Aircraft Maintenance
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Lecture 04
Aircraft Fuel System

Hello, this module we are going to study about the Aircraft Fuel System. The aircraft fuel system for small aircrafts, single engine aircrafts, we will be starting with the types of fuel the requirements of the fuel system, the different types of fuel systems, depending on the type of aircraft, depending on the type of wing configuration, depending upon the type of the fuel metering system in the aircraft, you have different types of fuel systems, and what are the servicing required on the fuel system? So, let us see what is the fuel system is all about, requirements of fuel system.

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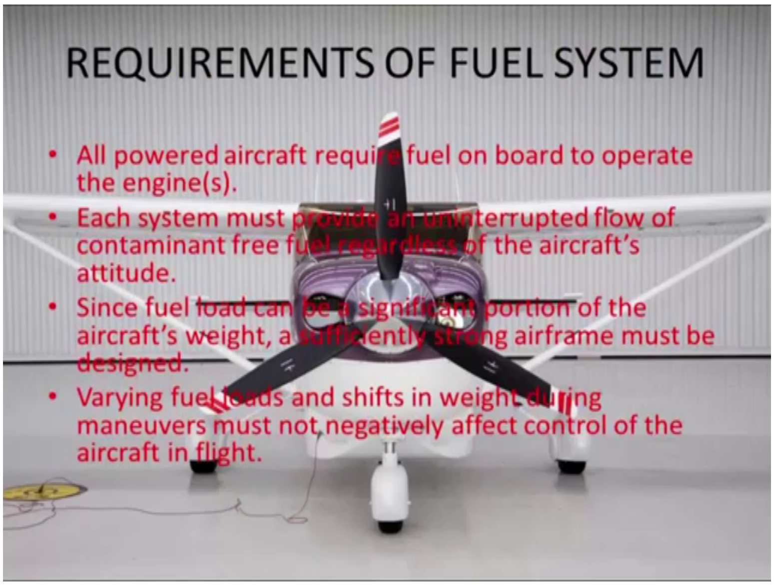

All powered aircraft require fuel on board to operate the engine, this is a very general thing yes fuel is required to operate an engine.

Each system must provide an uninterrupted flow of contaminant free fuel regardless of the aircrafts attitude. So, the engine needs uninterrupted flow of fuel contaminant free fuel regardless of whatever attitude the aircraft is flying in. So, regardless of the aircrafts attitude in all attitudes fuel uninterrupted flow of fuel contaminate free fuel is required.

Since fuel load can be a significant portion of the aircrafts weight a sufficiently strong airframe must be designed.

So, fuel is required to be stored in the fuel tanks in the aircraft, the load the fuel load is of a significant portion of the aircrafts weight. And to how to store the fuel in the aircraft you need a strong airframe a sufficiently strong airframe needs to be designed for the aircraft.

Varying fuel loads and shifts in weight during maneuvers must not negatively affect control of the aircraft in flight. So, while the aircraft is being operated the fuel is being consumed the fuel loads are varying the fuel loads the fuel is shifting, during maneuvers. So, that should not affect your control of aircraft in flight.

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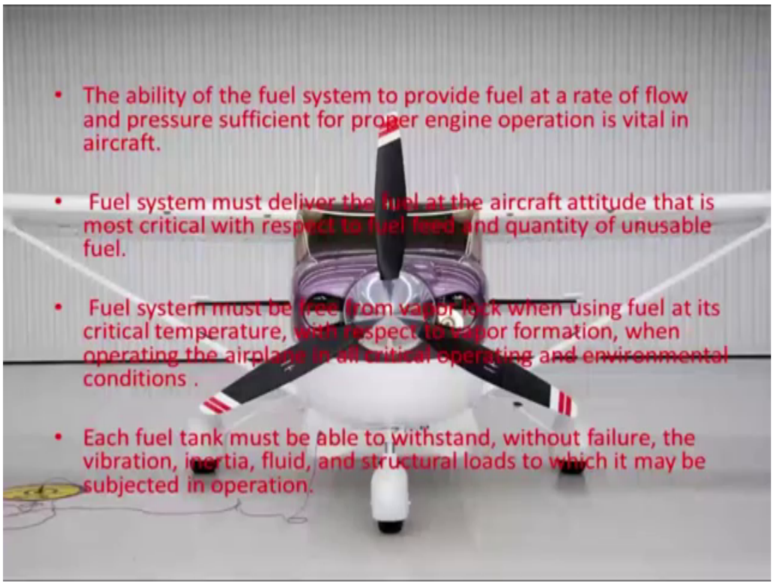

The ability of the fuel system to provide fuel at a rate of flow and pressure sufficient for proper engine operation is vital in aircraft. So, it is very important that the fuel system provides fuel at a rate of flow and pressure, which is sufficient for proper engine operation.

We had just earlier seen that in all types of aircraft attitude, you need an uninterrupted flow of fuel. So, the rate of rate of flow and pressure should be sufficient and it is a very very vital point. Fuel system must deliver the fuel at the aircraft attitude that is most critical with respect to fuel feed and quantity of unusable fuel.

It is the same thing at the aircraft attitude that is most critical with respect to fuel feed and quantity of unusable fuel the fuel system is supposed to deliver the fuel. Fuel system must be free from vapour lock, when using fuel at it is critical temperature. We will see what is vapour lock? What is vapour formation in the coming slides?

So, your fuel system must be free from vapour lock, when using fuel at it is critical temperature with respect to vapour formation when operating the airplane in all critical operating and environmental conditions. So, in whatever operating or environmental conditions you are operating the aircraft. The fuel system must be free from vapour locks and vapour formations. Each fuel tank must be able to withstand without failure the vibration, inertia, fluids and structure loads to which it may be subjected in operation.

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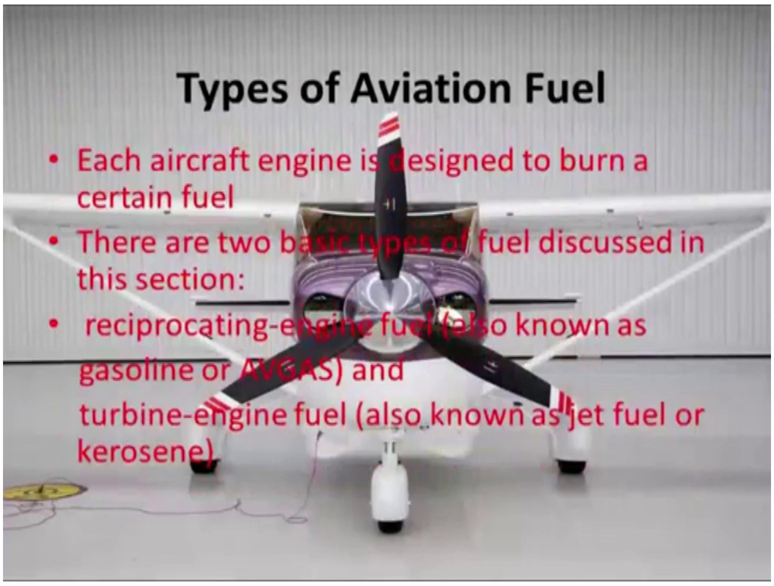

So, your fuel tanks which are there to store the fuel in the aircraft, they must be able to withstand; the vibrations, the inertia, fluid and structure loads, to which they are subjected during the aircraft operation.

Now coming to the types of aviation fuel there are 2 types of aviation fuel mainly being used. So, each aircraft engine is designed to burn a certain fuel yes there are 2 basic types of fuel discussed in this section. One is the reciprocating engine fuel, also known as gasoline or AVGAS and turbine engine fuel also known as jet fuel or kerosene.

So, mainly 2 types of fuels we are discussing one is the reciprocating engine for piston aircrafts, we are using it gasoline or AVGAS and for turbine engine fuels we use jet fuel or we also call it e t f that is aviation turbine fuel.

