IC Engines and Gas Turbines

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Lecture – 11
Carburetor, Mixture requirements (Contd.)

We will continue our discussion on IC engine. In fact, today I will continue our discussion with Carburettor. We have discussed about the function of carburettor that is to supply a homogeneous mixture of air fuel and also to supply air fuel mixture depending on the load of the engine and we have seen that what is the stoichiometric air fuel ratio or what is the rather chemically correct air fuel ratio. So, the function of carburettor is to provide the, you know chemically correct air fuel ratio, but it is not always possible to supply chemically correct air fuel ratio what we have seen for a given fuel there is a combustible range.

So, carburettor will be able to supply the air fuel ratio or fuel air mixture within that range and if the supplied air fuel mixture or fuel air mixture goes above or below that range, then combustion may not sustain. That is what we have discussed in detail in my last lecture.

Today I will continue what is you know different parts of the carburettor and as I said you that the carburettor the function of carburettor is to provides you know, chemically correct air fuel ratio or the air fuel ratio within the combustible range. Then in fact, we have discussed maybe that when we are doing analysis either for auto diesel and dual cycle, we are using the air standard cycles and we are doing air standard analysis only to quantify the thermal efficiency.

And we have seen that while we are doing air standard analysis, we are assuming that air to be an ideal gas and also we are using ideal gas relationship. Now question is we have discussed about the major differences from a real processes occurring in a internal combustion engine and you know the processes. Processes what we are considering using air standard analysis; that means, we are assuming that the air to be an ideal gas maybe in case of a SI engine. During inlet all maybe air maybe 7 percent of the fuel, but in other exhaust stroke or exit it is the combustion product.

So, my question is when you are supplying air plus fuel during intake stroke through carburettor for SI engine, most of the composition is air and very small fraction is fuel. So, when you have designed a carburettor to supply you know maybe 90 or 93 percent air and 7 percent fuel, then what it what you know what are the you know structure rather how a carburettor is supplying you know most of the air and small amount of fuel. And for that today, we will discuss a simple float type carburettor and we will see how it is possible to supply fuel air mixture through a carburettor depending upon the load or also rather the chemically correct air fuel ratio.

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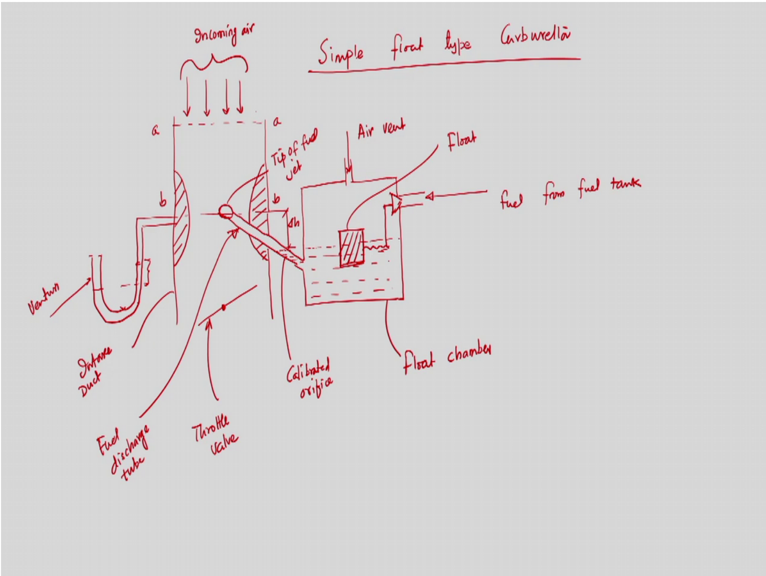

So, today I will discuss about a simple float type carburettor. Although these are not used nowadays, but still only to have a under only to have an understanding about only to have understanding about the you know processes which is there in a carburettor, how a carburettor is supplying air fuel ratio or fuel air mixture depending upon the requirement of the engine load; we should discuss this in detail.

So, simple float type carburettor while you are designing, we need to draw the schematic I mean what are the you know what are the constructional feature of a simple float type carburettor. So, if I draw, as I know that air is coming through you know air is coming through intake manifold right. So, air is coming through intake manifold right and we are supplying, I am drawing a simple float type carburettor and we are having one float over here and which is connected with this. So, from there we are supplying fuel, from fuel from fuel tank. This is air vent and this is the float. This is fuel tank and if the section is a maybe this is section a, this is you know, here you are having one throttle valve that is there. This is intake manifold this is intake duct or manifold.

And sometimes we measure a venturi sometimes, we connect venturi here right. So, maybe this is the pressure drop. So, this is venturi only to measure the pressure drop that I will discuss and we are having this is tip of the, you know jet tip of the fuel. So, maybe this is tip of fuel you know jet right and this height maybe delta h and this section is b b, this is section b b right. This is you know calibrated orifice and this is calibrated orifice. This is throttle valve right and this is fuel and this is fuel discharge tube; this is fuel discharge tube right.

