Abdulla Aljunibi

TURBINE LUBRICATION SYSTEMS

Both wet and dry sump lubrication systems are used in gas turbine engines

Wet sump engines store the lubricating oil in the

- engine proper

dry sump engines utilize an :

- external tank mounted on the engine

or

- somewhere in the aircraft structure near the engine

Turbine engine's oil systems can also be classified as a :

- pressure relief system that maintains a somewhat constant pressure

the full flow type of system;

- in which the pressure varies with engine speed

the total loss system, used in engines that are for:

- short duration operation (target drones, missiles, etc.).

One of the main functions of the oil system in turbine engines is :

- cooling the bearings by carrying the heat away from the bearing by circulating oil around the bearing

The exhaust turbine bearing is the:

- most critical lubricating point in a gas turbine engine

because of the:

- high temperature normally present

In some engines

- air cooling is used in addition to oil cooling the bearing, which supports the turbine.

TURBINE LUBRICATION SYSTEM COMPONENTS

1, OIL TANK

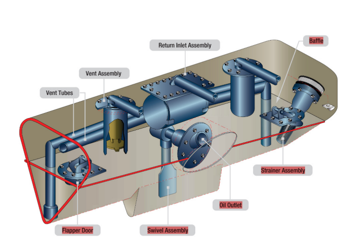

Figure 10-1. Oil tank.

It usually contains the:

- oil pump,
- the scavenge and pressure inlet strainers,
- scavenge return connection,
- pressure outlet ports,
- an oil filter,
- mounting bosses for the oil pressure gauge and temperature bulb connections

It is designed to furnish a constant supply of oil to the engine during any:

- aircraft attitude

This is done by a :

- swivel outlet assembly mounted inside the tank,

a horizontal baffle :

- mounted in the center of the tank

two flapper check valves :

- mounted on the baffle,

and a :

- positive vent system.

The swivel outlet fitting is controlled by a

- weighted end that is free to swing below the baffle

The flapper valves in the baffle are normally

- open
- they close only when the oil in the bottom of the tank tends to rush to the top of the tank during decelerations

This traps the oil in the

- bottom of the tank
- where it is picked up by the swivel fitting.

sump drain is located in the :

- bottom of the tank.

The vent system inside the tank is

- so arranged that the airspace is vented at all times even though oil may be forced to the top of the tank by deceleration of the aircraft.

All oil tanks are provided with:
- expansion space

This allows expansion of the oil after:
- heat is absorbed from the bearings and gears and after the oil foams as a result of circulating through the system

Some tanks also incorporate a:
- deaerator tray for separating air from the oil returned to the top of the tank by the scavenger system.

Usually these deaerators are the :
- can type in which oil enters at a tangent.

The air released is carried out through the
- vent system in the top of the tank

In most oil tanks, a pressure buildup is desired within the tank to ensure a:
- positive flow of oil to the oil pump inlet

This pressure buildup is made possible by running the vent line through an
- adjustable check relief valve

2, OIL PUMP

The oil pump is designed to:
- supply oil under pressure to the parts of the engine that require lubrication
- the circulate the oil through coolers as needed
- and then return the oil to the oil tank

Many oil pumps consist of not only a
- pressure supply element

but also a :
- scavenge elements (such as in a dry sump system)
- To return the oil back to the oil tank

The numbers of pumping elements: (two gears that pump oil)
- pressure
- scavenge,

depend largely on the type and model of the engine.

The pumps may be one of several types, each type having certain advantages and limitations.

The two most common oil pumps are the:
- gear
- gerotor

1, gear pump
with the gear type being the most commonly used

The gear type oil pump has only two elements:
1, one for pressure oil
2, one for scavenging.

However, some types of pumps may have several elements;
1, one or more elements for pressure
2, two or more for scavenging

The clearances between the gear teeth and the sides of the pump wall and plate are critical to:
- maintain the correct output of the pump.

regulating (relief) valve in the discharge side of the pump limits the output pressure of the pump by :
- bypassing oil to the pump inlet when the outlet pressure exceeds a predetermined limit

The regulating valve can be adjusted, if needed, to:
- bring the oil pressure within limits

Also shown is the shaft shear section that causes the shaft to:
- shear if the pump gears should seize up and not turn

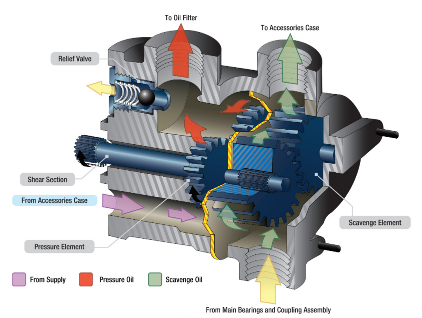

Figure 10-2. Cutaway view of gear oil pump.

