© 2018 IJSRSET | Volume 4 | Issue 1 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

Influence of Silicon on The Composition of The Molten Aluminum Silisium (Al-Si) for Increased Strengt Mechanical of 2 Stroke Motorcycle Piston

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ABSTRACT

A study of " Influence of silicon on the composition of the molten aluminum silisium (al-si) for increased strength mechanical of 2 stroke motorcycle piston". Melting is done with conventional methods by means of mixing aluminium with silicon, where silicon varied ranging from 9.7% Si Wt, 10.7% Si Wt, 11.7% Si Wt, 12.7% Si Wt, 13.7% Si Wt, 14,7% Si Wt. From the results of test perfomed, tensil value each 370.87 N/mm^2, 372.63 N/mm^2, 376.55 N/mm^2, 378.82 N/mm^2, 373,80 N/mm^2 and hardness in value each, 63.5 HRB, 65.5 HRB, HRB 66.44, 67.24 HRB, 68.12 HRB, 65,5 HRB test is increasing but the impact test value each 0.375 J/mm^2, 0.355 J/mm^2, 0.302 J/mm^2, 0.280 J/mm^2, 0.250 J/mm^2 and 0,215 J/mm^2. For XRD observation of crystal structure motorcycle 2 stroke piston is cubic with a = 4, b = 4, 0494A0, 0494A0, and c = 4, 0494A0 with aluminum, silicon. Qualitative observations using SEM-EDX shows that Silicon mixed evenly with aluminum.

Keywords: Compositions Silicon, Aluminum Silisium, Piston

I. INTRODUCTION

Aluminum is a light metal has good corrosion resistance and the groom a good electrical properties and other good properties as metal[1.]

Piston function is as a tool to suck fuel, compress the fuel (compression), hold the power and the expansion of a high-pressure gas with high temperature.

The Pistons made from aluminum because the piston must be lightweight, strong and resistant to high temperatures. Therefore, aluminium as a raw material component is often obtained in the form of an alloy with elements such as; CU, Zn, Si, Mg, Sn, so that it can increase strength had engineer.

This focus on research problems that want to be studied is the influence of the composition of the Molten Aluminum On Silisium Silicon (Al-Si) to improve Mechanical Strength of two stroke motorcycle Piston is not by giving heavy Silicon variation 9.7% Si Wt, 10.7% Si Wt, 11.7% Si Wt, 12.7% Si Wt, 13.7% Si Wt and 14.7% Si Wt. For two stroke motorcycles does not to do testing, such as pull-test, test, test the impact of hardness, microstrucuture.

Problems

a. How to influence the composition of the molten aluminum on silisium Silicon (Al-Si) to improve Mechanical Strength of two stroke motorcycle Piston is not by giving heavy Silicon variation 9.7% Si Wt, 10.7% Si Wt, 11.7% Si Wt, 12.7% Si Wt, 13.7% Si, Wt and 14.7% Si Wt.
b. How the microstructure observation test, tensile testing, impact testing, hardness testing effect to increase the mechanical Strength of two stroke motorcycle Piston.

II. A REVIEW OF THE LITERATURE

Aluminum is the third most populous of the contained element dikerak of the Earth. Naturally balanced aluminum form when combines with other elements such as silica or oxygen.[2]

Although aluminium has high power join to oxygen and arena said that easily oxidize (rust), in fact has the durability of rust. It is caused by a thin layer of saturated oxygen, however, formed on the surface and will protect them from assault next atmosphere.

Aluminum Alloy

Aluminum is used as an alloy of various metals, pure, as not to lose the nature of light and the properties of lift and be able to cornya improved by adding other elements, such as copper, manganese, magnesium, silisium, nickel, etc can change the nature of aluminum alloy.

