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CONTEMPLATION OF MICROSTRUCTURE DEFLECTION OF BUTTERFLY VALVE DISC USING ALUMINIUM (1100) AND Al- SiC15% COMPOSITE MATERIAL

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ABSTRACT

Aluminium [1100] is a very good material in the application of water line and drainage applications. If the aluminium [1100] surface contacts with water, an oxide layer were formed, it prevents the corrosion of aluminium [1100] compare to other metal and also it has less weight. But due to their low melting point and low hardness they will wear and deformed easily and cannot be used for high pressure applications. The metal aluminum [1100] cannot meet all the required properties suitable for various engineering applications. So we want to use aluminium alloy or aluminium composite material which has the higher melting point and higher hardness compare to aluminium [1100]. In our research paper we take the butterfly valve (Commonly used for water line application). We design the butterfly valve using Pro-E software, analysis its deflection and changes of grain structure using Ansys software. For this analysis we use two materials such as aluminium [1100] and aluminium silicon carbide 15% (Al-SiC15%) composite. We compare these two materials deflections and changes of grain structural due to heat and improvements in behaviors are noted.

KEYWORDS: Aluminium [1100], Aluminium Silicon Carbide 15% (Al-SiC15%) Composite, Butterfly Valve and Ansys Software

It is necessary to have high machinery service life, operation reliability low friction in bearings bushes piston rings brake pads driving mechanisms friction clutches couplings gears and moving parts etc. The working conditions of these parts differ in various aspects like sliding speeds loads environmental conditions and other parameters. No single metal can meet all the required property so it is necessary to develop a composite material that could have all combinational property satisfying all our engineering requirements. Metal matrix composite has enhanced mechanical properties than pure metal. Metal matrix composites are very attractive for all engineering applications.

Metal Matrix Composite

MMC is engineered combination of the metal (Matrix) and hard particle/ceramic (Reinforcement) to get tailored properties. MMC's are either in use or Prototyping for the space shuttle, commercial airliners, electronic substrates, bicycles, automobiles, golf clubs, and a variety of other applications. Like all composites, aluminum-matrix composites are not a single material but a family of materials whose stiffness, strength, density, thermal and electrical properties can be tailored. The matrix alloy, reinforcement material, volume and shape of the reinforcement, location of the reinforcement and fabrication method can all be varied to achieve required properties. The aim involved in designing metal matrix composite materials is to combine the desirable attributes of metals and ceramics. The addition of high strength, high modulus refractory particles to a ductile metal matrix produce a material whose mechanical properties are intermediate between the matrix alloy and the ceramic reinforcement. Metals have a useful combination of properties such as high strength, ductility and high temperature resistance, but sometimes have low stiffness, whereas ceramics are stiff and strong, though brittle.

Aluminium [1100]

Aluminum alloy 1100 contains a minimum of 99.00% Aluminum, and is also known as „commercially pure Aluminum ‟. It has excellent electrical conductivity, good formability and high resistance to corrosion, and is used where high strength is not needed. It has the low density and excellent thermal conductivity common to all Aluminum alloys.

Silicon Carbide

Silicon carbide (SiC), also known as *carborundum*, is a compound of silicon and carbon with chemical formula SiC. It occurs in nature as the extremely rare mineral moissanite. Silicon carbide powder has been mass-produced since 1893 for use as an abrasive. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics which are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Electronic applications of silicon carbide as light emitting

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diodes and detectors in early radios were first demonstrated around 1907, and nowadays SiC is widely used in high-temperature/high-voltage semiconductor electronics. Large single crystals of silicon carbide can be grown by the Lely method; they can be cut into gems known as "synthetic moissanite". Silicon carbide with high surface area can be produced from SiO2 contained in plant material.

Carreño-Morelli, et al., (2004) has proposed in their journal of Carbon nanotube/magnesium composites. The Resonant measurements showed an improvement of about 9% in the Young's modulus of Mg–2wt%CNTs (38.6 ± 0.7 GPa) compared with unreinforced sintered Mg (35.3 ± 0.8 GPa).

Esawi, et al., (2006) has proposed in their journal of Dispersion of carbon nanotubes (CNTs) in aluminium powder. One of the key issues in the development of CNT/metal matrix composites is controlling the agglomeration of the nanotubes. This has been a major impediment facing the development of these new materials. The results presented in this paper demonstrate that mechanical alloying is a promising technique to overcome this problem. The SEM results showed that the usual CNT clustering often observed when using Tubular mixing was eliminated; moreover, individual nanotubes were observed embedded in the aluminium matrix after 48 h of milling which did not appear to be damaged by the selected milling intensity (200 rpm) and ball-to-powder ratio (10:1).

