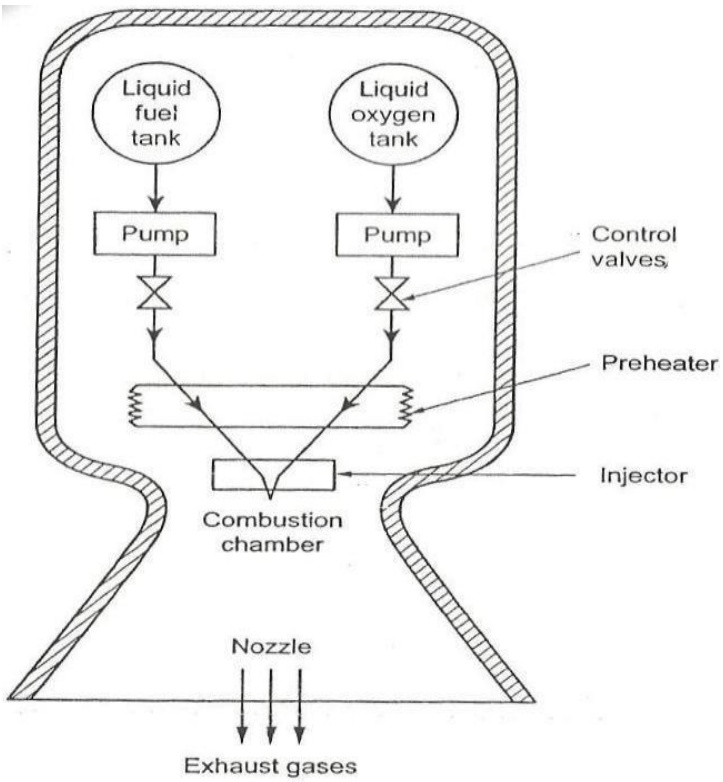
## ROCKET PROPULSION

## CHEMICAL ROCKET ENGINES

### LIQUID PROPELLANT ROCKET ENGINE

**Construction**

- The construction of Liquid Propellant Rocket engine is shown in Fig.
- Liquid fuel (refined petrol, liquid hydrogen, hydrazine, etc.) and liquid oxygen are used in this engine.
- Liquid fuel and liquid oxygen are stored separately in two different tanks as shown in Fig.
- Pre heater is used to heat the fuel and oxidizer.
- Nozzle is used to increase the velocity and decrease the pressure of the gases.



## LIQUID PROPELLANT ROCKET ENGINE

**Working**

- Liquid fuel and liquid oxygen are pumped separately into a combustion chamber through controlvalves.
- Since the liquid fuel and liquid oxygen are stored at very low temperature, they are preheated in the preheater to a suitable temperature.
- The preheated fuel-oxidizer mixture is injected into the combustion chamber through suitable injector and combustion takesplace.
- When the combustion takes place in the combustion chamber, very high- pressure and very high temperature gases are produced.
- The highly heated products of combustion gases are then allowed to expand in the nozzlesection.
- In the nozzle, pressure energy of the gas is converted into kinetic energy. So the gases coming, out from the unit with very high velocity.
- Due to high velocity of gases coming out from the unit, a force (or) thrust is produced in the Opposite direction. This thrust propels therocket.

**Advantages**

- Liquid propellant engines can be reused after recovery. So it is economical.
- Combustion process is controllable i.e., it is easy to stop the combustion by closing the fuel valve (or) oxidizervalve.
- Speed regulation i.e., increase and decrease of speed is possible.
- High specificimpulse.
- More economical for long rangeoperation.
- Malfunctions and accidents can be rectified at anystage.

**Disadvantages**

- Liquid propellant rocket construction is more complicated compared to solid propellantrocket.
- Manufacturing cost is high.
- There are additional handling and safety problems if the propellants are poisonous andcorrosive.
- The size and weight of the engine is more compared to solid propellantrocket.
- Highvibration
- Many liquid propellants can exist in liquid state at very low temperature. So proper insulation is needed.

**LIQUID PROPELLANTS**

Liquid propellants are classified into the following two groups.
(a) Monopropellants
(b) Bipropellants

**MONOPROPELLANTS**

A liquid propellant which contains both the fuel and oxidizer in a single chemical is known as a monopropellant. It is stable at normal ambient conditions and liberates thermo-chemical energy on heating. Monopropellants have been widely used in solid propellantrockets.
Examples:
1. Nitroglycerine
2. Nitromethane
3. Hydrogenperoxide
4. Hydrazine

**BIPROPELLANTS**

If the fuel and oxidizer are different from each other in its chemical nature, then the propellant is called bipropellant. Bipropellants have been widely used in liquid propellant rocket system. The mostly used bipropellant combinations are listed below.

| **Oxidizer** | **Fuel** |
|---|---|
| Liquid oxygen | Gasoline, Methane, Ethanol, Hydrazine Unsymmetrical Dimethyl Hydrazine (UDMH) |
| Red fuming nitric acid | Aniline, Ethanol |
| White filming nitric acid | Alcohol |
| Hydrogen peroxide | Hydrazine, Ethanol, Methanol |

**PROPERTIES OF LIQUID PROPELLANTS**

- Propellant should have high calorificvalue.
- It density should be high.
- It should have low values of vapour, pressure andviscosity.
- It should have higher specific heat and thermalconductivity.
- Products of combustion should have low molecular weight to produce high jet velocity.
- It should be non-corrosive and non-reactive with components of theengine.
- It should not be poisonous andhazardous.
- It should be cheap and easilyavailable.
- Energy released during combustion per unit mass of the propellant combination should be high.
- It should be easilyignitable.