SNS COLLEGE OF TECHNOLOGY

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Coimbatore – 35

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DEPARTMENT OF AEROSPACE ENGINEERING

19ASO301 BASICS OF AERONAUTICAL ENGINEERING

UNIT 4 – AIRCRAFT POWER PLANTS

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UNIT 4 – AIRCRAFT POWERPLANTS

- *Power Plant*
- *Reciprocating Engine*
- *Gas Turbine Engine*
- *Ramjet Engine*
- *Propeller*
- *Comparison - Helicopter & Airplane*
- *Rocket – Principle & Operation*

TEXT BOOK

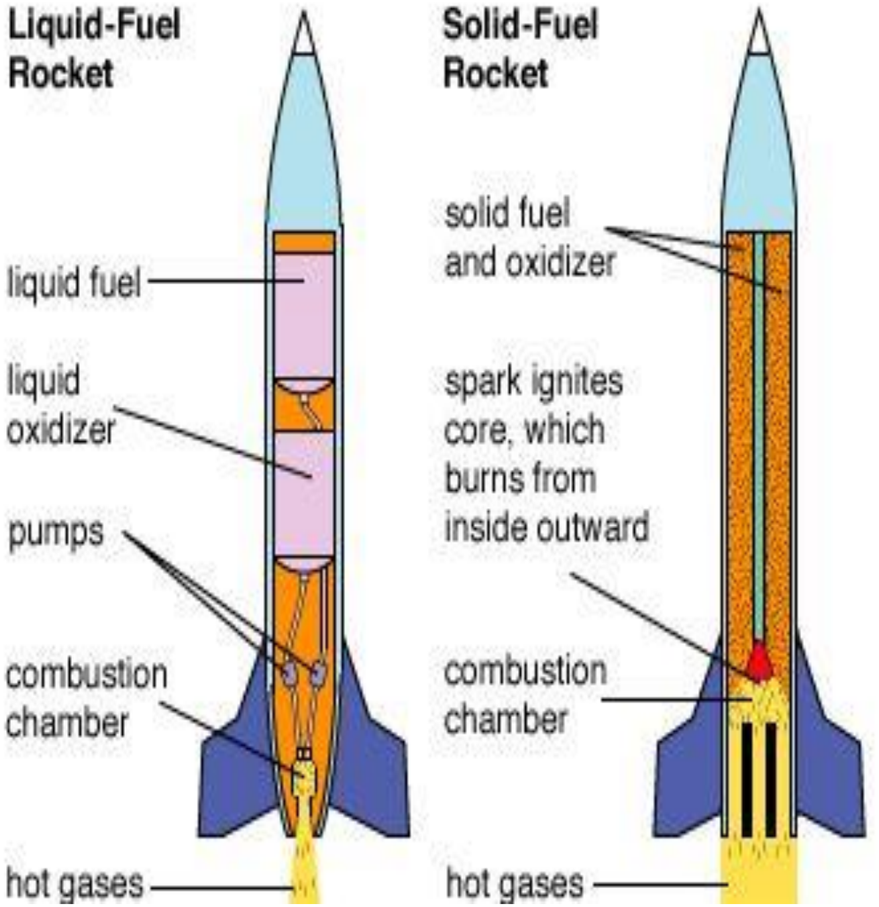
- ***Anderson. J D, "Introduction to Flight", McGraw-Hill, 1995***

- ***Richard S. Shevel, "Fundamentals of Flight", Prentice Hall, 2010***

Rocket - Operation

Action & Reaction

- *Thrust is generated due to high pressure gases exiting through the nozzle at a very high velocity.*
- *Going by the Newton's Third law, high exit velocity of the gases accelerates the rocket in the opposite direction.*
- *The propellant can be Solid, Liquid or Hybrid.*



