Для получения наилучшей общей картины работы системы водоснабжения и выявления возникающих проблем с утечкой целесообразно использовать комплексное системное решение, включающее несколько типов датчиков/регистраторов, облачные технологии и комплексные аналитические программные решения, а также следующие мероприятия и инструменты:

– оптимизация существующих и разработка новых методов герметичности водопровода;

– разработка стратегии предотвращения или минимизации новых утечек;

– создание точного водно-хозяйственного баланса на основании расчетов нормативов расходов и неучтенных потерь по всем параметрам;

– разработка активной эффективной системы контроля утечек и потерь воды, включающей: установку датчиков и сенсоров обнаружения утечек на наиболее проблемных участках сети, получение данных в реальном времени, применение средств дистанционного обнаружения утечек;

– управление давлением за счет установки редукционных клапанов (PRV) в ключевых местах в системе распределения воды. Однако использование слишком большого количества PRV (наряду с сопутствующими счетчиками и, возможно, новыми сегментами труб) может стать дорогостоящим, по сравнению со стоимостью сэкономленной воды.

– применение бестраншейных методов восстановления трубопроводов с применением пластиковых труб;

– использование научных подходов в понимании природы величин утечек в сетях водоснабжения.

Однако эти мероприятия будут выполняться только при условии, когда управление водопроводной инфраструктурой является наиболее экономически эффективным, если оно осуществляется в соответствии с целевыми исследованиями и водными аудитами, которые могут определить и даже предсказать, какие районные системы водоснабжения наиболее подвержены разрывам и утечкам. Однако после первоначальной оценки соотношения затрат с достижением эффекта в рамках системы эти усилия становится все труднее выполнять экономически эффективным образом. Таким образом, суть заключается в том, что никогда не может быть идеальной система распределения воды с 0 % недоходными потерями воды. Наступает момент снижения отдачи, когда дело доходит до сокращения этих потерь. Ключевым термином здесь является экономический уровень утечки, который определяется Международной ассоциацией по водным ресурсам как «уровень утечки, при котором предельные затраты на активный контроль утечки равны предельным издержкам протекающей воды» и как «экономический уровень реальных потерь, [который] возникает, когда сумма стоимости воды, потерянной в результате реальных потерь, и стоимость мероприятий, предпринятых для минимизации реальных потерь, находится на минимуме».

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SOME ASPECTS OF INDUSTRIAL POLYMER WASTE RECYCLING SYSTEM

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Among the wide range of wastes generated in the regional sphere of production and consumption, polymer wastes are of particular relevance, which are a set of products generated at various stages of technological processes at specialized enterprises for the production of chemical products, as well as amortized products of various functional purposes (packagings, packaging elements, film semi-finished products, medical products, household appliances and equipment) which are formed in the process of functional application as in specialized agencies and organizations (medical institutions, trade organizations, transport organizations), and in the system of housing and communal complexes (housing and communal services). A significant portion of some polymer waste is recycled at the site of generation and used to produce the product of the required quality.

Wastes (residual products) of the process of producing polyamide fibers and products from them are a full-fledged raw material for plastic masses and composite materials with a brand assortment of more than 50 types at quality parameters corresponding to domestic and foreign analogues.

Among the most mass polymer wastes are waste in the form of containers (containers for liquid-phase food, technical and special products, bags for storage and transportation of bulk food, construction, agricultural goods), sheet and film semi-products, medical products (disposable syringes, containers for storage of medicines) made from thermoplastic materials based on polyolefins.

A characteristic feature of polymer waste based on polymers of the polyolefin class is a pronounced technological predisposition to recycling, due to the features of the structure of the macromolecular chain, which provide relatively high resistance to multiple effects of technological factors (temperature, pressure, shear strain). These features of the polyolefin structure allow multi-cycle recycling of various types of waste to produce products in the form of regenerated raw materials with high parameters of consumer characteristics, which can be used as a semi-finished product in the manufacture of a wide range of products of various functional purposes.

When recycling film wastes, they are sorted, ground, cleaned of contaminants and residual products, dried, remelted in a multi-section extruder with degassing and subsequent granulation of the regenerate to obtain a semi-finished product with the most common dimensional parameters.

Among the most important indicators of the efficiency of the production activity of the enterprise specializing in the field of recycling of high molecular weight products are parameters characterizing the quality of products, primarily granulate based on regenerated raw materials obtained using process lines with various degrees of completion of the process.

Techniques for processing secondary polymeric thermoplastic materials based on various approaches are known. The most common method of processing secondary polymer materials is mechanical crushing of non-standard cushioned polymer products and production wastes (runner systems) with subsequent processing of crushed fractions with size from 5 to 15 mm in technological equipment ensuring achievement of viscous-fluid state (extruders, thermoplastic machines) with subsequent granulation. This method of recycling is simplest in technology, however, it results in a product with a large dispersion of service characteristics (rheological, deformation-strength, thermophysical, tribotechnical, adhesive, etc.) and is used, as a rule, to obtain products of low quality using an uncertain composition, large size or mass for recycling cushioned polymer products, or with the presence of large contaminants.

