POWER AUGMENTATION SYSTEMS

Extra information :

The power a gas turbine engine can produce mostly depends on how dense the air going through it is. When the aircraft climbs to higher altitudes, the air pressure drops, and when the temperature rises, the air becomes less dense. In both cases, the engine gets less air, which reduces its power output.

The maximum power output of a gas turbine engine depends to a large extent upon the:
- density of the airflow passing through it.

Thus there is a reduction in power as:
- atmospheric pressure decreases with altitude
- or increased temperature.

My statement:

the engine's power decreases in two main situations:

1, When the aircraft climbs to higher altitudes:

- The higher you go, the lower the atmospheric pressure.
- With less air pressure, the air becomes thinner, so the engine gets less air, which reduces its power.

2, When the temperature increases:

- Warm air is less dense than cool air.
- When the temperature rises, the engine takes in less air mass, which also lowers its power output.

In both cases, the engine has less dense air to work with, which affects its performance.

Under these conditions:
- the power can be restored

in some instance's boosted for takeoff by :
- cooling the airflow with water

My statement

To fix this, or even boost power for takeoff, water cooling can be used. Spraying water into the engine's airflow cools the air down. Cooler air is denser, which means it contains more oxygen. With more oxygen available, the engine can burn more fuel and produce more power.

When methanol is added to the water it gives:
- anti-freezing properties

and also an additional source of:
- fuel as the methanol can also be burned

There are two basic methods of injecting coolant into the airflow.:
1, COMPRESSOR INLET INJECTION: sprayed directly into the compressor inlet,
2, COMBUSTION CHAMBER INJECTION: sprayed directly into the combustion chamber, mixing with the high-temperature air and fuel to reduce combustion temperature and improve efficiency.

however injection into the combustion chamber is usually :
- more suitable for axial flow compressor engines.

This is because a:
- greater quantity and more even distribution of the coolant can be obtained.

COMPRESSOR INLET INJECTION

When the injection system is switched on:
- water/ methanol mixture is pumped from a tank to a control unit
- the control unit which meters the flow to the compressor inlet through a valve that is operated by a servo piston

The servo system uses:
- engine oil as an operating medium, and regulates the supply of oil

The servo valve senses:
1, propeller shaft torque oil pressure
2, atmospheric pressure
- to act on the assembly

The control unit's high pressure oil cock is interconnected to the:
- throttle control

so that , until the throttle is moved towards the takeoff position:
- the cock and metering valve remains closed and so prevents any mixture flowing to the compressor.

My statement

COMPRESSOR INLET INJECTION

When the injection system is activated:

• A water/methanol mixture is pumped from a tank to a control unit.

• The control unit meters the flow to the compressor inlet through a valve operated by a servo piston.

The servo system:

• Uses engine oil as the operating medium because it provides consistent pressure and reliability needed to control the servo piston accurately.

• This oil regulates the movement of the metering valve, ensuring the right amount of water/ methanol mixture is injected.

The high-pressure oil cock in the control unit is linked to the throttle control:

• This connection ensures that the injection system only activates when the throttle is moved toward the takeoff position.

• Until then, the cock and metering valve stay closed, preventing any coolant flow to the compressor, which avoids unnecessary injection during lower power settings.

