Lecture 08: Lubrication System Contd.

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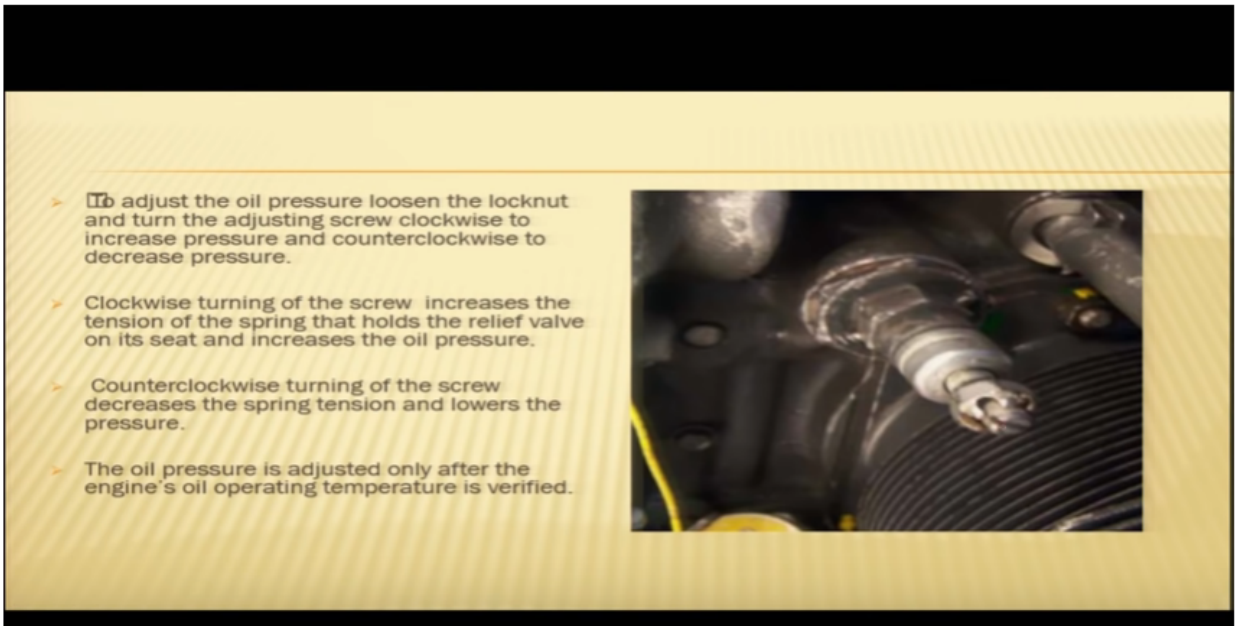

So, you can see here, in the figure ,we have shown you, oil pressure relief all, we will also show you in on, the real engine, you can see here in the figure, this is your oil pressure relief all, now in order to adjust the oil pressure, you need to loosen the locknut, this is your locknut, this needs to be, loosened and you can see the slotted head, of the screw, this is your screw, this is your slotted head and you loosen the lock nut here and turn the adjusting, screw clockwise to increase the pressure and counterclockwise to decrease, the pressure. So, this is your oil pressure relief valve this oil pressure relief valve is turned clockwise, to increase the pressure setting and counterclockwise, to decrease the pressure setting.

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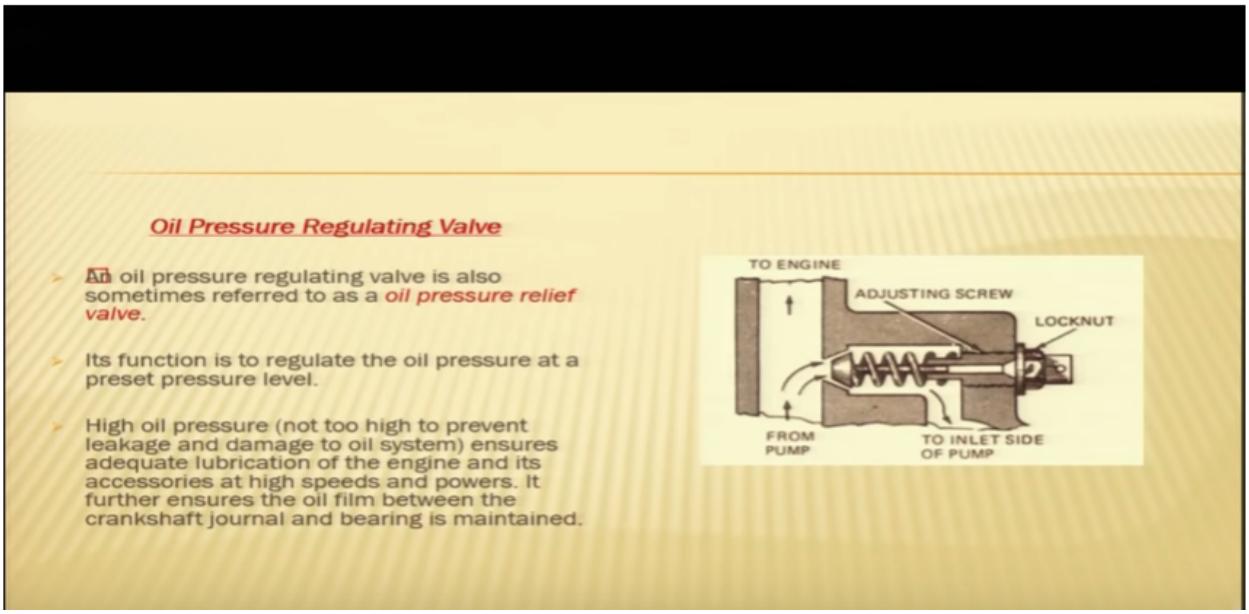

Now coming to this figure again, you can see here, this is your lock nut, this is spring-loaded, you can see the spring here and this is your valve here. Okay? So, if you tighten the lock nut here, it will compress the spring, is oil pressure setting will increase and if you turn it counterclockwise, it will decrease the tension, of the spring and you will, have a lower oil pressure setting. So, you can see here the oil supply, is coming from the pump and it is going to the engine, in case oil pressure in this line becomes, more than the, oil pressure which is set, which is preset through this valve it pushes this valve back, the higher oil pressure, will push this wall back and extra oil, will flow out from, this passage, this passage will open, them and this extra oil will flow, from this passage, to the inlet side of the pump, once the system pressure, is achieved, again this wall will go back and we'll seat and we'll in this part and we'll close the passage. So, again now, this passage is closed and your oil is flowing from the pump to the engine, by means of this lock nut, you can adjust the oil pressure, of the system.

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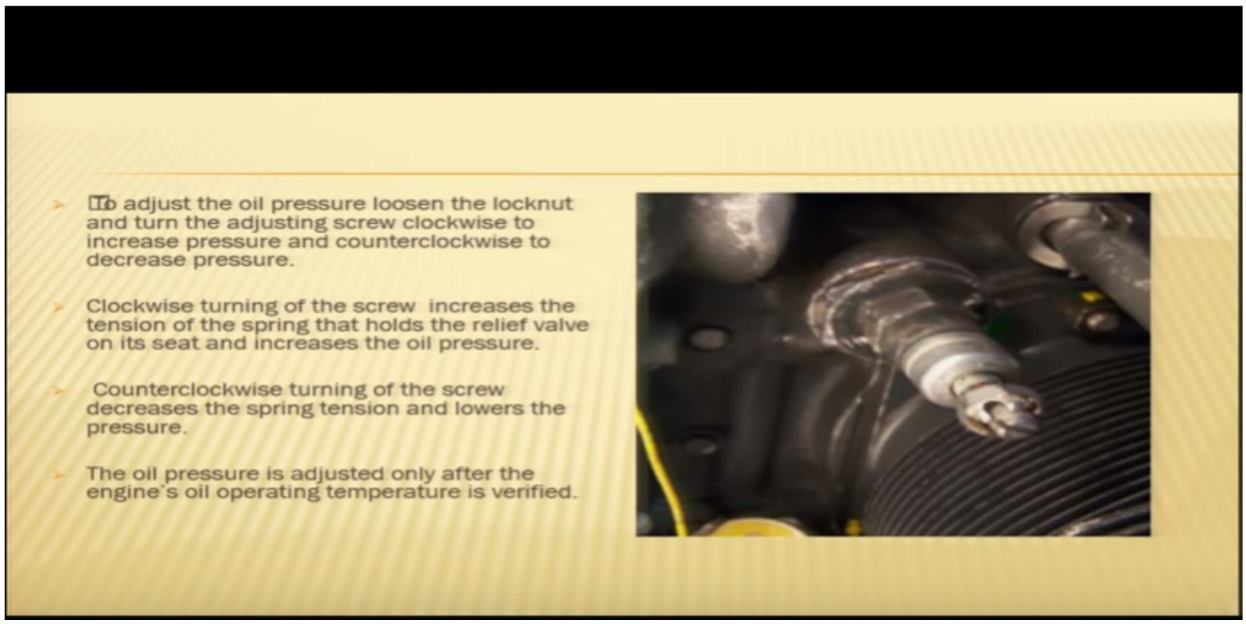

