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Tests of moulding mixture by using various clay binder granularity

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Abstract

Bentonite as foundry binder has dominant and important significance in Slovak and Czech foundries. Present – day wide world produce of casts is estimated to 80 mil ton. There are about 60-70% casts into bentonite moulding mixtures. We say about mixture of first binder generation where join is results of capillary pressure force and Van der Waals force (forming mixture on the base of bentonite binder). European initions of this technology be included in thirties last century. This technology will have dominant position in spite of formation and development of new manufacturing processes in future. There are these advantages of using moulding mixture on the bentonite base:
high value of compression strength and plasticity of this binder is achieved at low content of surface moisture – this fact makes it possible to pour by technology of raw clay, relatively low costs by up to raw material, Cca 95 – 98 % repeated usage of moulding mixture, high productivity of used production engineering, high quality of casts (quality surface, uniform accurance, casts without defects) is assured by modern way of ramming, hygienic and ecological advantage

Keywords: moulding mixture, opening material, inorganic binding system, clay binder

1. Introduction

Bentonite is clay casting scrap binding material, which includes marginally 75 % montmorillonit mineral. The rest pose additional aluminosilicates, especially kaolinite and clay, but it also calcite and next minerals. Therefore bentonite from various locations expressively differs and only 30 % world - wide production could be used for casting purposes [1].

As casting binding material are used three series of clay minerals:

1. clay illitic (most widespread binding material in natural sand)
2. clay kaolinit (belongs to high heat - resistant clay, binding material of refractory mixture of dehydration - burning)
3. clay montmorillonitic (smektit) -creates main part bentonite, raw bentonite mixtures [2]

Montmorillonit has typical three - ply structure, between by two of silicate tetraedras $[SiO_4]4$ - oneself finds gibbsit octahedron (AlO_6) – fig. 1[1].

In octahedrons and tetraedrons are their atoms bounded relatively firm covalent detentions and single plies are bounded by weak Van der Waals type power.

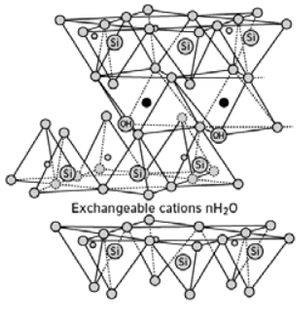


Fig. 1. Structure of montmorillonitic

2. Description of the approach

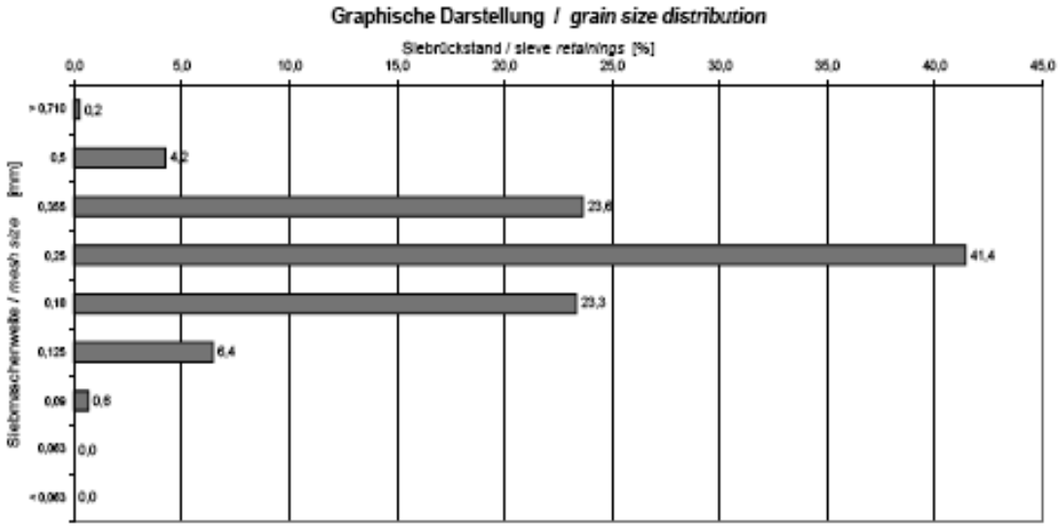
Goal of experiments has been:

- To set dependencies of technological properties of bentonite moulding mixture from degrees of sheerness grinding of bentonite
- Measured results to evaluate and optimize granularity bentonite from achieved strength weld characteristics of mixture point of wiev.