So, and this is float chamber or fuel tank this is sorry, this is float chamber not fuel tank fuel is from fuel tank and this is called float chamber right. This is the you know different parts of a simple float type carburettor. As I said you that air is coming from top so, air is coming from top so, this is incoming air. So, air is coming from the top through air duct through intake manifold. So, if I try to recall what is happening in an spark ignition engine in a spark ignition engine? During intake stoke, piston is coming from top dead centre to bottom dead centre.

While piston is coming from top dead centre to bottom dead centre, intake valve is opened, exhaust valve is closed. We are creating a pressure difference between the atmospheric pressure and pressure inside the cylinder rather we are creating the vacuum inside the cylinder and that vacuum will create a pressure difference rather create a driving force for the supply of air through intake manifold from ambience to the cylinder.

Now, air will rush from ambient ambience to the cylinder through intake manifold. Now while air is coming, then we are supplying we have to supply fuel at the middle of the intake may duct. So, that incoming air velocity will try to fragment the fuel you know fuel particle in a finer droplet, but since if you do not have any palm rather here we are having float chamber. So, because of the pressure difference you know between the cylinder and the ambience, air will come through intake manifold to the engine cylinder through intake duct. But we have to make an arrangement such that the pressure difference while air is coming from ambience to the intake through intake cylinder to the engine through intake duct to the engine cylinder, we can have also supply of fuel from float chamber to the that is the through fuel discharge tube at the in the intake duct. By how?

So, there are two ways of supplying fuel either you have to have one fuel sperm. So, that I can sperm the fuel from float chamber to the intake duct or we can utilize again a pressure difference between the middle of the duct rather where the fuel is discharging rather tip of the fuel jet and also the you know that is atmospheric pressure. Because the float chamber is open to atmosphere. So, at the top of the fuel level atmospheric pressure is acting.

So, if I am a create a pressure difference between that this two section maybe between the level of the between the atmospheric pressure that is there on the you know in the float chamber and the pressure which is there when fuel is discharged fuel is being discharge through fuel discharge tube. So, to do that what we have to do?

We have to do a necessary arrangement, how? So, we need to provide a you know that is very important step that is known as you know by how we can provide by how we can create the pressure difference. So, we will provide a projected you know areas must be provided. So, we can provide a projected area at the middle like this rather we can provide this projected area at the middle where fuel is being fuel is discharged while air is coming.

So, what will happen if you do if you provide a projected areas like this? That means, when air is coming and when air is approaching this part this portion rather section b b. then we are essentially we are doing or reducing the area. So, because of the reduction of area flow velocity of the air will increase because of the increase of the flow velocity pressure will drop and that pressure drop will create a sufficient driving force between the float chamber and the middle of the you know fuel discharge tube.

So, that the driving force will allow fuel to come from float chamber to the intake duct and for that you need to design such a way that, that drop in velocity the interim velocity rather drop in pressure will be good enough to create a pressure difference. So, that the required amount will be supplied from float chamber to the intake duct due to that you know pressure difference and that we need to design that what will be the its basically orifice meter that is we are having a constricted space restricted area.

So, that we can create we can drop pressure by increasing velocity so, that that we have pressure difference fine. So, that means, but where when you are designing you need to ensure that, that the you know the tip of the jet should be always higher than the what fuel level of fuel in the float chamber, otherwise there will be a continuous supply of fuel from float chamber to the intake duct that should not be there. So, the tip of the jet should be always above the fuel level in the float chamber, otherwise there will be a continuous supply of fuel from the float chamber to the intake duct.

Therefore, so what we can see from this arrangement that find the pressure difference between the between the cylinder and the ambience will allow that is essentially created by the you know, motion of the travel of piston from tdc to bdc that will allow incoming air to come into the cylinder through air intake through the intake duct. While we are having flow of air through intake duct, we can provide you know projected areas. So, that we can again you know create a pressure difference by increasing the flow velocity of air. So, that that pressure difference will create a driving force to a driving force which will allow fuel to supply from float chamber to the you know intake duct through fuel discharge tube.

So, with this I can supply air fuel mixture by properly designing the by properly designing the you know shape rather you know passage of this restricted area that is why properly designing the projected areas.

So, this is the you know operational principle of a simple float type carburettor and by how we can supply desired amount of air fuel mixture to the engine. But this is a very important to mention here that while you are designing this so, may be using this simple float type carburettor you can always provide required you know, constant amount of mass flow rate mass flow rate of air mass flow rate of fuel because we it is a possible to change the you know restricted area that is there in the intake duct.

So, while you are doing while you are supplying using a simple float type carburettor then of course, we can provide always depending upon the composition of the fuel we can supply always what will be the you know required you know or rather you can supply a constant amount of mass air and constant amount of fuel. That is a fuel air mixture or air fuel mixture that will be supplied will be constant. We cannot supply varying air fuel mixture or fuel air mixture depending upon the load requirement. That is why nowadays, simple float type carburettor is now absolute. Anyway only to have an understanding by how we can supply air fuel mixture through carburettor, we are doing this analysis.

So, now, I shall we should discuss about we should discuss about while we are doing this while you are using the simple float type carburettor, how we can supply, what will be the mass flow rate of air and what will be the mass flow rate of fuel and for that we will do a little bit mathematical analysis. So, if we go to the next step that. So, here we can see that initially we are having a pressure difference between section aa and the inside and inside the cylinder for which we are having supply of you know mass flow rate of air.