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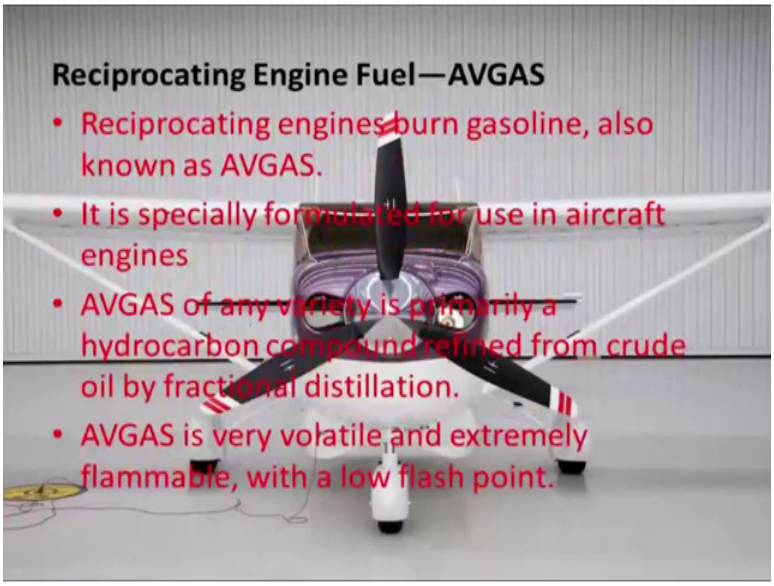

Coming to reciprocating engine fuel that is AVGAS, reciprocating engines burn gasoline also known as AVGAS it is especially formulated for use in aircraft engines. AVGAS of any variety is primarily a hydro carbon compound refined from crude oil by fractional distillation. So, AVGAS is mainly a hydrocarbon compound which is refined from crude oil by process of fractional distillation AVGAS is very volatile and extremely flammable with a low flash point.

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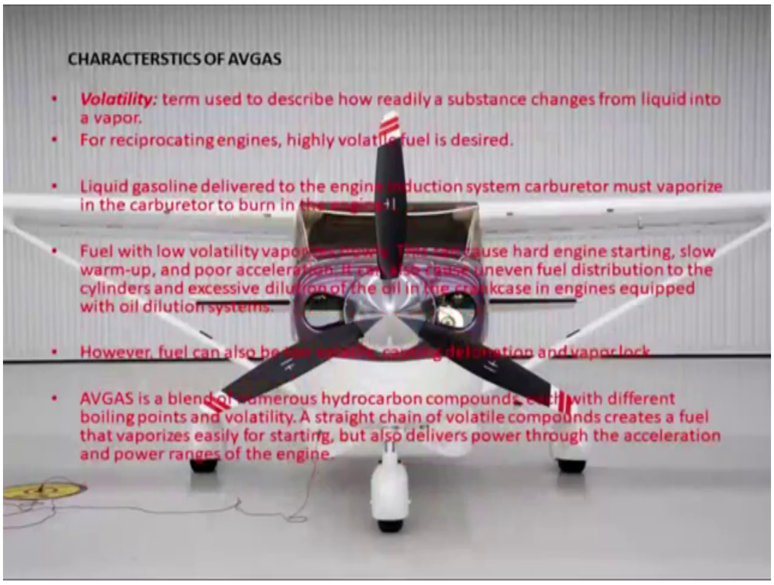

Now, coming to characteristics of AVGAS volatility it is a term used to describe how readily a substance changes from liquid into a vapour. For reciprocating engines high volatile fuel is desired, liquid gasoline delivered to the engine, induction system, carburetor must vaporize in the carburetor to burn in the engine. So, it is very important that liquid gasoline has to vaporize in the carburetor to for the engine to operate, fuel with low vol volatility vaporises slowly. This can cause number of problems, like hard engine starting, slow warm up and poor acceleration.

It can also cause uneven fuel distribution to the cylinders and excessive dilution of the oil in the crankcase in engines equipped with oil dilution systems. So, you can see those fuels who have low volatility they can cause number of problems like hard engine starting slow warm up poor acceleration, uneven fuel distribution to the engine cylinders and dilution of oil in the crankcase. However, fuel can also be too volatile causing des detonation and vapour lock.

Now, in case if the fuel is too volatile then also you can encounter some problems like detonation and vapour lock AVGAS is a blend of numerous hydrocarbon compounds, each with different boiling points and volatility. A straight change of chain of volatile compounds creates a fuel that vaporises easily for starting, but also delivers power through the acceleration and power ranges of the engine.

So, we have seen AVGAS is a blend of numerous hydrocarbons with different boiling points and volatility. The result is that it creates a fuel that vaporises easily for starting and delivers power through the different ranges of engine operation.

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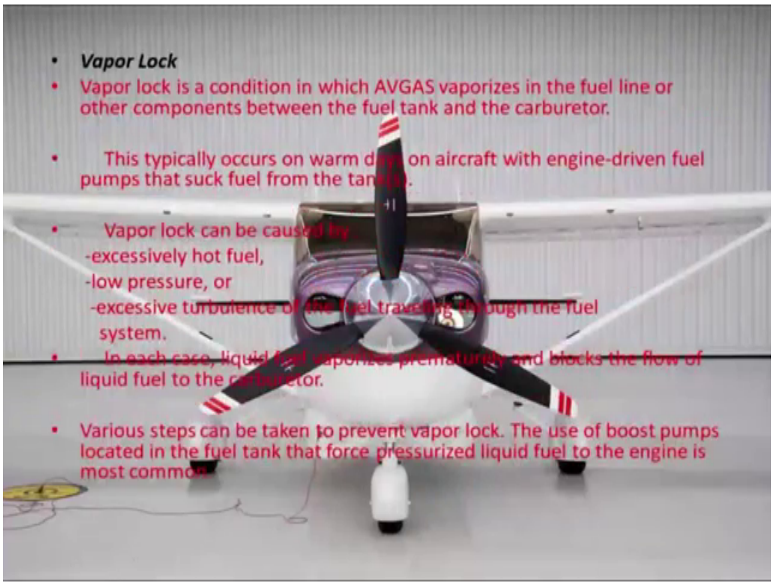

Next is vapour lock vapour lock is a condition in which AVGAS vaporises in the fuel line or other components between the fuel tank and the carburetor. So, anywhere between the tank and the carburetor, if fuel vaporises that is called vapour lock this typically occurs of warm days on aircraft with engine driven fuel pumps that suck the fuel from the tanks.

So, in case of aircrafts with engine driven fuel pumps, which are sucking the fuel from the tanks this problem may be there on warm days on these aircrafts. Vapour lock can be caused by excessively hot fuel, low pressure or excessive turbulence of the fuel, travel through the fuel system.

So, you have seen thee may be causes for vapour lock formation the causes are excessive hot fuel low pressure or excessive turbulence of the fuel travel through the fuel system. In each case liquid fuel vaporises prematurely and blocks the flow of liquid fuel to the carburetor. So, once the fuel gets vapourized in anywhere between the tank and the carburetor it blocks the flow of liquid fuel and so no fuel reaches the carburetor. This can be very very dangerous various steps can be taken to prevent vapour lock the use of boost pumps located in the fuel tank that force pressurized liquid fuel to the engine is most common.

So, in order to prevent vapour lock formation one of the most common things being used is the use of booster pumps, in fuel located in the fuel tank that will force the pressurized liquid fuel to the engine. So, liquid fuel is being pressurized to the engine by means of booster pumps to avoid vapour lock, formation octane and performance number rating.

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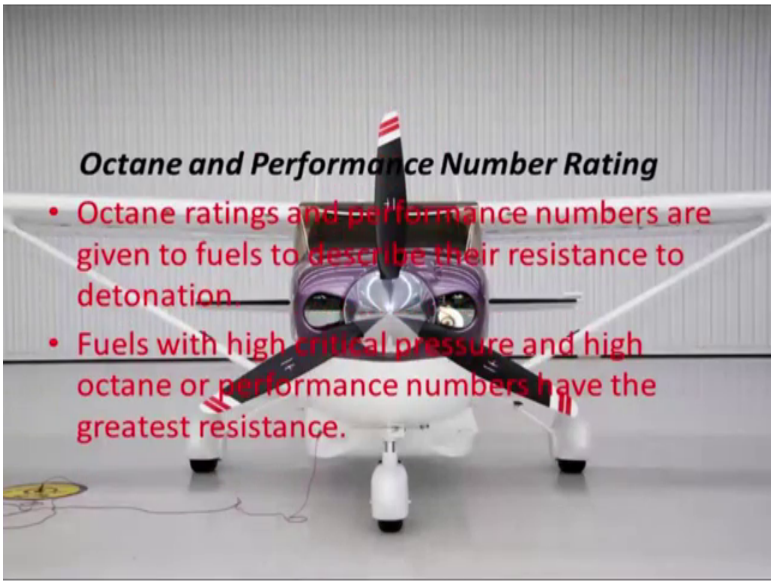

So, octane ratings and performance numbers are given to fuels to describe the resistance to detonation fuels with high critical pressure and high octane or performance numbers have the greatest resistance.

So, the resistance of the fuel to detonation is given in the form of octane ratings and performance numbers fuels, which have high critical pressures and high octane numbers or performance numbers have the greatest resistance to detonation.

