Finite Element Analysis of based Optimization Butterfly valve disc

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Abstract

In the field of competition, all companies should supply their goods and services with high quality, in shortest period with lower prices than its competitors in order to keep their capacity and power to compete .Butterfly valves are machine elements which are commonly used for regulation of fluid, semi-liquid and granular medium flow on variety of tanks and pipeline systems. Valves are widely used in various industrial branches, especially in power plant pipeline installations, transport systems for materials. The valves can be made of carbon and alloyed steel, grey or alloyed cast iron and of other plastic or rubber materials.

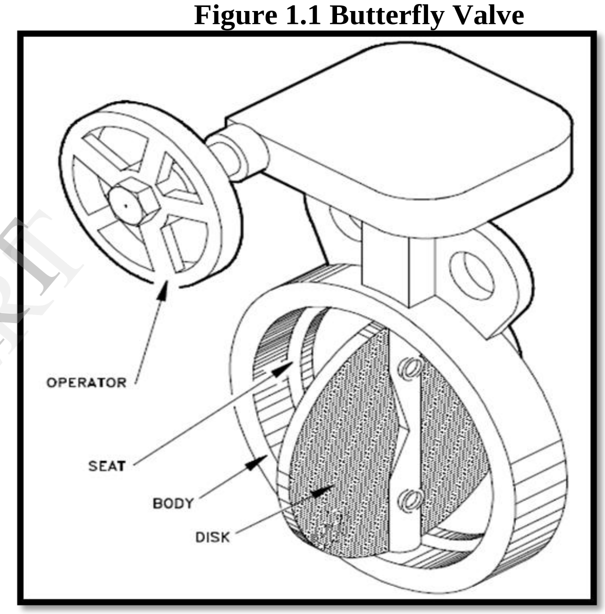
This paper discusses FEA analysis of Butterfly valve body and weight optimization. The weight reduction is done by changing the disc thickness. The results clearly shows the maximum weight reduction is 2Kg while keeping maximum stress level up to 140 N/mm2 which is safe for the applied load.

Keywords: *Butterfly valves, finite element analysis, Optimization*

1. Introduction

A butterfly valve, illustrated in Figure 1.1, is a rotary motion valve that is used to stop, regulate, and start fluid flow. Butterfly valves are easily and quickly operated because a 90^{o} rotation of the handle moves the disc from a fully closed to fully opened position. Nowdays, there are various simulation techniques are availbele for static analysis. Song, Wang and Park[1] carried out the CFD and structural analysis of butterfly valve disc for stress determination. Based on this results they done

Figure 1.1 Butterfly Valve



weight optimization of butterfy valve disc by 7.05per cent of its initial value. Song, Wang and Park[2] examined valve for both CFD for various angle and structural analysis, and concludes that there is chance for weight reduction. Song et al.[3], they carried out fluid and structural analysis based on this they done optimization of disc by changing shape of disc.

In main objective of study is obtain stress generated in disc, static analysis of butterfly valve disc of 250mm diameter is carried out which is

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suitable for 3 MPa pressure, is carried out using ANSYS. The aim of this is to find out stresses generated in disc under pressurized condition and optimization of valve disc.

2.Finite Element Analysis:

2.1 3D modelling of valve disc:

3D modeling is carried out with the help of modelling software CATIA V5 using the design details obtained.

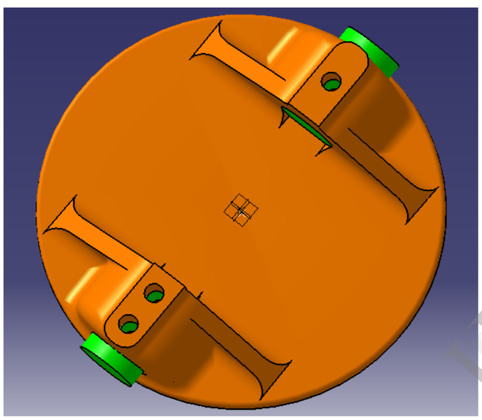


Fig.2.1 3D CATIA Model of Disc

2.2 Meshing:

Meshing is carried out with ANSYS software.

Fig.2.2 Meshed model

2.3 Define Material properties:

The following description and table provide basic information of material used for making casting of valve disc.

Material used- ASTM A351 Grade CF8M

Mechanical Properties:-

Young's Modulus= 195000MPa

Poisons Ratio =0.28

2.4 Pressure (load) and Boundary Condition:

Structural loading means applying internal hydraulic pressure to valve body or disc. Hydro test Pressure 3 MPa disc, which is shown in the figure.2.3 by 'A' in red color.

The disc is supported between two shafts which one is the fixed support for disc in analysis that one is the constraint, where the all degrees of freedom are restricted which is shown in the figure.2.3 by 'B' in blue color.

