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INFLUENCE OF MECHANICAL ACTIVATION OF QUARTZ SAND ON PHYSICAL AND MECHANICAL PROPERTIES OF FOUNDRY MIXTURES BY THE METHOD „NO BAKE”

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Abstract: *At the contemporary conditions of cast production there has been a permanent interest in economically more profitable technologies for obtaining moulds and cores of controlled properties. A part of this interest is related to quartz sands as a basic and the most common component in the practice of foundry mixture productions. State of sand surface and its influence in formation of foundry mould and core physico-chemical properties are of particular importance.*

In this report, various conditions of mechanical activation on the surface of quartz sand in "a fluidized bed" are discussed. The theory of such activation necessity has been partly explained. The "time" factor in preserving the activated layer potential is noticed. The efficiency of the activated layer in producing foundry mixtures strength by the method "No Bake is shown..

KEYWORDS: CASTING,QUARTZ SAND, MECHANICAL ACTIVATION, PHYSICAL AND MECHANICAL PROPERTIES

1. Introduction

In relation to improving the properties of foundry mixtures, special attention has been paid to the modern conditions of production. The mixture itself could be regarded as a dispersive system which is composed of solid non-metal particles (in our case quartz particles) wrapped up by a thin layer of binders. According to the second law of thermodynamics, foundry mixtutres would have an oprimum structure if they were in state of balance. Therefore, conditions have been created still at the time of homogenization where in the process of mixing two basic tasks are resolved – attaining a necessary homogeneity and maximum strength at limitation of other properties.

The mixtute structure is formed at the expense of some physico-chemical processes taking place at the border: quartz sand (solid) – binding composition (liquid system).

2. Presentation of the problem and ways to resolve

The modern binders, based on the use of organic resins, hardened in various kinds of liquid hardening agens, can rougly be classified into "No Bake" systems.

Strength formation is explained with an increase of the binder's molecular mass through linking many oligomer resin molecules when hardening in larger polymeric ones. Simultaneously with that "formation of adhesive strength", it begins processes of adhesion with the surface of sand particle, i.e. "creating adhesive strength" (AS).

Finally, the strength of mixutures is an entirety of two simultaneously performed processes at setting – formation of an adhesion link between quratz sand and the binding composition and cohesive strengthening of the composition itself. The difference between them is too great and according to some opinions [1,2] it reaches up to 15-20 times in favour of the cohesive strength.

The issues of growth of furan resin adhesion to quartz sands are exceptionally important for the practice. Even a minimum raise in (AS) would result in decrease of binding composition content in mixures, improvement in conditions at the border layer: "metal-form" and workplace environment.

The microrheolgical processes at the joint surface have an great effect upon the value of adhesion to quartz sand. These also are the beginning of the (AS) formation, and are determined by different factors as relief, surface cleanness etc.

Quartz sand surface is characterized by multiple of unevennesses defining the roughness. The unevenness reaches dozens to hundreds of angstroms. It is known that AS is increased when the degree of roughness and angularness raise [3].

Quartz sands are typical with the presence of great amount of "deaf pores" which is ovserved in most real pore bodies. In these cases, the front of binding composition entry is hindered by the presence of these pores or other products of sufficient penetrating ability that finally lead to AS reduction.

Different "activation" methods on the contact surface in order to control the mixure properties through governing the state of the limitating unit have been known. One of those methods is the performance of mechanical activation (rubbing through of quartz sand particles - either each other or on a separate surface) on the filler surface – quartz sand in the case.

The task assigned in the present job is to determine the rate of influence of the mechanical activation method on physico-mechanical properties, and particularly on AS in foundry mixtures.

3.Decision on the investigated problem

The quartz sands PK, UKSS1, and KLP of different nature and morphology (Fig.1, 2, 3) from Kaolin AD, in amounts of 2.0 kg. +/- 0.001 kg.) are put in a laboratory unit ("fluidized bed").Sands are of homogeneity over 90%, grain size 0.25 mm.

Intensity of processing sand surface, tuned by change in the process duration, at flow = const., was chosen as an influence factor.

Following activation, mixtures were produced in a vibrating mixer, type STATORMIX 22 of Klem with automated dosing of constant amount and ratio of the same type components. The binding system (resin + hardener) was Huttenes –Albertus.