2, gerotor pump

The gerotor pump, like the gear pump, usually contains a

- single element for oil pressure and several elements for scavenging oil.

Each of the elements, pressure and scavenge, are almost:

- identical in shape

however, the capacity of the elements can be controlled by:

- varying the size of the gerotor elements

Each set of gerotors is separated by a

- steel plate,
- making each set an individual pumping unit consisting of an inner and an outer element

The small star shaped inner element has:

- external lobes that fit within and are matched with the outer element that has internal lobes

The small element;

- fits on and is keyed to the pump shaft and acts as a drive for the outer free turning element.

The outer element:

- fits within a steel plate having an eccentric bore

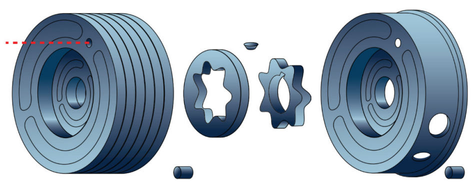

Figure 10-3. Typical gerotor pumping elemets.

My statement about (gerotor pump):

A gerotor pump is a type of pump used for oil pressure and scavenging, similar to a gear pump, but with specific features:

1, Multi-element Design: Typically has one element for creating oil pressure and several for scavenging oil.

2, Customizable Capacity: The size of the gerotor elements can be adjusted to control the pump's capacity.

3, Separate Units: Each set of gerotors is separated by a steel plate, creating individual pumping units with an inner and outer element.

4, Inner Element: A small, star-shaped piece with external lobes that match the internal lobes of the outer element. It is keyed to the pump shaft and drives the outer element.

5, Outer Element: Free-turning and housed in a steel plate with an eccentric bore, allowing it to create pumping action as it rotates.

This design ensures efficient oil circulation and scavenging in the system.

In some engine models, the oil pump design varies based on the number of elements:

1. Four-element Pump: Includes one feed element for supplying oil and three scavenge elements for returning oil to the reservoir.

2. Six-element Pump: Includes one feed element and five scavenge elements for enhanced oil recovery.

In all cases, the oil pump operates continuously, ensuring oil flow as long as the engine shaft is turning.

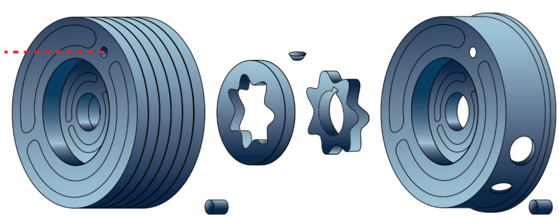

Figure 10-3. Typical gerotor pumping elemets.

3, OIL FILTERS

Filters remove;

- foreign particles that may be in the oil

This is particularly important in gas turbines as very high engine speeds are attained

the antifriction types of ball and roller bearings would become:

- damaged quite rapidly if lubricated with contaminated oil

there are usually numerous:

- drilled or core passages leading to various points of lubrication

Since these passages are usually rather small, they are easily :

- clogged

The filtering elements come in a variety of:

- configurations and mesh sizes

Mesh sizes are measured in :

- microns

which is a:

- linear measurement equal to one millionth of a meter (a very small opening).

The filtering element interior is made of:

- varying materials including paper and metal mesh

Oil normally flows through the filter element from the :

- outside into the filter body

One type of oil filter uses a ;

- replaceable laminated paper element,

while others use a :

- very fine stainless steel metal mesh of about 25-35 microns.

Most filters are located close to the

- pressure pump

consist of a

1, filter body or housing
2, filter element
3, a bypass valve
4, a check valve

The filter bypass valve

- prevents the oil flow from being stopped if the filter element becomes clogged.

The bypass valve opens whenever a:

- certain pressure is reached

If this occurs:

- the filtering action is lost, allowing unfiltered oil to be pumped to the bearings

However:

- this prevents the bearings from receiving no oil

The filters generally discussed are used as main oil filters; that is, they :

- strain the oil as it leaves the pump before being piped to the various points of lubrication

there are also secondary filters located throughout the system for various purposes.

