

Morphology Study on Different Composition of Bentonite and Silica Sand in Green Sand Mould for Zinc Alloy

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Abstract—Zn alloy casting industry using green sand molding is increasingly becoming to very competitive circumstance, due to the various casting methods such as die cast, sand mould and so on with the recent coming of the lightening demand in automotive and decorative industry. So, this project is to produce tertiary alloy of Zinc-Aluminium-Magnesium (Zn-3Al-2Mg) with different composition of bentonite and silica sand in the green sand mould. However, Zn alloy casting using green sand still now plays an important role in the foundry society, because it allows us to manufacture at low cost and also sand can be recycled. Furthermore, it is appropriate method for multi kind and small quantity production. The mentioned method of mold is differing in composition of bentonite with 5%-17%. Differ in the composition of bentonite and silica sand give differ in result. Sample with 13% of bentonite is the best surface properties while sample of 5% and 17% of bentonite gave dull surface properties. The morphologies give not much difference from each other. Sample of 13% of bentonite have the most amount of grain boundaries and the grain boundaries size is much bigger than the others.

Keywords: green sand mould, zinc alloy, silica sand

I. INTRODUCTION

Molding sands used by the metal casting industry are produced by mixing virgin silica sand with clay or organic chemical binders. The most widely used sand binders are bentonite clays (sodium bentonite and calcium bentonite), and these molding sands are known as green sands (Robert et al., 2007).

Green sand molding is one of many methods available for making a mold which molten metal can be poured. The term green sand is uses to denote the presence of moisture in the mould mixture when molten metal is poured into the mould just as green wood still contains its moisture (Luther, 1997-1998).

Green sand is prepared by coating the grains of sand with a clay-water mixture that's binds the sand into rigid mass by the application of force. Green sand is foundry sand that's uses clay-water bonding thus enabling moulds to be produced at high production rates by simple squeezing and compaction.

The main advantage of clay bonded sands is that they can be continually re-used by cooling and then remixing with additions of water, new clay and fresh coal dust,

etc. to replace the relatively small amounts lost or destroyed during casting, together with additions of some new sand. The raw materials used are relatively inexpensive and are only completely broken down in the very high thermal loaded parts of the mould that are in contact with molten metal (Kunihiro et al., 2008).

II. MATERIALS AND METHODS

GREEN SAND MOULD

Green sand mould consists of bentonite, silicate sand and water. When forming cast iron and gray iron, the green sand mould usually contain silica sand (82-90%), bentonite clay (5-8%), water (1.5-4%). When casting complex shape, core sands can also include organic resins binder eg phenolic urethane (Yujue, 2006). 7 moulds were prepared using 7 different ratios of silicate sand, bentonite and water. The ratio used as above, and the water ratio are the same for each mould.

Table 1: Ratios used for the green sand mould

Sample No.	Ratio	Silica sand (kg)	Bentonite (kg)	Water (kg)
1	95:5	5.70	0.30	0.24
2	93:7	5.58	0.42	0.24
3	91:9	5.46	0.54	0.24
4	89:11	5.34	0.66	0.24
5	87:13	5.22	0.78	0.24
6	85:15	5.10	0.90	0.24
7	83:17	4.98	1.02	0.24

Silica sand used was obtained from Dan Cast Sdn. Bhd. Clay used in green sand foundries is bentonite. Bentonite contains mineral montmorillonite, but it can also include portions of other clay minerals. Bentonite clays have been used as bonding materials in green sand foundries for centuries. Water is an important component of green sand matrix. Responsible for the proper clay activation during sand mulling and therefore the overall strength of the green sand mould, (Smiernow et al., 1980). Especially it is the clay-to-water-to-clay

interaction that creates the bridge and surface bonding within the mulled green sand mould; and these bonds are responsible for the moulds' strength (Odom, 1988)

The mixture of silicate sand, bentonite and water were weighed. Then the mixture was mixed using the mixer for about 10 minutes to get the homogenous mixture. At the same time, the moulding boxes were prepared and arranged on the flat area. The pattern of the dog bone then placed in the middle of the moulding box and the mixed of the silica sand and bentonite then placed in the moulding box, compressed layer by layer using the rammer. Parting powder is applied to the mould, for easy released of moulds and cores from pattern and core boxes. Then pattern is removed with the channel plug, leaving the mold cavity.

TERTIARY ZINC ALLOY

A zinc alloy with 3wt% aluminium and 2wt% magnesium was used for this study. Melting process of material use in this study was done using heating furnace with temperature range until 1000°C. In a furnace material which zinc, aluminium and magnesium have to be melt above their melting temperature in order to make sure that they are fully transform into liquid phase.

Table 2: Zinc, magnesium and aluminium characteristic

	Zinc	Magnesium	Aluminium
Physical properties	Bluish-grey metal	Lightest metal	Silvery colour and luster
Melting point	481°C	650°C	660°C
Boiling point	906°C	1107°C	2057°C

III. RESULTS AND DISCUSSION

The mentioned method of mold is differing in composition of bentonite with 5-17%. Differ in the composition of bentonite and silica sand give differ in result. The physical properties are obtains from the surface and the hardness test. Lowest and highest percentage of bentonite gives a dull surface properties compare to the in between. The product with 13% of bentonite gives the shiniest surface.

The results are affected by many factors that included both the green sand properties and the casting process parameters. The casting process parameters that could affect the results include the temperature of the metal poured, the geometry of the casting (e.g. specific surface area) sand-to-metal ratio, the length of time before shakeout, etc (Kauffman et al. 1997; Crandell et al. 2002).

