IC Engines and Gas Turbines

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Lecture – 12
Idling, cruising and power ranges

We will continue our discussion on IC engine and today, we will discuss about different zone of engine operation rather it idling zone, cruising zone and power zone. So, different zones of engine operation we will discuss in detail and what is the requirement of fuel air mixture? And at last we will discuss that what in last in my last lecture I have discussed about the simple float type carburetor.

So, if I use a simple float type carburetor simple float type carburetor for the operation and if you need to satisfy the requirement of fuel air mixture during three different zones then we need to know whether a simple float type carburetor can be you know suitable for that you know for that supply of fuel air mixture at three different zones and if it is not then what are the drawbacks and when we are trying to modify the design of a carburetor then what will be the what will be the objective over objective of the modern carburettor.

So, to do that at first I will draw the requirement of fuel air mixture at three different zones, that is three different zones are idling zone, cruising zone and power zone. I have discussed little bit maybe a day back that the requirement of fuel air mixture during idling zone is very high as compared to the you know cruising zone and power zone and almost to recover a constant fuel air mixture for during cruising zone. And for the power zone again we need relatively high you know air fuel mixture. So, you know this is very important that what are the three different zones rather I have discussed that fuel air requirement of the engine?

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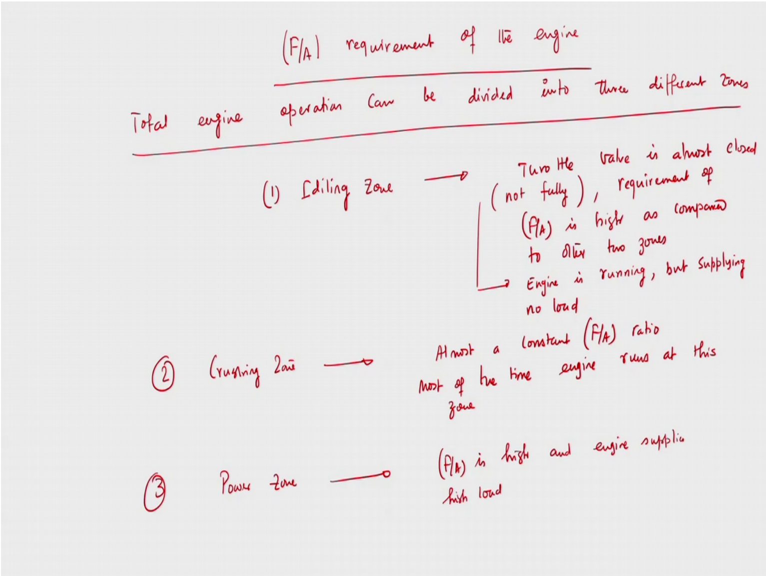

So, what are the fuel air ratio of fuel air mixture requirement? This is the fuel air requirement of the engine is very important and you know the total engine requirement or the total engine operation can be divided into three different zones that is what I wrote maybe in my last to last lecture, that the total engine operation can be divided into three different zone three different zones.

That is what I wrote that first is idling zone of operation. So, what this zone is I mean important why this zone is important and what will be the requirement of fuel air mixture during this zone? So, in this zone as I you know in this zone very important is that you know throttle valve is almost closed not fully almost closed. And the requirement of fuel air mixture requirement of fuel air mixture is high as compared to other two zones.

And in this zone engine is running this is very important engine is running, but without any load so, running, but supplying no load. So, engine is running still during start up condition, but we do not you know extracting load from the engine and during this zone is known as this zone is known as idling zone and during this zone we require high fuel air ratio and during this zone throttle valve is almost closed, but not fully.

Next is cruising zone this is again very important. This is very cruising zone and here we require almost constant fuel air ratio and most of the you know most of the time engine runs at this zone. And number 3, which is known as power zone. So, in that cruising zone this is the having zone and most of the time engines run the at this zone, but and the during this zone we require almost a constant fuel air ratio. And power zone again the fuel air requirement is high and engine supplies high load it is high load so, this is the power zone. So, we need to extract high load from the engine and the requirement of fuel air ratio is high.

So, if now I would like to draw the requirement of fuel air ratio versus percentage opening of throttle valve and what will be the curve?

