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The Main Areas of Application of Water-Soluble Polymers of Acrylamide to Solve the Problem of Environmental Protection and Structure Formation in the Soil

Abdurahimov D.Kh., Ismailov B.M., Tanatarov O.R., Adikamalova A.B., Kuldasheva Sh.A., Agzamova F.N.

Junior researcher, Institute of General and Inorganic Chemistry, Tashkent, Uzbekistan
Doctoral student, Karakalpak Scientific Research Institute of the Karakalpak Branch of the Academy of Sciences of the Republic of Uzbekistan
Doctoral student, Institute of General and Inorganic Chemistry, Tashkent, Uzbekistan
Leading researcher, Institute of General and Inorganic Chemistry, Tashkent, Uzbekistan
Chief researcher, Institute of General and Inorganic Chemistry, Tashkent, Uzbekistan
Junior researcher, Institute of General and Inorganic Chemistry, Tashkent, Uzbekistan

ABSTRACT:. Water-soluble polymers are widely used in various branches of the national economy and industry due to their improved functional characteristics and availability. One such polymer is various forms of acrylamide polymers. They have found applications from the food to the chemical industry. This review discusses the main areas of application of polyacrylamide polymers.

KEYWORDS: polyacrylamide, copolymer, erosion, anionic polyacrylamide, cationic polyacrylamide, hydrogel.

I.INTRODUCTION

Currently, one of the important environmental problems is water pollution, fixation of shifting sands, structure formation in soils to improve infiltration and fertility in them. Numerous studies have shown that acrylamide polymers and their modifications can solve the problems of flocculation, structure formation in dispersed systems, and many others.

Purification of natural and waste water from pollution is very relevant today. Currently, to improve the efficiency of wastewater treatment containing insoluble solid components, high-molecular water-soluble compounds - flocculants are used. Synthetic polymeric compounds are used as flocculants: polyacrylamide (PAA), polyethylene oxide, acrylonitrile copolymers, etc. [1]. The advantage of these polymeric flocculants is that they usually have a higher molecular weight than natural ones, their production is cheaper than the isolation of agents from natural compounds.

II. SIGNIFICANCE OF THE SYSTEM

Water-soluble polymers are widely used in various branches of the national economy and industry due to their improved functional characteristics and availability. The study of methodology is explained in section III, section IV covers the experimental results of the study, and section V discusses the future study and conclusion.

III. METHODOLOGY

The most famous and widespread synthetic flocculant in the world is PAA. This is due to its low cost, relatively low toxicity, rather high efficiency in many flocculation processes, especially in combination with coagulants.

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The reactive amide group of PAA allows a number of reactions to be carried out, as a result of which flocculants of various types are obtained.

Soil losses from erosion worldwide are estimated to be 5,669,139 hectares for this year alone. Land desertification has increased by 9,716,724 ha. Under natural conditions, increased erosion hazard manifests itself on sloping lands, which are either plowed up and used in agriculture for growing various crops or are occupied by shifting sands. The works of a number of authors [2-4] proved that such soil properties as structure, water resistance of aggregates, humus content and humidity are the main factors that determine their anti-erosion and anti-deflation resistance.

IV. EXPERIMENTAL RESULTS

It has been established that the anti-erosion efficiency primarily depends on the dose of the polymer, its nature and method of application to the soil. With an increase in the dose of the polymer, the erosion resistance of soils also increases, but the effectiveness of a unit of the preparation decreases. The properties of the soil itself have a great influence on the effectiveness of polymer preparations in increasing the resistance of soils against erosion. To prevent the washout of the soil surface and the transfer of surface runoff into subsurface runoff, it is necessary to structure the upper soil layer with a thickness of 3–10 cm [5].

In the experiments of the University of California (USA), the application of PAA in the form of granules and an aqueous solution (doses of 67 and 134 kg/ha) reduced soil erosion from 101 t/ha to 2.3 and 4.5 t/ha. Powdered PAA (at a dose of 16.8 kg/ha) completely ruled out erosion [6].

The main application of polyacrylamide is as an inexpensive water-soluble polymer with polyelectrolyte properties. Below are the main areas of application of PAA [7]:

1. As a coagulant and flocculant in water treatment (drinking and process water).
2. Preparation of gels (hydrogels) for chemical analysis of complex biological systems.
3. Medicine, polyacrylamide gel is used in traumatology (Noltrex, Noltrexin) for the treatment of osteoarthritis, arthrosis, osteoarthritis, arthritis, Urology (Dem+), Cosmetology (Argiform).
4. In the production of mineral fertilizers.
5. In molecular biology, PAA is used as a supporting medium for gel electrophoresis of proteins and nucleic acids (the so-called PAAG electrophoresis).
6. Use in the oil industry for waterflooding and carrying out repair and insulation work in the well.
7. Polyacrylamide is used in oil drilling fluids as a fluid loss regulator and an inhibitor of the clay swelling reaction.

Anionic polyacrylamide is a negatively charged polymer [8]. Therefore, it can attract particles of soil, clay or sand to itself. This type of polyacrylamide is used in irrigation systems for soils and crops, processing animal waste products, in the process of drilling wells, and mining. Cationic polyacrylamide has a positive charge, so it is used for wastewater treatment and purification, drinking water clarification, paper raw material purification, etc. Non-ionic polyacrylamide is a polymer with no charge. It is used on very rare occasions. It is often used in the mining process.

