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Speech From Head of Research and Community Service Center of State Polytechnic of Jakarta

Sambutan Ketua Pusat Penelitian dan Pengabdian Kepada Masyarakat (P3M) Politeknik Negeri Jakarta

Assalamualaikum Wr Wb

We pray to Allah SWT for all His grace and gift He has given to us all so that the International Seminar on the Results of Researches and Community Services can today be conducted.

This international annual seminar is aimed to provide a dissemitaion forum for the results of researches and community services. This is expected to be a forum for information exchanges, discussion involving many parties: scholars, practitioners, and government. Interaction among different perspectives could become a medium to create technology development and sustainability accurately applicable in industry and society to enhance and support their autonomy in this modern era. For this, P3M PNJ ASAIS 2012 invite scholars, practitioners and government to write and present their papers under the following fields:

1. TECHNOLOGY
   Computer and Information Technology, Telecommunication, Electrical and Electronics, Energy Conversion, Mechanical Technology, Manufacture and Production Process, Production Management, Machinery Maintenance, Heavy Equipment and Automotive Technology, Civil Engineering, Building Structure, Road and Bridge, Water Resource and Environment, Geotechnical, Engineering Materials, Construction Management, Graphics Technology, Animation Technology.
2. COMMERCE
   Finance, Accountancy, Banking, Law, Business Administration, Event Management, Communication, Publishing, e-commerce, e-government, e-learning, e-promotion, Islamic Banking, Islamic Economics.
3. ENVIRONMENT

As the person in charge of this Seminar, we thank the Director of State Polytechnic of Jakarta and all the management; resourcepersons, colleagues from colleges, universities, polytechnics; researchers, and all invitees. And we also thank all members of commitees who have worked hard and are full of spirit to make the seminar happen.

Finally, we look forward to suggestions and critisism so that we can carry out the next international seminar in 2013 better.

Wassalamualaikum Wr Wb

Jakarta, 6 November 2012
Head of P3M,
Politeknik Negeri Jakarta/State Polytechnic of Jakarta

Ir. Budi Damianto, M.Si
NIP. 19580108 198403 1 001

Speech From Director of State Polytechnic of Jakarta
Sambutan Direktur Politeknik Negeri Jakarta

Assalamu'alaikum Wr Wb,

We pray to Allah SWT for all His grace and gift He has given to us all so that today we can attend the International Seminar on the Results of Researches and community Services under the theme of "Creative industry based research and community services to encourage community autonomy", as a basis of knowledge and research development in higher education, both national and international which can be conducted by Research and Community Service Center in State Polytechnic of Jakarta.

The purpose of conducting this seminar is to provide knowledge and concepts exchange opportunity for multidiciplinary scientists to put forward their perspectives in national and state problems under the three defined sciences. Beside that, this forum can also be used to strengthen relationship of researchers from both national and international institutions.

In this instance we would like to thank:

1. Prof. DR. Djoko Santoso, Dirjen Dikti
2. Associate Profesor, Kume Yusuke, Saga University
3. Presenters
4. All boards of committee who have made this happens

We hope that this academic activity can be conducted regularly and the spirit of the research will always sustain and give valuable contribution to the welfare and the development of the nation.

We thank you and hope you gain valuable benefits from the seminar.

Wassalamu'alaikum Wr Wb,

Jakarta, 6 November 2012

Director of state Polytechnic of Jakarta

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TITLES OF COMMERCE AND ENVIRONMENT PAPER

TECHNOLOGY

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The Influence of Silicon (Si) Alloying to Homogenize the Bainitic Structure Formation on Bainitic Nodular Cast Iron

