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THE INFLUENCE OF BINDER VARIATION USING ERUPTION KELUD SAND ON SAND MOLD' STRENGTH, QUALITY AND FLUIDITY RESULTS ON AL-SI METAL CASTING

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ABSTRACT

Sand casting carried by medium and large scale industries typically uses commercial silica sand. Natural disaster on Mount Kelud eruption has introduced a new breakthrough in the form of ideas to use volcanic sand foundry sand as a base material for aluminum silica based products. This study, meanwhile, used the experimental method in which, prior to be given the treatment, the specimens were analyzed on the strength of molding sand, disability and ability to cast the metal flow (fluidity), and the quality of Al-Si as casting product. In addition, to observe the defects, tests on surface hardness and microstructure of Al-Si using Optical Microscope and Scanning Electron Microscope (SEM) were conducted. The results showed the best fluidity owned by the eruption of Mount Kelud sand specimens with a variety of bentonite 10% and hardness value at 129.71 HV. The data obtained from the microstructure result revealed that the eruption of Mount Kelud sand specimens with 10% portland cement variations have the pinhole defect size of most small amounting to ± 7 pieces and open grain structure defects ± 117 pieces. In other words, sand Kelud eruption molding sand can be an alternative to the metal casting industry.

Keywords: eruption sand kelud, strength, fluidity dan casting quality.

INTRODUCTION

Casting is one of the forming processes from metal. Principally, process in casting the metal involves the liquid metal entering to the mold cavity in which after being frozen, the metal will be equal to the form of cavity (Kalpakjian, 1991: 231). To have the desired result, it requires a number of processes. It begins by melting the metal into a melting furnace. It is then followed by making a model (pattern), making sand casting, making mold of sand (mold frame), metal melting, pouring the metal into the mold and disassembling and cleaning the casting results.

From the casting, it is found based on the fluidity and the level of metal hardness. Meanwhile, the fluidity of the level of metal hardness is determined by the process and molding system. The process and system of casting cannot be apart from mould that can influence the metal in terms of its hardness and form.

Material erupted from Mount Merapi has spread sand and dust containing SiO2. Meanwhile, the content of silica was in the range of 49.5-60.5% (Camus, et al., 2000: 145). The content of sand from the eruption can be used for any needs - particularly for casting. The molded sand commonly used is mount sand, beach sand and silica sand provided by nature (Surdia and Chijiwa, 1982: 110).

At recent times, most of communities or small-scale industries are using the molded sand as some of the mold of sand or soil contains the binding substance such as clay, bentonite, and other binding subtances. There are some factors influencing the casting process to result in a qualified casted thing: raw materials, quality of molded sand (if using sand mold), melting system, pouring system and final processing of casted product.

RESEARCH METHOD

Based on the research purpose to observe the influence of the use of a variety of binding materials with the sand from the eruption of Mount Kelud as the casted molded sand towards the strength of sand mold for Al-Si – metal mix. To observe the influence in the use of the variation of bindings with the sand from the eruption of Mount Kelud as the casted molded sand towards the fluidity of the result of metal casting mixed with Al-Si and to observe the influence of the use of a variety of bindings with the sand from the eruption of Mount Kelud towards the influence of metal casting mixed with Al-Si, this research used the design of experimental research.

As stated by Arikunto (1990: 272) "An experimental research attempts to examine the cause and result by comparing one or more group(s) of experiment given a treatment with on or more comparing group without any treatment".

Sugiyono (2010:72) explains that the method of an experimental research can be defined as a research method used to observe the influence of certain treatment on other in a controlled condition. In an experimental experiment, there are any treatments and researches conducted in a laboratory.

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This research used a design of pre-experimental research by using the model of one-shot case study in which a groups of samples were given a treatment before being observed as stated in Table-1 below.

Table-1. Research design..

No	Treatment	Test
1	The sand of eruption of Mount Kelud with 10% of Bentonite	Strength of sand mold
		Quality of casting results
		Fluidity of casting results
2	Sand of eruption of Mount Kelud with 10% of the Mud of Lapindo	Strength of sand mold
		Quality of casting result
		Fluidity of casting result
3	Sand of eruption of Mount Kelud with 10% of portland cement	Strength of sand mold
		Quality of casting result
		Fluidity of casting result

The technique in data analysis in this research used the descriptive data analysis that can be used to analyze the test on the strength of the molded sand, fluidity, number of casting defects and the test on the hardness of casted metal mixed with Al-Si.

