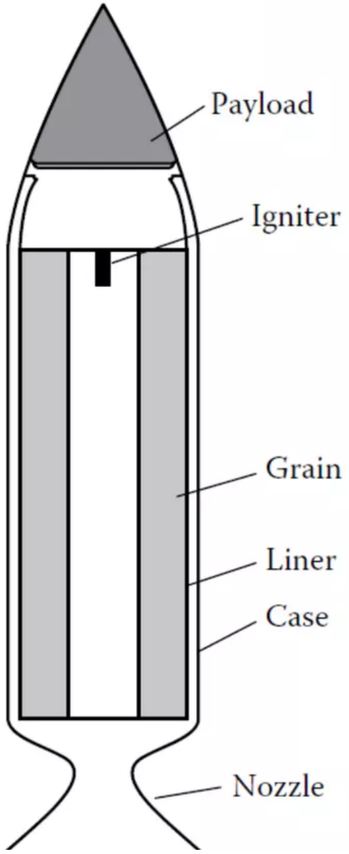
Rocket - Solid Propellant

- *Solid propellants are a mixture of solid fuel and oxidizer, used in rockets and missiles, offering advantages like ease of storage and handling, and high energy density.*
- *They are a common choice for military and space applications, especially for boosters and smaller rockets.*
- *Solid Propellant – Ammonium Perchlorate (70%), Aluminium (16%) and Binder (14%)*

Solid Propellant Rocket Engines



- Solid-propellant rocket engine (SPRE) is one of the oldest non-air-breathing engines.
- The solid propellant composition, which was initially black powder, underwent a series of changes with time.
- Propellant, which mainly consists of fuel, oxidizers, and various additives, is entirely stored within the combustion chamber in the form of blocks of definite shape called grain and is supported by the walls.
- Grain contributes to around 80%– 95% of the total mass of an SPRE.
- The igniter initiates the combustion process on the surface of the propellant when actuated with the help of an electrical switch.
- As a result, the propellant grains will start burning and filling the empty combustion chamber, hence building up the chamber pressure.
- Subsequently, the high-temperature and high-pressure gases are expanded in the supersonic nozzle to produce the requisite thrust.
- Solid rocket engine is considered to be a non-air-breathing vehicle without any moving parts

Solid Propellant Rocket Engines

Advantages

- It is simple to design and develop.
- It is easier to handle and store unlike liquid propellant.
- Detonation hazards of many modern SPREs are negligible.
- Better reliability than Liquid Propellant Rocket Engine (LPRE) (>99%).
- Development and production cost of SPREs is much smaller than that of LPREs, especially in the high-thrust bracket

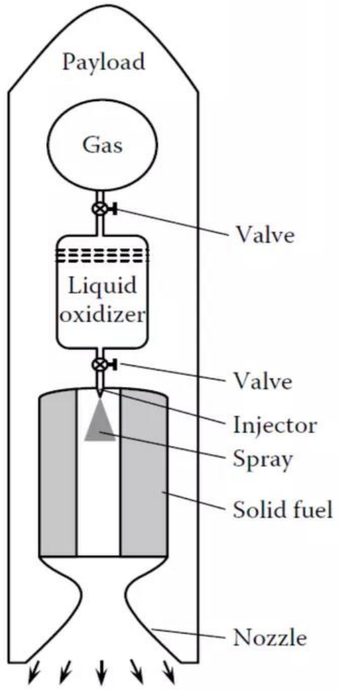
Disadvantages

- It has lower specific impulse compared to LPREs and hybrid propellant rocket engines (HPREs).
- It is difficult to turn off its operation unlike in an LPRE.
- Transport and handling of solid propellants are quite cumbersome.
- The cracks on the propellant can cause an explosion.

Rocket - Hybrid Propellant

A hybrid-propellant rocket uses propellants in two different phases viz. one solid and the other either gas or liquid, offering potential benefits like safety, low cost compared to solid or liquid rockets.

Hybrid Propellant Rocket Engines



- This engine can use both solid and liquid types of propellants.
- Most widely used propellant combination is a liquid oxidizer along with a solid propellant.
- Only the oxidizer propellant in the present example is stored in a special tank under high pressure.
- The pressurized propellants are converted into spray consisting of arrays of droplets with the help of atomizers.
- It consists of major components, namely, a propellant feed system, a combustion chamber, a solid fuel grain, an igniter system, and a nozzle.
- Some of the propellant evaporates due to the recirculation of hot gases and comes into contact with the gaseous fuel that emanates from the solid fuel grains due to pyrolysis
- The combustion products start burning and fill the empty thrust chamber, thereby building up pressure inside the chamber.

Hybrid Propellant Rocket Engines

Advantages

- An HPRE can be reused.
- It provides greater control over thrust.
- It has relatively lower system cost compared to the LPRE.
- It can have higher values of average specific impulse compared to the SPRE.

Disadvantages

- This engine is quite complex compared to the LPRE.
- It takes much longer to design and develop.
- It becomes heavy, particularly for short-range application.
- Certain liquid propellants require additional safety precaution