While we are having flow rate of air through the air intake through the intake duct, then we are providing projected areas at the middle and while you are doing so, we are increasing velocity and we are dropping the pressure and that dropping pressure will create pressure difference between float chamber and middle of that intake duct and that will create that we allow fuel to flow from float chamber to the intake duct anyway.

So, now if we will analyse that how we can calculate mass flow rate of air and mass flow rate of fuel for this particular configuration.

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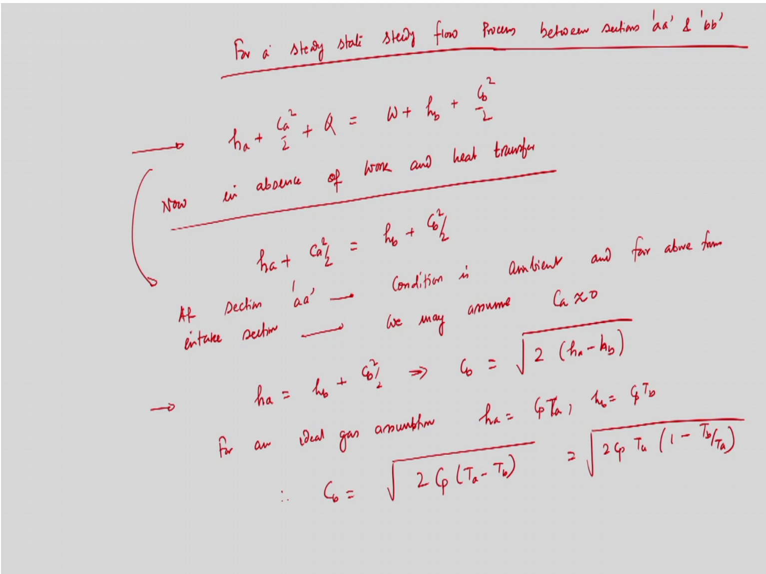

So, if I assume that the process is steady state steady flow. So, for a steady state steady flow process for a steady state steady flow process, we will see how we can have a steady state steady flow process because it is not always possible because you are supplying air fuel mixture only. If it is a four stroke engine, then we are supplying air fuel mixture only during the intake stoke and rest of the in a rest other stokes we are not supplying air fuel mixture.

So, how we can maintain a steady flow steady state process, but we will discuss the what by what will be the you know assumptions are there by how we can have this analysis valid for this particular case. So, for a steady state steady flow process if I write again if I process between section aa between sections aa and sections bb, then what I can write right? So, what I can write that h a plus C a square by 2 plus Q is equal to W plus h b plus C b square by 2. Q and W are the heat added and work heat and work transfer and then h and h with the enthalpy at point section a a and b b c a c b their flow velocity of air at section a a and section b b fine.

Now, in this absence of heat and work transfer; so, right this is the steady state steady flow process, I can write. So, now, what we can write in absence of work and heat transfer the. This equation will be h a plus C a square by 2 is equal to h b plus C b square by 2; that means, if I write this equation between sections a a and b b and there is no heat and work transfer then we this equation will be this h a plus C a square by 2 plus h b plus C b square by 2.

Here we have to write again at section a a condition is ambient rather section a is condition is ambient right. And for above from intersection and for above from intersection also the area of section a a is must much greater than section b b. So, we can assume. So, we can we may assume C a almost equal to 0. So, section a condition is at ambient condition is ambient and far above from intersection. So, we can assume C a is equal to 0 rather area cross section area of a is much much higher than cross section area of b b. So, that this assumption is not very bad assumptions. So, if that is the case then I can write h a is equal to h b plus C b square by 2. Therefore, C b is equal to 2 root h a minus h b of root that is velocity of air at section b b is equal to h a minus h b twice of h a minus h b root of that.

So, if I assume for an ideal gas assumptions because we have to assume there only air. So, for an ideal gas assumption this h a I can write C p into T a. Therefore, and h b is equal to C p into t b therefore, I can write C b is equal to root of twice into C p into T a minus T b. So, that is the you know rather I can write twice C p T a into 1 minus T b by T a under root of that. So, now that is what we can we have you know. So, c b the velocity of air at section b b is like this.

So, if because I know temperature at air at section a because it is ambient condition, but we have to calculate temperature at point b. Now if I attach a u tube manometer at section b b, then we one side one side it is ambient other side it is connected to the middle of the section that section b b then we can calculate you know pressure. So, we can calculate pressure at section b b by only attaching a u tube manometer because one side of is the atmospheric pressure fine.

So, we have calculated C b now if the process between C b and a to be isentropic process. Again we are assuming the process between a a and b b are to be the isentropic process because there is no heat transfer and if we assume that the fictional losses are very less.

