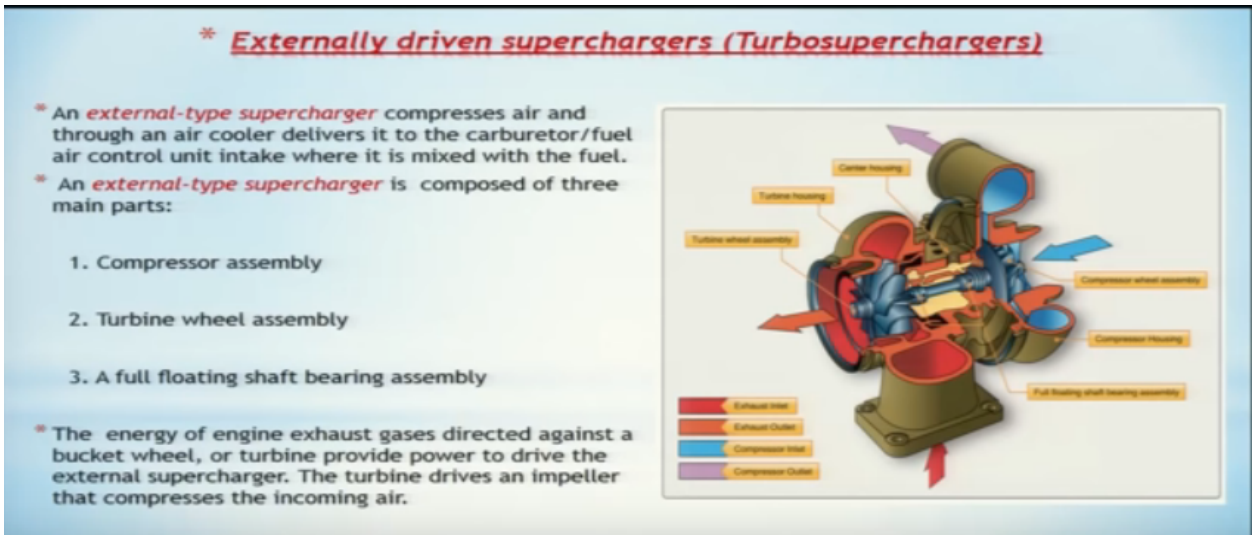
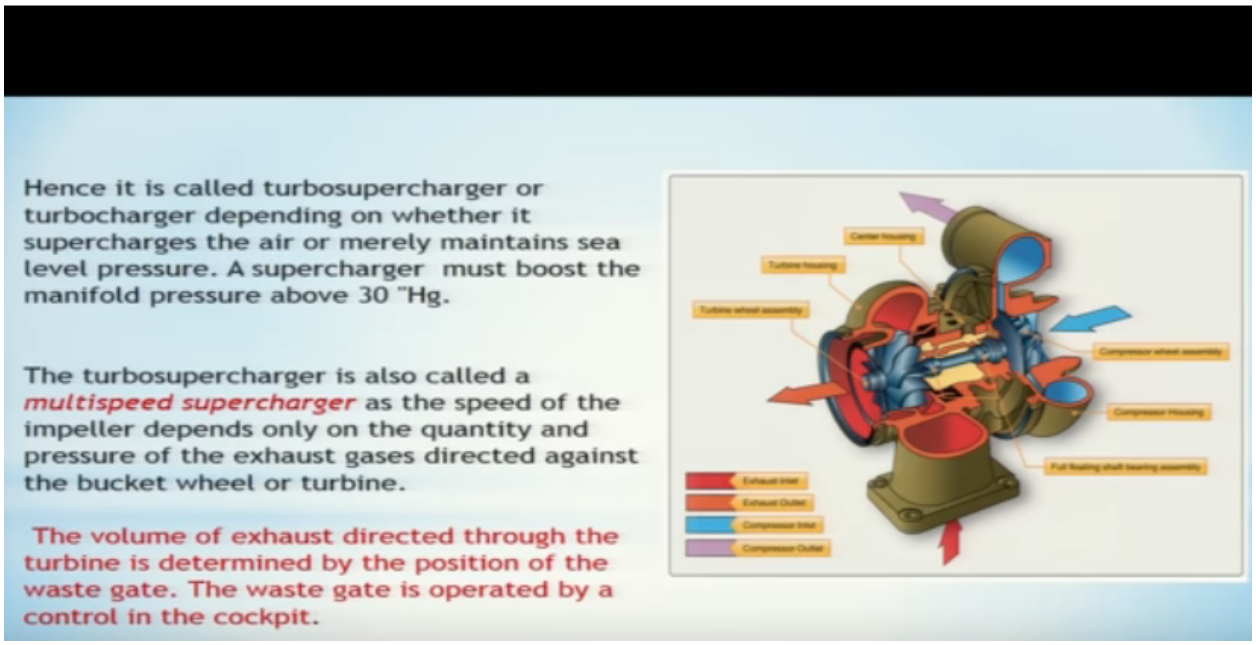
Lecture 10
Induction System Contd...

Refer Slide Time :(0: 14)



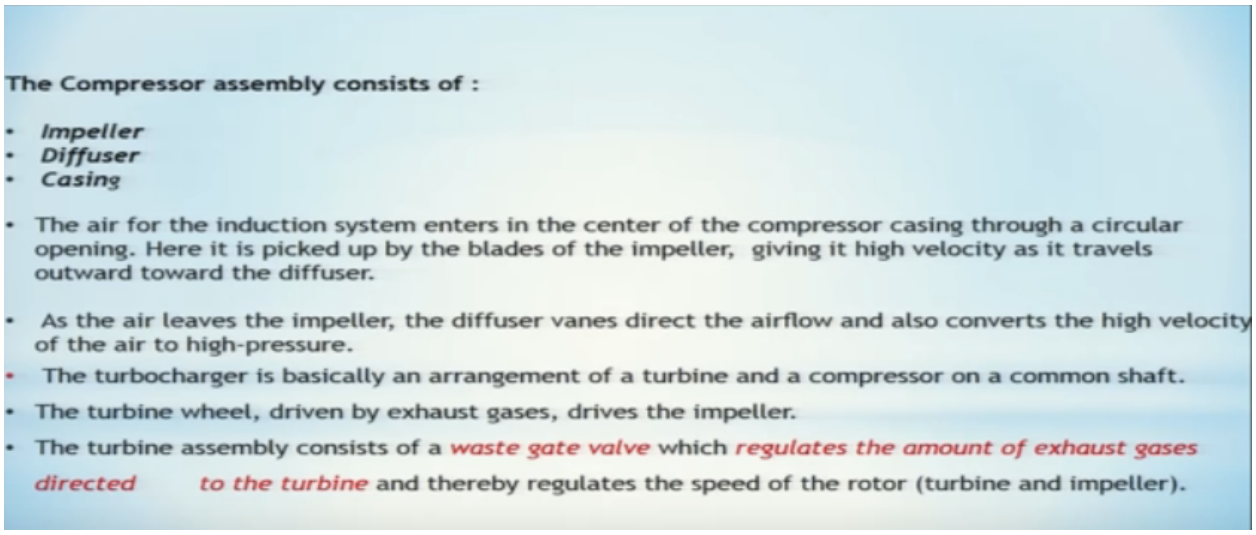
So, next is externally driven superchargers we also call them,' Turbo Super Charges'. An external type supercharger compressorors, air and through an oil cooler, delivers it to the carburetor fuel air control unit, intake where it is mixed with the fuel. Now this air, which is compressorors by the compressor, is routed through the air cooler. So, that the temperature of the compressorored air, is lowered, since after compression, the temperature of the air, will increase. So, in order to lower the temperature, the air is routed through the air cooler. Now, an external type supercharger, is composed of three main parts compressor or and assembly, turbine wheel assembly and a full floating shaft bearing assembly. So, the energy of engine exhaust gases, directed against a bucket wheel, or turbine provides power, to drive the external supercharger. The turbine drives an impeller, that compressors the incoming air. Now, this external type supercharger has got three main parts, one is the compressor assembly, you can see, in this picture, this is your compressor assembly, second is your turbine wheel assembly, this is your turbine wheel assembly, here and a full floating shaft bearing assembly and this is a pole floating shaft. So, three main parts, compressor, turbine and a shaft. Now, the energy of the engine exhaust gases. So, this turbocharger is basically using the energy of the exhaust gases, against a bucket wheel or turbine, this turbine extracts energy from the exhaust gases. Now, in this figure you can see this is this inlet this is the inlet through which exhaust gases are coming in these exhaust gases are directed against this turbine wheel the turbine wheel will extract the energy of the exhaust gases and this turbine will drive the pressure this compressor the compressor is here this turbine will drive the compressor since the turbine and the compressor are on the same shaft and it is extracting energy from the exhaust gasses, to drive the turbine wheel, which drives the compressor, since the turbine and the compressor are on the same shaft.

