INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING

ISSN (ONLINE): 2321-3051

Vol.3 Issue 12,

December 2015

Pgs: 119-124

High Temperature Tensile Testing of Aluminium Alloy- A413 by FEA

Parag Amrutkar[1] and Prof. R.R.Borse[2]

ME Student, Department of Mechanical Engineering, GulabraoDeokar College of Engineering
North Maharashtra University ,Jalgaon ,Maharashtra state, India

[1]parag.amrutkar@gmail.com 8275022324

Assistant Professor, Department of Mechanical Engineering, GulabraoDeokar College of Engineering.
North Maharashtra University ,Jalgaon ,Maharashtra state, India

[2]patil782004@yahoo.com 9421514492

Abstract

Tensile tests are performed for several reasons. The results of tensile tests are used in selecting materials for engineering applications. Tensile properties frequently are included in material specifications to ensure quality. Tensile properties often are measured during development of new materials and processes, so that different materials and processes can be compared. Finally, tensile properties often are used to predict the behavior of a material under forms of loading other than uniaxial tension. The tensile properties of Al, Cu, stainless steel and its alloy examined in the high temperature. The need for materials with useful strength above 1600k has stimulates the interest in refractory alloys. Cast aluminium alloys have found wide application to manufacture light-weight components of complex shape in automotive and aerospace industries.

Keywords*:* high temperature, uniaxial tension, refractory alloys.

1. Introduction

Among commercial aluminium casting alloys, aluminium silicon are the most important ones mainly due to their excellent combination of properties such as good cast ability, good surface finish, light weight, fewer tendencies to oxidation, lending to modification, low coefficient of thermal expansion, high strength-to-weight ratio and good corrosion resistance. These properties led to their excessive use in many automobile and engineering sectors where wear, tear and seizure are the major problems in addition to the weight saving. Some of these components are cylinder heads, pistons, connecting rods and drive shafts for automobile industries and impellers, agitators, turbine blade, valves, pump inlet, in many marine and mining sectors.

2. Literature Review:

Mohd Fizam bin Hj Zainon [2006] this paper focus on effect of heat treatment on aluminium alloy: a study of motorcycle piston. In this study, the effect of heat treatment on the mechanical properties of aluminium alloys piston has been investigated. These studies were carried out to improve the mechanical properties of the aluminium alloys piston by using heat treatment method. Characteristic of the heat treatment play a vital role for good combination of microstructure and mechanical properties. The aging temperature and time must be chosen carefully to allow the maximum hardness. The mechanical properties are attained when the temperature and time are within the specific range, if the temperature and time are too low, mechanical properties will be below requirements.

Abdulhakim Abdulrahman Almajid [2011] studied that the deformation behavior of 7010 Al-alloy at elevated temperature was investigated at temperatures ranging from **350 ºC (623K) to 450 ºC (723 K)** in the strain rate range from 10^{-5} to 10^{-2} s^{-1} . Analysis of experimental data of the alloy revealed the presence of a threshold stress that decreases with temperature with an energy term, Qo, 4.5kJ/mol. Enhanced ductility was observed with increasing strain rate and temperature at present experimental conditions.

G. Nicoletto, E. Riva, A. Di Filippo [2014] present work on Pistons of IC engines are typically subjected during operation to high cycle fatigue loading cycles at high temperatures (up to 350°C) in areas facing the combustion chamber. An extensive fatigue testing program of eutectic Al-Si alloys at room temperature and at several high temperatures **(250 °C, 300°C and 350°C)** is reported. The investigation of the fatigue behavior of two eutectic Al-Si alloys at room temperature and at high temperatures using specimens extracted from piston crowns presented here has reached the following conclusions. Increasing the test temperature reduces drastically the long life fatigue strength of near eutectic Al/Si alloys.