In the practice of recycling, a method of processing film cushioned thermoplastic articles (cover films, packaging of food materials) is used, consisting in mechanical fractionation (crushing of the semi-finished product) with subsequent exposure of the ground film fragments of the elements of the technological unit, which cause their mechanical deformation, leading to their heating. Under the influence of thermal energy of deformation from dispersed fragments of film materials and semi-finished products, so-called agglomerate - partially melted fragments with a particle shape close to spherical are formed. The obtained agglomerate is used for making articles by injection molding or extrusion using traditional equipment - casting machines (thermoplastic machines) and extrusion plants (extruders).

The technology of recycling secondary thermoplastic materials by agglomeration is quite widespread in the practice of recycling, since it has a relatively low energy consumption and simplicity of implementation, but has a number of disadvantages limiting the scope of its application. Firstly, it is effective only for film waste, and secondly, it requires careful preparation of raw materials (sorting and cleaning from contaminants and related products), since if this condition is violated, an unstable quality regenerate with low consumption characteristics is formed.

In the course of system research, an effective technology for recycling process waste of thermoplastic materials has been developed, which allows to obtain a product of high quality with stable parameters of consumer characteristics.

The essence of the developed technology of recycling secondary polymer materials based on thermoplastics is as follows. It is known that with uniaxial orientation of thermoplastic fibers, they are strengthened due to the formation of a specific supramolecular structure. This structure, formed from blocks of macromolecules with mainly parallel laying, has a memory effect due to the higher level of intermolecular interaction in the oriented supramolecular structure compared to the non-oriented periphery. Therefore, when cooling a re-melted fragment of oriented fiber of any section (cylindrical, rectangular, triangular, etc.), a significant part of the oriented reinforced structure is restored. Due to the same (or similar) molecular structure and chemical composition of the modifying component (oriented fiber fragments) and the matrix (undirected secondary raw material fragments), thermodynamic compatibility of the components of the regenerated material is ensured and a strengthening effect is achieved. In order to realize the reinforcing effect, from 1 to 100 parts by weight of fragments of uniaxially oriented fibers must be introduced into the non-oriented matrix. With the ratio "matrix-oriented fiber" 100:1, the effect of reinforcement of the regenerate is technologically significant, and with the ratio of components in 1:100, undirected matrix components perform the function of a kind of high-molecular plasticizer.

Subsequent drying of mechanical mixture of oriented and non-oriented components in suspended layer at close mass ratios of dispersed fragments ensures preservation of required ratio and achievement of homogeneous semi-product suitable for further remelting. Processing of the obtained mixture in a continuous process cycle and a closed volume of process equipment makes it possible to continuously supply the raw mixture to the feed hopper of the extruder, perform degassing of the melt through the zones of the melting cylinder, homogenize the melt due to the continuous action of the screw and granulate the regenerated product in the closed process space with minimal environmental access at all stages of the recycling process. These causes almost complete suppression of thermo-oxidative and thermo-destructive processes in the polymer material at various stages of the process and the production of a regenerated product (regenerate) of stable quality.

The developed recycling technology can be implemented when processing secondary polymer materials based on various thermoplastics - high pressure polyethylene (HDPE), low pressure polyethylene (LDPE), polypropylene (PP), polyamide 6 (PA6), and mixtures of LDPE + PP, HDPE + PP, etc. Studies of the structure and structure of thermoplastics regenerated according to various technologies using modern methods of physical and chemical analysis and determination of parameters of strain-strength and rheological characteristics have shown notable advantages of the product regenerated according to the developed method compared to the regranulate obtained according to the known technology.

As follows from the obtained data, the regenerated product (regenerate) obtained by the developed technology is superior in strength, impact toughness characteristics, the product obtained by extrusion remelting technology. The characteristics of the regenerate are not inferior in quality to the primary analogues (PP, LDPE, PA6), so it can be used as a full-fledged material for the manufacture of polymer products of various functional purposes instead of the so-called primary.

Regenerated polyolefins have been used as a matrix binder for composite materials with process and service characteristics that meet the requirements for products of a particular functional purpose.

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ЭНЕРГЕТИЧЕСКАЯ ЭФФЕКТИВНОСТЬ БЕЛОРУССКОЙ ЖЕЛЕЗНОЙ ДОРОГИ

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Проведенный анализ эксплуатационных расходов Белорусской железной дороги (БЖД) за предыдущую пятилетку показал следующее.

Наибольшая доля, 45–47 % эксплуатационных расходов Белорусской железной дороги на топливо приходится на Барановичское (НОД-2) и Витебское (НОД-6) отделения. Это свидетельствует о том, что двумя этими отделениями выполняется наибольший объем перевозок с использованием