Refer Slide Time :(2: 46)



It is called, ‘Turbo Super Charger’ or turbocharger depending on, whether it supercharges the air or merely maintains sea level pressure. Now, in case, if it is, super charging the air, then it is called, ‘Turbo Supercharger’ or if it is, merely maintaining the sea level pressure, that in that case it is called, ‘Turbocharger’. However the supercharger, is required to boost the manifold pressure above 30 inches of mercury, in case, if it is, a supercharger then it is required to boost the manifold pressure, above 30 inches of mercury. Now, this is called a, ‘Multi Speed Super Charger’. Because, the speed of this compressor, is dependent on the speed of the turbine, because they are on the same shaft and the speed of the turbine, is dependent on the quantity and pressure of the exhaust gases, directed against the turbine. So, because of that reason this is called a, ‘Multi Speed Super Charger’. The volume of exhaust, directed through the turbine, is determined by the position of the waste gate and the wastegate is operated by a control in the cockpit. Now, the volume of exhaust gasses, which is directed against this turbine, is controlled by the position of a waste gate. We will see, what is the waste gate? There is a, one kind of thing, which is called a, ‘Waste Gate’ and this is operated from a control in the cockpit. So, the position of the waste gate, will determine, the quantity, of exhaust gasses, being directed towards the turbine wheel.

Refer Slide Time :(4: 25)



The compressor assembly consists of impeller, diffuser and casing. Now, this compressor which is used to compressor or the air has got three main parts, impeller diffuser and casing. The air for the induction system enters in the center of the compressor. Now, the air which is to be compressorored, enters the center of the compressor you see this is your compressor and this is your compressor Inlet. Now, air which is to be compressorored it goes, through this opening, there is an opening on this side and the air which is to be compressorored, enters the compressor through this opening, you can see here, this is a blue arrow, which is showing compressor Inlet. So, this is compressor Inlet and after compression, the air is coming out, through this outlet. The air for the induction system enters in the center of the compressor casing through a circular opening, here it is picked up, by the blades of the impeller, giving it high velocity, as it travels outward, towards the diffuser. Now, the air which is entering, the compressor is picked up, by the impeller blades, these impeller blades, will give it high, velocity and it travels towards the diffuser, as the air leaves the impeller, the diffuser vanes direct the airflow and convert the high velocity, of air to high pressure. Now, impeller has picked up, the air it has given at high, velocity and the air from the impeller, has is directed towards the diffuser. Now, this diffuser vanes, will direct the airflow and will convert high, velocity of air to high pressure air, the turbocharger is basically an arrangement of a turbine and a compressor on a common shaft. So, we have seen it earlier, that the turbocharger, it is, an arrangement of a compressor and turbine. This is compressor, this is turbine on the same shaft, on the common shaft. The turbine assembly consists of a waste gate wall, which regulates the amount of exhaust gasses, directed to the turbine. So, in our last slide, we have read that the turbine assembly also, has a waste gate wall which will regulate the amount of exhaust gasses, being directed to the turbine and thereby, it will regulate the speed of the rotor, turbine and impeller. So, rotor is your turbine and impeller since, both are on the same shaft, they are rotating. So, this waste gate wall, is regulating the speed of the rotor.

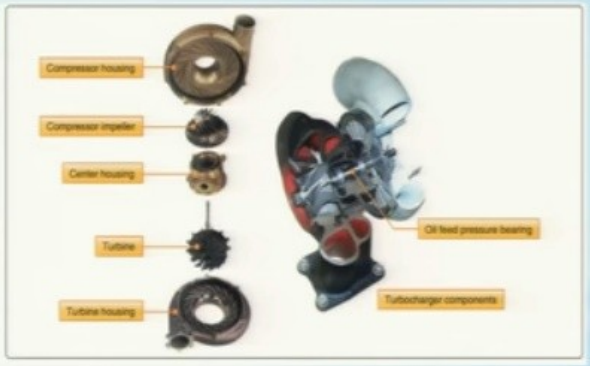
Refer Slide Time :(7: 10)

- If the *waste gate is completely closed*, all the exhaust gases are forced through the turbine wheel.
- If the *waste gate is partially closed*, a corresponding amount of exhaust gas is directed to the turbine.
- If the *waste gate is fully open*, nearly all of the exhaust gases pass overboard providing little or no boost.
- The directed exhaust gasses strike the turbine blades, and cause the rotor (turbine and impeller) to rotate.
- The gases are then exhausted overboard after most of their energy is extracted.
- The *degree of waste gate closing* determines the amount of air pressure boost obtained from the turbocharger.

If the base gate is completely closed, all the exhaust gasses, are post through the turbine wheel. If the base gate is partially closed. So, corresponding amount of exhaust gas, is directed to the turbine oh and if the waste gate is fully opened, nearly all of the exhaust gases pass overboard, providing little or no boost. So, in general the waste gate, if it is completely closed. So, in that case, all the exhaust gases, will be directed, will be forced, to go through, the turbine wheel, in case if it is partially closed, waste gate is partially closed, then corresponding amount of exhaust gas is directed to the turbine, the directed exhaust gases, strike the turbine blades. Yes, we have seen in our earlier slide also, the directed exhaust gasses they strike, the turbine blades and cause the rotor to rotate, the turbine and impeller, the gases are then exhausted overboard, after most of their energy is extracted. So, after the turbine has, extracted the energy of the exhaust gasses that air, is sent overboard and the turbine blades, are rotating. The degree of waste gate closing, determines the amount of air pressure boost, obtained from the turbocharger. So, the amount of boost, which is obtained from the turbocharger, depends on the degree of waste gate opening or closing.

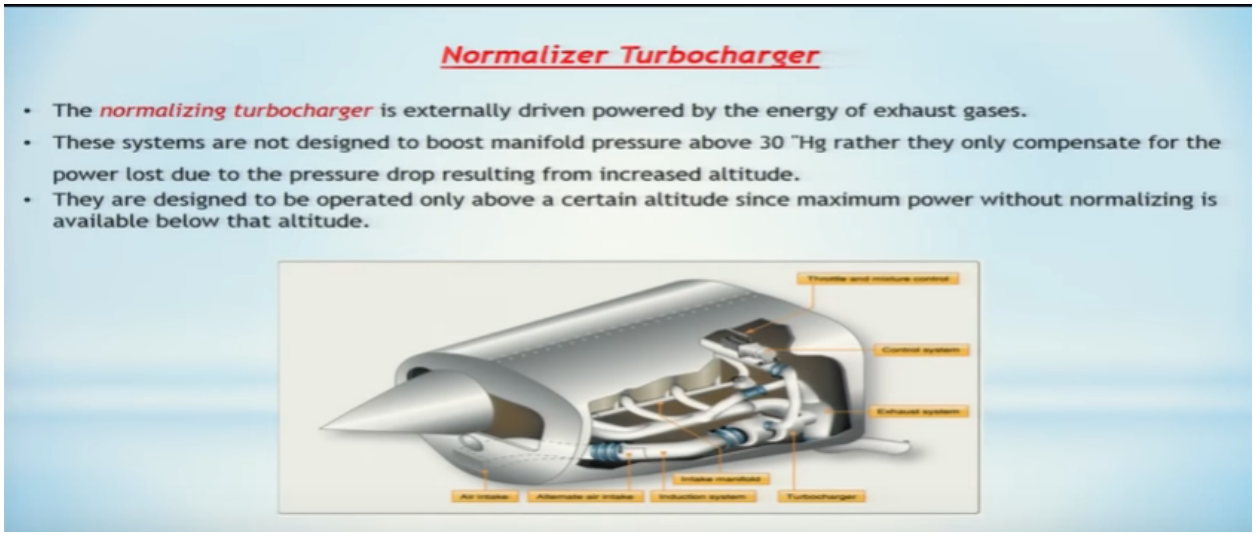
Refer Slide Time :(8: 39)

- The temperature of the air increases after compression, too high carburetor air temperature is not desirable as it may cause detonation in the cylinders.
- In order to reduce the compressed air temperature, it is required to pass through an intercooler.