RESULTS AND DISCUSSIONS

Prior to do the casting process towards the sand of eruption of Mount Kelud; bentonite, lapindo mud and portland cement have been tested using XRF test to observe the elements contained in those materials in which its result is presented in Table-2 as follows.

Table-2. Elemental Analysis using XRF.

No.	Element	Concentration unit %
1	Al	9.5
2	Si	32.8
3	K	1.89
4	Ca	24.2
5	Ti	1.4
6	Fe	25.0
7	Ni	1.24
8	Sr	1.9

Source: Result of Testing Samples at Laboratory of FMIPA UM

Fluidity Test

Fluidity is the ability of liquid metal to flow in a mold. This research used the patterns with the plates in different thickness following the pattern of Birmingham. The factors influencing the value of fluidity include the temperature (superheat level), chemical compositions, surface tension, conductifity of mold material, inclusion and vocisity (Flemings, 1974 and ASM Speciality Handbook Aluminium, 1993). The test on fluidity is conducted by considering the size obtained from the final result of casted metal.

The diagram below presents the comparison about the total size of the result of metal casting with a variety of 10% of bentonite bindings, 10% of Lapindo mud, and 10% of portland cement.

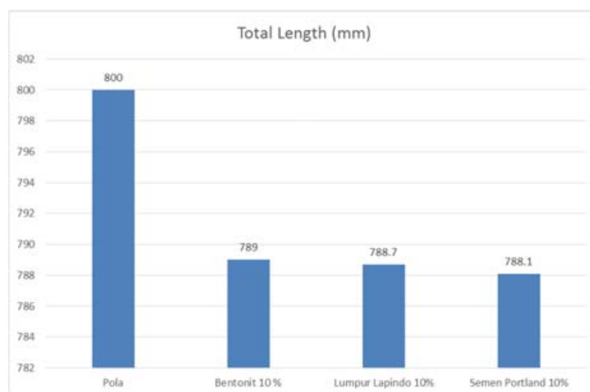

Figure-1. Diagram of comparison of the total size of things as the casting result.

Quality of Casting Results

Visual Checking

The defect of casting was conducted by visually examining the defects seen in the material of casting result.

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10% of Bentonite

10% of Portland Cement

10% of Lapindo Mud

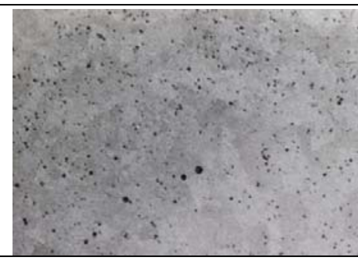
Figure-2. Casting result on Al-Si specimen using binder variation.

Based on the data obtained from the visual examination in each specimen, it was found that the defects emerging in this research were the defects in air cavity, pinholes, shrinkage, dropping mold, sand inclusion and roughness by erosion. The specimen of sand of eruption from Mount Kelud with variation of 10% of Bentonite was the best one as it had the fewer defects compared to other specimens.

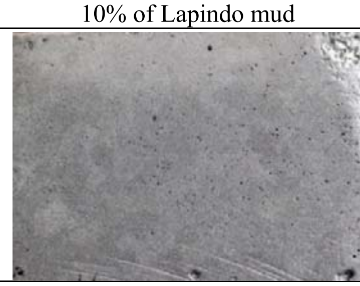
Macroscopic Structure

Macroscopic structure was conducted by using Camera of Canon EOS 600D powned by the Laboratory of Mechanical Engineering of Brawijaya University. It was used to see the spread of defects occurred on the surface of casted materials.

10% of Bentonite



10% of Lapindo mud



10% of Portland cement

Figure-3. Macroscopic structure on specimens surfaces.

Based on Figure-3 from the casted material with 10% bentonite, many defects of pinholes were found and spread in most of specimen surface. The defect of air hole occurred due to the air and water steam were entrapped in the inner walls of mold (Jain, 1979). Meanwhile, many defects of open grain structure were found, even much more compared to other specimens. The result from 10% portland cements' specimen showed few of defects of pinholes as seen on the spicemen surface. The defect of grain structure was found quite few even fewer than other specimens of casted materials.

Microstructure

As stated by Apelian (1984) in his book, a result of grain size microstructure from large to small, will create a development of mechanical properties. In addition, the development of mechanical properties in refined grains occur due to the process of hindering the dislocation movement passing the more limits of grains to the surface (Callister, 2007). The micrograph was conducted using the 400-time magnification.

