Fundamentals of Automatic Systems
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Module No # 05
Lecture No # 24
Analysis of Carburetor – Part 02

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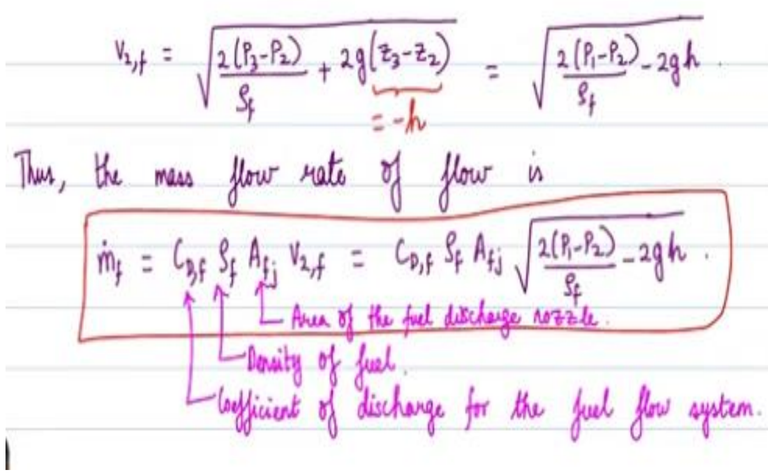

So we can see that once again if we look at the expression for the fuel flow rate it depends on density of the fuel by a (()) (00:26) fixed the area of the fuel discharge nozzle at the tip it is also fixed once we fix a carburetor H is fixed right by carburetor design P1 is what we get and coefficient of discharge is what we determine right by experimental calibration. So once again what can be varied to vary the mass flow rate of fuel P2 right.

So we can see that the mass flow rate of fuel is influenced by P1 - P2 so interestingly if we do not make P1 – P2 to be greater than row fgh you can see that there is no fuel flow rate right. Because if we look at the square root term we see that there is P1 – P2 / Rho f –gh okay taking 2 common from those 2 terms.

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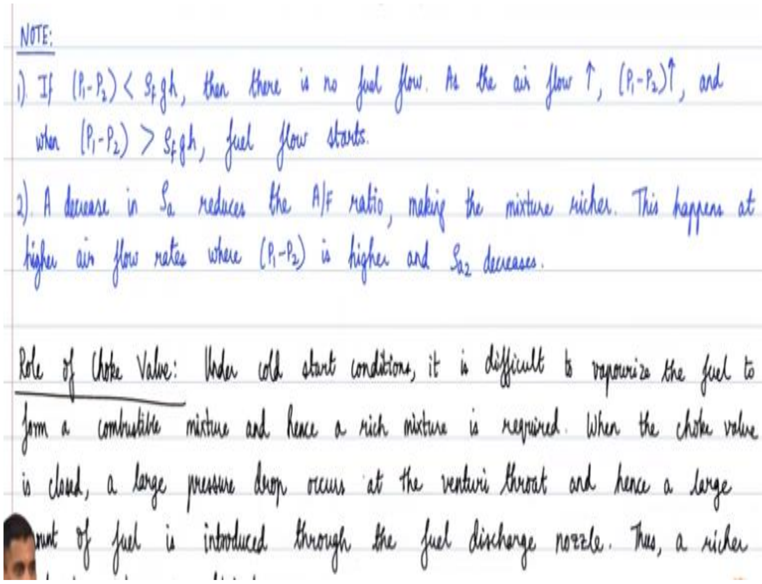

So we can observe immediately that if P1-P2 is less than rho f gh then there is no fuel flow. So in other words we need to decrease the value of P2 for the fuel to start flowing right so that is something which we need to observe so as the air flow also increases okay let us say we will come to the choke (()) (02:13) shortly but let us I give more throttle air flow starts increasing okay so then what will happen P1 – P2 will start to increase because as we did discussed and we keep on increasing throttle the pressure at the throat will start decreasing right.

So P1 – P2 will start increasing for same P1 right so once P1 – P2 starts increasing and when P1 – P2 becomes greater than rho f gh fuel flow starts okay. So that is the first observation okay so I hope this is clear to everyone right. So when we want a rich mixture during idling how do we get that because during idling the throttle valve is almost closed the value of P2 is anyway not that low P1 – P2 is not that low right then how do we get a rich fuel air mixture okay to idle and also to start the engine okay.