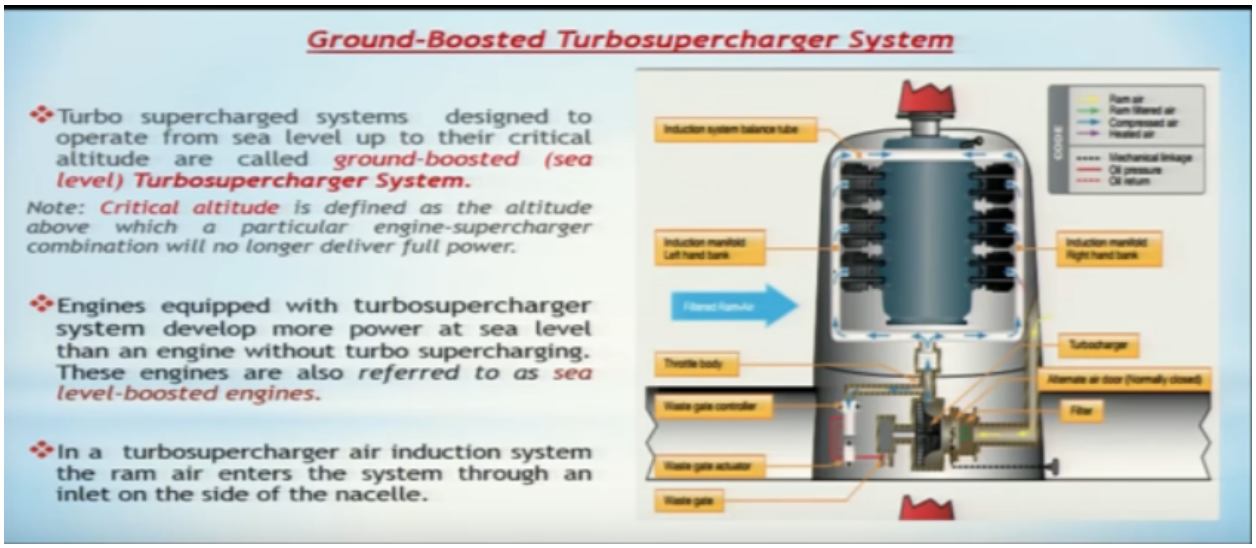
We have discussed this earlier also, like after compression the temperature of the air increases and to high, carburetor air temperature is not desirable, as it may cause detonation in the cylinders. So, we will read in our, next chapters, what is detonation? But, it is not a desirable characteristic. So, high temperature of air in the carburetor, will result in debt in the cylinders. So, in order to avoid that the compressorored air, is passed through the air coolers, in the figure you can see, there are this turbocharger unit is a split, you can see, this is your compressor housing, this is your compressor impeller here, this is your Center housing, this is turbine and this is your turbine housing, then again this is your shaft, where it is to be lubricated and this, complete thing is your turbocharger assembly.

Refer Slide Time :(9: 38)



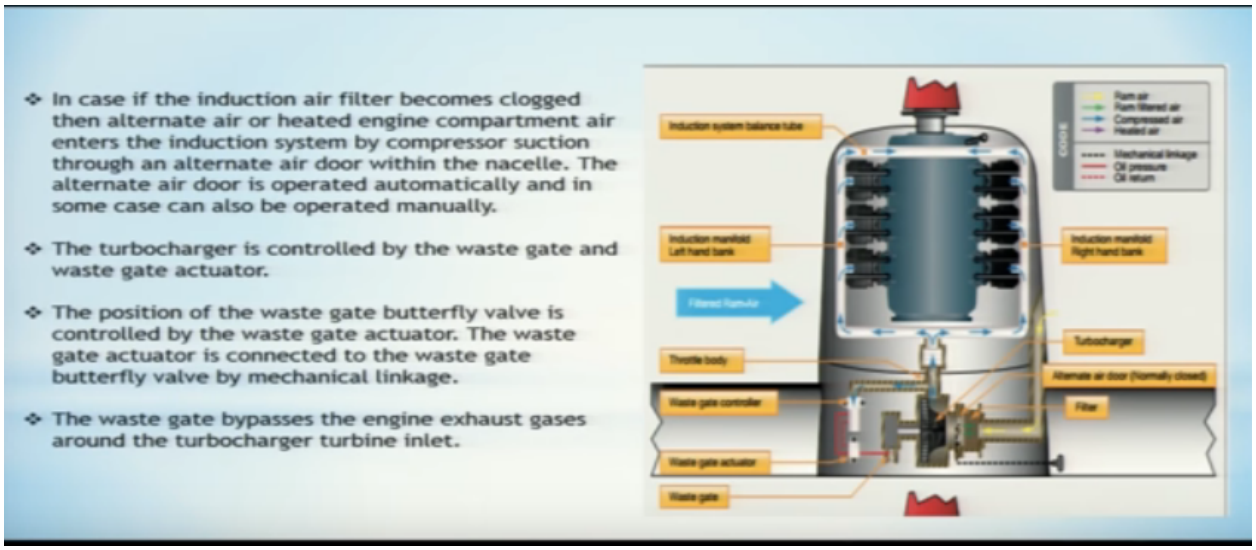
Now, normalize turbocharger, what is a normalizer turbocharger? The normalizing turbocharger is externally driven powered by the energy of exhaust gases. Now, this is also powered by the energy of exhaust gases and it is externally driven, these systems are not designed boost, manifold pressure above 30 inches of mercury, rather they only compensate for the power lost, due to the pressure drop resulting from increased altitude, as we know that, as we go up, you fly high, your pressure drops resulting in engine power loss. So, in order to compensate, for that power loss, we need a system, which can, boost the manifold pressure, the Normalizer turbocharger system, this will not boost the manifold pressure above 30 inches of mercury. But, it will only, compensate for whatever power has been lost, due to pressure drop, from increased altitude. So, it will just try to maintain your sea-level pressure, they are designed to be operated only, above a certain altitude. So, these normalize turbochargers you cannot operate them. Right? From the ground or from the sea level, but they can be operated, only above a certain altitude, since maximum power without normalizing, is available, below that altitude.

