EFFECT ON FLUID FLOW USING LAMINAR FLOW CABINET

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Abstract -***This project deals with the study and behavior of laminar and turbulent flow, and also reviews on the important parameter of the laminar flow such as, frictional losses, restriction in flow, effect on flow in various sections. In engineering applications it has been noticed that the cabinet do not work efficiently because presence of turbulence in the flow. So to avoid this laminar flow cabinet is very useful. This cabinet converts the turbulent flow to laminar flow, by reducing the disturbance and eddies present in the water providing the glassy and smooth flow of water. This paper shows the efficiency of the laminar flow. Still more particularly, this invention relates to laminar flow cabinets capable of producing a laminar trajectory stream suitable for water displays and fountains. The primary object of the present invention is to provide a laminar flow cabinet which produces a laminar output stream suitable for water displays and fountains.***

Key Words: *Laminar flow, Turbulent flow, Laminar flow cabinet, Fluid mechanics*

1. INTRODUCTION

In engineering, fluid plays an important role. We have studied many aspects of the fluid and their properties also, in fluid mechanics. What is fluid mechanics? Fluid mechanics is the branch of science in which we study the behavior of the fluid in rest and in motion. We say that, the fluid is incompressible, but it has wide range of application in the field of engineering. Laminar flow in the gentle flow in which, the layers of the fluid do not mix with each other and the particle flows with same velocity. In turbulent flow, the fluid particles have separate velocity of flow and the directions of the flow of particles are different. [1] Laminar flow is characterized by the smooth and regular flow of fluid in layers. It has therefore, been naturally assumed that, the creation of laminar flow may best be accomplished by forcing the flow stream into a number of small flow paths substantially axial to the flow of the fluid through the body of the cabinet. In this way, the Reynolds number for the flow in each path can be reduced to a value in the laminar region. The Reynolds number is a dimensionless value which indicates whether flow in a particular application can be expected to be laminar or turbulent. The relationship between the Reynolds numbers and the velocity of the stream, the diameter of the flow area, and the kinematic viscosity of the fluid is stated by the following equation: [2]

$$Re=\rho VD/\mu$$

Where:

Re= Reynolds Number

V= velocity of the stream

D= diameter of pipe

μ= viscosity of the fluid

ρ= Density of fluid flowing through pipe

For practical applications, a Reynolds number less than 2,000 generally indicates laminar flow and a value over 4,000 predicts turbulent flow. The range between 2,000 and 4,000 is called the critical region and the type of flow cannot be predicted due to the possible influence of outside factors such as pipe roughness. In fact, by minimizing these external disturbances, it is possible to maintain laminar flow for Reynolds number values as high as 50,000.

Since the kinematic viscosity is fixed for water, the only way to reduce the Reynolds number is to minimize the flow path diameter or the velocity. Reducing the diameter of the flow area have most often been accomplished through the use of perforated discs, multiple layers of screens, channels, fins, tubes, etc., placed in the flow path to promote straight and parallel flow in small segments over the flow area of the stream with the net result being the discharge of a larger laminar stream.

Such prior art methods do reduce the amount of turbulence in short streams as required for splash less and silent flow of water in lavatories, drinking fountains, and tubs. However, they are not, in general, suitable for use in fountain displays in which the flow stream must often remain clear, laminar, and coherent, over a trajectory path more than 10 feet high and 15 feet distant.

2. LAMINAR AND TURBULENT FLOW

In laminar flow the fluid particles moves in a defined path and the layers are straight and parallel to each other. The Reynolds number of laminar flow is less than 2000.

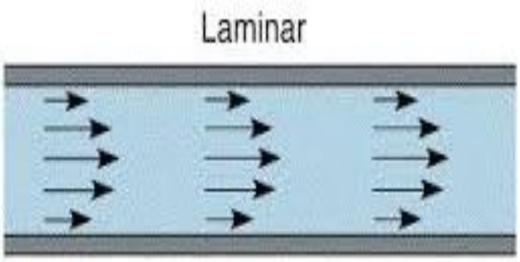

Fig 2.1: Laminar flow

Whereas, in turbulent flow the particles flows in zig – zag manner. The layers in turbulent flow get mixed with each other. The Reynolds number of turbulent flow is more than 4000. [2]

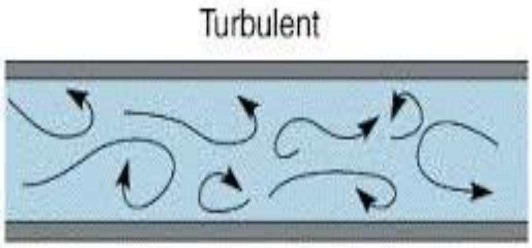

Fig 2.2: Turbulent flow

3. LAMINAR FLOW CABINET

Laminar flow cabinet converts the turbulent flow of water to the glassy finish laminar flow. This cabinet comprises casing, capillaries and the strainer. When the fluid flows form this cabinet, it first flows through two strainers. The small holes of the strainer, reduces eddies present in the fluid. When the fluid passes form the capillaries, the turbulence present in the fluid is completely reduced and the output we get is the glassy finished laminar flow.