Test bodies were obtained with the help of a laboratory press with cyllindrical specimens of sizes Φ=50 mm. and H=50 mm., and for beams with AxBxL = 24.5x24.5x172.5 mm, respectively.

Adhesive strength is determined at tensile under the method [4].

The activation process is composed of continuous rubbing between particles at normal environment temperature.

Mixtures' physico-chemical properties (strength of pressure, erosion resistance and gas permeability based on test bodies) are measured with the help of repsective laboratory testers LRu and LfR1 on IO PI.

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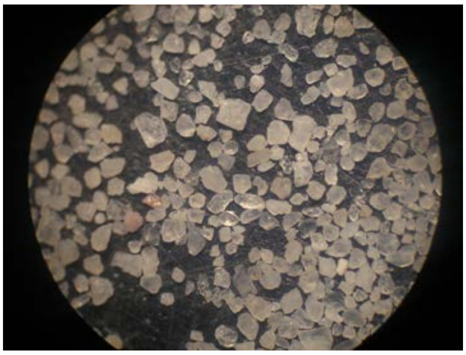

Fig. 1. *Sand 01PK025*

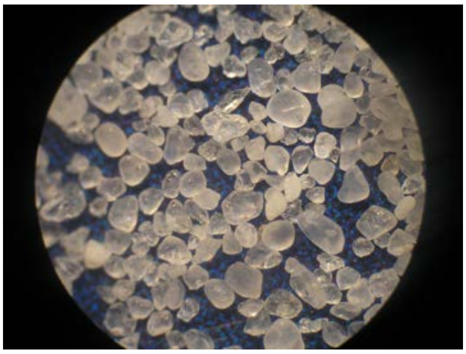

Fig.2 *Sand UKSS 1*

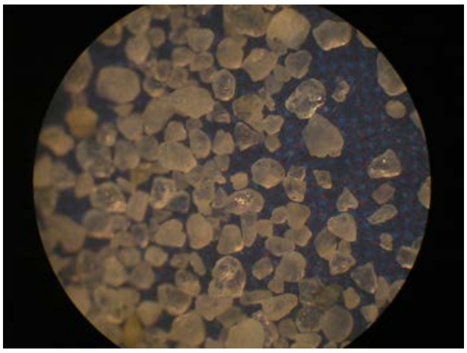

Fig.3 *Sand KLP026*

4.Results from the dicussion

The results from pressure strength tests on test bodies (Fig.4) with sand 01PK025, at various duration of processing, show an increae in strength, as a whole. Thus, for example, in the first 0.5÷-1.0 hours when a "manipulating strength" is created, strength values raise by 30 to over 70% at different times of processing. That difference is kept until the fourth hour is reached. After 24 hours, differences in strength of processed and unprocessed sand reduce down to 15÷20%.

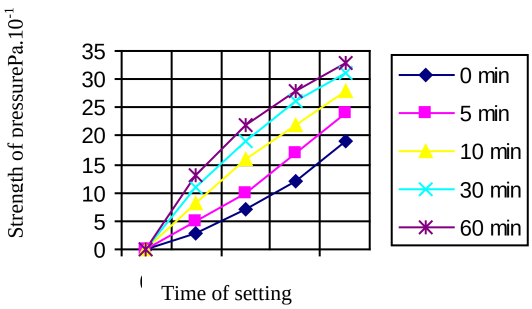

Fig. 4 *Strength of pressure at different times of activation, in min. for a mixture with sand 01PK025*

In the process of influence on sand surface, at conditions of "fluidized bed", at rubbing through, in addition to the increased agility of the atomic layer, from the surface itself it is detached contamination particles, stuck harmful oxides as well as adsorbed different gases and air, especially in sectors of microscopic cracks and unevenness. This is visually shown in sands of different origin and nature. For this purpose, three kinds of sand were selected: 01PK025, KLP026 и UKSS 1, differing in this case by the degree of morphology and state of surface [5].