Refer Slide Time :(10: 58)



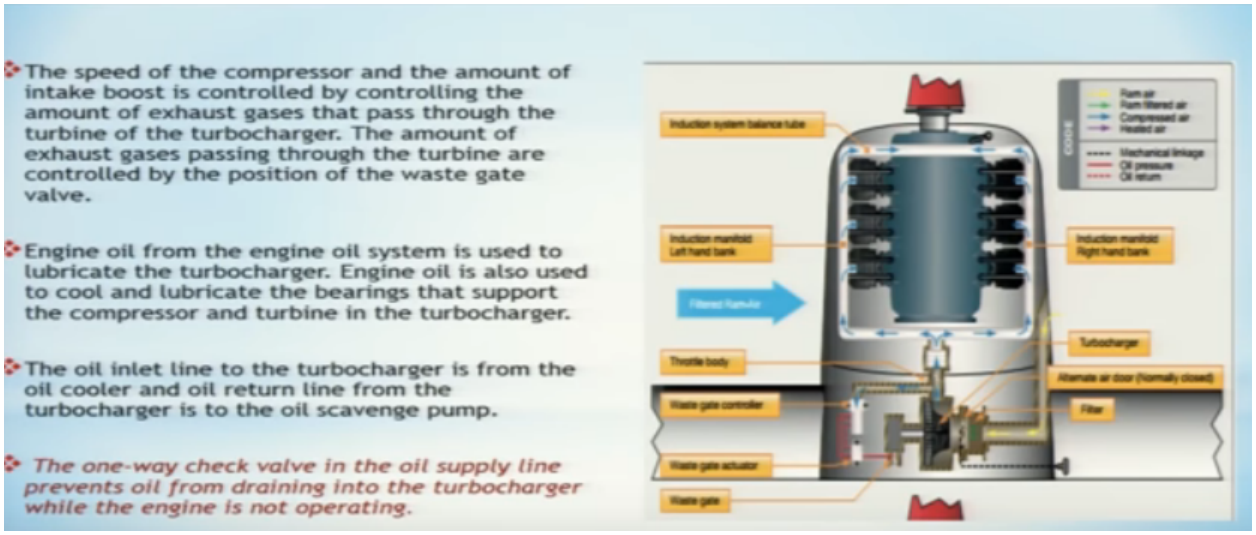
Now, coming to ground boosted turbocharger system. What is a ground boosted turbocharger system? We have just seen, a normalized turbocharger, where it was just trying to maintain the sea level pressure, it was not boosting the manifold pressure, about thirty inches of mercury. But, in case if we want to have a system, which can supercharged, with more thirty inches of mercury, in that case it will be a turbo supercharger system and they are called, 'Ground Booster Turbo Super Charger System'. Turbo supercharged systems, are designed to operate from sea level, up to their critical altitude and are called, 'Ground Boosted Sea Level Turbo Charger System' and are called, 'Ground Boosted' or sea level turbo supercharger system. What as a critical altitude? Critical altitude is defined, as the altitude, above which a particular engine supercharger combination, will no longer deliver, full power. Engines equipped with turbo supercharger system, develop more power at sea level, then engines without both super charging, these engines are also called, 'Sea level boosted engines', in a turbo supercharger, air induction system, the ram air enters the system, through an inlet on the side of the nestled. Now, you can see the figure here, this is, your side of the engine, side of the nestled or side of the cowling and your ram air is coming through this, Inlet you can see these, yellow arrows. Now, your air is coming through this thing, through the inlet opening. Now, after coming through this Inlet, the air passes through our filter, you can see here, this is your filter and after filter you get a filtered air, ram filtered air, you are getting, the serum filtered air passes through the turbo supercharger, see this ram filtered air is passing through the turbo supercharger, after passing through the turbo supercharger the air gets compressorored, the air you can see, this compressorored air, is going to the carburetor or the fuel injector, from the fuel injector or the carburetor, the air you can see here, is routed to different cylinders, the air is routed to different cylinders.

Refer Slide Time :(13: 25)



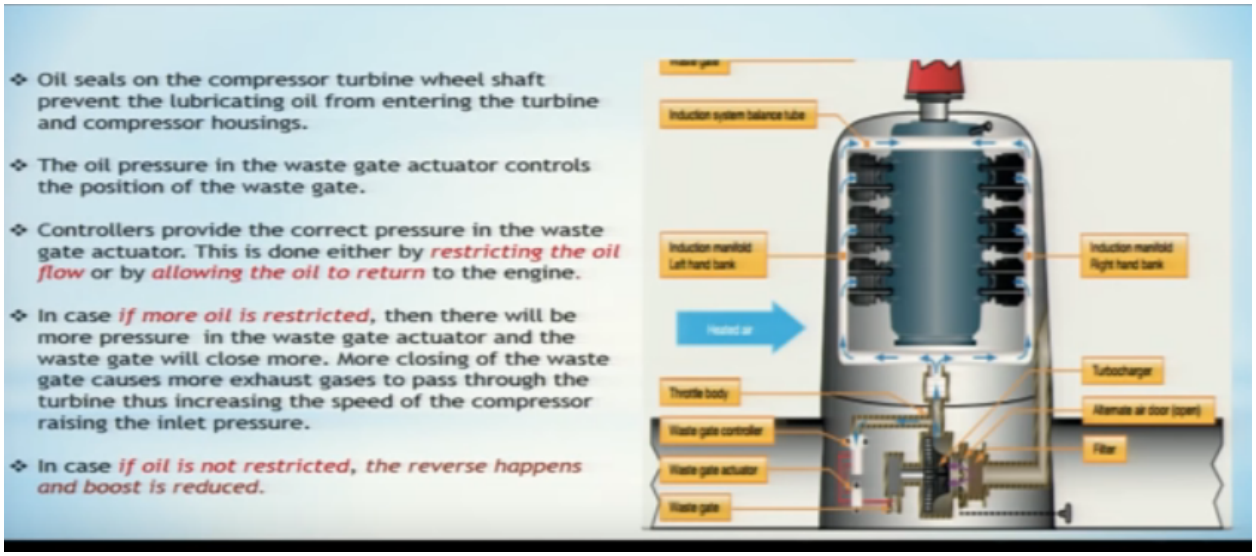
In case if the induction air filter becomes clocked, then alternate air or heated engine compartment air enters the induction system, by compressor suction through an alternate air door within that nestled. We have read about this, in our earlier slides, about the alternate air door. So, again this is, being repeated again like in case if the filter gets clocked, the air comes to the alternate your door within the nestled. The alternate air door can be operated automatically or it can be operated manually, we have read about this earlier, the turbocharger is controlled by the waste gate and the waste gate actuator. Now, here you can see in the figure, this is your turbocharger, on the turbocharger you have a waste gate, this is your waste gate, see this is your waste gate and this is your waste gate actuator. So, the waste gate, the waste gate will, regulate, the quantity, the amount of, exhaust gas, being driven, to the turbine. So, the turbocharger is controlled by the waste gate and the wastegate actuator, the position of the waste gate butterfly wall, is controlled by the waste gate actuator. Now, this waste gate wall, this position, its position is controlled by this actuator, wastegate actuator, the wastegate actuator is connected to the waste gate butterfly wall, with my mechanical linkage. So, both the actuator and the wall they are connected by to each other by mechanical linkage and the waste gate actuator, will control, the position of the waste gate butterfly ball. So, which gate will bypass, the engine exhaust gas, around the turbocharger turbine Inlet.

Refer Slide Time :(15: 12)