Clockwise turning of the screw, increases the tension of the spring, that holds a relief valve, on a seat and increases the oil pressure, I've just now explained in the above diagram, in the previous diagram, that clockwise turning of the screw, it increases the tension of the spring and holds the relief valve, on its seat and increases the oil pressure. Now counterclockwise turning, of the screw decreases the spring tension and lowers the pressure. So, by means, of this screw, you can adjust the tension, of the spring in turn, varying the pressure, of the lubrication system. So, this is your oil pressure reading ball, this is your regulator, through which you can regulate the system, pressure the, oil pressure is adjusted, only after the engine oil, temperature is verified. So, this pressure adjustment, is done only when your engine oil has attained the operating temperature, this is done so, that because, your oil has in case it is, very cold, then it must be very viscous. So, your pressure settings might vary so, in order to have proper readings, your oil should be at the operating temperature. So, proper viscosity is there, oil is viscous and the system pressure can be, adjusted.

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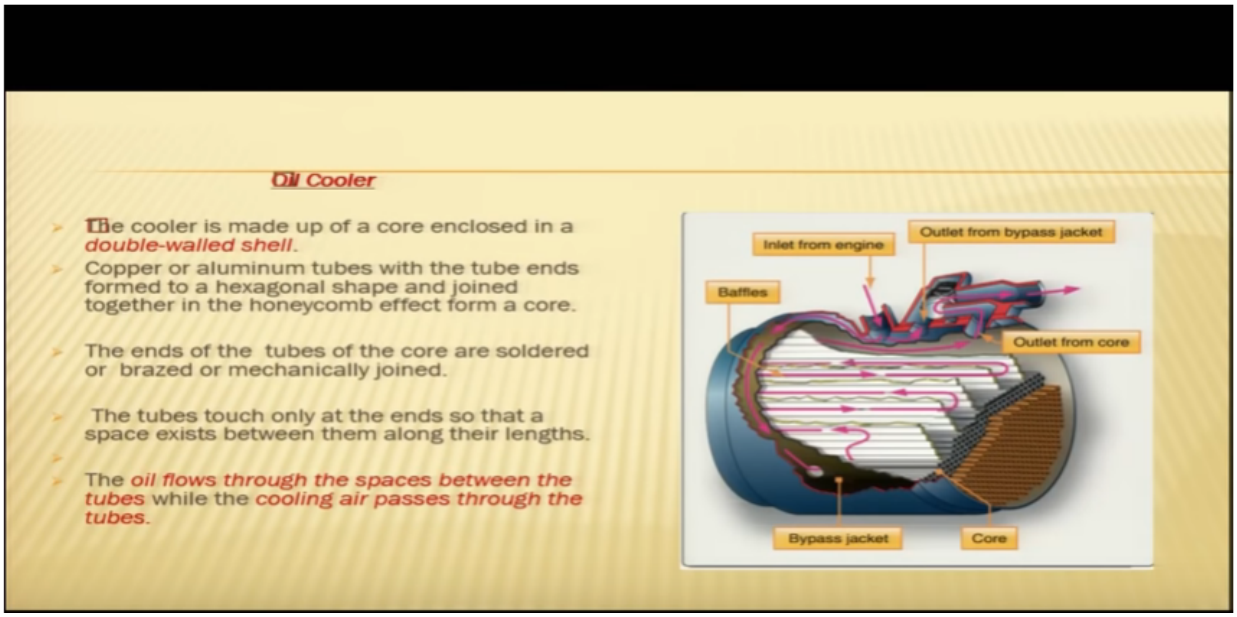

Next component a very important component, is the oil cooler, you can see in the figure, this is a oil cooler, oil cooler is made up of a core, enclosed in a double walled shell, this is your core and this is your shell, you can see double walled shell, this is one valve and this is another valve. So, what is the purpose of the oil cooler? Since the oil's also absorbing heat from the various parts, of the engine so it also needs to be cooled so, the oil cooler is there. So, that the hot oil, can be cooled and again, made ready, for lubrication. So, this oil cooler, it has a core, which is enclosed, in a double walled shell, copper or aluminum tubes where the tube ends formed to a hexagonal shape and joined together, in the honeycomb, effect form a core. So, there are copper tubes or aluminum tubes, they are formed to a hexagonal shape, the ends are formed to a hexagonal shape and join together, in the honeycomb effect to form a, core the ends of the tubes of the core are soldered or braced or mechanically joined. So, ends of the tubes of the core, they are soldered or braced or mechanically joined, the tubes touch, only at the ends. So, that a space exists between, them along their length, this is all along the length, the space exists between, them and the tubes, they touch only at the ends, now oil flows, through the spaces between the tubes, while the cooling air passes through the tubes. So, the spaces between the tubes, oil is flowing through it and through the tubes, the cooling air is passing. So, we have seen this oil cooler, it has a core, with a double walled shell, you have copper tubes or aluminum tubes, were the tube ends of hexagonal shape and joined together, to form a honeycomb effect, the ends of the tubes, of the core they are soldered or braced, the tubes touch, only at the ends, tubes are touching only at the ends, all along the length. So, the space between the tubes, the oil is flowing, between the two tubes there is as pace, your oil is flowing, while through the tubes, your cooling air is passing, the space between the inner and outer shells, is known as the annular or bypass jacket, two parts are open, to the flow of, oil through a cooler. So, through the cooler, you have two parts, during different occasions and there are two possible paths, for the oil to flow through the oil cooler, one path is, when the oil is, hot and it needs, to be cold. So, the baths followed by the oil when it is hot and it is to be cooled, from the inlet, you see this is your Inlet here, from the inlet, oil flows halfway, around the bypass jacket. So, oil has come inside, through this Inlet inside the cooler, it has flown halfway through the jacket, you can see it has flown halfway, through the jacket, it has come inside it is coming, like here and you can see here, in the figure, it has come halfway through the jacket, enters the core, from the bottom, it is entering the core, this is your core and it is entering the code, from

the bottom and then passes through the spaces between the tubes and out to the oil tank. And so, now the engine oil, when it is hot, it is coming, through the inlet passing through the jacket, halfway it has come and from the bottom, it is going inside the core. Now here, it goes inside the core, then out of flowing, between the spaces through the tubes, it is made to flow, out to the oil tank, see in the diagram, oil is coming inside, flowing through the jacket, enters the core, is passing through the spaces between the tubes and going out, through this passage to the oil tank, during the flow through, the core oil is guided by baffles, that force the oil to travel back and forth several times, before it reaches the core outlet. Now another part, that can be followed, in this oil can follow in, the cooler is when the oil is cold or when the core is blocked with thick or kind yield oil. So, in case, if the oil is cold, it doesn't need to be, sent through the oil cooler, it doesn't need to be cooled, further or when the core of the oil cooler, is blocked with thick, congealed oil in that case, you may have a different path, that I can follow, in this bypass route, the oil passes from the inlet, completely around the bypass jacket, to the outlet without passing through the core. So, in case when the oil is cold, it does not need to be further cool, enters through the inlet and passes completely, through the jacket and doesn't enter the code and to the outlet valve goes back to the tank.

