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Preparing and Improving the Properties of Sodium Acrylate Polymer by Adding Dentonite for the Treatment of Desertification Phenomenon

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ABSTRACT

The phenomenon of desertification has a negative impact on the national economy of any country and may usually be obtained for many reasons such as the removal of agricultural land, depletion of soil, overgrazing, methods of poor irrigation, high temperature, and the lack of rainfall. The following paper tackles solving the problem of the lack of rainfall through the use of chemical methods such as preparing sodium polyacrylate and improving its properties by means of adding bentonite and thus obtaining a new and improved water absorption compound. The study concludes that the suitable range of bentonite ratio that is between (0 - 20 wt %) ensures water absorption from 1340 gg - 1 to 1500gg – 1 and thus the researcher confirms that the cross-linked of the compound will not be changed and the absorption of water will be higher. The presence of bentonite with polymer at a perfect percentage contributes to the reorganization of the distribution of the granular size of the polymer sodium polyacrylate—a matter that is reflected on the growing of its ability to absorb water and thus becoming a suitable compound in the treatment of desertification.

Keywords: phenomenon of desertification, Superabsorbent, sodium polyacrylate, bentonite

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تحضير وتحسين خصائص بوليمر الصوديوم اكريلايت من خلال إضافة البنتونايت لمعالجة ظاهرة التصحر

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الخلاصة

إن ظاهرة التصحر مشكله لها تأثير سلبي على الاقتصاد الوطني لأي بلد، وقد تحصل عادة لأسباب عديدة مثل إزالة الأراضي الزراعية، استنزاف التربة، الرعي الجائر, أساليب الري الرديئة, ارتفاع درجة الحرارة, وقلة هطول الأمطار. لذا تناولنا في هذا البحث معالجة مشكلة قلة هطول الامطار باستخدام الطرق الكيميائية، ذلك من خلال تحضير بوليمر الصوديوم بولي اكريلايت ومن ثم تحسين خصائصه عن طريق إضافة البنتونايت، وبالتالي الحصول على مركب جديد ومحسن عالي الامتصاصية للماء. وقد توصلنا الى ان نسبة البنتونايت المناسبة تقع ما بين (0 – 20 wt %) لضمان امتصاصية للماء من ($1340\ gg^{-1}$) الى ($1500gg^{-1}$)، والتي نضمن عندها عدم تغيير كثافة التشابك للمركب واعلى امتصاصية للماء. إن وجود البنتونايت مع البوليمر بنسب مدروسة قد ساهم في اعادة تنظيم توزيع الحجم الحبيبي لبوليمر الصوديوم بولي اكريلايت المحضر مختبريا، مما انعكس بالنتيجة على زيادة قابليته على امتصاص الماء، وبالتالي جعله مركبا مناسبا في معالجة ظاهرة التصحر.

كلمات رئيسية: ظاهرة التصحر، فائق الامتصاصية، بوليمر الصوديوم اكريلات البنتونايت.

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1. Introduction

The highly absorbent polymer can be defined as a special substance with hydrophilic groups and a minimal tangle. It is capable of absorbing hundreds of thousands of times from the mass of water and noting the difficulty of removing the absorbed water under pressure—a matter that reflects its excellent specifications.

This polymer has been used for many purposes such as medicine, health, agricultural, and industrial fields in addition to preparation of super absorbent materials [1-4]. Desertification is the degradation of land in arid, semi-arid, and dry sub-humid areas, resulting in the loss of plant life and biodiversity. Consequently, this leads to the loss of soils, the loss of land capacity for agricultural production, and the unsupported life of animals as humans as well. Desertification has a significant impact on the country's economic situation, resulting in a loss of up to $ 40 billion a year in agricultural crops and thus their rising prices [1].

Desertification creates an appropriate atmosphere for intensifying forest fires, raising winds, and increasing the pressures on the most important land resources, namely water. According to the World-Wide Fund for Nature, land loosed about 30% of its natural resources between 1970 and 1995. Desertification is a global problem experienced by many countries around the world. It is known that the decline in the capacity of the earth's biological production or the degradation of a fertile land produced at the rate obtained by conditions similar to the desert climatic conditions. Hence, desertification leads to reduction of the production of plant life. The total desert area in the world is about 46 million square kilometers. Desertification situations can be illustrated as follows:

Desertification and severity vary from region to region depending on the nature of the relationship between the natural environments on the one hand and between humans on the other. There are four degrees or categories of desertification identified by the United Nation's classification of desertification:

- **Poor desertification:** Very little damage or damage to vegetation and soil that does not affect the biological capacity of the environment.