So we will discuss that point shortly okay then we can immediately observe that a decrease in density of air reduces the air fuel ratio. Because if you divide the mass flow rate of air by air mass flow rate of fuel we are going to get the air fuel ratio right. So if we have a lower density of air there the air fuel ratio will decrease so the mixture will become richer right. Because if the air fuel ratio drops that means we are going to have a richer mixture right.

So this when does it happens this happens at higher air flow rates where P1 – P2 is higher and since the pressure at point 2 decreases what can we say about the density of air at the throat that also falls down right. So and rho a2 decreases okay so that is one thing okay which we need to observe because as we go to this power range right we need a richer fuel air mixture right is it not? So as we go to the power range with increase in throttle we can immediately observe that the pressure drop is going to be higher and density of air is also going to be lower.

So as a result the mixture will become richer okay so that is an observation okay that we can make okay so now what happens when we do what is called as coal start right. So here so the role of the throttle wall I hope it is not clear when the choke wall is fully open the throttle wall helps us to regulate the value of P2 so that we can adjust the air flow rate and the fuel flow rate okay so that is the purpose right.

Because as we keep on opening the throttle wall the air flow rate will start to increase because more area is going to be now connected to the cylinder which is been subjected to the suction pressure right is it not? When the intake wall is open we are going to connect the carburetor to the combustion chamber and that is essentially at a lower pressure during the suction store. So as we keep on opening the throttle valve the air flow rate will increase the pressure at the throat will decrease right as a result the fuel flow rate also will start okay.

So the role of the throttle valve is now clear now what is the role of the choke valve okay so let us discuss that. So and I hope it is also clear how we get a richer air mixture when we want what to say to go the power range as we keep on increasing right so you see that it essentially the P1 – P2 keeps on increasing right as we increase the throttle valve towards the end P1 – P2 increases rho a2 decreases so the ratio becomes the mixture becomes richer okay so that is what I say.

Now what happens when we want to start so typically in vehicles with carburetor right so let us say you want to start the vehicle on a cold morning right after you parked the vehicle overnight okay so today carburetors are there in certain class of 2 wheeler so what do we do if the vehicle does not start the engage the choke valve so what do we do that? So let us look at the function of the choke.

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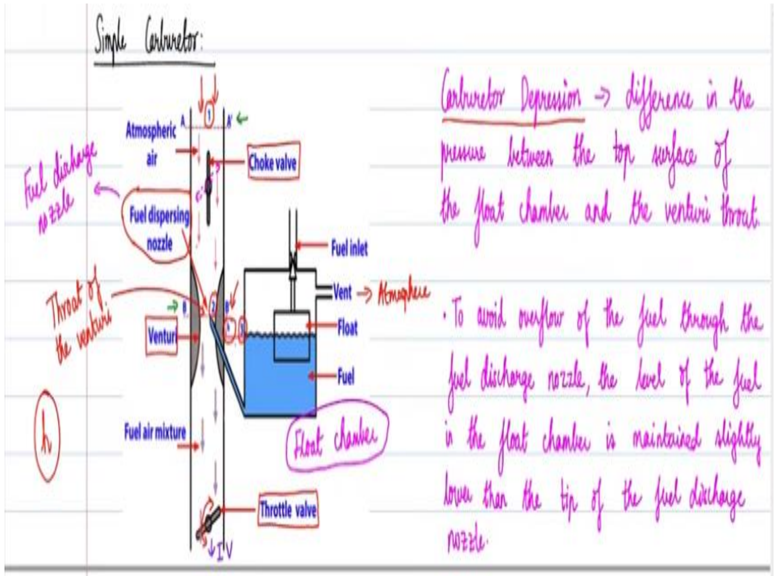

So by default this choke valve in this position okay it essentially offers the least resistance to the air flow path at the upstream section of the carburetor. Suppose let us say we want to what is called as cold start right that is like let us say we want to start the engine after it has been rest for long time right or under cold weather condition and so on. What we do is that we engage the choke and what happens to the choke? This goes in restricts the path once we restrict the path what is going to happen?

