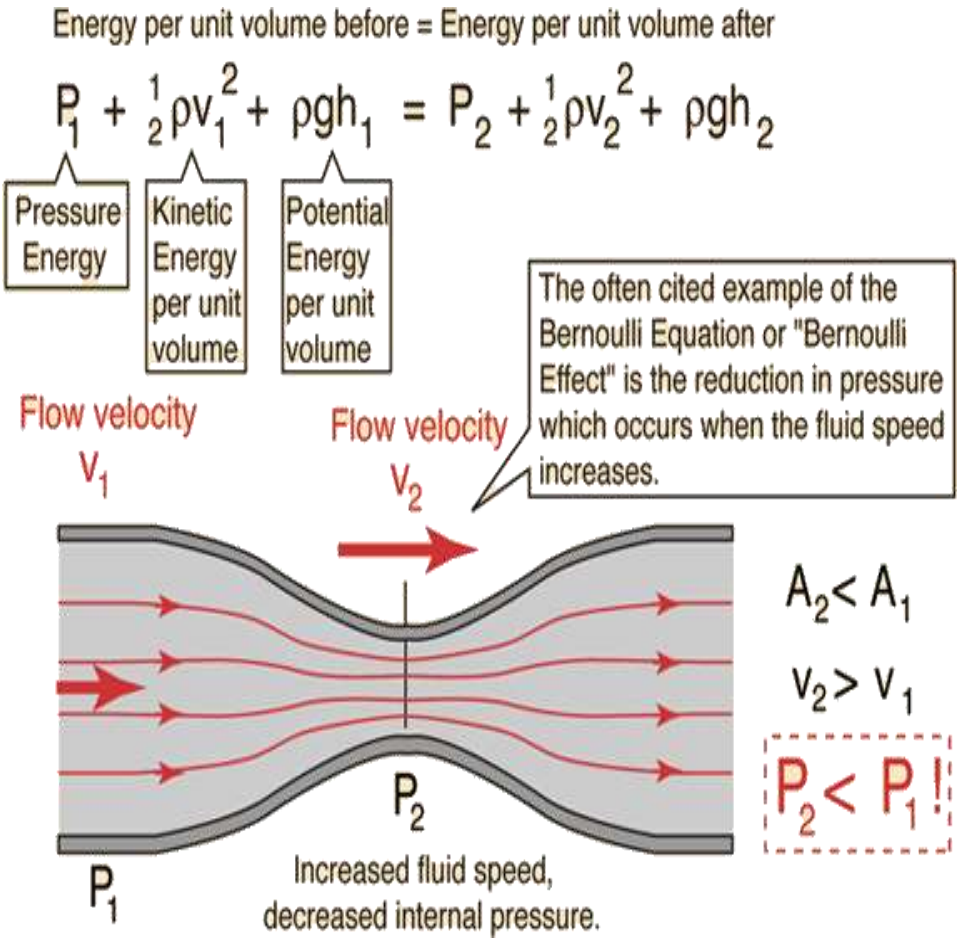
Lecture 9
Bernoulli Equation

The Bernoulli Equation can be considered to be a statement of the conservation of energy principle appropriate for flowing fluids. The qualitative behavior that is usually labeled with the term "Bernoulli effect" is the lowering of fluid pressure in regions where the flow velocity is increased. This lowering of pressure in a constriction of a flow path may seem counterintuitive, but seems less so when you consider pressure to be energy density In the high velocity flow through the constriction, kinetic energy must increase at the expense of pressure energy.



Steady-state flow caveat: While the Bernoulli equation is stated in terms of universally valid ideas like conservation of energy and the ideas of pressure, kinetic energy and potential energy, its application in the above form is limited

to cases of steady flow. For flow through a tube, such flow can be visualized as laminar flow .which is still an idealization, but if the flow is to a good approximation laminar, then the kinetic energy of flow at any point of the fluid can be modeled and calculated. The kinetic energy per unit volume term in the equation is the one which requires strict constraints for the Bernoulli equation to apply - it basically is the assumption that all the kinetic energy of the fluid is contributing directly to the forward flow process of the fluid. That should make it evident that the existence of turbulence or any chaotic fluid motion would involve some kinetic energy which is not contributing to the advancement of the fluid through the tube.

It should also be said that while conservation of energy always applies, this form of parsing out that energy certainly does not describe how that energy is distributed under transient conditions. A good visualization of the Bernoulli effect is the flow through a constriction, but that neat picture does not describe the fluid when you first turn on the flow.

Another approximation involved in the statement of the Bernoulli equation above is the neglect of losses from fluid friction. Idealized laminar flow through a pipe can be modeled by Poiseuille's law, which does include viscous losses resulting in a lowering of the pressure as you progress along the pipe. The statement of the Bernoulli equation above would lead to the expectation that the pressure would return to the value P_1 past the constriction since the radius returns to its original value. This is not the case because of the loss of some energy from the active flow process by friction into disordered molecular motion (thermal energy). More accurate modeling can be done by combining the Bernoulli equation with Poiseuille's law. A real example which might help visualize the process is the pressure monitoring of the flow through a constricted tube.

Pitot Tube | Types,Applications, Advantages, Limitations

Pitot tube is a mechanical device which is used to measure velocity of flow at any point in a pipe or a channel. It was invented by French engineer Henri Pitot and modified by French scientist Henry Darcy.

Pitot Tube works on a basic principal of fluid Mechanics and that is, *if a fluid stops flowing, all its kinetic energy gets converted into pressure energy*. It helps us in measuring that pressure energy of stopped fluid.

1. Simple pitot tube
2. Static source
3. Pitot-static tube

Types of pitot tube arrangements (in case of Pipe)

1. Pitot tube along with a vertical piezometer tube
2. Pitot tube connected with piezometer tube
3. Pitot tube and vertical piezometer tube connected with a differential U-Tube manometer
4. Pitot static tube

Applications of Pitot Tube

- It is used to measure speed of an aircraft
- It is used to measure speed of a boat
- It is used to measure fluid flows in different industries
- It is used where very high accuracy is not required
- It is used to measure flow profile in a duct or channel

Advantages of pitot tube

- It is easy and economical to install and remove
- It has no moving parts which helps in minimizing frictional losses
- It is small in size
- It is low in cost
- It causes very less pressure loss

Limitations or disadvantages of pitot tube

- Any foreign material in flow, can change the accurate reading.
- Its accuracy is not that good
- It has low rangeability
- It has low sensitivity
- It works better in high velocity flow

- A change in velocity profile can cause significant changes in readings
- It cannot be used with dirty fluids
- Its sensitivity gets disturbed by flow direction.