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ANALIZE DIE CASTING PROCESS AND STRUCTURE OF MOLDING FOR INTERNAL COMBUSTION ENGINE VEHICLE

Muhammad Yusuf Nurfani[1*], Abdulrahman Agung Ramadhan[2]
[1,2]Mechanical Engineering, Gunadarma University, Indonesia

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Corresponding author*:
yusufnur18@staff.gunadarma.ac.id

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***Abstract*:** Die casting is part of manufacturing process for making metal product, especially internal combustion engine of vehicle. Molding is component for making product from metallurgy process or polymer process. Basically, all part of molding process will be using 3 conditions of process. First is solid raw material for process production, second is melting process of raw material for making product using molding and third is solid for part of finish product after process molding process. In this research will analyze of molding process and structure of engine for internal combustion engine vehicle. Mold casting will be using specification for SUV capacity 2.7L. basic raw material is silica sand, resin, bentonite, and sea coal. The result show that after process mixing optimal pressure from machine to molding is 109675,8 N. and spot test check result show that, after process die casting no any crack founding by 10 specimens of engine of vehicle.
***Keyword*:** Die Casting, Molding, Internal Combustion Engine.

INTRODUCTION

Internal Combustion Engine (ICE) is part of component of vehicle. Process of development of engine one of them is die casting. Die casting is manufacturing process on automotive industry for development. Basically, durability of engines be affected by design, structure, and production process when development. [1]. Die Casting Die Design and Process Optimization of Aluminum Alloy Gearbox Shell, the result show that Aiming at the leakage problem of the gearbox shell in the bench and road test after assembly, the cause was found through numerical simulation and industrial CT analysis, and the problem was solved by adding high-pressure point cooling at the corresponding position of the leakage, and the correctness of the optimization was verified [2]. Design and Analysis of Pressure Die Casting Die for Automobile Component, the result show that the reduced all machining and can make the process the optimum choice for small volume production as well [3]. Effect of refractory aggregate shape on the porosity of A356 alloy castings in lost foam casting, the result show that Defects at specific locations of the castings were analyzed and statistically counted through optical microscopy. In conclusion, the combination of expanded graphite and bauxite clinker yields the best quality castings in A356 LFC. [4]. The Application of the Direct Water-Cooling Process on the Lost-Foam Casting Technique to Improve Microstructural and Mechanical Properties of A356 Alloy, the result show that the highest obtained mechanical values were found around to be approximately 195 ± 3.5 MPa ultimate tensile strength, 4.45 ± 0.78% elongation, and 84 ± 1.77 HB in hardness.

RESEARCH METHODOLOGY

The research method is using material HSN 7061-2 for Engine 2.7L and base material for molding using silica, bentonite, and sea coal. Base material for mold will be mixed using Mix Muller. After competed mixing will be continued die casting process using Aluminum Ingot HSN 7061-2. Die casting process will process in temperature ≥ 400°C. After part shaped finished and cooling down material will be finishing for delete flashing are from engine areas. Performance of material or Die casting result will test using non-destructive test (NDT) ARDROX 9814. Metal areas will check using X-ray machine for finding crack or failure area of casting process. The final inspection will separate good part of engine for continue assembly or bad structure for disposal of part.