Li Qianqian, et al., (2010) reveals that most of the studies that has proposed in their journal of improved processing of carbon nanotubes/magnesium alloy composites. In this study, a two-step process was applied. In first stage, a block copolymer was used as a dispersion agent to pre-disperse multiwall carbon nanotubes (MWNTs) on Mg alloy chip. Then the chips with the well dispersed MWNTs on their surface were melted and at the same time vigorously stirred.

MATERIALS AND METHODS

Here we use aluminium [1100] and Al-SiC15% as the two materials for design and analysis of butterfly valve. The aluminium [1100] has density of 2700 kg/m^3, elastic modulus of 80 GPa , poission ratio of 0.33, thermal conductivity of 218 w/mk and coefficient of thermal expansion of 23.6x10^{-6}/^{0}C at 20-100^{0}C.

According to balamurugan et al,, (2012) has found in his research in characteristics optimization of aluminium with silicon carbide using melt stirring method the coefficient of thermal expansion of aluminium [1100] is 0.045x 10^{-6}µm/m^{0}C at 413^{0}C using automated dilatometer equipment, yield stress is 38 MPa and the properties of Al-SiC 15% composite is 0.026x10^{-6}µm/m^{0}C at 450^{0}C using automated dilatometer equipment, yield stress is 60 MPa. So these details are used for our analysis purpose using Ansys software (figure 1).

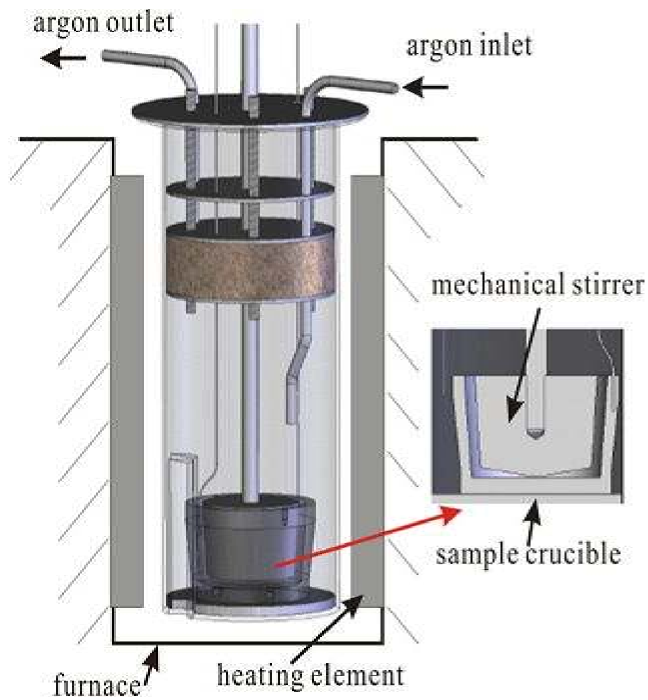

Figure 1: Melt stirring Machine

EXPERIMENTAL PROCEDURE

The experimental procedure have two steps first we want to design the butterfly valve using Pro-E software and Analysis the valve using Ansys Software with different material like Aluminium and Al-CNT4% composite.

Design of Butterfly Valve

Butter fly valve having six major parts. The parts are given below.

1. Disc
2. Stem
3. Bolt and nut
4. Body
5. Bush

Here we design the butterfly valve using Pro-E software

Disc

Disc is the major portion of butterfly valve to regulate the flow of liquid. It is commonly made of aluminium or cast iron. Disc edge is individually processed through machining and hand buffing for smooth edge, providing a bubble tight shut off and maximum seat life. Here we take diameter of disc is 100mm and thickness of disc is 20 mm (figure 2).

