flight training adelaide

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DOCUMENT TITLE
AIRCRAFT GENERAL KNOWLEDGE

CHAPTER 7 – COOLING

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COOLING

7.1 Introduction

The burning fuel within the engine's cylinders produces intense heat. While the engine oil system is essential to internal cooling of the engine, additional cooling is required to maintain normal temperatures. If waste heat is not rapidly removed, the cylinders may become hot enough to cause complete engine failure.

Excessive heat results in the following:

- The combustion of the fuel/air mixture is adversely affected.
- Engine life is weakened and shortened
- Efficiency of the lubrication is affected. (Viscosity of oil affected by temperature)
- It may cause detonation in the cylinders.

On aircraft engines cooling is achieved by the following methods:

- Air
- Liquid.

7.2 Air Cooling

Most modern light aircraft engines are air cooled by exposing the cylinders and their cooling fins to the airflow. The fins increase the exposed surface area to allow for better cooling.

7.2.1 Cooling Fins

Cylinder heat is conducted through walls into the cylinder fins which increase the surface area, and thus rate of heat dissipation by radiation to the atmosphere is increased. Broken fins induce local hot spots.

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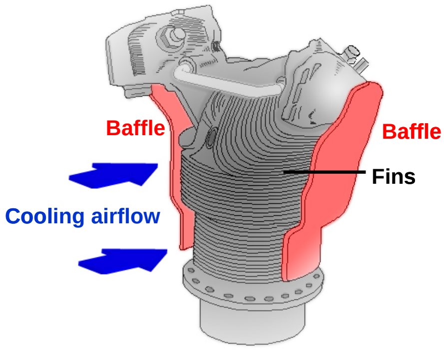
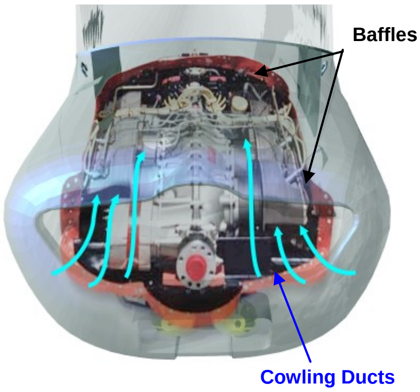
7.2.2 Cowlings, Baffles and Deflectors

As the airflow passes around a cylinder it may become turbulent and break away in such a manner that uneven cooling occurs, forming local, poorly cooled hot spots.

To avoid uneven cooling, cowling ducts at the front of the engine capture air from the high-pressure area behind the propeller and baffles distribute it as evenly and close as possible around and through the cylinder cooling fins. After cooling the engine, the air flows out of cowl openings at the bottom rear of the engine compartment.

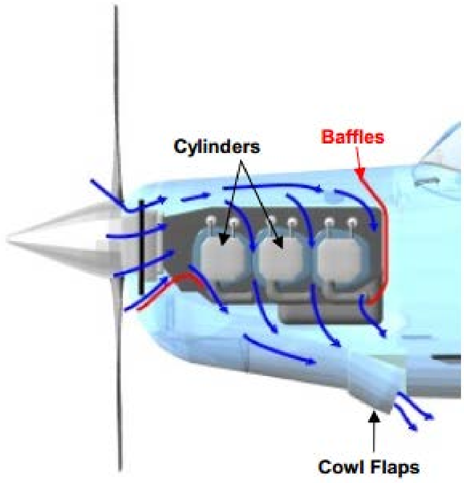




7.2.3 Cowl Flaps

Some aircraft have movable cooling cowl flaps that can be operated (electrically or manually) from the cockpit, giving the pilot more control over the cooling of the engine.

Open cowl flaps permit more air to escape from the engine compartment, causing an increased airflow over and around the engine. By closing the cowl flaps, the exit area is reduced, which effectively decreases the amount of air that can circulate over the cylinder fins. Thus, a constant temperature over the cylinders may be maintained when in level high-speed flight.



Cowl flaps are normally open for take-off, partially open or closed during the climb and the cruise, and closed during a power-off descent. Cowl flaps should be open when taxiing, to help dissipate the engine heat.

The air cooling system is less effective during ground operations, takeoffs, go-arounds, and other periods of high-power, low-airspeed operation. Conversely, high-speed descents provide excess air and can shock-cool the engine, subjecting it to abrupt temperature fluctuations and possible cylinder cracking.

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Under normal operating conditions in airplanes not equipped with cowl flaps, the engine temperature can be controlled by changing mixture, the airspeed, or the power output of the engine. High engine temperatures can be decreased by increasing the airspeed and/or reducing the power.

Operating the engine at higher than its designed temperature can cause loss of power, excessive oil consumption, and detonation. It will also lead to serious permanent damage, such as scoring the cylinder walls, damaging the pistons and rings, and burning and warping the valves. Monitoring the cockpit engine temperature instruments will aid in avoiding high operating temperature.