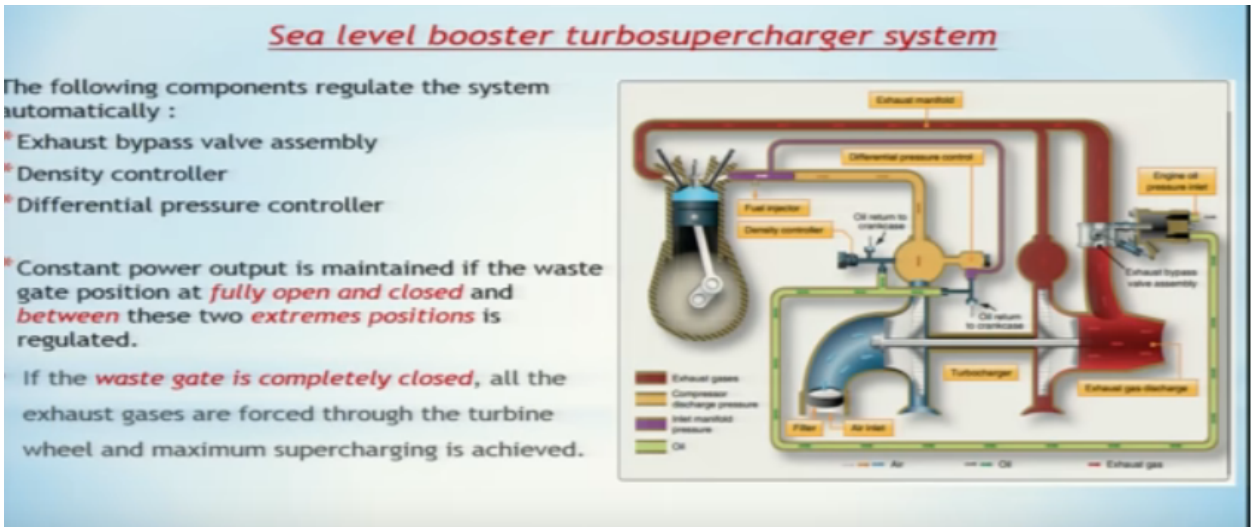
The speed of the compressor and the amount of intake boost is controlled, by controlling the amount of exhaust gases that pass through the turbine, of the turbocharger. Now, since the amount of exhaust gas, which is passing through the turbine, is controlled by the position of the wastegate wall, this is controlling, the speed of the compressor and finally the amount of boost being created by the turbocharger. Now, engine oil from the engine oil system, is used to lubricate the turbocharger. Now, since, you have, the rotating parts in the turbocharger, it needs lubrication. So, that lubricating oil is from the engine oil system. Agent oil is also used to cool and lubricate the bearings that support the compressor and turbine in the turbocharger. So, lubrication is one requirement and the engine oil, will also cool and lubricate the bearings that support the compressor and the turbine in the turbocharger. The oil inlet line to the turbocharger, is from the oil cooler, rather I will say that, the oil inlet line from the turbocharger is, from the oil pump and oil return line from the turbocharger is, to the oil scavenge pump. Now, this turbocharger, this will have two lines, oil inlet line and one oil outlet line. The oil inlet line, in the oil inlet line which is coming to the turbocharger, is from the oil pump, from the oil pump, it is being routed, through the oil cooler and comes to the turbocharger. The oil which is going out, of the turbocharger, is going to the scavenge pump, to the oil scavenge pump and finally from the scavenge pump it is sent back to the oil tank, we have read in the lubrication chapter, the purpose of the scavenge pump. There is also one which I call in the oil supply line, which prevents oil from draining, into the turbocharger while the engine is not operating. So, at the time when your engine is not operating, this check hole, will prevent oil from draining into the turbocharger.

Refer Slide Time :(17: 50)



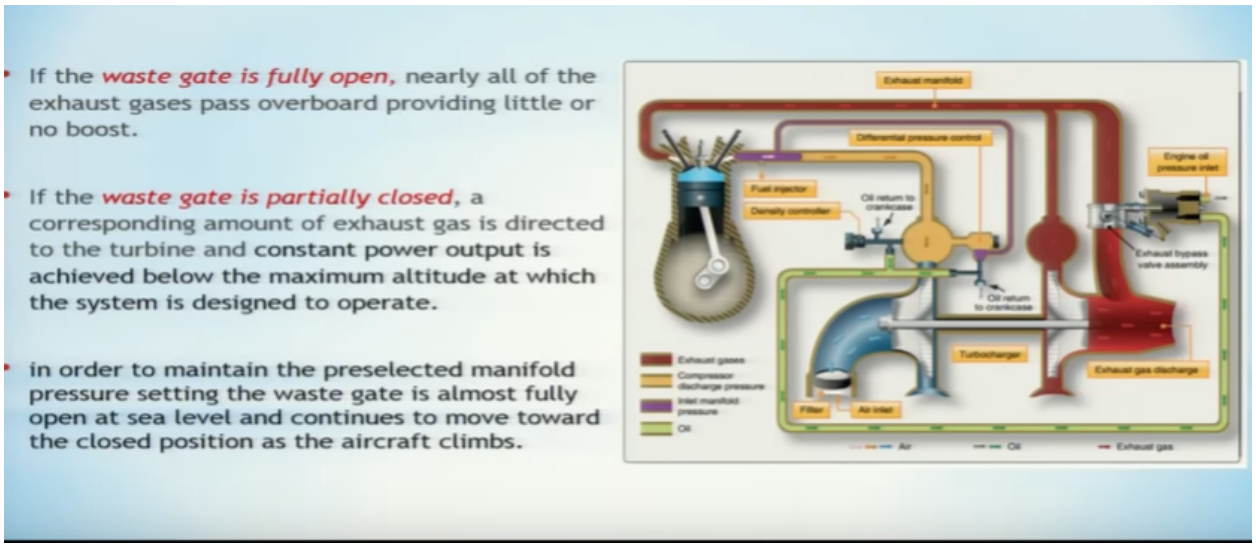
So, oil seals on the compressor turbine wheel shaft, will prevent the lubricating oil from entering the turbine and the compare housing, the oil pressure in the wastegate actuator controls the position of the waste gate. We have seen that there is a wastegate actuator and there is a waste gate wall, butterfly ball, the waste gate actuator controls the position of the wastegate butterfly ball. But, how, does it control. Now, the oil pressure is coming to the waste gate actuator, which controls the position of the waste gate, there are controllers, which provide the correct pressure in the waste gate actuator. Now, the oil which is coming to the wastegate actuator, that pressure is controlled by the controllers, these controllers they'll either, restrict the oil flow or allow the oil, to return to the engine. So, now, two cases in case if, oil is restricted, more oil is restricted, then there will be more pressure in the waste gate actuator. So, if the controller restricts, more oil, then there will be, more pressure and due to the more pressure in the wastegate actuator, the wastegate will close more, more closing of the waste gate, causes more exhaust gases to pass through the turbine, which results in increasing, the speed of the compressor and then, finally raising the inlet pressure or you get more boost, another case, in case if all is not restricted, then reverse will happen and you will have a reduced boost pressure. So, the controllers, they are restricting the oil flow or they are not restricting the oil flow, to the actuator which, finally controls the position of the waste gate.

Refer Slide Time :(19: 53)



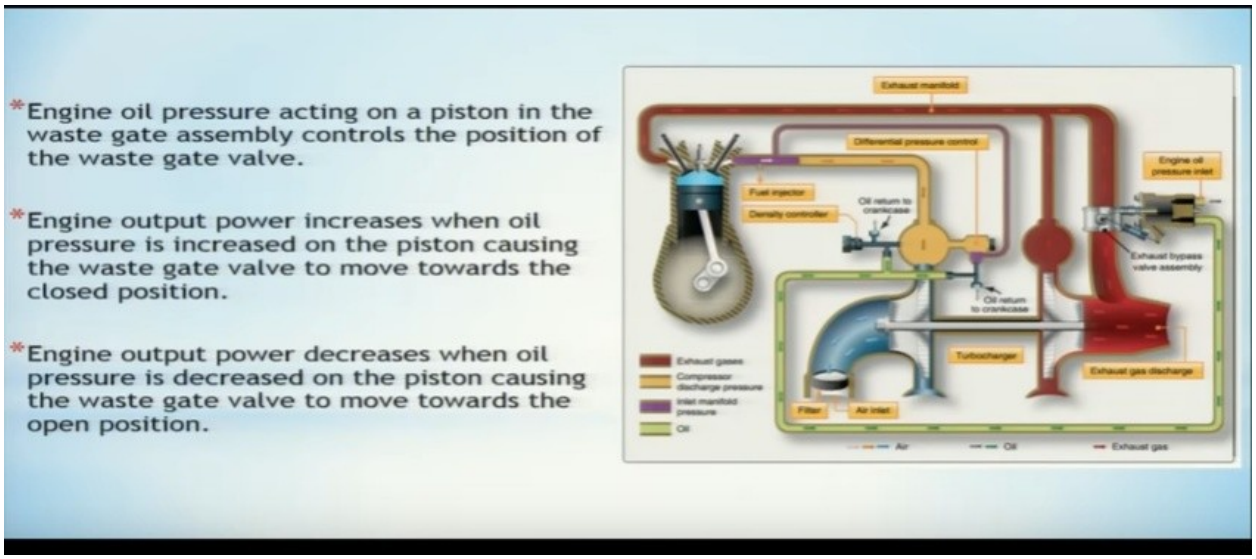
Another example, of ground booster turbo supercharger system or a sea-level booster turbo supercharger system, the following components regulate the system, automatically. So, in this system, this is, there is there is an automatic control, you have exhaust I pass bulb assembly, then you have a density, controller and you have a differential, pressure controller. So, let us see the figure, you have this, engine exhaust gases, these engine exhaust gases they are coming to the, turbine to the turbocharger and from the turbocharger, these gases, rather these compressorored gases, they go to your cylinder intake. So, you see here, here is being compressorored, this exhaust gas has entered the turbocharger, from the turbocharger it goes, to the, cylinder intake after compression. Now, constant power output is bent eight, if the waste gate position, at fully open and closed and between these two extremes is regulated. Now, in case, if the position of the waste gate, is regulated, at the extreme positions that is the full open position or the full closed position and also, in between these two positions, these two extreme positions, in case, if we are able to regulate, the position of the base gate, in that case, we will be getting, a constant power output from the system, if the waste gate is completely closed, all the exhaust gases are forced through the turbine wheel and maximum supercharging is achieved. So, we have seen this earlier, in case if the base gate is completely closed, then we get more exhaust gases through the turbine wheel and we get maximum supercharging.