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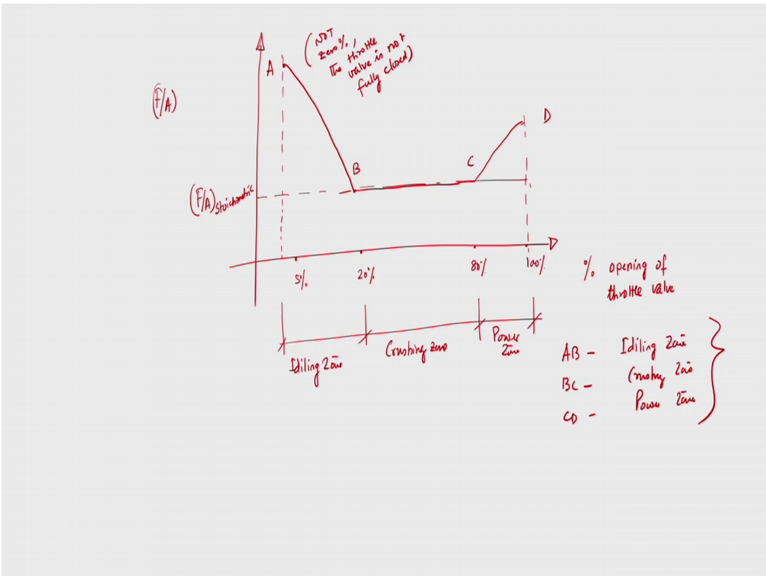

So, if I now try to draw this is you know this is percentage opening of throttle valve and this is fuel air requirement or fuel air ratio right. So, whenever we talk about the requirement of fuel air mixture for any particular engine, of course we have seen that during idling zone we require high fuel air ratio. Cruising zone most of the time engine should run at this zone, we require almost a constant air fuel air ratio and during power zone again we require high fuel air ratio.

Whatever in which zone I mean we should try to run engine most of the time during cruising zone, but depending upon the load requirement and also we need to start the engine. So, while you are starting engine may be engine is in running condition, but we should not we are not extracting load from the engine. So, whenever we are supplying any particular fuel for that fuel we have a you know to have a efficient combustion we need we know that what will be the stoichiometric air fuel ratio or chemically correct air fuel ratio.

So, ideally if this becomes the so, if this become fuel air ratio stoichiometric and if I try to draw the curves during different zones maybe as I said you that during engine start up valve is almost close, but not fully closed. So, if I now write maybe this is 5 percent, then maybe this is 20 percent, then maybe this is 80 percent and this is 100 percent right. So, this is suppose 20 percent so, here and then it will be almost constant then it will go up to 80 percent then it will be like this so, this is 100 percent.

So, this is A, this is B, this is C, this is D, right. So, if we now split three different zone so, this is the zone; so, this is the idling zone, this is cruising zone and this is power zone. So, if we look at carefully that of course, when we demand more load from the engine we need to open throttle valve fully and during that time throttle valve is almost open and requirement of fuel air mixture again increases. So, the entire figure entire you know variation can be splitted into three different parts AB, BC and CD. AB is the requirement as this is the idling zone, BC is the cruising zone and CD is the power zone.

So, we can see that and the point A is this is no zero percent not completely closing. So, this is the point A this is exactly not zero percentage or the throttle valve is not fully closed. So, 1 percent, 2 percent depending it depends upon the so many other factors anyway, but this is the idling zone. So, what we can see from this figure and that is what we have discussed that during the idling zone we require high fuel air ratio most of the time engine should run at the cruising zone where you require almost a stoichiometric air fuel ratio; that means, we will have a efficient combustion.

As I said you that it is it may not be always possible to supply stoichiometric fuel air ratio to the cylinder although we are having carburetor, but we try to we will try to supply we will supply while we are designing carburetor we need to keep in mind that it will try to supply fuel air ratio within the combustible range; not above not below that range otherwise combustion should would not sustain. So, 20 percent to 80 percent that is you know throttle valve opening that is the you know cruising zone where most of the engine should run during this zone almost the fuel air ratio I mean becomes stoichiometric that is chemically correct air fuel ratio to have a efficient combustion.

Of course, when we demand more power from the engine to attain certain altitude then suppose an engine is attaining certain altitude from during that time we need to extract more load from the engine. And again during this zone we need to supply higher fuel air ratio as compared to the cruising zone and that is represented by the line CD and during that time throttle valve is remaining almost open.

