Ministry Of Higher Education and Scientific Research

Salahaddin University - Erbil

College of Engineering

Aviation Engineering Department

Fluid mechanic

Spring semester

First year
Lecture: 1

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Outline
In this course we will Study:

01 Fluid Mechanics Overview

Characteristics of Fluids 02

03 Compressible and Incompressible Fluid

Viscosity, Density, Pressure, Speed, and then 04

1. Introduction

❖ **Mechanics -** it is a physical science that deals with the state of rest or motion of bodies under the influence of forces (compressor, tensile and shear).

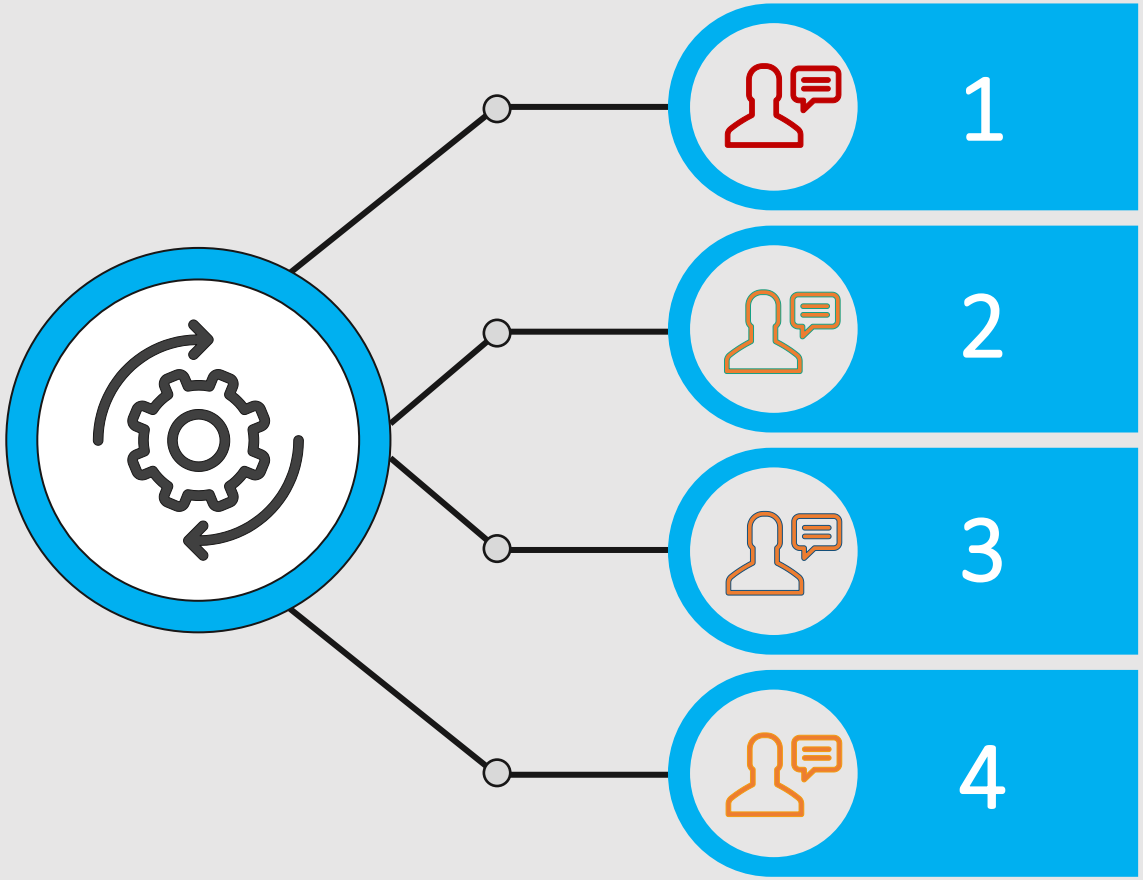
1. **Statics -** The branch of mechanics that deals with bodies at rest is called statics.
2. **Dynamics -** the branch that deals with bodies in motion under the action of forces is called dynamics.

❖ **Fluid mechanics -** the science that deals with the behavior of fluids at rest (**fluid statics**) or in motion (**fluid dynamics**), and the interaction of fluids with solids or other fluids at the boundaries.

1. **Fluid statics -** it is a branch of fluid mechanics that deals with the response behavior of fluid when they are at rest. The study of incompressible fluids under static conditions is called **hydro statics** and that dealing with the compressible static gases is termed as **aerostatics.**

2.Fluid dynamics - is "the branch of applied science that is concerned with the movement of liquids and gases“ It deals with the relations between velocities, accelerations of fluids with the forces or energy causing them.

