ROLE OF SiO_2 ON MOLD MAKING PROCESS IN FOUNDRY METALLURGY

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ABSTRACT

Natural sands are varied, both chemically and physically. SiO_2 is the largest content besides of Na_2O, K_2O and Fe_2O_3 with variety of grain size distribution. For molding purposes, sands should have a minimum of 95% SiO_2, a maximum of 1.50% Na_2O + K_2O and maximum 1.0% Fe_2O_3 with wide distribution of grain sizes. Chemical composition, grain-size distribution, grain fineness number, shape, and clay content are the common test for basic characteristics. Another additional characteristic such as permeability, compressive strength, shearing strength have also being carried out on the natural sands used in mold making process in foundry such as CO_2 mold and green sand mold. CO_2 mold consist of SiO_2 with Na_2SiO_3 (Sodium Silicate) and for green sand mold consist of SiO_2 with bentonite.

Keywords: Sand mold; Foundry Metallurgy

INTRODUCTION

Sedimentation of sand generally depends on its chemical composition and physical properties. Sand generally as sedimentary from material consists of silicon dioxide (SiO_2) such as granite, riolite and granodiarite. Generally the grains contain and mix with clay feldspar(K,Al,Si_3O_8), magnetite(Fe_3O_4), ilmenite($FeTiO_3$), limonite($HFeO_2$), pyrite(FeS_2), mika(mineralmixtures), biotite $\{K(MgFe)_3\ (OHF)_2AlSi_3O_{10}\}$ hornblende$\{Ca_2(MgFe)_5(OH)_2(AlSi)_8O_{22}\}$, zirconium($ZrSiO_4$) and organic materials from plants and others. In casting industry, most metals are cast in mold made by sand, water and clay materials. Casting defects such as the change of mold shape occur due to fail of the mold and blow holes.

The casting defects are mostly caused by the unsuitable sand condition such as grain size. Therefore physical and chemical properties of sand need to known to ensure good sand molding. Also, sand preparation is important before the sand is ready for use. Generally, the sand preparation involves cleaning to eliminate clay and sieving for particle size separation. Sand mold with clay is commonly used as its relatively low price. Quartz sand is the main component in sand molding where mould properties are defined by main component. Sand shapes can be divided to rounded, sub-angular, angular and compound. Rounded sand gives higher sieve number compared to angular sand but with lower molding strength. The narrow grain size is better because of its large surface area and good mold strength. Large surface area results in high mold strength.

DISCUSSION

Generally, the distribution of sand grain sizes can be divided into:

1) very narrow grain distribution
2) narrow grain distribution (about 90% of big grain size with one fraction)
3) wide grain distribution
4) very wide grain distribution

Distribution of sand particles influences the mold strength. Larger distribution results in better mold strength. The thermal resistance of sand particles, that is the ability to not change phase at elevated temperature is influenced by the content of silicon dioxide (SiO_2) in sand. High SiO_2 content results in high thermal resistance. Sand with high content of SiO_2, Na_2O, K_2O, CaO and $Fe_2O_3SiO_2$ is prior and preferred in sand molding.

Clay as a component in sand molding should have properties such as higher bonding ,easy to shape and strong in dry condition. Common clays used are montmorillonite (bentonite), halloysite, and illite. Clay cannot tie together sand without water. So, the function of water as a binder for clay and sand produce the clayish to the clay. Increasing of water content in sand molding will influence the mold strength. Certain amount of water is needed to get the optimum characteristic. From the physical and chemical properties of two main components of sand molding clay and sand could be determined the combination properties and of course should be suitable with physical condition of sand mold , casting and the quality needed.(Table 1).

Table 1: Physical requirements and cast product dimensions

Metal type	Sieve number	Grain Fineness Number	Clay content (%)
Cast steel			
Large, medium	100-200	35-50	10-16
Small	>100	50-70	12-16
Cast iron			
Large	50-150	40-70	15-20
Medium	50-80	70-100	12-18
Small	20-50	100-140	12-18
Cast copper			
Large	20-50	90-110	15-20
Medium	20-40	100-120	12-18
Small	15-30	<140	12-18
Cast aluminium			
Large	20-40	100-120	15-20
Medium/small	10-25	<140	10-20

Product dimension influences the properties of sand mold. For large sized molding product, sand mold with wide grain size with certain allowable sieve number used. One of sand molding condition, in term of its relation to the resistance is the high percentage of SiO_2.

SiO_2 is the main component in sand molding. The molding properties are defined by SiO_2. SiO_2 does not change phase even at elevated temperature and has high sintering point.

The requirements are based on the surface quality of casting metal. Smooth surface needs to use pure and fine silica sand. Fine silica sand is only be added on the facing sand to achieve finer and purer result. The requirements to be used as molding sand are depend on the SiO_2 content, clay content, Grain Fineness Number, grain distribution and grain shape.

Grain shape of the sand also influences the strength of the mold. Generally, sand comprises variant of shapes. Therefore separation according to shape is needed.

CONCLUSION

In short, the physical and chemical behavior of the sand need to be known before started a sand mold, especially the content of SiO_2 which more than 95%. Besides, the sand preparation steps such as cleaning need to be considered for the suitability of grain size distribution. Also, the product dimension influences to the sand mold properties. Mostly casting defect caused of not able to fulfill the condition such as the condition of grain size.

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