So, question is why fine we can see from this figure from this graph that we need to supply stoichiometric air fuel ratio during cruising zone that is justified because most of the time engine should run during this zone and we should have fuel economy. That means, efficient combustion will be efficient and we will supply fuel and air in such a way that it will try to attain the stoichiometric air fuel ratio fuel air ratio. But, again it is also justified that we need to supply more fuel air ratio during power zone because essentially you are try to extract more load from the engine.

But, during idling zone although engine is running that is engine in start up condition, but still we are not extracting we are not demanding load from the engine yet we require high fuel air ratio that is what is seen from the figure. So, what is the reason behind it? That means, why we need to supply more amount of fuel air ratio during idling zone although we are not demanding load from the engine and engine is in start up condition.

So, to explain this again we need to draw the schematic and one with while we are explaining rather while we are trying to explain this we need to keep in mind that during this zone throttle valve is not open not fully open rather also it is not closed fully closed; that means, it is closed, but still there is no I mean not zero percent. So, now we should try to explain why the requirement of fuel air ratio is higher rather becomes higher during idling zone as well as in the power zone.

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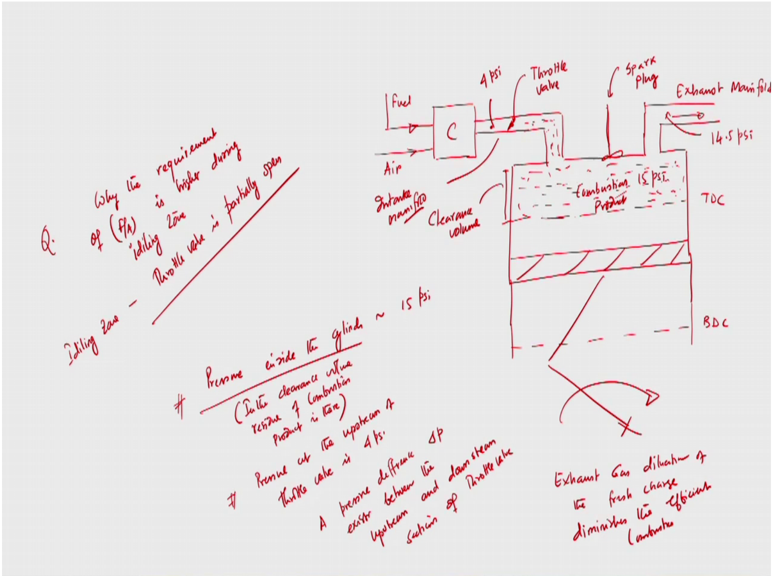

So, to do that again we have to draw the schematic and suppose if I try to draw schematic of a engine cylinder. So, maybe we have one carburetor this is the air stream and this is the fuel stream. So, this is carburetor and then carburetor is connected to the engine cylinder, then we have so, this is the location of top dead centre. This is top dead centre and this is bottom dead maybe this is bottom dead centre and this is exhaust that is exhaust manifold or (Refer Slide Time: 16:27) and we have one throttle valve over here. So, this is throttle valve and this is spark plug which is again very important element for the operation of SI engine.

So, this is very important. So, maybe this is filled up with. So, this is combustion product. So, what is happening we are trying to explain why we need to supply higher fuel air ratio during the idling condition. So, what is happening? So, this zone is known as you know clear zone rather it is known as the you know clearance volume, the clearance zone so, this is this volume is known as clearance volume.

So, what is happening suppose we are trying to draw air during intake stroke not only air rather air fuel mixture during intake stroke through carburetor and I have explained that during idling condition rather when you are trying to draw air fuel ratio during idling during idling stroke during idling zone throttle valve is remaining almost close not fully closed.

So, what will happen at the end of the compression stroke when piston reaching at TDC it is not possible that the combustion product that is there in the clearance volume should be spill out from the cylinder. So, there will be a certain amount of residue or the combustion product and they will that combustion product will occupy the space of the in the clearance zone. Now, next stroke is the intake stroke the next first stroke of the next cycle then when piston is trying to come from TDC to BDC during intake stroke; that means, I am talking about during idling zone then throttle valve is not fully opened rather partially open.

So, the throttle valve so, we are trying to explain the requirement why the requirement of fuel air ratio is higher during idling zone. So, this is question, why the requirement of fuel air ratio is higher during idling zone. So, what is happening as I said you during idling zone throttle valve is partially open not fully. So, during intake stroke when we are trying to drop piston from TDC to BDC pressure at the top of the piston that is pressure within inside the control clearance volume present inside the cylinder rather pressure inside pressure in the clearance volume is nearly about 15 psi.