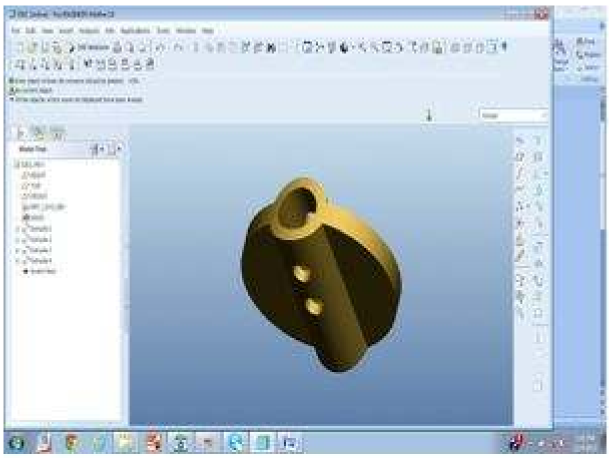

Figure 2: Disc

Stem

Stem extends through disc and aligns socket in body. Stem end has standard dimensions for operator interchangeability. Here in our design diameter of stem is 30mm.

Bolt and nut

Stainless steel Bolt and nut securely holds the disc to stem. O ring seal prevents the leakage in stem area and creates positive connection. Here in our analysis size of bolt is M10

Body

The outer body is build with flanges for fixing the bolt and nut. So it is able to fix the required pipe line. Body machined to high tolerances. Guaranteed standard dimensions for interchangeability of parts and actuators. Here the inner diameter of Body is 105mm and Outer diameter of body (Flange) is 150mm. The thickness of body is 40mm.

Bush

Bush protects the disc from side thrust. They are made up of impact and corrosion resistant material Commonly the bush is made by flexible material like Rubber or Elastomers. Here the Inner diameter of bush is 100mm and outer diameter of bush is 105 to 106 mm. The thickness of Bush is 30mm (figure 3)

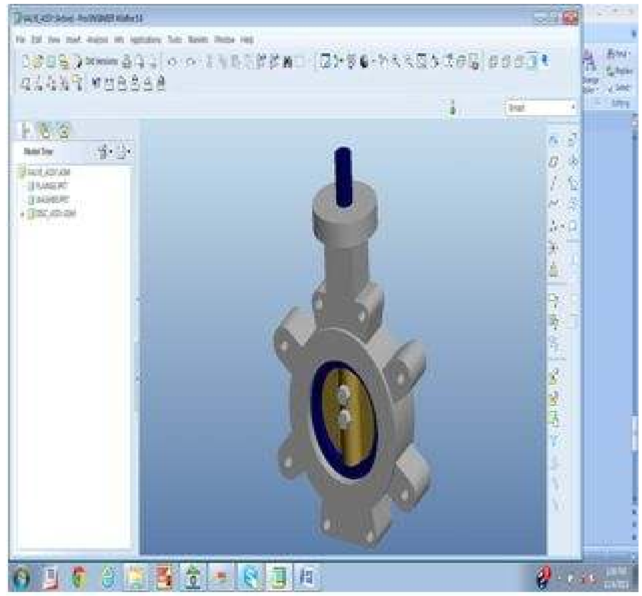

Figure 3: Butterfly valve assembly

Analysis of Butterfly Valve

The analysis of butterfly valve has two stages. First stage is we want to analysis with aluminium [1100] next we want to analysis Al-SiC15% composite. Here we use ANSYS 12.0 software is used for our analysis purpose (figure 4 to 15).

Structural Analysis of Aluminium [1100]

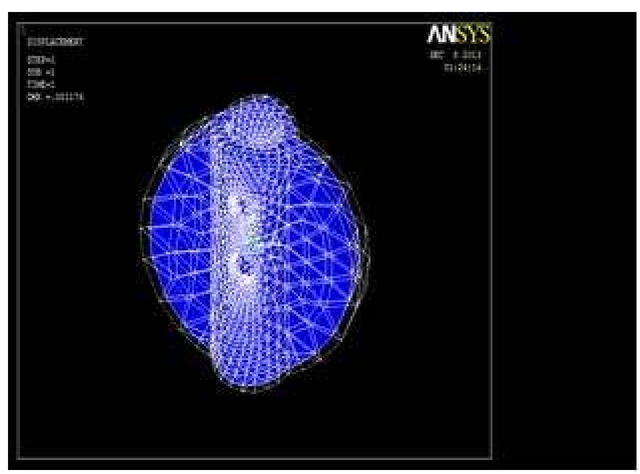

Figure 4: Shows the disc subjected to 100 N/m^2. Pressure then the maximum deflection is 0.001176m