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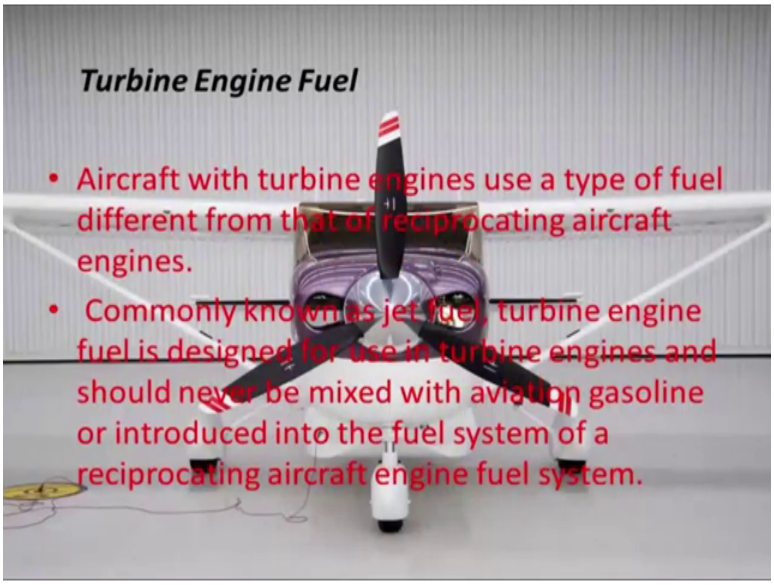

So, you can see fuels are being designated by octane numbers also. Now coming to turbine engine fuel aircraft with turbine engines use a type of fuel, which is different from that of reciprocating aircraft engines. So, the fuel being used in turbine engines is totally different from that being used in reciprocating engines, commonly known as jet fuel turbine engine fuel is designed for use in turbine engines and should never be mixed with aviation gasoline or introduced into the fuel system of a reciprocating aircraft engine fuel system.

So, turbine engine fuel should never be mixed with the aviation gasoline that is for the reciprocating engines or turbine engine fuel should not be introduced in the reciprocating aircraft engine fuel system. This is very important you we are not supposed to mix the 2 types of fuels nor are we supposed to operate a reciprocating aircraft engine with a turbine engine fuel, because both the fuels have different properties they are meant for different systems.

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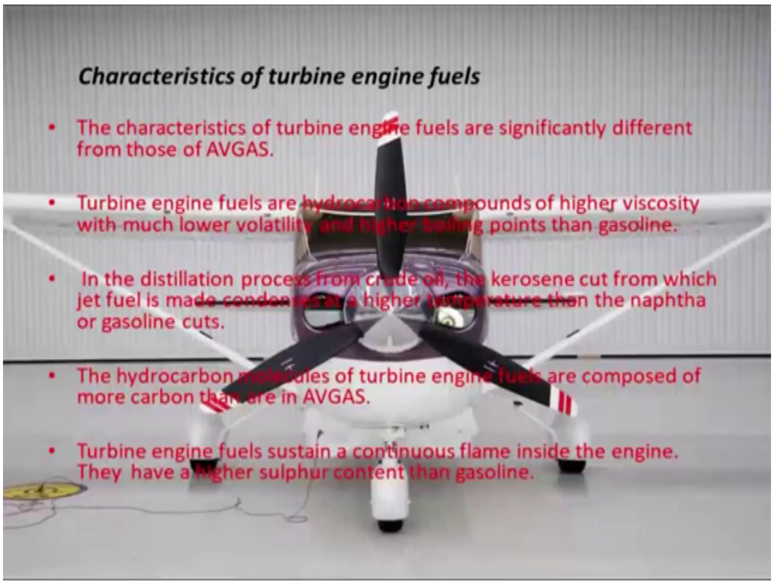

Characteristics of turbine engine fuels, the characteristics of turbine engine fuels are significantly different from those of AVGAS. Turbine engine fuels are hydrocarbon compounds of higher viscosity, with much lower volatility and higher boiling points than gasoline.

So, if you compare turbine engine fuel with that of gasoline, they are hydrocarbon compounds which are of higher viscosity. Yes low volatilty and higher boiling points than gasoline. In the distillation process from crude oil, kero the kerosene cut from which the jet fuel is made condenses at a higher temperature, than the naphtha or gasoline cuts. The hydrocarbon molecules of turbine engine fuels are composed of more carbon than are in AVGAS.

So, the hydrocarbon molecules of turbine engine fuels has have more carbon than in the AVGAS, turbine engine fuels sustain a continuous flame inside the engine they have higher sulphur content than gasoline.

So, turbine engine fuels are being used in the engine, they are being subjected to continuous flame inside the engine and they have a higher sulphur content as compared to gasoline.

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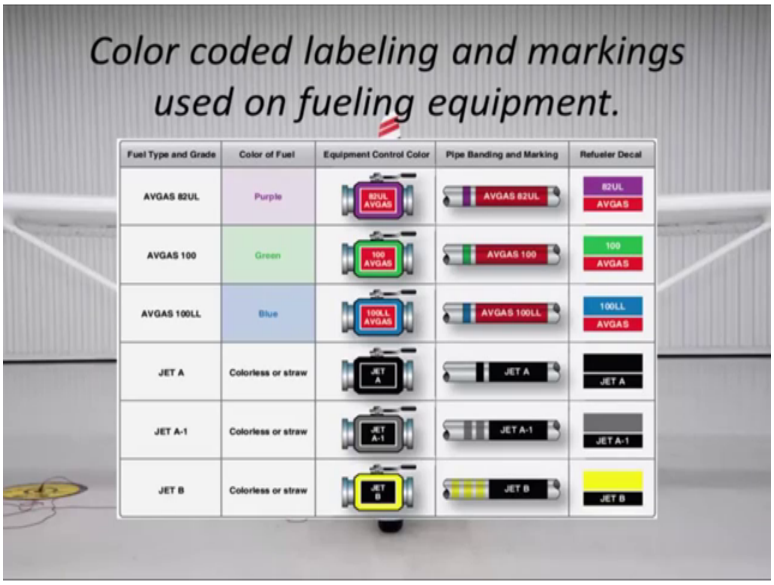

Now, in this diagram you can see the colour coded labelling and markings which is used on the fueling equipment. In the first column you see fuel type in red, second is colour of fuel, third is equipment control colour, fourth is pipe banding and marking and fifth is refueler decal.

So, in the first 3 rows you can see AVGAS is given different types of AVGAS that is the aviation gasoline fuel used for reciprocating engines. First one is AVGAS 8 2 UL, which is purple in colour AVGAS 100, which is green in colour AVGAS 100 LL that is LL is low lad which is blue in colour. So, these are different types of aviation gasoline being used.

However in the present days we are mainly using aviation gasoline 100 LL. Then next 3 rows you can see this is the type of different types of turbine fuels JET A, JET A-1, JET-B mainly they are colourless or straw. And in third column you can see the equipment colour control colour and fourth column you see pipe bending and marking.

So, on all the pipes on all the fuel lines you can see the markings the markings are given see the AVGAS 100 LL marking you can see on the on the fuel line that is a purple colour, the blue colour band. So, that indicates that you are being you are V using AVGAS 100 LL in this fuel system.

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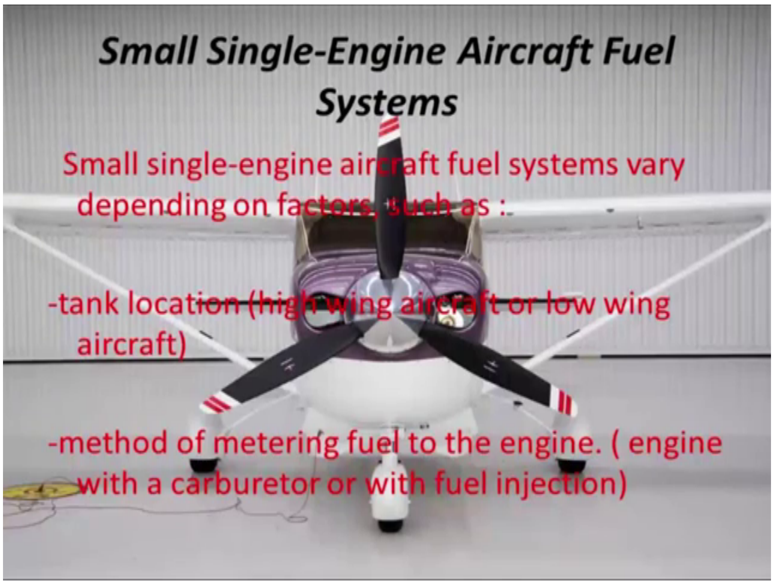

In this module, we are mainly focusing on small single engine aircraft fuel systems. So, small single engine aircraft fuel system vary depending on the factors such as tank location, we have different types of aircrafts, small engine aircrafts, small aircrafts, high wing aircrafts or low wing aircrafts.