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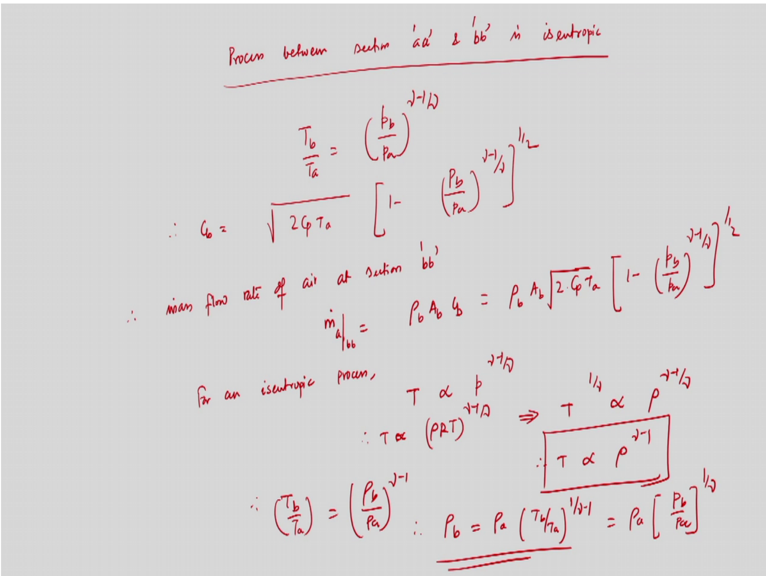

So, we can assume the process between section a a and b b is isentropic. So, process between section a a and b b is isentropic this is not again a very bad assumptions because there is no heat interaction between the between these two section and also the frictional loss is very negligible. We can assume because viscosity of it is very less; anyway in a true sense it is not isentropic process, but I can assume we can assume the process is isentropic. If that is the case because if we look back if we go back to our previous slide where we have seen that I can calculate C b or you can directly get pressure by attaching u tube manometer, but here T b is unknown because we know T a we know C p.

So, if I write if I assume the process isentropic, then what can I write? T b by T a that is ideal isentropic process that will be p b by p a to the power gamma minus 1 upon gamma right. Therefore C b that will be equal to root of twice C p into T a into 1 minus p b by p a to the power gamma minus 1 upon gamma to the power half.

So, what will be mass flow rate of air? That is very important. Mass flow rate of air mass flow rate of air because we have to calculate mass flow rate of air at that section that is the venturi where we have provided you know projected areas. So, mass flow rate of air at section b b because mass flow rate of air at section b b that is very important.

Because of that mass flow rate will get what is the amount of mass flow rate of fuel. So, because of that this amount of mass flow rate what we will obtain the mass flow rate of fuel at that section. So, we need to calculate mass flow rate of air only that section where you are providing venturi as a projected part because of the pressure difference because of the drop in pressure over there, we will have a continuous supply of fuel from float chamber to there.

So, mass flow rate of air at section b b that is m dot b b m dot a b b mass flow rate of air m dot a b b that will be equal to rho b area of section b into C b. So, rho b rho b into area of section b into root C p T a into 1 minus p b by p a to the power gamma minus 1 upon gamma to the power half. Now p b information I can obtain from the u tube manometer that I have attached with that section b b fine. So, this is the mass flow rate of air at section bb.

Now, we have assumed isentropic process. So, again for an isentropic process I can write for an isentropic process, what I can write? T is proportional to p power to the power gamma minus 1 upon gamma that I can obtain from the above expression. If that is the case; that means, T is proportional to rho RT to the power gamma upon 1 minus gamma. Therefore, if I do this analysis I can write T to the power 1 by gamma will be proportional to rho the power gamma minus 1 upon gamma. Therefore, T is proportional to rho to the power gamma minus 1. This is very important for an isentropic process.

Therefore I can write that T b by T a to the is equal to rho b by rho a to the power gamma minus 1 gamma minus 1 or therefore, rho b is equal to rho a into T b by T a to the power to the power 1 upon to power 1 by gamma minus 1. This is very important because if I look at the expression of mass flow rate of air at section bb, their unknown is rho b because we know area we can calculate. So, unknown is rho b. So, I have now expressed rho b in terms of rho a and T b by Ta. So, that is again I can write rho a into T b T b by T a is equal to. So, p b by p a to the power 1 upon gamma.

Because T a T b by T a is equal to p b by p to the power gamma minus 1 upon gamma. So, it will be 1 by gamma. So, now, we have expressed rho b in terms of p b by p a.

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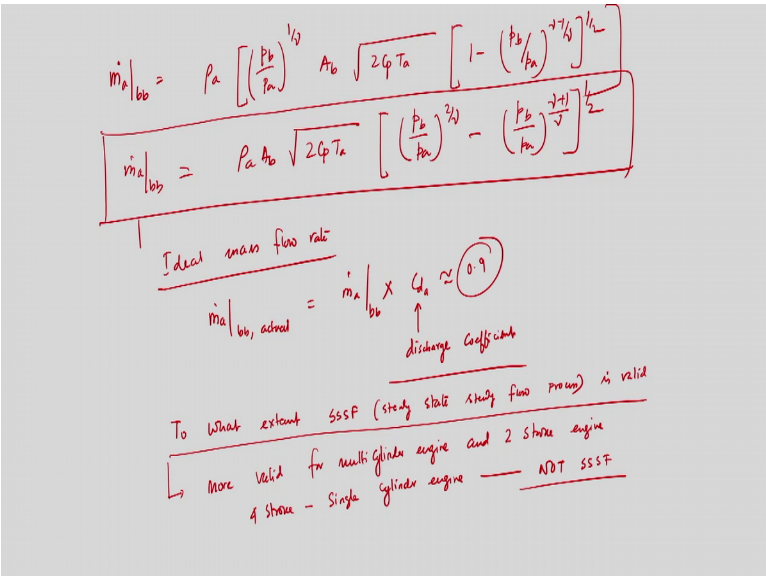