Literature



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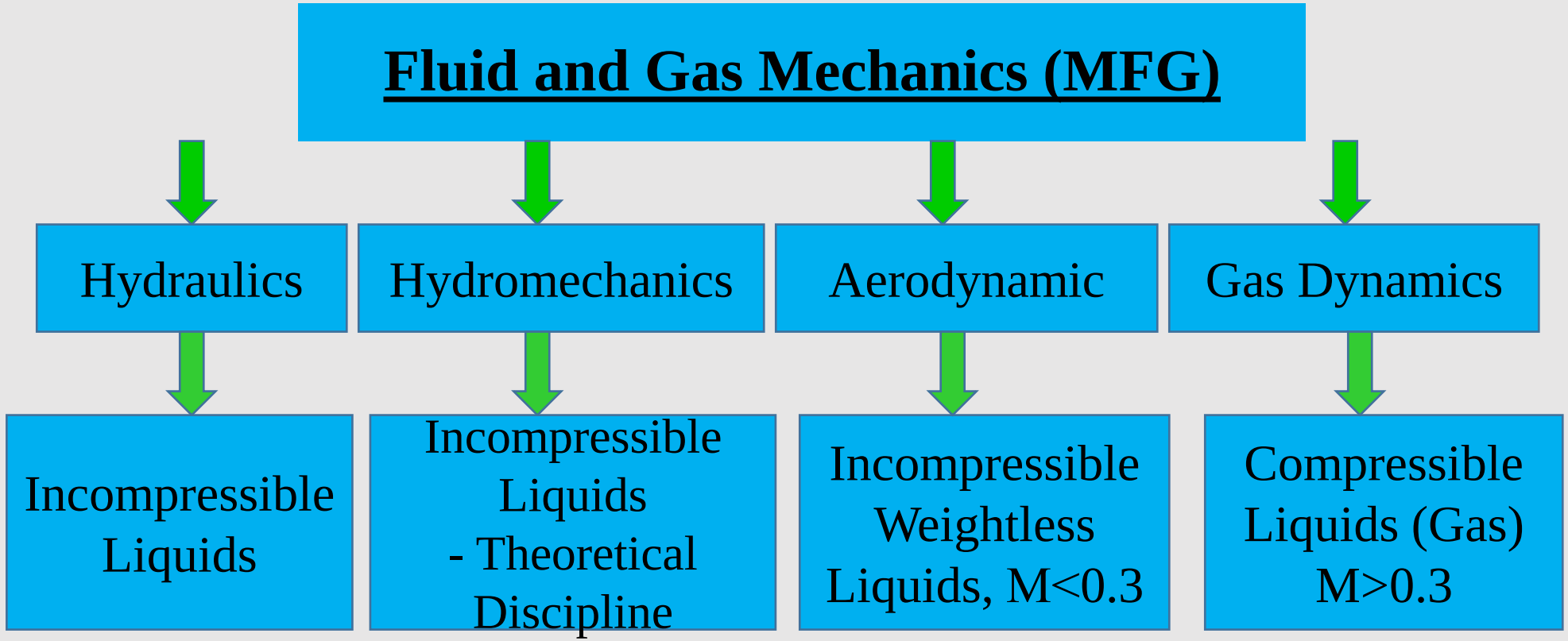
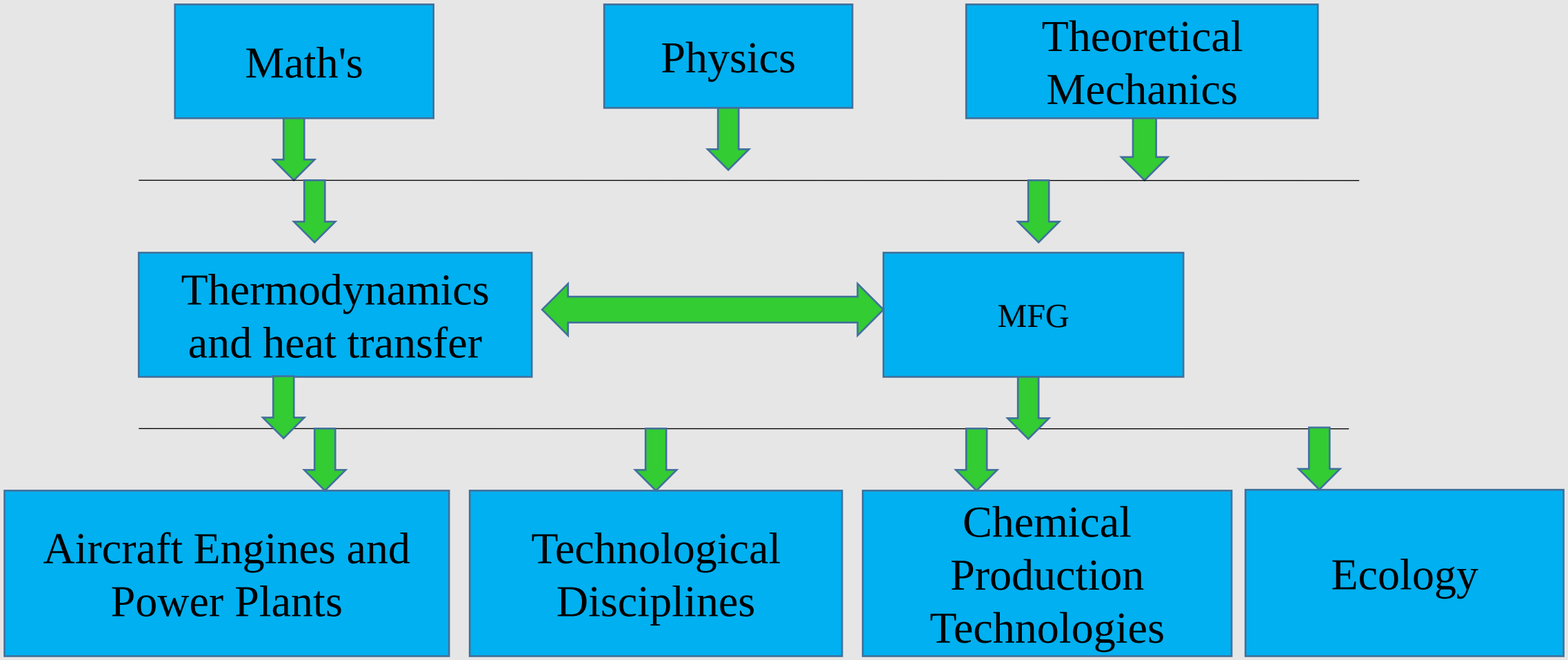
❖ **Fluid and gas mechanics** – is a science that studies the laws of equilibrium and motion of liquids and gases, as well as their interaction with solids.