So, mainly your fuel tanks are located in the wings. So, in the high wing aircraft your fuel tanks are above the engine, they are in this slide in the background you have (Refer Time: 16:08) 206 aircraft, this is a high wing aircraft you can see a high wing aircraft wings are on the high position and engine is at the lower position.

So, this is a high wing configuration in the low wing configuration; you have engine is at the top and the wings are in the lower side. So, the tanks in the high wing are on the higher side, in the low wing the tanks are in the lower side.

Then the method of metering fuel to the engine the type of fuel system depends on the wing location, the location of your fuel tanks, as well as the method of metering fuel to the engine. For example, you may have a carburetor to meter the fuel or you may have a fuel injection. So, it depends on the type of metering unit being used to meter the fuel to the engine.

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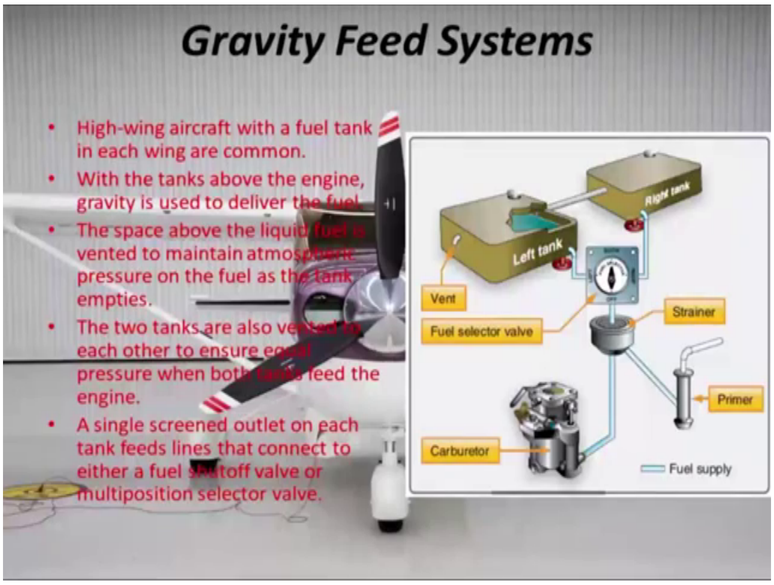

Now, the first type of fuel system is the gravity feed system. So, in this slide you can see the diagram this is the gravity feed system for the wings which are in the high position the fuel tanks, which are on the higher configuration.

So, all the high wing aircrafts with a fuel tank in each wing are common with the tanks above the engine gravity is used to deliver the fuel. So, in case when the tanks these are the tanks you can see in the diagram these are the tanks left tank and the right tank these tanks are above the engine, engine is somewhere here in the lower side. So, tanks are above the engine level. So, when the tanks are above the engine level we use gravity to deliver the fuel to the engine. The space above the liquid fuel is vented to maintain atmospheric pressure on the fuel as the tank empties

So, this is the fuel tank you can see at the top of the fuel level your space above the fuel level is vented to maintain the atmospheric pressure on the fuel as the tank empties. The 2 tanks are also vented to each other you can see these 2 tanks they are vented to each other they are connected through this vent line to ensure equal pressure when both tanks feed the engine. So, when both the tanks are feeding the engine to ensure that pressure both the tanks have equal pressure on the fuel. So, these 2 tanks are vented to each other.

A single screened outlet on each tank you can see there is a single screening outlet; one out is from this tank, the other outlet is from the this tank, a single screened outlet on each tank feeds lines that connect to either a fuel shutoff valve or a multi position selector valve.

So, you can see here one outlet is coming from this tank; this is one outlet, this is another outlet, in this diagram you can see there is a fuel selector valve over here this is the fuel selector valve.

So, fuel coming from the left tank to the selector valve fuel coming from the right tank the select to this side of the selector valve. This selector valve you can see has got 4 positions off left, right and both. Off means fuel supply is shut off left means fuel is coming from the left tank, right means fuel is coming from the right tank and if your fuel selection is both if your knob is on the both side; that means, you are simultaneously supplying fuel from both the tanks. Left tank is also supplying right tank is also supplying and fuel from both the supplies is going further down to the engine.

So, in this diagram you see that there is a fuel selector valve, but in case you have a shutoff valve then shutoff valve will have 2 positions fuel on or fuel off. Just now I have told you fuel selector valve it has got 4 positions off, left, right and both. Fuel feed to the engine from both tanks this both position will feed fuel to the engine from both the tanks simultaneously. Left will left selection will give you the fuel from the left tank only, right selection will give you the fuel feed from the right tank only and both selection will give you the fuel from both the tanks simultaneously and when that is why we have given a vent line here. So, that you have equal pressure in both the tanks when fuel is being simultaneously supplied from both the tanks.

So, coming down to this coming downstream of the selector valve, you can see there is a strainer here this is a strainer or a filter then you have an engine primer plus you have a carburetor here or the fuel metering unit. So, on the downstream of the selector valve you can see there is a strainer here, which is also which is called a filter here you have an engine primer and here you have a carburetor or the fuel metering unit.

So, this is a very very basic diagram just to give you a basic understanding of how the fuel system works? Down you can see downstream of the shutoff valve the fuel passes through a main system strainer. So, fuel is coming from the tanks from the tanks fuel is coming going to the strainer through the selector valve it has come to the strainer, this often has a drain function to remove sediment and water.

Generally at the strainer you also have a drain valve. So, that you can drain the fuel and you can remove sediments or and water from the fuel in the line. From there from the strainer the fuel flows to the carburetor fuel is flowing to the carburetor or to the primer, you can see the fuel from the strainer is coming to the primer fuel is coming to the carburetor for starting. So, during when you start the engine before starting you need to prime the engine for priming purpose you are getting fuel from this passage to the primer, having no fuel pump the gravity feed system is the simplest aircraft fuel system.

So, in this diagram we have seen there is no fuel pumps in the system only the gravity is being used to feed the carburetor. So, this is the most simple fuel system with a high wing configuration the tanks being located on the higher position and gravity being used this is the most simple aircraft fuel system.

So, now, the next fuel system is the pump feed system this is in case you have a low wing aircraft or a mid-wing aircraft, your fuel tanks are in the lower position, here are the fuel tanks which are mainly located in the wings since the wings are on the lower side your fuel tanks are on the lower side, your engine is above the level of the fuel tanks, in that case there is no gravity you do not have gravity option. So, you need a pump to pull the fuel out of these tanks.

So, low and mid wing single reciprocating engine aircrafts cannot utilize gravity feed fuel systems, because the fuel tanks are not located above the engine. Since the fuel tank is not located above the engine you do not have gravity and you need a pump, instead one or more pumps are used to move the fuel from the tanks to the engine.

So, in order to move the fuel from the tanks to the engine you need a pump. Each tank has a line from the screened outlet to a selector valve. These are the tanks this is your selector valve here you have a strainer or a filter, this is your primer, this is your electrical pump, this is your engine driven pump and this is the carburetor.

Now, each tank has got a outlet, this is outlet for this tank, this is outlet for this tank, each tank has a line from the screened outlet to the selector valve this is your selector valve. So, outlet from the tank to the selector valve outlet from the right tank to the selector valve.

Now fuel cannot be drawn from both the tanks simultaneously in the low wing aircraft this is one of the biggest disadvantage in this type of system, where you cannot simultaneously take fuel from both the tanks; the reason being that if the fuel is depleted in one tank the pump would draw air from the tank instead of fuel from the full tank.

Suppose in case if the fuel is depleted in this tank and you are you have selected the fuel tank selection to both. Then instead of the fuel the pump will suck the air from the tank from the depleted tank. So, in this case in this type of fuel system you do not have both selections.

Now since fuel is not drawn from both tanks at the same time there is no need to connect the tank band spaces together. Now since there is no both selection. So, you do not have venting of the 2 tanks venting to each other there is no vent line which connects both the tanks. From the selector valve selector valve has got off position left position or right position.

So, from the selector valve left right or off fuel flows through the main strainer fuel is coming from this tank left tank or the right tank. So, you can select left position or the right position. So, fuel is coming from the tanks to the selector valve, from the selector valve to the strainer, from the strainer the fuel is made available to the primer as well as to the pumps, from the selector valve fuel flows through the main strainer where it can supply the engine primer, then it flows downward downstream to the fuel pumps you can see the 2 pumps here.

Typically one electric and one engine driven pump are arranged in parallel. So, these 2 pumps this is the electric driven pump, this is the electric pump and this is the engine driven pump. So, these 2 pumps are arranged in parallel to each other, they draw fuel from the tanks and deliver it to the carburetor.

