Ain Shams University
Faculty of Engineering

Improving the Performance of Pressure Reducing Valve Using Two Stages

A Thesis submitted in fulfillment of the requirements of the degree of

M.Sc. in mechanical engineering

by

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STATEMENT

This thesis is submitted as partial fulfillment of M.SC degree in Mechanical engineering, Faculty of engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or qualification at any other scientific entity.

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Abstract

Control valve is required to control flow or pressure of fluid flowing in piping systems. In the present work, experimental measurements are reported for flow characteristics of single stage and two stage control valves are reported under non-cavitating and cavitating conditions. A test rig was constructed to test valve performance at the Faculty of Engineering, Ain Shams University. The test rig of the experiment consists of a vertical, multistage inline centrifugal pump driven by variable speed motor, piping system, flow meter, pressure gauges, differential pressure manometer. Water is recirculated to a large water tank 25 m^3. Insertion type magnetic flow meter the effects of diameter ratio and spacing between the two stages are examined. Four single stage valves and five alternatives of two stage valves are investigated. The results show that the pressure loss coefficient is inversely proportional to the distance between the two seats in the two stage valves. Cavitation occurrence decreases if the area ratio of the valve is reduced and the distance between the two stages decreased. The inherent characteristics of the valve are also affected by the geometry parameters of the two stage valve.

Keywords: cavitation – two-stage valve – pressure control

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NOMENCLATURE

Ar	Area ratio
C_v	Flow Coefficient
d	Pipe diameter
F	Frequency
K	Pressure loss coefficient
L	Distance between the two seats
P	Pressure
Q	Volumetric flow rate
Re	Reynolds number
V	Fluid velocity
ΔP	Pressure drop across valve
σ	Cavitation parameter
ρ	Fluid density
μ	Fluid dynamic viscosity

Subscript

1	First stage
2	Second stage
d	Downstream
u	Upstream
l	Local
v	Vapour

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Chapter 1

Introduction

1.1 Introductory Remarks

A control valve plays an important role in a closed pipeline system and is widely used in a variety of industries such as chemical engineering and petrifaction. Among control valves, a globe valve is commonly used as a flow regulation device under extremely high pressure conditions. For example, the inlet pressure may be higher than 100 bars and from time to time 200 bars. For a globe valve, which conveys liquids, cavitation is a serious and destructive problem during its operation because pressure may drop owing to the variation of velocity according to Bernoulli's equation. The inception of cavitation occurs when the local pressure in a globe valve drops from the increase of velocity and is below the corresponding saturated vapor pressure of a working liquid at a specific temperature. Vapors begin to form in bubbles in low pressure regions and then burst immediately from pressure recovery as they flow downstream, resulting in vibration and erosion. Additionally, this not only causes vibration of the valve body but also induces a high noise level. Because of cavitation, a globe valve is damaged quickly. It is common to replace damaged globe valves in a pipeline system every few months in petroleum industry. Replacing globe valves damaged by cavitation in a factory becomes a regular and costly affair; this is an important issue in the design of a globe valve. Currently, most valve