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Abstract

Bainitic structure can be made on nodular cast iron by giving a Nickel and Molibdenum as an alloying. The bainitic structure should be homogen without any other structure in its matrices. In practice the bainitic structure formation is not fully homogen. Another undesirable structure such as ferrit and ledeburit structure can be found in the matrices of its microstructure. The microstructure formation is associated with the thickness (module) of casting which could influence the cooling rate. Ledeburit formation could be occur when the cooling rate is relatively fast and in contrary a ferritic formation could be occur because of slow cooling. The addition of Silicon (Si) content is used particularly to promote graphite formation. Silicon also can influence the formation of the matrices structure. That depend on carbon content left behind on the matrices and the thickness of the casting. Ferit and ledeburit formation can be avoided or minimized by controlling the Si content. The addition of more Si content on the thin casting sample will reduce the possibility of ledeburit formation. The Si content must be controlled and reduced on the thick sample to make sure that the ferrit formation is not too much present. The research has been done by make a casting sample with a three variation of its thickness which is represent its casting module. The casting module is made to 0,33, 0,78 and 1,22. The melting of nodular cast iron is done with a composition of C 3,2%, Mn 0,3%, Mo 0,7%, Ni 2,6% and Mg rest 0,03%. The Silicon is given by three variation of 2,0 %, 2,3 % and 2,6%. The research find a conclusion that at the addition of 2.3 % Si could omit the ledeburit formation at thin module and the ferrit formation is relatively reduced to a small amount at thick module.

Keywords: *cast iron, Bainitic structure, Module, Cooling rate, Si alloying*

1. INTRODUCTION

Nodular cast iron is an alloy of iron with carbon for its main content which is gave up to 3.8% [Minkof, 1983]. One consideration nodular cast iron material selection is the ease of casting process, compared to the temperature of steel melting, nodular cast iron has lower melting temperature at 1450 oC whereas steel is about 1600o C. With that temperature difference the cost of the cast iron production process is lower.

Development of nodular cast iron performed by improving the mechanical properties of nodular cast iron. Conventional nodular cast iron has a variety of strengths from 40 to 80 kgf/mm2, with elongation of 17% and 2%. The need for materials that are easily to processed by casting but has better mechanical properties led researchers to develop the mechanical properties of nodular cast iron to be a material that has a higher strength [Bandanadjaja, B, 2001]. The development is taken by making a bainitic structure in nodular cast iron. The bainit structure has higher tensile strength than conventional nodular which only has perlitic structure.

This research aims to improve the quality of the bainitic nodular cast iron material. Through the process of integrating Silicon elements modification. It is expected that the research will get bainitic structure matrix is more homogeneous. Thus, material hardness may still be high enough but not too brittle.

2. THEORY

The way that can be taken to get the as-cast bainitic structure is to provide special alloy composition of the nodular cast iron nickel and molybdenum. Both of these elements affect the shape of the TTT diagram nodular cast iron material. With normal cooling in the mold sand the final microstructure that would be obtained in as-cast condition is bainite and in addition there may also be residual austenite [Porter, 1992].

Nickel effect as a promote in the formation of graphite on cast iron structure. It also stabilizes the austenite. The effect of nickel addition on the Fe-C diagram is expanded austenite area. At 30% Nickel the transformation temperature is decrease down to below room temperature. The addition Nickel make the eutectic point shifts to the left and also lower it temperature. The interval of□ - graphite formation and□ - Fe3C is enlarge and it decrease the tendency of the white structure formation [Rohrig, 1970].

Alloying Nickel will shift the overall TTT diagram to the right [Rohrig, 1970]. As seen in Figure 1. with nickel content of 1% then the TTT diagram of cast iron with a carbon content of 3.6% is shifted to the right approximately 20 seconds. The larger of nickel content would make diagrams more shifted to the right. In such conditions with normal cooling it is possible to martensitic structure to be formed. Another effect of nickel is lower eutectoid temperature, it also affects the position of the martensite start by decreasing its position. In these conditions the formation of austenite structure at room temperature could be possible.

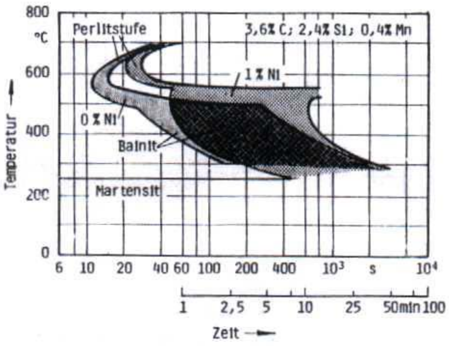

Figure 1. The Influence of Nickel Alloying

Molybdenum effect TTT diagram by shifting the bainite nose becomes more forward [Rohrig, 1970]. As shown in Figure 2. with the addition of 0.5% Mo, the bainite nose which was originally located behind the pearlite nose becomes forward. Under such circumstances with normal cooling in the sand molding the bainite structure can be found in as-cast condition.