So, these pumps they are taking fuel from the tanks and delivering to the carburetor the 2 pumps provide redundancy in case for example, if this pump fails the engine driven pump fails you have another pump at your convenience to supply fuel to the carburetor, the engine driven fuel pump acts as the primary pump. So, in this case your engine driven fuel pump this is your primary pump, the electric pump can supply fuel should the other pump fails. In case is this pump fails this pump can supply fuel to the carburetor, the electric pump also supplies fuel pressure while starting and is used to prevent vapour lock during flight at high altitudes.

During starting during engine starting your electric pump is used also during high altitude operation, where there are chances of vapour locks. So, this electric pump helps in avoiding vapour locks. So, this low wing configuration you see tanks on the lower side tank fuel cupping from the tanks to the selector valves, from the selector valve, going to the strainer, from the strainer fuel is available to the primer as well as the pumps, fuel from the strainer is going to the 2 pumps which are arranged in parallel to each other, the 2 pumps provide redundancy to the system, the engine driven pump and the electrical driven pump.

The engine driven pump this is the primary pump in case if your engine driven pump fails you have the electrical pump, this electrical pump is used during engine starting as well as it is used at higher altitude operations, where you have chances of vapour locks. So, this electrical pump comes in the action during high altitude operations also from the pumps the fuel is supplied to the carburetor.

So, this is the low wing configuration where your fuel tanks are on the lower level as compared to the engine. In this system you do not have the gravity option with you. So, that is why you have the 2 pumps.

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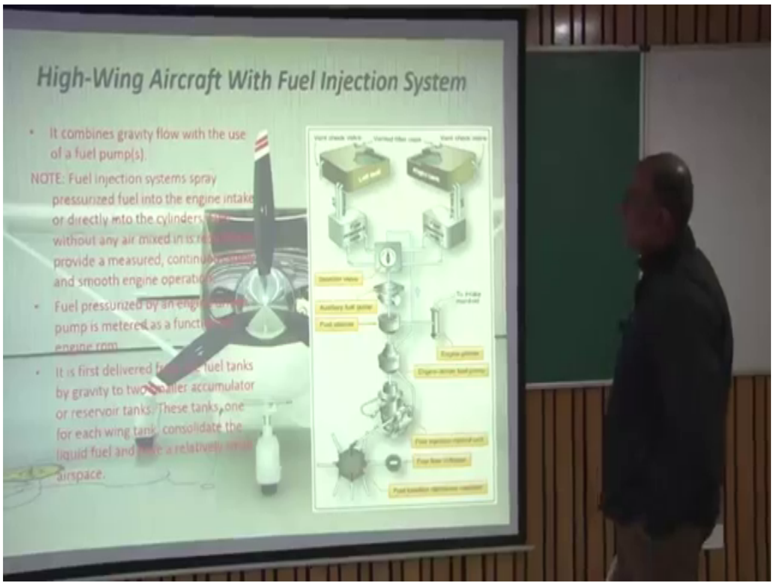

So, now we can see there is another configuration it is a high wing aircraft with fuel injection system. Till now, we have seen the 2 systems where we had a high wing configuration and we were using a carburetor, but in this case we are using a high wing aircraft with the fuel injection system. So, your fuel metering system you have a fuel injector.

Here since it is a high wing aircraft you have an advantage of gravity feed also. So, in this case it combines gravity flow with the use of fuel pumps. So, in this type of system we are using gravity as well as the fuel pumps. Fuel injection systems spray pressurized fuel into the engine intake or directly into the cylinders. So, in this system you can see here the 2 tanks this is the left tank, this is the right tank. Since this is a high wing configuration the tanks are on the higher level as compared to the engine, you have reservoir tank also; this reservoir tank is for the left tank this reservoir tank is for the right tank.

Then this is your fuel selector valve the reservoir tanks are connected to your fuel selector valve. Further down the selector valve you have an auxiliary fuel pump, further you have a fuel strainer or a filter, which is connected to the engine primer, downstream of the strainer you have an engine driven fuel pump, this engine driven fuel pump supplies fuel to the fuel injector. From the fuel injector fuel is distributed to the distributor manifold.

So, this is your distributor manifold each line this is going to each cylinder. So, from the distributor manifold the fuel is being supplied to the different engine cylinders. You can see here now the fuel injection system, this fuel injector system this sprays pressurized fuel into the engine intake or directly into the cylinders.

So, this fuel injector is spraying pressurized fuel into the engine cylinders directly. It provides a continuous spray and a smooth engine operation fuel pressurized by an engine driven pump fuel, which is pressurized by an engine driven pump is metered as a function of engine RPM. So, depending on your engine RPM your fuel metering is being done it is first delivered from the fuel tanks by gravity.

So, from the fuel tanks the aircraft is coming by gravity to the reservoir tanks. These tanks one for each wing you can see the reservoir tank, one tank for the left wing, one tank for the right wing, they consolidate the liquid fuel and have a relatively small airspace. So, these are the main tanks these are your reservoir tanks or we call them accumulators also you have one reservoir tank for the left wing one reservoir tank for the right wing.

So, fuel from the left tank to the reservoir tank is coming by gravity you can see here from the reservoir tanks the fuel is coming to the selector valve.

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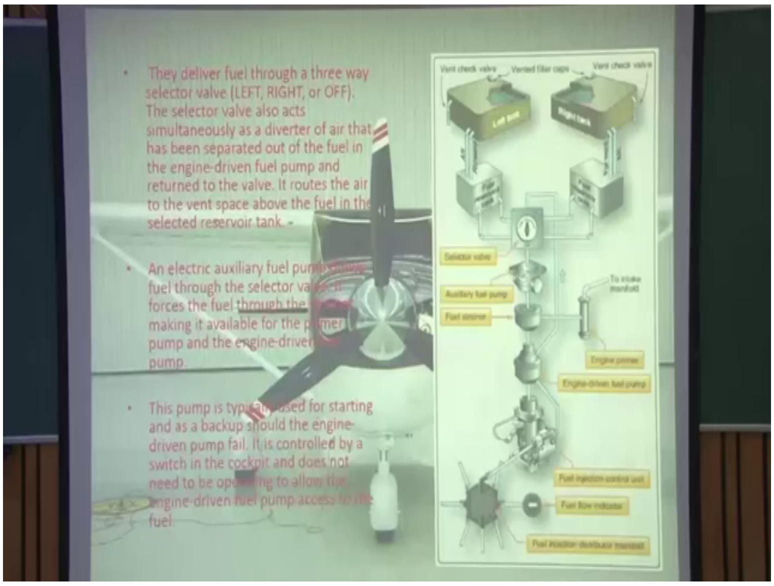

The selector valve this also acts simultaneously as a diverter of air that has been separated out of the fuel in the engine driven fuel pump. So, this is your engine driven fuel pump some air, which has been separated out of the fuel this goes from this line to the selector valve. And from the selector valve it goes to the selected reservoir tank, and the selector valve also acts simultaneously as a diverter of air that has been separated out of the fuel in the engine driven fuel pump. And is returned to the valve it routes the air to the vent space above the fuel in the selected reservoir tank.

So, from this the air which is coming from engine driven fuel pump goes to the selector valve from the selector valve, it is sent back to the selected reservoir tank. And electric auxiliary fuel pump this is your auxiliary fuel pump electric auxiliary fuel pump draws fuel through the selector valve, this fuel pump is drawing fuel from the selector valve it forces the fuel through the strainer.

So, this pump is drawing fuel from the selector valve forcing it to the strainer and is making it available for the primer pump and the engine driven fuel pump. So, this electric auxiliary fuel pump is drawing fuel from the selector valve, supplying to the strainer which is the filter after the fuel is filtered it goes to the primer and to the engine driven fuel pump. This pump is typically used for starting and as a backup should the engine driven pump fail.

So, this auxiliary fuel pump is mainly used for starting the engine and also as a backup system in case your engine driven pump fails. It is controlled by a switch in the cockpit this pump is controlled since this is an electrical pump, it is controlled by a switch in the cockpit and does not need to be operating to allow the engine driven fuel pump access to the fuel.

So, we need not allow this fuel to continuously operate during the flight during the cruise flights we do not require this pump to operate. Generally as a general practice this pump is switched on during take offs landings and during very high altitude operations.