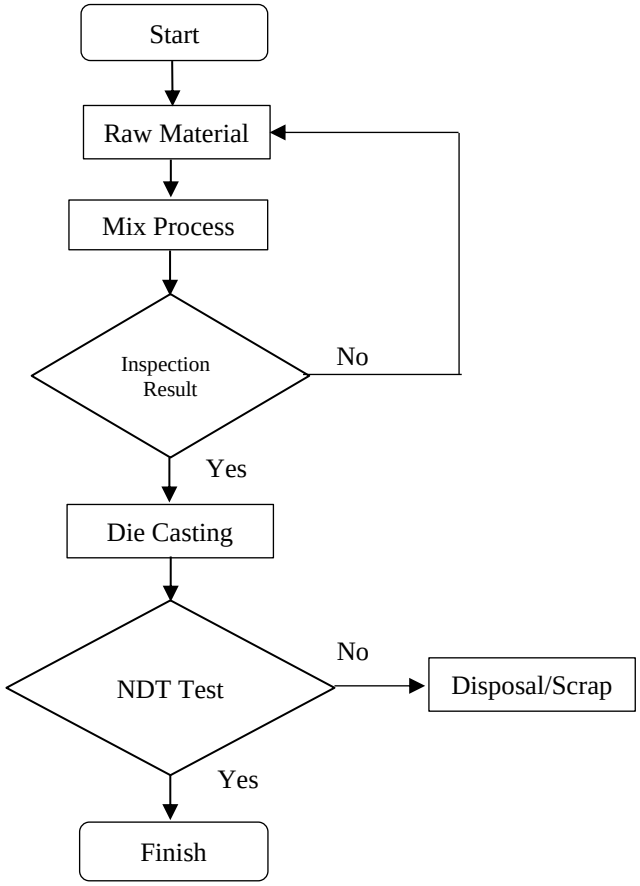

Figure 1. Research Methods

Material Composition

Engine 2.7 will develop using material aluminum HSN 706. Base material for molding using silica sand 3Ton, bentonite 20Kg, sea coal8.2 Kg and water 35 L. material will be mixing with machine and after completed inspection will be continue for die casting process. Material of HSN 7061 using composition of aluminum 80-95%, Silicon 0.1-1%, Zinc 0.1-2%, Iron 0.1-2%, Manganese 0.1-1% and Magnesium 0.1-1%.

Table 1. Material Composition of mold

No	Composition	Qty	Unit
1	Silica Sand	3	Ton
2	Bentonite	20	Kg
3	Sea Coal	8.2	Kg
4	Water	35	L

Figure 2. Material of Molding (Silica Sand, Bentonite, Sea Coal)

Figure 3 Aluminum Ingots

Table 2. Material Composition of Almunium Ingots HSN 7061

No	Composition	CAS Number	Percentage
1	Aluminum	7429-90-5	80-95%
2	Silicon	7440-21-3	0.1-1%
3	Zinc	7440-66-6	0.1-2%
4	Iron	7439-89-6	0.1-2%
5	Manganese	7439-96-5	0.1-1%
6	Magnesium	7439-95-4	0.1-1%

Analize Pressure to create mold

The main objective of this research is to create and develop a mold for engine. To be create good quality and good density molding need to check optimum of pressure from machine to raw material. Optimization of manufacture and technology of pressure die casting molding is a complicated problem due to the complex character s: temperature of fatigue, mechanical fatigue, erosion, and cavitation of part, dissolving of molding material by liquid of material metal, adhesion of cast to mold etc. The holding time was length of time from start molding to the opening mold and closed. It was an important factor to ensure the heat dissipation and shaping. To accurate of setting of pressure of machine can be calculate formula as below:

$$P = F/A \quad (1)$$

P = Pressure (N/m^2)
A = Cross-Sectional Area (m^2)
F = Gaya (N)

Setting Hydraulic Press

When setting of hydraulic press need to analyze optimize pressure for making mold for die casting. The machine for press is TRFD-2000T using motor power 7.5Kw, Slide stoke 400 mm, working speed 8-15 mm/s and Ejecting Force 35 ton, will calculate pressure requirement as below:

P = 13kg/cm^2 = 1275300 N/m^2

A = Length × Width (2)

= 47,05 cm × 18,40 = 865,72 cm^2 = 0,086cm^2

F = P × A

= 1275300 N/ m^2 x 0,086 m^2

= 109675,8 N

Figure 4. Hydraulic Press

Table 3. hydraulic Machine Specification

No	Description	Unit	Injection Unit
1	Manufacture		Wodda
2	Model		TRFD-2000T
3	Slide Stroke	mm	400
4	Working Speed	mm/s	8-15
5	Ejecting Force	ton	35
6	Motor Power	kw	7.5
7	Ejecting Stroke	mm	200

RESULT AND DISCUSSION

Result of mold processing using raw material of Molding Silica Sand, Bentonite, Sea Coal are completed created by hydraulic press processing using pressure 109675,8 N without any defect. Figure 7 show that process die casting using aluminum Ingots HSN 7061 with temperature ≥ 400°C. Setting of temperature will be referred of technical data sheet of raw material, and then material will be transfer to molding for casting proves of engine 2.7L. process transfer of material to molding using automatic, in this case molding of engine is 1 cavity of part.