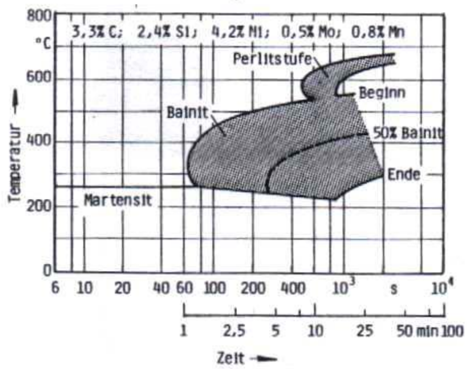

Figure 2. The Influence of Molibdenum Alloying

The rate of cooling can affect the formation of microstructure. For nickel and molybdenum additions will produce certain specific TTT diagram. At the same composition, then when applied to a different cooling rate, it will produce a different microstructure. Look at Figure 2. for rapid cooling rate (60 s), it will produce martensite. For slower cooling rate (200-400 s), it will produce bainite matrix. For a very slow cooling rate (104 s), it will produce a matrix of pearlite. Therefore, when giving the composition of Ni and Mo then the cooling rate of the casting should be noted. Cooling rate can be represented by a number which is called modules. The module of workpiece is calculated as the volume divided by the heat loose area of the objects. The smaller number of modules the faster the cooling rate.

The researchs that have been done before by Bandanadjaja, B [2004] show the results as shown in Figure 3.

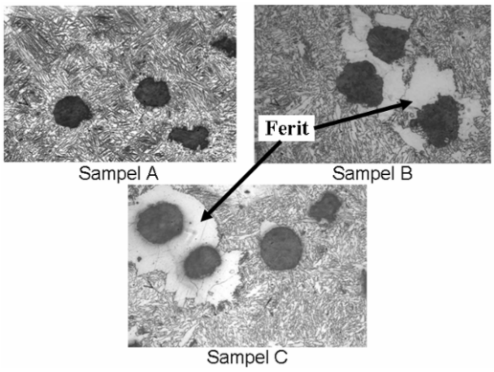

Figure 3. Microstructure of Nodular Cast Iron With Cooling Rate Variation

The three samples have the same composition according to the standard C 3.17%; Si 2.61%, Mn 0.39%, Ni 2.68%, Mo 0.60 and 0.025% Mg [Brunhuber, 1989]. The difference in the three samples is the sample module. Sample A has a module 0.33, sample B 0.56, and sample C 0.78. Modules in this case describes the cooling rate which is owned by the sample. The smaller the module indicates the faster the cooling rate. The experimental results show that the composition of the nickel and molybdenum are the same, the number of the module is very influential on bainite homogeneity. In a large module (0.78) looks the presence of ferrite phase (white). It does not happen on a small module. This is analyzed as follows: the cooling rate is quite slow then carbon get together to form graphite. The graphite forming makes carbon leaving the area around it, where the poor content of the carbon at that area consequences the decreasing of bainite forming. The presence of ferrite phase will decrease the overall strength of sample material, because the ferrite material has low strength individually.

Silicon is a chemical element that has a function as promote of graphite formation [Burdit, 1993]. The existence of Si is required in production of cast iron. Without Si or lack of Si will promote white structure formation. White structure is consist of cementite structure which is too hard and brittle. Hard and brittle properties disadvantage because it become susceptible to impact loads. The excessive content of silicon will promote larger formation of graphite. If these condition supported by the slow cooling rate then it will produce a large graphite and around it would lack of carbon and it will form the ferrite phase. Thus, to overcome that case it can be set the amount of Si is arranged to the right amount for certain thickness to avoid the ledeburit or ferrite structure formation. [Foseco]

3. METHODOLOGY

Research activities carried out by performing experiments in casting the sample. The sample were designed so that the cast process had a variety of cooling rate. The samples were fabricated cuboid with 3 variations in size so it will result in 3 variations of the module. Module variation will result in variation of the cooling rate of each sample. Sample shape as shown in Figure 4. The sample size as shown in Table 1.