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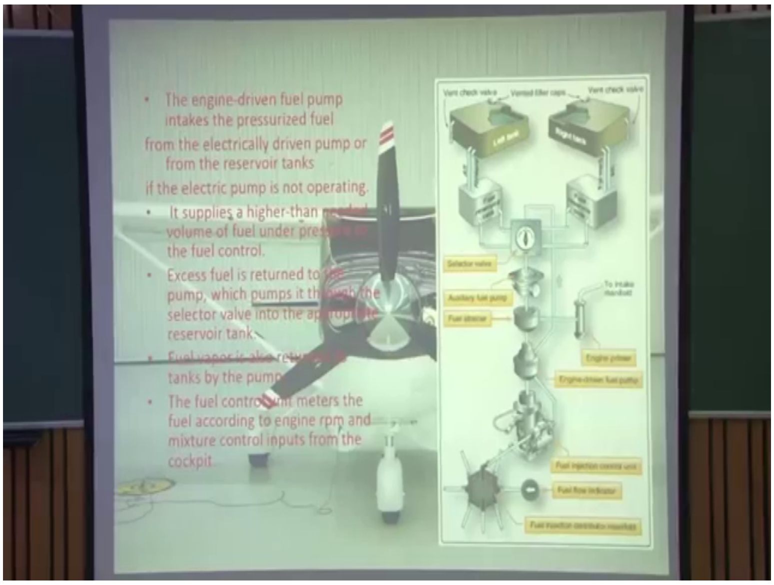

The engine driven fuel pump intakes the pressurized fuel from the electrically driven pump or from the reservoir tanks if the pump is not operating.

So, this engine driven fuel pump is getting the fuel supply from the auxiliary pump or from the reservoir tanks in case if this pump is not operating. It supplies a higher than needed volume of fuel under pressure to the fuel control.

So, this engine driven fuel pump is supplying higher than needed fuel, whatever volume of fuel is required this pump is supplying, more than that to the injector and that fuel is going under pressure. The excess fuel the excess fuel which is being supplied is being returned the excess fuel, which is being supplied is returned to the pump you see the excess fuel is supplied is returned to the pump, which pumps it through the selector valve into the appropriate reservoir tank.

So, you can see this is your engine driven fuel pump this is supplying fuel to the injector this is fuel injector, this pump is supplying extra fuel whatever is required by this injector this pump is supplying extra fuel. So, the extra fuel is being supplied is being returned back and via this line this is this goes back to the selector valve and from the selector valve goes back to the selected tanks. Fuel vapour is also returned to takes by the pump in addition to the extra fuel, fuel vapours are also returned to the tanks selected.

So, this pump this pump is supplying fuel to the injector and it is also returning the extra fuel back to the tanks, the fuel control unit meters the fuel according to the engine RPM and mixture control inputs from the cockpit. This is your fuel metering unit this is the fuel injector, this will meter the fuel according to your engine RPM and the mixture control inputs which the pilot has given in the cockpit.

So, as per the input as per the engine RPM as per the mixture control inputs this fuel metering unit this injector will meter the fuel.

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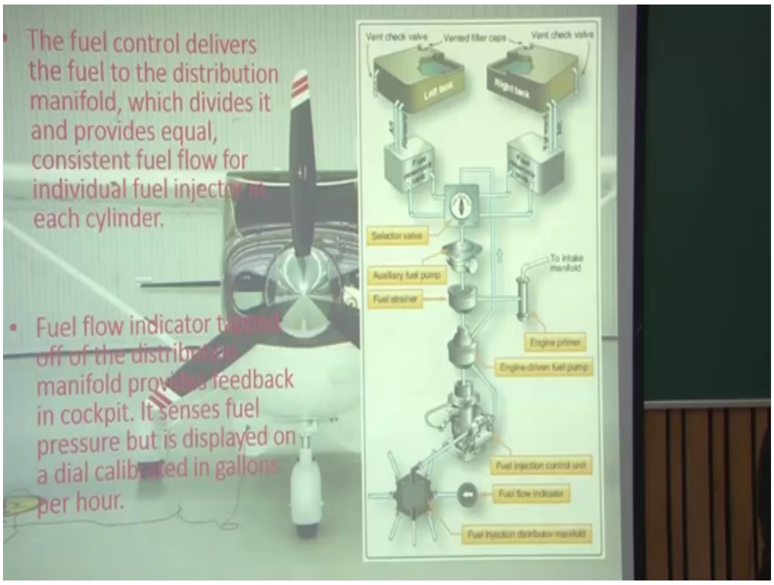

The fuel control this is the fuel metering unit the fuel control delivers the fuel to the distribution manifold. So, this fuel control will deliver the fuel to the distribution manifold which divides it and provides equal consistent flow fuel flow for individual fuel injector in each cylinder.

So, this injector this fuel injector is providing fuel supply to the distribution manifold and from the distribution manifold equal and consistent flow of fuel goes to each cylinder. This is your distribution manifold; this is your fuel injector. Fuel flow indicator tabbed of the distribution manifold, now you can see this is your distribution manifold from this one line has been tabbed where we have fixed a fuel flow indicator. So, from this line fuel flow indicator which is tabbed off the distribution manifold provides feedback to the cockpit.

So, from this fuel flow indicator we get the feedback in the cockpit, it senses fuel pressure, it this fuel flow indicator this will sense the fuel pressure, but is displayed on a dial calibrated in gallons per hour. So, this fuel flow indicator gives the indication in the form of gallons per hour and it senses fuel pressure, it is fixed, it is tapped, and corrected to the distribution manifold.

So, to sum up again you see you have a hiring configuration, the wings on the higher level, left tank right tank with your reservoir tanks, one for the left tank, one for the right tank fuel coming by gravity to the reservoir tank, the reservoir tanks are further connected to the selector valves, from the reservoir tank the fuel is coming to the selector valve from the selector valve fuel going to the auxiliary fuel pump, which is an electrical fuel pump, it has a control in the cockpit, it has a switch in the cockpit from where you can operate this pump, from the fuel pump auxiliary fuel pump fuel goes to the strainer the filter, from the strainer the fuel is supplied to the engine driven fuel pump, and is also made available to the engine primer.

From the engine driven fuel pump fuel under pressure comes to the fuel injector, the extra fuel which is supplied goes back is given back and from the pump it goes back to the selector valve and from the selector valve, it goes back to the respective tanks the selected tanks. From the fuel from the fuel injector the fuel is supplied to the distribution manifold this distribution manifold connects via few lines to each cylinder to each engine cylinder and it is provides consistent and equal flow of fuel to each cylinder.

In the distribution manifold we have taken a tapping, where we have fixed a fuel level indicator fuel flow indicator sorry a fuel flow indicator, this senses the pressure here and provides a display in the cockpit in the form of gallons per hour.

So, this was the fuel system in which we have used a gravity feed gravity feed plus we have used the electrical fuel pumps as well as the engine fuel pump, engine driven fuel pump.

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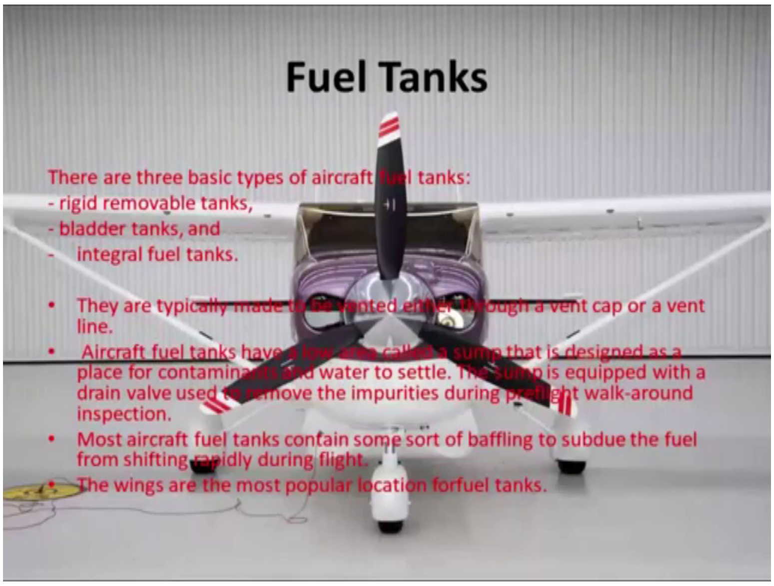

Now, coming to the types of fuel tanks as we have seen there are different types of fuel systems, there are different types of fuel systems depending on the wing location, depending on the fuel tank location, depending on the fuel metering being used. Similarly depending on the different requirements, depending on the sophistication of the aircraft fuel tanks are designed there are different types of fuel tanks mainly of 3 basic types; one is the rigid removable tank, one is the bladder tank, and the integral fuel tank they are typically made to be vented either through a vent cap or a vent line.

So, we are very well aware that we need to vend the fuel tanks either through a vent line or a vent cap venting is required. So, that you can the fuel level the fuel has got an atmospheric pressure to act on it. Aircraft fuel tanks have a low area called the sump that is designed as a place for contaminants and water to settle.

So, all fuel tanks have a low area which is called a sump which is designed. So, that the contaminants and water can settle in that low area the sump is equipped with a drain valve. So, the sump has got a drain valve which is sued to remove the impurities during free flight walk around inspection.

