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"A REVIEW ON OF TURBINE INLET LARGE SIZE BUTTERFLY VALVES"

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ABSTRACT

Butterfly valves are widely used in various industries such as water distribution, sewage, oil and gas plants. The hydrodynamic torque applied on the butterfly valve disk is one of the most important factors which should be considered in their design and application. Although several methods have been used to calculate the total torque on these valves, most of them are based on the hydrostatic analysis and ignore the hydrodynamic effect which has a major role to determine the torque of the large-size valves. In this paper, we will revive the dynamic-valve-torque has been calculated for a large size butterfly valve under different conditions and also at the different opening angles of the valve disk.

KEYWORDS: *Butterfly Valve, Hydrodynamic, Hydrostatic analysis, Valve disk*

I. INTRODUCTION

Large size butterfly valves are widely used in water distribution systems, fuel transferring lines, power plants etc. Different scientific and industrial researches have been carried out to study the hydro-mechanical behavior of these valves. Pressure loss, cavitation and the required torque to operate these valves are the most important subjects which are discussed in these works

The study of butterfly valves has evolved over the years; most of the earlier studies were based on analytical and experimental approaches. Because of the notable influence of the butterfly valve on the fluid flowing through it, many researchers have done lots of work to study the fluid characteristics of the butterfly valve.

Fig.1 Turbine inlet Valve

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II. LITERATURE SURVEY

One the earliest and most comprehensive pieces of research on the flow characteristics and performance of butterfly valves was performed by

Cohn [1]. Using data provided by previous authors, Cohn attempted to parameterize torque and flow coefficients based on thickness to diameter ratio for numerous butterfly valve geometries, most of which were symmetrical.

McPherson [2] studied various blade variations of single eccentric butterfly valves in incompressible turbulent flow subject to free, submerged, and continuous piping discharge arrangements. McPherson found that for a given type of installation, the flow characteristics were not significantly influenced by either the shape of the blade or by the closing angle except for the near-open and closed positions, respectively. Using a two dimensional setup of different symmetric butterfly valve blades, cavitations was also predicted.

Sarpkaya [3] also studied the torque and cavitations characteristics of idealized two-dimensional and axially symmetrical butterfly valves by considering an idealized case of laminar uniform flow through a symmetrical lamina (representing the butterfly valve) be-tween two infinite walls. Using these assumptions, Sarpkaya was able to extend approximate solutions to hydrodynamic torque, cavitations, and flow coefficients for three dimensional butterfly valves using semi-empirical equations.

Addy et al. [4] conducted several small-scale compressible flow experiments with sud-den enlargement configurations for butterfly valve models to predict mass flowrate and overall pressure characteristics. In addition, a full size butterfly valve was built and tested. The sudden enlargement configurations were classified as three different types of nozzles: contoured converging, conical converging and sharp-edge orifice. It was concluded that the performance characteristics of the valve can be predicted if the valve flow coefficient is known for a specified operating pressure ratio.

Eom [5] building off the work of Cohn [1] and McPherson [2], studied the performance of butterfly valves as a flow controller. From compared the flow characteristics of perforated and non-perforated butterfly valve discs and found their performance to be in good agreement with one another, except at low blade (opening) angle values of about 10 degrees. He also studied the effect that blockage ratios (area of disc to area of pipe or duct) had on butterfly valves as throttling devices. Furthermore, Eom was able to predict loss coefficients sufficiently well from blockage ratios at Reynolds numbers in the range of 104.

Morris and Dutton [6] experimentally investigated the aerodynamic torque characteristics of butterfly valves using two dimensional planar models and three dimensional prototype valves at chocked and un-chocked operating points, and the results revealed the significance of the flow separation and reattachment phenomena on the aerodynamic torque characteristics of butterfly valves.

Morris and Dutton [7] also investigated the operating characteristics of two similar butterfly valves mounted in series, and an experimental investigation concerning the operating characteristics of a butterfly valve downstream of a 90 degree mitered elbow.