Polyacrylamide is considered to be a versatile chemical that is used to gel liquids in the film manufacturing process. It also acts as a high-quality coagulant and flocculant. This material was first produced in 1950 [8].

The influence of the conditions for obtaining hydrogels based on acrylamide and N,N'-methylenebisacrylamide on the properties of gels in the condensed state and on the structure of the polymer network has been studied using IR and NMR spectroscopy, thermomechanical analysis, and computer simulation. It was found that, depending on these conditions, gels have different physiological effects on a living organism [9].

The energy crisis, the sharp deterioration of the ecological state of the environment, the insufficient effectiveness of the means of preventing and eliminating the consequences of natural disasters (mass fires, earthquakes, floods, etc.) and man-made accidents have become one of the most important problems for virtually all countries of our planet in recent decades. Low efficiency, from an environmental and energy-saving point of view, of technologies and technical means that are used on an industrial scale, as well as for solving technogenic and environmental problems, can threaten national security even in the developed countries of the world. The presented article shows that the creation and use of hydrodynamically active compositions based on water-soluble high molecular weight polymers (VP) and micelle-forming surfactants can solve a number of problems of energy saving, ecology and technogenic environmental safety in fire fighting, emergency pumping of wastewater, solving environmental problems large livestock complexes, etc. [10]

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The introduction of preparations based on polyacrylamide (PAA) into the soil of arid regions has a pronounced positive effect on the growth and survival of plants. The widespread use of acrylic polymers is limited mainly by the high cost of such preparations. The synthesis of polymers with organomineral fillers (sawdust and solid waste from the biotechnological production of acrylic monomers) will reduce their cost, and the biodegradation of these wastes can serve as an additional source of plant nutrition. In addition, polyacrylamide gel can be considered as a potential carrier for insecticides, fungicides, herbicides, and fertilizers [11].

Acrylamide-based polymers are widely used in wastewater treatment, agriculture, medicine, and the pharmaceutical industry [12]. The main method for obtaining polymers based on acrylamide (AA) is radical solution polymerization. A less common way to obtain such polymers, in particular polyacrylamide, is frontal polymerization (FP). FP is a simple and convenient technological method of polymerization [13]. One of the main advantages of FP is low energy consumption, since FP reactions are exothermic and self-sustaining. It is also possible to carry out the synthesis without the use of solvents. A significant advantage of the FP is the possibility of implementing the process in high-performance tubular continuous reactors. To prevent and combat this dangerous phenomenon, various methods are used, for example, various chemical polymers and structurants are used. Polyacrylamide (PAA) is a high molecular weight polymer. It is known that PAA on irrigated lands reduces surface compaction and crust formation, and prevents the manifestation of the consequences of erosion [14].

High molecular weight (106×107 Da) polyacrylamide is commonly used as a flocculant in water and wastewater treatment, as a soil conditioner, and as a viscosity and friction modifier in both enhanced oil recovery and large volume hydraulic fracturing. A brief review of current applications of high molecular weight PAA is presented, including the potential for PAA degradation by chemical, mechanical, thermal, photolytic, and biological processes. Then methods for treating wastewater containing partially degraded PAA are discussed, as well as issues related to the potential toxicity and mobility of PAA in the environment after disposal or accidental release [15].

Humanity is facing a climate and energy crisis that requires global and rapid action to minimize the negative impact on the environment and on the lives of millions of people. Among all disciplines that play an important role, chemistry has a chance to rethink the way molecules are created and find innovations to reduce the overall anthropogenic impact on the environment. A review of the literature and recent developments in the production and end use of acrylamide-based polymers in accordance with the concept of "green chemistry" is presented. After a review of feedstock source options (fossil-derived or bio-based), improvements in monomer production are discussed, followed by a second part on polymer production processes and ways to reduce energy consumption and CO2 emissions. The analysis shows that polyacrylamides help to reduce the impact on the environment: agriculture or wastewater treatment [16].

High molecular weight PAA is widely used in the development of unconventional natural gas as a “friction reducer” to minimize frictional losses during pumping. The drag reducing properties of PAM are due to the elongation of the polymer, which dampens the quasi-longitudinal vortices characteristic of turbulent flow [17].

Anionic polyacrylamides work better as drag stabilizers in freshwater environments; cationic PAA has shown improved performance at high salinity by reducing the electrostatic repulsion from shielding by an electrolyte containing anionic particles [18].

PAM is also widely used as a flocculant in drinking water treatment (in concentrations <1 mg/l) [19]. PAA can create bridges between destabilized particles, forming micron-sized aggregates with good settling properties. Cationic, nonionic and anionic PAAs have been studied for flocculation. The flocculation and adsorption capacity increase with increasing molecular weight due to the larger number of binding contacts [20].

Polyacrylamide against soil erosion has been used since the [23] due to its effectiveness in improving the structure of aggregates and their stability even at low costs for tillage [24, 25]. The data shows that flocculating materials such as PAA are able to bind soil particles and thereby reduce adverse physicochemical effects [26], while aggregation increases the porosity between the contacting particles and the rate of water infiltration, which also increases the stability of soil aggregates [27]

V. CONCLUSION AND FUTURE WORK

Polyacrylamides increase the stability of soil aggregates by 17-18%, by increasing the infiltration rate by more than 2 times. The best stability characteristic was shown by the cationic form of polyacrylamide.

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