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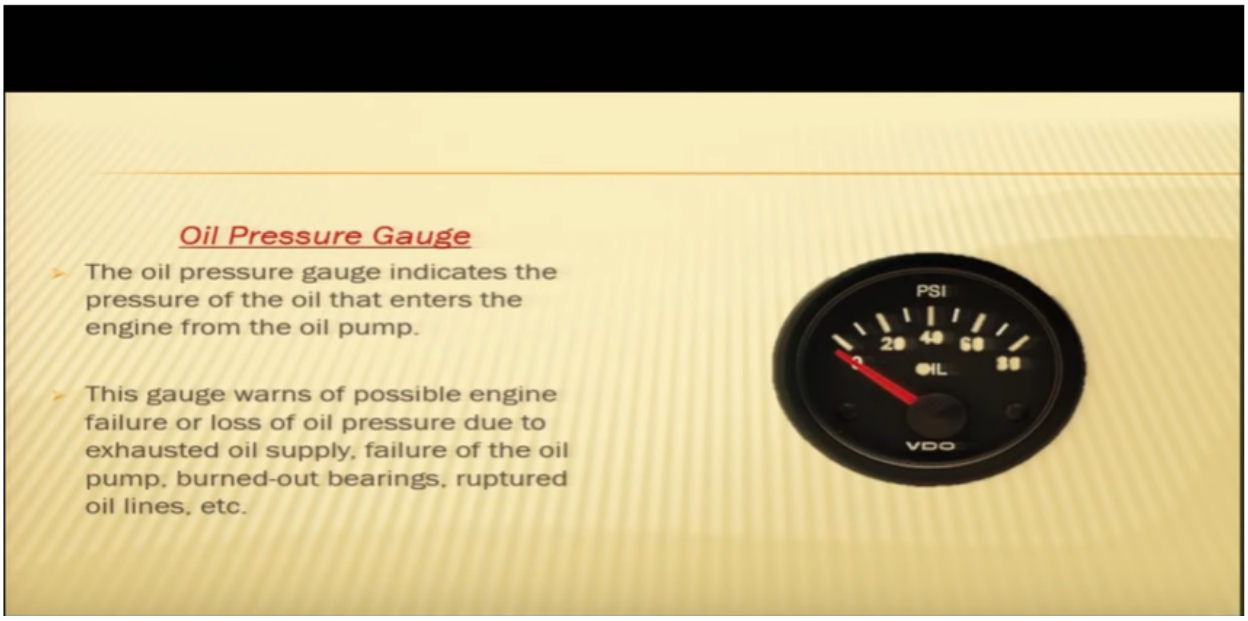

Next component, is your oil pressure gauge, the oil pressure gauge indicates, the pressure of oil, that enters the engine, from the oil pump, as we have mentioned earlier, that the oil which is being used in the lubrication system, needs to be pressurized, walled and regulated, for pressurizing the oil, oil pump was

being used, but in order to, verify the oil pressure of the system, we need to have a oil pressure gauge, the oil pressure gauge, it is a very, very important gauge, very important instrument, in a reciprocating engine, lubrication system. This gauge warns of possible, engine failure or loss of oil pressure, due to exhausted oil supply, failure of the oil pump, burned-out bearings, ruptured oil lines, etc. As in a reciprocating, engines soon as we start the engine the very first thing to be observed is your oil pressure gauge. So, just after starting the engine, the oil pressure gauge is to be observed, oil pressure gauge should register, within 30 seconds, why we need to observe the oil pressure gauge, the oil pressure gauge, registering means, that the oil has started circulating inside the system and now your rotating parts, the moving parts, inside the engine are being lubricated, in case your oil pressure does not register within 30 seconds, of starting the engine, we are supposed to switch off the engine and look for the cause, in case your oil pressure, has not registered, that means your oil has not started circulating in the engine and your moving parts are not being lubricated, which may result in severe, damage to the engine. So, we are supposed, to just switch off the engine, in case your oil pressure, does not register, within 30 seconds, there may be several reasons, why your oil pressure has not registered, we have to look for the cause. So, oil pressure gauge is one of the most in Mortal Instruments, of the reciprocating engine.

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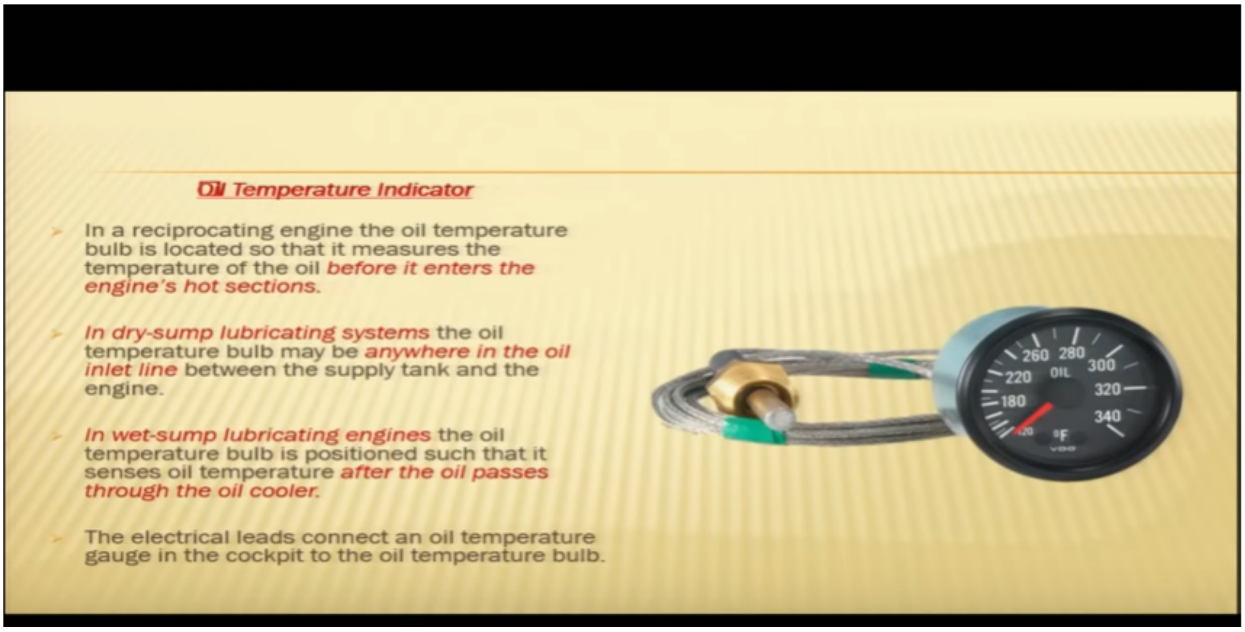

Another instrument, is oil temperature, indicator in a reciprocating engine, the oil temperature bulb is located. So, that it measures the temperature of the oil, before it enters the engines, hot sections you can see here, in the figure this is your temperature indicator and this is your oil temperature bulb, which senses the temperature of the oil, before it enters the hot section. So, this oil is located so, that it measures

the temperature of the oil, therefore it enters, the engines hot sections, in dry sump lubricating systems, the oil temperature bulb, may be anywhere in the oil inlet line, between the supply tank and the engine, in a dry sump lubrication system your, oil temperature may be anywhere, in the oil inlet line, between the supply tank and the engine in a wet sump lubricating engine, the oil temperature bulb is positioned, such that it senses oil temperature, after the oil passes through the oil cooler. So, the in a wet sump lubrication system, the oil temperature bulb, is position, is located. So, that it senses the oil temperature, after the oil has passed through, the oil cooler, the electrical leads connect, an oil temperature gauge, in the cockpit to the, oil temperature bulb. So, this high temperature bulb is connected to the, cockpit by means of the electrical leads.