The place of MFG in the curriculum in the direction « Engines of Aircraft »



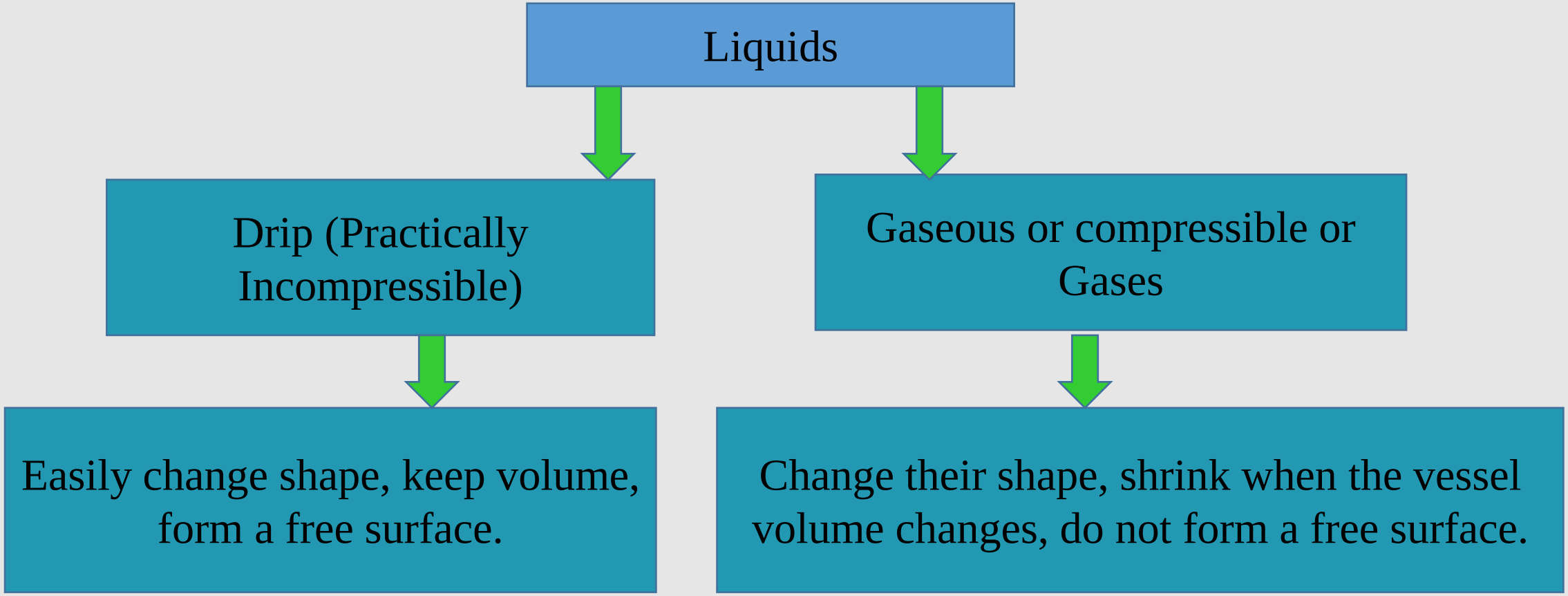
2. Basic concepts MFG. Properties of liquids and Gases