So, pressure inside the cylinder is nearly about 15 psi that is in the clearance volume residue of combustion product is there. So, when you are bringing piston from TDC to BDC during intake stroke pressure in the cylinder and the pressure in that clearance volume which is occupied by the residue of combustion product is nearly about 15 psi and pressure in the exhaust manifold here it will be around 14.5 psi so, here 15 psi.

Now, pressure at the upstream of the throttle valve is nearly about 4 psi. So, when throttle valve is partially open that is almost closed only 2 percent is open, then pressure inside the cylinder is nearly about 15 psi because that clearance volume is occupied by the residue of the combustion product. So, and pressure at the upstream of the throttle valve is 4 psi. So, there is pressure difference between upstream part of the throttle valve and the downstream part of the throttle valve including the engine cylinder.

So, during idling stroke when you open you know the throttle valve rather you know by 2 percent by opening 2 percent of the flow passage, then since the pressure inside the cylinder is higher than the upstream pressure somehow somewhat amount of combustion product will rather residue of the combustion product will try to rush towards that space; that means, this intake manifold.

So, this is intake manifold intake manifold so, throttle is almost close and as the pressure and it is about 4 psi. So, pressure at the upstream of the throttle valve is 4 psi and pressure in the clearance volume is 15 psi. So, when we open the throttle valve by 2 percent which is required which an requirement which is a requirement during idling condition or idling zone because of this pressure difference residue of the combustion product will rush towards the intake manifold and the entire intake manifold will be filled up by the combustion product.

So, pressure inside cylinder is 15 psi pressure at the upstream of throttle valve is 4 psi, right so, there exist a pressure difference across the throttle valve. So, a pressure difference a pressure difference delta p exist between the section or between the upstream and downstream; upstream and downstream section of throttle valve fine.

So, because of this pressure difference a part rather a portion of the combustion product will try to rush towards the intake manifold and it will try to you know it will try to mix the fresh charge rather the combustion product will mix with the fresh charge that is going to come in the next intake stroke. So, we have understood that during idling condition since the throttle valve is not fully closed, fully open because of it partial opening there exist a pressure difference between the upstream and downstream section of the throttle valve. And that pressure difference allow the combustion product residue of the combustion product to rush towards the intake manifold and it will try to restrict the path of the fresh charge that is going to come rather it will try rather combustion product will mix with the fresh charge of the incoming fresh charge during the intake stroke next intake stroke.

So, now when intake during intake stroke piston is coming from TDC to BDC not only the fresh charge the fresh air fuel mixture, the intake stroke will try to draw the combustion product that is there in the intake manifold along with the fresh charge that is coming because of this partial opening on the throttle valve. So, in the intake stroke instead of getting only fresh charge we are getting rather somehow you know larger mixture larger portion of the combustion product and a very small amount of fresh charge that is coming during the index stroke.

So, that means, the dilution of the you know fresh charge that is very important that we need to know the very important that the exhaust gas dilution of the fresh charge. So, this is known as exhaust gas dilution of the fresh charge. So, the pressure difference will allow the combustion product to rush into the intake manifold and it will try to dilute the fresh charge that is going to come. Not only that it also try to restrict the part of the incoming fresh income charge that is going to come during the intake stroke.

So, during intake stroke not only the fresh charge rather combustion product together with the fresh charge that will be filled up in the cylinder and whatever amount of fresh charge that is being introduced that will remain almost that will be surrounded by the a large you know portion of the combustion product. And this exhaust gas dilution; this exhaust gas dilution; this exhaust gas dilution of the fresh charge you know diminishes the diminish rather diminishes the efficient combustion.

That means the exhaust gas will try to occupy the most of the space in the cylinder and that exhaust gas would not allow the fuel particle to be come into contact the fuel particle will be come into contact with air. So, exhaust gas dilution of the fresh charge which will try to diminish the efficient combustion because this exhaust gas or exhaust the combustion product would not allow the fuel particle to be come to be fuel particle will come into the in contact with the air.

So, fuel particle would not come would not directly come in contact with the fresh air as a because of the presence of the exhaust gas as a result of which the combustion should be poor. And to have sufficient combustion what we need to do? We have to supply we have to (Refer Time: 27:49) the fuel air mixture by supplying more amount of fuel so that although we are not extracting load from the engine, but still since engine is in running condition so, we have to have running in a running mode of the engine and to sustain that running mode we should have at least proper combustion or efficient combustion.