Refer Slide Time :(21: 54)



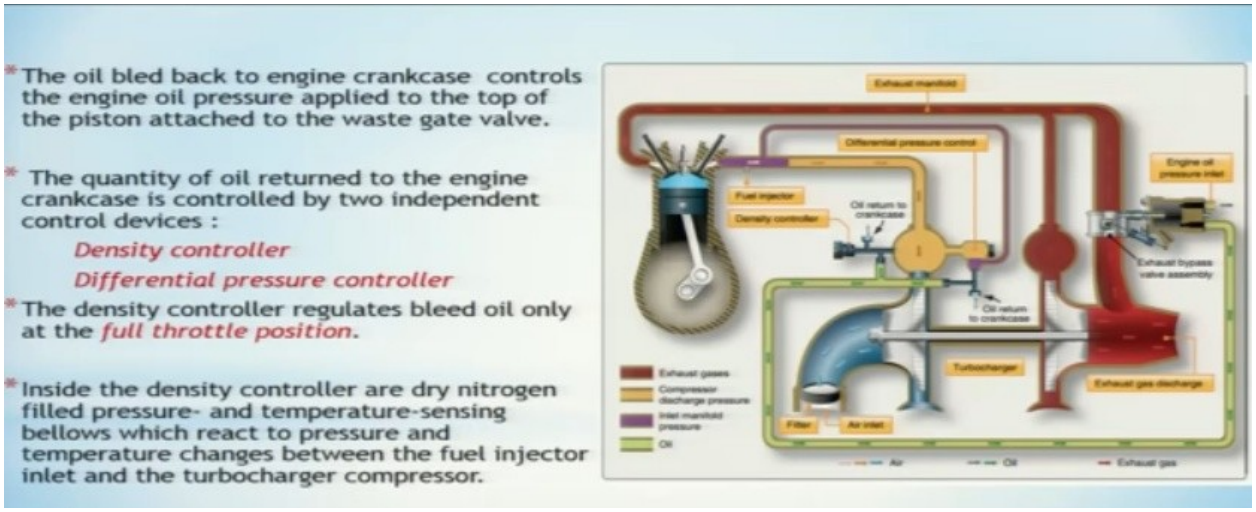
If the base gate is fully open, nearly all the exhaust gases pass over world, providing little or no boost. If the base gate is partially, closed a corresponding amount of exhaust gas, is directed to the turbine and constant power output is achieved, below the maximum altitude at which the system, is designed to operate. Now, in case if the base gate, is partially closed, that as, it is, in between the two extreme positions, in case, that corresponding amount of exhaust gas, is directed to the turbine and we get constant power output, below the maximum altitude for which the system is designed to operate, in order to maintain the pre-selected manifold pressure setting, the waste gate is almost, fully open at sea level and continues to move towards the closed position, as the aircraft climbs. Now, when we are at the sea level, your waste gate is almost fully open and as, the aircraft starts climbing, in that case, your waste gate, starts moving to the closed position as the aircraft climbs.

Refer Slide Time :(23: 06)



So, we have seen in our, earlier slides that the engine oil pressure, is controlling the position of the waste gate wall, the engine oil pressure, which is acting on a piston, in the wastegate assembly, controls the position of the waste gate wall. Engine output power, increases when oil pressure is increased, on the west in causing the waste gate wall to move, towards the closed position. So, we have seen this earlier, your output power, your engine output power will increase, when your oil pressure is increased agent output power will decrease, when your oil pressure is decreased, on the piston causing the wastegate wall to move, towards the open position.

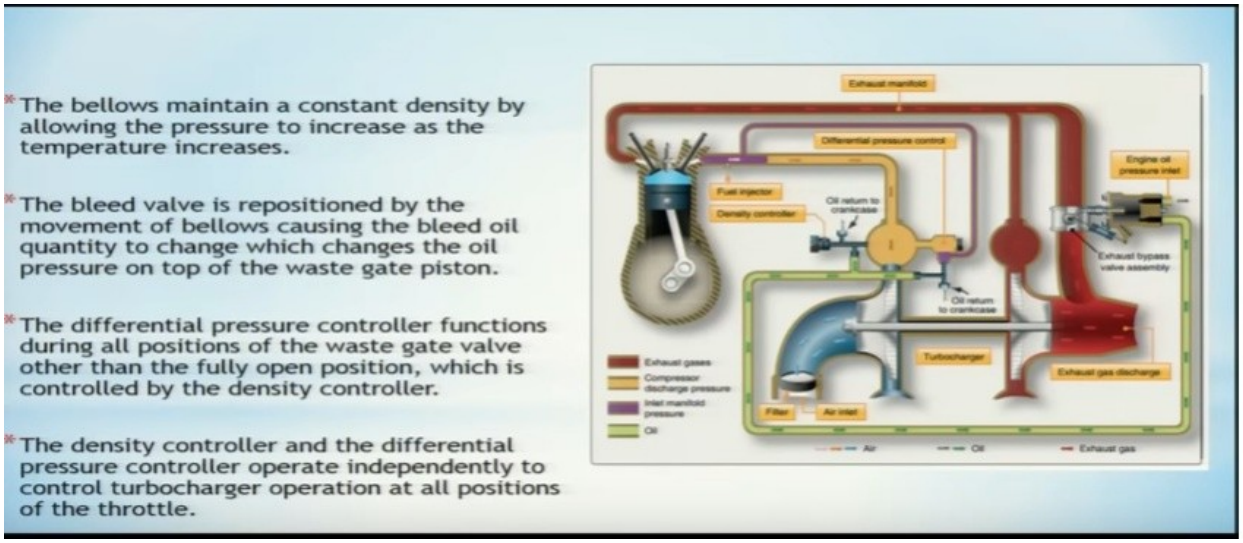
Refer Slide Time :(23: 47)



Now, the oil pressure, how is the oil pressure controlled? The engine oil pressure is controlled, by the oil which is, bled back to the engine crankcase. Now, the oil which is bled back to the engine crankcase, that will control the engine oil pressure applied to the top of piston, attached to the waste gate warp. So, this oil which is bled, back to the engine crankcase, will control the engine oil pressure, which is applied to the wastegate wall. The quantity of oil returned to the engine cranking, is controlled by two, independent control devices. One is your density controller and another is your differential pressure controller. So, here in the figure you can see, you have a density controller, this is your density controller, here you have a differential pressure controller. So, these two, units they will regulate the bleed oil. So, in the figure you can see here, you have the engine oil pressure Inlet, your engine oil is coming here, from this side that is going to the waste gate actuator. So, this is here, it is your, engine oil from this line your engine oil is returning back, this engine oil is returning back, to the crankcase. This is your crankcase area here. So, engine oil is returning back to the crankcase. Now, the quantity of injured oil, which is bled back, to the crankcase is controlled, by the two controllers, one is your density controller and another is your differential pressure controller and the oil, which is bled back to the crankcase, this controls the engine oil pressure, being applied to the top of the piston, attached to the base gate wall. So, basically the oil which is being bled to the crankcase, controls the oil pressure, acting on the piston of the waste gate wall and this, return oil, is controlled by two controllers, one is the density controller and another is your differential pressure controller, the density controller regulates bleed oil only at the full throttle position. So, this density controller this, regulates the bleed all only at the full throttle position. Inside the density controller are our dry nitrogen, filled pressure and temperature sensing bellows. So, inside the density controller you have bellows, which are filled with dried dry nitrogen, these are pressure and temperature