So, before the flight before the aircraft is flown we carry out a free flight inspection. So, during that free flight inspection, we have to drain the fuel from the fuel sump through that drain valve using the drain valve. And the basic purpose of taking the fuel sample using the drain valve is that you remove the fuel, whatever contaminants and whatever water has settled at the lowest position, it is removed. Most aircraft fuel tanks contain some sort of baffling to subdue the fuel from shifting rapidly during fly the wings are the most popular location for fuel tanks.

So, some fuel tanks may also have baffles. So, that in case the fuel shifts rapidly during flight. So, you can sub how subdue that fuel shifting.

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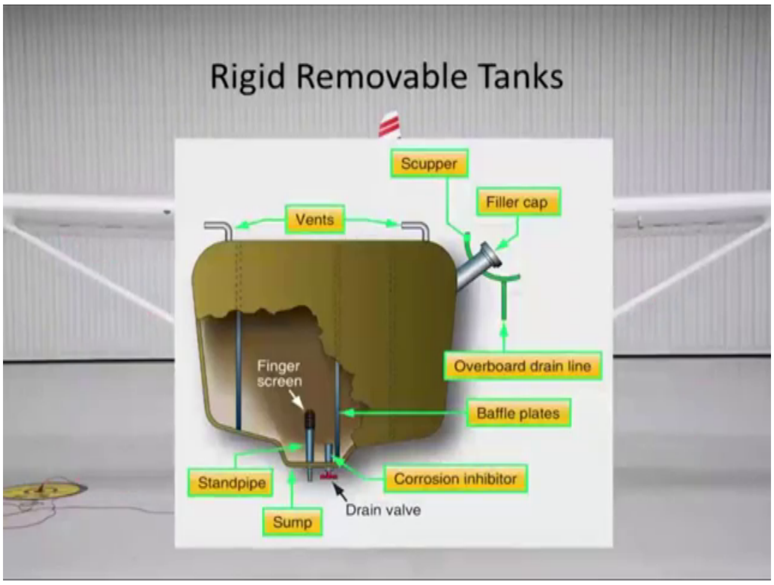

In this diagram you can see this is a rigid removable tank, this you can see the vent lines the vents on the top of the tank, a filler cap through which you fill the fuel, there is a overboard drainline in the filler cap, inside the fuel tank you can see there are baffle plates. Then just at the bottom of the tank you can see there is a sump, where we just discussed you can and there is a drain valve attached to the sump, from the drain valve you can take the fuel sample and remove the contaminants and water that has settled in the lowest position.

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This is a sort of a bladder tank which is used in some of the aircrafts.

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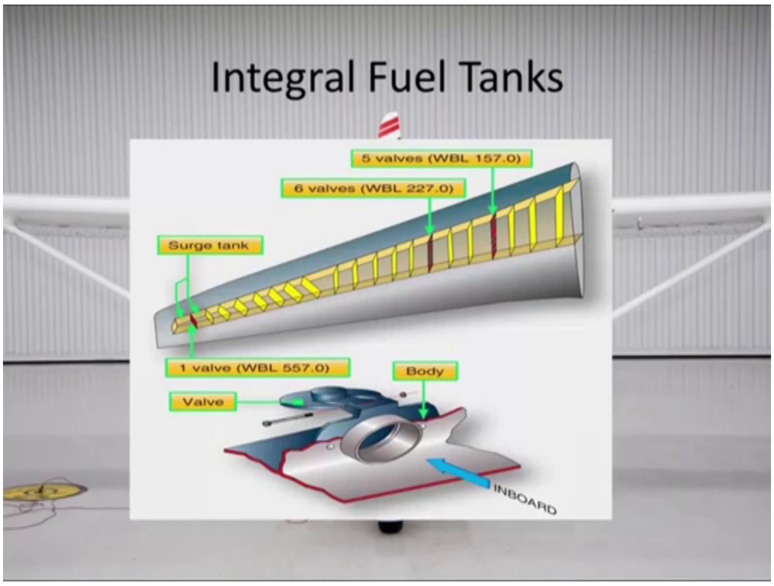

This is your integral fuel tank; in the integral fuel tank you identify a space in the wing and that space is used as a fuel tank.

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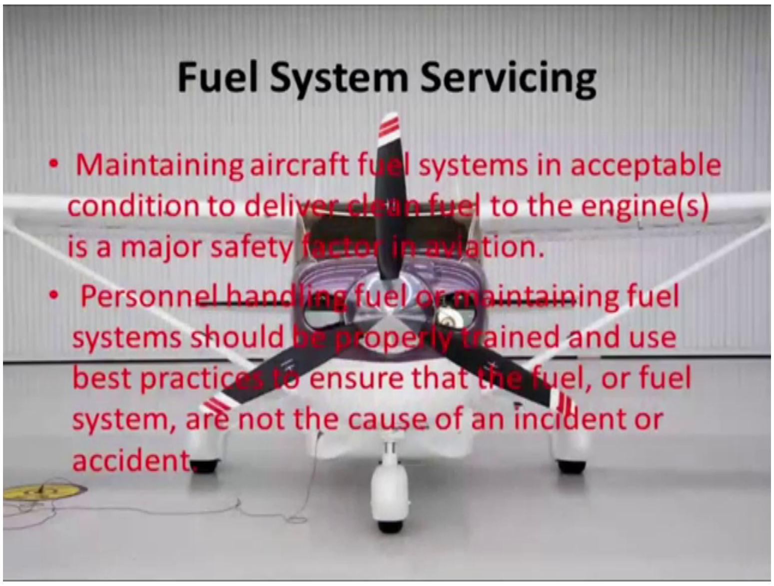

Now, coming to fuel system servicing maintaining aircraft fuel systems in acceptable condition to deliver clean fuel to the engines is a major safety factor in aviation. So, this is one of the major safety factors that you have to maintain your fuel system inacceptable conditions. So, that you are able to deliver contaminant free clear and continuous flow of fuel to the engine. Personal handling fuel or maintaining fuel systems should be properly trained and use best practices to ensure that the fuel or fuel system are not the cause of of an incident or accident.

So, people who are handling the fuel system people who are working on the aircraft they need to be properly trained, they need to be aware of the safety precautions to be followed, the best practices to be followed to ensure that the fuel or fuel system do not become a cause of any incident or accident.

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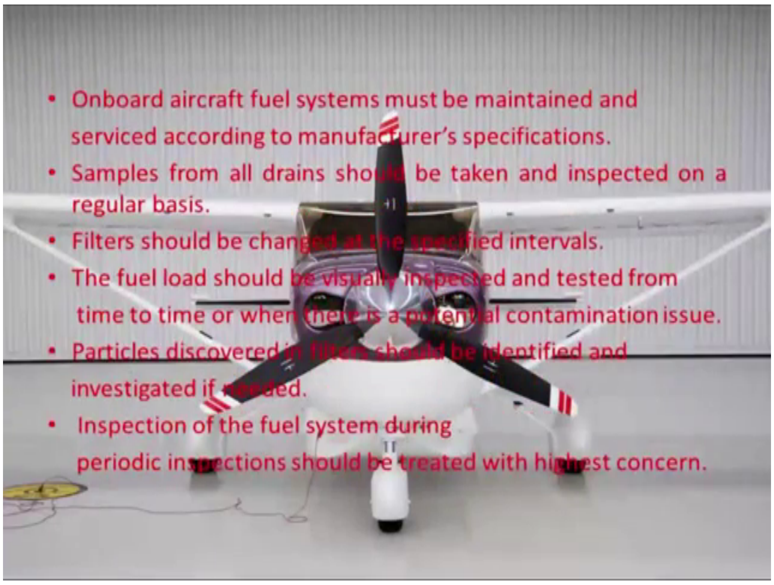

On board aircraft fuel systems must be maintained and serviced according to the manufacturer specifications.

So, whatever work we are carrying out on the aircraft it has to be carried out as per the manufacturer's, specifications, samples from all range should be taken an inspected on a regular basis. So, from all the draining points from all the drain points we need to take the samples, we need to inspect the samples and it has to be done on regular basis. Filters should be changed at the specified intervals.

So, filters they also have a specific life. So, once the life is over the filters need to be changed, the fuel load should be visually inspected and tested from time to time when there is a potential contamination issue.

So, fuel loads should be inspected and tested in case is there is a contamination issue. Particles discovered in filters should be identified and investigated if needed. So, in case if we discover some particles in the filter, we need to identify those particles and investigate them inspection of the fuel system during periodic, inspections should be treated with highest concern.

So, needless to say that the fuel system inspection has to be the fuel system, has to be inspected at periodically at periodic inspections and this is a major system where we need to be very careful.

