IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.67

Volume 5, Issue 2, March 2025

# Design and Fabrication of Reynolds Apparatus

**Mr. Yash Vispute[1], Mr. Sarthak Kirve[2], Mr. Rohan Kamble[3], Mr. Atharva Randive[4], Prof. Bhagyashree Sable[5]**

Students, Department of Mechanical Engineering[1,2,3,4]

Lecturer Department of Mechanical Engineering[5]

Zeal Polytechnic, Pune, Maharashtra, India

**Abstract:** *The Reynolds apparatus is a laboratory device used to demonstrate and study the concept of fluid flow and the Reynolds number. This apparatus is commonly used in fluid mechanics to visualize the transition between laminar and turbulent flow regimes. The Reynolds number, a dimensionless quantity, helps determine the flow characteristics of a fluid, indicating whether it will be laminar (smooth and orderly) or turbulent (chaotic and irregular).In the apparatus, a fluid (often water or air) flows through a transparent tube or pipe. Flow characteristics are observed visually, usually with the aid of dyes or tracers. By varying the flow velocity and measuring fluid properties, students and researchers can calculate the Reynolds number and analyze how it influences flow behavior. When the Reynolds number is below a critical threshold, the flow remains laminar, while above that threshold, it becomes turbulent. The Reynolds Apparatus provides valuable insight into concepts such as viscous forces, inertial forces, and the critical conditions under which flow transitions from laminar to turbulent. It is widely used in educational settings to teach the fundamental principles of fluid dynamics and in research to explore the behavior of various fluids under different flow conditions.*

**Keywords:** Reynolds Number, Laminar Flow, Turbulent Flow, Fluid Mechanics, Fluid Dynamics, Flow Regimes

## I. INTRODUCTION

In fluid mechanics, the Reynolds number (Re) is a dimensionless quantity that indicates the ratio of inertial forces to viscous forces, and thus measures the relative significance of these two types of forces in specific flow conditions. The Reynolds number (Re) of a flowing fluid is obtained by multiplying the fluid velocity by the internal pipe diameter (to obtain the fluid's inertial force) and then dividing the result by the kinematic viscosity (viscous force per unit length). The Reynolds number, abbreviated as Re, is used to determine whether the fluid flow is laminar or turbulent. In technical terminology, the Reynolds number is the ratio of inertial forces to viscous forces. In practice, the Reynolds number is used to predict whether a flow will be laminar or turbulent. The Reynolds number is the most widely used metric for determining the boundary between laminar and turbulent flow. As the average velocity of the fluid flow increases and the Reynolds number increases, inertial forces take over.

## II. CONSTRUCTION PROCESS

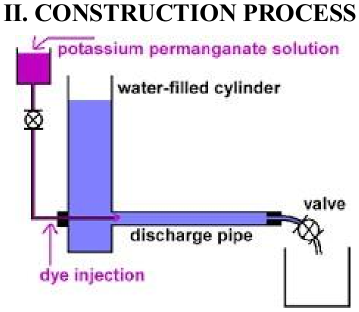



Fig. Working of reynolds apparatus

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 2, March 2025

Fig. Reducer

Fig. jar of 1 liter

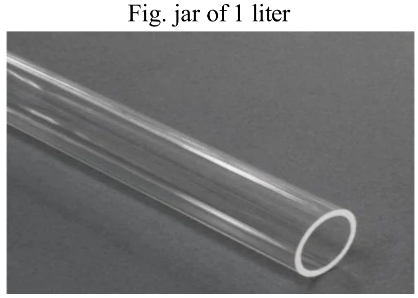


Fig. Acrylic pipe

Fig. adaptor valve


DOI: 10.48175/568

Fig. saline pipe

Fig. Injection neddle

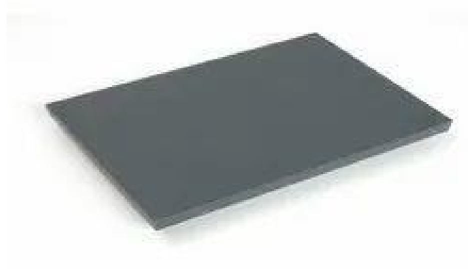


Fig. Pvc sheet

Fig. Nozzle

## III. METHODOLOGY

The methodology for using the Reynolds number apparatus involves a systematic procedure for observing, measuring, and analyzing the transition between laminar and turbulent flow. The following steps describe the typical approach:

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 2, March 2025

**Setup and Preparation**

Apparatus Setup: Ensure the Reynolds number apparatus is properly set up. This includes connecting the transparent tube or pipe, the fluid supply (usually water), and any instrumentation needed to measure flow (e.g., flow meters).

Fluid Selection: Choose the fluid (usually water) for the experiment, as its density and viscosity will affect the flow characteristics. Fluid temperature should be monitored, as it can influence its viscosity.

Tracer Dye (optional): If you need to visualize the flow, introduce a tracer dye or small particles into the fluid stream to make flow patterns observable. This is particularly useful for monitoring laminar and turbulent flow behavior.