- **Moderate desertification:** It is moderately damaged by vegetation, small sand dunes or small soil sediments, as well as soil salinity, which reduces production by 10-15%.
- **Severe desertification:** It is engendered by the spread of unwanted grasses and trees in pasture at the expense of desired and desirable species. Furthermore, it is caused by the increased activity of erosion—a matter that affects vegetation and reduces production by 50%.
- **Very severe desertification**: It is all about the formation of large, naked and active sand dunes, and the formation of many sediments, salts and soil salts [2].

The causes of desertification are engendered by many influential atmospheric and humanitarian conditions such as:

- The excessive use of the land that leads to soil depletion.
- Deforestation that works on land cohesion.
- Overgrazing that leads to the depravity the land's grasses.
- Poor irrigation methods that go hand in hand with poverty.

This means that the phenomenon of desertification is the transformation of highly productive and large fertile areas to poor areas regarding plant and animal's life; this is engender by either the brutality of man's dealings with them or with climate changes. The state of weakness and the weakness that the environment suffers from is either due to what man does or the lack of other effective natural factors which man does not get income from. Soil is the part that complains and grumbles every day of this bad treatment of the land. There is a difference between land and soil. The soil is the surface of the soil, which is suitable for the growth of the plants, and the roots which are penetrated in order to obtain the nutrients necessary for their growth. Soil is the foundation of agriculture and life. Soil was formed during complex processes and during a time period estimated at millions of years. It is influenced by many factors such as climate, temperature, humidity, wind, as well as agricultural treatment of irrigation, drainage, fertilization, repair and other agricultural transactions.

2. Factors Leading to Desertification

2.1. Climate changes such as:

- High temperature, lacking rain, and scarcity help to accelerate the evaporation and accumulation of salts in the territories.
- Bullets sweep soil and uproot crops threaten soil fertility.
- Sand dunes that cover plowing and planting by wind.
- The rising level of groundwater.
- Agriculture based on rain.
- Dependence on well water in irrigation—a matter that makes groundwater more salinity over time and thus increasing the salinity and desertification of the soil.
- Winds lead to a rapid drying and dehydration of plants especially if they persist for a long time. In addition, they tear and uproot plants especially when shallow roots lead to deforestation.

This may lead us to a more focus on wind, heavy rain, flood, in a sense that it causes erosion of soil, where thousands tons of soil particles containing organic matter, nitrogen, phosphorus, potassium, calcium, sulfur, and other elements are dumped every year. According to this context, the amount of polluted soil is more than the amount of fertilizer plants. Although erosion of soil has been a natural phenomenon since the time of immemorial, it has been increased significantly by man's increasing activities, as well as unconscious factors.

2.2. Removed Vegetation.

2.3. Overgrazing Especially in the Dry Period.

2.4. Unsustainable Agricultural Practices: such as tillage of the soil in times of drought is not appropriate in a sense that it leads to the disintegration of the surface layer of the soil, making them vulnerable to erosion. The drift is divided into two types:

- **Wind Drift:** The wind drift that produces dust and dust storms occurs at any time, depending on the intensity of the wind. It is particularly important in areas where

vegetation is degraded, especially when the wind speed is between 15-20 meters / second or more.

- **Water Drift:** Water erosion is caused by surface water jars or by rain drops. The effect of water erosion is increased when rain is heavy, so that the soil cannot absorb the rainwater and thus it is formed as a result of this flood.