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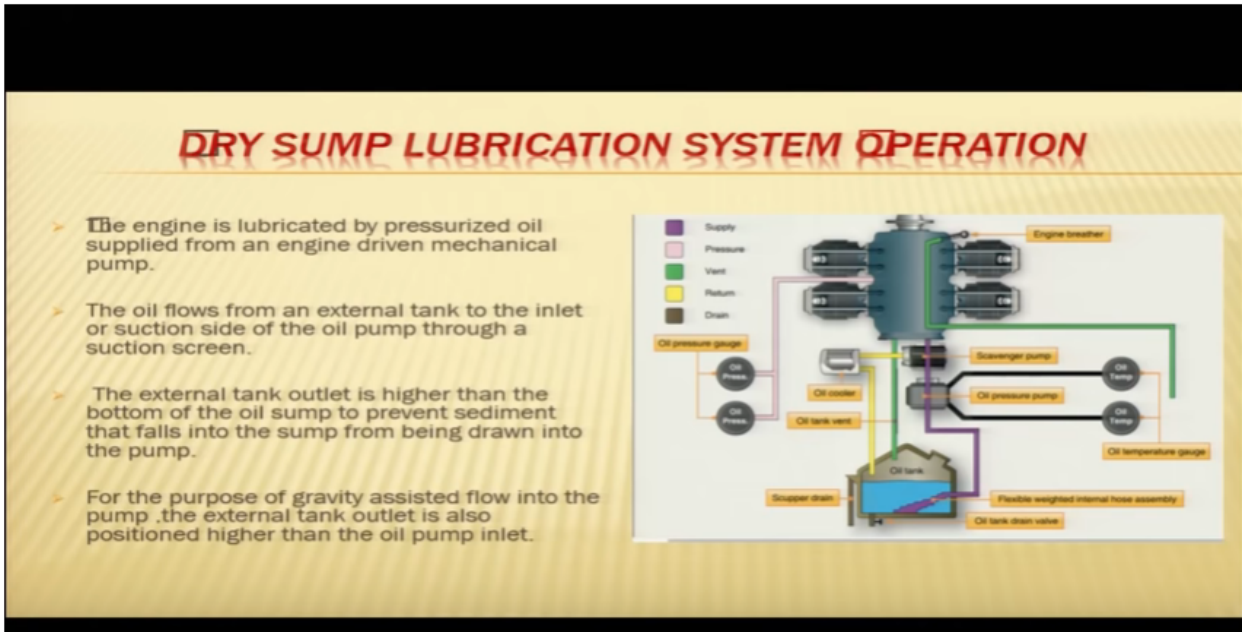

Now coming to the lubrication system, operation, how the system is operating? This is your dry sump lubrication system, you can see a figure, very simple figure, is shown, of a dry sump, the engine is lubricated by pressurized, oil supplied from an engine driven mechanical pump. So, in a dry sump lubrication system, we all know that the dry sump has got an independent, oil tank. So, here in the diagram, you can see it has an independent, oil tank and the engine, this is your oil tank and this is your pressure pump, you can see this is your oil pressure pump, it has a scavenger pump, we know that in the dry sump lubrication system, there are two pumps, pressure pump and the scavenge pump, then you have this is your oil cooler, this is your vent line also, you have the temperature gauges, here you have the pressure gauges here and the engine here. So, this is your dry sump lubrication system, the engine is

lubricated by pressurized, oil supplied from an engine, driven mechanical pump. So, there is a pump, this engine driven mechanical pump, this supplies, this takes oil from the tank, it will take the oil from the tank to this line and supplies the engine, the oil flows from an external tank, to the inlet or suction side of the oil pump. So, from the oil tank, it comes to the inlet or the suction side of the pump, through a suction screen. So, this is your suction screen here, it takes the oil from the hey prom here, to the inlet side of the pump, the external tank outlet is higher, than the bottom of the oil sump. So, you can see the external tank, outlet this is your oil tank, the external tank, out let is higher than the bottom of the oil sump, this is your bottom of the oil some so, this tank outlet is higher than the bottom, of the oil sump to prevent sediment that falls into the sump from being drawn into the pump. So, in order to avoid the sediments being, drawn into the pump, this oil outlet the is tank outlet, is at a higher level from the bottom of the sump, for the purpose of gravity assisted flow into the pump, the external tank outlet is also positioned, higher than the oil pump Inlet. So, this external oil tank outlet this is position, this is positioned, in such a way, that this is higher than the oil pressure pump Inlet. So, that you, you are able to provide, a gravity assisted flow, to the pump.

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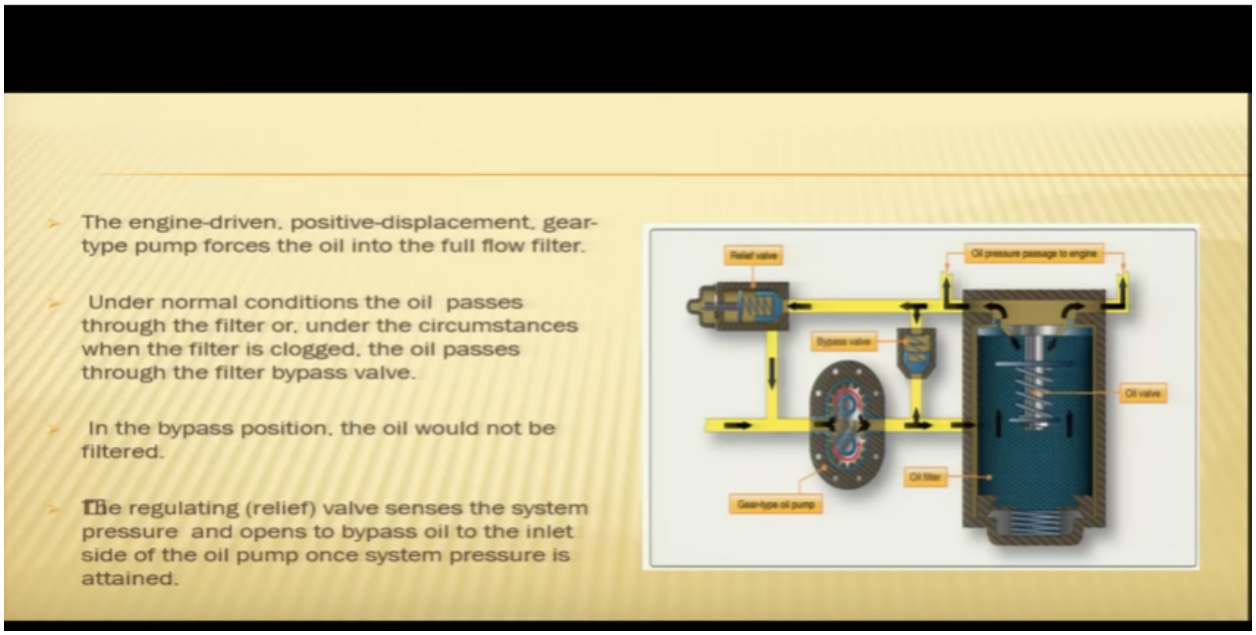

The engine driven positive-displacement, gear type pump, forces the oil into the full flow filter, here you can see a schematic diagram, you can see this is your pump, this pump this is the engine driven pump, there is a positive displacement pump, gear type pump, it forces the oil to the filter, you see the oil is flowing from the pressure bump, to the filter under normal conditions, the oil passes through the filter, or under circumstances when the filter, is clocked the oil passes through, the filter bypass valve. But circumstances when your filter, is clocked this filter is clogged then your oil is made to flow, through this valve, this is your bypass valve, this valve will bypass the clogged filter here and will supply the oil

through this passage, to the engine, in the bypass condition, oil would not be filtered. So, in case your filter is clocked or there is some malfunction, in the filter, your this the flow of oil, will be through the bypass valve, this bypass valve will bypass the filter and it will provide, unfiltered oil to the engine. But we need to understand, that unfiltered oil is better than no oil, the relief valve senses the system pressure, here in the diagram, this is your relief valve we know what is the relief valve, it senses the system pressure and opens to bypass, oil to the inlet side of the pump. So, this ready valve will always sense the system pressure and in case if the system pressure, is more than the preset value, it will open and it will bypass the oil, the regulating relieve all senses the system pressure and opens the bypass oil to the inlet side of the pump, once system pressure is attained.