So, if I plug in this expression in the mass flow rate of air in at section b b, so we will get again m dot air at section bb that will be equal to rho a into p b by p a to the power 1 by gamma a b root of twice C p T a into 1 minus p b by p a to the power gamma minus 1 upon gamma two power half. So, if I now if I now put this value of you know p b by pa inside the you know square root, then I can write this will be rho a a b root to C p T a into p b by p a to the power twice by gamma minus p b by p a to the power to the power gamma plus 1 upon gamma to the power half.

So, this is the expression of mass flow rate of fuel at section bb. So, this is the expression of mass flow rate of fuel at section bb that is what I obtain. So, this is mass flow rate of fuel at section bb p b by p a to the power 2 by gamma. So, I have expressed mass flow rate of fuel at section bb in terms of known quantities because I know rho a, I know area b and pb by pa that information I can obtain by attaching new tube manometer at section bb because whose one side is open to atmosphere.

So, this mass flow rate of air whatever we have obtained is not actual mass flow rate rather it is a ideal mass flow rate because we did not take into account the frictional losses and that is why we have used isotropic relationship. So, this is ideal mass flow rate ideal mass flow rate. So, this is the expression of ideal mass flow rate. Now to get actual mass flow rate, what we have to do? So, mass flow rate of air at section bb actual will be mass flow rate of air at section bb into a factor that factor is known as co discharge coefficient.

So, C d a so, this is known as discharge coefficient discharge coefficient whose value is very small, 0.9 like this. So, we have to multiply a discharge coefficient just like a flow through orifice meter or venturi meter; that means, we have calculated mass flow rate at section bb using following an isentropic process. There we did not construct the frictional losses, but in there it will be frictional losses and to take into account that losses the actual mass flow rate will be always less than that predicted by this equation and that will be multiplied by factor which is known as coefficient of discharge or discharge coefficient.

So, now very important C d a is value is almost equal to 0.9. So, value is almost equal to 0.9. Now while we have calculated mass flow rate of air at section bb, we have assume the flow to be steady state steady flow process. But as I said that we are supplying air fuel mixture only during intake stroke while if it is a 4 stroke engine 3 other remaining strokes are ideal. So, there during that stroke we are not supplying air fuel mixture rather intake valve is remaining open, then how we can assume that a process to be steady state steady flow process.

So, to what extents the steady flow steady state process is valid that is very important. So, to what extent the steady state steady flow process is valid? As I said you if it is a 4 stroke engine, only we are supplying air fuel mixture during intake stroke; 3 remaining for the 3 remaining other strokes, we are not supplying rather intake valve is remaining closed then how we can assume steady state steady flow process. So, these assumption is more valid this assumption is more valid for multi cylinder engine, multi cylinder engine and 2 stroke engine

Because if it is a multi stroke engine maybe you when intake is one stroke may be idle in other cylinders. So, here we are having continuous intake stroke in either of in any one of the cylinders in a multi cylinder engine. So, if it is a multi cylinder engine, we have to supply air fuel mixture always. So, it is valid for a multi cylinder engine and also for 2 stroke engine; if it is 2 stroke engine may be only 1 stroke is intake and other stroke is exhaust. So, that is also valid, but in a 4 stroke engine it is not valid at all 4 stroke single cylinder engine no intake so not SSF.

So, 4 stroke and single cylinder engine single cylinder engine, this steady state steady flow process is not valid not steady state steady flow process is valid. So, it is valid only for so, that is valid only for multi cylinder and 2 stroke engine fine. So, we have calculated mass flow rate of air at section b, now we have to calculate mass flow rate what will be the mass flow rate of fuel at section b b because that is if I calculate mass flow rate of fuel at section bb, then we can calculate fuel you know fuel air ratio or air fuel ratio. That is fine.

So, if I would like to calculate mass flow rate of fuel at section b b so, again if I assume that this is a section cc. So, maybe if I assume this is the section cc so, maybe this is section cc. So, again we have to write you know steady state study flow process in for a flow. So, if I now again write you know steady flow energy equation of steady flow energy equation between section c c and to obtain.