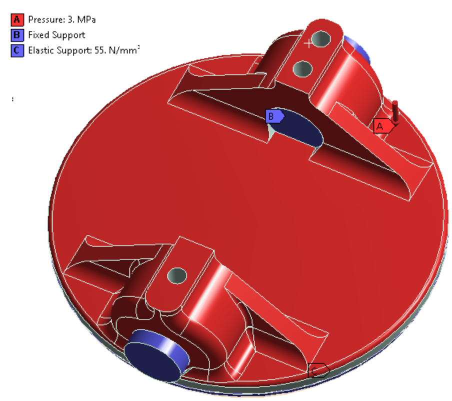


Fig.2.3 Pressure and boundary condition

2.5 Solver:

After applying material properties and boundary conditions, problem was solved by the ANSYS solver.

2.5.1 Analysis Results and their interpretation

Results of FEA for applied internal pressure 3 MPa are shown in following figures.

FEA results for 3 MPa internal pressure applied on disc:

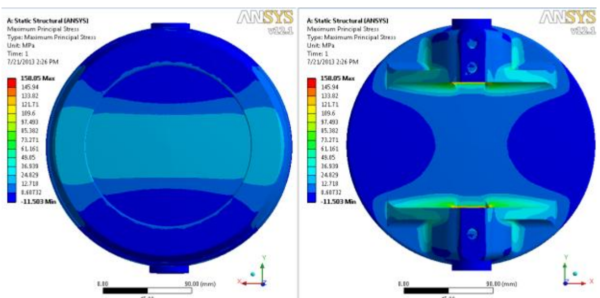


Fig.2.4 Maximum Principle stresses

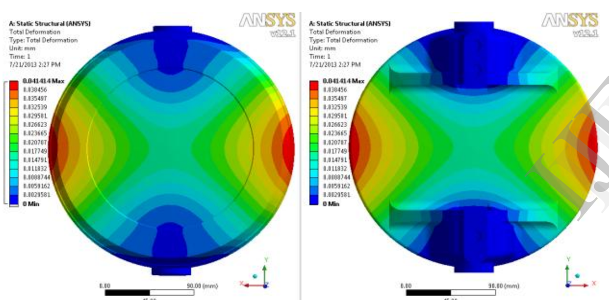


Fig.2.5 Deflection of Disc

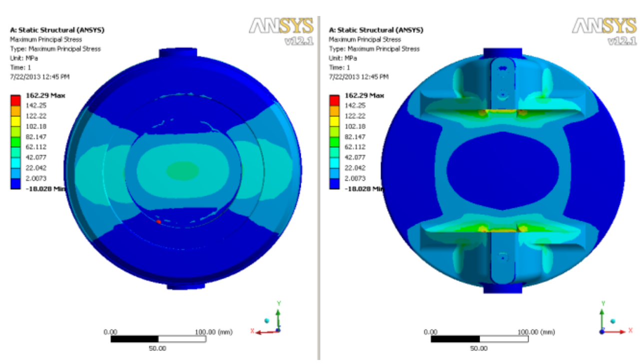
At left hand side of above analysis figure, there is a vertical column of various colours which indicates the stress pattern with different values. Out of this various colours, there is some indications for respective colour like 1) the red colour indicates high stress value, if this red colour is in point form then this form known as singular stresses which are neglected here. 2) faint brown colour which one below to the red colour which indicates the region of moderately stresses (tensile stress) and 3) blue colour which is at lower indicates the region of low stresses (compressive stresses). This is about the various colour pattern and there indication.

From the FEA analysis we got some stress values in particular region as maximum principal stress 158.05 N/mm^2 at 3 MPa internal pressure As the internal pressure acts on the internal effective area of valve disc, results to expand the valve disc, but shaft hold the valve disc in original position. As the internal pressure increases stresses in the valve disc increases linearly.

3.Design Optimization:

Optimization of valve disc by making Pocket on the disc Surface:

For first condition pocket is made on the disc surface of 125mm diameter and 5mm depth. and remodelling is carried out. None other parameters changed. Then again FEA analysis is carried out for seeing weather the stresses are coming in limit or not. After modeling again the weight of the model checked.



From above results it's clear that the stress level is up to the 162.29 N/mm^2, and mainly the weight is reduced by 0.5 kg from present model. and the stress pattern is looking safe one after changing.

Result Table

Parameter changed	Stress level (N/mm^2)	Reduction in weight (Kg)
Pocket of 125mm diameter and 5 mm depth	162.29	0.5
Pocket of 125mm diameter and 10 mm depth	165.56	1
Pocket of 125mm diameter and 15 mm depth	176.13	1.5

Conclusion:

Different optimized models created by changing the design parameters and analyzed. Reducing the disc thickness by making pocket of 125mm diameter and 5 mm depth, weight is reduced by 0.5 kg, where as if the wall disc thickness reduced by making pocket of 125mm diameter and 10 mm depth, weight is reduced by 1 kg,. In 3rd case thickness is varied by making pocket of 125mm diameter and 15 mm depth, weight is reduced by 1.5Kg but stress level increases. Then also, this is best optimized model is model because this stress values are below yield stress value.

References:

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