Aircraft propulsion systems

An aircraft's propulsion system is directly related to the tasks and objectives it carries out

Propellers are the most representative symbol of aerial propulsion. They are made up of a variable number of blades which, when rotating around a shaft, generate a propulsive force.

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Flight depends on the balance of four forces: thrust, drag, lift and weight

Internal combustion engine

Up until the Second World War, the only propulsion system used in aircraft was internal combustion engines. The technique they employ consists of transmitting the power obtained from a reciprocating engine to a rotating shaft. The shaft is solidly attached to a propeller that is ultimately responsible for propulsion, as its rotational movement generates thrust in the required direction.

Two-stroke engine

Air-cooled or liquid-cooled (heavier) engines, with no lubrication requirements (oil and fuel are mixed). They are used for RPAS and light aircraft.

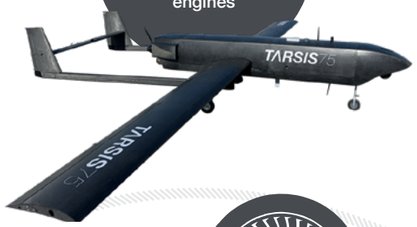
Four-stroke engine

These engines have a specific cooling system. The lubrication system (oil) is separate, which reduces exhaust emissions.

Douglas DC3

The DC3 had an internal combustion engine, and revolutionised passenger transport in the 1930s and 1940s.

TARSIS 75
Fixed-wing RPAS often use reciprocating engines



Reaction engines

Reaction engines operate by taking air from outside through a diffuser, compressing it in the compressor, passing it through a combustion chamber mixed with fuel, and burning it to raise the pressure and temperature. It then passes through a turbine, where the pressure and temperature are reduced in exchange for mechanical power to drive the compressor. The air is expelled at high speed through the nozzle in the opposite direction to the aircraft's movement.

With a compressor

Turboprop

Low speeds (<<M=1) and high efficiency

This is a turbojet engine with a coupled propeller (with speed reducers), which rotates thanks to the turbine's excess power. The propeller generates traction and increases thrust.

Turbofan

Medium speeds (<M=1) and high efficiency

This is a variant of the turbojet that has a fan incorporated into the engine. Its function is similar to that of the propeller: increasing thrust.

Turbojet

High speeds (>M=1) and inefficient

This is one of the simplest turbine engines, consisting of a compressor, combustion chamber, turbine and nozzle. The turbine is located in the gas expansion zone and uses part of the power output of the gases to drive the compressor.

Without a compressor

Ramjet

Very high speeds (>>M=1) and very inefficient

Reaction engine with no compressors or turbines. The air is compressed by the geometry of the engine, passing to the combustion chamber and then to the exit nozzle, where it is expelled at high speed.

Pulsejet

Very high speeds (>>M=1) and very inefficient

The air is mixed with the fuel by means of valves and injectors and passes into the combustion chamber, where combustion occurs in on/off pulses.

Heinkel He 178 (1939)
First jet aircraft

De Havilland Comet (1952)
First passenger jet aircraft

Rocket engine

Rocket engines generate thrust by expelling gases from the combustion chamber into the atmosphere. They combine both the fuel and a comburent (oxidiser). These are the most powerful types of engine known, and their weight/power ratio makes them ideal for use in spacecraft.

Solid propellant

These rockets have an engine that uses a solid propellant (reducing and oxidising agents). They consist of a casing, nozzle, grain (propellant charge), and igniter. Their major advantage is constant availability, short start-up time, and easy transport and storage. Their drawback is the inability to control the thrust (or even turn it off) before the fuel has been completely consumed.

Wernher von Brown next to the F-1 rocket engines on Saturn V

Liquid propellant

Liquid propellant engines have an oxidiser and a liquid reducing agent (e.g. liquid oxygen or hydrogen). With the correct injection of fuel into the combustion chamber, it is possible to control the engine thrust.

Hybrid propellant

These have a solid propellant in the combustion chamber, and have another propellant (liquid or gas) added for combustion.

Thermal rocket engine

These engines have an inert propellant that is heated with a non-chemical energy source (solar, nuclear or radiation).

J-2 rocket engine on Saturn V

Other aeronautical propulsion systems

Electric motor

Their main components are the battery, controller, motor and rotor. They generate torque that is proportional to the supply voltage. They have almost no moving parts, which increases their operating tolerance at higher revolutions, and they are more efficient than other types of engines. Their disadvantage is their low energy storage capacity.

Solar Impulse
Electric motor

Fuel cells

These are electrochemical devices in which a continuous flow of fuel and an oxidising agent undergoes a controlled chemical reaction, supplying an electrical current to an external circuit. Typically used fuels include molecular hydrogen and methane, using oxygen as an oxidising agent. The electrochemical process that takes place is highly efficient and has minimal environmental impact.

Ion drive

Ion drive is a type of propulsion that uses beams of ions (electrically charged molecules or atoms) for propulsion. The general working principle involves the use of the charge/mass ratio of ions to accelerate them to very high speeds using an electric field.

Solar sail

This system captures thrust produced by sources external to the aircraft, meaning there is no need to carry either an engine or fuel. Photon sails take advantage of solar radiation pressure to gain propulsion. Plasma sails intercept solar wind plasma to gain propulsion.

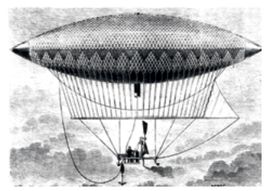
JULY 2015
The Airbus E-FAN crossed the English Channel (74 km) in 34 minutes

Aeronautical milestones

Did you know...?

1785
Jean Pierre Blanchard crossed the English Channel in a balloon that used flapping wings as a propulsion mechanism and had a rudder shaped like a bird's tail. This is the first record of a propelled flight.

1852
Henri Giffard was the first person to carry out a powered flight. He flew 27 km in a dirigible powered by a steam engine.



1903
The Wright brothers were the first to fly in a heavier-than-air aircraft, powered by a combustion engine.

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