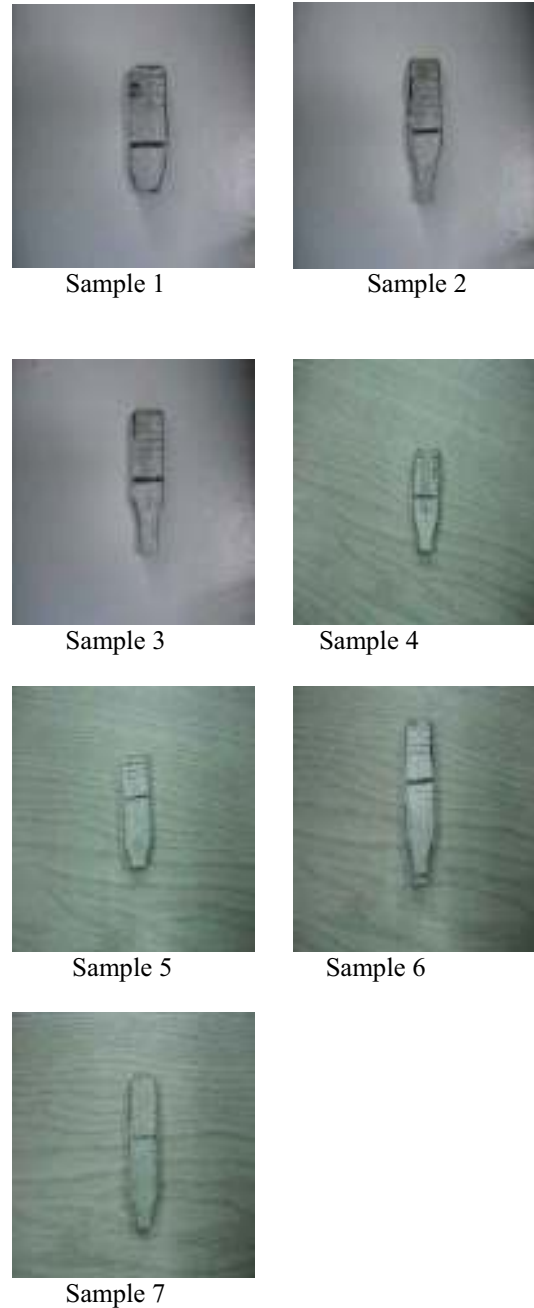


Figure 1: Surface properties for all the ratios

When molten metal is poured into the green sand mould, silica sand helps to absorb the intense heat and transfer this heat away from the casting. The porosity among the sand grains also provides a pathway for gases that are generated during the metal pouring to escape from green sand mould interior, thus reducing the possibility of gas related casting defects.

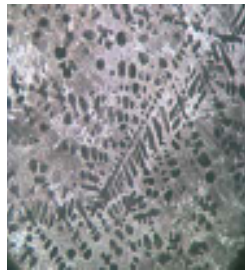
The permeability of the green sand is primarily determined by the shape and size of the silica sand. Generally large and coarser grains provide more porosity than smaller and smooth grains (Ammen, 2000). Shape

and size distribution of the silica sand also dictates the amount of bonding materials needed and the compressive strength the mould will achieve; also affect the quality of casting finish, with finer sand grains creating a smoother casting surface than coarser sand grains.

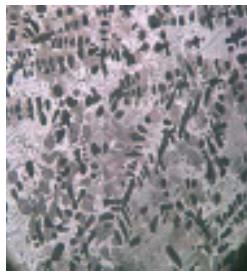
When bentonite mulled with water and other compositions of green sand in a muller, the bentonites become hydrated, expanded, dispersed, and coat the surface of sand grains, where the sand, clays and water bond together via hydrogen. This film holds grains together and provides the different necessary strength (green, dry and hot strength) to maintain the shape of green sand mold during mold preparation and metal pouring (Smiernow et al., 1980; Kawatra et al., 2001).



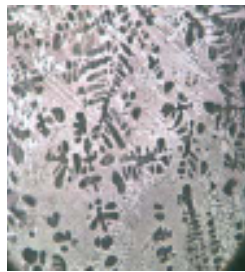
Sample 1



Sample 2



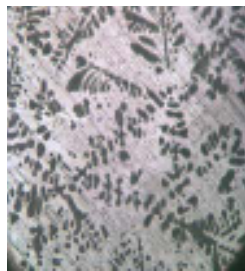
Sample 3



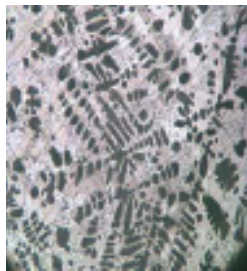
Sample 4



Sample 5



Sample 6



Sample 7

Figure 2: Microstructures for the 7 different ratios

At higher water levels, clay platelets can no longer absorb the water, and the excess water exists as free water that simply coats the outer surface of clay platelets and impedes bonding. As a consequence, too much water caused a decreased in the green strength and this can lead to gas related defects, poor surface finish and difficulty in the make out of sand (AFS, 1987). At lower water levels, clay is not fully activated, since the potential exists for further water adsorption and swelling; and this leads to brittle, friable molds that may crack prior to pouring or during pouring.

IV. CONCLUSION

- i. The best ratios for the bentonite and silica sand in the mixture of green sand mould is the 13% and 15% of bentonite
- ii. The mixture of bentonite and silica sand does give the influence towards the sample.

V. REFERENCES

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