For instance, there may be a :

- finger screen filter

that is sometimes used for :

- straining scavenged oil

These screens tend to be large mesh screens that

- trap larger contaminants

there are fine mesh screens called :

- last chance filters for straining the oil just before it passes from the spray nozzles onto the bearing surfaces

Figure 10-4. Turbine oil filter element.

Figure 10-5. Turbine oil filter paper element.

Figure 10-6. Last-chance filter before spray nozzle.

4, OIL PRESSURE REGULATING VALVE

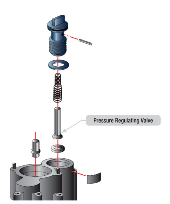

Figure 10-7. Pressure regulating valve.

A regulating valve system controls the:

- systems pressure to a limited pressure within the system

It is more of a regulating valve than a relief valve because it:

- keeps the pressure in the system within certain limits
- other than only opening when the absolute maximum pressure of the system is exceeded

The regulating valve has a valve held against a

- seat by a spring

By adjusting the tension (increase) on the spring, you change the;

- pressure at which the valve opens and you also increase the system pressure

A screw pressing on the spring adjusts the tension on the valve and the system pressure

5, OIL PRESSURE RELIEF VALVE

The system pressure varies with:

- engine rpm and pump speed.

A relief valve is used to:

- relieve pressure only if it exceeds the maximum limit for the system

relief valve system is preset to :

- relieve pressure and bypass the oil back to the inlet side of the oil pump whenever the pressure exceeds the maximum preset system limit

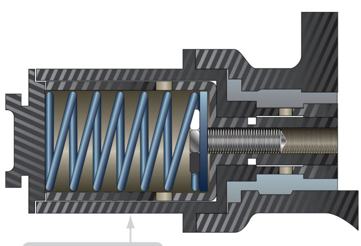

Figure 10-8. Pressure relief valve.

6, OIL JETS

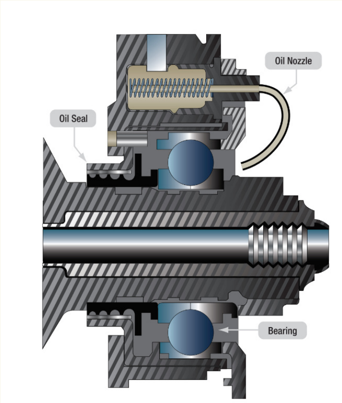

Figure 10-9. Oil nozzles spray lubricate on bearings.

Oil jets (or nozzles)
The oil from these nozzles is to;

- deliver in the form of an atomized spray

The oil jets are easily clogged because of the

- small orifice in their tips

the oil must be free of any :

- foreign particles.

7, LUBRICATION SYSTEM BREATHER SYSTEMS (VENTS)

Breather subsystems are used to:
1, remove excess air from the bearing cavities
2, return the air to the oil tank where it is separated from any oil mixed in the vapor of air and oil by the deaerator

Then, the air is vented overboard and back to the:

- atmosphere

8, LUBRICATION SYSTEM CHECK VALVE

Check valves are sometimes installed in the oil supply lines of dry sump oil systems to prevent:

- reservoir oil from seeping (by gravity) through the oil pump elements and high pressure lines into the engine after
- Meaning: Going back means don't allow going back to the previous place

Check valves, by stopping flow in an opposite direction, prevent accumulations of:

- undue amounts of oil in the accessory gearbox, compressor rear housing, and combustion chamber.

Such accumulations could cause:

- excessive loading of the accessory drive gears during starts

9, THERMOSTATIC BYPASS VALVES

Thermostatic bypass valves are included in
- oil systems using an oil cooler.
- Although these valves may be called different names

their purpose is always to;
- maintain proper oil temperature by varying the proportion of the total oil flow passing through the oil cooler

This valve consists of a valve body, having:
- two inlet ports
- one outlet port
- spring loaded thermostatic element valve

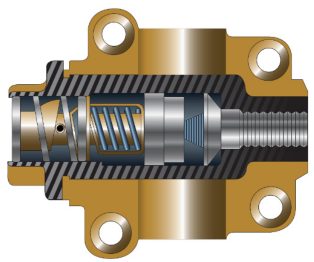
Figure 10-10. Typical thermostatic bypass valve.