- 2.1. Working body. Liquids and gases

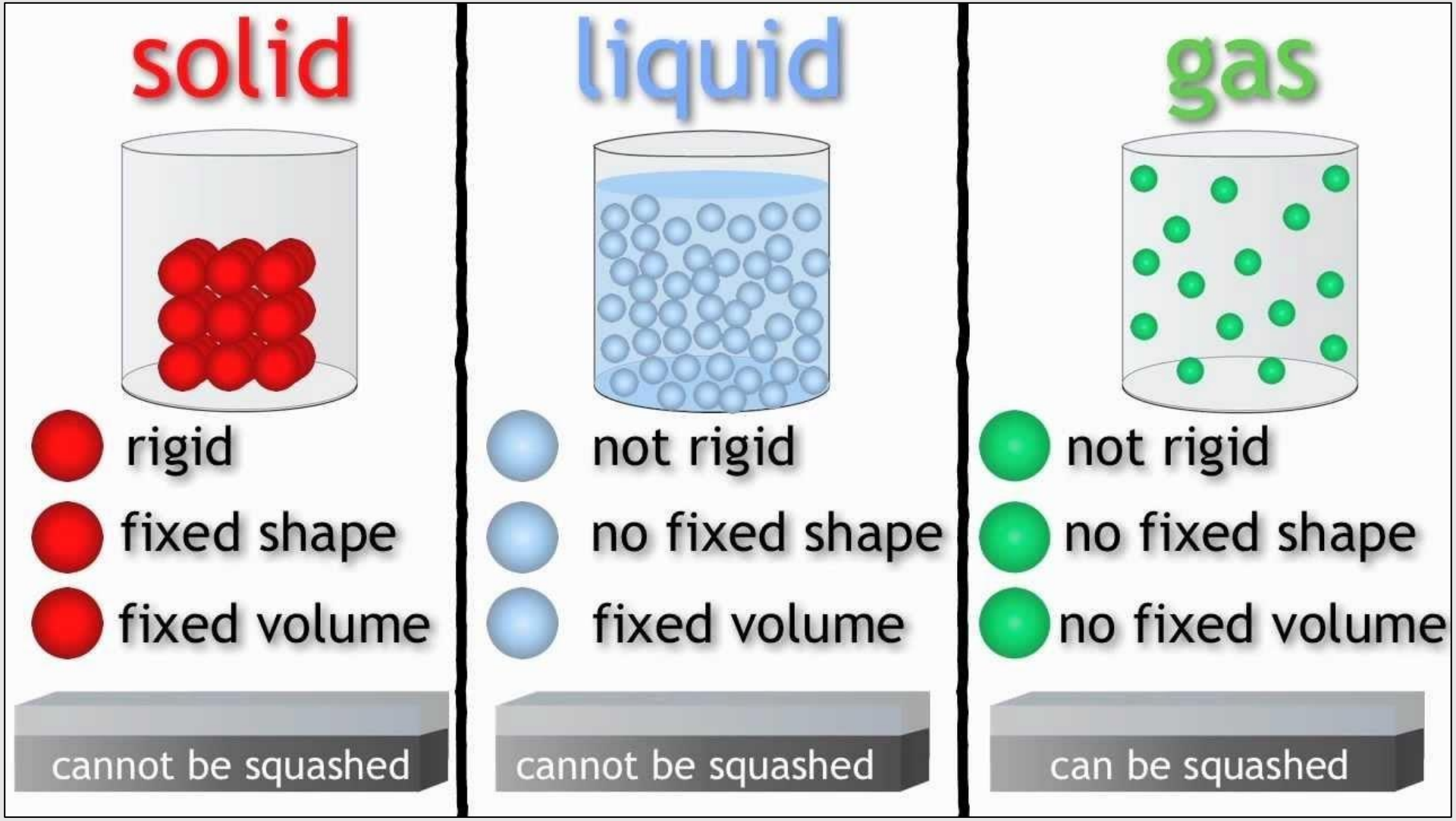
❖ The working fluid – is a moving material medium (liquid or gaseous), which serves as an intermediary in the process of converting heat into mechanical work or in transferring energy from one place of the machine to another.

