A Review of Finite Element Analysis methods of Butterfly Valves

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ABSTRACT

Butterfly valves are machine elements which are commonly used for regulation of fluid, semiliquid 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.

Keywords--- Butterfly valves, finite element analysis, Optimization

I. 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° rotation of the handle moves the disc from a fully closed to fully opened position.

Fig. 1. Butterfly Valve[1]

Nowadays, there are various simulation techniques available for static analysis. 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 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.
II. STEPS FINITE ELEMENT ANALYSIS METHOD

Step 1 3D modelling of valve disc:
3D modeling is carried out with the help of modeling software CATIA V5 using the design details obtained.

![3D Model of Valve](image)

**Step 2 Meshing:**
Meshing is carried out with ANSYS software.

![Meshing](image)

**Step 3 Define Material properties:**
Provide basic information of material used for making casting of valve disc like, Material used and Mechanical Properties, Young’s Modulus Poisons Ratio etc. While designing and manufacturing of any component, the first step is material selection for component. This Material selection is usually based on the applied pressure, temperature to component and corrosive properties and erosive properties of the flow media which comes in contact with component. Mostly in control valve applications which handle relatively non-corrosive fluids at reasonable pressures and temperatures or some additives are added to fluid for reducing corrosion of component. Therefore, cast carbon steel is the most commonly used valve body and disc. The following description and table provide basic information of material used for making casting of valve disc.

**Step 4 Pressure (load) and Boundary Condition:**
Structural loading means applying internal hydraulic pressure to valve body or disc. Hydro test Pressure on disc. 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.

**Step 5 Problem Solving**
After applying material properties and boundary conditions, problem was solved by the ANSYS solver. ANSYS solver formulates the governing structural stress strain equations for each and every element those formulated governing equation are solved for deformation. With this governing equation other quantities such as stresses, strains can be calculated. Results are shown with the different colour strips of the
stresses at the side of figure. Principal stresses, von-
mises stresses are the logical checks for structural valve
disc analysis.

**Step 6 Analysis Results and their interpretation**

Study of different results obtained from stress
diagrams as shown in case study.

**III. CASE STUDY**

Consider a valve for 1.0 MPa internal
pressure applied on disc.

![Example of Valve Analysis](image)

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. 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.

**IV. CONCLUSION**

From above analysis of disc, it is found that the
maximum principle stress value is below yield stress of
material. So the valve disc is very safe under working
condition. But this stress value is very less as compared
to yield stress, so it’s found that there is much chance for
weight reduction of disc in future. This work discusses
Finite Element Analysis of Butterfly valve Disc. For the
solid modelling of valve body CATIA V5 software is
used. The solid model is discretized into finite elements
and logical constrains are applied in boundary
conditions. The stress results obtained in finite element
analysis shows that there is chance for optimization of
design.

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