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ИССЛЕДОВАНИЕ МАГНИТНЫХ ПОЛИМЕРНЫХ КОМПОЗИТНЫХ СОРБЕНТОВ

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THE RESEARCH OF MAGNETIC POLYMERIC COMPOSITE SORBENTS

Мустафаева Рена Эльдаровна
кандидат химических наук,
старший научный сотрудник,
научно-исследовательская лаборатория
«Новые химические материалы и технологии»,
Азербайджанский Государственный Университет
Нефти и Промышленности
rena-babaeva0@rambler.ru

Аннотация. Разработаны синтетические подходы к созданию магнитоактивных полимеров, способных сорбировать субстраты различной природы (газы, алканы, спирты). Показано, что магнитные характеристики таких систем определяются магнитными свойствами полиядерных фрагментов в их составе, что является важным свойством для направленного получения композиционных материалов с заданными магнитными свойствами. Полученные соединения могут найти применение как основа создания новых магнитных материалов, магнитных сорбентов.

Ключевые слова: магнитореологические материалы, ферромагнитные наполнители, магнитные материалы, магнитные сорбенты.

Mustafayeva Rena Eldar
Leading Research fellow, chem. Sciences,
Scientific-research laboratory
«New chemical materials and technologies»,
University of Oil and Industry,
Republic of Azerbaijan
rena-babaeva0@rambler.ru

Annotation. Synthetic approaches to the creation of magnetically active polymers capable of sorption substrates of various natures (gases, alkanes, alcohols) have been developed. It is shown that the magnetic characteristics of such systems are determined by the magnetic properties of polynuclear fragments in their composition, which is an important property for the directed production of composite materials with specified magnetic properties. The resulting compounds can be used as the basis for the creation of new magnetic materials, magnetic sorbents.

Keywords: magnetorheological materials, ferromagnetic fillers, magnetic materials, magnetic sorbents.

Magnetic polymer composites are of great interest in terms of fundamental research. Magnetorheological materials refer to composite materials consisting of ferro- or ferrimagnetic particles having their own magnetic moment, placed in a paro- or diamagnetic medium with rheological properties. The rheological properties of such materials are altered by the interaction of the magnetic filling particles with the external magnetic field. Para- or diamagnetic medium with rheological properties. The mechanical, electrical and magnetic properties of magnetic composites can be controlled by a magnetic field, which allows them to be classified as multifunctional materials. The search for and development of such magnetic elastomer materials is relevant. We have studied the technology of making composite materials based on polymer and a mixture of ferromagnetic fillers. [1]

As you know, composites are many component materials consisting of two or more components with a clear between phase boundaries them, while the properties of the composites can not be determined by the properties of each of the phases separately, but only taking into account their interaction. Such materials, which are actually a matrix with fillers included in it, differ in the types of matrices (organic, inorganic, polymer, metal) and fillers. [2] Obtaining new effective sorbents is of paramount importance for solving environmental problems associated with the increased content of a number of toxic compounds in natural waters used in urban water supply systems, as well as in the oil industry, as it is known, oil production is accompanied by the inevitable release of hydrocarbons into the environment. The largest losses of oil and petroleum products are associated with their sea transportation from production areas. Despite the fact that oil pipelines are a cheaper and more environmentally friendly method of oil delivery, tankers carry out the bulk of the transportation. Emergencies on board tankers, draining of flushing and ballast water worsen the environmental situation, cause significant damage to the environment. Oil spills also occur during accidents on offshore platforms from which wells are drilled and oil is produced offshore. To clean the surface of water from oil films, it is necessary to use magnetic composite sorbents based on polymer matrices, which have increased buoyancy, mechanical strength and high absorption capacity in relation to oil products and oil. It should be noted that today polymer-inorganic sorbents have become the objects of a wide variety of sorption studies.

The purpose of the work is to develop effective ways to obtain magnetically active polymer sorbent composites, which combine the presence of magnetic centers with the presence of pores suitable for sorption of certain substrates, and to establish factors affecting their structure, magnetic and sorption characteristics.

When dispersing crystals of magnetite Fe_3O_4 and maghemite γ-Fe_2O_3 in porous polymer spherical granules, non-magnetic sorbents become magnetically active and react to a magnetic field. The use of such materials in sorption processes makes it possible to replace the complex procedure for separating spent sorbent from solution with a simple magnetic separation method. Magnetic polymer granules can be obtained by depositing iron oxides directly in a polymer matrix that limits the growth of magnetic particles, as a result, their size becomes smaller than in the absence of polymer, and magnetic properties are improved.

At the same time, hybrid materials must satisfy the following two conditions, firstly, so that the imposed magnetic activity does not impair the sorption properties of polymer materials, and secondly, that the composites remain magnetized for many sorption-desorption cycles.

Results are obtained on the effect of a magnetic field on the process of producing magnetic composites. It is established that the combination of magnetic and elastic properties leads to the appearance in these types of composite materials of a unique ability of the material to reversibly change the size and viscous elastic properties in an external magnetic field. In a uniform magnetic field, such materials have a magnetically controlled elastic modulus, and strong magnetostriction is observed in inhomogeneous fields. For the synthesis of magnetic elastomers used silicone polymer matrix SIEL. Silicone oligomer with vinyl and hydride groups at 100-150^{0}C interacts in the presence of a platinum catalyst. Magnetic particles are introduced into the matrix: Fe – 2 μm, Fe_3O_4 – 0.2-0.5 μm.

In a magnetic field, the polymer macromolecules are oriented, and in the presence of magnetic particles, the elastomers are structured. To achieve high magnetic characteristics of magnetic elastomers, it is known that it is necessary to introduce the maximum possible number of magnetic fillers. However, at a very high value of the degree of filling, the material loses cohesive strength. At various degrees of filling with magnetic particles of 3, 5, and 12 volume % Fe, structured elastomers with various elastic magnetostrictive characteristics were obtained. There is a different viscoelastic behavior of the polymer when exposed to a uniform magnetic field during various deformation processes. The residual deformation in a uniform magnetic field depends on the type of magnetic particles and increases with an increase in their content.

Synthetic approaches to the creation of magnetically active polymers capable of sorption substrates of various natures (gases, alkanes, alcohols) have been developed. It is shown that the magnetic characteristics of such systems are determined by the magnetic properties of polynuclear fragments in their composition, which is an important property for the directed production of composite materials with specified magnetic properties. The resulting compounds can be used as the basis for the creation of new magnetic materials, magnetic sorbents.

The highest value of the elastic modulus is observed for structured compositions with parallel oriented strains and magnetic field intensities. It has been revealed that with the use of a magnetically sensitive polymer in the process of sequential pumping as a liquid separator it gives the greatest economic effect. Depending on the relief of the pipelines and the properties of the relief of the pipeline and the properties of the pumped liquids, the necessary magnetic field strength is selected using the results obtained.

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