3. Means of Reducing Soil Erosion and Desertification

- Identifying the causes of environmental degradation by means of environmental survey.
- Installing sand dunes which entail the erection of front and defensive barriers as front lines for sand progress.
- Establishing small windbreakers and covering sand dunes with dead vegetation.
- Oil derivatives, chemicals or rubber.
- Planting sand dunes next to suitable plants that blend with the middle of the sand dunes.
- Preserving natural pastures and developing natural vegetation.
- Stopping the expansion of rain fed agriculture at the expense of natural pastures.
- Exploitation of water in agriculture.
- Stop logging and logging for use as an energy source.
- Controlling irrigated agriculture and reviewing current irrigation and drainage methods.
- Dry agriculture, where plants that require little water and are highly drought resistant are cultured.
- Improving soil structure by adding organic matter to it and plowing it with the plants in which it lives.
- Eliminating the tendency to create terraces.
- Plowing land in the first rainy season.
- Creating ponds and lakes in the fields to stop the eruption of water.
- Constructing dams to reduce the strength of the fluid.
- Preserving vegetation and avoid overgrazing.
- Surrounding fields and lands prone to erosion with boulders from trees and shrubs.

4. Ways to Combat Desertification

It is very difficult to re-establish a new life in the desert land or towards comprehensive desertification. Therefore, fertile land must be preserved before it deteriorates and the most effective and economical causes of desertification should be eliminated. This is represented by:

- Regulation of grazing, grazing and mitigation of overgrazing and rangeland development.
- Organizing grazing on all grazing lands by controlling the movement of animals within the grazing area temporarily and spatially
- Trying to stop the sand dunes in several ways, including:

4.1. Mechanical Methods: By creating vertical barriers to the direction of the wind through:

- **Vegetative barriers:** There are many plants that have the ability to install sand. Roasting is the best in the installation process, but the appropriate plant species should be selected in terms of length, branching, root strength and resistance to extreme environmental conditions.
- **Hard barriers:** Using the newly industrialized barriers of walls or trunks of trees and strong interlocking with each other.

4.2. Chemical Methods: Such as oil derivatives in the form of spray that adhere to the surface soil, however; this method has risks such as pollution of soil and water and the negative the impact on plants.

4.3. Maintenance and Protection of Water Resources: Using these resources, rationalizing their use and using modern irrigation methods.

4.4. Developing Human Capacities: Using modern technologies and training specialists, especially in combating desertification such as remote sensing and aerial photography, determining the presence of underground water in the ground, and spreading

environmental awareness among citizens, especially farmers, livestock owners, and pastoralists.

5. Theoretical Background

The process of mixing polymers with liquids with low molecular weight and swelling and then melting them at the end is of great importance in the manufacture of these materials, as well as in the use of different walks of life. On the other hand, it is important to know the effect of different liquids, such as water and others, on polymer models. To answer the question of solvents the polymer melts in any case it is necessary to have a good background concerning the basic rules of polymer interference with low-molecular weight analyzers. In the case of low-weight materials, polymers dissolve in all liquids. Some polymers spontaneously dissolve in some solvents when they are placed in a direct contact with them, while lipid is readily soluble in other solvents. There is usually a common affinity between the polymer and the solvent in some cases and in others there is no such familiarity. The polymerization of polymers is practically observed. However, this process has certain pre-melting properties. The polymer begins to bloom [5], which increases the size and weight of the polymer as a result of the absorption of liquid particles. If we move the polymer model into small parts and then pour a little liquid over it, the swelling will appear at the beginning but after a while we will notice their overlapping with each other to be a homogeneous mixture of the polymer and the liquid absorbed. At this stage, the system is real.

The swelling process involves an inevitable change in the shape and size of the polymer, leading to a sharp increase in the size of the model and thus the swelling process may be limited or unlimited. Unlimited swelling is the process that automatically leads to melting and it is similar to the process of the full mixing of two different liquids such as water, alcohol, water, sulfuric acid and others.

The limited amplification is applicable to our research topic, as it involves the process of mixing polymers with liquids of fine size when it is limited. As such certain phase of absorption of the latter initially takes place, and does not notice the automatic appearance of the solution of the polymer. In other words, chains of the polymer are not separated

completely from one another. As a result, the two separate phases are formed, one from the solvent solution in the pulsed polyamide, and the other from the pure solvent (if the polymer is completely lithium) or a diluted solution of the polymer in the solvent. These two phases separate a clear surface in the equilibrium. It is also necessary to distinguish between the limited swelling of linear and interwoven polymers. The process in the case of linear polymers is similar to that of liquids.

