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Jet propulsion system pdf

Jet Propulsion Fred Landis Near the end of World War II, allied pilots were memorized by a new German fighter jet. He didn't have a propeller, he flew with a deep howoed and flashed the air at more than 500 miles per hour. This incredible plane was a Jet propulsion plane, a Messerschmitt Me-262. Today, jet fighters fly through the stratosphere faster than sound. Jet jets are flying higher, faster and farther than ever before. Jet propulsion accelerates the missiles to their targets. In addition, rockets are boosting Earth's satellites into orbit. Although most of the jet propulsion was for flight, it can also be applied to hydraulic jet propulsion for small, fast ships and pleasure vessels. In such applications water is taken to the front end of the boat, compressed by high pressure pumps and discharged through the nozzle at the back of the boat. The need for efficient pumps and boat speed limits have not made the hydraulic jet propulsion an attractive or economic alternative to propeller-powered vessels. Jet propulsion is driving forward the body using a jet of gas or liquid. The idea dates back to the 1st century BC, when the Alexandrian hero built an engine called the aeolipile. He mounted a hollow metal globe with projection tubes between the two tubes so he could spin. Steam entered the world through pipes. As he escaped through bent tubes, jets of steam swirled the world. Hero's machine illustrates the scientific principle that Sir Isaac Newton formulated in 1687. Newton's third law of movement says that for every action there is an equal and opposite reaction. In Hero's machine, the jets of steam running from the tube are action, turning the globe into a reaction. The same principle applies to jet engines, so for this reason they are called reaction engines. Newton designed a jet carriage called Newton's Wagon himself. A ball filled with water is heated by fire, creating steam. A large nozzle projected back from the sphere. As the pair escaped from the jet, she launched the car forward. Principle There are many everyday examples of jet propulsion. An inflated toy balloon with a closed neck does not show a tendency to move, as the air inside presses equally in all directions. If the neck suddenly opens, the balloon cracks. The escaping air relieves pressure on the neck, and there is an aerial reaction across the door. However, the air that heals from the neck and pushes towards the outer air does not propel the balloon forward. It's the air that pushes towards the inner front wall of the balloon that pushes it forward. In fact, the jet would function more efficiently in a vacuum because there would be no air to interfere with the gases that are escaping. The twitch of the rifle also illustrates the action and reaction. The spread of gases forces the bullet out of the pipe at a high level A rifle in response to the force of the gases strikes back. Another example of the action of the jet is a garden hose whose nozzle jumps back when the water suddenly turns on at full power. Types There are two general types of jet propulsion for breathing in the air and engines that breathe nonair. Air-breathing engines use oxygen from the atmosphere to burn fuel. They include turbojet, turboprop, ramjet and pulse-jet. The term jet is generally used only in relation to engines that breathe air. Nonair breathing engines carry oxygen supply. They can be used both in the atmosphere and in the outer space. They are commonly referred to as rockets and are two types of liquid propulsion and solid propulsion. Air-breathing engines can be further divided into two groups, based on how they compress the combustion air. Turbojet and turboprop each have a compressor, usually powered by a turbine, for air. They're called gas turbine engines. Ramjet and pulse-jet don't have compressors. Turbojet engines. The most commonly used air breathing engine is a turbojet. After the air is drawn into the engine through the inlet, its pressure is first increased by a component called a compressor. The air then enters the combustion chamber, where it is burned with fuel to increase the temperature. The hot, high-pressure gas is then spread through a wheel-like device called a turbine, where it produces power. The turbine is connected to the axle compressor, and the turbine output power is powered by the compressor. At the turbine output, the pressure of hot gas is still above the ambient pressure, and the final expansion takes place through the exhaust nozzle where the exhaust gas speed is increased. It's the final high-speed jet that produces thrust to push the plane through the air. Although the jet engine is much simpler than a reciprocal propeller-turning engine in the concept, the actual design for efficient operation is complex, and the large jet engines are extremely expensive. Today, almost all airborne jet engines use axion flow compressors. In these devices, the air flows in one direction in one direction along the shaft that connects the compressor and the turbine; moves through alternate rows of stationary and rotating sets of blades called statories and rotors. The blades are arranged so that the air enters as it passes through them and increases its