

# International Journal of Innovative Research in Science, Engineering and Technology

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## Analysis and Optimization of Ball Valve

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**ABSTRACT:** There are so many valves applicable in industry, one of them is Ball valve because Ball valve is widely used. Valves are commonly used for safety, to control flow, to direct the flow, to allow only one directional flow in the pipe line. In this project we perform Analysis and optimization of Ball Valve. In the Optimization of the Ball Valve the weight, cost and flow parameters considered. It is important to design the valve in such way that optimum efficiency can be achieved in plant by considering the flow parameter such as pressure drop, velocity etc.

**KEYWORDS:** Ball valve, CFD analysis of Ball valve, Ball valve experimental analysis.

### I. INTRODUCTION

Ball Valve has been used widely in many industries. A valve is Mechanical Device which regulates the Flow or Pressure of the Fluid and Air. Its function can be Stopping or Starting the Flow, Controlling the Pressure or Relieving Pressure. Valve can be modelled to Regulate Flow of material and Energy within a process. There are several Different types of Valve. Its selection depends on the application and chemical process. Valve controls the internal flow of both Compressible and Incompressible fluids. It gives in the form of laminar helps to reduced pressure loss. The Ball has hole or port throughout in the middle so that when port is in line with both ends of the valve the flow will occur. When valve is closed the hole is perpendicular to the end of valve and the flow is blocked.

The Quarter-turn (90°) required to fully cover or fully uncover the Ball valve. The spherical plug lends itself not only precise control of the flow through the valve body but also to tight shut-off. In this manner the ball valve may accept the twofold job of control and block valve. In the Ball valve special material used for valve seats. Ball valve can be sealed by using either flexible metal seals or soft PTFE seals.<sup>[7]</sup>

### II. LITERATURE SURVEY

#### 1. "Performance test and flow Visualization of ball valve" Ming-Jyh Chern, Chin-Cheng Wang, Chen-Hsuan Ma

The performance, flow patterns and cavitations phenomena of a ball valve are examined experimentally. Different patterns of flows in and downstream the ball valves with respect to different valve openings and inlet velocities are envision using a particle tracking flow visualization method (PTFV). Meanwhile, cavitation phenomena are observed under certain conditions. Co-efficient regarding to the performance of valve are determined by pressure and flow rate measurements. The correlations between the valve work and the flow patterns are presented and discussed. The proposed method provides an effective way to determine the performance co-efficient of a valve and to understand the condition for the inception of cavitation.

#### 2. "Optimization of Industrial Valve Design Considering Flow Parameter using CFD" Shailesh Wamanrao Lokhande, Dr.A.M.Langde

There are so many valves applicable in industry, one of them is ball valve because ball valve is mostly used in power plant to control and regulate the flow hydraulic plant. It is important to design the valve in such way that best

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efficiency can be achieved in plant by considering the flowing parameter such as pressure drop, velocity, and viscosity etc. CFD analysis improve the valve performance and valve life in industry at desire valve closing angle such as 0°, 15°, 30°, 45°, 60° by changing the ball valve shape and checking the pressure drop at certain angle for getting best result.

