Solid Fuel or Liquid Fuel?

Until 1926, all rockets used solid propellants. A chemical fuel (a material that can be burned to create heat or power) and a chemical oxidizer (a material that supplies oxygen to burn the fuel) were mixed and packed around the inside of the rocket shell. An open space was left in the center of the rocket. An igniter in the open space started the inner surface of the fuel and oxidizer burning, producing hot gas. As the gas shot out the open back end of the rocket, the rocket was pushed forward. The fire would continue burning until all of the propellant mixture was used up.

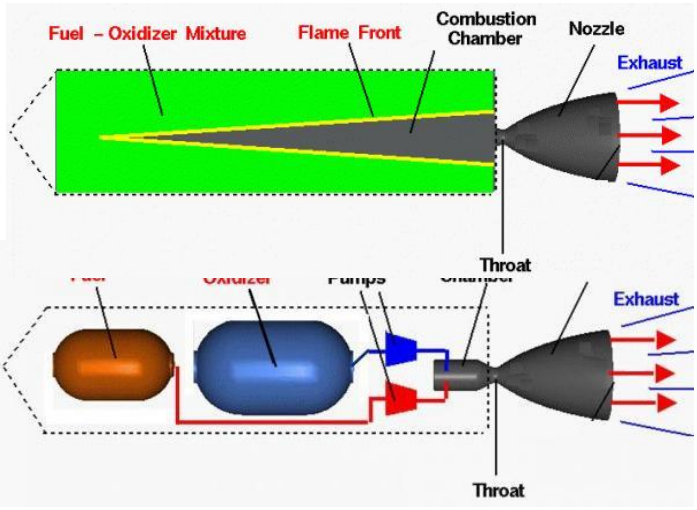
Dr. Robert Goddard started his research by trying to improve solid-propellant rockets. Progress was slow, until he did some computations. He found that in existing rockets, only 2 percent of the solid fuel's chemical energy was turned into thrust, with the rest going unused or producing heat, light, and noise rather than thrust.

Goddard's research on alternative fuels revealed that liquid hydrogen fuel with liquid oxygen as an oxidizer would provide much more chemical energy while weighing far less than the solid propellants that powered existing rockets. Liquid hydrogen was expensive and difficult to work with, but his calculations showed that ether, kerosene, or gasoline would be more practical fuels to use while still providing abundant chemical energy. In addition to providing more power with less weight, liquid propellants could be fed at different rates to produce variable thrust, and liquid-propellant engines would be able to be shut down before the fuel was exhausted and restarted at a later time.

The tanks that would hold the liquid fuel, liquid oxidizer, and combustion chamber would have to be made strong enough to contain the propellants' pressures and the heat and pressure produced by the combustion. Even then, though, the total weight would be less than that of the solid propellant that normally filled a rocket.

He would also have to devise a way to combine the fuel and oxidizer in the correct proportions within the combustion chamber in a way that would produce a continuous, powerful stream of exhaust gas.

Solid Propellant Rocket



Liquid Propellant Rocket

[Illustrations by NASA]