Under certain conditions (such as heat and concentration), the swelling is limited, but the changed conditions may transform the limited swelling to be unlimited. It is recommended to add a small and enough amount of solvent at the beginning to cover the surface of the polymer with a thin layer. This process will lead to a faster polymerization, forming a permeable layer on the bulging surface, and then adding the remaining quantity of the solvent with the continuous stirring until we reach the desired concentration Blow Mold automatically into solution state. In some cases, the polymer is not fully melted. We observe small pieces of the floating polyamide floating in the inside of the dissolved medium. These particles are called Gelites. Therefore, the solutions must be separated in the solution in the absence of the desire to exist during the filter or by centrifugation. Many electrolytes have been synthesized with periodic replicates and these can be decomposed into ions such as acryl polycrystalline and polyethyl acryl acid and dissolve the salts of these acids (soluble in water). One of the most important materials is cross linkedpoly electrolytes. These polymers are brought together by being mixed carefully into the polymer's structure. The factors that indicate the way bulge and breakdown of polymers are affected are enlisted below:

The nature of the polymer and the solvent.

- Polymer chain elasticity.
- The molecular weight of the polymer.
- Chemical composition of the polymer.
- The crystalline structure of polymers.
- Chemical tangling between chains.
- Temperature.

Among many important points that this research tackles are whether the amount of tangling is relatively small. In other words, it examines whether the intertwining bonds are very long and thus the chances of the solvent molecules to penetrate through the polymer chains are high. In this case, some chains are removed from each other, resulting in a swelling of the partially tangle polymer. The greater the density of the tangles is, the more polymers' ability to absorb the solvent is decreased. The interlocking polymer loses its ability to bulge completely when the interlocking bonds become very short [5].

6. Practical aspect

6.1 Materials

- **Bentonite** is one of the important materials used in this research. There are different types of Bentonites (Potassium, Sodium, Calcium and Aluminum). It is used in other large fields such as Cement and Adhesives, Steel, Transformer Oil, Bentonite, Treatment of dermatitis [6]. Bentonite used in the practical part is clay with a layer of aluminum silicate with all active (OH) groups on the surface. It should be dried at 105 ^{O}C before use [7].
- **Acrylic acid**, a monomer is used in the preparation of the polymer, it is purified by refrigeration before being used.
- **Potassium Persulfate** is the catalyst for initiation of the first step of the polymerization process.
- **N, N-methyl enebic acryl amide**, is the substance used as a cross-linker.

6.2 Preparation of high - absorbent Polymer Poly Sodium Acrylate Pentolite

This polymer was prepared laboratory by Inverse Suspension, as well as the slow distillation of the monomer acid to the sodium hydroxide solution at 0 ° C, where it is cooled by a snow bath with constant stirring. By following:

- Adding the amount of bentonite (which we will determine in the experiment) to the sodium acrylate solution.
- Then, cyclohexane with sodium hydroxide and sorbitan monostearate.
- Nitrogen pressure, N (N-methyl enebisacryl amide) and potassium persulphate are placed on the mixture that will stir at room temperature for 30 minutes.
- The mixture will be placed in a water bath where it is slowly heated at 65o C with a continuous movement for 90 minutes
- Filtering the solution and then washing it with methanol for three times.
- Drying in oven 70°C for more than 24 hours until the weight is stabilized and results in a powder which is the highly absorbent compound that is called poly sodium acrylate bentonite.

6.3 Method of Working and Measurements

- We take 3gm from the dry powder prepared and put it in (500 ml) of distilled water at a lab temperature for 4 hours to reach the state of bloating [10].
- We work to separate the water-blown from other elements, which did not absorb the water by filtration.
- The following equation is applied to calculate water absorption (Q_{H2O}) [11].

$$Q_{H_2O} = \frac{m_1 - m_2}{m_1 - m_0} = \frac{m_2 - m_1}{m_1 - m_0} \quad (1)$$

Whereas.
m_0 = weights of clay in the sample (gm).
m_1 = dry sample polymer (3gm).
m_2 = swollen sample.