3. **"Determination of Flow Parameters through CFD Analysis for Agricultural Irrigation Equipment: A Case Study for a Mini Valve"** H. Kursat CELIK, Allan E. W. RENNIE, Davut KARAYEL, Ibrahim AKINCI  
Computational Fluid Dynamics (CFD) is a powerful technique, which has been used successfully for a number of years in a wide variety of engineering disciplines, to develop an approach for solving complex fluid flow problems. In more recent years, with the desire to provide more efficient operations, it has become increasingly important to adapt this analysis methodology for advanced agricultural engineering design applications. This paper presents a case study for determining a number of flow parameters for a mini valve, which is used in agricultural irrigation systems, through the utilisation of CFD techniques. In the study, a sample plastic mini valve has been utilised for CFD analyses. Flow behaviour of the fluid in the valve was simulated three-dimensionally using a commercial CFD code. Pressure loss, head loss, flow coefficient, resistance coefficient and cavitation index parameters were calculated for different flow rates with different valve opening positions with the aid of simulation results. According to CFD results; maximum pressure loss of 8214.47 Pa was obtained in the analysis which was set up with flow rate of 4 L min<sup>-1</sup> at 45° valve opening positions. And the pressure loss is increasing if valve opening angle and inlet flow volume rates are increased. The Head loss and resistance coefficient are also increasing but flow coefficient is decreasing. The valve opening positions are affecting to the pressure and velocity distributions. In addition to this, charts have been provided to evaluate variations of the pressure, velocity and the flow parameters for the valve. This research improved the understanding of the fluid flow performance of the irrigation equipment and contributes to further research into the development of agricultural irrigation equipment enabled through the utilisation of advanced computer aided engineering (CAE) tools.
4. **"Design and Analysis of Industrial Ball Valve using Computational Fluid Dynamics"** P. Ebenezer Sathish Paul, G. Uthaya Kumar, S. Durairaj, D. Sundarajan  
Computational Fluid Dynamic examination is carried out to establish a robust affiliation between the design variables of material design domain and product design domain. The CFD analysis performed for both ball valve and gate valve is necessitated with input parameters that outfits the function such as pressure, density, viscosity and temperature. The maximum pressure acting over diverse regions of the valve system that crop up due to fluid flow was examined by the extension of pressure concentration for different fluids viz. water, lubricant and diesel. The analysis is presumed to be familiar with material selection strategies that satisfy the criteria for the new product development and therefore well defined inputs inclusive of virtual solid model, boundary conditions are promoted with higher grade mesh resolutions. In these cases, estimated selections are exercised and numerical scheme of properties has been adhered to embrace perfection in simulation investigation. The CFD study exemplifies accurate regions wherein maximum pressure assaults the valve body and so the observations originate to ascend product development without the expense of physical testing. The verification studies put forth for the pressure division generated due to fluid flow through the valve system is in stripe with end results. Furthermore valve deformation and valve performance is obligatory for material and product design integration and hence customary predictions is done by coupling the CFD results with finite element analysis.
5. **"Investigation of Ball Valve Design for Performance Enhancement"** Vishal A. Andhale, Dr. D. S. Deshmukh  
Flow is controlled using ball valve is most common process in hydraulic system. As Chlorinated Polyvinyl Chloride (CPVC) ball valve is considered in this paper for study of each component. Owing to reliability factor and operating conditions, that is quick opening and closing at high temperature and pressure conditions ball valves are mostly used as flow controlling device. Also generally CPVC ball valves are in use when operating pressure is relatively low. Further scope is observed in designing the valve for leak proof and trouble free performance in hydraulic systems. Fast progress of the flow visualization and numerical technique should be incorporated for further flow visualization through the valve and to evaluate the performance of valve. In this experimental work flow evaluation

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through Ball valve is accomplished using Computational Fluid Dynamics (CFD) software. CATIA V5 R20 software is used for Modelling of valve and ANSYS FLUENT 14.5 is used for analysis. Amount of water leakage is calculated from numerical analysis and it is compared with experimental data. Difference between experimental results and computational results obtained for two cases shows good agreement with each other.

## 6. “Numerical Analysis of Ball valve performance for coefficient of flow” Akshay B Ravande, D N Jadhav, Tansen Chaudhri

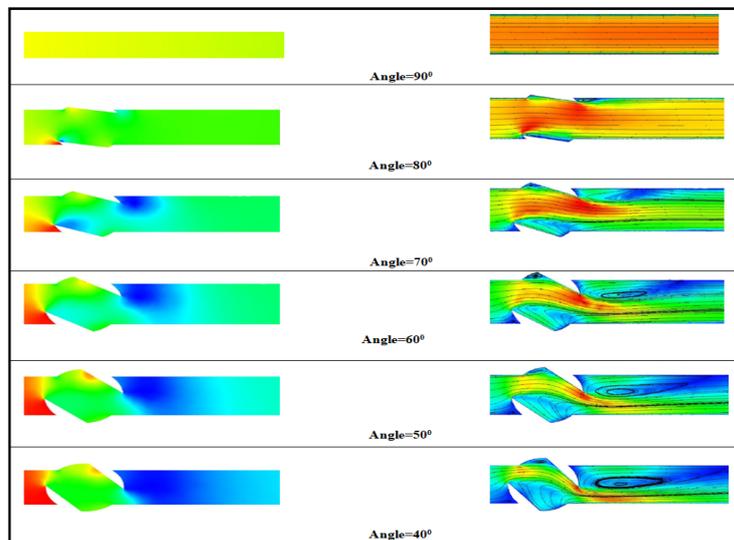
Ball valves are commonly utilized in piping system to manage the flow. They are additionally utilized for on/off or throttling tasks. Valves are indicated by estimations of their flow coefficient (CV). CV for liquid is nothing but volume of the water at 680F in US gallons per minute that passes through the valve at pressure drop of 1PSI. In the present work, volumetric flow control of water through valve is finished by making distinctive opening of ball i.e. 10% to 100% and CV esteems with regarding edges are determined numerically. For calculating the CV, firstly model of ball valve is prepared by using tool SOLIDWORKS 2014 and also simulations are carried out in SOLIDWORKS FLOW SIMULATION. From grades obtained from numerical analysis, it was found that flow rates with different opening angles are comparative and by decrease in pressure drop CV values for valve are increased. Though the ball valve Cv value is not focused in the past, with recent trends in piping design advancements its being essential to focus these values.