In Fig 5, it is shown strength test data at constant parameters and processing conditions in different selected sands

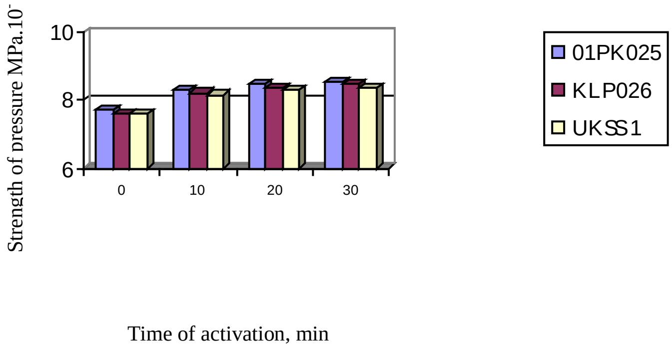

Fig.5. *Strength of mixtures, in MPa from sands 01PK025, KLP026 и UKSS 1 depending on time of activation at setting time 1 hour*

It is evident that strength is most intensively increased during the first 5 to 10 minutes of activation with gradual attenuation over the time. Morphology degree of these sands varies from $K_м$=0.82 for 01PK025 to $K_м$=0.96 for UKSS 1.

The first sand strength is higher mainly because in a better morphology the number and area of the contact points between particles is less in comparision to sands of worse morphology like 01PK025. The presence of cracks and unevennesses at 01PK025 is greater [5] compared to KLP026 и UKSS 1, which additionally creates conditions of improved adhesion contact. Adhesive strength measurement data [4,6,7] confirms the given explanations. In the figure, the results coming from strength change values show an increase by 10÷15% for the first hour from the start of setting, and almost equal dynamics change for the three kinds of sand for the strength ratio change among them.

Another essential technological characteristic of state of the shape hardened is the erosion resistance. It is measured by the so called "surface strength", and is directly dependant with the conditions of formation of strong bond in the contact surface between the sand grain and the binding composition. The level of this stability is directly related to the geometrical accuracy and quality of the cast.

Measurement is most often performed gravimetrically by determining the loss of weight of a cylindrical specimen of Φ=50 mm. and H=50 mm. when rolling on an abrasive surface.

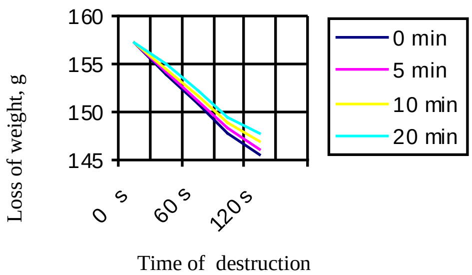

Fig.6. *Erosion resistance of a mixture with sand 01PK025 at different times of activation.*

The test data is shown in Fig.6. It is evident that the erosion resistance is increased with a raise of processing time through activation of quartz sand surface, and within the set limits of tests the difference reached 6÷8%.

One very important operation parameter is the gas permeability in a mould. The resuirements for it are very high due to the direct relationship to the mould quality, use of accessory materials and additional measures.

The test results given in Fig. 7 show that with increase of activation time on the surface of the tested sands, gas permeability is elevated by 4÷6% at KLP026. At 01PK025, increase is by 3÷4%, and the greatest is at UKSS1 - 7÷10%.

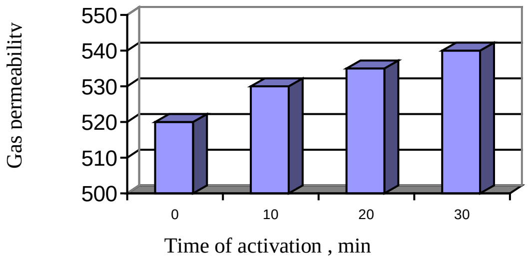

Fig.7 *Gas permeability, (x 10^{-8} m^2/Paxs) of a mixture with sand KLP026 after 24 hours at different time of activation*

It is worth noting that one of the parameters being recently seriously addressed is gassing. It is logical that when taking out different fluids from the sand surface to expect gassing reduction after activation. However, in the concrete work that parameter has not been investigated.

In this work, no tests have been done on one very important condition for applying the quartz sand mechanical activation method in practice, namely, keeping the properties of the activated layers at longer preserved conditions.

It would be also expedient to determine and compare the method's technical and ecomomical advantages and disadvantages, and the efficiency potential of its use.

5.Conclusions

1. The results obtained allow us to assert that the methods of mechanical activation on the surface of quartz sands can improve their efficiency at the border with the biding system.
2. There is a possibility for an optimized reduction of the binder content, at equal other conditions, particularly in cases of limitated manipulating strength.
3. It is proved that by improving the conditions of adhesive strength formation, the properties and effectiveness of foundry mixtures are enhanced.

6. Literature

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