Aluminum alloy elements can be classified as the following[3]:

a. Al-Si Alloy
b. Alloys of Al-Cu and Al-Cu-Mg
c. Al-Mn Alloys
d. Al-Mg Alloys
e. Alloy Al-Mg-Si
f. Alloy of Al-Mn-Zn

Al-Si Smelting

Alloy Al-Si cast was able to have the properties of good, corrosion resistant, it can be processed with machining and welding can be

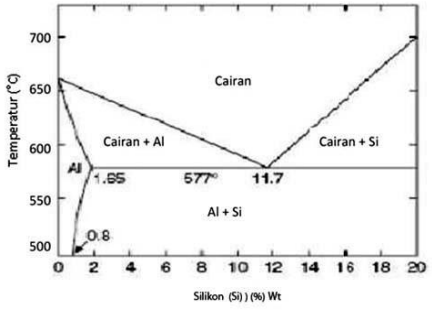


Figure 1. The Phase Diagram of Al-Si (Surdia, 1995:137)

Piston

Piston in Indonesia language also known as the shaft is a component of internal combustion engine that acts as a suppressor of incoming air and the receiver beat burning on combustion chamber cylinder linear.

Piston work nonstop during the engine life. This component has increased temperatures and high pressure so that the absolute must have high durability. Therefore, manufacturers now prefer aluminum alloy (Al-Si). Most or even all types of vehicles now uses a system of explosion combustion chamber to drive the crank spinning motion be forwarded, forwarded to the crankshaft, gearbox from there forwarded to chains that connect with wheels. The main function of the piston to transform heat energy from the combustion of the fuel mixture with fresh air in the combustion chamber into mechanical energy. The piston moving in the cylinder in translation continues to rotate the crankshaft through a drive shaft.[4]

Motor Gasoline

The main characteristic of motor gasoline is the fuel combustion process that occurs in the cylinder volume in space anyway.

Mechanical Properties Of Materials

Mechanical properties of materials is the relationship between the response or the reform of material against the objects that work. Mechanical properties of materials is carried out on the investigation of Al-Si includes a powerful pull, violent, impact and microstructure.[5]

Tensile Test

The tensile test is one test of stress-strain mechanical aiming to find out the strength of materials against the style done in drag, materials test dotted until withdrawn.

Strong Pull

Tensile testing performed on a solid material (metal and non metal) can provide relative information

about the behavior of the material against the mechanical loading.

Elongation

Long added a pull-test after experiencing the material is called elongation. The value of the Oomph of a material is usually indicated by this elongation rates.

Test Hardness

Hardness was defined as the resistance of a material against penetration of the surface, caused by the emphasis by the particular shape of press due to the influence of a particular style. Testing the hardness is very useful to know the quality of a material that will be used on metal products such as iron components.

Test The Impact

This test aims to find out the toughness of a specimen against a load of broken. On the test impact it is making special thoroughness that requires the notch and high-precision.

A common method for measuring the energy of the impact are:

- ✓ Test impact Charpy
- ✓ Test impact Izod

Micro Structures

Microstructure grain-grain is a very small metal objects and cannot be seen with the naked eye so it is necessary to use certain tools like XRD and SEM-EDX for the inspection of grain-grain of the metal.

Micro-structure analysis is used to determine whether a parameter structure are in certain specifications and in this research is used to determine the micro structure changes that occur as a result of variations in composition, microstructure analysis using XRD and SEM-EDX.

XRD

In x-ray monocromatis on Crystal materials, then every field of crystals will reflect or scatter x-rays in any direction. Interference occurs only between rays reflected rays-sefase so there is only a certain reflection x-ray alone. Strengthen mutual interference may occur if the sinarX that sefase has a difference in the trajectory of the round multiples of wavelengths (λ).[6]

Scanning Elektron Microscope (SEM)

Scanning Elektron Microscope (SEM) is a tool that can form a shadow surface. SEM is a type of electron microscope images of the surface of the sample is scanned using a high-energy electron beam scan patterns in the pixels. Scanning electron microscope (SEM) is a microscope utilizing electron scattering in forming a shadow.

III. METHODS

Location Research

Melting samples implemented in research and standardization of Industrial Hall Medan, JL. Sisingamangaraja No. 24 field implementation in Tanjung Morawa. Tensile testing, impact testing, hardness testing and funded at PTKI.

The Materials Used

1. Aluminum (95.8%) (Product Inalum)
2. Silicon (100%) (Product Inalum)

IV. RESULTS AND DISCUSSION

Creation Of Test Samples

Creation of sample test done by melting the raw materials in the form of pure aluminum at induction electric furnace with conventional methods. The composition of the weight of Silicon (Si) varied by as much as five variations namely: 9.7% Si Wt, 10.7% Si Wt, 11.7% Si Wt, 12.7%, Si Wt, 13.7% Si Wt, and 14.7% Si Wt. Sample casted on the mold remains.

