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REVIEW PAPER ON AIRCRAFT NOZZLE

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Abstract:

The nozzle is crucial component of propulsion system. The purpose of the exhaust nozzle is to increase the velocity of the exhaust gas, To collect and direct the gas flow before it leaves the nozzle. For Larger values of specific thrust, the kinetic energy of the exhaust gas should be high, because area is Reduced than pressure is also reduced after that velocity is increasing.

The engine is achieved when the exhaust pressure Pe is equal to the ambient pressure P0. Two basic types of nozzles used in jet engines are convergent and convergent-divergent (C-D) nozzles.

Introduction:

The whirl of the turbine exit flow is reduced by the turbine rear support struts, which turn the flow straight. This straight, high-pressure flow is fed to a converging section, which changes the pressure back to velocity. This flow is often choked; i.e. the exit velocity cannot be increased. This is sometimes seen on engines with a very high pressure ratio. Due to the

wide range of operating conditions some engines must endure, sometimes it is advantageous to have an adjustable nozzle. The nozzle is often cooled by flow around the outside, using a variety of methods. The nozzle as a whole must be able to expand and contract with temperature, without damage or distortion.

The exhaust nozzle of an aircraft is a crucial component of its propulsion system, particularly in jet engines. It is located at the rear of the engine and serves several important functions:

Exhaust Direction:

The primary function of the exhaust nozzle is to direct the flow of hot gases expelled from the engine in a specific direction, usually rearward. This generates thrust according to Newton's third law of motion (for every action, there is an equal and opposite reaction).

Thrust Control:

The design of the exhaust nozzle can affect the amount of thrust produced by the engine. By varying the size, shape, and configuration of the nozzle, engineers can optimize the engine's performance across different operating conditions, such as takeoff, cruising, and supersonic flight.

Exhaust Mixing:

In some engines, particularly in modern turbofan engines, the exhaust nozzle may also play a role in mixing the hot gases from the engine core with cooler air from the bypass duct. This enhances the efficiency of the engine and reduces noise. Afterburner Operation: In engines equipped with afterburners (also known as "reheat"), the exhaust nozzle is designed to accommodate the additional fuel injection and combustion that occurs in the afterburner section. The nozzle may be adjustable to optimize performance in both afterburner and non-afterburner modes. Noise Reduction: Certain designs of exhaust

nozzles incorporate features to reduce the noise produced by the engine, such as chevrons or serrations along the nozzle's rim. These features help to shape and control the exhaust plume, reducing its impact on the surrounding environment and community. There are different types of nozzles, each designed for specific applications and operating conditions. Some common types include convergent-divergent (CD) nozzles, convergent nozzles, divergent nozzles, and variable-area nozzles. Convergent-divergent (CD) nozzles, also known as De Laval nozzles, are widely used in supersonic propulsion systems. They consist of a converging section followed by a diverging section. As the flow passes through the converging section, its velocity increases and pressure decreases, reaching sonic conditions at the throat of the nozzle. Beyond the throat, in the diverging section, the flow expands further, reaching supersonic velocities. Variable-area nozzles allow for adjustment of the nozzle exit area to optimize performance across different operating conditions. This flexibility is particularly valuable in aircraft engines, where airflow and operating conditions vary during different phases of flight. In addition to propulsion systems, nozzles are also used in various other applications, such as in fluid dynamics experiments to produce controlled flows, in fire fighting equipment to direct water or foam onto fires, and in industrial processes such as spray painting and chemical processing.

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CHOCKED FLOW:

Choked flow in propulsion refers to a critical condition where the flow of gases through a propulsion system, typically a nozzle, reaches its maximum velocity. This phenomenon occurs when the flow velocity of the gases at a certain point in the system, usually the throat of the nozzle, equals the local speed of sound. At this point, the flow is said to be "choked."

The conditions for choked flow depend on the properties of the gas and the geometry of the flow passage. In a convergent-divergent (CD) nozzle, which is commonly used in supersonic propulsion systems, choking typically occurs at the throat of the nozzle. The throat is the narrowest section where the flow velocity reaches the speed of sound. Beyond the throat, in the diverging section of the nozzle, the flow continues to expand, reaching supersonic velocities. Choked flow is characterized by several important properties

Maximum Velocity:

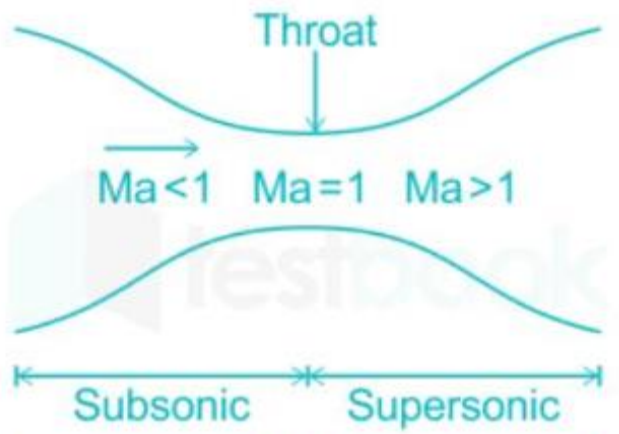
At choked conditions, the velocity of the gas flow cannot exceed the speed of sound. Any further expansion of the flow results in an increase in pressure rather than velocity.