Table 1. Dimension Data and Modul of Sample

No	P Cm	L Cm	T Cm	Vol.	Area	Module	D Module	Weight (kg)
a	4	4	1	16	48	0,33	-	0,152
b	6,5	6,5	3	126,75	162,5	0,78	0,22	0,94
c	9,5	9,5	5	451,25	370,5	1,22	0,22	3,181

Casting process carried out by first making a sample pattern. The next step is done by making three sand moulding, each of which contains three sample with three module variations. Nodular cast iron smelting made with alloying composition C 3.2%, Mn 0.3%, 0.7% Mo, 2.6% Ni and 0.03% Mg. Elements of Si is given with 3 variation is 2.0%, 2.3% and 2.6%. Thus obtained sampling module in 3 variations and 3 variations of Si content all of thess produce as much as 9 variation. Samples are numbered by 1a, 1b, 1c, 2a, 2b, 2c, 3a, 3b and 3c. Numbers shows the composition while the letter indicates the module.

The metallographic testing then performed to verify the results of casting sample to see microstructure formed. Further analysis and conclusions obtained. From the process of research activities given a data about the effect of the number of silicon content to each sample which has a different cooling rate (module). Then can be calculated the suitable silicon content to be applied economically to obtain a homogeneous bainite structure.

4. RESULTS AND DISCUSSION

The composition of the material of each sample is checked by spectrometry, the results as shown in Table 2.

Table 2. Composition of Sample

Sample	C	Si	Mn	Ni	Mo	Cu	Mg
1	3,04	**2,0**	0,35	2,63	0,52	**0,15**	0,024
2	3,14	**2,3**	0,41	2,82	0,51	**0,13**	0,017
3	3,23	**2,6**	0,39	2,57	0,51	**0,15**	0,018

Microstructure formation is viewed by metallographic examination. Etching using Nital 3%.

Microstructure observation found that a sample of moulds 1 with 2.0% of Si content produces ferrite structure, the module is thicker, and still appears ledeburit structures on thin modules (see Figure 5.). This is unwanted because of the thick part hardness being dropped by the ferrite structure. Whereas at the thin sections its hardness becomes too high and the material becomes brittle due ledeburit structure.

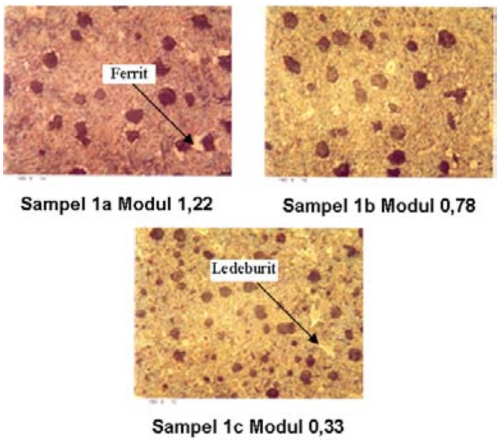

Figure 4. Microstructure of Sample 1 With 2,0 % Si.

Modifications is continued with the addition of Si up to 2.3% for a sample in the moulding 2. The results showed that the ledeburit structure is disappeared at thin module. Yet still produces slightly ferrite structure in large and medium modules (see Figure 6). Ferrite structure was seen around the graphite. This conditions is better than sample 1 which contains ledeburit structure on a small module. The material is not brittle any more.