pressure. Modern axial flow compressors can increase pressure 25 times in about 16 stages, and each stage consists of a set of rotor blades and stators. Centifugal compressors, which are used in the aircraft's early jet engines, take the air in the center of the impeller, or wheel, and compress it in a radial or external direction. Lower efficiency, limited pressure increase and large diameters that add engine assembly resistance now limit the use of compressor with small engines and applications that are not flying. When the air in the turbojet engine leaves the compressor and enters the combustion chamber, it is mixed with finely atomized kerosene-like fuel and incinerated. In theory, for the best performance the combustion temperature should be as high as can be achieved by the complete combustion of fuel and oxygen in the air. This would, however, make the turbine cartridge temperature too high to operate, and currently turbine temperatures are limited to about 1,900 to 2,200 F (1,040 to 1,200 C). The temperature is controlled by burning only part of the compressor's air, while the rest is diverted past the burning part and mixed with high-throther gases further along the combustion chamber. Combustion chambers may consist of individual cans or cylinders arranged around the turbine shaft. Another approach is the use of a ring chamber in which the lining, or tubular sleeve, surrounds the shaft. Special frames that are both strong and light are needed in turbine blades to withstand high temperatures and stresses there. Among those being studied are combinations of metal and ceramics called cermets. Turbine blades can be cooled by diverting part of the unburned compressor air and feeding through the inner passages to small holes at the front or leading edge of the turbine blades. This provides a cold air film that protects the blade wall from hot gases. High pressure-ratio engines are made with two axles rotating in each other. The outer pane is a high-speed pane, which can work with about 11,000 shcreassings per minute (RPM). It connects a high-pressure turbine and compressor. The internal shaft, which operates at about 3,000 RPM, connects the low-pressure turbine and compressor part of the engine. The greatest thrust would be obtained if the exhaust nozzle could extend the gas to the pressure of the surrounding air. However, the nozzle capable of doing so would be too large and heavy, so the shorter nozzles used cause small losses in engine performance. The turbojet engine cannot be run directly from idle. The external initial engine is powered by a unit that spins. The fuel is then lit by a heated spark plug. After the engine is running, combustion can be maintained without a spark plug. A useful output of the turbomed is its thrust, which is proportional to the speed of air mass flow through the engine and the change in speed between the outlet and the socket. (The flow rate of the mass is the mass of the liquid in motion that exceeds a specific area per unit of time.) Because of this it is desirable to achieve high speed at the output of the nozzle. Two performance characteristics are commonly used to describe turbos: specific thrust and specific fuel consumption. Specific thrust produced (thrust units per unit) gas flow per second) increases with the temperature of the turbine refuge. For this reason, engineers are continuously looking for higher turbine plug temperatures using improved materials and better blade cooling. The specific fuel consumption (the thrust unit produced per fuel combustion unit per second), which decreases as the engine efficiency increases, improves with an increase in the pressure ratio. This requires more and more compressor stages. In a real jet engine, there must be a compromise between high pressures and high temperatures for the best overall performance. Another important factor in the performance of the turbojet engine is the efficiency of the drive during flight. In this case, the best performance is obtained if the jet's exit speed (from the jet) is approximately twice the speed of flight of the aircraft. As the thrust increases by raising the temperature of the turbine plug, the turbine's output speed increases, and the jet's output speed becomes too high. In this case, drive performance can be increased by adding air bypass, as later discussed in this article. Maximum thrust is usually required at takeoff, while maximum efficiency is preferred at aircraft cruising speed, which is about 500 to 550 miles (800 to 880 kilometers) per hour for most commercial aircraft. For take-off from a high altitude airport on a hot summer day, lower air density results in a lower air mass flow rate through the engine, thereby reducing the available thrust. In this case, the aircraft may have to fly partially empty. Since combustion products leaving the turbine still have a large amount of oxygen contained in them (from the mixing of additional compressed air in the combustion chamber), it is possible to put another combustion chamber on the turbine output. This so-called afterburner is used in some military aircraft to ensure emergency speed bursts. Fuel consumption in the afterburner is, however, very high, so this increase in thrust, or increase, is not practical for cruising or