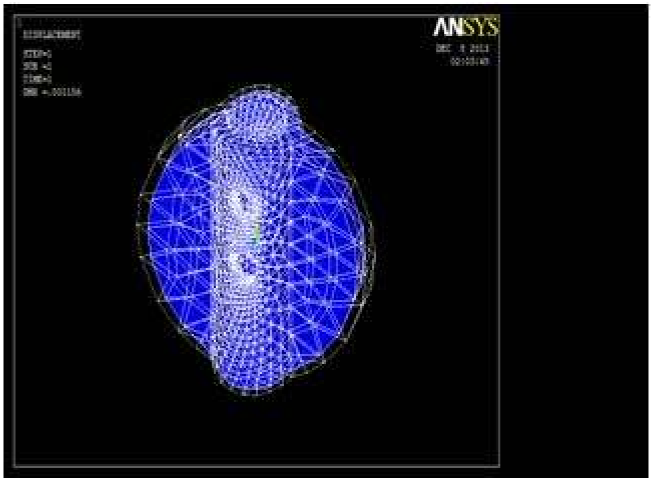

Figure 5: Shows the disc subjected to 250 N/m^2. Pressure then the maximum deflection is 0.001156m

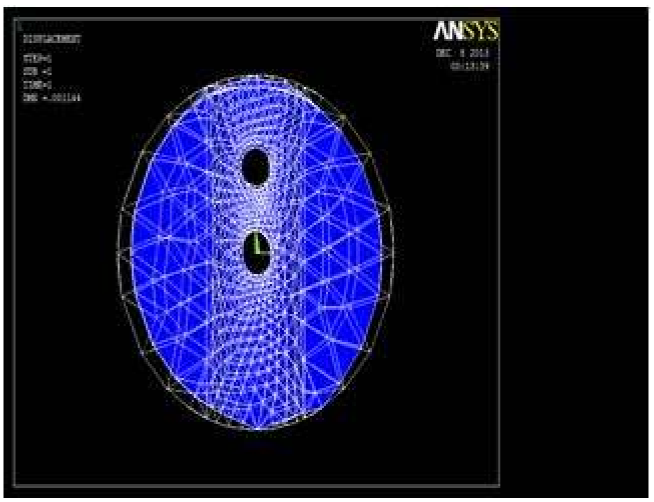

Figure 6: Shows the disc subjected to 500 N/m^2. Pressure then the maximum deflection is 0.00114m

Structrural Analysis of Al-SiC15% Composite

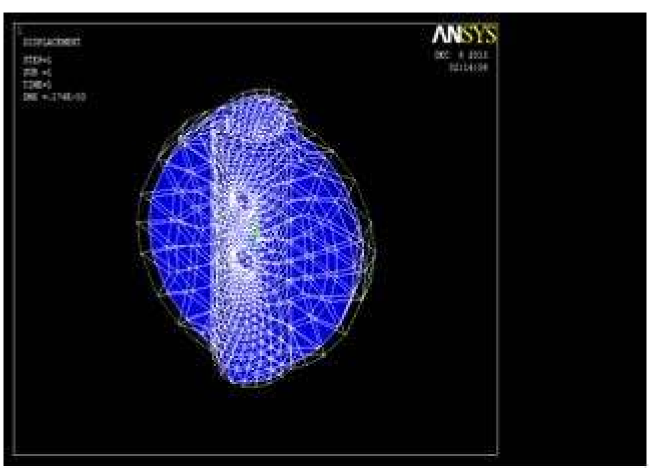

Figure 7: Shows the disc subjected to 100 N/m^2. Pressure then the maximum deflection is $0.174 x 10^{-3}$m

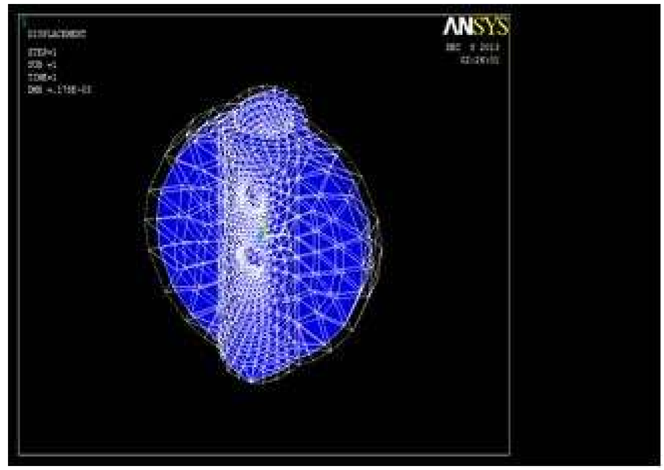

Figure 8: Shows the disc subjected to 250 N/m^2. Pressure then the maximum deflection is $0.178 x 10^{-3}$m