Rocket - Operation

Thrust & Efficiency

- *Thrust is the force exerted backward to move a rocket forward*

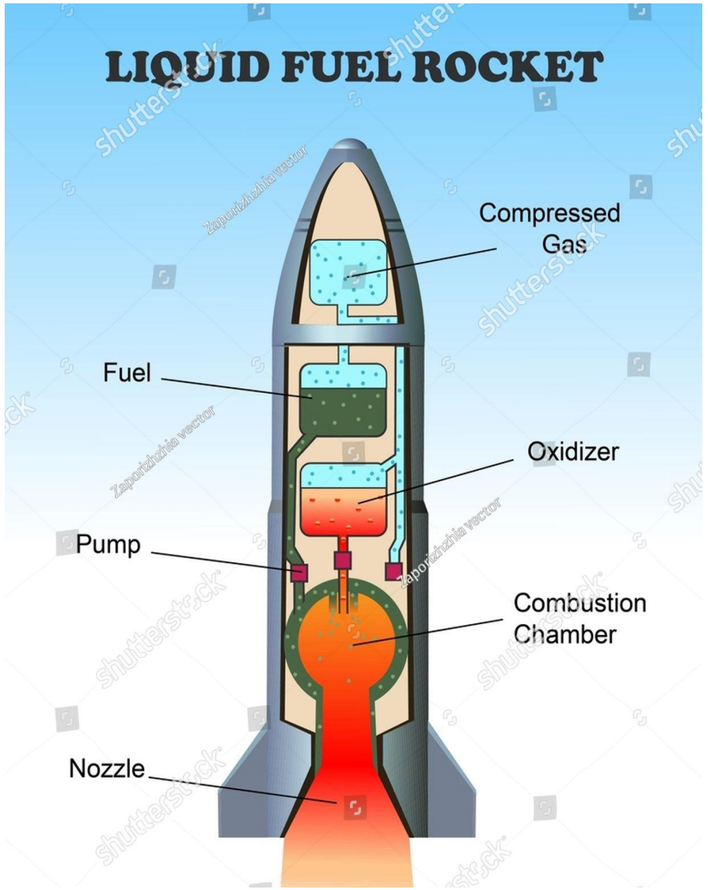
- *Efficiency- How effectively the chemical energy is converted into kinetic energy.*

Stages

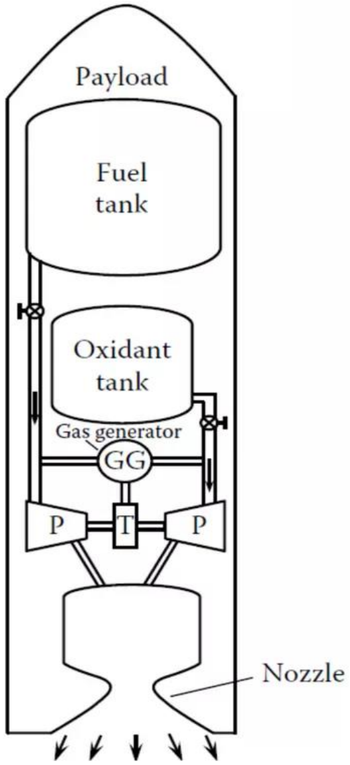
- *In some cases, multiple stages/ multiple rockets in every stage are there to boost the thrust.*

Rocket - Liquid Propellant

- *Rocket that uses liquid fuel and oxidizer to create thrust.*
- *Liquid propellants are often used because they have a high density and high specific impulse*
- *High Specific Impulse - More fuel efficient, which means producing more thrust for the same amount of propellant.*
- *Liquid Propellant – Liquid Oxygen, Liquid Hydrogen, Nitrogen Tetroxide, Hydrazine (inorganic Nitrogen compound) & Red fuming nitric acid (Nitric acid with dissolved Nitrogen dioxide)*



Liquid Propellant Rocket Engines



- Around 1927, an American professor, Robert Goddard, had designed and developed an LPRE.
- In addition to having a liquid form, this propellant can be stored in a separate tank and can be controlled easily, and hence thrust can be varied easily unlike in an SPRE.
- As LPREs are stored in separate tanks unlike SPRE, one can achieve a higher level of thrust and is thus considered to be more powerful than an SPRE. Therefore, it is preferred for large spacecraft and ballistic missiles.
- Both fuel and oxidizer propellants are stored separately in special tanks at high pressure.
- The pressurized liquid propellants are converted into spray consisting of arrays of droplets with the help of atomizers.
- An igniter is used to initiate the combustion process on the surface of the propellant.
- As a result, the propellant will start burning and fill up the empty thrust chamber, thereby building up pressure in the chamber
- High-temperature and high-pressure gases are expanded in a CD nozzle to produce the requisite thrust.

Liquid Propellant Rocket Engines

Advantages

- An LPRE can be reused.
- It provides greater control over thrust.
- It can have higher values of specific impulse.
- It can be used for long-duration applications.
- It is easy to control this engine as one can vary the propellant flow rate easily.
- The heat loss from the combustion gas can be utilized for heating the incoming propellant.

Disadvantages

- This engine is quite complex compared to the SPRE.
- It is less reliable as there is a possibility of malfunctioning of the turbopump injectors and valves.
- Certain liquid propellants require additional safety precaution.
- It takes much longer to design and develop.
- It becomes heavy, particularly for short-range application.