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# Production and application of environment-friendly starch derivatives for the protection of the environment

## Objective of the project

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The goal of the project is to develop a starch-based biopolymer product family the members of which can be used in the fields of industry, agriculture and water treatment protecting the public health and the environment.

The synthetic polymers used as additives in the industry are not degradable by environmental effect, and because of the monomers remaining in the products they are toxic. The natural polymer of the starch can be made suitable for partial or complete substitution of synthetic polymers in certain fields of application by chemical modifications.

If the polymer structure is preserved and appropriate function groups are built into the monomers, quite many biopolymers can be obtained.

Advantages of using such products:

- they come from renewable raw materials,
- they are non-toxic in case of using appropriate reagents,
- they are degradable by environmental effect.



## Participants

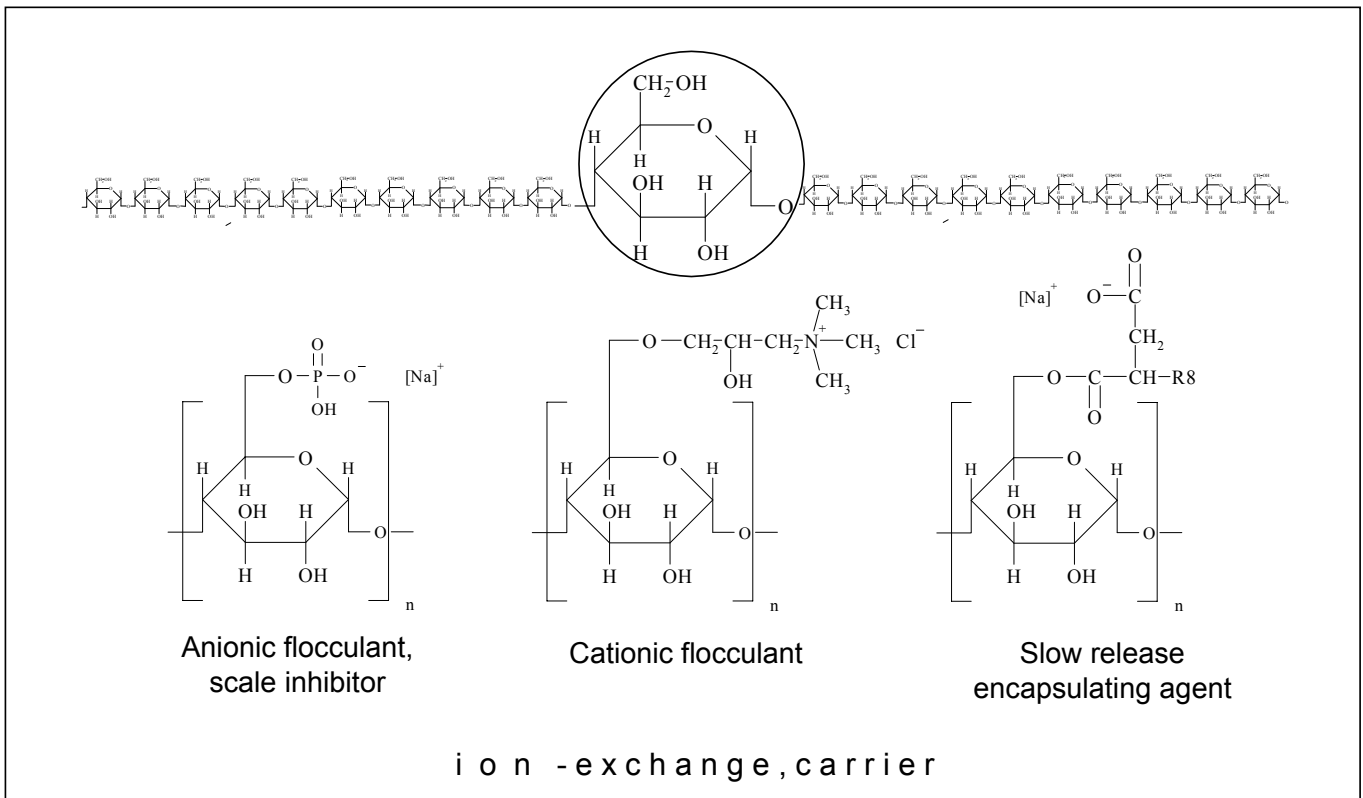
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## Products

