

21.1 Purpose and Types

- The compressor's function is to take in air from the intake, compress it to a high pressure, and deliver it to the combustion chamber. There are two main types:
- ☐ Centrifugal Flow Compressor:
 - Components: An impeller (a high-speed rotating rotor) and a diffuser (a set of stationary vanes).
 - Operation: The impeller spins at high speed, flinging air outwards by centrifugal force. The air is accelerated and gains some pressure. It then passes into the diffuser, which is a divergent duct that slows the air down, converting its velocity into high pressure.
 - Characteristics: Very robust and simple, but has a large frontal area and a limited compression ratio per stage (approx. 4:1).
- ☐ Axial Flow Compressor:
 - Components: Consists of multiple stages, with each stage comprising a row of rotating blades (rotors) followed by a row of stationary blades (stators).
 - Operation: Air flows parallel to the axis of the engine. The rotors accelerate the air, and the stators (which form divergent passages) slow it down, increasing its pressure. Each stage provides a small pressure increase (approx. 1.2:1), so many stages are needed to achieve a high overall compression ratio.
 - Characteristics: Can handle a very large mass of air and achieve very high compression ratios (30:1 or more). This is the standard type for all modern transport aircraft engines.

21.2 Compressor Stall and Surge

- A compressor blade is an aerofoil and can stall just like a wing if its angle of attack becomes too high.
- ☐ Compressor Stall: Occurs when there is an imbalance between the incoming air's axial velocity and the compressor's rotational speed. This can cause one or more stages of the

- compressor to stall.
- Indications: Engine vibration and a rise in Exhaust Gas Temperature (EGT).
- ☐ Surge: A severe, complete breakdown of airflow through the compressor. The high-pressure air in the rear of the engine can flow violently forward and out of the intake, often with a loud bang. This causes a significant loss of thrust and a rapid rise in EGT.
- ☐ Prevention Systems: To prevent stall and surge, especially during acceleration or at low RPM, high-compression engines use:
 - Variable Inlet Guide Vanes (VIGVs) and Variable Stator Vanes: These vanes automatically pivot to adjust the angle at which the air strikes the subsequent rotor blades, maintaining an optimal angle of attack.
 - Compressor Bleed Valves: These valves are opened automatically at low RPM to bleed off excess air from the middle stages of the compressor, increasing the axial velocity in the front stages and preventing stalls.
 - Multi-Spool Compressors: The compressor is split into two or three sections (Low Pressure, Intermediate Pressure, High Pressure), each driven by its own turbine at its own optimal speed. This allows the engine to operate efficiently over a wide range of RPM without stalling.

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