A. Tensile Testing

Pull-test sample after casted then formed using a lathe in accordance with shape and size in accordance with standard ASTM E 8 m-04[7]. Pull-test sample is made of each 5 pieces for each variation of Silicon (Si). To

know the influence of the concentrations of Silicon in alloy Al-Si, conducted testing tensile test samples against for each variation of Silicon.

Table 1. Calculation of Tensile Testing Test value of Al-Si

No.	Compositio n Variations Al: Si % Wt	Melt tension (σy) N/mm²	Maximum voltage (σ max) N/mm²	Broken voltage (σ_f) N/mm²	Elongation (e) %	Long multiplication (Δl) Mm
I	90,3 : 9,7	170,661	370,87	273,64	0,6	0,3
II	89,3 : 10,7	213,748	371,034	351,88	0,5	0.2
III	88,3 : 11,7	250,656	372,63	353,15	0,3	0,17
IV	87,3 : 12,7	289,29	376,55	356.89	0,2	0,11
V	86,3 : 13,7	300,52	378,82	362,08	0,1	0,05
VI	85,3 : 14,7	252,75	373,80	355,20	0,05	0,02

From table 1 above it can be seen that the strong pull of heavy Silicon variation 9.7% Si Wt, 10.7% Si Wt, 11.7% Si Wt, 12.7%, Si Wt, 13.7% Si Wt, and 14.7% Si Wt, increase caused silicon particles fused with aluminum.

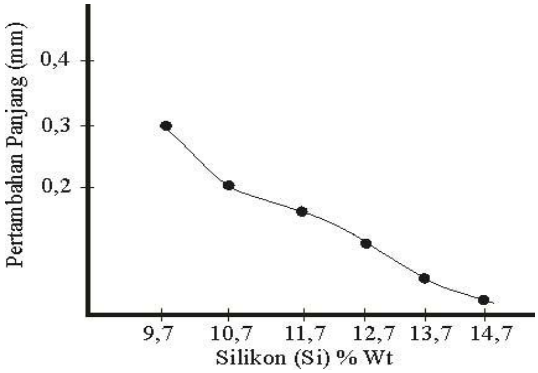


Figure 2. Added Length VS. Weight Silicone

B. HARDNESS TESTING

Table 2. Test Results of K on the Impact of Al-Si Alloy

No.	Composition Variations Al : Si (%)	Point 1 (HRB)	Point 2 HRB)	Point 3 HRB)	Point 4 HRB)	Point 5 HRB)	The average hardness (HRB)	Hardness (MPa)
I	90,3 : 9,7	63	65	63	64	62	63.5	400
		62	64	65	63	63		
		63	65	63	66	62		
		64	62	63	65	64		
		65	63	64	62	65		
II	89,3 : 10,7	64	68	66	64	62	65.5	400
		63	64	67	68	66		
		64	68	65	66	63		
		65	67	68	65	64		
		63	64	65	68	62		
III	88,3 : 11,7	65	68	67	66	63	66.44	416
		67	66	68	65	68		
		65	67	68	66	64		
		66	65	68	67	66		
		68	66	67	65	66		
IV	87,3 : 12,7	66	68	64	67	65	67.24	416
		66	67	68	66	66		
		68	69	67	66	65		
		67	68	68	67	66		
		69	68	69	66	67		
V	86,3 : 13,7	68	69	67	69	68	68.12	431
		67	68	69	67	67		
		69	69	68	67	66		
		68	69	69	68	67		
		69	69	69	68	69		
VI	85,3 : 14,7	65	68	67	66	63	66,44	416
		67	66	68	65	68		
		65	67	68	66	64		
		66	65	68	67	66		
		68	66	67	65	66		

Hardness was defined as penetration resistance of materials on the surface. Testing the hardness test Rockwell tools at done Hardness Tester, hardness test samples after the cast is then formed using a lathe with standard ASTM E18-08b, hardness testing performed on a five-point. Research data as table 2.