We are going to restrict the flow of air right is it not? Correct so anyway the venturi throat will be at some pressure but we observe that the channel for the flow of air is now restricted. So what can you say about the mass flow rate of air mass flow rate was density times the area times the speed okay speed depends on the pressure drop right that we all of us agree. But now once we apply the choke the area through which the air flows is now reduced.

So what can you say about the flow rate of air it reduce right now the pressure at the venturi anyway drops. So the fuel essentially gets discharge through the fuel discharge nozzle and that is affect only by the pressure drop and the area of the fuel discharge nozzle right is it not okay. Then what can we say about the mixture is it going to becoming progressively richer yes and that is what we figure out that we require during idling right when we discussed about the mixture requirement for idling right we figure out that during idling we require a rich mixture because the challenge was.

See during idling what happens the throttle wall is almost close that is very small opening so the main challenge was exhaust gas dilution right. Because the exhaust gas is mix with the incoming fresh charge and that (()) (10:33) the combustion process the sustainability of the combustion process okay. So what happens is that we essentially wants to ensure that when we want to start we give a richer fuel air mixture okay to enable the combustion process to start okay.

So this choke wall helps in making the fuel air mixture richer and there is also an what is called as an idling adjustments okay. An idling adjustments okay which is also a part of the carburetor but not shown in this schematic would also ensure that a richer mixture is provided when the engine is under idling condition. So the role of choke valve essentially is to enable the initiation of combustion during cold start conditions when we want to provide a richer fuel air mixture okay that is point number 1.

And during idling we want a richer mixture and that is provided for by what is called as an idling adjustment mechanism okay. So those are systems that we have in a typical carburetor. So let me write down the main points as far as choke valve is concerned okay so under cold start conditions it is difficult to vaporize the fuel right coal start means you know like that means the engine is cold and also the may be the ambient is also cool right. So it is difficult to vaporize the fuel to form a combustible mixture and hence a rich mixture is required.

So we require a rich mixture to hope that at least a significant part would get vaporized and initiate the combustion okay. So the probability of combustion is increased so a rich mixture is required. So when the choke valve is closed a large pressure drop a comparatively large pressure drop than when it is open occurs at the venturi throat. And hence a larger amount of fuel is discharged is introduced through the fuel discharge nozzle okay.

And this along with the construction to air flow right makes a fuel air mixture richer okay that is a richer fuel air mixture is okay so that is what happens in this choke value and please note during idling also we need a richer fuel air mixture right. As we discussed choke valve the main purpose is to help with cold start okay so with idling we have a richer fuel air mixture because there is something called an idling compensating mechanism which is not been shown in that schematic.

But there is some mechanism for compensating for the provision of a richer fuel air mixture during the idling process in a carburetor so this is the role of the choke valve okay. So we can enable a rich fuel air mixture during cold start okay. So that is a broad analysis of a simple carbonator okay so we just looked at what factors affect the mass flow of air and mass flow rate of fuel in it. And how the fuel air ratio or the air fuel ratio becomes adjusted once we adjust the value of P2 right and the role of the throttle valve and the choke valve okay in its function.

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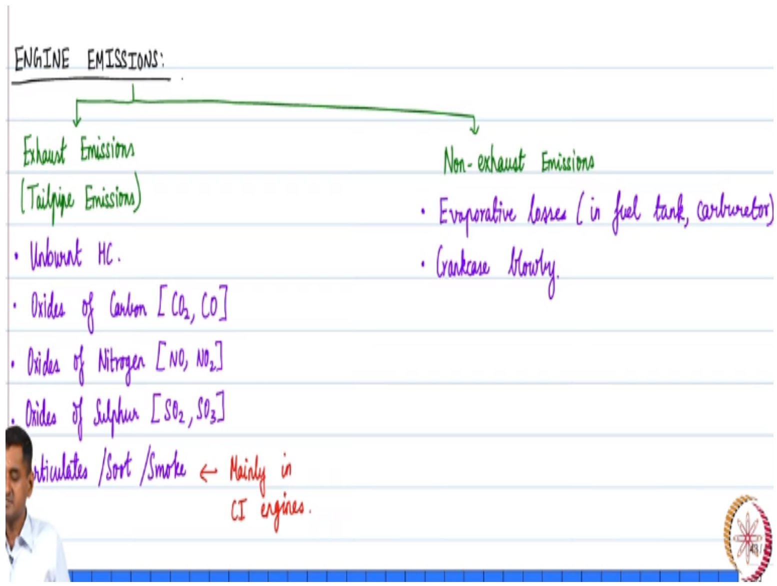