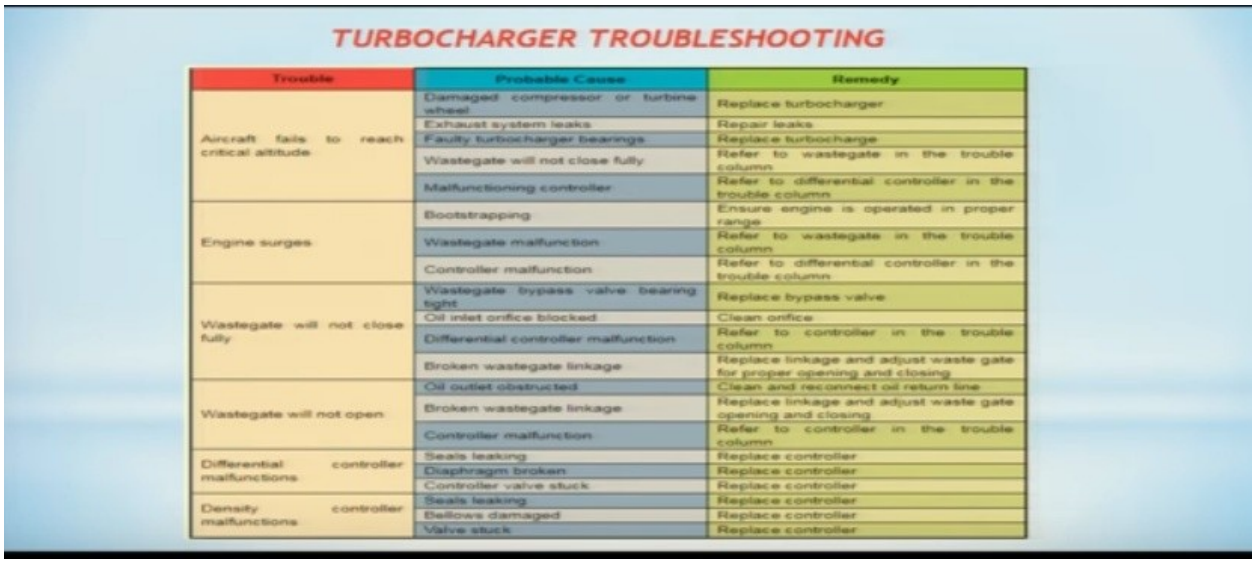
sensing bellows and these bellows, react to pressure and temperature changes, between the fuel injector inlet and the turbocharger compressor.

Refer Slide Time :(26: 50)



The bellows maintained constant density, by allowing the pressure to increase, as the temperature increases. So, as the temperature increases, it will cause the pressure to increase and will maintain the constant density. Now, due to the movement of the bellows inside the density controller, the bleed wall repositions it and it causes the bleed oil quantity to change, which changes the oil pressure, on top of the waste gate piston. The differential pressure controller functions during all, positions of the waste gate ball other than the full open position. So, this density controller, this is operating only at full throttle position, whereas your differential pressure controller, operates at all positions except, the full throttle position, where your density controller is operating, the density controller and differential pressure controller operate independently, to control turbocharger operation, at all positions of the throttle. So, these two controllers they are operating independently, at all positions of the throttle. So, this was about, an automatically controlled turbocharger system, although the internal functioning of this system, was beyond the scope of this course. But, just to give a brief idea, we have discussed about the controllers, the density controllers the inside mechanism of the density controller. So, we have seen what is the turbocharger? What is the supercharger? What is the purpose of these turbochargers?

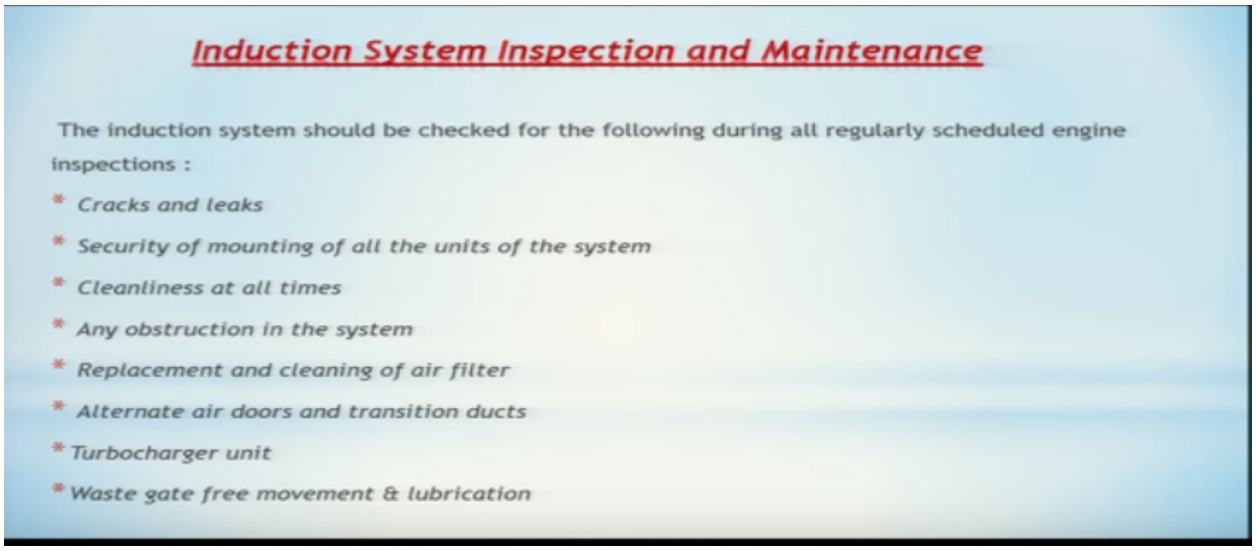
Refer Slide Time :(28: 30)



Now, there may be, problems there may be snags, we may encounter, in the system. So, let us see what are the troubles? What are the common troubles encountered in this system? First problem may be, that the aircraft fails to reach critical altitude, we have seen what is the critical altitude? So, let us see in case, if you encounter a problem that your aircraft, is not reaching the critical altitude and what may be the probable reasons. So, another probable cause whiskey, is not closing fully and malfunctioning of controller. So, we will see in, in the below columns that, what will be the rectification action for that. So, in case you have trouble that aircraft is, not reaching your critical altitude we have seen the probable causes, damage compressorors turbine wheel, you have to replace the turbocharger, exhaust system leaks, you have to repair the leaks and faulty turbocharger bearings you have to replace the turbocharger. Now, whether your waste gate is not closing fully, in that case what will be the probable cause, ways Gate bypass small bearing, is tight, that may be the reason oil inlet or FS blocked, your oil which is Inlet, orifice is blocked, differential controller malfunction and broken ways gate linkage. So, this gate is not fully closing, there may be several reasons, you know? Let us see, one by one, you are waste gate bypass ball bearing is tight, nothing can be done. We just have to replace the bypass valve. So, oil Inlet or if is blocked, in that case you have to clean the orifice. Broken waste gauged, waste gate linkage. Now, in case if the linkage is broken, then we have to replace the linkage and adjust the waste gate for proper opening and closing then. Now, in case if the differential controller is malfunctioning, then we have several reasons, seals leaking, in that case you have to replace the controller, there from broken, you have to replace the controller and controller wall stuck, in that case also, you have to replace the control. So, in the, in case if you have, encountered a problem where, aircraft is not reaching your critical altitude and the reason is, that your controller is malfunctioning, in that case, you have to replace the controller, then another problem that might be encountered as, engine surges, then again there are several reason, one is bootstrapping and then you may have waste gate malfunction and you may have controller malfunction. So, in case of bootstrapping, you ensure that the engine is being operated in the proper range. So, we have to ensure, that engine is operating in the proper range, in case of controller malfunction we have seen, that we have to replace the controller, in case of waste gate malfunctioning, we have seen the several reasons and the rectification actions, another is density controller malfunctioning, again there may be several reasons, seals leaking, bellows damaged, wall stuck, in all the cases we just have to replace the controller. So, in most of the cases, in case if your wastegate is malfunctioning, your controllers are malfunctioning,