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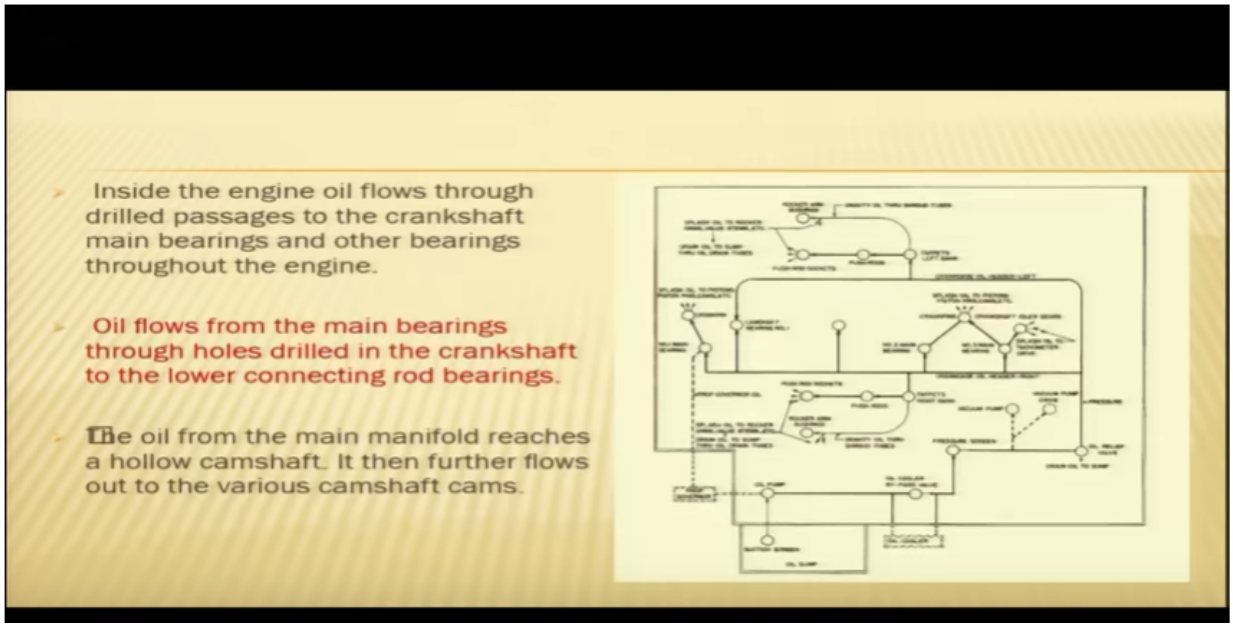

Inside the engine oil flows through drilled passages, to the crankshaft main, bearings and other bearings throughout the engine. So, in the diagram you can see, this is the part of the oil, being followed inside the engine, this is a diagram, is of a Lycoming engine. So, oil flows from the main bearings, through holes drilled in the crankshaft, to the lower connecting rod bearings, the oil from the main manifold reaches a hollow camshaft, it then for the flows out to the various, camshaft cams here, you can see, these are your main bearings, we will see it on the on the real engine also, this is in the diagram you can see this oil, has is coming to the bearings, from the bearings and has come to the crank prints and to the pistons and the piston pins, here you see the oil has come to the tappets, from the tappets, it has come to the push rod push, rod to push rod sockets and also to rocker arm bushings. So, this is just an illustration, we will show you, on in on the real engine.

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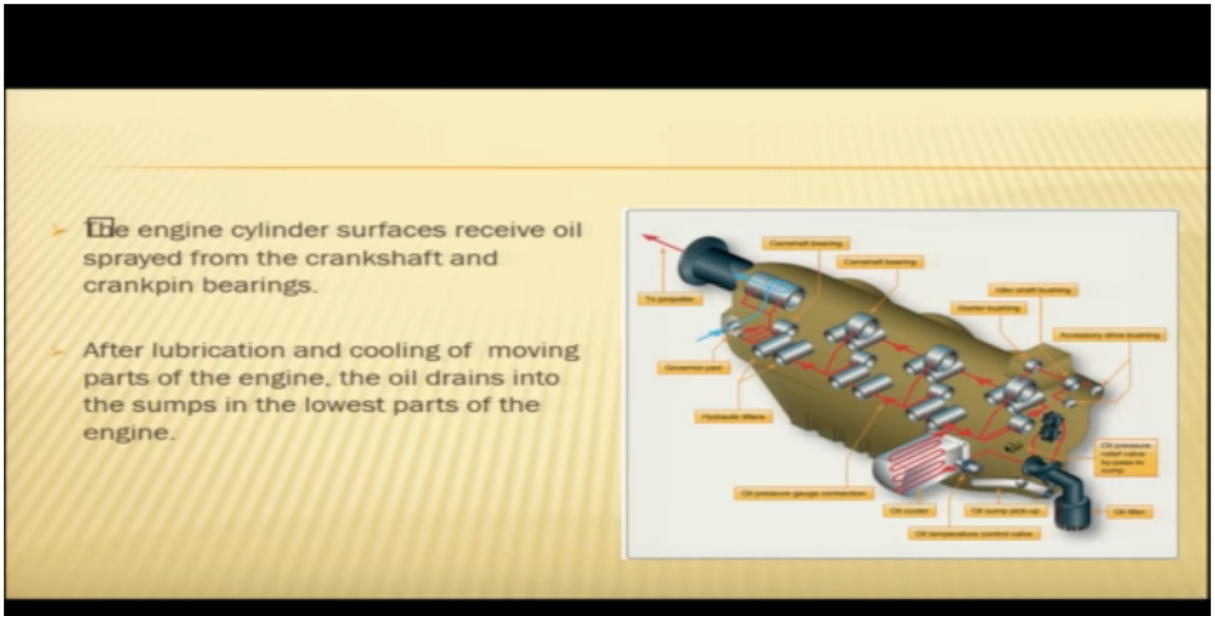

The Alain engine cylinder surfaces receive oil, spread from the crankshaft and crank pin bearings. So, the engine cylinder, surfaces they are receiving oil, which is a spread from the crankshaft and the crank pin bearings, after lubrication and cooling of moving parts of the engine, the oil drains into the sump in the lowest parts of the engine, this is your oil filter here, this is your oil sump pickup, this is your oil pressure pump here, this is your oil pressure relief all and these are your bearings, you can see these are your crankshaft bearings and these are your tappets and oil is also flowing through the oil cooler. So, this is an illustration, of how oil is lubricating the engine.