- **Flocculants:** water soluble, ionic polymers of high molecular weight, so-called polyelectrolytes that can be used in the clarification step of the water and wastewater treatment. They promote the sedimentation and the filtering of colloid size particles in aqueous suspensions binding them by charge neutralizing and bridge forming mechanisms. There are two types of flocculants :
  - anionic flocculants: e.g. starch phosphates,
  - cationic flocculants: e.g. starch ether derivatives.
- **Slow release encapsulating agents:** organic starch esters with controlled water repellency can decrease the rate of leaching of pesticides or other bioactive components. The formula is safe, has no toxic effect on humans during its production, packaging and application. The efficiency of the active agent is better, it results in less consumption.
- **Scale inhibitors:** starch phosphates of lower molecular weight are dispersants, they prevent the scale formation in cooling water lines. The heat transfer is better and the corrosion decreases. Significant spare of equipment and energy can be achieved.
- **Natural carriers, ion-exchangers:** crosslinked starch esters with anionic function groups can remove heavy metal cations from wastewaters. Their non-toxic, natural character can be very advantageous in processes of biotechnology.

## Functional character of the products



## Laboratory scale results

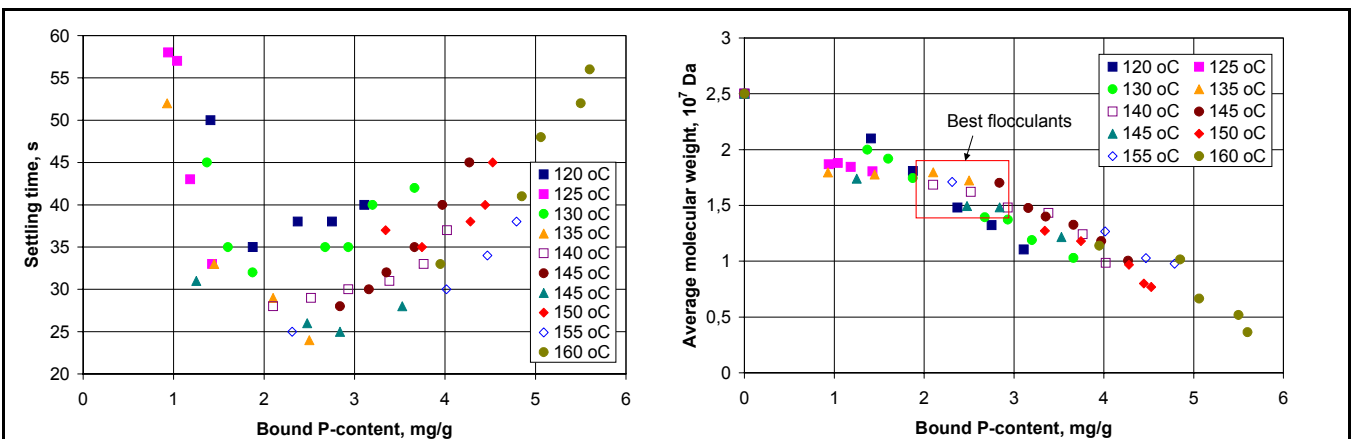
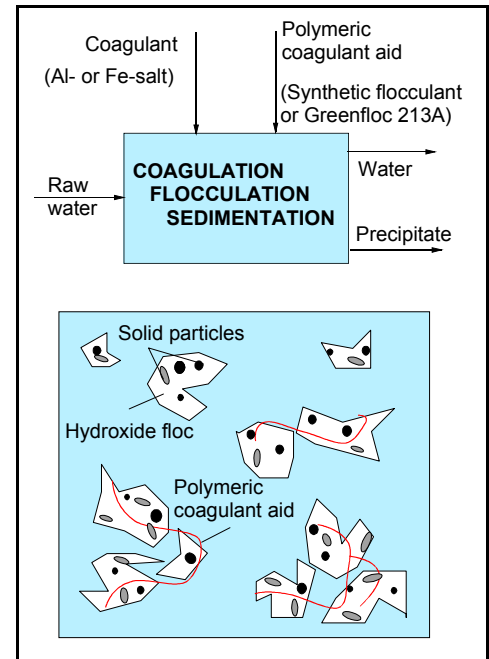
Our first results are related to starch based anionic flocculants. A new product was developed that can be applied in the drinking water treatment as coagulant aid together with Al- or Fe-salt coagulants.

This flocculant is a starch phosphate with very low P-content (0.6 %). It can replace the commonly used synthetic flocculants, the dosage is the same as that of synthetics (0.2-0.5 g/m<sup>3</sup> water).

During the experiments we investigated the two parallel reactions of the phosphorylation :

- building-up of the phosphate groups,
- degradation of the starch polymer.

The first reaction increases the solubility of the starch in water and the ability of the polymers to bind to the particles. The latter one decreases the molecular weight of the polymers and through that the chance of bridge forming. The optimal reaction parameters were determined by qualifying the derivatives by their flocculating efficiency.