Figure 5. Mold Process and Die Casting

Figure 5. Show that final product of block engine of internal combustion engine (ICE) 2.7L. In this process final product, no any defect of crack, flash, flow mark finding by visual check. After completed visual inspection, will be continue to analyze by NDT process for final quality inspection result. Structure of engine will be check by measurement test and will be check by random as lot of production 2.7L engine.

Figure 6. Internal Combustion Engine Block 2.7L

Figure 6 show that process NDT preparation process for analyze structure of engine 2.7L, for this analyze sampling of engine will be analyze will using ARDROX 9814 (penetrant) for detail structure area for crack avoidance. Crack issue will be impacting long term for durability of engine because of process compression of engine too high and high temperature when engine running process especially on high RPM.

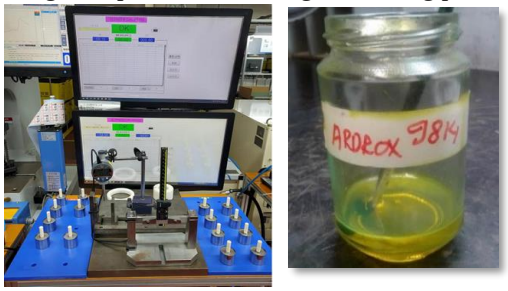

Figure 7. NDT Process Measurement

Figure 7 show that result of NDT process analyzes for engine, and structure of engine is normal. And process analyze with NDT will using random to 10 specimens of engine for final inspection of part. Random test of engine 2.7L will apply for standard quality and make sure of all product production. If engine have crack issue will next step will disposal material and continue for cursing process (disposal).

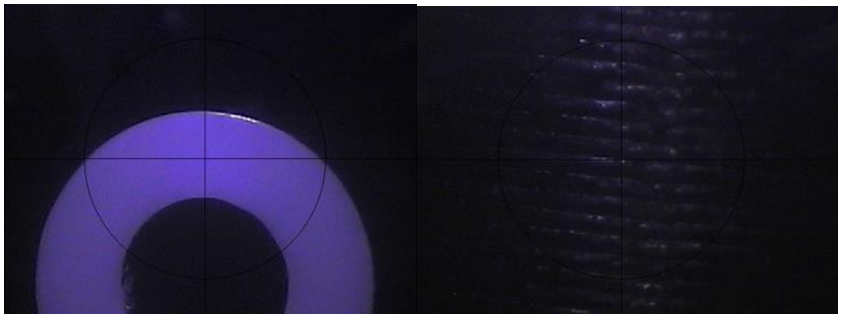

Figure 8. Structure of Engine 2.7L

Table 4. NDT test result

No	Data	Crack Test
1	Sample 1	Passed
2	Sample 2	Passed
3	Sample 3	Passed
4	Sample 4	Passed
5	Sample 5	Passed
6	Sample 6	Passed
7	Sample 7	Passed
8	Sample 8	Passed
9	Sample 9	Passed
10	Sample 10	Passed

In table 4, show that from 10 sample check, the all part no any crack issue after inspection process. When bushing was completed all test, engine will continue for assembly process in line production.

CONCLUSION

The result show that internal combustion engine 2.7L can be production using material Almunium Ingots HSN 7061 without any issue with die casting process production using 1 cavity mold. Based on production process result visua test resul no any short mold, cract and another issue of internal combustion engine. NDT test result show that after using ARDROX 9814 (penetrant) on part, after processing test is there no any crack or anoter issue on 10 speciment test result. And overall this result show that engine using material alumunium can be using for mass production dan good durability. When engine was completed all testing, will be continue for assembly process for input to line production, figure 7 mold and process are presented press processing using pressure 109675,8 N.

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