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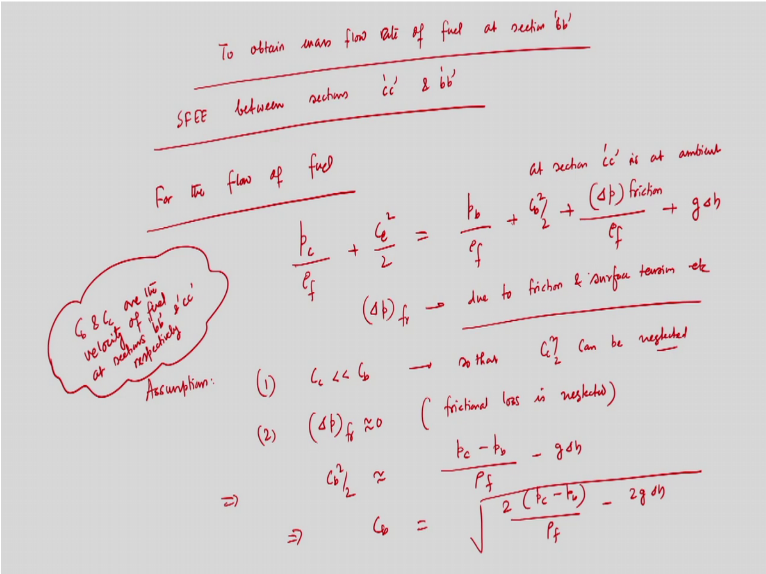

Now, to obtain mass flow rate of fuel at section b b, we have to apply steady flow energy equation between section bb and section cc. So, we are applying steady flow energy equation between section cc and bb.

So, this is very important. We have to apply steady flow energy equation between sections cc and bb on and that is required to obtain the mass flow rate of fuel. So, if I apply mass flow; now for the flow of fuel if I apply this equation between so for a flow of fuel for you know, for the flow of fuel; if I apply that equation between section cc and bb if I go back to my schematic where we have drawn that you now simple flow type carburettor so, then delta h is the difference between the fuel level in the float chamber and the section b b.

But now the question may arise that the float chamber were having a float simple float. So, this float will allow a continuous it will allow maintain the level of fuel constant in that float chamber. So, whenever there will be a drop of the level and drop in level of the you know fuel in a float chamber, float will allow fuel to come in to the float chamber from fuel tank. So, the purpose of providing a float valve at the float is to provide a constant level of the fuel in the float chamber. So, if sum how if we can maintain a constant level of fuel in the float chamber; that means, it will always would be in a section cc.

So, now if I write this equation between section cc and section b b, then for the flow of fluid what type I can write? Mind it at section cc again condition is ambient. So, section cc at section cc. So, at section cc condition is section cc is at ambient right. So, atmospheric pressure and atmospheric temperature that is there. So, if that is the case, then how I if I write that for the energy equation for the flow of fuel I can write that p a that is pressure at sections cc that by rho fuel plus p c rather p c plus c c square by 2 is equal to p b by rho f because now I have to take density of the fuel itself because it is not air rho f plus C b square by 2 plus delta p friction because whenever fuel is divided by rho f plus g into delta h.

So, whenever fluid rather fuel is flowing from float chamber through discharge tube to the air intake duct at section b b of course, you have to take into count the frictional losses and that is why we are writing anyway. So, delta p friction is the frictional losses due to friction and surface tension surface tension. So, this is the frictional due to surface tension etcetera right. So, again we have to take the assumptions, what is the assumptions that we are going to take what are the assumptions? Assumptions 1 is C c is much much less than C b that the velocity of fuel at section cc is much much less than at section b b that is justified because area at sections c c is much much higher than at section b b so, that C c square by 2 can be neglected.

Again this assumptions is not a assumption because cross sectional area at c c is much much greater than cross sectional area at you know at section b b. So, this assumption is not a bad assumption. So, this can be neglected. And also we are taking that ideal fluid flow so, rather you know delta p f r almost equal to 0 that is you know frictional loss is neglected; losses due to friction and surface tension is neglected fine.

So, if I write this then equation becomes C b square by 2 will be equal to you know p c minus p b divide by rho f minus g into delta h. Therefore, c b will be equal to twice into p c minus p b divide by rho f minus twice g into delta h of under root. So, this is the velocity at section b b of fuel. So, this is the velocity of fuel. So, there this is C b, here C b C b and C c are the velocity of fuel at sections b b and c c respectively. So, the velocity of fuel we have obtained at section b b is equal to this 2 of p c minus p b by rho f minus 2 g into delta h delta h is the deference in height between the float chamber and the section b b water is fuel level in the float chamber and section b b. So, if I write that. So, we obtain the velocity of fuel. So, then how I can obtain the mass flow rate of fuel at section b b?

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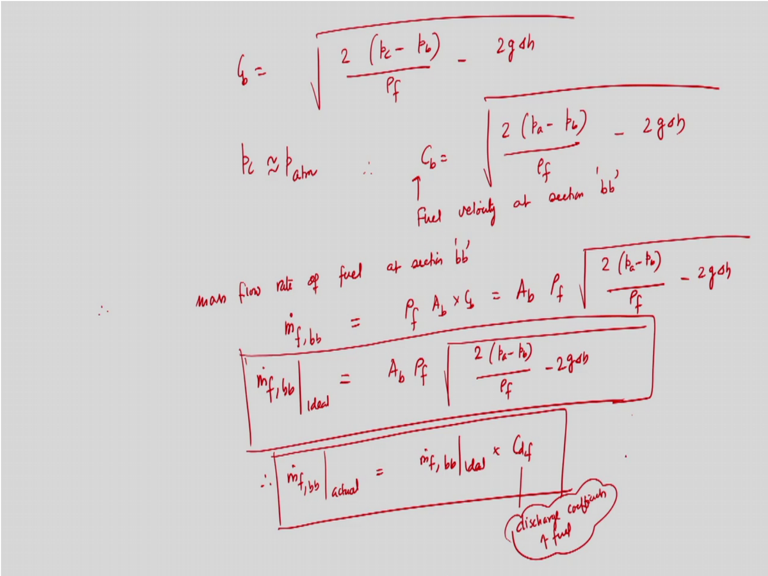

Therefore we have obtained the velocity of fuel at section b b that is C b is equal to twice into p c minus p b divided by rho f minus twice into g into delta h under root. Note that p c is almost equal to p c is equal to atmospheric pressure p atm. Therefore, I can write C b is equal to twice p atmospheric minus twice p b divided by rho f minus twice g into delta h that is the velocity of. So, this is the fuel velocity at section b b.