M. Radovic M. W. Barsoum T. El-Raghy J. Seidensticker and S. Wiederhorn [2000] in the paper "Tensile properties of Ti3SiC2 in the 25–1300°C temperature range" are investigated. The ternary carbide Ti3SiC2 exhibits a unique combination of properties that have been studied. It report on the functional dependence of the tensile response of fine-grained (3–5 μm) Ti3SiC2 samples on strain rates in the **25–1300°C** temperature range. High temperature mechanical properties; Stress–strain relationship measurements; Plastic; Creep; It reported on the properties of fine- and coarse-grained, predominately single-phase Ti3SiC2 samples in compression and flexure. In both cases, a

brittle-to-plastic transition occurs at ≈1200°C, at which point large plastic deformation levels (strains >20%) are obtained prior to failure.

3. High temperature Tensile Test: Hot tensile test is the method in which we use tensile testing machine with furnace & extensometer where the specimen is hold. By using this method we can find out the tensile strength, elongation, yield strength properties of different materials and its alloy, at high temperature. Also we can study the micro structural changes at high temperature by examine the fractured components under SEM, TEM.

4. Advantages of Al-Si Alloy Piston:

Most automotive engines use aluminium pistons that move in an iron cylinder. The average temperature of a piston crown in a gasoline engine during normal operation is typically about 300 °C (570 °F), and the coolant that runs through the blocks usually regulated at approximately 90 °C (190 °F). Aluminium expands more than iron at this temperature range, so for the piston to fit the cylinder properly when at a normal operating temperature, the piston must have a loose fit when cold.

In the 1970s, increasing concern over exhaust pollution caused the U.S. government to form the Environmental Protection Agency (EPA), which began writing and enforcing rules that required automobile manufacturers to introduce changes that made their engines run cleaner. By the late 1980s, automobile exhaust pollution had been noticeably improved, but more stringent regulations forced car manufacturers to adopt the use of electronically controlled fuel injection and hypereutectic pistons. Regarding pistons, it was discovered that when an engine was cold during start-up, a small amount of fuel became trapped between the piston rings. As the engine warmed up, the piston expanded and expelled this small amount of fuel which added to the amount of unburnt hydrocarbons in the exhaust.

By adding silicon to the piston's alloy, the piston expansion was dramatically reduced. This allowed engineers to specify a much tighter cold-play between the piston and the cylinder liner. Silicon itself expands less than aluminium, but it also acts as an insulator to prevent the aluminium from absorbing as much of the operational heat as it otherwise would. Another benefit of adding silicon is that the piston becomes harder and is less susceptible to scuffing which can occur when a soft aluminium piston is cold-revved in a relatively dry cylinder on start-up or during abnormally high operating temperatures. [en.wikipedia.org/wiki/Hypereutectic_piston.]

5. Limitation of hyper eutectic piston (high Si %):

The biggest drawback of adding silicon to pistons is that the piston becomes more brittle as the ratio of silicon to aluminium is increased. This makes the piston more susceptible to cracking if the engine experiences pre-ignition or detonation. [en.wikipedia.org/wiki/Hypereutectic_piston.]

