HUNGARIAN BENTONITES AS BONDING MATERIALS FOR FOUNDRIES

by

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Hungary is very rich in bentonites. Bentonite is found in almost every mountainous part of the country (Mecsek, Bakony, Dunazug, Mátra, Bükk, Tokajhegyalja mountains). The most important sites are Bánd, Tétény, Istenmezeje, Mád, Komlóska.

Bentonites formed originally not only from acidic volcanic rocks rich in silica, but also from more intensely basic rock types, *e. g.* basalts.

Theory of bentonite sand bonding

Among the many theoretical interpretations advanced for the bentonite bond probably the one is the most appropriate which explains the bond among sand grains by a of the film formed on the surface of sand grains. It has been proven by R. E. Grim and F. L. Cuthbert, that among all kinds of bonding materials those containing montmorillonite form the best bonding films and this explains the extraordinary bonding capacity of bentonite.

So far as film strength is being investigated, Hungarian bentonites behave in very different ways and can be classified in two groups. Using a simple testing method, *i. e.* drying on a glass plate 20 millilitre of a 5 per cent dispersion in original state and with optimum soda content, it is found that certain Hungarian bentonites, those of Type "A" give a perfectly adhesive, crack-free film, while others, those of Type "B" form heavily cracked films (see Figs. 1 and 2).

This particular phenomenon can be explained in the following way: In contact with water, Type "A" bentonites show a definite growth, they become very plastic and their viscosity decreases as the water content is being increased. This means that even in case of low water content, sand grains are being enveloped by the bentonite film and because of the high plasticity of this film, the grains become dislodged even at a very low pressure, so that green mould strength is extremely low. As bonding strength in dried state of the film formed on the sand grain surface is largely a function of the uniform thickness of the film, the film of a Type "A" bentonites will produce an integral, hard and strong bonding film between the sand grains. Thus Type "A" bentonites are extremely suitable for dried or surface-dried moulds.

The phenomenon just described cannot be observed with Type "B" bentonites until a given water content, no uniform bentonite film is being formed. Under the influence of intense surface forces the water is very strongly bonded to the bentonite, so that the bond in the points of contant of bentonite-enveloped sand grains is a consequence of the great adhesive forces.

As the films of Type "B" bentonites in normal grinding fineness are cracking during drying, no particular strength can be obtained from the dried moulds and so they are not suitable for foundry purposes.

Adhesion may be defined as surface interaction of solid particles and bodies with developed surfaces. Adhesion is inversely proportional to adsorption energy. Bond between the sand grains in a moulding mixture can be intensified by producing a film of bentonite on the grain surfaces and thus bonding the grains. Obviously, a high compressive strength is obtained, if high adhesion can be ensured between the sand-bentonite and thebentonite-bentonite boundary surfaces.

Adhesion between sand-bentonite surfaces ensures the perfect film formation, *i. e.* a uniform film of high adhesive capacity on the grain surface.

Adhesion between bentonite-bentonite surfaces ensures proper bond in the mould, the cementing of sand grains to attain high strength.

These two factors together define the mould strength, apart from the number of bonds and the magnitude of cemented surfaces, the latter being only functions of the sand itself.

Thus for green or dry moulds, the primary factor influencing mould strength is the adhesive capacity of bentonite and various bentonites differ in just this characteristic.

Sound bonds are obtained by reducing the adsorption energy on the bentonite surface by binding it through water dosage, utilizing the adsorption of water. Because of their high adsorption energy, water molecules of dipole character are adsorbed in high density, with preferred orientation to the surface and they form a mono-, bi- or perhaps trimolecular film layer on the surface. In case of larger water contents, water layers bound by less energy will be also present, showing diffuse structure and giving plastic qualities to the bentonite.

The distribution of adsorption energy, as a function of moisture content, defines an exponential function, the slope of which is determined by surface characteristics and varying from bentonite to bentonite. The shape of the curve determines the quantity of water bound by directed adsorption on the surface and on the energy binding water to the surfaces. By a water dosage which reduces the adsorption energy of bentonite in the mixture to a minimum, so far as further water adsorption is being concerned, but still ensures the preferred orientation in adsorption phenomena and leaving no "free" water, the maximum of adhesion will be attained. On the other hand, a certain quantity of water is necessary to coat sand grains by bentonite, this rendering bentonite itself highly plastic. The two antagonistic effects result in an optimum water content offering the best result.

