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Influence of atmospheric conditions on surface layers of sand moulds and cores made of moulding sands with chemical binders

This doctoral dissertation is a source of information about the impact of atmospheric conditions on surface layers of sand moulds and cores made of moulding sands with chemical binders. Because a huge number of casts defects are surface defects, of which the periodic increase in the foundry, the workers associate most often with the seasons (change in weather conditions), an attempt was made to assess the impact of the changing atmospheric conditions on the surface layers of sand moulds. These very surface layers determine the quality of the surface of the produced casts. The role of every component of moulding sands with chemical binders — organic (alkyd and furfuryl resins) and inorganic (hydrated sodium silicate hardened with liquid esters) — and protective coatings (zirconium, zirconium- graphite, water-based and alcohol-based) applied on the elements of moulding sands, in the moisture sorption or desorption ability was also analysed.

The doctoral dissertation contains the analyses and description of moulding sands as porous materials with complex considerations on moisture flow and transport between the surface layers of sand moulds and cores and the surroundings. The analyses of weather conditions in Poland and a literature review of casts surface defects caused by insufficient strength of moulding sand as well as an excessively high moisture content are also included.

The experimental part consists of results obtained from measurements of moisture sorption processes through surface layers in humid air condition (RH > 95%) and of the influence of adsorbed moisture on moulding sand (quantitative measurement of moisture sorption, measurement of the wetting angle of hardened binders, strength tests, ultrasonic tests, measurement of gases emission during pouring of sand moulds). Under the conditions of a moderate relative air humidity (RH = 28–32%), the natural drying of damp cores was carried out. The quantitative measure of moisture sorption and desorption was made using the gravimetric method in the on-line continuous measurement system. On the basis of the conducted experiments and research, it was proved that the ambient conditions influence (affect) the surface layers of sand moulds. The fact that moulding sands with a resin-based binder are not sensitive to humid air (do not lose strength) does not mean that they do not

absorb moisture from surroundings under these conditions. Their sorption ability is lower than that of the moulding sands with hydrated sodium silicate hardened liquid esters, however they do absorb moisture as well. That can lead to the forming of casts defects, especially of gaseous origin. Moreover, not every protective coating can protect sand moulds and cores against the humid air. This additional moisture content in moulding sands can increase the gas volume emitted during pouring of sand moulds and casts solidification (1 g of moisture generates about 75 cm3 of gases). Even the natural drying process cannot completely eliminate the moisture previously absorbed by cores or sand moulds. Under the given research conditions (temperature and humidity), it is only possible to dry the moulding sand to the equilibrium moisture level. The material cannot reach its complete dryness level.

The analysis and conclusions presented in this dissertation are a response to the industry needs and can be used in practice, in particular when it comes to the selection of conditions and storage time of sand moulds and cores awaiting pouring. It allows for minimalizing the opportunity of the formation of casts defects, especially of gaseous origin.