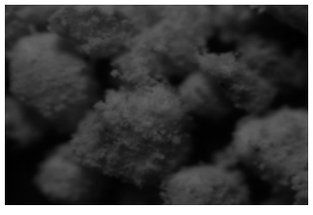
2.1 Work methodology and materials for research

Each of experiments has been used input opening material from locations Šajdikove Humence, marking sand SH 27 (d_{50} = 0,27mm).

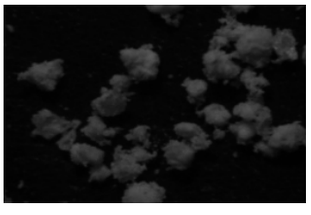
Shape of grains is rounded, surface smooth, powder density 1580 kg/m3, angle of repose 30 - 35^{o} ,loss of flame - patterned 0,2 – 0,3 %. In the picture 2 is illustration of its sieve analyse [3].



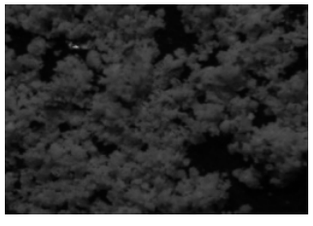
a. Specimen > 200 µm



b. Specimen <100 µm



c. Specimen< 45 µm



d. Specimen<30 µ

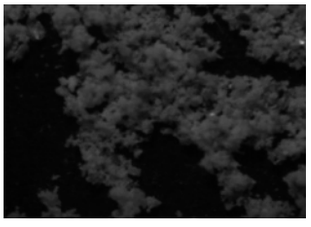


Fig. 2. Grain size distribution[2]

As binding material was used bentonite about various granularities, natural, untidy Ca, Mg bentonite from locations Jelsovy potok (pict. 2a – 2d).Total representation of montmorillonit was from 50 - 85%, average humidity 12%. For experimentations we used bentonits with different granularity:

a. bentonit > 200 µm
b. bentonit > 100 µm
c. bentonit < 45 µm
d. bentonit < 30 µm
e. bentonit < 10 µm

We mixed moulding mixtures with individual bentonites in sand mill mixer about this compounds: 93 weight portions of siliceous opening material , 7 weight portions of bentonite and water. Mixing time was 5 minutes. Has been mixed moulding mixtures with individual bentonites by the two different humidities – 3 % and 10 % . The following technological properties were measured: wet compression strength ,tensile strength, strength in condensation zone ,baked strength, venting property (permeability).

3. Description of achieved results of own researches and discussion

We can to observe clear positive influence of grain sheerness increase of bentonite to some technological properties of mixtures from measured results.
The best favourableness results we measured by using the best fine - grained clay

Dependency of technological properties of bentonite moulding mixtures from granularity bentonite binding material by the 3% humidity are they mentioned in table 1 and summary graphic visible at a picture 3[4].

Table 1. Dependency of technological property bentonite moulding mixtures from granularity bentonite binding material by the 3% humidity

3%	Green strength [kPa]	Tensile strength [kPa]	Ten/gr. strength [kPa]	Strength in condensation zone [kPa]	Baked strength [MPa]	Permeability [n.j.p]	Thermostability [%]
> 200 µm	70	19	27	0.25	0.51	130	55.7
> 100 µm	72	19	26	0.26	0.41	138	69
< 45 µm	80	20	25	0.24	0.53	150	73.7
< 30 µm	88	22	25	0.27	0.46	155	75
< 10 µm	122	30	25	0.25	0.33	147	78

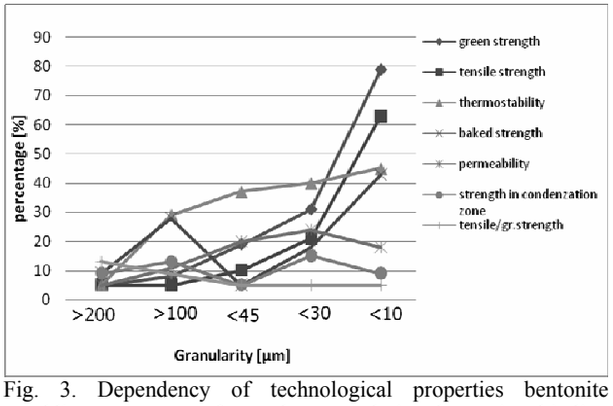


Fig. 3. Dependency of technological properties bentonite moulding mixturess from the granularity bentonite binding material by the 3% humidity

Dependency of technological properties of bentonite moulding mixtures from granularity bentonite binding material by highly advanced humidity are they mentioned in table 2 and graphic visible at a picture 4.

