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Design and Development of Experimental Set Up of Bernoulli's Principle

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Abstract*: This project focuses on the design and development of an experimental setup to demonstrate Bernoulli's Principle, which states that an speed of a fluid is increases results in pressure is decreases. The setup includes a venturi-meter with 11 pressure tapping holes , pressure measurement scales, and air pressure bulb mechanism. The primary objective is to visually and quantitatively observe pressure variations corresponding to changes in flow velocity. This experimental arrangement facilitates a better understanding of fundamental fluid dynamics concepts. The design is simple, cost-effective, and highly suitable for educational and laboratory applications*.

Keywords: SET UP OF BERNOULLI`S PRINCIPLE

I. INTRODUCTION

Bernoulli's Principle states that an speed of a fluid is increases results in pressure is decreases. This principle is fundamental in fluid mechanics and is widely used in aerodynamics, hydraulics, and engineering applications. The goal of this project is to design and develop an experimental setup to effectively demonstrate Bernoulli's Principle in a controlled laboratory environment.

II. CONSTRUCTION PROCESS

Design and Planning: The design involves a Venturi-meter with 11 pressure tapping holes to measure pressure variations at different flow velocities, along with pressure measurement scales and an air pressure bulb to regulate flow. The setup will allow both visual and quantitative observation of pressure changes, demonstrating Bernoulli's Principle in a simple, cost-effective, and educationally valuable manner. The system's design ensures ease of use in laboratory settings and provides clear insights into fluid dynamics.

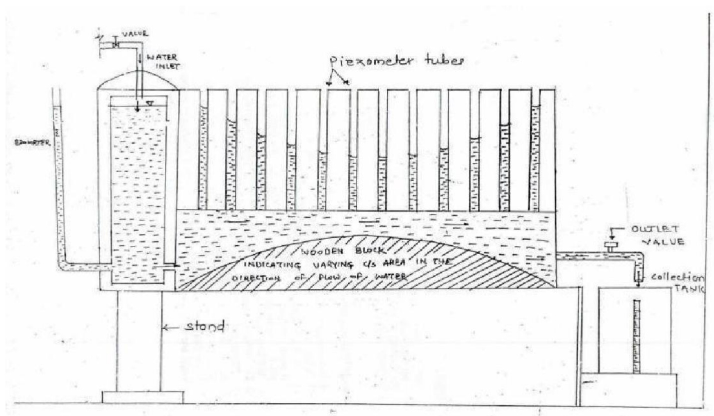

FIG. 1.1 **DESIGN OF EXPRIMENTAL SETUP OF BERNOULLI'S PRINCIPLE**

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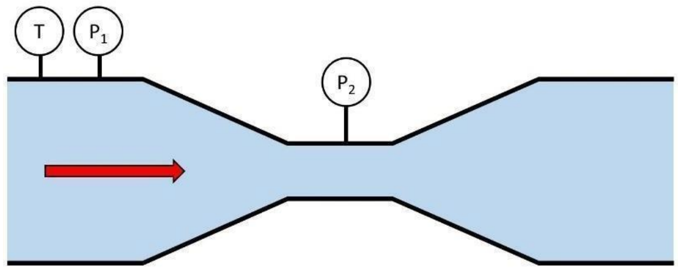

FIG 1.2 DESIGN OF VENTURIMETER.

Material Selection: Appropriate materials like sump tank, water pump, air pressure bulb

Fig. 2.1 SUMP TANK

Fig. 2.2 WATER PUMP

Fig. 2.3 AIR PRESSURE BULB

Fabrication of Components: Supported bars and wooden frame constructed to suspend the setup in a horizontal way. PVC tanks constructed for outlet and inlet.

Fig. 3.1 GRINDING & WELDING

Assembly: All the components are assembled after fabrication as per the schematic diagram. Water-tight connections made using seals or adhesives. Flow regulation valve and flow measuring unit fitted. System leak-tested and pressure loss tested.

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Fig. 4.1 Assemble of set-up

Testing and Calibration: System tested at various flow rates. Pressure and velocity readings are measured and compared with theoretical values. Calibration of flow measuring instruments is done.

Fig 5.1 Water Tank & Tubes Testing

Final Touches: After successful testing, the experimental setup of bernoulli's principle is finished with safety features and correct readings.

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Fig 6.1 Final Touches

III. METHODOLOGY

1. THEORY:-

When an incompressible fluid is flowing through a closed conduit, is may be subjected to various forces, which cause change of velocity, acceleration or energies involved. The major forces involved are pressure and body forces. Due to elevation of conduits, pressure may change or due to change of cross section, velocity of fluid may change. But, though there is change of velocity, pressure also changes accordingly. In other words, if velocity energy of fluid is raised, its pressure will drop, i.e. total energy of fluid is constant at any two points in the path of flow. The theorem is known as Bernoulli's theorem. Hence, when applied to **steady irrotational flow of incompressible fluids**, (**Density is Constant**)

Where,

$$\frac{P}{w} + \frac{V^2}{2g} + Z = Constant$$

P = Pressure

V = Velocity at the point

Z = Potential head from datum w = Specific Weight

Bernoulli's equation for section 1 & 2 are

$$\frac{P_1}{w} + \frac{V^2{}_1}{2g} + Z_1 = \frac{P_2}{w} + \frac{V^2{}_2}{2g} + Z_2$$

But all the real fluids are viscous and hence offer resistance to flow.Thus thereare always some losses in fluid flows and hence in the application of Bernoulli's equation, these losses have to be taken into consideration. Therefore Modified Bernoulli's equation is

$$\frac{P_1}{w} + \frac{V^2{}_1}{2g} + Z_1 = \frac{P_2}{w} + \frac{V^2{}_2}{2g} + Z_2 + h_L$$

Where,

h_L =loss of head between section 1 and 2 Section velocity.

$$V_x = \frac{Q_x}{A_x}$$

Where,

Q_x = Discharge through section

$$= \frac{Volume of water}{Time required to collect water in water tank for\ 0.1m rise}$$

$$= \frac{Area of tank \times Rise of water level}{Time}$$

IV. CONCLUSION

In conclusion, the experimental apparatus designed for illustrating Bernoulli's Principle is successful in its goal of visually and metrically showing how fluid velocity and pressure are related. The use of the venturi-meter with 11 holes for pressure tapping, pressure measurement scales, and air pressure bulb mechanism in this setup allows for easy observation of how increasing flow velocity causes corresponding pressure reduction, all according to Bernoulli's Principle. The setup design is easy, economical, and effective and is extremely appropriate for laboratory and academic settings. It offers a low-cost platform for researchers and students to interact with basic principles of fluid dynamics and provides hands-on training in studying the behavior of fluids under different flow conditions. The success of the project serves to underscore the significance of practical demonstrations in enhancing understanding of theoretical principles. It not only solidifies the fundamental principles of fluid dynamics but also fosters further research and experimentation, thus serving as a useful resource for both research and educational endeavors. In general, this experimental setup is a powerful method to close theoretical knowledge and experimental observation, benefiting greatly the learning process of the discipline of fluid mechanics.

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