And for that the to overcome that exhaust gas dilution of the fresh charge we have to supply we need to supply more amount of fuel into the cylinder to only to enrich the fuel air mixture, so that the fuel particle will come into contact of the fresh air and the engine will be in running condition. And that is why the requirement of fuel air mixture during the idling condition is higher as compared to that of the cruising zone and the power zone.

Cruising zone because as I said that cruising zone we recover almost stoichiometric air fuel ratio or chemically correct air fuel ratio because engine is running most of the time during this zone and we are not extracting more load or we are demanding more load during this you know zone. So, this zone air fuel ratio will be almost stoichiometric may be little bit I mean somewhat above or somewhat below the stoichiometric air fuel ratio, but it will be within the combustible range, so that there should not be any problem for the efficient combustion.

But, during idling condition because of this dilution of the exhaust gas that there are two reason; one is because of the pressure difference that is because due to the partial opening of the throttle valve the combustion product dilution of the residue of the combustion product will rush towards the intake manifold, it will try to restrict the path of the incoming fresh charge. Not only that while during intake stroke when we are bringing piston from TDC to BDC that during that stroke not only the fresh charge rather combustion product and most combustion product will come to the engine and that while it is coming to the engine that will allow a small portion of the fresh charge to be introduced in the engine.

That means, during intake stroke combustion product rather almost large amount of combustion product that was there in the intake manifold together with the fresh charge will be introduced and since the entire space will be covered by in; covered by the combustion product since throttle valve is not fully open. So, we are arriving very small portion of the fuel air ratio to be introduced. On the top of that it will be surrounded by you know large amount of combustion product so the fuel particle would not come in contact with the in direct in with the direct contact of the air so, that we should not have efficient combustion.

So, this you know dilution of exhaust gas dilution of the fresh charge to overcome that effect we need to supply larger amount of fuel only to enrich the fuel air mixture. So, that the you know fuel particle will be in contact with the air and we should have combustion only to run the engine because we are not extracting any load from the engine. So, this is the reason for which we need to supply higher fuel air ratio during idling zone although we are not you know extracting load from the engine fine, this is that I guess.

So, an cruising zone as I said you that if I go back to my previous slide. In the cruising zone what is happening that is B to C it is very important than most of the time engine is running and we require almost stoichiometric air fuel ratio and this is basically the maximum fuel economy. So, the primary interest obtain primary lie interest lie is in obtaining the fuel economy because we are running engine may be we are demanding high load, but primary interest lies in running engine in cruising zone only to obtain fuel economy.

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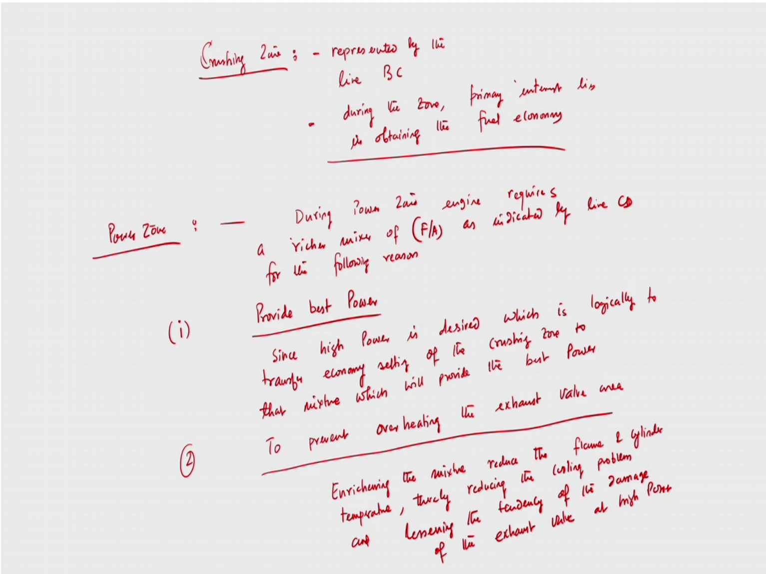

So, if I write that while you talk about cruising zone; while you talk about cruising zone. So, in this zone that is the a line BC represented by the line BC and during this zone primary interest lies; primary interest lies in obtaining the fuel economy. This is quite obvious because as I we have seen from the graph itself that the fuel air ratio is almost stoichiometric, that is coming chemically correct fuel air ratio, we are having efficient combustion so, it will we will have fuel economy.