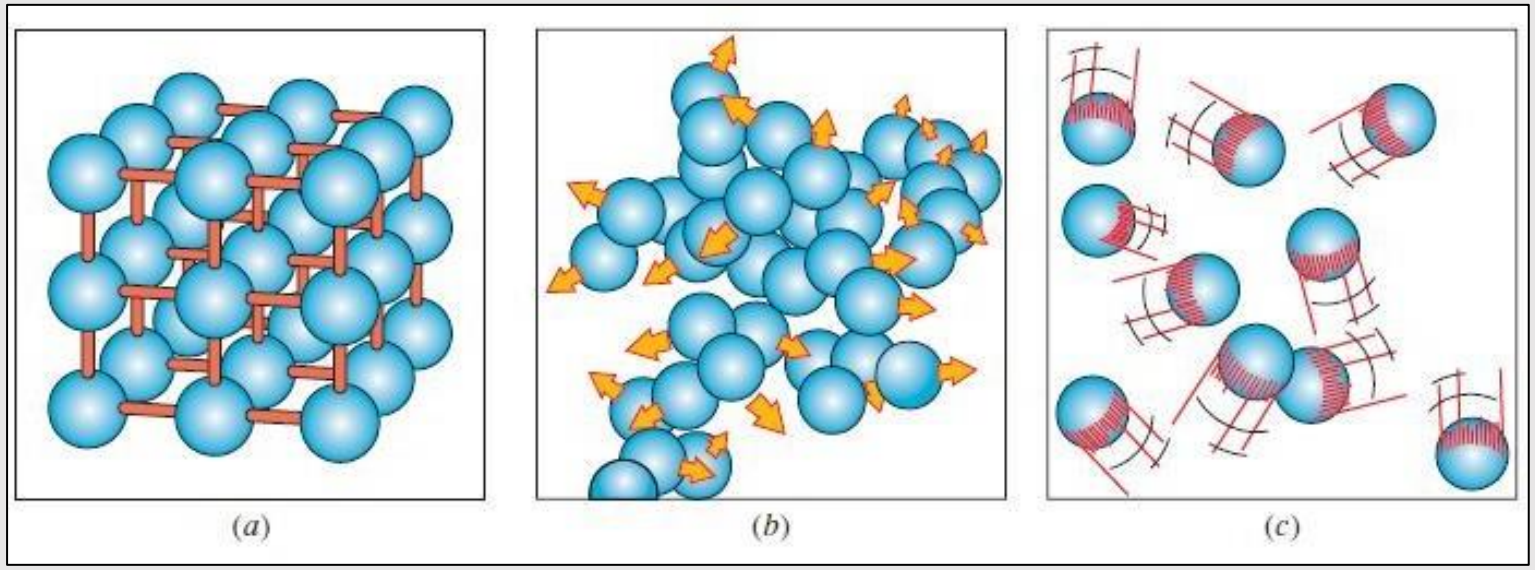
❖ The working fluid in jet engine and internal combustion engines and other engines are gases (air, combustion products) and liquids (kerosene, oil).

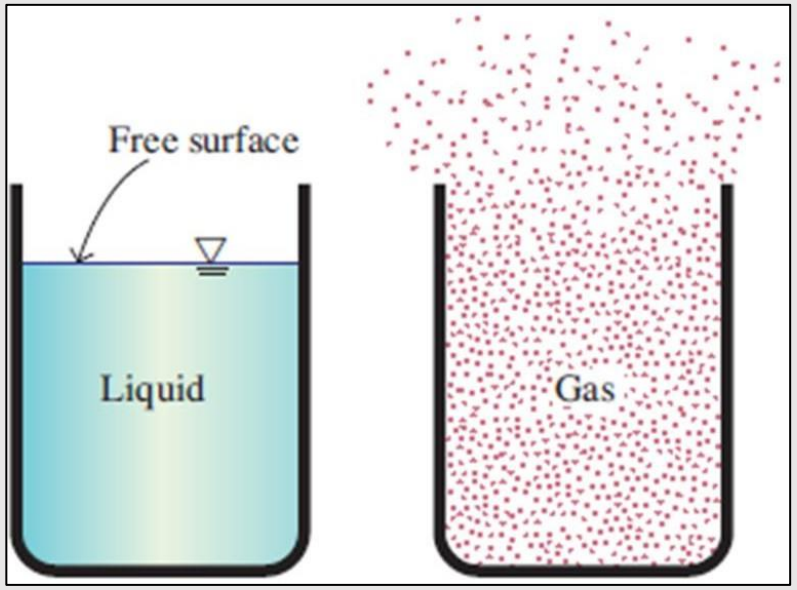
The general name is – liquids. They have high particle mobility and very low tensile and shear resistance.