## Pilot scale reactor

A small company, Hydra 2002 R&D and Consulting Ltd. took part in the research and development of starch based products from the beginning of the work. Realizing the importance of the technology transfer they built a pilot scale plant that can be used for starch modification by dry technology.

The main part of the plant is a multifunction batch type reactor:

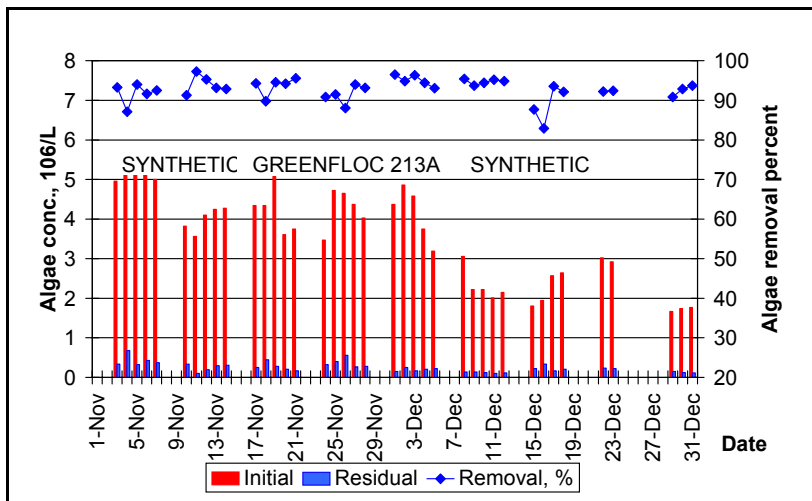
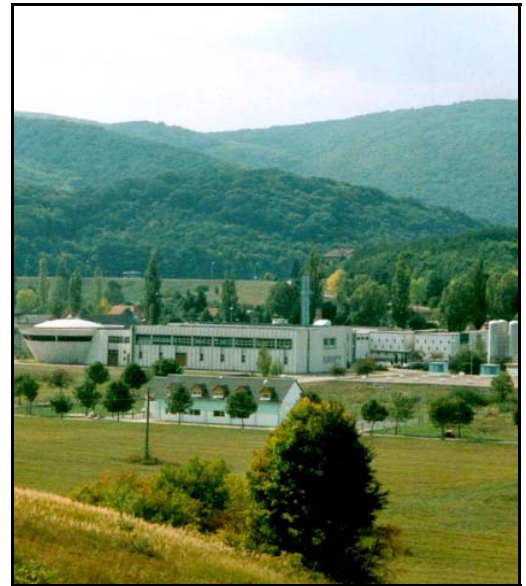
- capacity: 100 kg/charge,
- reactor volume: 0.45 m<sup>3</sup>,
- spraying: pneumatic nozzle,
- mixing: horizontal impeller,
- vacuum and condenser,
- electric heating,
- temperature control.



## Industrial scale experiments

The National Public Health Service registered the flocculating agent by the brand name Greenfloc 213A and allowed its application in the drinking water supply systems. According to the report of the "B. Johan" National Institute of Public Health (Budapest, Hungary) the application of the flocculant in the drinking water purification is permissible from a hygienic point of view. The maximum of dosage is 1 ppm.

The amount of flocculant produced in the pilot plant made possible industrial scale experiments. The objective of the experiments was to find out whether our flocculant is suitable for the substitution of the synthetic agents in the coagulation-flocculation step of water treatment. The experiments related to the applicability of the Greenfloc 213A were carried out at the Waterworks of Lazberc (ERV) located in the heart of the Bukk mountains.



Water characteristics measured:

- turbidity removal,
- algae removal,
- DOC removal,
- residual coagulant,
- residual coagulant aid,
- total organic carbon.

The results of the algae removal are shown in the chart left.

## Direct and indirect impacts of the project

- **Pollution** of the environment originating from the use of synthetic polymers **can be reduced**.
- Due to the replacement of the synthetic flocculants used in drinking water treatment the **consumers can get healthier drinking water**.
- The slow release encapsulating agents directly **protect the health of workers** who use the active agent, but indirectly also that of consumers who may meet the active agents in small concentrations.
- The scale inhibitors **decrease the energy consumption** due to the better heat transfer.
- The ion-exchangers and carriers also **decrease the harmful effect of synthetic products** of similar purpose on the environment.
- The Nitrokemia 2000 Co. locating in the near of Lake Balaton wishes to **introduce up-to-date low-waste technologies** for the production of its products planned.