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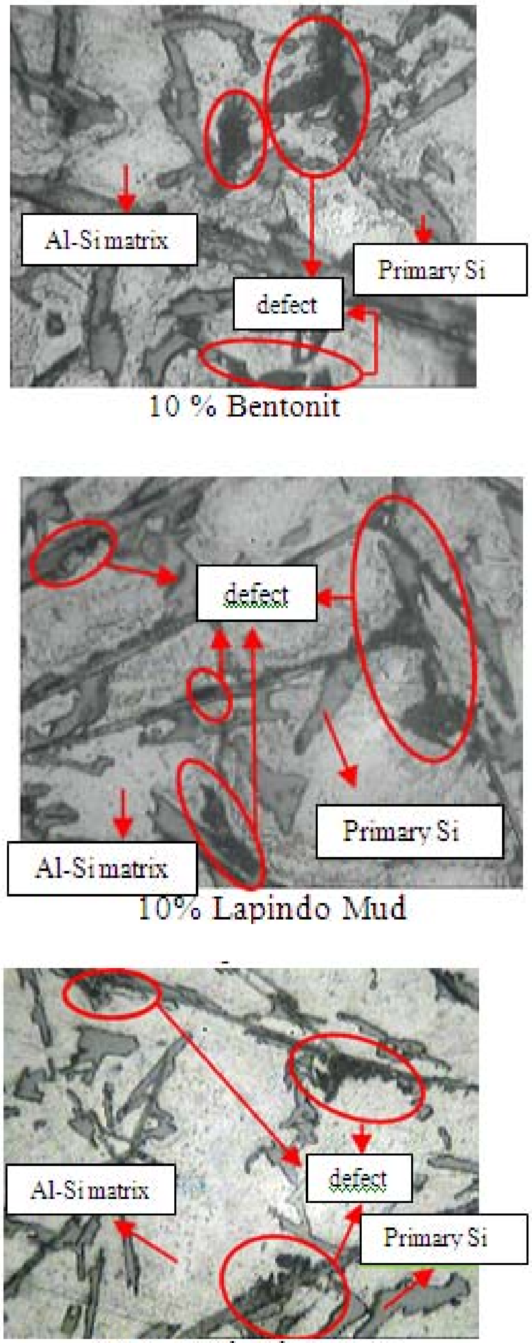

Figure-4. Micrograph of Al-Si specimens using binder casting variation.

Figure-4 shows specimen with the binding variation of 10% Bentonite has small casting defects and one quite large casting defect in the result of casting. Meanwhile, the matric of Al-Si had the smallest size compared to the size of Primary Si. The specimen with 10% of Lapindo mud shows three small defects and one large defect. Meawhile, matrix of Al-Si had a larger size and primary Si seemed to be little bit dominant compared to the 10% bentonite' specimen. One small defect and one large defect were found in specimen with 10% of portland cement binder. In addition, the matrix of Al-Si seems to have the largest size and Primary Si seems to be fewer compared to other specimens.

Hardness Result

Hardness results was obtain using microvickers hardness tester with HV scale. The hardness test was to observe the influence of sand from the eruption of Mount Kelud with three various bindings towards the hardness of Al-S1 metal.

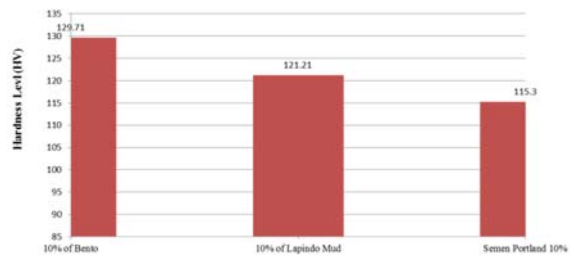

Figure-5. Bar diagram of the metal as a result of casting.

Based on the research result that have been displayed in Figure 5 above, it can be seen that the highest hardness was found in the specimen with the variety of 10% binding bentonites at 129.71 HV. In contrast, the lowest one was found in the variation of 10% binding portland cement at 115.3 HV. It showed that microstructure of matrix of Al-Si and primary Si highly influenced the value of the result of metal hardness.

CONCLUSIONS

The highest fluidity was found in the sand from the eruption of Mount Kelud with the variation of 10% bentonite. It is proven from the total length of the casting result that was mostly close to the size on 38mm. Based on hardness test, it is found that the highest mean value was in the specimen of sand from the eruption of Kelud Mouth with the variation of 10% bentonite at 129.71 HV. Based visual examination on each specimen, it is found that the defects emerging in this research were the defect of air cavity, pinholes, shrinkage, dropping mold, sand inclusion and roughness by erosion.

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