COMPRESSOR INLET INJECTION

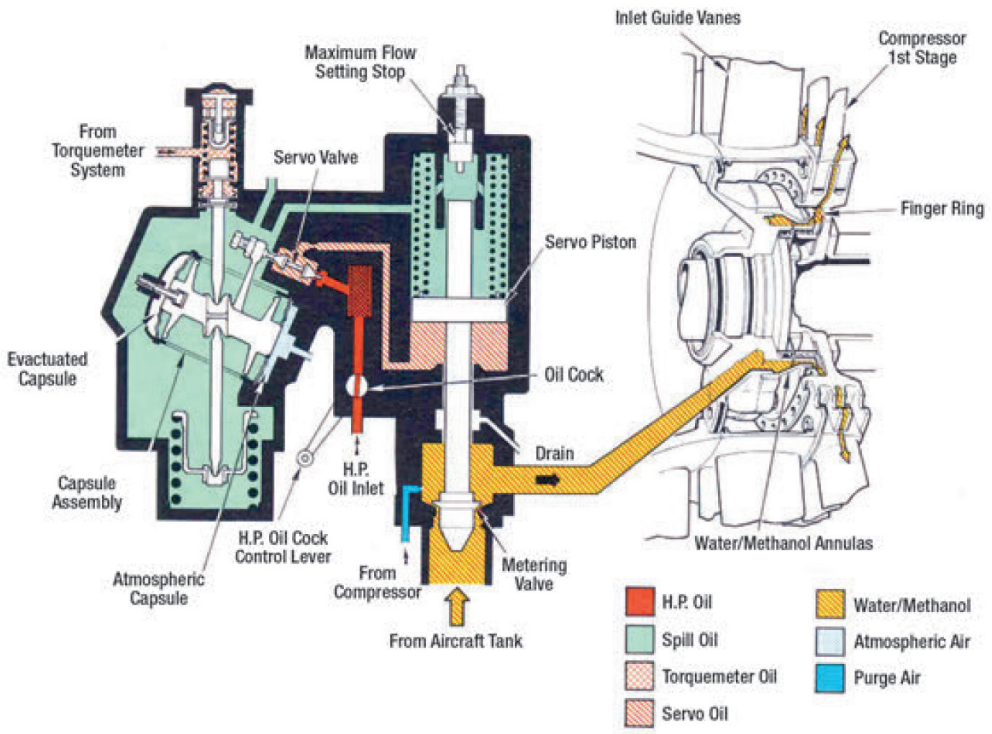

Figure 15-1. Compressor inlet injection system as on a turboprop engine.

COMBUSTION CHAMBER INJECTION

The coolant flows to an:

- air driven turbine pump that delivers it to a water flow sensing unit

The water passes from the sensing unit to:

- each fuel nozzle and is sprayed onto the swirl vanes into the combustion zone

The water pressure between the sensing unit and the discharge jets is :

- sensed by the fuel control system, which automatically resets the engine governor to give a higher maximum speed.

The water flow sensing unit opens only when:

- the correct pressure difference is obtained between compressor delivery air pressure and water pressure

The system engages when the throttle is moved to the:

- take-off position causing micro-switches to operate and select the air supply for the turbine pump

My statement:

COMBUSTION CHAMBER INJECTION

1, Coolant Flow:

- Coolant is sent to an air-driven turbine pump, which pushes it to a water flow sensing unit.

2, Injection:

- Water moves from the sensing unit to the fuel nozzles, spraying onto the swirl vanes and into the combustion zone.

3, Pressure Control:

- The fuel control system monitors water pressure and resets the engine governor for a higher maximum speed when water is injected.

4, System Activation:

The water flow sensing unit opens only when:

- there’s the correct pressure difference between compressor air pressure and water pressure.
- The system engages when the throttle reaches the takeoff position, activating micro-switches to start the turbine pump.

