SNS COLLEGE OF TECHNOLOGY
(An Autonomous Institution)

Department of Aerospace Engineering

23AST101-Fundamentals of Aerospace Engineering

UNIT-2:
AERODYNAMICS

MACH NUMBER

Mr.N.Venkatesh (AP/Aerospace)

The **Mach number** (denoted as **M**) is a dimensionless quantity used in fluid dynamics to describe the speed of an object moving through a fluid (such as air) relative to the speed of sound in that fluid. It is defined as:

$$M = v / a$$

Where:

v = velocity of the object relative to the fluid.

a = speed of sound in the fluid.

The Mach number is used to categorize flow regimes and the behavior of objects moving through a fluid. These regimes are divided into distinct regions based on the value of the Mach number:

1. Subsonic Flow (M < 1)

The object moves slower than the speed of sound.

Low subsonic (M < 0.3): Compressibility effects are negligible, and the flow can be treated as incompressible.

High subsonic (0.3 < M < 1): Compressibility effects become significant, and the flow is treated as compressible.

2. Transonic Flow (M ≈ 1)

The object moves close to the speed of sound (typically between 0.8 < M < 1.2).

Both subsonic and supersonic regions coexist around the object.

Shock waves begin to form, leading to increased drag and aerodynamic instability.

3. Supersonic Flow (M > 1)

The object moves faster than the speed of sound.

Shock waves form, creating a sharp pressure change.

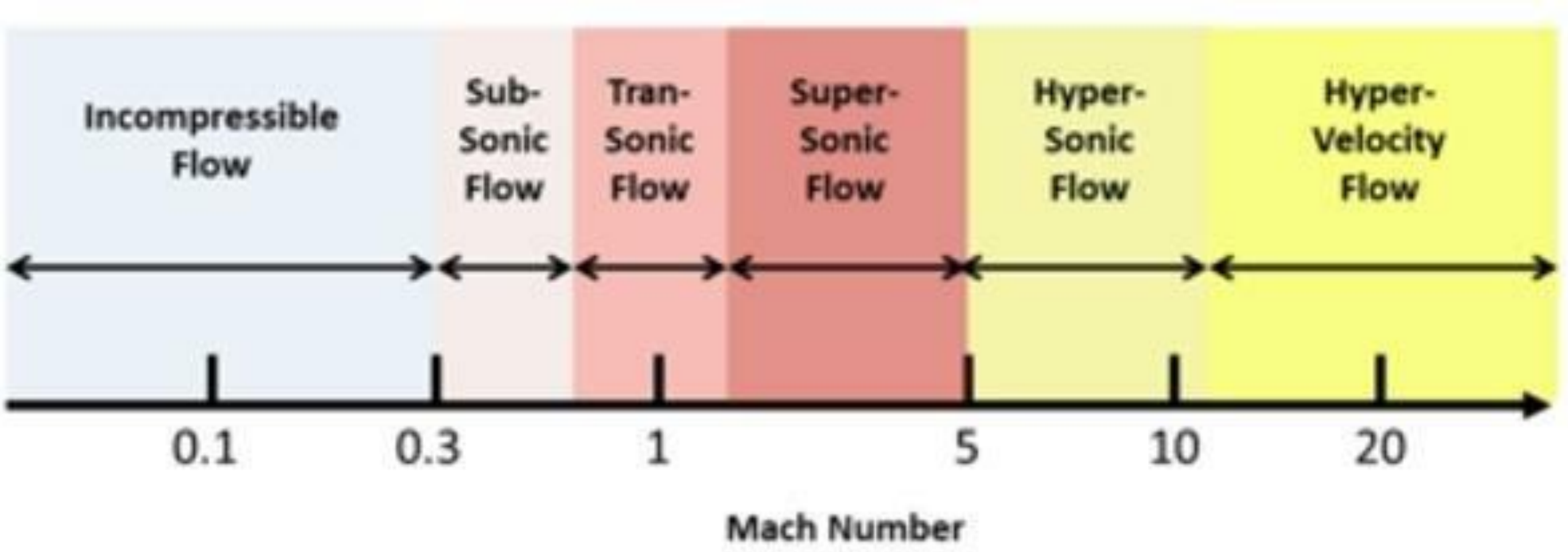
Aerodynamic heating and compressibility effects are significant.

4. Hypersonic Flow (M > 5)

- The object moves much faster than the speed of sound.
- Extreme aerodynamic heating occurs due to air compression.
- Chemical reactions in the air (such as dissociation and ionization) become significant.

Key Characteristics of Each Region

Flow Regime	Mach Number (M)	Characteristics
Subsonic	M < 1	Smooth flow, no shock waves, compressibility negligible at low M.
Transonic	0.8 < M < 1.2	Mixed subsonic and supersonic flow, shock waves form, increased drag.
Supersonic	1 < M < 5	Shock waves dominate, compressibility effects are significant.
Hypersonic	M > 5	Extreme heating, chemical reactions, and strong shock waves.



Applications

- **Subsonic:** Commercial aircraft, cars, and most everyday objects.
- **Transonic:** High-speed aircraft (e.g., jet fighters approaching the sound barrier).
- **Supersonic:** Military jets (e.g., Concorde, SR-71 Blackbird).
- **Hypersonic:** Spacecraft re-entry, hypersonic missiles, and experimental vehicles.


THANK YOU!