

Analysis based on Al-Si alloys used in automotive air brake system manufacturing

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Abstract

Aluminium Silicon alloys are widely used to make automotive components like pneumatic cylinder sleeves, fuel lines, CRDi...etc.these components subjected to high internal pressure due to the pneumatic pressure developed during the braking action. Hence the project work is undertaken to study the mechanical properties of Al-Si cast alloys. It is done by select casting of cylindrical Al-Si sleeve as not much informations are available about its properties from literature. Hence the present work is undertaken with the following responsibilities

- To select Al-Si sleeve alloy
- To cast test bar as per approved standard
- To test the specimen for evaluating mechanical properties such as hardness, tensile, impact test...etc
- To find the microstructure using scanning electron microscope
- To compute all properties and analyze the suitability of material to fabricate sleeve for automotive braking system

1. Introduction

The one of the most important property of aluminum is the Ability to form wide range of alloys with different alloying elements .Other important properties include high wear resistance, high ductility and appreciable yield stress. Due to this less weight and high tensile strength aluminium silicon alloys blessed with high strength to weight ratio, which makes them an important engineering material. The good cast ability, machinability, surface finish and corrosion resistance of aluminium alloys also makes them more and more important in engineering applications.

In this thesis work, an attempt has to make to study the mechanical properties and industrial applications of Al-Si cast alloys. An Aluminum silicon sleeve casting used in air braking system of

heavy articulated vehicle is taken for examination and study. The specimens where made as per the dimensions of sleeve casting and subjected to study. For conducting the experiments, hollow cylindrical casting are made using Al-4Si and Al-7Si using sang molds. The mechanical properties are studied and analyzed using maximum shear stress theory. The hollow cylindrical casting subjected to high internal pressure and corresponding inner and outer diameter to withstand the pressure, shearstress, radial stress .etc. are to be recorded. From the tensile test maximum permissible shear stress is can be calculate.

2. Scope of the project work

It is found that not much work has been done yet to analyze the Al-Si castings subjected to internal pressure. The information available in the literature survey are in efficient to design and analysis the Al-4Si and Al-7Si castings which are used as components in the air braking system which subjected to very high pneumatic pressure.

2.1 Objectives of the project work

1. To study the properties such as ultimate tensile strength, hardness and internal pressure in sleeve casting of air brake systems.
2. To establish a pressure vs. critical thickness relations
3. Make comparative study between Al-4Si and Al-7Si alloy and find the most suitable alloys to make cylindrical components subjected to high internal pressure air brake systems
4. Easley find out various mechanical properties by c programming.
5. Implementation of new technology in automotive sector.

3. Cast Al-Si cylinder

The machining process on specimen after casting the cylinder drilling is carried out on

specimens using a vertical drilling machine. after drilling the whole diameter is increased by using a reamer .after the remaining process the cylinder is subjected to boring operation in which the thick walled hollow cylinder is made which is subjected to higher air pressures with which is about 2-3 times that of conventional air brake line pressure.it is also subjected to very high pressures up to 1600Bars in the case of a CRDi systems by using a fuel pump and the corresponding properties are studied.



Fig No.3.1 Cast Al-Si cylinder specimen

3.2 Air brake system

The air brakes or more formally a compressed air brake system is a type of friction brake for vehicles in which compressed air pressing on a piston is used to apply the pressure to the brake pad needed to stop the vehicle. Air brakes are used in large heavy vehicles, particularly those having multiple trailers which must be linked in to the brake system, such as trucks, buses, trailers, and semi-trailers in addition to their use in rail road trains.

Sleeves are usually used to connect the tractor braking system to trailer braking system in case of articulated heavy vehicles. These sleeves and connectors convey the braking pressure from the tractor to the trailer unit. Hence the sleeves are often subjected to heavy high pressures .the typical air braking systems on heavy vehicles in India works by using a reciprocating air compressor .this air compressor is attached to the engine and the compressor sucks the air from the atmosphere and feeds to the braking circuit. The brakes becomes functional only when the system reaches a pressure around 10 bar to 12 bar.

3.3 Prepare the mold

Foundry sand are mixed with water, binder and additives to form green sand. The pattern is then placed carefully with green sand or chemically bonded sand. The pattern is placed on the molding box and rammed throughly.In test bar casting there is no need for runner and riser because its enlarged portion will act as runner for pouring molten metal. But in conventional full mould casting it requires gating system, its top and bottom portion is placed in the moulding box.

3.4 Inspect the casting

Casting cooled. After the solidification the casting is removed from the mould cavity. Mechanical test are carried out to find out mechanical properties such as tensile strength and hardness of the specimen. The result is reported.