The pigure below shows the influence of the composition of 3 unwieldy Silicon (si) against hardness start 9.7% Si Wt, 14.7% Si, Wt this event occurs because the elements silicon particles fill the void aluminium smelting at the time, due to the nature of Silicon (Si) effect in the alloy to enhance liquid state (fluidity) in the foundry, hardness and heat resistant

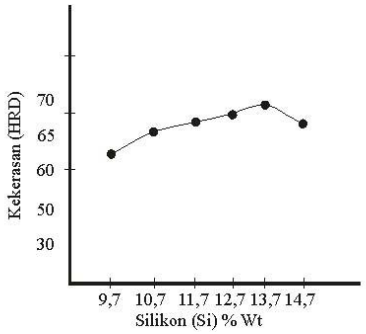


Figure 3. Rating hardness VS. Weight Silicone

C. Impact Testing

Table 3. Test Result K on The Impact of Al-Si Alloy

No. sampel	Komposisi Variasi Al : Si ((%) Wt)	Dimensi Sampel		Luas patahan sampel (mm^2)	Energi (Joule)	Nilai Impact (Joule/mm^2)
		a (mm)	b (mm)		Rata- rata	
I	90,3 : 9,7	8	10	80	30	0.375
		8	10	80		
		8	10	80		
		8	10	80		
		8	10	80		
II	89,3 : 10,7	8	10	80	28.4	0.355
		8	10	80		
		8	10	80		
		8	10	80		
		8	10	80		
III	88,3 : 11,7	8	10	80	24.2	0.302
		8	10	80		
		8	10	80		
		8	10	80		
		8	10	80		
IV	87,3 : 12,7	8	10	80	22.4	0.280
		8	10	80		
		8	10	80		
		8	10	80		
		8	10	80		
V	86,3 : 13,7	8	10	80	20	0.250
		8	10	80		
		8	10	80		
		8	10	80		
		8	10	80		
VI	85,3 : 14,7	8	10	80	10	0.215
		8	10	80		
		8	10	80		
		8	10	80		
		8	10	80		

Impact test was conducted to compare the test objects i.e. aluminum with different Silicon elements. So a specimen is made in such a way so that

the two objects this test actually have the same dimensions, in accordance with ASTM E23-07aε1. This testing using Charpy Impact Machine. This test aims to find out the toughness of a specimen against a load of broken. After testing the retrieved data and included in table 3 above.

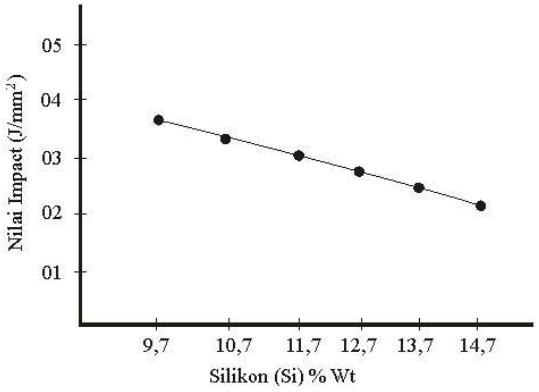


Figure 4. the value Impact of Al-Si Alloy VS. Percent Weight Silicone

Figure 4 above showing the influence of heavy silicone composition against aluminum on the test impact raised 9.7% Si Wt-14.7% Si Wt impact value is getting smaller because of the clay materials absorb the energy to break it up and material getas require energy to break it up. Thus the addition of silicone concentration more add kegetasan so that impact energy is getting smaller.

D. Testing The Crystal Structure

The test has been conducted of the structure of Al-Si with XRD to diffraction patterns: 9.7%, 10.7%, 11.7%, 12.7%, 13.7% and 14.7% with the following results:

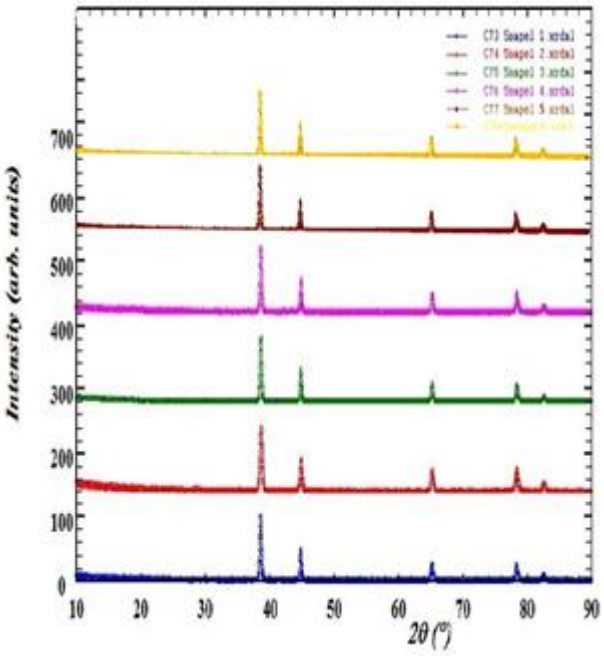


Figure 5. Difraction Pattern of Al-Si 9.7% Si Wt, 10,7% SiWt 11,7% Si Wt, 12,7% Si Wt, 13, 7% Si Wt, 14,7%SiWt

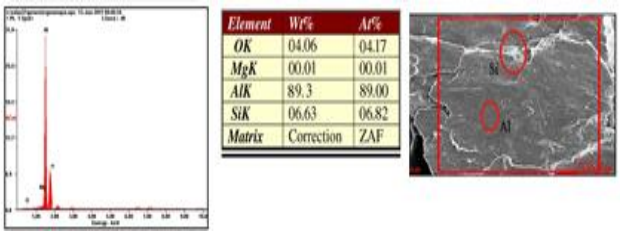
The diffraction patterns in Figure 5 the result can also be seen in table 4 from below in a process with the ICDD reference code: 00-004-0787M then retrieved a = 4, b = 4, 0494A0, 094A0, and c = 4, 094A0, so that alloy Al-Si is a crystal system cubic.

Table 4. Analisys Value of XRD Test

No	h	k	l	d (A⁰)	2 Theta (deg)	I (%)
1	1	1	1	2.33800	38.473	100.0
2	2	0	0	2.02400	44.740	47.0
3	2	2	0	1.43100	65.135	22.0
4	3	1	1	1.22100	78.230	24.0
5	2	2	2	1.16900	82.438	7.0
6	4	0	0	1.02140	99.081	2.0
7	3	3	1	0.92890	112.046	8.0
8	4	2	0	0.90550	116.574	8.0
9	4	2	2	0.82660	137.463	8.0

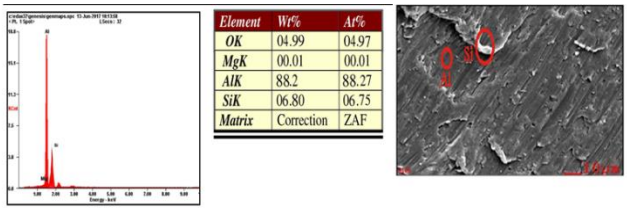
E. Test The SEM-EDX

SEM-EDX testing is done with the purpose to know the micro structure characterization. Micro-structure is the result of observations by SEM-EDX and this includes observations of the composition of the grains, the grain boundaries and the void-emptiness.



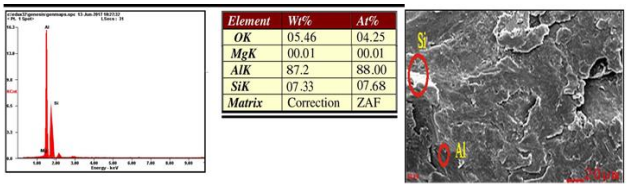
Element	Wt%	At%
OK	04.06	04.17
MgK	00.01	00.01
AlK	89.3	89.00
SiK	06.63	06.82
Matrix	Correction	ZAF