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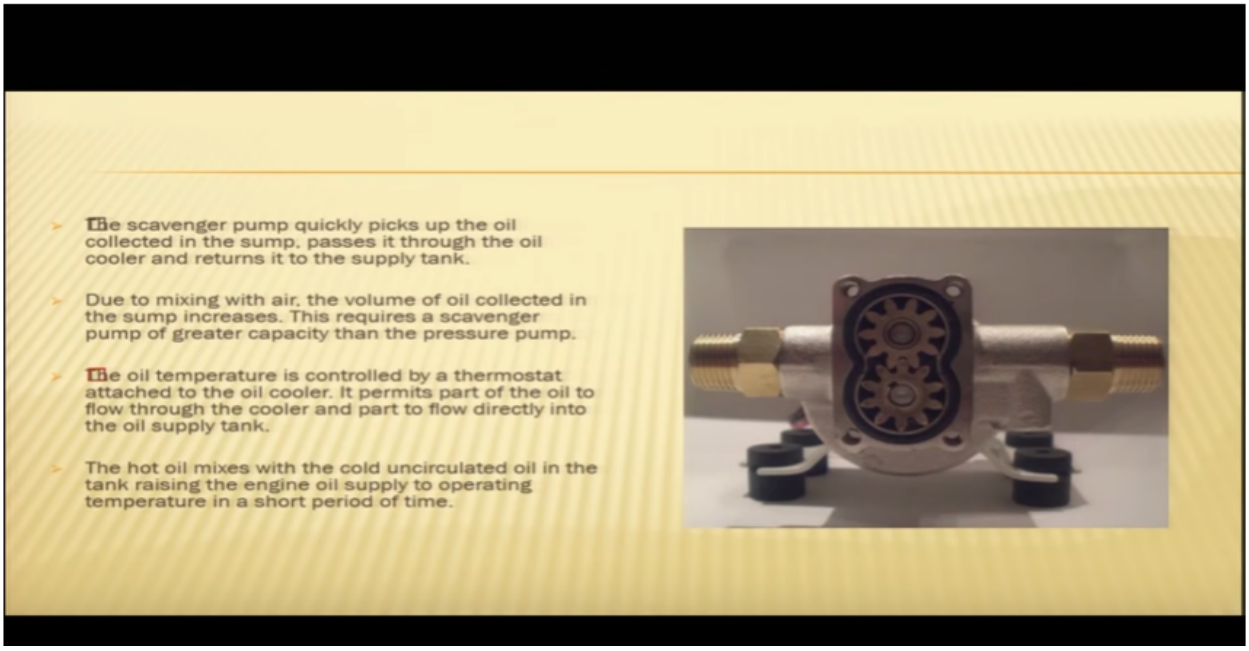

The scavenger pump quickly picks up the oil, collected in the sump passes, it through the oil cooler and returns it to the supply tank. Now since we are talking about the dry sump lubrication system, we know that the dry sump lubrication system, has got a scavenger pump purpose is to pick up the oil collected, in the sump pass it through the oil cooler and return it to the supply tank, due to mixing with air the volume, of oil collected in the sump increases, this requires a scavenger pump, of greater capacity, than the pressure pump. We have seen in our earlier slides, why the scavenger pump, is required to be of a greater capacity, than the pressure pump, the oil temperature is controlled, by a thermostat attached to the, oil cooler, it permits part of the oil to flow, through the cooler and part to flow directly to the oil supply tank . So, in the, oil cooler there is a thermostat, we will show you, on the engine, real engine there is a thermostat, wit which maintains the temperature of the oil and it permits part of the oil to flow through the cooler and part to flow directly, into the oil supply tank, the hot oil mixes with the cold uncirculated, oil in the tank raising the engine, oil supply to operating temperatures, in a short period of time. Now this hot oil mixes with the cold uncirculated oil in the tank.

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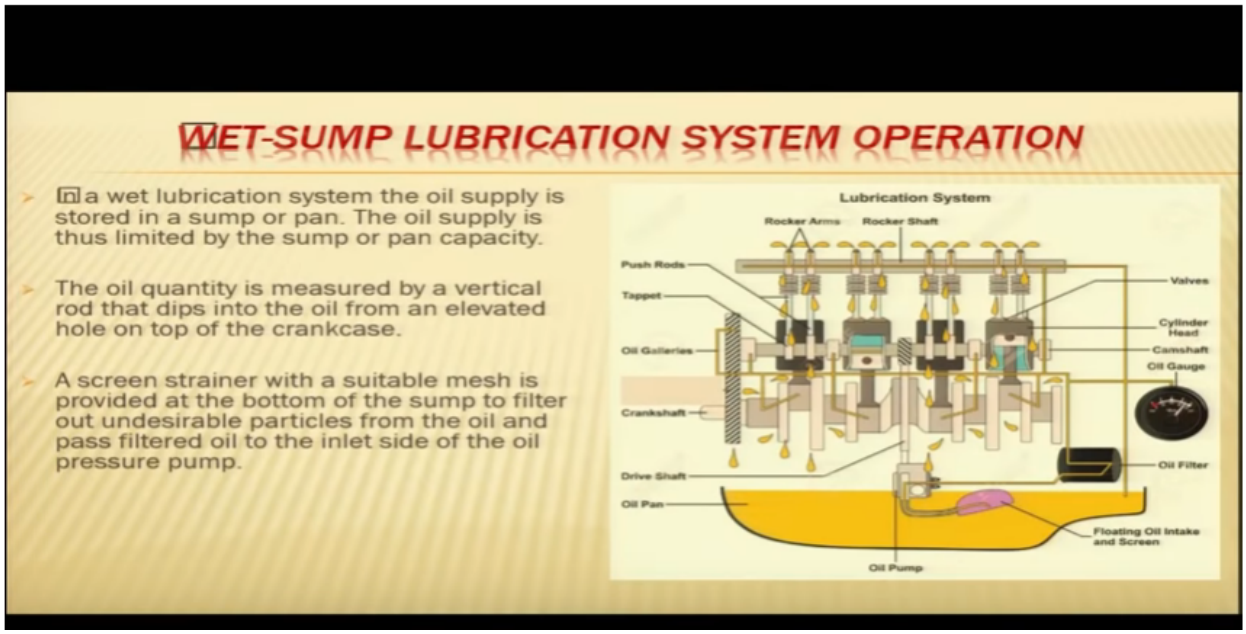

Next is your wet sump lubrication system, now I have just seen the dry lubrication in the wet sump, you do not have, an independent oil tank, the oil is stored in the engine, you can see in the diagram here, is your oil which is in the in a oil pan, which is attached to your, crankcase in, a wet lubrication system the oil supply is stored in a sump or pan, you see here is your oil supply, which is stored in a sample pan, the oil supply, is thus limited by the sump or pan capacity. So, this capacity, the capacity of the sump or pan limits, the oil supply, the oil quantity is measured by a vertical rod that dips into the oil from an elevated hole, on top of the crank. So, on the real engine we will show you, how the oil quantity is measured and there is a dipstick, which measures the quantity of oil, a screen strainer with a suitable mesh is provided at the bottom of the sump, to filter out undesirable particles, from the oil and pass filtered oil to the inlet side of the oil pressure pump. So, in a wet sump lubrication system, you also have a screen strainer, with a suitable mesh which is located, at the bottom of the sump and its purpose is to filter out, all the undesirable particles, from the oil and pass the filtered oil, to the inlet side of the oil pressure pump. So, we will show you, on the engine, the drain plug the screen strainers, the filler points, the dipsticks,