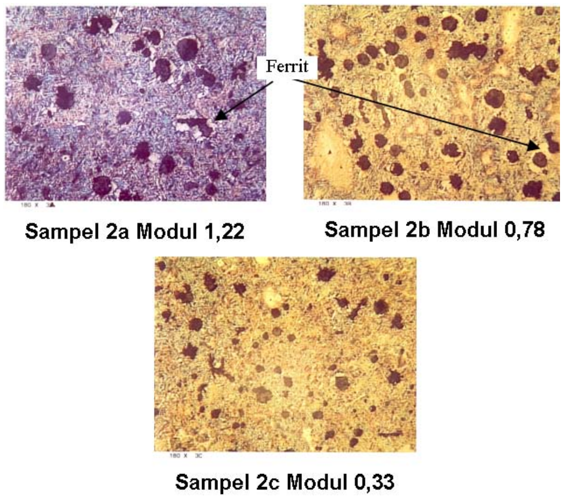

Figure 5. Microstructure of Sample 2 With 2,3 % Si.

The moulds of samples 3 is given 2.6% Si. It produces more ferrite structure. Ferrite structure formed as white appearance around the graphite. Ferrite structure is formed in all modules. While no longer ledeburit structure formation (see Figure 7).

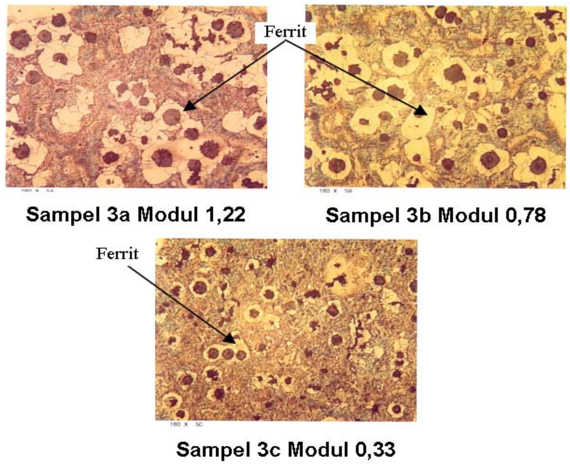

Figure 6. **Microstructure of Sample 3 With 2,6 % Si**

The addition of an effective amount of silicon is considered eliminating ledeburit structure which is brittle on the thin module. But giving silicon in large numbers will encourage the tendencies of ferrite structure formation. Figure 7 is show graph of increasing number of ferrite comparison charts to silicon content in the three different module. For the same composition ferrite content increases with increasing module. For the same module ferrite content increases with increasing Si content.

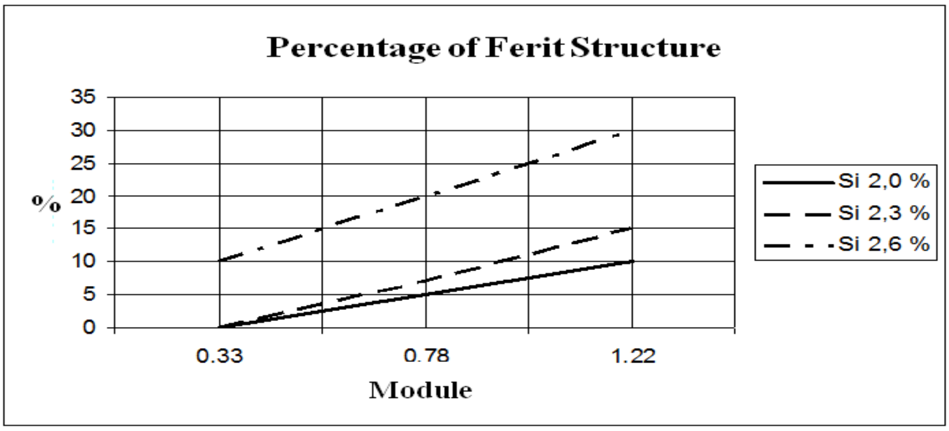

Figure 7. **Percentage of Ferit Structure on Variation of Module and Si Content**

5. CONCLUSION

The results of research concluded that:

The size on module number is represent the cooling rate of the sample.

The smaller of the module number the higher tendency of the formation of unwanted hard structures like ledeburit.

The larger of the module the higher tendency the formation of soft ferrite structure.

Addition of a silicon content can reduce the formation of ledeburit hard structures.

The more silicon addition can encourage the larger formation of ferritic structure.

Addition of silicon up to 2.3% can produce a relatively small ferrite structure and does not produce ledeburit structure. It can be concluded as the optimal condition for silicon content.

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