10, AIR OIL COOLERS

ask

11, FUEL OIL COOLERS

12, DEOILER

The deoiler removes the oil from the:
- breather air

The breather air goes into an:
- impeller that turns in the deoiler housing

Centrifugal force:
- drives the oil towards the outer wall of the impeller.
- Then, the oil drains from the deoiler into a sump or oil tank

Because the air is much lighter than the oil, it goes through the:
- center of the impeller and is vented overboard.

13, MAGNETIC CHIP DETECTORS

Magnetic chip detectors are used in the oil system to:
- detect and catch ferrous (magnetic) particles present in the oil.

Chip detectors are placed in several locations but generally are in the:
- scavenge lines for each scavenge pump, oil tank, and in the oil sumps.

During maintenance, the chip detectors are:
- removed from the engine and inspected for metal

1, if none is found:
- the detector is cleaned, replaced, and safety wired.

2, If metal is found on a chip detector:
- an investigation should be made to find the source of the metal on the chip.

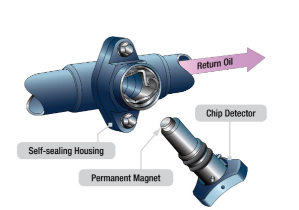

Figure 10-13. Chip detector.

14, LUBRICATION SYSTEM INSTRUMENTATION

Gauge connection provisions are incorporated in the oil system for:
- oil pressure
- oil quantity
- low oil pressure
- oil filter differential pressure switch
- oil temperature

The oil pressure gauge measures the :
- pressure of the lubricant as it leaves the pump and enters the pressure system.

An electronic sensor is placed to send a signal to the :.
- Full Authority Digital Engine Control (FADEC)

The differential oil pressure switch alerts the flight crew of an impending oil filter bypass because of a:
- clogged filter

15, SCAVENGE SYSTEM

The scavenge system :

- scavenges the main bearing compartments and circulates the scavenged oil back to the tank

ACCESSORY SECTION

The primary function is to:

- provide space for the mounting of accessories necessary for operation and control of the engine

it also includes accessories concerned with the aircraft, such as :

- electric generators and hydraulic pumps

Secondary functions include acting as an:

- oil reservoir and/or oil sump and housing the accessory drive gears and reduction gears.

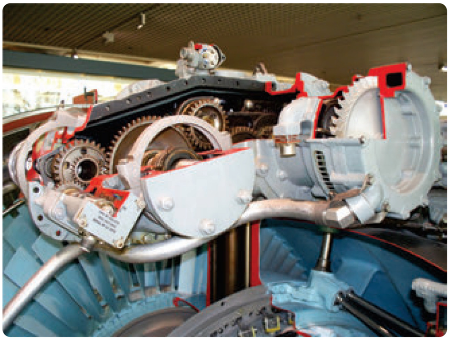

Figure 10-18. Cutaway view of an accessory case of a Rolls Royce Pegasus engine.

BREATHER PRESSURIZING SYSTEM

The breather pressurizing system:

- Ensures a proper oil spray pattern from the main bearing oil jets.
- Provides a pressure head to the scavenge system.
- Combines vapor-laden atmospheres from the oil tank and bearing compartments into the deoiler in the accessory gearbox.
- The deoiler separates oil from the air/oil mist and vents air back to the atmosphere.

DRY SUMP LUBRICATION SYSTEMS

Pressure Regulated Lubricating System

- High-pressure design with three subsystems: pressure, scavenge, and breather.
- Pressure System: Supplies oil to main engine bearings and accessory drives.
- Scavenger System: Returns oil to the tank mounted on the compressor case.
- Breather System: Equalizes pressure, separates air and oil, and vents air overboard.
- Uses a relief valve to maintain proper oil pressure.

Variable Pressure Lubricating System

- Pressure depends on engine speed (not regulated by a bypass valve).
- Oil pressure increases with engine RPM (ranges from 100 psi to over 260 psi).
- Includes a relief valve to prevent excess pressure.

WET SUMP LUBRICATION SYSTEMS

- Reservoir is part of the engine (e.g., accessory gear case or sump).
- Key Components:

1. Sight Gauge: Indicates oil level.
2. Vent/Breather: Equalizes pressure.
3. Magnetic Drain Plug: Collects ferrous metal particles.
4. Temperature Bulb and Oil Pressure Fitting: For instrumentation.

- Oil lubricates bearings and gears via a splash system, and gravity returns it to the reservoir.