Glimpses of Fluid Mechanics in Nature, Science, Engineering and Technology: A Review

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ABSTRACT

Fluid mechanics an omnipresent subject, deals with behavior of fluid (liquids, gases) both at rest and in motion. Fluid mechanics has an extensive range of applications. In this paper applications of fluid mechanics in nature, science, engineering and technology are presented and discussed. At first the fluid mechanics in nature is explained. Which gradually turn to science and provide the base for the development of engineering and technology.

Introduction:

According to theory of evolution human was originated from a water (a fluid) with by birth talent of survival of life and hence the principles of fluid mechanics. The highly interwoven human life with fluid made him think to extend the area as per need. During 285-212 B.C Archimedes [1] has developed the law of buoyancy also called as Archimedes principle. Roman uses aqueducts for the irrigation and selling of boats [2]. After 150 B.C. Hero of Greece studied the flow rate [3]. 18^{th} and 19^{th} centuries are assumed to be the era of development in fluid mechanics. Due to wide range of application properties and flow pattern of fluid was studied by Newton (law of viscosity) [4], Magnus (spinning effect) [5,6] and Milne-Thomson studied the flow around circle which plays a vital role in a civil engineering [7]. The study of flow ranges from aperture to the pockmarks [8]. Now a day's tiny nano particles of nano fluid [9] and computational fluid dynamics [10, 11, 12, 13] are the subjects of main interest of researchers. However, study of fluid mechanics cannot be precluded from the field other than mathematics and engineering. In the recent years complex valued functions are used to construct the flow patterns [14, 15, 16].

Some Governing Equations:

Equation of Continuity:

The principle of conservation of matter, in a fluid region, say in the absence of inlets and outlets the amount of fluid remains same. This principle is termed as equation of continuity [17].

The mathematical form of equation of continuity is

$$\frac{\partial \rho}{\partial t} + \nabla.(\rho \overline{q}) = 0$$

Where $\rho = \rho(x, y, z, t)$ represents the fluid density at any point P (x, y, z) in cartesian, at any instant t.

If the pattern of flow is independent of the time at any instant of time t and location P (x, y, z) then $\frac{\partial \rho}{\partial t} = 0$.

Therefore, equation of continuity becomes

$$\nabla.(\rho \overline{q}) = 0$$

For an incompressible, homogenous fluid, the density is constant in the entire fluid.

Above equation becomes

$$\nabla . \overline{q} = 0$$

Euler's Equation of motion:

At time t if $\overline{F}$ is force per unit mass with fluid density ρ and pressure p of moving fluid with velocity $\overline{q}$ then the Euler's equation [17] is

$$\frac{d\rho}{dt} = \overline{F} - \frac{1}{p}\nabla \mathrm{p}$$

Bernoulli's Equation:

For non-viscos fluid relation between velocity and pressure is the Bernoulli's equation, first developed by Euler

$$p + \tfrac{1}{2}\rho\overline{q^2} = 0$$

Discussion:

Blood running through veins and arteries, air we breathe are fluid. The lymphatic system carries fluid (blood) to the important organs of body. The flow of urine in urethras, blood flow, and flow of air in a bronchial airway [18] are the flows governing the principles of fluid mechanics. Also, these flows are the types of conduit or couette or pipe flow. However, translocation of assimilates in the plant are based on the source-sink flow which is responsible for plants photosynthesis that is growth and development. Photosynthesizing tissues transporting carbon worked as source and sink. The strength of source (or sink) is the ability to carry the photo-assimilates. Therefore, the parts of plants can be allocated as source and sink as per the ability of translocating the assimilates through phloem [19-20]. Dancing smoke release from early morning burning stoves, selling of tiny revolute on river surface and wake left behind by huge fighter jets are all follows the rules of fluid mechanics. Vorticity in Bermuda triangle is again a part of study of fluid mechanics.

Joukowsky, the father of Russian aviation presented successfully, so called, the Joukowsky transform, to prove that the cross section of air craft wing is same as the cross section of circle [21]. Since then the aviation industry is using the circle for the air flow around airfoil and developed the high-speed airplane. Hydraulic and pneumatics are the branches of engineering purely based on air pressure. Bridge piers are fundamentally set on the basic study of flow around cylinder either circular cross-section or rectangular cross-section. To avoid over heating of engine fluid coolant are used circulating around the device. In the engine block converts the heat into steam as an energy as a result block itself heated. To avoid heating the extra plates are used where heat should be transferred. Among the popular form of air cooling is ducting to keep the desired room temperature and fresh air, it uses the concept of bend pipe flow or Poiseuille flow if in case the duct in in linear form [17].

Conclusion:

The branches of fluid mechanics are enticing in nature, science, engineering and technology also it is tempting for coming new generation researchers.

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