for commercial aircraft. Water injection consists of the introduction of water into the compressor. This increases the thrust by cooling the air and thereby increases its density and mass that can be transmitted for a certain air speed. Water injection can be used for emergency take-off thrust, but the weight of water that must be carried on board the aircraft does not make it desirable to operate during flight. As noted above, it is desirable to have an average jet release speed about twice the air speed of an aircraft. Directly spreading all gases through the turbine would result in a jet speed that would be too high for effective in-flight performance. Most modern aircraft now use a turbofan, in which much of the air is only slightly compressed by a propeller-like compressor device at the front of the engine and then transferred around the engine core for with turbine exhaust gases, thus bypassing the main engine. Bypass engines provide increased thrust for take-off and climb, and also reduce jet noise. Modern engines can bypass five or six times the flow that passes through the engine core, and in the future even higher bypass ratios are expected for engines operating at higher temperatures of the turbine plug. In most commercial aircraft engines, the initial compression for core and bypass flow is achieved by a large fan consisting of one or two compressor-like stages. Once the flow is divided, the core flow is further compressed, and the flow of the bypass is directed around the engine. Turbojet engines tend to be noisy, which creates a problem in neighborhood airports. There is also high-frequency noise, or whining, that comes out of the compressor and lower frequency noise from the output jet while mixing with the surrounding air and producing turbulence. The noise of the compressor can be reduced by placing the material that absorbs sound into the wire duct. The noise of the jet mixing is reduced by increasing the bypass air and special mixers in the exhaust pipe. These mixers are corrugated to maximize the area where hot and cold gases are in contact as they begin to mix. On the tail of the engine is the thrust of the brakes, or the thrust reverser. This is a shell-like device that the pilot activated after landing. It closes over the jet's output jet to deflect the flow outwards and slightly forward so that the thrust that is being made on the plane is now backwards, helping to brake the aircraft. With thrusters, the jet can roll backwards on the ground. The most serious problem a jet can encounter is the break of the turbine or compressor blade if it is hit by a foreign object or if it is released due to an internal engine failure. All engines must be designed with a housing strong enough to contain decaying blades and to prevent the broken blade from being cut through the engine and damaging vital parts or penetrating the passenger space. The most serious problem faced by the compressor is the birds. All engines must be able to swallow a heavy bird without catastrophic failure, as birds can be unpredictably sucked into jet engines at low altitudes or on the ground. In case of engine failure in flight, the engine must be switched off. All multi-engine aircraft can land safely on a single engine so that the passengers involved have little more than an inconvenience if the aircraft has to return for safety reasons. Turboprop engines. In turboprop engines, conventional aircraft propeller is usually mounted in front of the jet engine, and in one type of engine is powered by another or a free turbine. This is behind the turbine that powers the compressor. In other projects, power is obtained through additional stages on the main turbine. As turbine speeds are much higher than the propeller speed, a reduction gear between the turbine and the propeller is required. About 90 percent of the energy in hot gases is absorbed in the turbine, and only about 10 percent remains to increase the speed of the exhaust jet. Accordingly, the jet produces only a very small part of the total thrust; Most come from the propeller. Turboprops are suitable for small and medium-range aircraft and at air speeds of 300 to 400 miles (480 to 640 kilometers) per hour. I can't compete with turbojets for very large planes or at higher speeds. Ramjet engines. The air the engine rushes into at high flight speeds is partially compressed by the so-called ram effect. If the speed is high enough, this compression may be sufficient to operate the engine without a compressor or turbine. Ramjet is called a flying stove because it is open at both ends and has only fuel nozzles in the middle. However, the flat furnace would not work; ramjet must have a properly designed diffusion of the socket that produces low-speed and high pressure air on the combustion section, and must also have a properly designed exhaust nozzle to increase the flow rate. Ramjets can operate at speeds of more than 200 miles (320 kilometers) per hour, but they only become practical at very high speeds, which must be greater than the speed of sound. Rockets or other similar devices are needed to produce the initial speed at which ramjet can begin operating. Pulse jet engines. The pulse jet is similar to the ramjet except that there is a series of spring-type valves in