6. Application of Hot Tensile Test:

1. To study the tensile strength of material at high temperature.

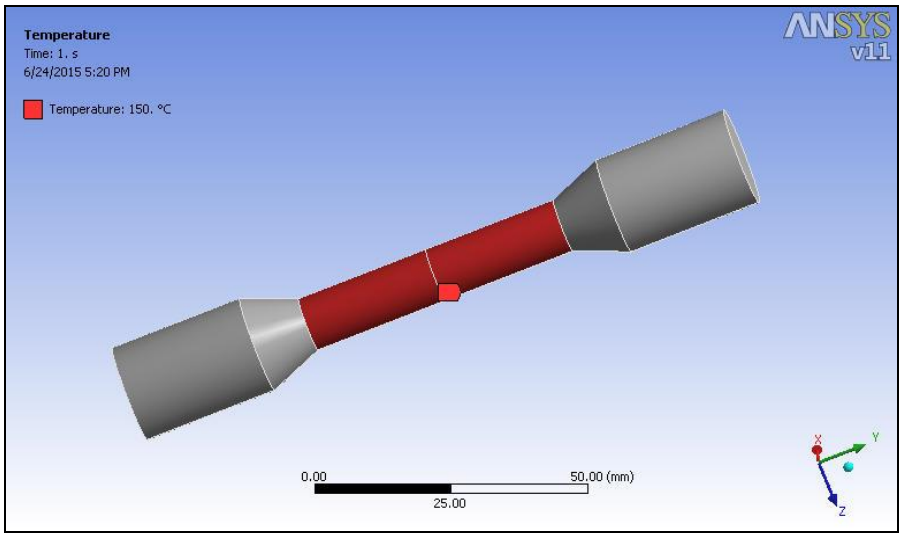
2. To investigate the effect of different strain rate on material.

3. To study the behaviour of material at elevated temperature.

7. Software Analysis:

7.1 Steady-State Thermal: Model > Steady-State Thermal > Temperature

In steady state thermal condition, we apply temperature [150°C, 250°C, 350°C] at gauge length of specimen.



7.2 Static Structural: Model > Static Structural > Loads.

In this step, we fixed the one end of specimen and apply the constant load at other end to find out the tensile strength of material.

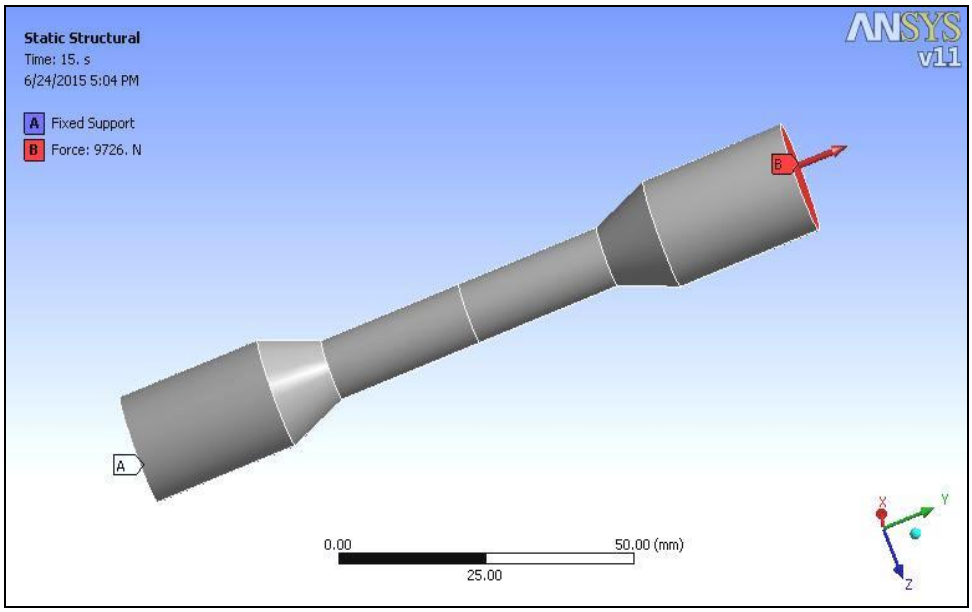
INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING

ISSN (ONLINE): 2321-3051

Vol.3 Issue 12,

December 2015

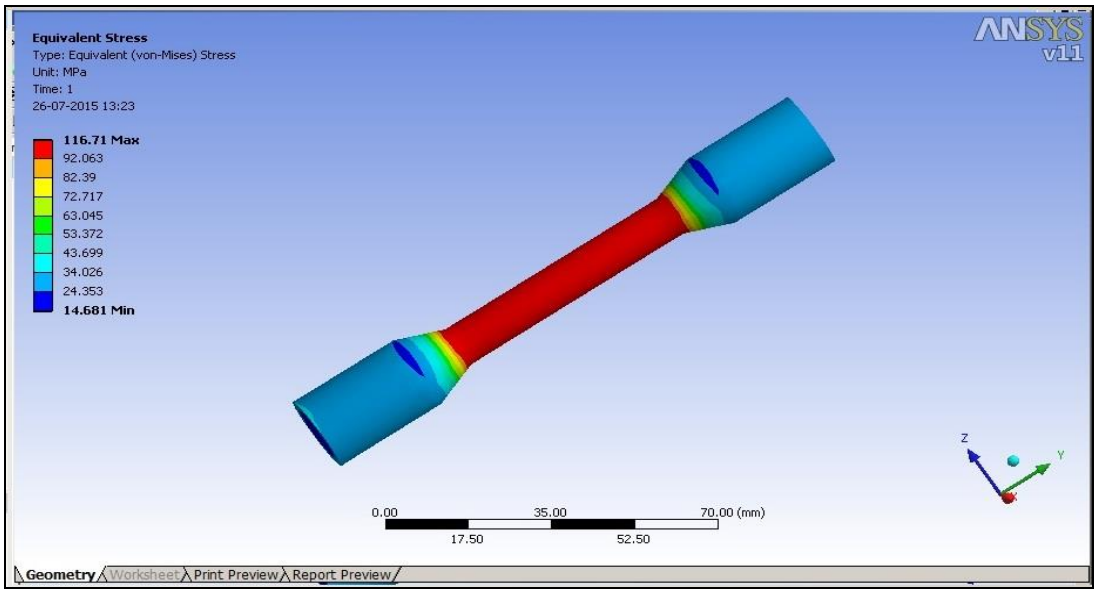
Pgs: 119-124



7.3 Stress analysis with following parameters:

At strain rate 0.1, 0.05 min^{-1}

At temperature 150,250,350°C



7.4 Software result with above parameters:

Table No: 7.3

Sr. No.	Strain Rate (per min)	Temperature (°C)	Tensile Strength By FEA (MPa)
1	0.05	150	126.25
		250	114.51
		350	58.721
2	0.1	150	116.71
		250	124.05
		350	68.997

Conclusions:

1. High temperature tensile testing carried out at 150, 250, 350,°C temperature, we find out result as strain rate increases, tensile strength will also increases.
2. By considering temperature parameter as temperature increases tensile property of aluminium alloyA413 decreases.
3. Bases on FEA result we conclude that, at 250°C and 0.1 min^{-1} strain rate, we got maximum tensile strength of aluminium material.

References

1. Abdulhakim Abdulrahman Almajid, High temperature deformation of solution treated 7010 Al-alloy, Journal of King Saud University – Engineering Sciences (2011), pp 21–25.
2. Mohd Fizam bin Hj Zainon, Effect of Heat Treatment on Aluminum Alloy: A Study of Motorcycle Piston, 2006.
3. M. Radovic M. W. BarsoumT. El-Raghy J. Seidensticker and S. Wiederhorn, Tensile Properties Of Ti3SiC2 In The 25–1300°C Temperature Range, Department of Materials Engineering, Drexel University, Philadelphia, PA 19104-2875, USA National Institute of Standards and Technology, Gaithersburg, MD 20899, USA (2000)
4. G. Nicoletto, E. Riva, A. Di Filippo, High Temperature Fatigue Behavior of Eutectic Al-Si-Alloys used for Piston Production, Procedia Engineering 74 (2014) pp 157 – 160.
5. [en.wikipedia.org/wiki/Hypereutectic_piston.]

A Brief Author Biography:

Parag Amrutkar– BE Mechanical, ME Mechanical appeared, **research interests**: I have interest in work on high temperature application such as piston, cylinder, turbine, heat exchanger.

Prof. R.R.Borse– BE Mechanical, ME design, **research interests:** in design related work.