### III. CFD ANALYSIS

In this experiment a computational method to predict steady and single phase flow inside a pipe joined to a ball valve has been examined. Governing equations for continuity and momentum are 1st integrated over an impact volume and so the resultant algebraically equations are numerically resolved.

Steady and single part flows occurring as internal flows significantly are of nice importance. The flow inside a pipe is joined to ball valve is an example of internal free, steady and turbulent single phase flow. The objective of present study was develop a CFD model that can predict the steady free flows inside a pipe controlled by a ball valve in order to obtain the pressure drop coefficient by means of the CFD method.

Solve Navier – stokes and Euler equations to finite volumes method is developed that it satisfies conservation equations (continuity, momentum and energy) discretized over each volume element in computational domain with better accuracy.<sup>[8]</sup>



(a). Statics pressure change Through the pipe at Different angle.

(b) Axial velocity Magnitude change Through the pipe at Different angle.

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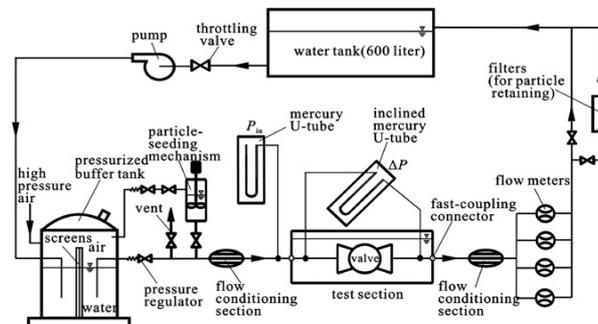
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## IV. EXPERIMENTAL RESULTS

First, the aim of the experiment was to determine the response of the system when the increase of pressure difference reaches 100 Pa for the fully-opened position of the ball valve. The valve inlet pressure was gradually increased up to 3500 Pa, whereas the outlet pressure was kept constant at 2400 Pa, and volumetric flow rates ( $Q$ ) were measured by a flow meter.

In the next steps, the handle of the ball valve was turned towards its closed position  $10^\circ$  once again, after volumetric flow rates ( $Q$ ) were measured. The minor loss coefficients were determined by Equation 1 with measured



(c) Schematic diagram of experimental apparatus

pressure differences  $\Delta p$  and respective velocities that were calculated from the volumetric flow rates.

The system consists of a ball valve of DN 32, regulation valves at the inlet and outlet sections, a flow meter measuring the flow rate of air passing through the system, a manometer measuring inlet pressure and an electronic panel measuring pressure difference between the inlet and the outlet sections. The compressed air flows into the system through the plug valve. The inlet pressure of the air is set to 2500 Pa by the pressure regulator as shown in the manometer. When the ball valve is at “fully opened” position, outlet pressure is set to 2400 Pa by means of the valve. The difference between inlet and outlet pressure can be observed on the digital panel as 100 Pa during the experiment process. Under these circumstances, the volume flow rate of the air is measured per minute. When the handle of the ball valve is turned towards its fully-opened position, change in the flow rate is also measured.