Thus for green moulding sands such a bentonite must be used, which even in case of a watery coat still conserves a high adhesion energy, where the water, giving plasticity, is bound by a relatively high energy.

For Type "A" bentonites the energy curve shows a rather flat shape, which also entails high plasticity, high viscosity values for the suspension and excellent film-formation capacity after drying. Such bentonites — as already mentioned — cannot be used for green moulds.

In the group of Hungarian Type "A" bentonites it is grade "ON" which in dried state ensures a bonding capacity far exceeding any similar bentonite of foreign origine.

Among bentonites of Type "B" it is grade "O" which ensures a particularly high compressive strength as shown by experiences of recent years.

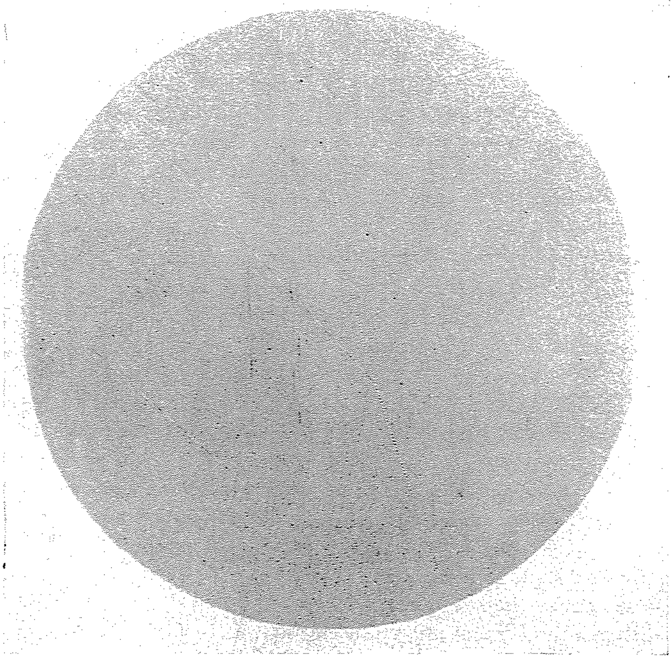
Undoubtedly, a universal foundry grade bentonite offers certain advantages, as it renders superfluous the storage of two grades of bentonite, however no high compressive strength values can be obtained by using the universal grades.

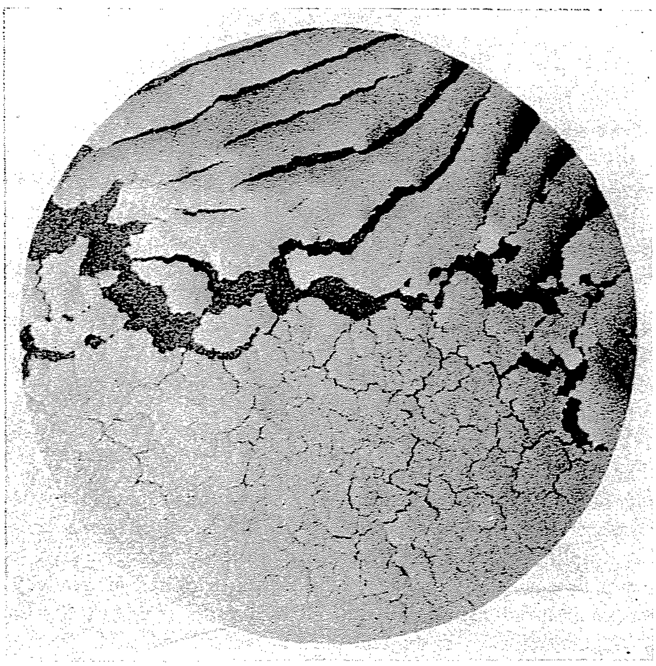
Recent investigations have shown that with Hungarian bentonites the capacity for fast peptization may be not only an individual quality, but it can be intensely developed by fine grinding.

According to the latest experiences in the Ganz works, bentonite from the Istenmezeje site, ground to a grain size of 60 microns, will satisfy all requirements for bonding agents to be used with green, dry or surface-dried moulds. This grade of bentonite will be marketed in the near future.

Bentonite in foundry practice
Advantages of batch dosage of bentonite

In practical applications of bentonites the theory of bentonite bonds as already explained should be taken into account and every-





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thing must be done in order to promote the formation of a perfect bonding film around sand grains.