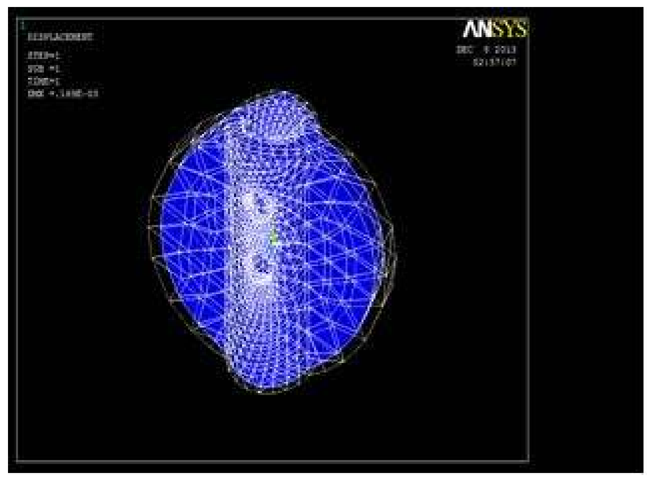

Figure 9: Shows the disc subjected to 500 N/m^2. Pressure then the maximum deflection is $0.169 x 10^{-3}$m

Thermal Analysis of Aluminium [1100]

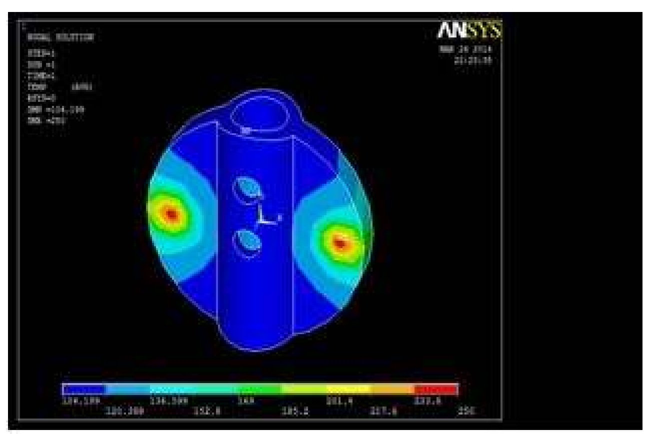

Figure10: Shows the disc is at the temperature of 250^0C and also a fluid flow through at a temperature of 100^0C, the structural changes of grain structure starts at 104.199^0C

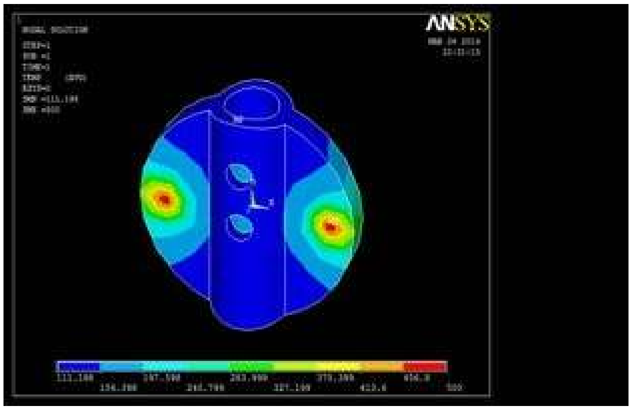

Figure 11: Shows the disc is at the temperature of 500^{0}C and also fluid flow through at a temperature of 100^{0}C, the structural changes of grain structure starts at 111.198^{0}C

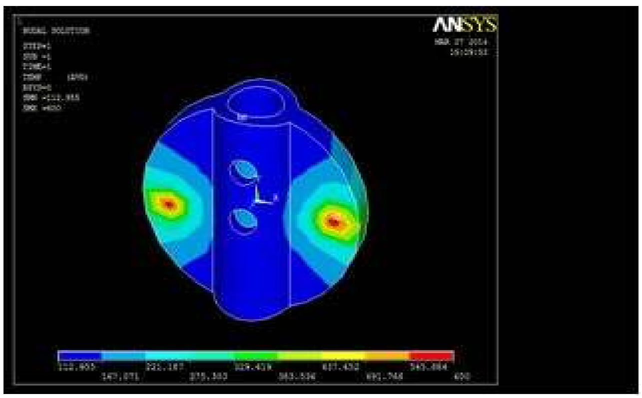

Figure 12: Shows the disc is at a temperature of 600^{0}C and also fluid flow through at a temperature of 100^{0}C, the structural changes of grain structure starts at 112.955^{0}C