So, what will be the mass flow rate of fuel at section b b? So, mass flow rate of fuel at section b b that is m dot fuel at section b b will be equal to rho f area b into C b that is expression so; that means, rho f sorry A f rho f twice p a minus p b divide by rho f minus twice g into delta h. Here delta h that information is known p a atmospheric pressure I know and p b that can be obtained by the u tube manometer. So, that is the pressure at that section b b. Area at section area at section b b that I know area at section b and density of fuel air I know. So, I can write this A b into twice rho f p a minus p b minus twice you know that is twice g into h so, twice into g into delta h into rho f.

So, if I take this and that I will get expression like this. So, write rho f into g into h. So, if I this is this is the exploit of mass flow rate a mass flow rate of fuel at section b b. So, this is the exploit rate of fuel at section b b and rather instead of writing this I can write this is the expression. So, mass flow rate of fuel that is mass flow rate of fuel at section bb and this will be the again ideal mass flow rate because we did not take into account of the frictional losses. So, that is A b into rho f root of twice p a minus p b divide by rho f minus g into delta h twice. So, this is the expression of mass flow rate and this is again ideal.

So, we have to obtain mass flow rate of fuel at mass flow rate of fuel at section b b actual will be again mass flow rate mass flow rate of fuel at section b b ideal into coefficient of this discharge coefficient fuel discharge coefficient Cdf. So, this is the mass flow rate actual mass flow rate that I can obtain by knowing the Cdf.

So, we have obtained by doing a simple analysis and using a simple float type carburettor, what will be the mass flow rate of air and mass flow rate of fuel at section b b? Because our aim was to calculate mass flow rate of air and mass flow rate of fuel at section b b and for that we have calculated b at taking a few assumptions and those assumptions are not very bad assumptions because we have explained all those. But the mass flow rate of air and mass flow rate of fuel that we obtain those are the ideal mass flow rate. In a actual case, the flow rate will be lesser than that predicted by those equation because we did not take the frictional losses into account.

Now, question. So, if you use a simple float type carburettor, you have discussed that fine you are using a steady state steady flow process we are taking assumption, but that assumption is valid only for multi cylinder and for 2 stroke engine, but for a single cylinder and 4 stroke engine this assumption is invalid at all. And the area provided at section b b because of the projected parts, there will be a drop in pressure because of the increment of velocity and that pressure depends will create not only because that pressure difference will create a continuous supply of fuel from float chamber to that section b b and because of what we are calculating mass flow rate of fuel and air at that section only.

So, now question is when you know the mass flow rate of air and mass flow rate of fuel at section b b, then from there we can calculate what will be the fuel air ratio or air fuel ratio. And I just said you if I use a simple float type carburettor when you are designing that particular projected parts, we cannot change depending upon the requirement of load and if you cannot change the projected parts of projected area, we cannot change the mass flow rate of air and mass flow rate of fuel and that is why simple float type carburettor is not is not used now a days. But this is the concept by how we can have a flow of fuel without having external pump using a simple float type carburettor.

Nowadays what is done because air will come through intake manifold because of the you know because of the pressure difference that was created by the moment of the piston itself. Because when piston is coming from t d c to b b d c that, it movement of the piston itself creating a vacuum pressure inside the piston cylinder which in a sense create a pressure difference between the between the ambience and the inside between the ambience and engine cylinder and that pressure deference allow air to be introduced in the engine cylinder during intake stroke.

But in case of a , but in case of a supply of fuel we need to use a fuel pump and that is what is done in case of the in most of the modern C I engine because we are having fuel pump and fuel pump supplies fuel through you know injected into the cylinder. But even for s I engine since we have discussed that you can we have discussed that simple float type carburettor holds up the purpose to supply you know varying air fuel ratio or air fuel mixture or vice versa. Depending upon the requirement of load that we have discussed that in idling condition, in cruising zone, idling zone and power zone, we may require different you know ratio of different fuel air ratio or air fuel ratio. If that is the case, it is really impossible to supply that using a simple float type. It is not possible at all using a simple float type carburettor and that is why the simple float type carburettor is replaced by a modern carburettor where you have to supply fuel through fuel or we can supply only air through and take manifold and we can supply the fuel through fuel pump.

And the requirement of air fuel mixture and fuel air mixture that we have discussed that that varies from you know in three different zone. When we are starting engine maybe that time only to keep the engine in start up mode, we need to supply air fuel ratio and that air fuel ratio of that fuel air ratio will be higher than what is required during cruising zone. In most of the time, engine should run in a cruising zone and there we require a constant fuel air constant you know value of fuel air ratio.