## V. CFD RESULT VALIDATE THROUGH EXPERIMENTAL RESULT

Relation of Pressure drop coefficient vs. Ball angle.			Pressure drop vs. flow rate			Pressure drop vs. Outlet velocity	
Ball angle	CFD	Experimental	Pressure Differences	CFD	Experimental	CFD	Experimental
90	0	0	100	1.25	1.15	12.01	10.81
80	2	5	200	1.70	1.55	16.95	15.26
70	5	10	300	2.05	1.85	20.75	18.68
60	15	20	400	2.35	2.20	23.94	21.55
50	20	30	500	2.60	2.45	26.61	23.95
40	70	95	600	2.85	2.65	29.17	26.26
30	375	380	700	3.15	2.90	31.51	28.36
20	920	975	800	3.35	3.10	33.69	30.32
			900	3.55	3.30	35.85	32.27
			1000	3.70	3.45	37.84	34.06

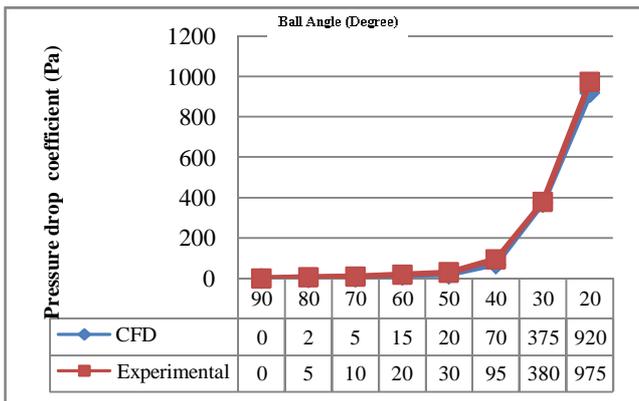
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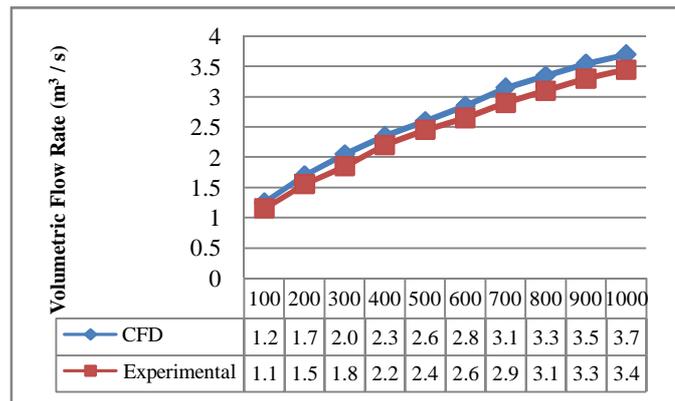
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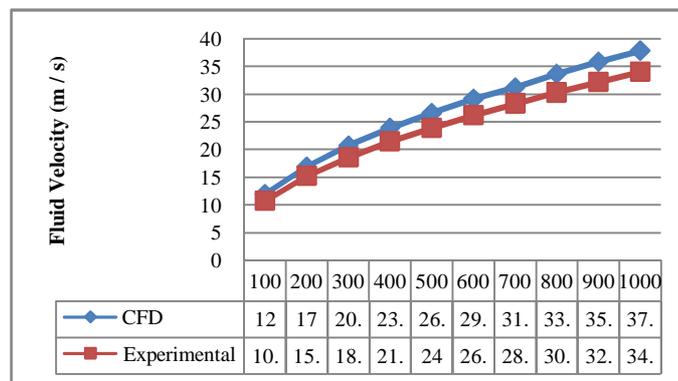
## VI. RESULT



(d) Relation of Pressure drop coefficient vs. Ball angle opening.



(e) Relation of Pressure drop vs. Flow Rate.



(f) Relation of Pressure drop vs. Fluid velocity.

## VII. CONCLUSION

According to the results of CFD analyses, it is observed that the pressure loss changes with inlet flow volume rate and valve opening positions. If valve opening angle and inlet flow volume rates are improved, pressure loss, head loss and resistance coefficient are increased. The pressure drop coefficient values of other valve types are much higher than those of ball valve.

The result obtained in the experiment and CFD analysis shown that the computational model adopted can be used as a tool to design better and efficient generated system with different ball valves subjected to similar condition such those of this experiment.

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