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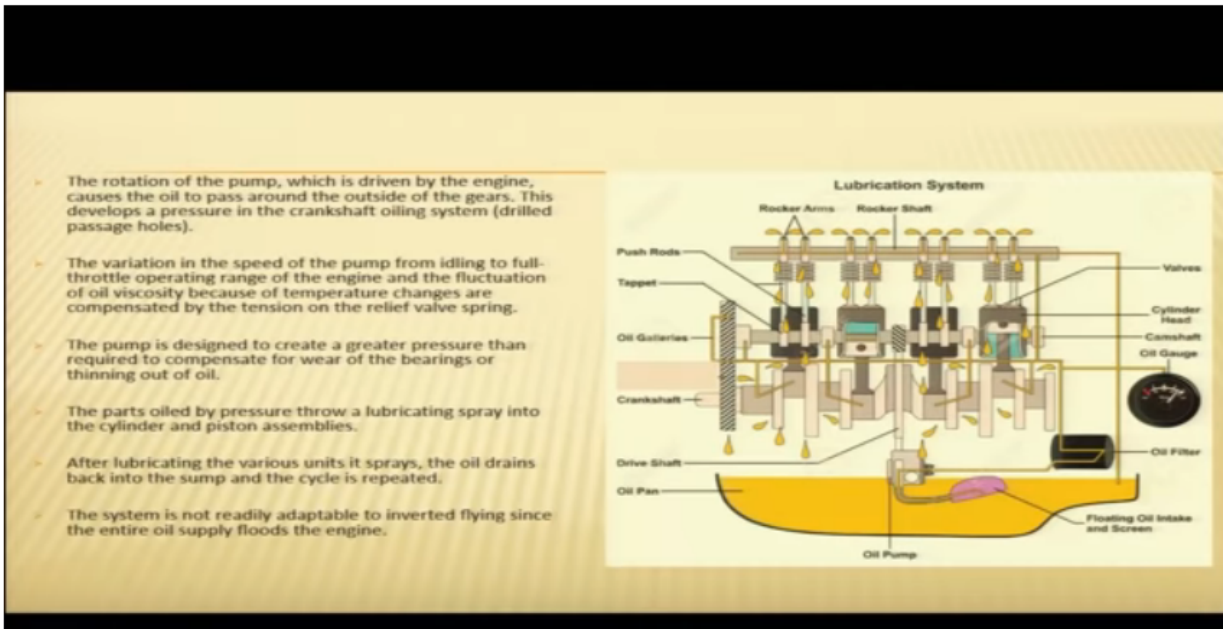

the rotation of the pump, the rotation of the oil pump, which is driven by the engine, causes the oil to pass around outside of the gears, this develops a pressure in the crankshaft ,oiling system. So, we all know that the oil pump, is used to pressurize the oil, it is a gear type pump driven by the engine, it causes the oil to pass around, the outside of the gears and it develops pressure in the crank shaft oiling system, the variation in the speed of the pump, from idling to full throttle operating, range of the engine and the fluctuation of oil viscosity, because of temperature changes are compensated by, the tension on the relief valves spring. So, we have seen, in our earlier slide, that the purpose of the oil pressure relief valve, is to regulate the lubrication system, pressure, the pump is designed to create a greater pressure than required, to compensate for veer of the bearings or thinning out of oil, the parts oiled, by pressure through a lubricating spray, into the cylinder and piston assemblies. So, this these parts which are lubricated by, a pressure they throw a spray, lubricating spray, on the cylinder and piston assemblies, after lubricating, the various units, it sprays the oil drains back into the sump and the cycle is repeated but there is a drawback in the system, it is not adaptable to, inverted flying since the entire oil supply can flood the engine.

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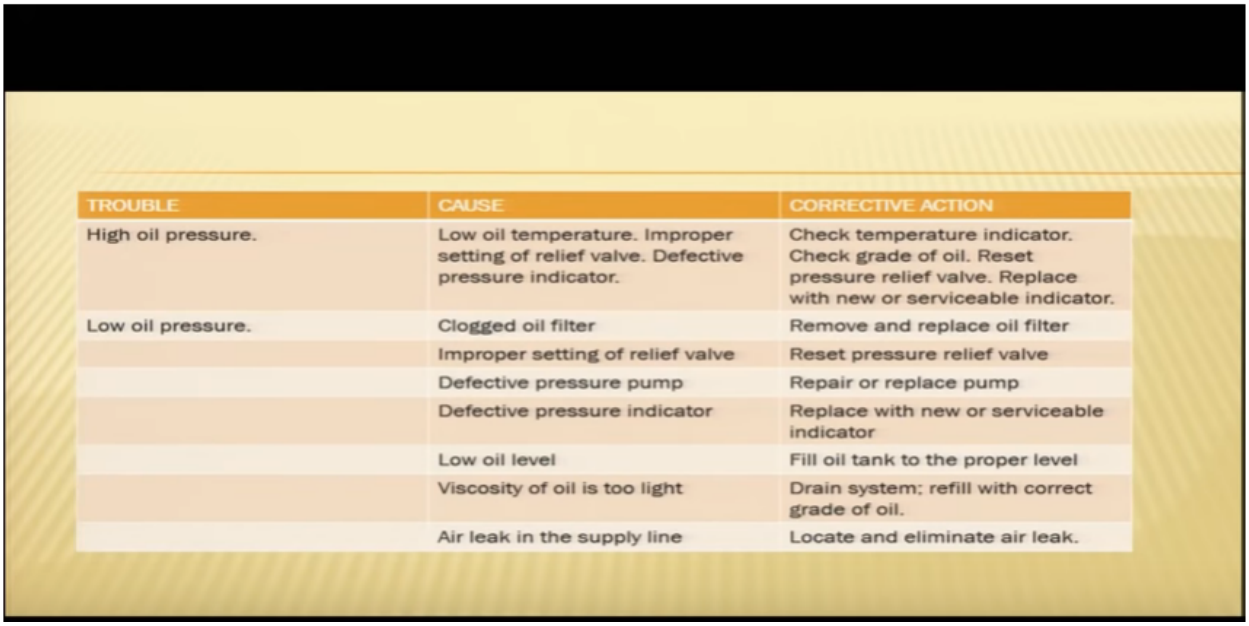

TROUBLE	CAUSE	CORRECTIVE ACTION
High oil pressure.	Low oil temperature. Improper setting of relief valve. Defective pressure indicator.	Check temperature indicator. Check grade of oil. Reset pressure relief valve. Replace with new or serviceable indicator.
Low oil pressure.	Clogged oil filter	Remove and replace oil filter
	Improper setting of relief valve	Reset pressure relief valve
	Defective pressure pump	Repair or replace pump
	Defective pressure indicator	Replace with new or serviceable indicator
	Low oil level	Fill oil tank to the proper level
	Viscosity of oil is too light	Drain system; refill with correct grade of oil.
	Air leak in the supply line	Locate and eliminate air leak.

So, we have just seen what the lubrication system is all about? So, now let us see, what are the troubles? What are the malfunctions? What are the snacks? We can encounter in the lubrication system. So, there may be a high oil pressure, your oil pressure gauge, may be indicating high oil pressure. So, there are various causes, of high oil pressure it may be low oil temperature, it may be improper setting of relief valve and it may be a defective pressure indicator. So, there are probable cause, in case you have high oil pressure you, you can have low oil temperature, it maybe because of the low oil temperature, first important thing in case you have low oil temperature, you need to check your temperature indicator, after that you need to check the grade of oil being used. So, in case you are having low oil temperature, check the temperature indicator, check the grade of oil being used. Now another reason for high oil pressure, may be improper setting of relief valve, we have seen in our earlier slide, how the relief bulb is set there is a lock nut you loosen the lock nut there is a slotted head clockwise increasing, increases the oil pressure setting of the relief valve, counterclockwise setting rotation decreases, the setting of the relief valve. So, improper setting of relief valve, may also be the reason of high oil pressure, in if that is the case you need to reset the pressure relief valve, another probable reason, of high oil pressure indication is, that your pressure indicator may be defective, in case if your oil pressure indicator is defective, replace it with a new or serviceable indicator. So, these were the causes and collective actions, for high oil pressure in case you encounter, high oil pressure, another problem may be low oil pressure, in case if your gauge is indicating, low oil pressure, then what are the probable causes, first cause may be a clogged oil filter, another cause may be improper setting of relief valve and others caused defective pressure pump, then defective pressure indicator low oil level, viscosity of oil is too light or air leak in the supply line. So, you have so, many reasons why you can have a low oil pressure, coming to the first, probable cause clogged oil filter. Now in case, if your oil filter is clocked, your system, may have oil pressure, in that case you need to remove and replace your oil filter, second cause improper setting of relief valve, we have just seen it in the above case also, in case your relief valve is not set properly, you may also have high oil pressure, you may also have low oil pressure. So, in case if you're relieved all is not set try to reset your pressure relief valve, third cause, defective pressure pump, another probable cause your oil filter might be ok,

your relief valve setting might be ok then your pressure pump, might be defective. So, in that case replace or repair your oil pump, then another reason a very simple reason for low oil pressure, indication is that your pressure indicator, might be defective. So, in case if your pressure indicator might be defective, you have to replace with new or serviceable indicator. So, cases of snag rectification you have to go step by step, you have to start with very simple, reasons and gradually move ahead and you have to eliminate each and every reason by doing your maintenance actions by doing your sang rectification the snag rectification is all about diagnosis and step by step, elimination of all the reasons, another reason might be low oil level. So, in case if your oil level is too low, in that case also you may encounter, low oil pressure, in this case you need to, fill your oil tank, to the proper level. Now another reason is viscosity of oil is too light, now incase if your oil viscosity is too light, then you need to drain the system and refill with correct grade of oil, air leak in the supply line. So, this is also one of the probable cause for, low oil pressure, in case if there is a leak in the supply line, if there is a air leak in the supply line, then also you may encounter low oil pressure in that case the corrective action will be, to locate and eliminate the air leak, as I just meant that in case of in slide electrification, you have to start with very simple reasons and eliminate each probable cause and finally you will be able to rectify your snack. So, these are the probable causes and corrective action for, low oil pressure.