Kimura et al. [8] and Ogawa and Kimura [9] used free-streamline and wing theory to model symmetric butterfly valves between infinite parallel walls in two dimensions and used correction equations to compensate for pipe wall conditions. The correction equations also required a corrected opening angle and thickness of the discs, and uniform velocity. Using the given two-dimensional models, torque characteristics, pressure loss, and cavitation of three-dimensional experiments were predicted and analyzed. While the general pattern of torque coefficients followed the experimental data, the differences between the predicted and actual values were large. In more recent years since

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Kimura and Ogawa, scientific and engineering communities in the field of fluid dynamics and valve research have placed more emphasis in Computational Fluid Dynamics (CFD), especially with the advent of commercial CFD software in the 1990s.

Huang and Kim [10] were some of the first to use commercial CFD software to investigate three dimensional flow visualization of a symmetric butterfly valve (modeled as a thin flap valve disc). Huang used CFD code FLUENT to

simulate a steady incompressible flow with k-ε turbulence modeling. Valve positions were simulated at openings of 30, 45, 60, 70, and 90 degrees. Huang also investigated the length downstream of the valve in which flow would return to fully developed conditions. Due to computational restrictions, a relatively coarse mesh of a maximum of 25,000 cells was used in the CFD calculations. Huang also compared his numerical results with the experiments carried out by **Blevins [11].** The 45 degree case was found to be the most agreeable with the experimental data, while the rest lacked agreement.

Lin and Schohl [12] used commercial CFD software FLUENT to predict drag coefficients for a symmetric coin shaped butterfly valve at opening angles in an infinite flow field with results obtained experimentally.

Hoerner [13]. Sensitivity of the results to turbulence model selection, accuracy of discretization schemes, grid quality, and grid dependence were studied as part of the validation. Lin compared k- ε, k-ω, and k- ω SST turbulence models and opined that the later model was preferred for resolving the Reynolds-averaged Navier-Stokes equations and that use of a 1st order discretization for the flow domain led to predictions significantly higher than those from the 2nd order schemes. Flow coefficients aligned well with experimental data overall, however it should be noted that exact modeling comparisons between the experimental setup and the numerical model were difficult to match. Lin also modeled a 3.66 meter diameter butterfly valve within a pipe at valve openings of 20, 40, 50,60, 70, 80, and 90 degrees with cavitations free conditions and incompressible flow using CFD.

A computational mesh size included about 1.5 million tetra and hexa-elements. Pressure drop across the valve was calculated and predicted flow coefficients matched relatively well with experimental data provided by the United States Army Corps of Engineers (USACE) for a similarly shaped disc butterfly damper.

Song et al. [14] performed a structural analysis of large butterfly valves, in addition to validating three-dimensional experimental data of a butterfly valve's pressure drop, flow coefficient, and hydrodynamic torque coefficient using general purpose CFD code CFX [15].The k- ε turbulence model was selected by Song since it does not involve the complex non-linear damping functions required by other models. A mesh of nearly one million cells was used with a domain extending eight pipe diameters upstream from the valve and approximately ten pipe diameters downstream. Cases were run for disc opening angles of 5 to 90degrees in increments of 5 degrees. Generally, good results were obtained except when the valve opening angle was less than 20 degrees. In the 20 degree case, differences between experimental and simulation data were found to be nearly 50%.

III. CONCLUSION

In this paper, commercial CFD software to investigate three dimensional flow visualization of a symmetric butterfly valve and the dynamic-valve-torque has been calculated for a large size butterfly valve under different conditions and disk opening angles using Computational Fluid Dynamics (CFD) methods. Moreover, the effects of disk shape and its deformation, surface roughness, upstream/downstream pressure variation and disk-offset value have been studied and now we will be study on Structure analysis with help of ANSYS software and check stress level with pressure boundary condition.

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