Thermal analysis of Al-SiC15% Composite

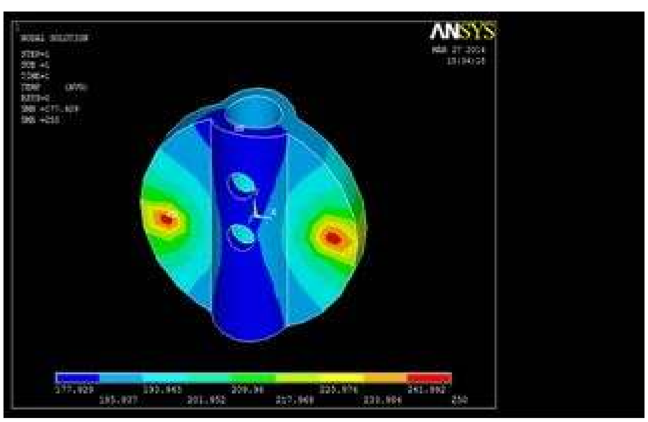

Figure 13: Shows the disc is at the temperature of 250^{0}C and also fluid flow through at a temperature of 100^{0}C, the structural changes of grain structure starts at 177.929^{0}C

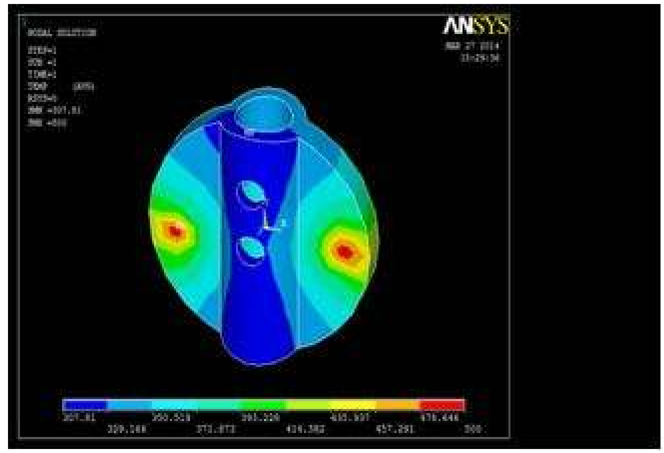

Figure 14: Shows the disc is at the temperature of 500^{0}C and fluid flow through at a temperature of 100^{0}C, the structural changes of grain structure starts at 307.81^{0}C

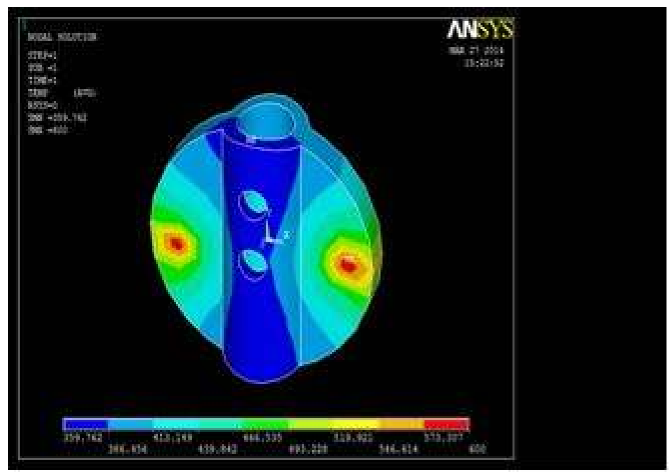

Figure 15: Shows the disc is at the temperature of 600^{0}C and also a fluid flow through at the temperature of 100^{0}C, the structural changes of grain structure starts at 359.762^{0}C

RESULTS AND DISCUSSION

Structural analysis

Table A: Deflection of Butterfly

S. No	Pressure in N/m^2	Deflection of disc in mm	
		Aluminium [1100]	Al-SiC15%
1	100	1.176	0.174
2	250	1.156	0.178
3	500	1.140	0.169

The table A shows the details about the maximum deflection of butterfly valve disc for applying different pressure values and using Aluminium [1100] as a material, the maximum deflection of the entire pressure category in my all analysis is almost same, so the value is 1.176mm. The table A also shows the details about the maximum deflection of butterfly valve disc for applying different pressure values and using Al-SiC15% as a material, the maximum deflection of the entire pressure category in my all analysis is almost same, so the value is 0.174mm. The amount of decrease in maximum deflection is 0.998mm and the percentage of decrease is 84.86% (figure 16).