3.1 PARTS OF CABINET

CASING

Casing is the outer covering of the model consisting, strainer and capillaries. It is made of plastic and protects the inner portion and prevents leakage.

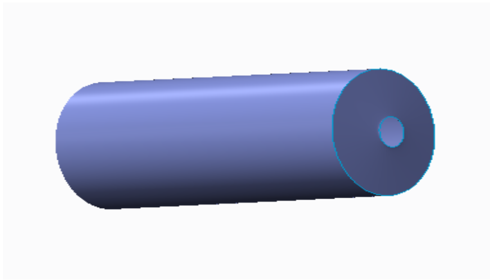

Fig 3.1: CAD Model of Casing [4]

CAPILLARIES

The Capillaries are the soul of the laminar flow cabinet. It is the only reason to generate the laminar flow. The Capillaries are having very small cross section area i.e. 0.01 times of the area of the casing or cabinets. Generally the Capillaries are been arranged in honey comb structure as shown in the figure which helps to create laminar low as shown in fig.3.2. The comb structure of capillaries is the group of small plastic tubes which is used to reduce the turbulence of fluid.

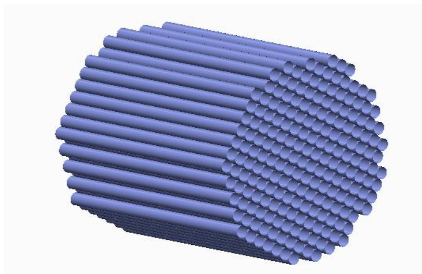

Fig 3.2: Comb Structure of Capillaries. [4]

STRAINER

The strainers are nothing but the filter which avoids the contamination of foreign materials which my hamper the flow. The strainer also helps to regulate the flow inside the casing which further results in laminar flow as shown in fig. 3.3.

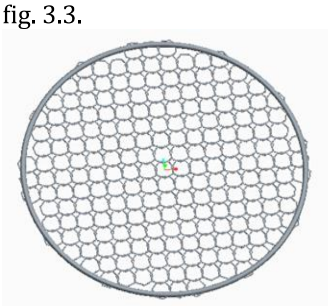

Fig 3.3: CAD Model of Strainer. [4]

4. A SCHEMATIC VIEW OF LAMINAR FLOW CABINET

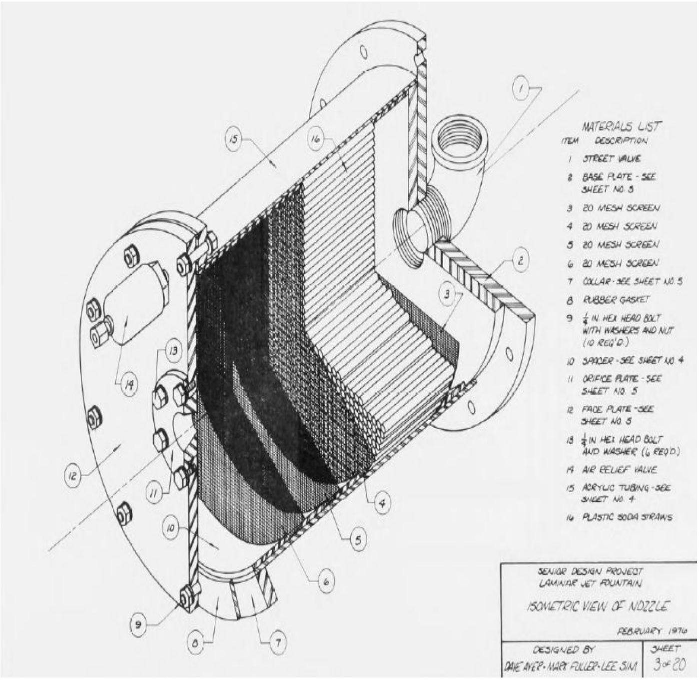

Fig 4.1: Schematic View of Laminar Flow Cabinet. [3]

5. ACTUAL MODEL

Fig. 5.1: Front View of Laminar Flow Cabinet.

Fig 5.2: Side View of Laminar Flow Cabinet.

6. WORKING

The working of this cabinet is very simple. The water from the pipe enters at one end and the output is the laminar flow. The process of conversion into laminar flow is such that, when the water enters the cabinet it flow through the strainer which reduces the turbulence in some amount. After the strainer the water flows through the capillaries (plastic soda straws), as shown in [3]. The capillaries are the main part to convert the turbulent flow to laminar flow. In capillaries, due to the small flow area, the layers of the water gets distributed, by which the layers of the water flows layer by layer (i.e. parallel to each other), which completely reduces the turbulence. Further, water flows form the two fine holes strainers which give the glassy finish laminar flow of water.

7. CONCLUSIONS

The present invention provides a laminar flow cabinet producing a laminar output stream of fluid suitable for use in water displays and fountains. The present invention includes an enclosure with an inlet port, and out port, a discharge laminar flow cabinet body having a discharge outlet passage there through, and a means for reducing turbulence within the enclosure by increasing the random and chaotic interaction of the fluid molecules to create a more uniform velocity profile across the flow area of the enclosure. The discharge outlet passage has a gradually reducing flow area to further reduce turbulence.

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