But while during idling zone engine is supplying no load, but still it is running still it is in start up mode. So, you have to supply higher fuel air ratio and we will discuss why it is happening. So, and also during the power zone when engine is providing because we need higher power from the engine that time we have to provide higher fuel air ratio that is quite obvious.

But during idling zone even without having no load from the engine, we had we need to supply air fuel ratio that we will discuss in you know systematically. So, from here we can say that the discharge coefficient of air that we have seen that you know you know 9 4.99, but discharge coefficient C df represent the effect of. Here while we are calculating ideal actual mass flow rate of fuel, we have multiplied the ideal expression in the coefficient you know constant which is not discharge coefficient of fuel. So, this is discharge coefficient of fuel C df and these because it takes care of all the deviation that we have we did not considered during the analysis right.

But it influenced by many factor which is, but this discharge coefficient ideal deviation from one d isentropic flow because you have considered one dimensional isentropic flow while you are considering the while you are trying to calculate the mass flow rate of air and mass flow rate of fuel. So, it is. So, the actual mass flow rate of fuel will be multiply in you know actual to obtain the mass flow rate of fuel, we have to multiply the ideal expression using a coefficient discharge coefficient C df. But you know the most important you know it discharge coefficient Cdf, Cdf is influenced by a few factors are most important factors are that fluid specific gravity.

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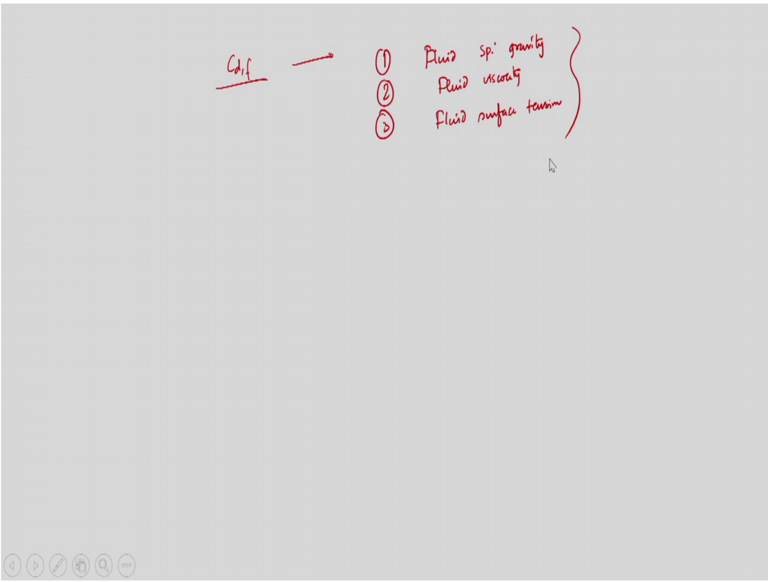

So, I am writing that C df that is discharge coefficient for fuel which is I mean which this factor needs to be multiplied with the idle expression only to obtain actual mass flow rate of fuel. But there are several factors which influences this you know several factors which influence this discharge coefficient of you know fuel. The most important are number one is fuel specific gravity whether fuel in fluid of course, it depends upon fluid specific gravity fuel is of course, fluid specific gravity , number 2 fluid viscosity , number 3 fluid surface tension.

So, these three are the most important parameter that influence the coefficient of discharge or the discharge coefficient of you know fuel and for that we need to multiply because we did not you know consider all these you know factors while we have calculated the mass flow rate of fuel at section b b.

So, that means, using a simple float type what is the conclusion for today's analysis is that, using a simple float type carburettor, how we can provide the mass flow rate of air and without providing a fuel pump it rather providing a fuel pump by changing the design of the air intake duct, how we can supply fuel pump float chamber to the to the to that duct. That is what we have discussed and also we have discussed how we can calculate the mass flow rate of fuel and mass fuel rate of air at section b b.

Of course, for that we have taken up your assumptions and those assumptions are not very bad assumptions because and finally, all though we have carried out one dimensional isentropic analysis. But we did not consider because the there will be a deviation from we have there if we have used one dimensional isentropic analysis , but that is why the mass flow rate of air and mass flow rate of fuel what you have whatever you have calculated all those are ideal in.

But to obtain that actual values we have multiple we have seen that that you know express an ideal expression will be multiplied by discharge coefficient and then we can obtain the actual mass flow rate of fuel and actual mass rate of air. From there we can calculate what will be the fuel air ratio supplied by that particular carburettor to the engine.

And we have discussed that the simple float type carburettor is not able to supply varying fuel air ratio depending upon the load that is why nowadays it is not used and finally, we have discussed that that coefficient discharge coefficient of fuel which we did not take into account if varies it is it influenced by a several factors and we have you know identified a few factors like fluid specific gravity, fluid viscosity and fluid surface tension.

So, we will discuss that if you need to vary mass flow rate of air and fuel for different engine requirement, that is what you have discussed that idling zone cruising zone and power zone. We will discuss in detail that aspects in the next class and with this I stop my discussion today.

Thank you very much.