7.2.4 Cooling of Pistons

The pistons are made of high grade aluminium alloy which has a high thermal conductivity. Primary cooling occurs as heat passes progressively through the piston, piston rings, cylinder walls and finally the fins and out into the air stream. The underneath of the pistons are also finned to aid cooling by the air/oil mist in the crankcase.

7.2.5 Cooling of Valves

The inlet valves are cooled by the low temperature of the incoming fuel air mixture. Some exhaust valves have hollow stems which are partly filled with sodium. The sodium melts as the valve heats up and carries heat from the valve head to the valve stem, which is then cooled by an oil spray under the rocker cover.

Advantages of Aircooled Engines:

- Quick pick up to normal running temperatures
- Higher power-weight ratio
- Less susceptible to climatic conditions
- Less maintenance required.

Disadvantages of Aircooled Engines:

- Larger cross section giving increase in drag
- Difficult to cowl, giving poor streamlining
- Noisier in operation
- More susceptible to damage through shock cooling or high loads.

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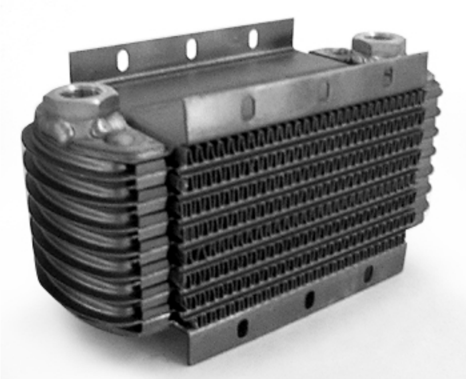
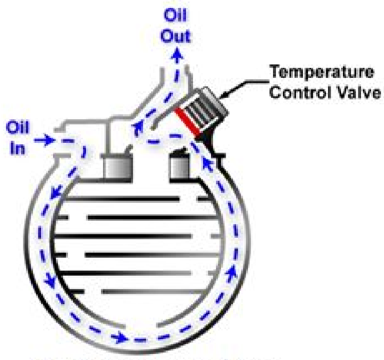
7.3 Oil Cooling



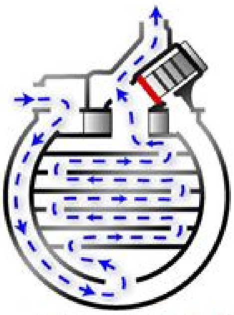
Oil is used as a cooling medium in the engine. As the oil reaches the oil cooler, it has a high temperature, and therefore the viscosity is low. In order to return the desired characteristics to the oil before recycling, it is cooled.

If the oil gets too hot then it will fail as a lubricant and, as a consequence, the engine will also fail. To prevent the oil temperature becoming too high an oil cooler is introduced into the system. The oil cooler consists of a matrix block which forces the oil into a thin film as it passes through it. The cooler matrix is exposed to the flow of cold slipstream air which is directed through the cowlings.

Some engines have thermostat controls fitted to the oil cooler. These help maintain a more even oil temperature over a variety of engine power settings.



When the oil is cold, it flows around the core of the cooler



When the oil is hot, the temperature control valve shuts off the passage in the shell of the cooler, and the oil must pass through the core, where it transfers its heat to the air passing through the cooler

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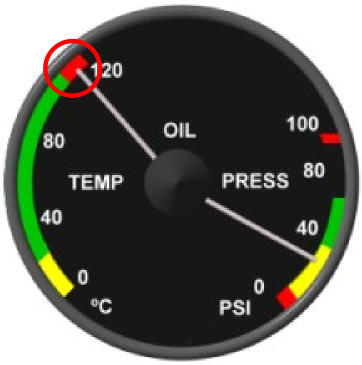
7.3.1 Engine Temperature Indicator

Like the other engine gauges, the normal range for the CHT gauge is marked in green. The Maximum allowable temperature is marked in red.

- Green – Normal Operating Range
- Red – Maximum Allowable

The readings from the CHT gauge as well as that from the oil temperature gauges should be compared. A disparity between the two may indicate a malfunction in one of the instruments.

Oil Temperature Gauge



CHT Gauge

7.4 Methods of Improving the Cooling of the Engine

If excessive cylinder head temperatures are noted in flight, the cooling of the engine can be improved as follows:

- Opening the cowl flaps fully to allow greater airflow around the engine
- Making the mixture richer as extra fuel has a cooling effect in the cylinders due to a greater amount evaporated – a rich mixture cools better than a lean mixture
- Reducing the engine power so that less heat is produced
- Increasing the airspeed for greater cooling.

Other methods that will influence engine cooling which the pilot has little control over during flight include:

- Condition of the oil cooler
- Outside air temperature.

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