Figure 6. Topografi SEM EDX with Silicon variation 9,7 % Si Wt



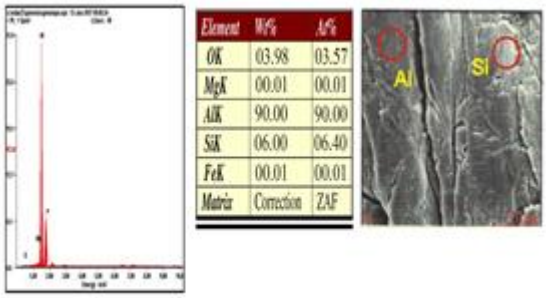
Element	Wt%	At%
OK	04.99	04.97
MgK	00.01	00.01
AlK	88.2	88.27
SiK	06.80	06.75
Matrix	Correction	ZAF

Figure 7. Topografi SEM EDX with Silicon variation 10,7 % Si Wt



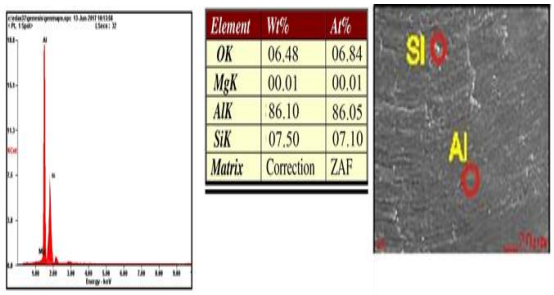
Element	Wt%	At%
OK	05.46	04.25
MgK	00.01	00.01
AlK	87.2	88.00
SiK	07.33	07.68
Matrix	Correction	ZAF

Figure 8. Topografi SEM EDX with Silicon variation 11,7 % Si Wt



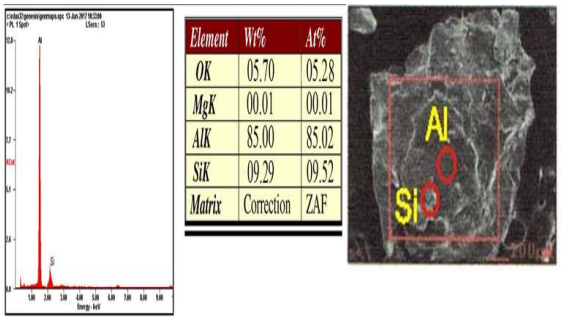
Element	Wt%	At%
OK	03.98	03.57
MgK	00.01	00.01
AlK	90.00	90.00
SiK	06.00	06.40
FeK	00.01	00.01
Matrix	Correction	ZAF

Figure 9. Topografi SEM EDX with Silicon variation 12,7 % Si Wt



Element	Wt%	At%
OK	06.48	06.84
MgK	00.01	00.01
AlK	86.10	86.05
SiK	07.50	07.10
Matrix	Correction	ZAF

Figure 10. Topografi SEM EDX with Silicon variation 13,7 % Si Wt



Element	Wt%	At%
OK	05.70	05.28
MgK	00.01	00.01
AlK	85.00	85.02
SiK	09.29	09.52
Matrix	Correction	ZAF

Figure 11. Topografi SEM EDX with Silicon variation 14,7 % Si Wt

V. CONCLUSIONS

After observation, testing and measurement can be summed up as follows :

1. The influence of variation of Silicon 9.7% Si Wt, 10.7% Si Wt, 11.7% Si Wt, 12.7%, Si Wt, 13.7% Si Wt, 14.7% Si Wt alloy castings Wt against Al-Si caused the strong pull of the more value each 370.87 N/mm2, 372.63 N/mm2, 376.55 N/mm2 and 378.82 N/mm2 strain, the smaller the value each 0.6 0.3, 0.5, 0.2, 0.1, increase the length of the smaller value each 0.3 mm, 0.2 mm, 0.17 mm, 0.11 mm, 0.05 mm increases the hardness value each 63.5 HRB, 65.5 HRB, 66.44, HRB and 67.24 HRB 68.12 HRB impact value, the smaller the value each 0.375 J/mm2, mm2, J/0.355 0.302 J/mm2, 0.280 J/mm2 and 0.250 J/mm2.
2. From the XRD test system of the Crystal is cubic with a = 4, b = 4, 0494A0, 0494A0, and c = 4, 0494A0.
3. From the results of SEM-EDX grain-grain silicone evenly between aluminum with 9.7% Si Wt, 10.7% Si Wt, 11.7% Si Wt, 12.7% Si Wt and 13.7% Si Wt 14.7% Si Wt.

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