7. Results and Discussion

The effect of the quantity of bentonite added to the polysodium acrylate compound is shown in Tables (1), (2) and Figure (1). Therefore, we can see that QH2O increases from 1340gg-1 to 1500gg-1, and this occurs when the percentage of the added Bentonite increases (0-20 wt %). We also note that after adding 20 wt% of bentonite, QH2O begins to decrease gradually. The polymerization compound is a bond between the acrylite and bentonite [10],

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which plays an important role in the formation of the compound. When the quantity of bentonite is as appropriate as the weights between (0-20 wt %), the tangling density of the compound does not change or it is changed slightly [11]. The super absorbent compound has enough space to absorb and hold water molecules. As the pentonite increases in the compound (25 wt %) or (30 wt %), the density of the entanglement increases and the vacuum begins to shrink [12], making it difficult to receive the water molecules in the compound. Thus, QH2O decreases with the increase of the percentage of bentonite [13].

Table 1 The values of m_0, m_1, m_2 are shown in gram units

No.	Weight of clay in the sample, m0 (gm)	Dry sample polymer, m1 (gm)	Swollen sample, m2 (gm)
1	0	3	4020
2	0.05	3	4127
3	0.1	3	4144
4	0.15	3	4215
5	0.20	3	4200
6	0.25	3	3957
7	0.30	3	3642

Table 2 Q_{H2O} values are shown according to the quantities used in Table (1)

No.	QH2O g.g -1
1	1340
2	1398
3	1428
4	1478
5	1500
6	1440
7	1348

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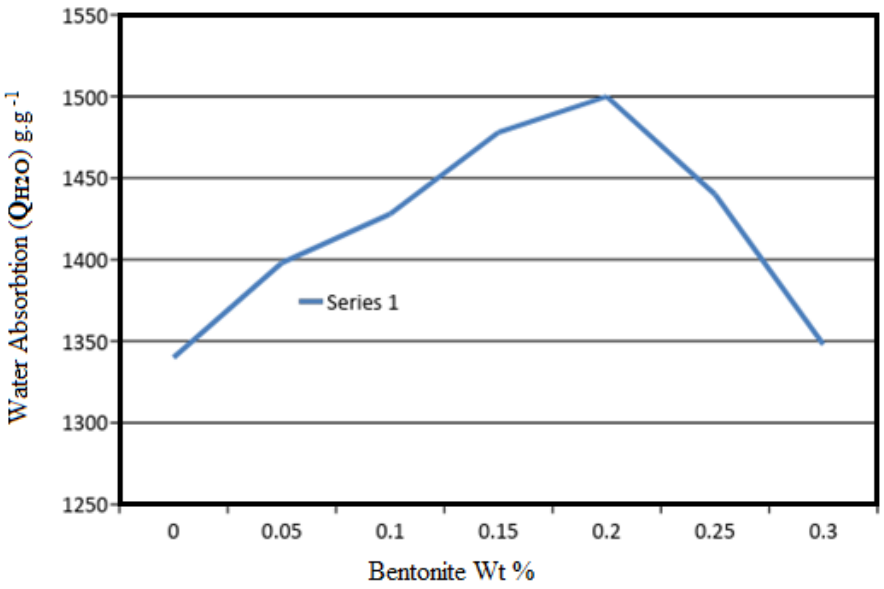

Fig. 1 The relationship between (Q_{H2O}) and the amount of bentonite added (wt %)

8. Conclusions and Recommendations

a. In this paper, a very important phenomenon was discussed: the phenomenon of desertification and how to deal with adding bentonite to the sodium acrylate polymer, where we found that there is a limited quantity of bentonite added to increase the absorption of water and above. The inverse takes place because the density of the entanglement increases, and the void start to shrinkage and finds difficulty in receiving water molecules.

b. When the quantity of bentonite is as appropriate as the weights between 0-20 wt %, the tangent density of the compound does not change, or it is changed slightly. Hence, it has enough void to absorb and hold the water molecules.

c. The erroneous notion must be corrected. In spite of the fact that desertification is the result of a lack of rainfall, there are many and more serious reasons for this phenomenon.

d. Afforestation and application of agricultural activities or cultivation of drought-resistant crops.

e. Strengthening the possibilities of scientific research and training in countries suffering from desertification and drought through the establishment of efficient training programs for the conservation of natural resources.

f. Providing means of training and technology to exploit alternative energy sources, especially renewable sources.

g. The lack of excessive or inappropriate exploitation of land, as well as the less paid attention to the phenomenon of overgrazing and the use of poor irrigation methods.

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