Abstract

The aim of the research was to synthesize new bioflocculants based on selected polysaccharides, their physicochemical characteristics and to determine their effectiveness in purifying backwash water at Water Treatment Plant (WTP) in Kutno. Chitosan (CT), corn starch (ST) and their two derivatives: dialdehyde (DCT, DST) and carboxymethyl (CMC, CMS) were the subject of the dissertation.

Chitosan derivatives were obtained in the process of its chemical modification. CT was oxidized with sodium iodate (VII) in acetic acid solution to obtain DCT with a degree of substitution with dialdehyde groups of over 44%. In the case of CMC synthesis, after alkaline activation of chitosan, monochloroacetic acid was added to the solution to obtain carboxymethylated chitosan with a DS of approx. 50%. Starch derivatives were obtained in a similar way. The degree of substitution of dialdehyde starch (DST) was ≈40%, and that of carboxymethyl derivative (CMS) ≈39%.

Characterization of the obtained bioflocculants using FTIR and ^{13}C-NMR spectroscopic techniques and elemental analysis confirmed successful modification of polysaccharides. Scanning electron microscopy (SEM) was also used to investigate changes in morphology that had a significant impact on the flocculation properties of the obtained biopolymers. Thermogravimetric (TG) analysis also showed partial thermal stabilization caused by the modification of chitosan and starch.

The application potential of the obtained biopolymer materials in the process of purifying backwash water at Water Treatment Plant in Kutno has been proven. Due to the high content of iron compounds causing increased turbidity of the purified water, the reduction of turbidity and iron ion concentration was adopted as a measure of the effectiveness of the process. Flocculation efficiency was determined in a series of tests according to the Jar Test procedure.

At first, the optimal dose of synthetic flocculants was determined, which allowed to design of the second stage of research using the obtained materials. Applying biopolymers, an over 90 % reduction of the tested water parameters was achieved, which corresponds with the values obtained for commercial flocculants.

The highest flocculation efficacy was achieved by carboxymethyl derivatives of chitosan and starch. These biomaterials (CMS, CMC), used at an optimal dose of 0.2 mg/L, had the iron removal efficiency of approx. 99% and turbidity reduction of 98%.

Based on the analysis of the results, a flocculation mechanism was also proposed, in which the functional groups (COOH, OH, NH_2) present in the structure of biopolymers played an important role.

Moreover, the biodegradability of the tested polymers and the resulting post flocculation sludge was tested using the OxiTop® measuring equipment. The determined BOD values during biological decomposition of the polysaccharide materials used confirmed their high susceptibility to biodegradation.