



INVESTIGATION OF THE BINDING PROPERTIES OF TECHNICAL STARCH IN MOLDING AND CORE SAND MIXTURES

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Abstract. This thesis investigates the potential of technical-grade starch as a natural polymeric binder for molding and core sand mixtures used in foundry production. The binding mechanism is considered in terms of the macromolecular structure of starch, which consists predominantly of amylose and amylopectin, as well as its swelling and gelatinization in the presence of water, resulting in the formation of an adhesive polymer film on the surface of sand grains. The effects of starch content, moisture level, thermal treatment, and chemical or physical modification on the mechanical strength, gas permeability, and moisture uptake of molding and core mixtures are also discussed.

Keywords: technical-grade starch, binder, molding mixture, core mixture, gelatinization, mechanical strength, gas permeability, modified starch

Introduction. In foundry production, the quality characteristics of molding and core materials directly affect the dimensional accuracy, surface quality, and defect level of the final casting. In sand mixtures, the binder consolidates individual sand grains into a mechanically stable interconnected structure. Bentonites, sodium silicate, and various synthetic resins are widely used in practice. However, increasingly stringent environmental requirements, the formation of decomposition products from organic resins, and challenges associated with the reclamation of used molding sand have intensified the need for binders based on renewable raw materials [1]. In this context, starch and its modified derivatives are of particular interest as natural, relatively low-cost, and



renewable biopolymeric materials. Starch consists predominantly of amylose and amylopectin macromolecules. The numerous hydroxyl (-OH) groups in these polysaccharide chains can form hydrogen bonds with water molecules and mineral particle surfaces. Upon addition of water, starch granules absorb moisture and swell; with increasing temperature, gelatinization occurs. As a result, a highly viscous colloidal system is formed, which coats the surfaces of sand grains. During drying, part of the water evaporates and polymeric bridges develop between adjacent grains. These intergranular bridges provide the mixture with the required mechanical strength. Thus, the binding efficiency of starch is governed by its molecular architecture, interaction with water, viscosity, and film-forming ability[2]. The main limitation of unmodified starch is its relatively low specific binding strength in the native state. Therefore, studies employ modification approaches such as carboxymethylation, oxidation, dextrinization, and blending with other polymeric or mineral additives. A carboxymethylated corn-starch-based binder has been reported to exhibit higher viscosity and specific binding strength than native starch. This finding indicates that chemical or physical modification of technical-grade starch can promote the formation of stronger intergranular bonding bridges between sand particles[3,4].

Conclusion. Technical-grade starch can be used as a natural binder capable of forming polymeric bridges between sand grains in molding and core mixtures. Its performance is determined by the starch type and degree of modification, binder dosage, mixture moisture content, and the gelatinization and drying regimes. Literature data indicate that modified starch exhibits superior binding characteristics compared with native starch and can provide practically relevant dry strength in certain core mixtures. Further selection of technical-grade starches derived from locally available raw materials, together with optimization of their dosage and modification methods, can contribute to the development of environmentally safer binder systems for foundry applications.



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