Maximum Mass Flow Rate:

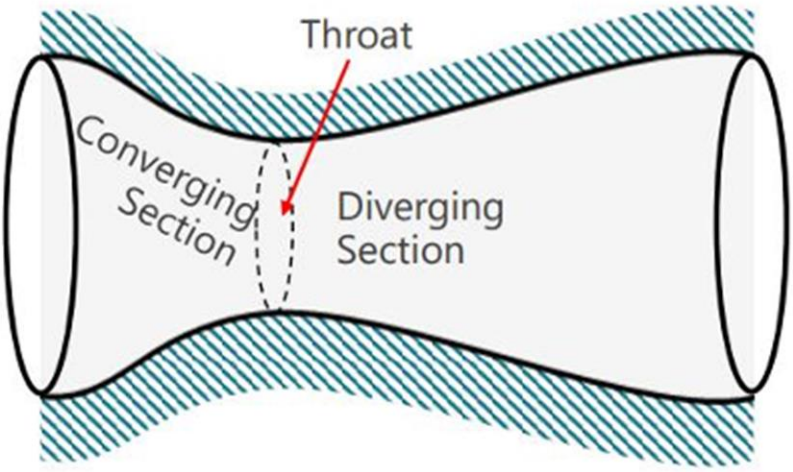
Choked flow represents the maximum achievable mass flow rate through the system under the given conditions. This is an important consideration for the design and operation of propulsion systems.

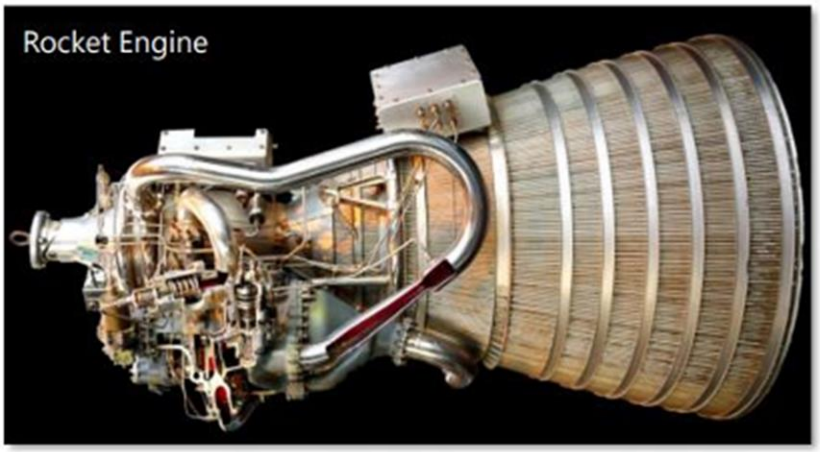
Optimal Thrust Generation:

Achieving choked flow ensures that the nozzle is properly matched to the engine's operating conditions, maximizing thrust output. It indicates that the nozzle is operating at its peak efficiency in converting the energy of the exhaust gases into forward propulsion.



A convergent-divergent nozzle





NOZZLE FLOW:

Nozzles that consist of a convergent section followed by a divergent section are also called De Laval nozzles.

TYPES OF NOZZLES:

Based on the flow condition at the exit section , we find three different types Of nozzles

TABLE : NOZZLE TYPES

	SUBSONIC	SONIC	SUPERSONIC
Throat velocity	V1<a1	V1=a1	V1=a1
Exit velocity	V2<a2	V2=v1	V2 > v1
Mach number	M2<1	M2=m1=1.0	M2>1

Over –expanded nozzles:

- Discharge the fluid at lower pressure than the exterior;
- The exit area is too large for optimum;
- Expansion is completed in the nozzle entirely.

Conclusion:

In conclusion, the study of the aircraft nozzles and types of nozzles, and

The aircraft nozzle provides high speed by the designing, The design of the nozzle is important because it is tapered along the groove centerline, with an elongated geometry in the plane perpendicular to the centerline, increasing the efficiency of the propulsion system.

The aircraft propulsion system assembly described in the paper includes a unique design of nozzle with an inlet lip, a bulkhead and a distribution groove and one or more nozzle ports.

The design is intended to provide efficient support and fixation to the aircraft exhaust nozzle, ensuring ease of operation and transportation. Overall, the proposed trailer design provides a practical solution for the safe and convenient movement of aircraft exhaust nozzles, addressing the challenges associated with their handling and transportation in aviation maintenance operations.

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