front of the combustion section. In the pulse-jet, the combustion is intermittent or pulsating, not continuously as in the ramjet. The air is recognized through the valves and begins to burn. This increases the pressure and closes the valves, preventing the flow of the back through the ute. As the gases spread through the rear nozzle to produce thrust, the pressure in the combustion section falls to the point where the valves reopen to allow fresh air. This cycle is then repeated. The most famous pulse-jet was a German V-1 missile, or buzz bomb, which was used towards the end of World War II and which was shot at a frequency of about 40 cycles per second. Pulse jets are inefficient,efficient and susceptible to heavy vibrations. Their use is now limited to low-cost, pilotless vehicles. Nonair-breathing, or rocket, engines. The rocket engines on board carry both fuel and oxidizer, so they do not depend on the surrounding atmosphere for the necessary oxygen supply. Accordingly, they provide the primary means of propulsion in space. Rockets are usually classified according to the type of burned fuel; solid-powered rockets carry a solid blend of fuel and oxidisers. This mixture is similar to gunpowder and completely burns after ignition. Incineration creates volume of high-pressure gases in the combustion area. This gas is then extended into a high-speed jet as it leaves the exhaust nozzle. The combustion rate is controlled by forming a solid fuel in such a way that combustion gases are released at an almost uniform rate. Thrust control, however, is limited, making solid-propelled rockets suitable only for the first, or takeoff, phase of space rockets. Better control can be obtained in liquid-powered rockets. In them, both the fuel and the oxidiser are stored in separate containers and then carefully measured in the combustion chamber. There they are atomized, mixed and burned. Because liquid-powered rockets can be restarted and fully configured, they have become the primary propulsion systems in space programs. The history of the Hero of Alexandria applies the principle of jet propulsion in its first century after Christ. The Chinese probably invented the missiles around 1100. About 1,400 wealthy Chinese developed a rocket-propelled sled chair, but it exploded during testing. In the 16th century, Leonardo da Vinci used the jet engine principle to devise a mechanism for turning the baking skewers. In 1629 Giovanni Branca, an Italian engineer, built a steam turbine that drove a stone-crushing mill. John Barber, from England, won the first gas turbine patent in 1791. Sanford A. Moss in 1902. Working for General Electric Company, he designed the aircraft's gas turbine in 1918. In England, A. A. Griffith of the Royal Aeronautical Establishment experimented with gas turbine compressors in 1927. In 1930, another Englishman, Frank Whittle, patented the design for the jet engine, and in 1937, such an engine was successfully tested and in 1941 he made his first flight. In Germany, in 1939, the ernst heinkel airline was launched. The following year Caproni-Campini CC2 flew in Italy. A reciprocal engine, not a gas turbine, was used to provide the exhaust jet. In 1941, the British flew their first Gloster E28/39 jet, powered by a Whittle engine. In the United States, General Electric Company built an engine based on Whittle's design. He powered the Bell XP-59 Airacomet in 1942. In the same year, the Germans produced the first successful fighter jet, the Messerschmitt Me-262. Germany was the only nation with jets to fight during World War II, but they were introduced too late to be decisive. After completing his research on war jets. In 1947, the U.S. Bell X-1 rocket-propelled grenade became the first aircraft to fly faster than sound. The following year, Britain flew its first supersonic aircraft, the De Havilland DH-108. In 1959, the U.S. F-106, built by Convair, flew more than twice Sound. Britain began its first jet service in 1952. However, that service was halted after two serious accidents in 1954. In the United States, the first jet to be tested commercially in 1954 was the first aircraft to be tested. Since then, numerous jet liners have been developed, both large and small, and today the main part of all commercial air fleets around the world uses jet planes. The British and French Concorde, the first supersonic transport made in the non-communist world, entered commercial service in 1976. Flying at a speed 2.5 times the speed of sound, there are only about 100 passengers on board. Due to high fuel consumption and low seating capacity, it has not proved a commercial success. While the original Boeing 707 and Douglas DC-8 aircraft used four engines, the increase in engine size and improved performance allowed the use of a smaller number of engines. The Lockheed L-1011 and McDonnell Douglas DC-10 are large three-engine aircraft with two engines under the wing and one centered on the tail. More recently, medium-sized twin-engine aircraft like Airbus, built by several European companies, and the Boeing 767 have been introduced with fuel-saving engines. They compete with the Boeing 727, a three-engine aircraft that has become one of the most widely used aircraft in the free world. Source: Compton Interactive Encyclopedia