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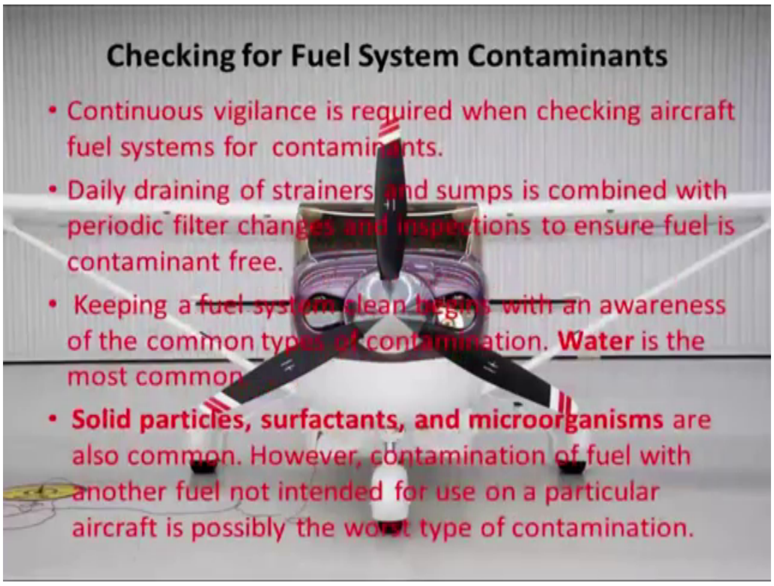

Now, checking for fuel system contaminants, continuous vigilance is required when checking aircraft fuel systems for air contaminants, daily draining of strainers and sumps is combined with periodic changes and inspections to ensure fuel is contaminant free.

So, we need to drain the strainers and sumps on daily basis and filters need to be periodically replaced and inspections of the fuel samples should be carried out regularly to ensure that fuel is contaminant free. Keeping a fuel system free begins with the awareness of common types of contamination and water is the most common. So, water is the most common contaminant in the fuel and we should be very careful about it. Solid particles surfactants and micro-organisms are also common.

However, contamination of fuel with another fuel not intended for use on a particular aircraft is possibly the worst type of contamination. So, in addition to the above contaminants mixing of 2 different types of fuel is the worst possible thing. So, we need to be very careful, while filling in the aircraft that we are using the correct type of fuel which is which the aircraft is supposed to use.

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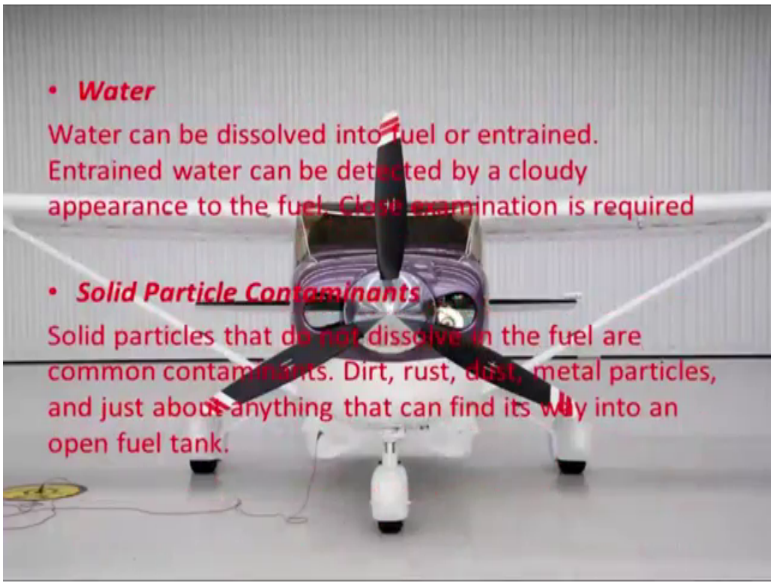

Now, in case water is the contaminant; water can be dissolved into fuel or entrained, entrained water can be detected by a cloudy appearance to the fuel. So, close examination is required. So, in case there is a cloudy appearance of the fuel. So, we can identify that water has been entrained and we need to be very careful about it. There may be solid particle contaminants; solid particles that do not dissolve in the fuel are common contaminants it may be dirt rust dust metal particles and just above about anything that can find it is way into an open fuel tank. So, these are solid particle contaminants we also need to be very careful about these contaminants.

Surfactants are liquid chemical contaminants that naturally occur in fuel. So, these are naturally occurring contaminants, they are chemical contaminants in fuels; they can also be introduced during the refining or handling processes. These surface active agents usually appear as tan to dark brown liquid when they are present in large quantities.

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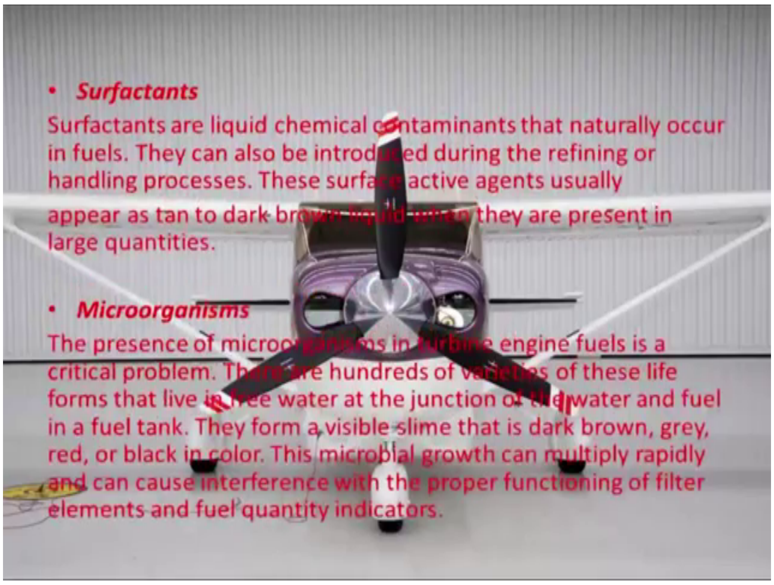

So, these are liquid chemical contaminants which may be introduced during refining or handling processes and may appear as tan to dark brown liquid. Next is microorganisms, this is generally found in turbine engine fuels and is of a major problem and is a cause of concern the presence of microorganisms in turbine engine fuels is a critical problem.

There are hundreds of varieties of these in life forms that live in free water at the junction of the water and fuel in a fuel tank. They form a visible slime that is dark brown, grey, red or black in colour. The microbial growth can multiply rapidly and can cause interference with the proper functioning of filter elements and fuel quantity indicators.

So, we need to be very careful about these microorganisms this is there in case of turbine engine fuels and periodically there is a microbiological test, which is carried out on these fuels.

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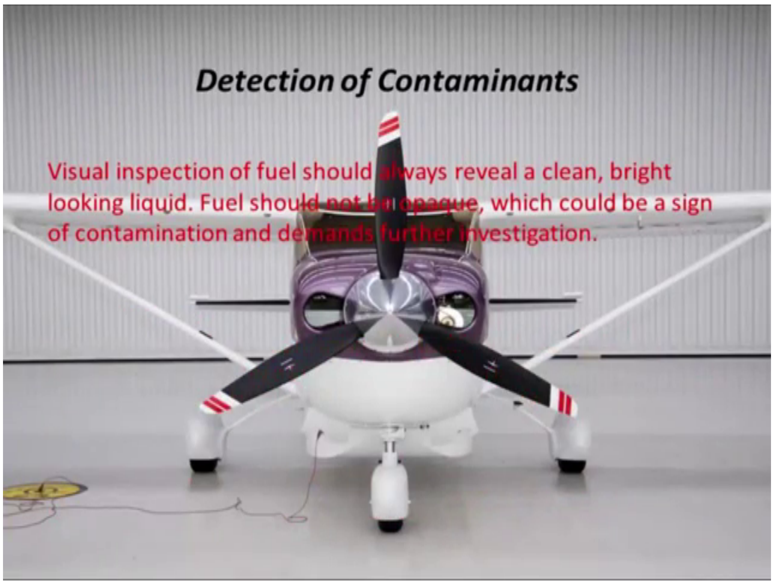

Detection of contaminants visual inspection of fuel should always reveal a clean bright looking fluid; fuel should not be opaque which could be a sign of contamination and demands further investigation. So, this is one sort of inspection visual inspection where with experience, we can find out that fuel is contaminated or not apart from visual inspections there are other tests also like I the aviation gasoline, we are using a water wipe finding paste which is used to identify, whether your fuel has got moisture or not you can visually inspect for solid contaminants. So, there are various ways of investigating the contaminants to find out whether your fuel is contaminant free or not.

So, we need to be very very careful about these contaminants and the safety precautions to be followed during the fuel system maintenance.

Thank you.