COMBUSTION CHAMBER INJECTION

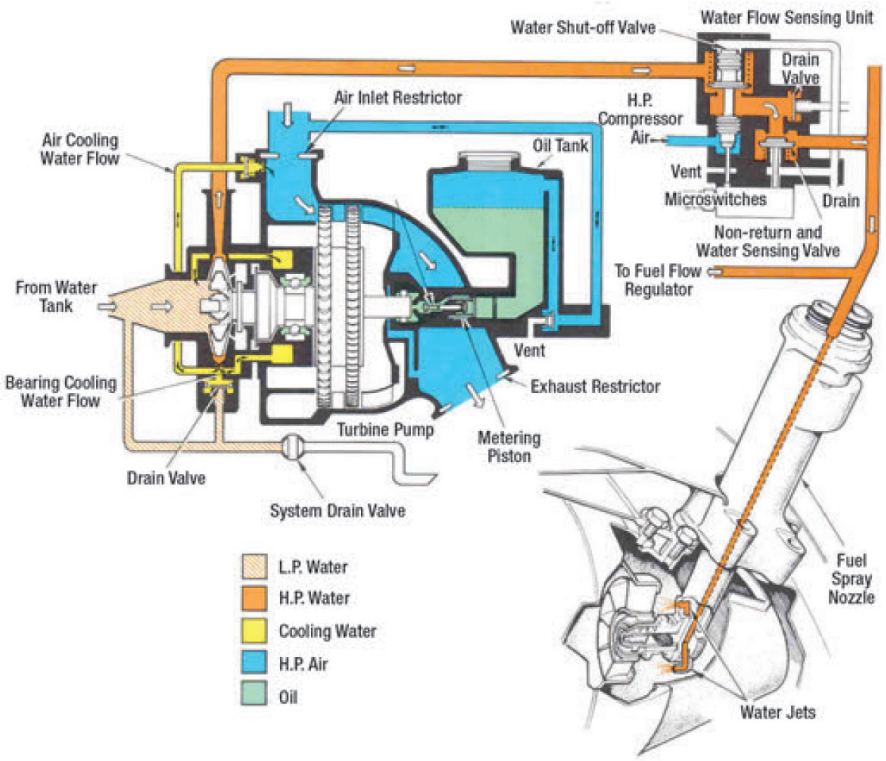

Figure 15-2. Combustion chamber system on a turbojet engine.

WATER INJECTION

Before high bypass turbofan engines, some older types of engines used :
- water injection to increase thrust for takeoff (wet)

The rating is obtained by:
- actuating the water injection system
- setting the computed wet thrust with the throttle, in terms of a predetermined turbine discharge pressure or engine pressure ratio for the prevailing ambient conditions

The rating is restricted to:
1, takeoff,
2, is time limited
3, has an altitude limitation

Water injection is not used very much on:
- turbine engines any more.

On warm days, thrust is reduced because of the:
- decrease in air density

This can be compensated for by:
- injecting water at the compressor inlet or diffuser case

This lowers the:
- air temperature and increases air density

A microswitch in the fuel control is:
- actuated by the control shaft when the power lever is moved toward the maximum power position.

A water injection speed reset servo resets the speed adjustment to a:
- higher value during water injection

Without this adjustment, the fuel control would:
- decrease rpm so that no additional thrust would be realized during water injection

The servo is a :
- shuttle valve that is acted upon by water pressure during water injection.

Movement of the servo displaces a:
- lever on the cam operated lever linkage to the speed governor speeder spring,
- increasing the force of the speeder spring and increasing the set speed.

My statement

WATER INJECTION (Simplified)

Before high-bypass turbofan engines, older engines used water injection to increase thrust during takeoff (called “wet” thrust).

How It Works:

• Water injection is activated, and the throttle is set to achieve the computed wet thrust based on engine pressure and current weather conditions.

Limitations:

• Used only for takeoff

• Time-limited

• Altitude-restricted

Why It’s Needed:

On hot days, air density drops, reducing thrust. Water injection compensates by:

• Cooling the air at the compressor inlet or diffuser case

• Increasing air density and boosting engine performance

System Operation:

• A microswitch in the fuel control is triggered when the throttle nears max power, starting water injection.

• A water injection speed reset servo increases the engine’s set speed during water injection.

• Without this adjustment, the fuel control would lower rpm, preventing any thrust increase.

How the Servo Works:

• The servo is a shuttle valve moved by water pressure during water injection.

• This moves a lever on the cam-operated linkage connected to the speed governor’s speeder spring.

• The increased spring force raises the set engine speed, allowing more fuel flow and greater thrust.

WATER/METHANOL

Some water injection systems use a:
- water methanol mixture.

The methanol acts as an:
- antifreeze for the water while it is in the storage reservoir

Methanol also :
- burns in the engine combustion chamber thus contributing to the production of thrust

AFTERBURNER SYSTEMS

Afterburning is a method of augmenting the thrust of an engine to improve:
- take off,
- climb
- combat performance in military aircraft

While this increased power could be:
- obtained by the use of a larger engine, this would increase the weight, frontal area and overall fuel consumption

Thus afterburning provides the best:
- method for thrust augmentation for short periods