So, now next is the power zone so, again we have seen power zone. So, we have seen that again if it that is 80 percent to 20 percent throttle opening of course, we have to have because we are trying to obtain you know relatively higher load from the higher power from the engine because engine load is higher. So, we have to supply higher fuel air ratio that is obvious. So, during power zone engine requires a richer mixture, why?

So, during power zone, again we have seen during power zone; during power zone engine requires you know a richer mixture of the fuel air ratio or richer mixture of fuel air right as indicated by line CD by line CD for the following reason so, why? Number 1, is to obtain provide best power. So, that is very important provide best power. So, why we need to supply again richer mixture as indicated by line CD during power zone? Of course, we have to provide best power because we are demanding high load from the engine.

So, that is since high power is desired so, since high power is desired high power is desired which is logically to transfer; logically to transfer you know economy settings of the cruising zone to the economy setting of the cruising zone to that mixture which will provide the best power, this is very important that is true. So, we have to shift rather we have to transfer the economy settings of the cruising zone toward that mixture that will provide best power because during this zone we are trying to get high load from the engines only one is best power.

Another is very important, number 2; that is to prevent overheating of the exhaust valve areas to overheating to prevent overheating the exhaust valve area. So, during power zone what we are trying to obtain from the engine high power because we are having high load engine is having high load. So, engine needs to supply high load; that means, we should have high power we should have efficient combustion.

So, when we have high power it is very important that means, at high power increased mass of gas passing through the exhaust valve cylinder you know mainly the intake valve is in the same position as compared to the exhaust valve, but through exhaust valve we are supplying you know combustion product. We are allowing combustion product to go away through exhaust valve so, a normal tendency of the exhaust valve will be always that will be heated up I mean will be will normal tendency of the normal condition-rather normal condition of the heat exhaust valve will be always you know high temperature in that particular area.

So, and that means, but we are trying to obtain high power. So, if it is high power then of course, we have to supply high fuel air ratio that is we obtained to provide the best power. So, when you are supplying high mass rather high mass of the combustion product high mass of the increased mass of the gas; so, when increased mass of the combustion product or gas that will pass through the exhaust valve which is having even high temperature it will try to again heat up the exhaust gas and it may try to reduce the life of the exhaust valve and the exhaust manifold.

And to prevent that that is to prevent overheating what I need to do? We have to enrichening the mixture. So, to prevent that overeating what we have to do? We need to enrichening the mixture and this enrichening will reduced they reduce the flame and cylinder temperature flame. And cylinder temperature thereby reducing the cooling problem temperature thereby reducing the cooling problem and you know prevent or lessening and lessening the tendency of the you know damage of the exhaust valve at high power.

So, the normal tendency during high power is that high power means we are supplying larger increased mass of combustion product or gas. Whenever that increase mass of combustion product or when the exhaust increase mass of combustion product will go will pass through the exhaust valve and through exhaust manifold and it will try to overheat the exhaust valve because we need best power. So, we have to have increased rate of gas.

So, while we are trying to why we are trying to obtain high power best power and for that we have to supply we need to have you know we have to open the throttle valve from 80 percent to 20 percent which will increase the you know mass flow of the gas mass flow rate or mass flow of the gas to be higher. Now, so that means, 80 percent to 20 percent opening of the throttle valve of course, will give us the best power, but the simultaneous effect is that will have you know increased rate of combustion you know combustion product and that combustion product when we will go through the exhaust valve or exhaust manifold it will try to overheat the exhaust value.

Now, to avoid now to prevent the overheating only to lessening the tendency of damage of the exhaust valve what we need to do we need to enrichening the mixture by supplying larger amount of fuel and this enrichening mixture what will it will reduce the flame temperature as well as the cylinder temperature by taking some amount of fuel.

So, now a question may arise that when you are supplying high amount of fuel enrichening of the fuel. So, enrichening of the fuel will try to you know reduce the flame temperature of course. So, then will there be a effect of the efficient combustion? No, my answer is no because throttle valve is 80 percent to 20 percent. So, we are supplying larger amount I mean larger amount of charge into the cylinder only to have only to provide best power. So, to have a sufficient you know that is that you know opening of the throttle valve itself will try to provide best power because we have supplied larger amount of a charge.