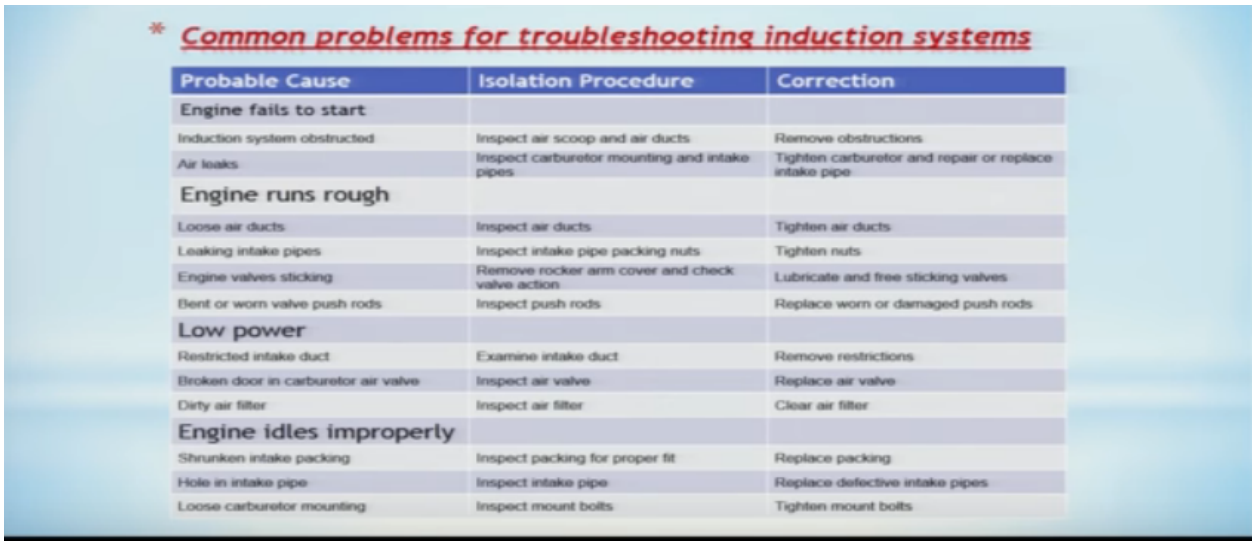
we just have to replace the controllers and the waste gate malfunctioning, we can either, check the linkage, if case, in case if the linkage is broken, we can repair it, we can adjust the opening and closing of the waste gate.

Refer Slide Time :(32: 31)



Now, what are the different inspections and maintenance on the induction system? So, let us see there are a few, inspections which are done on the induction system. The induction system should be checked for the following during all, regularly scheduled engine inspection. So, during all inspections polling should be checked, cracks and leaks there might be cracks and leaks, in various parts of the induction system, there might be leaks. So, we need to verify that there are no cracks, no leaks, during the inspections. Security of mounting of all the units of the system. So, all the units of the system they should be secured properly, they should be mounted properly, cleanliness at all times. So, this is very important, the induction system, should be cleaned, at all times, we need to be very careful, about the filter, the induction air filter and it should be cleaned regularly. So, any obstruction in the again there should be no obstruction in the system, replacement and cleaning of air filters. So, air filters they are to be cleaned, regularly and they are replaced, after a fixed interval of time. So, clean air filters are also very important, alternate air dose and transition ducts, we need to verify that the alternate air dose, are free to move, there is no obstruction, there is no breakage and all the ducts, they are leak proof, they are mounted properly. On the turbocharger unit, we need to verify secured mounting, we need to verify leakage and we need to see the linkage, is not broken, the linkage between the waste gate wall and the wastegate actuator is not broken, the wastegate wall, is free to move and it is also, to be lubricated at fixed interval, then phase get free movement and duplication. So, these are some of the points, which we verify during our inspections, some of the maintenance actions which we perform on the induction system.

Refer Slide Time :(34: 45)



Common problems for troubleshooting induction systems

Probable Cause	Isolation Procedure	Correction
Engine fails to start		
Induction system obstructed	Inspect air scoop and air ducts	Remove obstructions
Air leaks	Inspect carburetor mounting and intake pipes	Tighten carburetor and repair or replace intake pipe
Engine runs rough		
Loose air ducts	Inspect air ducts	Tighten air ducts
Leaking intake pipes	Inspect intake pipe packing nuts	Tighten nuts
Engine valves sticking	Remove rocker arm cover and check valve action	Lubricate and free sticking valves
Bent or worn valve push rods	Inspect push rods	Replace worn or damaged push rods
Low power		
Restricted intake duct	Examine intake duct	Remove restrictions
Broken door in carburetor air valve	Inspect air valve	Replace air valve
Dirty air filter	Inspect air filter	Clear air filter
Engine idles improperly		
Shrunken intake packing	Inspect packing for proper fit	Replace packing
Hole in intake pipe	Inspect intake pipe	Replace defective intake pipes
Loose carburetor mounting	Inspect mount bolts	Tighten mount bolts

Now, there are a few problems, which may encounter in our induction system, we have seen the problems what we encounter in the turbocharger. Now, these are the problems which we, encounter in the induction system. The first problem you may see, that your engine fails to start. Now, in case if the agent is not starting, what may be the probable causes, your induction system might be obstructed, number two there might be air leaks in the system. Now, in case if your induction system is obstructed. So, we need to check, you're a scoop and the air ducts, in case, if there is any obstruction, we need to remove it that should that will be the corrective action. In case, there are air leaks, the air leaks might be at the carburetor mounting and intake pipes. So, we need to check, the carburetor mountings and also the intake pipes. So, small amount of air leakage, will also not start the engine. So, in case, if there are leakages, you have to tighten, the carburetor and repair or replace the intake pipe. Circuit problem might be, engine is running rough, in case, if your engine is running rough, there might be several reasons, it may be loose air ducts, may be leaking intake pipes, your engine valves sticking, bent or worn wall push rods. So, several reasons, let us see one by one, loose air ducts, in case, if the ducts are loose, if the air ducts are loose, then we need to inspect, these ducts and tighten the, leaking intake pipes. Now, in case if your pipes or intake pipes are leaking, then we need to check the intake pipe packing nuts and tighten them, basically in case if, they might be loose, we need to tighten them, engine walls are sticking. Now, in case if the engine walls are sticking, then we need to remove the rocker arm cover and check the valve action, the corrective action will be to lubricate and free the sticking bolts, bent or worn wall push rods, in case if the push rods, the wall push rods are bent or worn, then we need to inspect them and replace the worn or damaged push rods, another problem might be, low power in case if we are seeing low power, then the causes may be, restricted intake duct, second may be broken door in carburetor air valve and dirty air filter. So, in case if the reason is restricted intake duct, we need to examine the intake duct and remove, any restriction. If the reason is broken door, in carburetor air valve, in that case we need to first inspect the air valve and replace it, in case if we find it defective, if your air filter is dirty, we need to inspect, as the case may be. So, we may clean the air filter or in case if required, we can also replace the air filter, another problem that we may paces, engine, idles, improperly. There are several reasons one is shrunken intake packing, another is hole in intake pipe or another reason might be loose carburetor mounting. So, it case, if your intake packing is shrunk, in that case we need to inspect that packing for proper fit and replace if it is defective. Now, if there is a hole, in the intake pipe, we need to person inspect the intake pipe and replace in case if it is found defective, carburetor mounting is loose, in that case we just need to

tighten the mounting bolts, first we need to check, whether it is loose, the bolts are loose, in case if they are found loose, we have to tighten them. So, we have seen, about the induction system, we have seen about the not naturally aspirated engines, we have seen about the supercharged engines, we have read about the turbochargers, we have read about the problems being encountered in the induction system and what are the inspection and maintenance required in the induction system. Thank you.