ABSTRACT

The subject of research of the doctoral thesis were the resol resins which are obtained in the phenol-formaldehyde condensation process, in the presence of basic catalysts. The type and amount of catalyst are decisive for the course of the reaction (mechanism and kinetics of individual stages) and the structure of the obtained resin, and thus for its physico-chemical and application properties. The motivation to carry out these research was the need to reduce the content of harmful substances in phenol-formaldehyde resins (formaldehyde and phenol and its mono- di- and trihydroxymethyl derivatives) emitted into the atmosphere during high-temperature processing (drying, curing). The dissertation combines elements from the field of basic research with the applied research related to the industrial production of phenolic resins. The main aim of the presented work was to determine the effect of amine catalysts and catalyst systems consisting of triethylamine (TEA) and another amine co-catalyst for the course of resole resin synthesis and the possibility of reducing the unreacted formaldehyde, phenol and hydroxymethylphenol content in the final product, to a minimum level, in which the resin preserves the required application properties. So far not used in the synthesis of resole resins amine catalysts differing in the amount of amine groups and their ordinariness, the length of the carbon chain and its structure were selected for studies. Admixture of a polyamine co-catalyst (TEA + diethylenetriamine and TEA + triethylenetetraamine ) in the synthesis of resol resins made it possible to obtain the products with low contents of unconverted substrates and hydroxymethyl derivates, with required physico-chemical and application properties maintained at the same time. An important aspect of this work was tracking changes in substrates concetntartions during syntheses in the presence of selected amine catalysts and catalytic systems, which allowed to determine the reaction rate constatnts and determine the dependence of changes in phenol and formaldehyde concentrations as a function of time. Results of kinetic studies have already been used by engineers during design (at the stage of creating heat balances and assumptions for reactors and cooling systems) of a newly built resol resins plant at Pfleiderer Silekol sp. z o. o. After the plant has been started up, the results of kinetic studies will enable the development of algorithms to control the course of the resin synthesis process, allowing to obtain products with required and reproducible properties.