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RESEARCH ARTICLE OPEN ACCESS

VERIFICATION OF REYNOLDS NUMBER BY DENSITY METHOD

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Abstract:

The laminar and turbulent flow the density of fluid plays vital role in classification of flows. In present study an attempt made to verity the Reynolds number by varying the density of flowing fluid. A in this study fine filament of dye is introduced in to the flow of water through the glass tube where different types of flow are seen at its entrance. At low velocities the dye filament appeared as straight line through the length of the tube and parallel to its axis, characterizing laminar flow. As the velocity is increased the dye filament becomes wavy throughout indicating transition flow. On further increasing the velocity the filament breaks up and diffuses completely in the water in the glass tube indicating the turbulent flow.

***Keywords* — Reynolds number, Laminar Flow, Turbulent flow, density, relative density**

I.INTRODUCTION

If there were no viscosity, the velocity of a flowing fluid would be uniform across a pipe section. the presence of a gas induces a shearing action between adjacent fluid particles that reduces the velocity to zero at the pipe wall an d thus forms a no – uniform velocity profile. Reynolds observed that, in the absence of swirl, a Newtonian fluid had two distinctly different velocity profiles.

In Reynolds experiment, a dye stream was injected into a flow of water in a glass pipe. At low velocities the dye stream was observed to remain parallel to the pipe axis along the length of pipe. However, when the velocity was increased, the dye stream initially oscillated, but eventually mixed completely with the water, at some distance from the dye injection point. The fluid moves in layers or laminar, with one layer sliding over another. Dye mixes with the fluid, and turbulent agitation occurs .These Profiles were observed to be separated by a transition regime where both laminar and turbulent conditions may exist at differing pipe radius At lower velocities, or for more viscous forces restrain fluid particles into parallel – layer motion. At higher velocities, or less fluids, inertia forces overcome viscous forces and particles move in turbulent profiles with their complex and random motions are not well understood.

II.OBJECTIVES

To estimate the values of the upper and lower critical Reynold's Number by conducting the experiments.

To observe on the behavior of the film of dye as a function of water velocity. Materials & Equipment: Reynold's Apparatus, stopwatch, beaker, funnel, stirring rod, thermometer.

III.METHODOLOGY

The apparatus consists of supply tank (with provision for maintaining the constant head),collecting tank (with over flow pipe),sump tank pump set, the glass tube to pass the water at required velocity, and the dye tank to supply the colored liquid. The water is drawn from the sump tank and fed to supply tank through valve. The constant head can be maintained either by controlling the water flow or by over flow pipe adjustment. The water enters the glass tube through bell mouth entry and passes through the glass tube. The velocity in the glass tube is controlled by outlet valve at the downstream. During the flow, the dye is injected to the Centre of the tube just after the entry, and the flow is observed, and the results tabulated

Fig:1 VERIFICATION OF REYNOLDS NUMBER BY DENSITY METHOD

The Reynolds number is the ratio of inertial forces to viscous forces within a fluid which is subjected to relative internal movement due to different fluid velocities, in what is known as a boundary layer in the case of a bounding surface such as the interior of a pipe. A similar effect is created by the introduction of a stream of higher velocity fluid such as the hot gases from a flame in air.

With respect to laminar and turbulent flow regimes:

- laminar flow occurs at low Reynolds numbers, where viscous forces are dominant, and is characterized by smooth, constant fluid motion;
- Turbulent flow occurs at high Reynolds numbers and is dominated by inertial forces, which tend to produce chaotic eddies, vortices and other flow instabilities.

The Reynolds number is defined as

$$\mathrm{Re} = \frac{\text{inertial forces}}{\text{viscous forces}} = \frac{(\text{mass})(\text{acceleration})}{(\text{dynamic viscosity})\left(\frac{\text{velocity}}{\text{distance}}\right)(\text{area})}$$

$$= \frac{(\rho L^3)\left(\frac{v}{t}\right)}{\mu\left(\frac{v}{L}\right)L^2} = \frac{(\rho L^3)\left(\frac{1}{t}\right)}{\mu\left(\frac{1}{L}\right)L^2} = \frac{(\rho L^2)\left(\frac{1}{t}\right)}{\mu} = \frac{(\rho)\left(\frac{L}{t}\right)(L)}{\mu} = \frac{\rho v L}{\mu} = \frac{vL}{\nu}$$

Where:

- ρ - density of the fluid (SI units: kg/m3)
- u - velocity of the fluid (m/s)
- L - characteristic linear dimension (m)
- μ – dynamic viscosity of the fluid (N·s/m2 or kg/m·s)
- ν - Kinematic viscosity of the fluid (m2/s).

