Use of modified polyketones in water

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Description of research

Motivation

Nowadays water softening is performed by using ion exchange resins that bind the calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions present in industrial water-flows. Softening of water using this technology is frequently used as pretreatment to prevent occurrence of scaling in process equipment. A main disadvantage of this technology is the need to use rather huge amounts of salt (e.g. NaCl) to regenerate the resin. Focus of my research is to develop a more sustainable alternative. Functional polymers (e.g. polymers containing amine groups and its derivatives) form complexes with, for example, metal ions. Remarkably, depending the precise chemical structure of these resins, the binding affinity for the metal ion is sensitive to temperature. The regeneration of a resin based on such material can thus be accomplished by a simple change in temperature, thereby avoiding the use of NaCl. Besides water softening, this technology can be used for recovery of heavy metal ions. Preliminary ion uptake is performed using a lab-scale continuous absorption column.

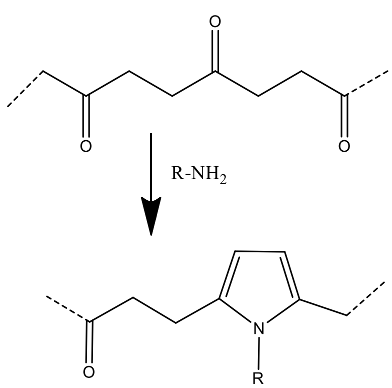

Fig.1. Schematic representation of the Paal Knorr synthetic route. Kind of di-amines. *$-NH_2$* is the primary moiety and *R* is the functional region.

Technological challenge

Starting point for the synthesis of our functional polyketones is the Paal Knorr modification route. Here, polyketones react with di-amines to form functionalized polyketones (left side of Fig.1). The benefits of the Paal Knorr reaction are its chemical diversity in terms of wide range of modifications possible, no need for catalysts or toxic solvents and, finally, its fast kinetics and low costs. Due to statistical reasons, the maximal polyketone modification degree is 80%. Depending on the chemical nature, cations other than Ca^{2+} and Mg^{2+} ions can be bound, as well as anions. The challenge is thus to fine-tune the chemical structure of the polymer in exactly the way it meets its required functional and operational demands.

Objectives

- One of the main objectives of this project is to characterize the parameters that predominately define the structure-function relationship of the functional polyketones synthesized.
- Parameters to study include the initial molar ratio of the polyketones, the nature of functional groups (e.g., aromatic vs aliphatic modifications, right side of Fig.1); and, finally, the number of functional groups.
- By doing so we aim to define a new class of chemical compounds that selectively interact with either cations or anions and that can be used in, for example, heavy metal recovery or desalination processes.
- Finally, functional polyketones will be operationally tested in a module based on either absorption or membrane technology.