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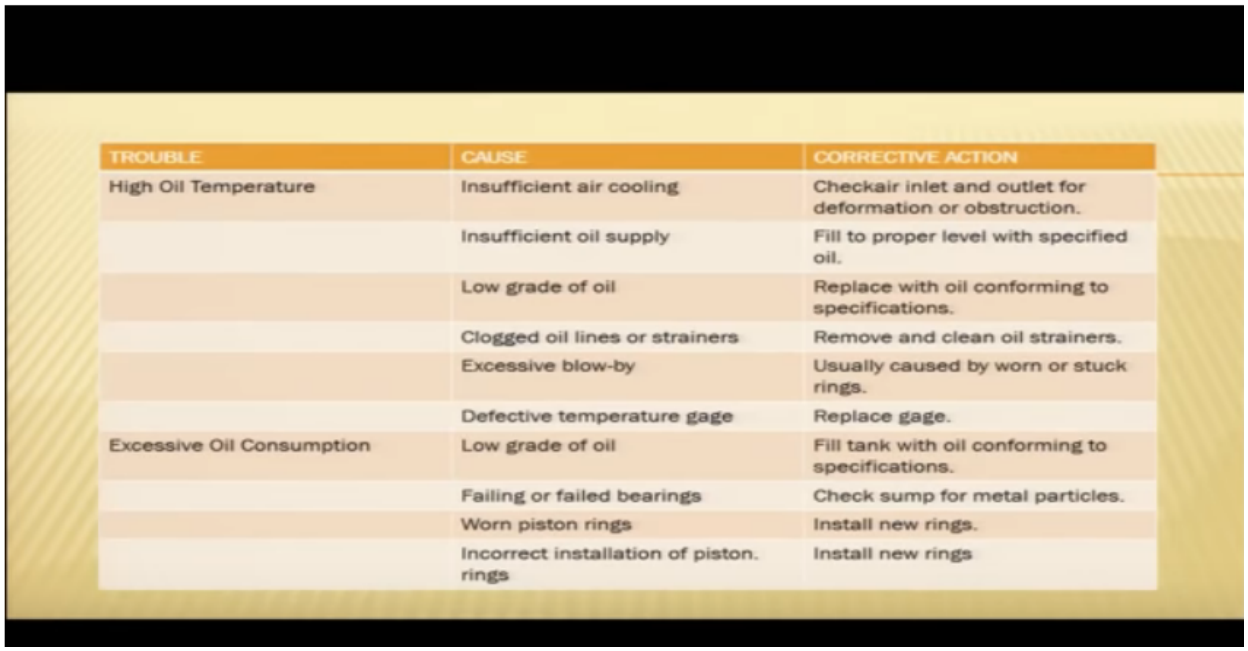

TROUBLE	CAUSE	CORRECTIVE ACTION
High Oil Temperature	Insufficient air cooling	Checkair inlet and outlet for deformation or obstruction.
	Insufficient oil supply	Fill to proper level with specified oil.
	Low grade of oil	Replace with oil conforming to specifications.
	Clogged oil lines or strainers	Remove and clean oil strainers.
	Excessive blow-by	Usually caused by worn or stuck rings.
	Defective temperature gage	Replace gage.
Excessive Oil Consumption	Low grade of oil	Fill tank with oil conforming to specifications.
	Failing or failed bearings	Check sump for metal particles.
	Worn piston rings	Install new rings.
	Incorrect installation of piston. rings	Install new rings

Now another problem that you may encounter is high oil temperature. Now in case if your oil temperature is too high, what are the probable causes insufficient air cooling, this is one cause, another cause is insufficient oil supply, then low grade of oil clogged oil lines or strainers excessive blow by and defective temperature gauge. So, these are the probable causes, of high oil temperature we will see, one by one, what corrective actions can be taken, in these cases. So, in the first cause insufficient air cooling,

in case if the air cooling is insufficient, then also you will have a high oil temperature problem, in that case, we need to check air inlet and outlet for deformation or obstruction, another reason insufficient oil supply, in case the oil supply, is insufficient then also you will encounter high oil temperature, the corrective action is filled to the proper level with specified oil, low grade of oil in case the oil being used is not of the specified grade or of the lower grade, then also we will encounter high oil temperature and the corrective action will be replace, oil with oil which confirms, to the specification. So, whatever oil is specified by the manufacturer we need to use the that oil. So, that we do not encounter these kind of problems, clogged oil lines or strainers. So, there might be strainers which are clocked there might be oil lines, which are clocked, they may also result in high oil temperature, in that case we need to remove and clean the oil strainers. So, another reason is excessive blow by, for Hawaii oil temperature this is one of the probable, cause excessive blow, by might be the reason for high oil temperature, in that this is usually caused by, worn or stuck rings, we need to take the rectification action, we need to take the proper action. So, that the rings are replaced, in case if they are worn or stuck, another reason for high oil temperature might be, might be a defective temperature gauge.

So, defective temperature gauge, in that case we need to replace the gauge and we might be able to solve this problem of high oil temperature. So, we have seen the probable causes and the corrective actions to be taken, in case of high oil temperature problem, another problem that we might encounter is excessive oil consumption, this is a very important problem, we need to be very careful of this in case if your engine is consuming, excessive oil, there might be, various causes, post is low grade of oil, then failing or failed bearings, worn piston rings and incorrect installation of piston rings. So, these are the probable causes of excessive oil, consumption let us look ,at them one by one in case, you are using a low grade of oil, then also you will have the excessive, oil consumption in that case, you need to replace the oil with the specified oil by the manufacturer, the oil which is specified by the manufacturer, that is supposed to be used in case if we you are using a low grade of oil, replace the oil with the correctly specified oil, then another problem probable, cause for excessive, oil condition is failed bearings or failing bearings. Now in case if the bearings, have failed or they are about to fail, then also we may encounter, excessive oil consumption, in that case we need to check the sump, for metal particles in case your piston rings are borne out, then also you we may face excessive oil consumption, in that case we need to replace the piston rings, we need to put the new rings. And another reason might be incorrect installation of piston rings, now in case if the piston rings are not installed properly, then also we will face excessive oil consumption, in that case also we need to remove those rings and put the new rings properly. So, we have seen the probable causes of excessive oil consumption and the corrective actions taken, as I have mentioned earlier also, in snag rectification we have to move, with the very simple steps, we have to eliminate, each and every probable cause and finally we will be able to figure out, what is the cause and we will be able to rectify the problem. So, this was all about the lubrication system, we have seen the different components being used, in the lubrication system the different types of lubrication systems. Now we will see in on the aircraft on actual aircrafts the different systems the Waxhaw lubrication system the dry Waxhaw lubrication system, we will also see in one of the stripped engines, the different parts and how the oil is flowing in that engine. Thank you.