The Reynolds number can be defined for several different situations where a fluid is in relative motion to a surface. These definitions generally include the fluid properties of density and viscosity, plus a velocity and a characteristic length or characteristic dimension (L in the above equation). This dimension is a matter of convention – for example radius and diameter are equally valid to describe spheres or circles, but one is chosen by convention. For flow in a pipe or a sphere moving in a fluid the internal diameter is generally used today. Other shapes such as rectangular pipes or non-spherical objects have an equivalent diameter defined. For fluids of variable density such as compressible gases or fluids of variable viscosity such as non-Newtonian fluids, special rules apply. The velocity may also be a matter of convention in some circumstances, notably stirred vessels.

In practice, matching the Reynolds number is not on its own sufficient to guarantee similitude. Fluid flow is generally chaotic, and very small changes to shape and surface roughness can are widely used result in very different flows.

IV.READINGS AND CALCULATIONS

NORMAL WATER: **ρ=1000 kg/m^3, H=0.05m**

Trail No.	Volume A*H m^3	Time In sec	Discharge Q=volume/Time m^3/s	Velocity V= Q/A m/s	R_e=ρvD/μ	Remark (type of flow)
1	$2*10^{-3}$	32.3	$6.191*10^{-5}$	0.05460	2600.1	Transition
2	$2*10^{-3}$	52	$3.846*10^{-5}$	0.03391	1615.0	Laminar
3	$2*10^{-3}$	61	$3.278*10^{-5}$	0.02891	1376.7	Laminar

Table:1

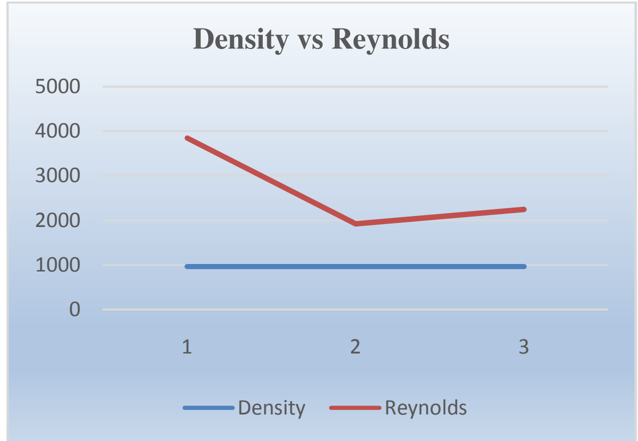

Fig:3

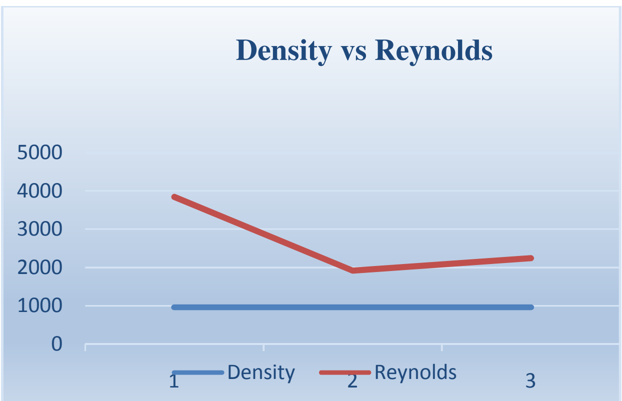

Fig:2

MUD WATER (10%=8kg):

