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БИОРАЗЛАГАЕМЫЕ КОМПОЗИТЫ НА ОСНОВЕ ИСКОПАЕМЫХ ВИДОВ СЫРЬЯ. ЧАСТЬ II: ПРОЦЕСС БИОДЕГРАДАЦИИ (ОБЗОР)

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В части I обзора (№ 2, 2022) были рассмотрены стратегии получения биоразлагаемых композитов с матрицей из ископаемых видов сырья, характерные свойства этих композитов, тенденции развития рынка биоразлагаемых материалов.

В части II обзора изложены основы процесса биодеградации полимерных композитов, указаны факторы, влияющие на эффективность протекания абиотической и биотической стадий разложения материалов. Особенное внимание уделено биотической стадии окисления, отмечена доминирующая роль микроорганизмов в процессах биоразложения пластиков, которая возможна как в аэробных, так и в анаэробных условиях. Приведены данные об идентифицированных микроорганизмах, разлагающих негидролизуемые полимеры (или матрицы композитов) на основе ископаемых видов сырья, указаны основные группы ферментов, способные диссимилировать макромолекулы, особенности их строения и механизмы. В статье указаны альтернативные способы биодеградации полимерных материалов: введение энзимов в полимерную матрицу или ферментативная конверсия пластика; биологические методы утилизации полимеров с участием живых организмов. Отмечены проблемы использования описанных способов биодеградации полимерных композитов.

Показано, что при биоразложении полимерных композитов возникают новые экологические проблемы, связанные с наличием в их составе токсичных органических добавок (модификаторов полимерных материалов) и тяжелых металлов (компоненты оксо-добавок). В статье приведен целый ряд методов оценки степени биологических разрушений пластика, обсуждена их объективность и надежность. Отмечено, что принятые в последние годы государственные стандарты РБ относительно биоразлагаемых полимеров опираются на данные респирометрических тестов.

Ключевые слова: полимерный композит, абиотическая и биотическая стадии, минерализация, диссимиляция, биомасса, компостирование, гидролизируемые и негидролизируемые полимеры, микроорганизмы, ферменты, кофактор, инкапсулирование, биологический метод, государственный стандарт.

BIODEGRADABLE COMPOSITES BASED ON FOSSIL TYPES OF RAW MATERIALS. PART II: THE PROCESS OF BIODEGRADATION (REVIEW)

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In part I of the review (No. 2, 2022), strategies for obtaining biodegradable composites with a matrix

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from fossil raw materials, the characteristic properties of these composites, and trends in the development of the biodegradable materials market were considered.

Part II of the review outlines the fundamentals of the process of biodegradation of polymer composites, indicates the factors that affect the efficiency of the abiotic and biotic stages of material decomposition. Particular attention is paid to the biotic stage of oxidation, the dominant role of microorganisms in the processes of biodegradation of plastics, which is possible both under aerobic and anaerobic conditions, is noted. Data on identified microorganisms that decompose non-hydrolyzable polymers (or composite matrices) based on fossil raw materials are presented, the main groups of enzymes capable of dissimilating macromolecules, their structural features and mechanisms are indicated. The article indicates alternative methods for the biodegradation of polymeric materials: the introduction of enzymes into the polymer matrix or the enzymatic conversion of plastic; biological methods of polymer utilization with the participation of living organisms. The problems of using the described methods for the biodegradation of polymer composites are noted.

It is shown that the biodegradation of polymer composites gives rise to new environmental problems associated with the presence of toxic organic additives (modifiers of polymeric materials) and heavy metals (components of oxo additives) in their composition. The article presents a number of methods for assessing the degree of biological destruction of plastic, discusses their objectivity and reliability. It is noted that the state standards of the Republic of Belarus regarding biodegradable polymers adopted in recent years are based on the data of respirometric tests.

Keywords: polymer composite, abiotic and biotic stages, mineralization, dissimilation, biomass, composting, hydrolysable and non-hydrolysable polymers, microorganisms, enzymes, cofactor, encapsulation, biological method, state standard.

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