**Initial Calibration**

Flow Rate Measurement: Calibrate the apparatus to accurately measure flow rate. This is crucial for determining the Reynolds number later in the experiment.

Pressure Measurement: Measure the pressure drop across the tube, which can provide information about the flow regime.

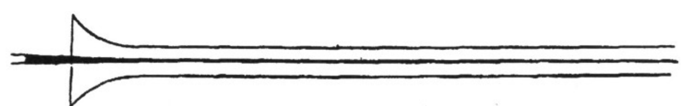
Record Initial Conditions: Take initial readings such as fluid temperature, pressure, and initial flow rate.

**Flow Regime Observation**

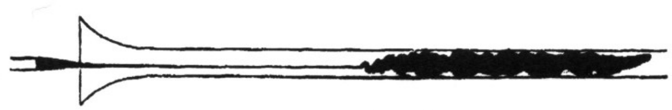
Start with Low Flow Rate: Begin the experiment by circulating the fluid at a low speed. Under these conditions, laminar flow is expected, meaning the fluid moves in smooth layers without mixing.

Increase Flow Rate Gradually: Slowly increase the flow rate in the system. As the rate increases, observe the transition in flow behavior. When the fluid reaches a certain speed, you may notice the flow becoming turbulent, with chaotic eddies and vortices.

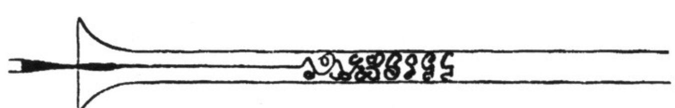
Visualize Flow Patterns: Depending on the setup, use the tracer dye or particles to visualize the flow. In laminar flow, the dye moves in a straight line, while in turbulent flow, the dye is dispersed in irregular patterns.



*Laminar flow*



*Turbulent flow*



*Turbulent flow (observed with an electric spark)*

## IV. THEORY

**Laminar flow: -** It is defined as that type of flow in which fluid particles move along well defined paths or stream line and all the stream lines are straight & parallel. Thus the particle moves in laminas or layers gliding smoothly over the adjacent layer. This type of flow is also called stream line or viscous flow.

Example: - 1. Flow of ink through nip of pen.
2. Flow of blood in veins.

**Turbulent flow: -** It is that type of flow in which the fluid particles move in zigzag way. Due to the movement of fluid particles in Zigzag way, the eddies formation takes place which are responsible for high energy loss.

Example: - 1. Flow of water through the river.
2. Flow in natural streams.

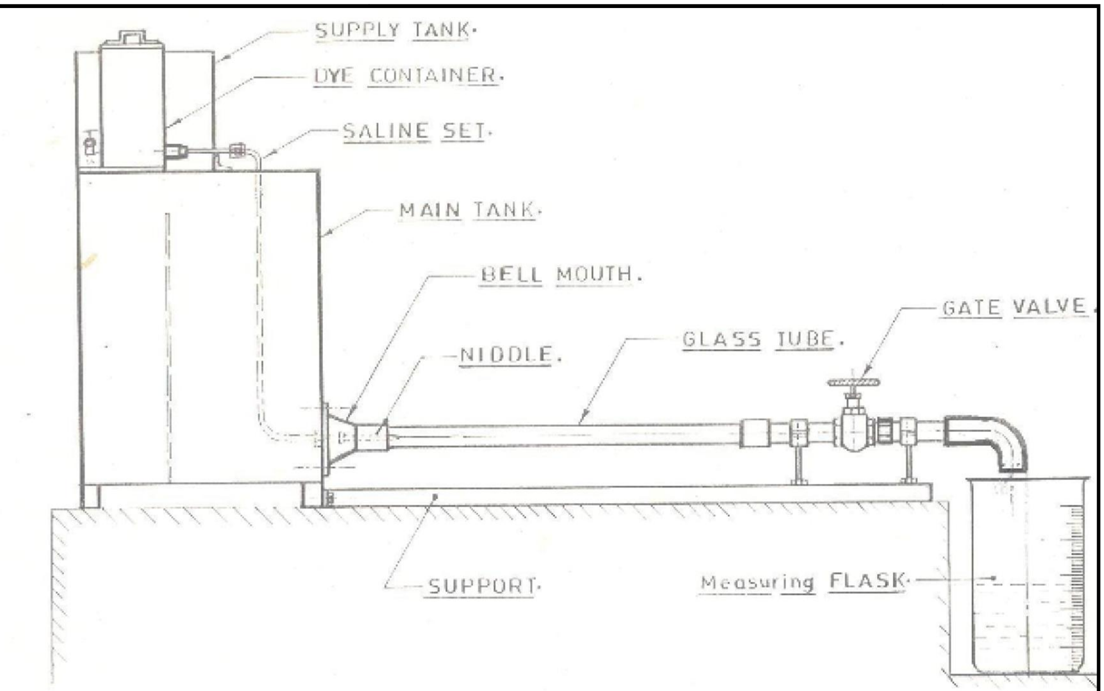
For a pipe flow, the type of flow is determined by a dimensionless number called the Reynold's number,

$$R_e = \frac{\rho v D}{\mu} = \frac{v \times D}{\nu}$$

Where, D = diameter of pipe
v = mean velocity of flow in pips = Qa /A $\mu$ = dynamic viscosity of the fluid.
If, Re < 2000 then, flow is called laminar flow. Re
> 4000 then, flow is called turbulent flow.
Re is between 2000 &4000 flow is called transitional flow.

