Engine oil pan and functions

This report will analyze the engine oil pan as one of metallic component in car application. The analysis will cover the role of the component, the material for the component and the properties of the material. We will cover the process of how the properties are achieved. We will also analyzing the alternative material suitable for the specific component, compare and contrast with the alternative material.

Introduction

Engine oil pan is a simple automotive component with a very simple function. However, it is very vital for you're the engine part to operate properly. By understanding the function, the specific requirement and the material for an oil pan, it would help us to understand more on material selection for specific automotive applications.

Engine Oil Pan and Functions

For engine to work at its best, it must be running at a specific operating temperature. This temperature can only be maintained with the aid of engine oil that acts as a coolant. Subsequently, it needs a component to store the oil and continuously reuse it. That is the main function of the engine oil pan. Besides a storage component, oil pan will also collect some of the residue picks by engine oil while passing through the engine. Oil pan also served as a bottom cover of engines.

Component Condition and Requirement

In relative to the oil pan application, certain condition and requirement of the material should be meet. First, the material for the component should have a good corrosion resistance. It is to ensure that the oil in the sump will not

contaminated. Even though the function of the oil pan is not for cooling, but the good thermal conductivity property will give an advantage for the application. Furthermore, it has to have a good ductility to prevent crack or damage due to stone impact. Low density in material will be a great advantage for the component, as it will reduce the weight. Above all, the most important criteria for the component are the ability to sustain the operating temperature of the engine. However, the engine operating temperature is considered low for all kind of metallic material to withstand.

Materials and Properties for Oil Pan application

In this paper, we will analyze the properties of cast aluminum alloy as a material for the oil pan. Aluminum alloy (2. 7 g/cmïƒµ) is characterized as a nonferrous alloy, which relatively low density material compare to steel (7. 9 g/cmïƒµ) (Callister 2007). Beside low in density, it is also comparatively high thermal conductivity and inherent corrosive resistance in some common environment. Furthermore, the ductility of Aluminum alloys is retained at low temperature due to Aluminum has a FCC crystal structure (fig. 1-1).

Face Centered Cubic Crystal Structure. In hard sphere unit (a), a reduced sphere unit (b) and in aggregate of many atoms.

An important characteristic of this material is the specific strength, which is determined by the tensile strength to specific gravity ratio (Callister, 2007). Even though aluminum alloy have a tensile strength relatively compare to the higher density material (such as steel), on a weight basis it will able sustain a larger load (Callister, 2007).

In particular to the casting alloys use for productions of oil pan in automotive industry, the die casting process is used. In general the AlSiMg alloys is use for the production of the oil pans.

Table 1. 1 Composition, Mechanical properties and common application for cast-heat treatable Aluminum alloys

(Callister, 2007)

Silicon in the range of 5 to 12% by weight is the most important element in aluminum alloying due to ability to increase the fluidity of the molten metal as well as strengthens the aluminum. Magnesium in the range of 0. 3 to 1 % by weight is added to increase strength (Smith, 2004).

The silicon content in the component will cause the formation of acicular silicon. It will cause the considerable reduction in the ductility of the component. Therefore the heat treatment is necessary for the component, after molding process. It is to obtain the appropriate adequate mechanical properties with respect to hardness and ductility. The heat treatment process at an appropriate temperature and for an appropriate duration is carried out to produce the component with a different hardness. In this case, production of oil pan used the solution heat treatment and followed by artificial aging process, indicate by (T6) in table 1. 1. As for the oil pan, in the region of a flange is kept untreated in order to retain high level of hardness and low level of ductility. Thus, the hardness will be 85 to 110 HB and the ductility of 0. 5 to 2. 5%. While on the base region, it is heat treated appropriately to create a hardness of 55 to 80 HB and ductility greater than 4%. Hence, the ductility is increased and the hardness is reduced.

Properties of Aluminum Alloy suit the Oil Pan Requirements

Aforementioned, we had discussed the condition and requirement of the oil pan application. Through the material analysis of Aluminum alloy, we found that aluminum alloy has a good corrosive resistance. Furthermore, the mechanical property of aluminum alloy as good thermal conductivity would provide a better heat dissipation for the engine oil. Through solution heat treatment process the aluminum oil pan have had a sufficient ductility to sustain stone impact from bottom. With a considerably good hardness the aluminum alloy oil pan would maintain the component shape from deformation due some level of impact.

Comparison to other possible materials for oil pan

Other material commonly used to produce oil pan is low carbon steel. Oil pans made of steel are produced with a stamp forming process. Physically, in contrast to the aluminum alloy oil pan, the steel oil pan is light in weight. It is because it was produce with a thin steel sheet compare to a thicker cast aluminum alloy oil pan.

Based on properties of the material, steel oil pan has a higher ductility but less hardness compare to aluminum oil pan that has high hardness and low ductility. Advantage in having high ductility material is the ability to withstand impact without crack or damage. The comparison of those material (Table 1. 2) shows the difference in elasticity, which the modulus of elasticity determined the resistance to elastic deformation. The greater the modulus (Steel alloy) the stiffer the material will be.

However, with that property the shape of the component will easily deformed. In case of oil pan application, it might damage other component inside the pan such as oil strainer. Other advantage of the aluminum oil pan in contrast to steel oil pan is the ability to acts as a noise shield, especially on diesel engine. In term of heat dissipation, aluminum oil pan will have advantage in dissipating more head compare to steel oil pan.

Table 1. 2 Room temperature Elastic, Shear Modulus and Poisson’s Ratio for Aluminum Alloy and Steel Alloy.

Aluminum

Aluminum offers many advantages over other materials. Some of these include:

- Light weight (~2/3 the weight of steel) - Machinability - High strength-to-weight ratio - Non-oxidizing when exposed to air

- Excellent heat dissipation - High electrical conductivity - Can be cast by all common casting methods - Heat treatable for higher strength and hardness

Willian D. Callister, Jr. (2007). Materials science and engineering : an introduction, 7th Edition. United States of America, John Wiley & Sons, Inc.

Martin, J W.(2006). Materials for Engineering. Cambridge, Woodhead Publishing, Limited

William F. Smith (2004). Foundation of Material Science and Engineering, Third edition. New York, McGraw-Hill.