Different state of matter





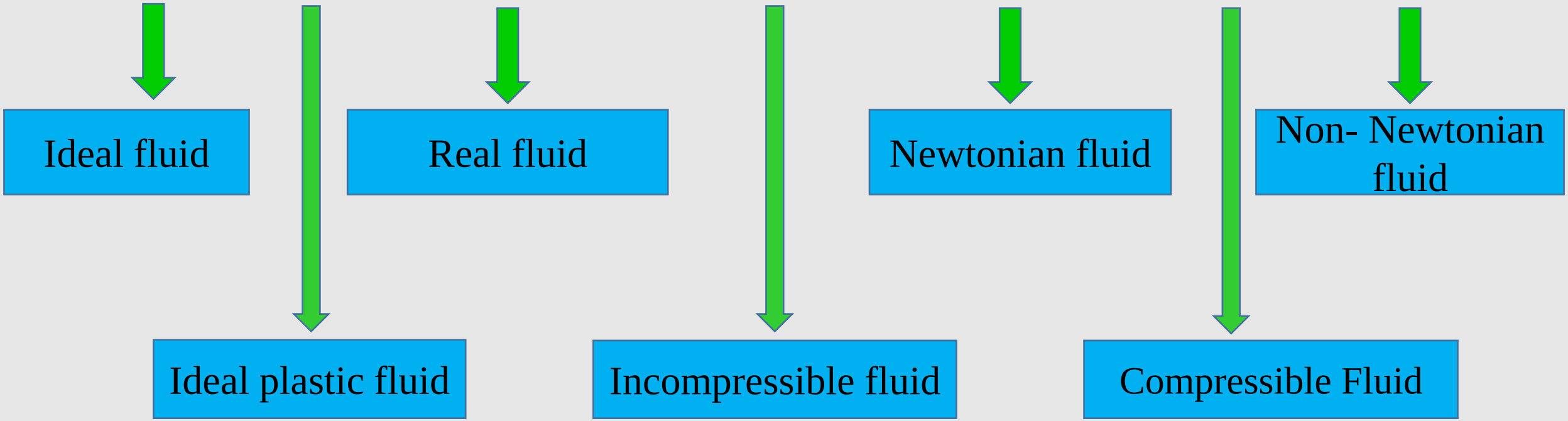


The arrangement of atoms in different phases:

- a) molecules are at relatively fixed positions in a solid.
- b) groups of molecules move about each other in the liquid phase.
- c) individual molecules move about at random in the gas phase.

Unlike a liquid, a gas does not form a free surface, and it expands to fill the entire available space