**Experimental Set Up**

The apparatus consists of a glass tube with one end having bell mouth entrance connected to a water tank. The tank is of sufficient capacity to store water. At the other end of the glass tube a cock is provided to vary the rate of flow. A capillary tube is introduced centrally in the bell mouth entry. To this tube dye is fed from a small container placed at the top of tank through polythene tubing.




SCHEMATIC LAY-OUT OF:- REYNOLDS APPARATUS.

## V. LITERATURE GAP

A literature gap in the context of the Reynolds apparatus relates to areas where existing research has not thoroughly explored or addressed critical aspects of its application, design, or functionality. One such gap is the lack of modernization in the design of the apparatus, which remains largely traditional and has not incorporated advanced sensors or real-time data analysis tools. Furthermore, while the Reynolds apparatus has primarily been used for large fluid systems, its application in microfluidics remains underexplored, particularly with regard to differences in fluid behavior at smaller scales. Another gap exists in the use of advanced noninvasive flow visualization techniques, such as particle image velocimetry (PIV), which could offer more detailed insights into flow patterns. Likewise, while Reynolds apparatus data are often compared with theoretical models, more extensive comparisons with Computational Fluid Dynamics (CFD) simulations are needed, especially for more complex fluid systems. Standardizing calibration procedures for the Reynolds number apparatus is another underexplored area that could improve experimental accuracy and repeatability. Finally, there is limited research on the behavior of non-Newtonian fluids and multiphase flows within the Reynolds number apparatus, despite its relevance in numerous industrial applications. Addressing these shortcomings could lead to significant improvements in fluid dynamics research and practical engineering applications.

## VI. CONCLUSION

The Reynolds Apparatus serves as a fundamental tool for demonstrating and understanding fluid flow concepts, particularly the transition between laminar and turbulent flow regimes. Through the experiment, one can directly observe how flow characteristics change as the Reynolds number varies with changes in fluid velocity, pipe diameter, and fluid properties such as viscosity and density.

The results of the experiment allow for a better understanding of fluid behavior under different flow conditions. By calculating the Reynolds number and identifying the critical threshold (typically around 2000), one can predict whether the flow will be laminar, turbulent, or transitional. This experiment highlights the importance of the Reynolds number in fluid dynamics and its relevance to practical applications such as pipeline design, aerodynamics, and industrial fluid flow systems.

In summary:

- Laminar flow occurs at low Reynolds numbers ($Re < 2000$), where fluid particles move smoothly in layers. Turbulent flow occurs at high Reynolds numbers ($Re > 4000$), where chaotic eddies and vortices dominate the flow.

The transition zone ($2000 < Re < 4000$) marks the change between laminar and turbulent flow, depending on other factors such as fluid properties and surface roughness.

This experiment not only reinforces theoretical knowledge of fluid mechanics but also provides valuable hands-on experience with the practical implications of fluid flow behavior. By understanding these principles, they can be applied to a wide range of scientific and engineering problems where fluid flow plays a fundamental role.

**ACKNOWLEDGMENT**

I would like to express my sincere gratitude to all those who contributed to the successful completion of this experiment and the preparation of this report. First, I thank my instructor/professor for their invaluable guidance, support, and encouragement throughout this project. Their experience and knowledge of fluid mechanics were instrumental in helping me understand the concepts and methodologies involved. I also thank the technical staff and laboratory assistants for providing the necessary equipment, ensuring the proper functioning of the Reynolds apparatus, and assisting with its setup and calibration. In addition, I would like to acknowledge the contributions of my classmates, whose discussions and collaboration helped improve the quality of the experiment and analysis. Their collective feedback was vital in refining the methodology and results.

Thank you all for your unwavering support and guidance.

## REFERENCES

**[1].** White, F. M. (2011). Fluid Mechanics (7th ed.). McGraw-Hill Education.

**[2].** Cengel, Y. A., & Boles, M. A. (2015). Thermodynamics: An Engineering Approach (8th ed.). McGraw-Hill Education.

**[3].** Meyer, M. (2003). Introduction to Fluid Mechanics (3rd ed.). John Wiley & Sons.
**[4].** Schlichting, H. and Gersten, K. (2017). Boundary Layer Theory (9th ed.). Springer.
**[5].** (2008). Fluid Mechanics (4th ed.). Elsevier.
**[6].** Fox, R. W., and McDonald, A. T. (2015). Introduction to Fluid Mechanics (8th ed.). Wiley