Figure No3.2 Test bar



Figure No 3.3 Test specimen

4. Conclusions

4.1 Effect of silicon in Al-Si alloys

In this project has been taken to study and analyses the effects of silicon on the mechanical properties of casting produced using Al-Si alloys. The mechanical properties of Al-Si alloy are dependent on the size, shape and distribution silicon particles. Small, spherical, uniformly distributed silicon particle enhance the strength properties of Al-Si alloys. It is noted that the amount of silicon in the alloy increases, the strength and mechanical properties of Al-Si alloys are also increases up to a particular extend. Then after which they show a decline with further increase in the silicon content. However the hardness increases and the elongation decreases (%) continuously with the increase of silicon content. This may be largely due to the size, shape and the distribution of silicon particles as fine dendritic structure in the cast structure up to eutectic composition. The silicon effect on the thermal coefficient of expansion of the aluminium. Aluminium has a high value of thermal expansion which has negative effect on casting and also working condition. by the adding of silicon the thermal expansion coefficient of aluminium is lowerd. this makes them compatible in high temperature applications.

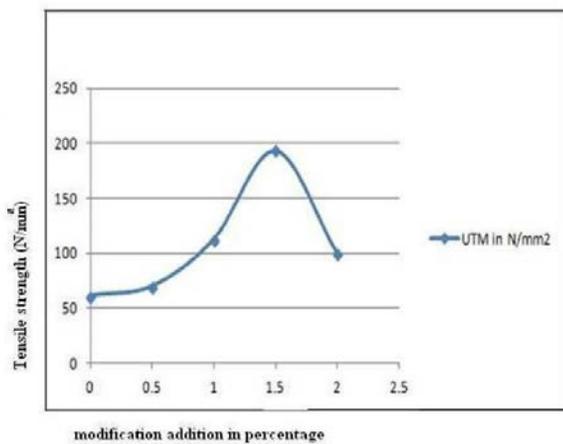
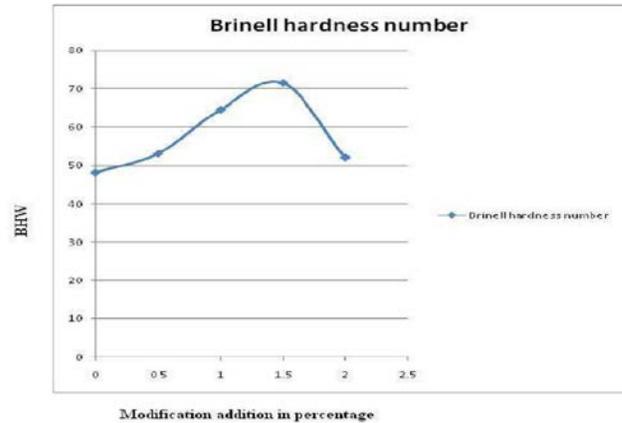


Fig No4.1 Effect of Silicon addition on tensile strength

Fig No 4.2 Relation between silicon addition and BHN



4.2 Variation of thickness needed with internal pressure

The thickness required for the cylinder for withstanding different magnitude of internal pressure and as shown below

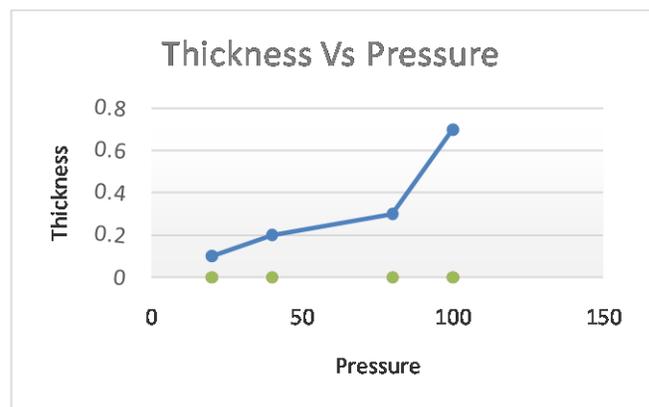


Fig No4.3 Relation between thickness and Pressure

- Al-7Si alloy can withstand large amount of radial and tangential stress as comparing with Al-4Si alloy. Due to high yield point stress and maximum shear stress.
- Al-Si alloys are used to manufacture high pressure air brake components because of their high strength to weight ratio and its various mechanical properties.
- For cylindrical specimens the radial and tangential stress is higher at inner radius and it decreases in outward direction
- The amount of silicon component in alloy increases ultimate strength, hardness and yield stress are also increases
- Thickness of cylinder increases corresponding internal pressure also increases.

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