovative composite materials from separated-treated waste to increase the cost of production through their practical use of new thermal insulation materials derived from waste paper waste. This would support creative small and medium enterprises and startups in context of application of highly innovative technological achievements in materials science for commercial and applied applications. The fraction of crushed and purified separated cellulose was reused to obtain thermal insulation material such as "Ecowool". as well as a filler for building materials. For example, instead of asbestos or natural pulp-paper in the production of construction asbestos-cement slate slabs at PJSC "Ivano-Frankivskcement" Ukraine, you can partially or completely replace natural materials - pulp and asbestos with shredded and separated pulp from wallpaper. The polymer fraction was additionally used as a component in the creation of new polymer composite materials from polyvinyl chloride and polyethylene.

Promising areas of use of technology of grinding, separation and recycling of polymer-containing

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waste paper are the leading countries and Ukraine, which have a highly developed technological paper industry and creative small and medium enterprises for processing and utilization of waste paper and waste paper with high polymer content. to connect the following problems:

1. Provide Ukraine and other countries with new, environmentally friendly technologies and equipment for complex grinding, separation, processing and use of solid paper waste - polymer-containing waste paper (wallpaper, including packaging such as "Tetrapack") with recycling of separated waste - cellulose and polymers.
2. Will significantly reduce several times the needs of the paper industry in raw materials, namely in harvested wood and significantly reduce the number of forests cut down and preserve the ecology of the planet Earth;
3. Reduce by 90% the amount of unused paper waste of waste paper containing polymers and reduce environmental pollution by this waste.
4. Reduce several times the amount of waste paper containing polymers in Ukraine and other countries that can be disposed of by incineration, as a result will not pollute the atmosphere with harmful chemical gases;
5. Solve some social problems of Ukrainian and other small and medium business countries by creating new enterprises, reducing unemployment and creating new jobs, by increasing the innovative potential and competitiveness of European enterprises by selectively combining and transferring new and existing knowledge .