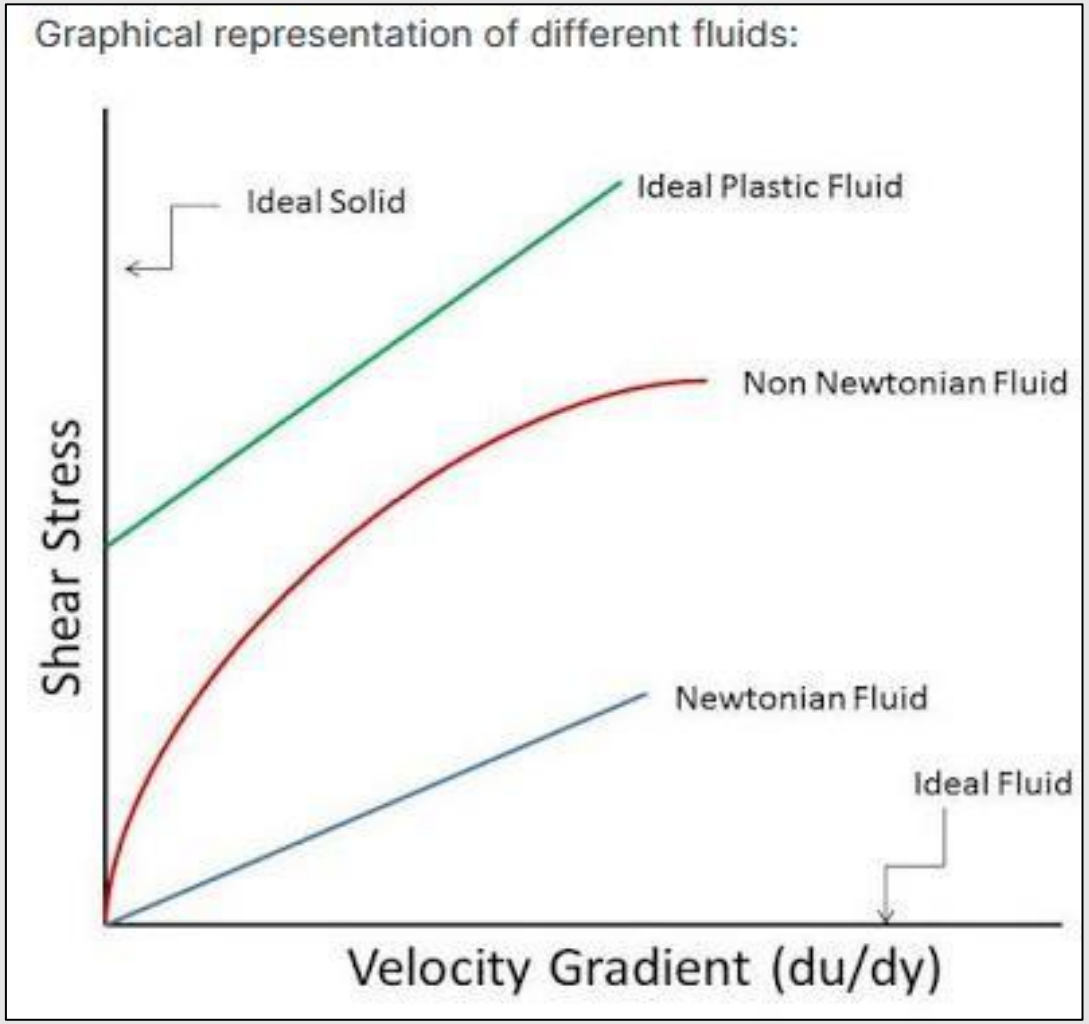
3. Classification of fluid



1. Ideal fluid- A fluid, which is incompressible and having no viscosity, is known as an ideal fluid. Ideal fluid is only an imaginary fluid as all the fluids, which exist, have some viscosity.

2.Real fluid- A fluid, which possesses viscosity, is known as real fluid. All the fluids, in actual practice, are real fluids. Example: Water, Air etc.

3.Newtonian fluid: A real fluid, in which shear stress in directly proportional to the rate of shear strain or velocity gradient, is known as a Newtonian fluid. Example: Water, kerosene etc.



❖**Shear rate** is the rate of change of velocity at which one layer of fluid passes over an adjacent layer.

4. Non Newtonian fluid - A real fluid, in which shear stress in not directly proportional to the rate of shear strain or velocity gradient, is known as a Non Newtonian fluid. Example: Coneflower, butter, motor oil.

5. Ideal plastic fluid - A fluid, in which shear stress is more than the yield value and shear stress is proportional to the rate of shear strain or velocity gradient, is known as ideal plastic fluid. Example: Tooth paste.

6. Incompressible fluid - A fluid, in which the density of fluid does not change which change in external force or pressure, is known as incompressible fluid. All liquid are considered in this category.

7. Compressible fluid - A fluid, in which the density of fluid changes while change in external force or pressure, is known as compressible fluid. All gases are considered in this category.

4. Compressible versus and Incompressible Flow

❖ A flow is classified as being compressible or incompressible, depending on the level of variation of density during flow.