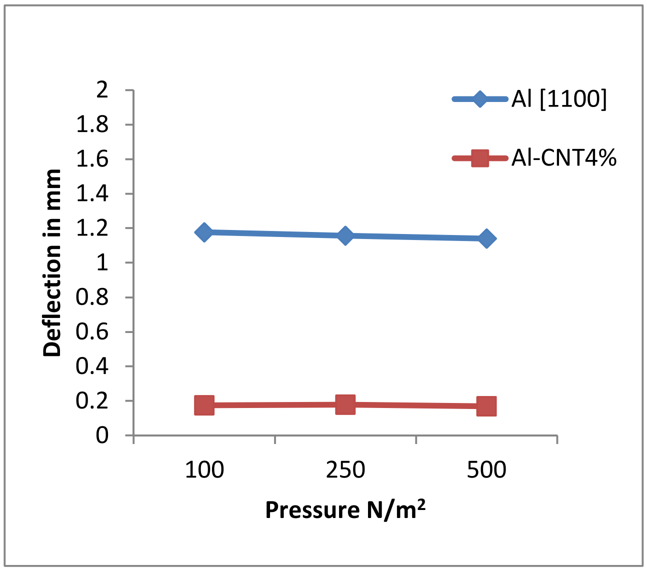

Figure 16: Shows the comparative chart of pressure versus deflection for aluminium [1100] and Al-CNT4%.

Thermal analysis

Table B: Structure Changes of Butterfly

S. No	Temperature of Disc (^{0}C)	Grain change of Disc (^{0}C)	
		Aluminium [1100]	Al-SiC15%
1	250	104.19	177.92
2	500	111.19	307.81
3	600	112.95	359.76

The table B shows the details about the grain structure changes of butterfly valve disc for applying different temperature values and using Aluminium [1100] as a material. In this material the minimum temperature of grain structure change of the entire heat application in my all analysis is almost same, so the value is 112.95^{0}C at disc temperature of 600^{0}C and fluid temperature of 100^{0}C.

The table C also shows the details about the grain structure changes of butterfly valve disc for applying different temperature values and using Al-SiC15% as a material. In Al-SiC15% show the value is 359.76^{0}C at disc temperature of 600^{0}C and fluid temperature of 100^{0}C is the highest value (figure 17).

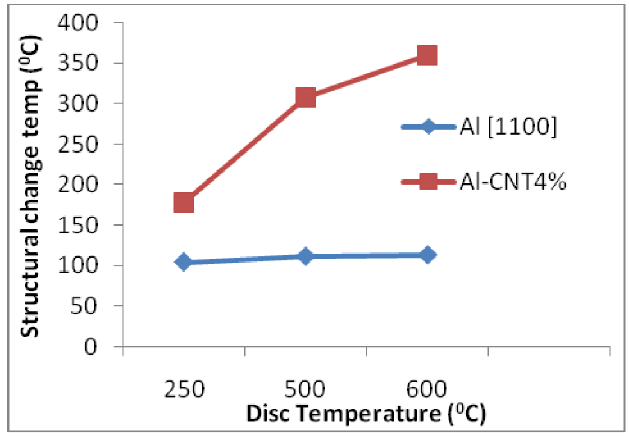

Figure 17: Shows the disc temperature versus grain structure changing temperature of butterfly valve disc

So the above table C and figure.17 shows that Al-SiC15% is thermally more stable than aluminium [1100]

CONCLUSION

The result of present study reveals that the amount of deflection in Al-SiC15% composite is around 7 times lesser than aluminium [1100]. So according to the deflection Al-SiC15% is more stable than the aluminium [1100] for the application of butterfly valve disc. According to thermal consideration the change in grain structure take place at Al-SiC15% is at least 1.5 times to at maximum 3 times greater than aluminium [1100], so for both this analysis Al-SiC15% composite is more stable than aluminium[1100]

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