So now he next topic which I am going to start in this class and then we will continue in the next class is also like very important as far as engines are concerned and that deals with engine emissions right. So if we look at emissions right today you know it has become pretty important and in India we follow what is called as a Bharat stage emission norms for automotive road vehicle emissions right.

So right now we have here in what is called as Bharat stage 4 and we are directly going to Bharat stage 6 by next year okay. So essentially emissions of series concerned and you know the norms are becoming stricter and stricter and traditionally you know like the Bharat stage emission norms are also motivated from the European emission norms what are called as the Euro norms right.

So what constitutes these emissions you know like what effects do they have from scientific prospective on the engine performance how the engine characteristic in operating conditions affect this emissions are a few topic's that we are going to discuss and what are the solutions available right. So and what are the tradeoff's due to application of those solutions you know like in a nutshell that is what we are going to discuss in this topic okay.

So if we look at emission (()) (17:31) we can broadly divide them into what are called as exhaust emissions okay so what we call as tailpipe emissions. So these are let into the atmosphere through the tailpipe right of the exhaust system then we have what are also called as non-exhaust emissions. So what are these so what come under both categories so tail pipe emissions you know like happened due to the combustion process that takes place in the combustion chamber and do the chemical reactions of the hydrocarbons present in the fuel with oxygen okay.

But more importantly please note that the fuel also contains some other compounds such as sulphur okay. A fuel is a hydro carbon it contains carbon in hydrogen air contains oxygen and nitrogen so we are going to have different combinations of these elements right. So ideally if a combustion process is ideal all the hydro carbons in the fuel must be oxidized into CO_2 and H_2O okay so that is the ideal combustion process.

But that does not take place so what are all the emission that come about and which impact the what to say our environment so sometimes the hydrocarbon present in the fuel will come out un-burnt there is a chance okay they do not a part of it may not get oxidized okay. So you get un-burnt hydrocarbons we get oxides of carbon okay CO_2 is the byproduct if we have a good combustion partial oxidation we get carbon monoxide okay.

So these are the oxides of carbon and then we have oxides of nitrogen so typically nitrogen gets oxidized at high temperatures okay so we get NO and NO_2 as oxides of nitrogen in the exhaust there can be oxides of sulphur because sulphur if present in the fuel also get oxidized as SO_2 and SO_3. And then like we have carbon particles which come out as particulates, soot, smoke okay this last aspect is mainly in CI engines okay compression emission or diesel engines is last emissions okay that is the emissions where we get particulates, soot, smoke and so on.

Am sure you would have seen in buses and trucks when they start from rest right so you would see black smoke coming out of the tail pipes so we will discuss what that is right so then how do we eliminate them. So non-exhaust emissions particularly are un-burnt hydrocarbons that is the fuel which escapes without getting what to say combusted. So we can have evaporative losses in fuel tank okay.

If we use a carburetor there are evaporative losses in a carburetor etc., okay so we can have the fuel evaporating okay. You see because and then that is the loss right so then we can have what is called as crank case blow by. So what is this crank case blow by? That means that in the what to say although we introduce a fuel in the combustion chamber there are always small crevices between the compression rings, oil rings and the cylinder okay.

And some un-burnt fuel vapor may escape through that small crevices they can come into the crank case and escape that is what is called as crank case blow by okay. And that is all exhaust right it is a loss of fuel but more importantly it is a un-burnt hydro carbon okay. So these are non-exhaust emissions okay so in the next class what we are going to do is that we are going to discuss each aspect of this emissions in greater detail and we will see how they affect engine performance and how engine operation is also effected affecting these emissions okay so that is something which we will continue in the next class thank you.