ρ=1070 kg/m^3, H=0.05m

Trail No.	Volume A*H m^3	Time In sec	Discharge Q=volume/Time m^3/s	Velocity V= Q/A m/s	R_e=ρvD/μ	Remark (type of flow)
1	$2*10^{-3}$	21.9	$9.1324*10^{-5}$	0.08053	4103.1	Turbulent
2	$2*10^{-3}$	24.1	$8.2987*10^{-5}$	0.07318	3728.6	Transition
3	$2*10^{-3}$	33.5	$5.97014*10^{-5}$	0.05264	2682.1	Transition

Table:3

MUD WATER (5%=4kg):

ρ=1030 kg/m^3, H=0.05m

Trail No.	Volume A*H m^3	Time In sec	Discharge Q=volume/Time m^3/s	Velocity V= Q/A m/s	R_e=ρvD/μ	Remark (type of flow)
1	$2*10^{-3}$	18.5	$1.081*10^{-4}$	0.0953	4674.2	Turbulent
2	$2*10^{-3}$	20.2	$9.900*10^{-5}$	0.08730	4281.85	Turbulent
3	$2*10^{-3}$	27.8	$7.1942*10^{-5}$	0.0634	3109.6	Transition

Table:2

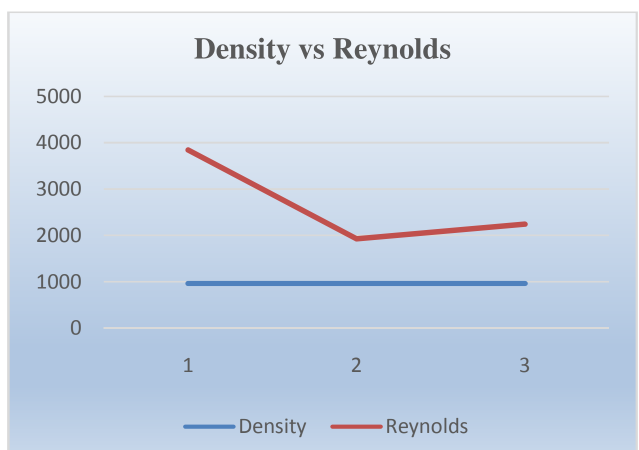

Fig:4

OIL WATER (5%=4 litre):

ρ=962 kg/m^3, H=0.05m

Trail No.	Volume A*H m^3	Time In sec	Discharge Q=volume/Time m^3/s	Velocity V= Q/A m/s	$R_e=\rho vD/\mu$	Remark (type of flow)
1	$2*10^{-3}$	21	$9.523*10^{-5}$	0.0839	3843.4	Turbulent
2	$2*10^{-3}$	42	$4.761*10^{-5}$	0.0419	1923.6	Laminar
3	$2*10^{-3}$	36	$5.555*10^{-5}$	0.0489	2244	Transition

Table:4

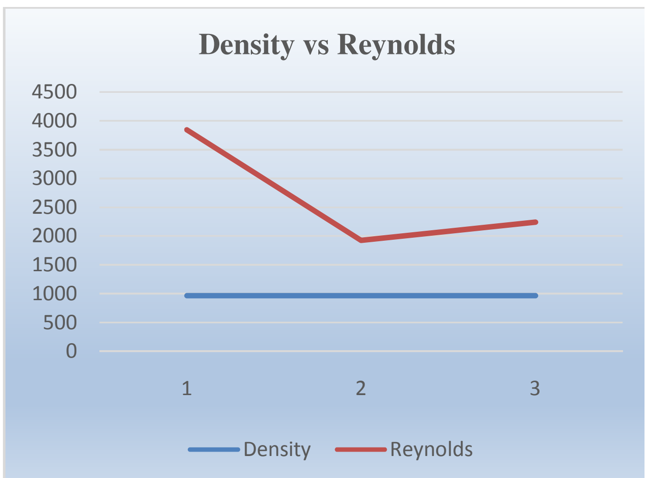

Fig:5

V.CONCLUSION

- From the results we can understand that the increase in rate of flow of fluid . In the pipe the flow observed is from laminar to turbulent
- We can also conclude that more the denser liquid more is the tendency of the fluid flow to be between transition and turbulent

VI. REFERENCES

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