A INTRODUTION TOFLUID DYNAMICS(NEWTONIAN AND NON NEWTONIAN FLUIDS)

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Abstract

Fluid means study of a substance that continually deforms (flows) when shear stress is applied. Fluids includes liquids, gas and plasma. In fluid mechanics the study of fluids and forces on them. Fluids mechanics has three main fields they are namely fluid static the studies the fluids are at rest, describe the fluid motion and its consequences without considering forces causing the motion. Fluids kinematics that studies the effect of forces on fluids motion.

These fields are very important when it comes to subject like aeronautical engg. civil engg. etc. These are three approaches to fluids mechanics-experimental, theoretical and computational approach. Experimental approach is the oldest approach where you will make measurements using equipment's but this is costly. Then we have theoretical approachwhere we apply the mathematical equations. Mathematical equations that goes on the flow and try to capture the fluidic behavior with within a closed form solution i.e. Formulas that can be readily used. Limitation come when the result equations may be too complicated to solve easily.

Then comes computational approach. Here we try to solve complicated governing equations by computing them using a computer. In the recent year computational fluid dynamics(CFD) has become a very powerful approach in industry and research.

It is the branch of fluid mechanics that uses numerical method and algorithm to solve and analysis the problem involved in the fluid flow. Computers are mainly used to simulate interaction of fluids with surfaces defined by boundary conditions.

KEYWORDS

Fluid Dynamics, Computational Fluid Dynamics, Kinematics, Boundary conditions,Newtonian, Non-Newtonian, Newton's Laws

INTRODUCTION

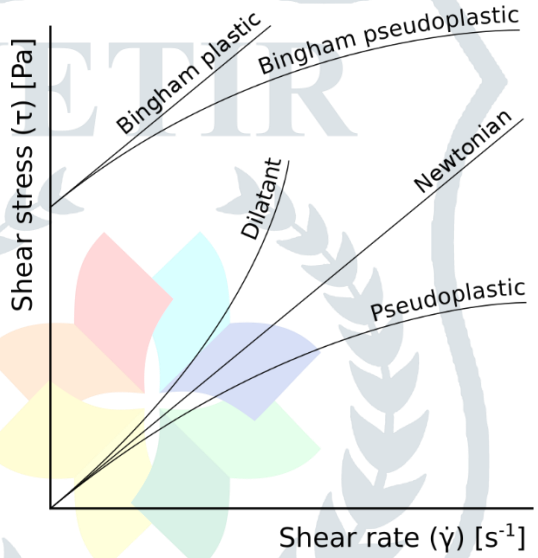
In this paper we study two type of fluids i.e. Newtonian and Non Newtonian fluids and their behavior. First of all, we will discuss Newton's law of viscosity for a given shear stress acting on a fluid element the rate of fluid deformation is inversely proportional to the viscosity. In simple words it states that the shear stress is directly proportional to the rate of shear strain or velocity gradient.

Before going further, let we know "No slip boundary condition". Consider a fluid flowing over a flat plate. The plate is at rest, while fluid is flow over it. Now let's zoom into the molecule level at any point on the plate. Due to frictional force and adhesion between the plate and the fluid molecules, the water molecule which are directly in contact with the plate do not flow. They stick to the plate, so their velocity is zero. Similarly, above the immobilized fluid molecule is showed down and this effect propagates. As molecules, which are in contact with the plate are unable to move/slide along the plate, this effect is known as "no slip boundary condition".

Non Newtonian fluids are those fluids which do not follow Newton's law of viscosity.

Types of Non Newtonian Fluids:

(i) Those whose shear stress is dependent on time.
(ii) Those whose shear stress is independent of time.



Bingham Plastic fluids are the simplest type of non-Newtonian fluids. They differ from Newtonian fluids only in the linear relationship that they do not pass through origin. They need minimum stress to be applied before they flow. Ex. Soap, toothpaste, paper pulp, chocolate mixture printer ink etc. if we invert the toothpaste tube without applying any force, we do not get the paste out immediately. It is static duration and after the application of more force toothpaste comes out.

Pseudo plastic fluids are those fluidsin which decrease in apparent viscosity with increase in shear rate. They are also known as shear thinning fluids. Ex. Blood, milk, paper pulp, ketchup, paints, starch suspension, rubber etc.

Dilatant fluids are less common then Pseudo plastic fluids. Flow behavior of dilatant fluids show as increase in apparent viscosity with increase in shear rate. They are also known as shear thickening fluids. Ex. Butter, sugar in solution, starch in water etc.

Thixotropic fluids decrease their viscosity as the time of application of stress increases. Ex nail polish,

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