In foundry moulding practice, however, the effect of the film-forming water content is of an always more and more limited character, because of the universal tendency for reducing the water content and for shortening the duration of mixing the bentonite—water—sand mixture.

The quantity of water to be applied may be determined from the following empirical formula :

$$\text{water \%} = \frac{\text{overall bentonite content \%}}{2} + 2{,}5\ \%$$

Thus, knowing the bentonite content of the sand—bentonite-mixture — (in case of renewed burnt sand its bentonite content must also be taken into account) — half of its value plus 2,5 per cent will give a proper water demand. However, the use of dosed water for bentonite film formation will largely depend on the very nature of bentonite. Hitherto water and bentonite have been added to the sand in about the same percentage and at once in their total quantity. Under these circumstances first of all the sand grains tended to adsorb a water coating so that a relatively smaller quantity of water than proportion 1:1 was available for bentonite film formation. This also means that bentonite and the available water quantity formed an extremely though adhesive, paste-like substance not capable to form a uniform bentonite film. Instead of it swollen bentonite nuclei are being formed on the surface of sand grains and these can be comminuted only by an intensive stamping to bentonite film sections of more or less surface area. This, obviously, is very far from a uniform bentonite film enveloping the grain as a whole

This experience has induced the author to split up the dosage of bentonite so as to add only one-third of bentonite to the sand—water mixture and to add the rest only after a thorough mixing of 1 or 2 minutes. Sand—bentonite mixture produced by this procedure usually shows a compressive strength increased by 10 to 30 per cent.

The advantages of batch loading of bentonite are explained by the fact, that the first dosage of bentonite finds an ample quantity of water for intensive peptization and to envelop the sand grains by a uniform film of bentonite dispersion. The second batch of bentonite is used to increase the thickness of an already existing bentonite film. By a simple analogy, this may be regarded as to provide sand grains — by means of the batch dosage of bentonite — with a ground dope layer, ensuring sound adhesion along a large surface, reinforced by the second batch of bentonite and increased in thickness.

Batch loading of bentonite will also largely reduce the peeling-off of sand on mould surfaces. It has been found with moulds produced by batch dosage of bentonite, that edges and corners retain more or less their well-defined shape, thus reducing the amount of machining on the castings.

It can be shown also that batch dosage of bentonite will also reduce the dilatation effect resulting in sand penetration.

As batch dosage of bentonite increases mould strength, less bentonite and consequently less water is being needed. The latter circumstance is also advantageous from the point of view of reducing the amount of gas-porous castings.

Batch dosage of bentonite will be, therefore, much more valuable for modern foundry technologies tending to reduce moulding rejects, than hitherto known, existing moulding procedures.

Summary

In foundry moulding using bentonite-bonded moulding sands the bonding effect is a result of bentonite film formation. Hungarian bentonites of grade "O" and grade "ON" ensure excellent film-forming capacity and strong bond with green and dry or surface-dried moulds.

Recently universal foundry bentonites have been produced by extrafine grinding and these will be marketed in the near future. Advantages of the batch dosage of bentonite as proposed by the author and introduced in Hungarian foundries are also explained.

Zusammenfassung

In Gußformen aus Formmaterialien mit Bentonitzusatz wird die Bindung durch die Bentonitfilmbindung ermöglicht. Bentonite ungarischer Herkunft, u. zw. der Qualität "O" und "ON" sichern eine äußerst gute Filmbildung und zugleich eine hochfeste Bindung sowohl in "grünen" wie auch in trockenen und flächengetrockneten Sandformen. In neuester Zeit wurde durch Extra-Feinmahlen eine universale Gießerei-Bentonitqualität hergestellt und die wird in kurzer Zeit auf dem Markt erscheinen. Vorteile des vom Verfasser in den ungarischen Gießereien eingeführten geteilten Bentonitzusatzes werden ausfürlich geschildert.

Résumé

L'effet de liaison dans les moules en sables dosés par bentonite résulte de la formation d'un film de bentonite. Bentonites de qualité "O" et "ON" de provenance hongroise possèdent une capacité excellente pour former ce film et pour assurer la liaison forte des particles dans les moules à sable vert, sec ou séché à la surface. Bentonites pour la fonderie, ayant des qualités universelles, peuvent être produits par broyage extrafin et seront lancés sous peu sur le marché. L'article donne une explication des avantages du procédé à dosage divisé du bentonite, proposé par l'auteur et introduit par les fonderies hongroises.

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