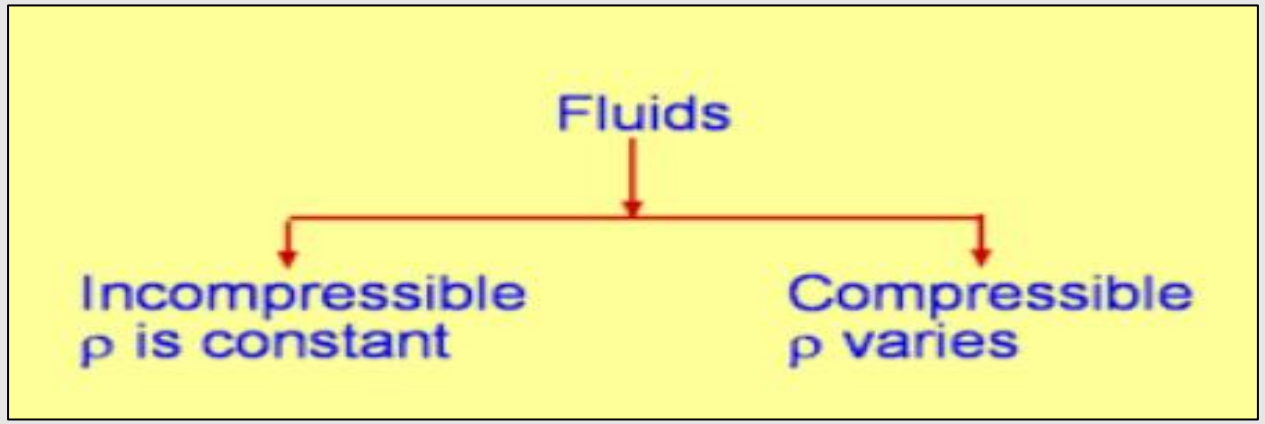
1. Incompressible flow: if the density of the flowing fluid remains nearly constant throughout. The densities of liquids are essentially constant, and thus the flow of liquids is typically incompressible. Therefore, liquids are usually referred to as incompressible substances.

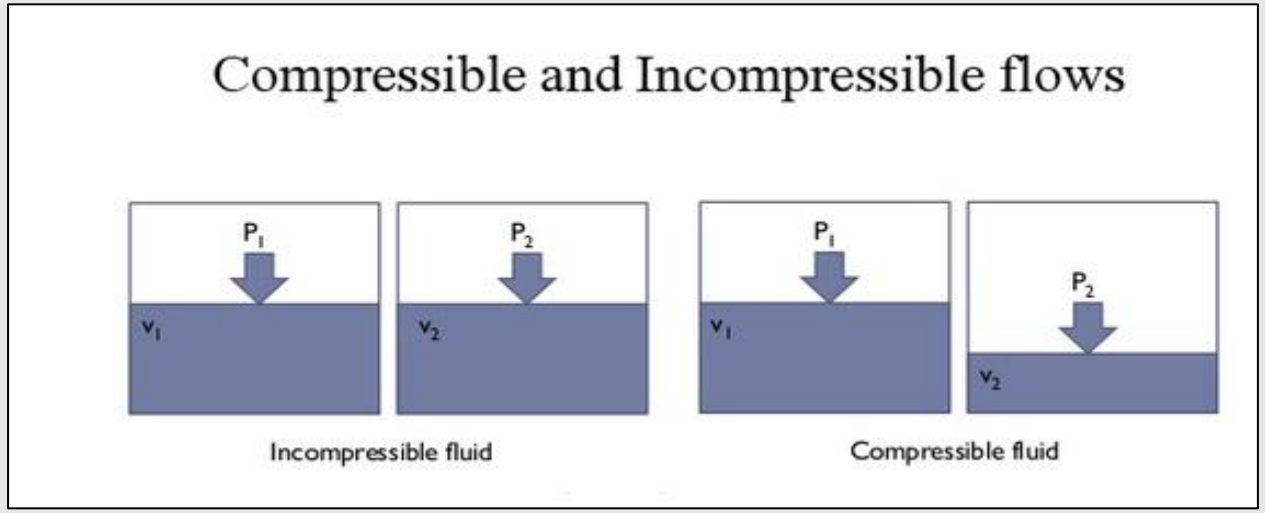
2. Compressible flow: if the density of the fluid changes during flow(e.g, high speed gas flow).

Gases, on the other hand, are highly compressible, when analyzing rockets, spacecraft, and other systems that involve high-speed gas flows, the flow speed is often expressed in terms of the dimensionless Mach number defined as:

$$\text{Ma} = \frac{V}{c} = \frac{\text{Speed of flow}}{\text{Speed of sound}}$$

4. Compressible versus Incompressible Flow





Ma = 1	Sonic flow
Ma < 1	Subsonic flow
Ma > 1	Supersonic flow

5. Units of measurements

Quantity	Name	Symbol	SI base unit	Derived unit
Area	square metre	A	m^2	-
Volume	cubic metre	V	m^3	-
Velocity	metre per second	u	m/s	-
Acceleration	metre per second squared	a	m/s^2	-
Force	newton	N	$kg\ m/s^2$	J/m
Energy	joule	J	$kg\ m^2/s^2$	N m
Pressure or stress	pascal	Pa	$kg/m\ s^2$	N/m^2
Power	watt	W	$kg\ m^2/s^3$	J/s

Questions

1) What is fluid Mechanics and is it divided into two parts?
2) Define Fluid and gas mechanics and what to include?
3) Define working fluid?
4) What is difference between state of matter?
5) What is the classification of liquids and the definition dates for each?