Table 2 Dependency of technological property bentonite moulding mixtures from granularity bentonite binding material by the 10% humidity

10%	Green strength [kPa]	Tensile strength [kPa]	Ten/gr. strength [kPa]	Strength in condensation zone [kPa]	Baked strength [MPa]	Permeability [n.j.p]
> 200 µm	40	15	37	0,25	>2	52
> 100 µm	54	15	28	0,26	>2	47
< 45 µm	55	15	27	0,25	>2	44
< 30 µm	55	18	33	0,28	1,8	68
< 10 µm	93	27	29	0,28	1,8	98

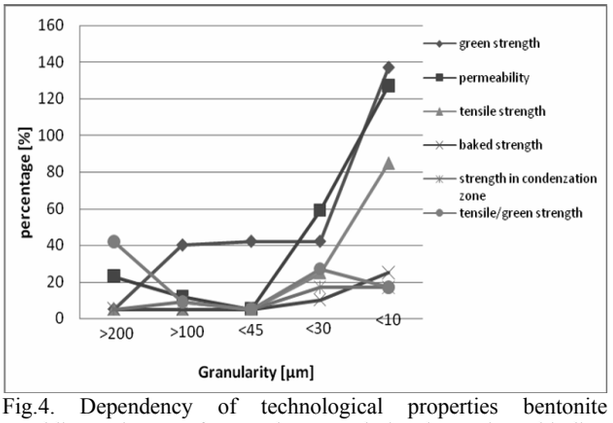


Fig.4. Dependency of technological properties bentonite moulding mixtures from the granularity bentonite binding material by the advanced humidity

The most high values of selected technological properties of these bentonites mixtures were measured by using granularity less than 30µm and than 10µm, therefore by using the most delicate bentonite. Advanced softness of bentonite equals superior plumping and advanced attributes settling volume. That means more perfect pack on waters at a surface of bentonite besides advanced custodial accomplishment bentonite binding material.

Bigger specific surface of bentonite means that there are advanced technological facilities of bentonite mixtures mainly fortresses.

Green strength variances of mixture are not very markedly near grain size from more than 200 µm to less than30 µm, more expressive increase of strength was measure at grain less than 10 µm.

Tensile strength characterize real bound mixture abilities because towards breakage made by tensile force. This examination confirmed antecedent measurements, value of this characteristic increased with grinding of sheerness .

Also the influence of bentonite sheerness to tensile strength in zone of condensation is not as vivid as in previous experiments, but we can observe slight increase of strength in condensing zone with the growth of grain sheeness

Thermal stability is presented in percentage of bounding strength which is determined form the sample of tempered bentonite to the bounding strength of the same bentonite which is not tempered. The highest value of thermostability was measured by sand mixture with bentonite with fraction less than 10 um.

The highest value of thermal stability are measured at the finest bentonite.

5. Conclusion

Quality of cast is conditional to quality of moulding mixture. Quality of moulding mixture is effected mainly to quality of input raw material (bentonite, opening material, ingredients and below) and quality of mixture arrangements. Quality of moulding mixtures is based on technological tests, result of those are specifically comparable values. This presentation is focused on influence of valuation of input raw materials quality, specifically bentonite quality to its granularity on bentonite mixture technological facilities.

Results of these measurements have particularly informative character and do not solve specific problem. By the change of bentonite granularity in cooperation with time mixing of BFZ we are able to positively influence to facilities bentonite moulding mixtures and subsequently to solve specific questions of foundry practice. By the resolving specific issues of moulding mixture in foundry we often forget at a positive influence of mechanical activation bentonite binding material. Measuring surface of bentonite (bentonite granularity) belongs to characteristic facilities of bentonite, which however is not shown in description of casting bentonite, so important from bentonite point of view comparison.

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