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APPLICATION OF RED SLUDGE AS AN ALTERNATIVE COAGULANT FOR WATER PURIFICATION AND RESTORATION OF DEGRADED SOILS

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Abstract

The possibility of using red sludge in water purification and soil remediation technologies was investigated. The effectiveness of the use of coagulants synthesized from red sludge to remove water turbidity was evaluated. The results confirm the feasibility of using red mud in water treatment processes.

Key words: *red sludge, synthesized coagulants, water treatment, soil remediation, reducing soil acidity.*

Water pollution and soil degradation are among the most pressing challenges of our time. One of the most common methods of water treatment is coagulation, but traditional coagulants such as aluminum or iron sulfate are characterized by high costs and the associated generation of secondary hazardous waste. In this context, there is growing interest in using alternative materials, including industrial waste, as a source of reagents.

One such material is red mud, a by-product of alumina production rich in Fe and Al oxides. It is known that red sludge-based activated coagulants can effectively clarify water, competing with traditional reagents [1]. The effectiveness of sludge-based composites for phosphate removal to a concentration of <0.02 mg/L has been confirmed [2]. Other studies have shown the effectiveness of using red sludge to treat wastewater with a high arsenic content generated in the metallurgical industry. The results showed that almost 100% of arsenic was gradually removed [3].

Another promising area in the use of red sludge is the development of new composite materials for water treatment [4]. This approach involves the combination of industrial waste, such as red sludge, with functional polymer structures, which allows for both adsorption and oxidation mechanisms. This creates opportunities for the development of environmentally friendly and efficient water treatment solutions.

In addition to water purification, alumina by-products have a high potential for use in the restoration of degraded soils Studies have shown that adding red sludge to soils can improve their structure, increase nutrient content, and help restore biological activity [5]. Sludge should only be used after preliminary treatment. In its original form, sludge is hazardous to the environment, so direct application to soil without neutralisation is prohibited. Methods of neutralising sludge before use:

carbonation - treatment with CO_2 to lower the pH; mixing with biocompost or peat - reduces toxicity; use in the form of hydrogel or granules - dosage control.

Stabilisation with phosphates - reduces the mobility of heavy metals. Potential benefits after treatment:

1. Improvement of soil structure - sludge can act as a structure-building agent after treatment.
2. Reducing soil acidity - due to its high pH, it can neutralise acidic soils in small doses.
3. Enrichment of soils with microelements - especially iron, calcium, magnesium.

A study was conducted on rice fields with sodium saline soils in the Sunnen Plain in North-East China. The results show that the combined application of aluminium sulphate at a dose of 500 kg/m^2 with an inorganic fertiliser is an effective means of improving sodium saline soils in the Sunnen Plain, Northeast China. Based on the results, the pH, EC, ESP, total alkalinity, SAR, Na^+, and HCO_3 were significantly reduced in the sodium saline soil, while CEC, SOC, available nitrogen (AN), available phosphorus (AP), available potassium (AK), K^+ were significantly increased compared to the other fertilizer [6].

This opens up new opportunities for sustainable land management and reducing the negative impact of industrial waste on the environment.

Studies were conducted to determine the effectiveness of water turbidity removal by coagulants SCM_1 and SCM_2 synthesized from red sludge in comparison with the widely used aluminum sulfate (Fig. 1).

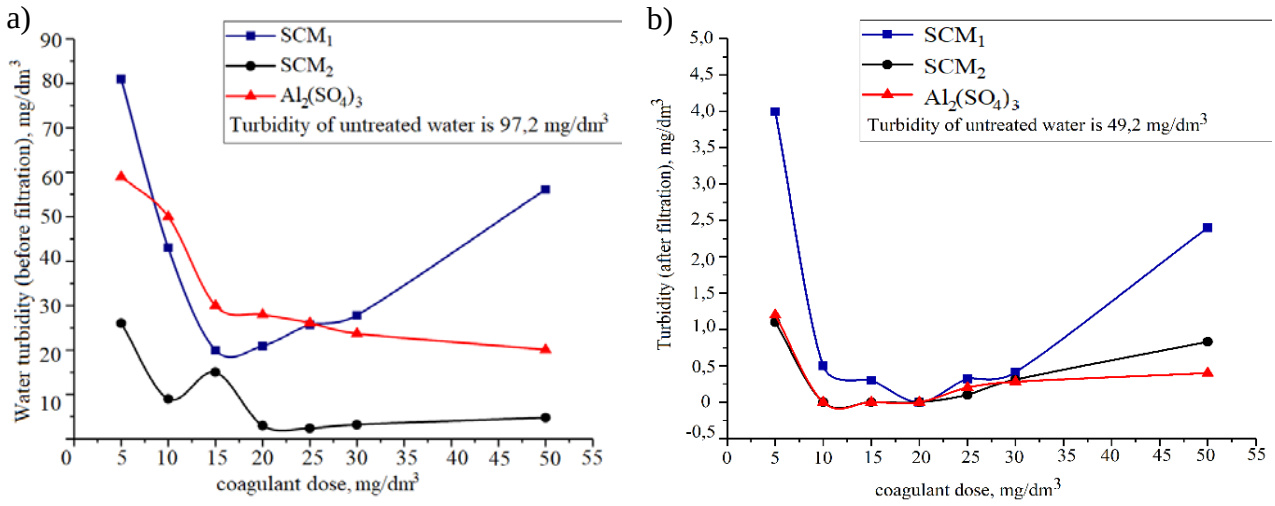

***Fig. 1** Turbidity removal before (a) and after (b) filtration by SCM_1, SCM_2 and $Al_2(SO_4)_3$ coagulants accordingly*

According to the results, SCM_2 is more effective in removing turbidity before filtration. After filtration, all coagulants reduced turbidity to drinking water levels. However, an increase in turbidity was observed at concentrations of 25 mg/dm^3 and above. Thus, the synthesized coagulants SCM_1 and SCM_2 demonstrated high coagulation properties in water treatment at low doses. These coagulants can become an alternative to commercial aluminum sulfate, since they will have a lower cost and will not be inferior in terms of application efficiency.

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ЗАСТОСУВАННЯ ЧЕРВОНОГО ШЛАМУ ЯК АЛЬТЕРНАТИВНОГО КОАГУЛЯНТУ ДЛЯ ОЧИЩЕННЯ ВОДИ ТА ВІДНОВЛЕННЯ ДЕГРАДОВАНИХ ҐРУНТІВ

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Анотація

Досліджено можливість застосування червоного шламу у технологіях очистки води та відновленні ґрунтів. Проведено оцінку ефективності застосування синтезованих з червоного шламу коагулянтів для видалення каламутності води. Результати підтверджують доцільність використання червоного шламу у процесах очищення води.

Ключові слова: червоний шлам, синтезовані коагулянти, очищення води, відновлення ґрунтів, зменшення кислотності ґрунтів.