But, while you are trying to larger amount of charge; that means, you will have a you know the combustion the overall combustion the effective combustion will be you know pressurized to a effective combustion will be high. But, so whenever mass flow rate of the combustion gas combustion product increases that will try to overheat the exhaust wall. And there we need to increase the you know fuel ratio fuel you know the percentage of the fuel that is being supplied with the fresh air and that increment of the fuel will try to reduce the flame temperature as well as the cylinder temperature and it will try to you know prevent the overheating of the exhaust valve.

So, now we have seen that depending we the total engine operation can be you know divided into three different parts that is what we have seen. And we have seen that the requirement of fuel air ratio during idling is even higher as compared to two other zones and of course, during power zone because we need to obtain high power from the engine we have to supply higher you know larger rather higher fuel air ratio fine.

So, now of the question is if I have a simple float type carburetor that is what I have discussed in the last lecture is it really possible to supply you know varying fuel air ratio during different modes of operation during different zones of operation that is what we have discussed. Now and if we cannot even supply using a simple float type carburetor rather we need to first know what will be the problem rather what will be the limitation of a simple float type carburetor to provide varying fuel air ratio during because, when we when a particular engine is equipped with a simple float type carburetor we cannot change, we cannot say that ok, fine the simple float type carburetor will be used when only the engine is running during cruising zone.

But, when engine run engine is running in either in idling zone or in the power zone then will be used different carburetor that may not be possible that may not be the case at all. So, what we need to do; that means, if a engine is equipped with a simple float type carburetor then what will be the limitation of that particular carburetor to supply you know the required amount of fuel air ratio during three different zones of operation and then if we need to design a modern carburetor what should be the objective of designing a modern carburetor that is what I should discuss now.

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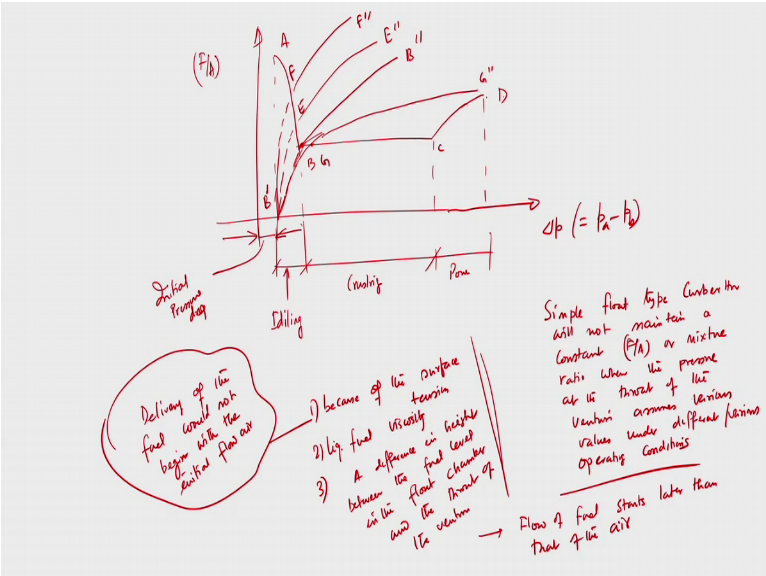

So, as we have seen that very importantly that if I now, try to draw the fuel air ratio versus we have identified that this is the fuel air requirement and we have seen that the total engine operation can be you know divide into three different parts that is AB and CD. So, this is cruising zone, this is CD, this is idling zone so, this is idling zone, this is cruising zone and this is power zone and this is very important that we have discussed the that mass flow rate of air and mass flow rate of fuel how we are getting using a simple float type carburetor right.

But, the mass flow rate of air and mass flow rate of fuel you know we have obtained from you know applying steady flow energy equation between two sections in a intake manifold. But, the question is the flow of liquid does not follow the same law as the flow of air whatever we have obtained using the equations because when we have discussed about the flow of fluid from float chamber into the venturi rather into air intake duct we did in considered the effect of viscosity as well as the surface tension of the fluid.

So, such a simple float type carburetor when you have designed will not maintain a constant mixture ratio when pressure at the throat; pressure at the throat because if we can recall that the pressure at the venturi rather whenever we are having you know projected part projected parts rather we are providing a constricted passage inside the air duct only to reduce the pressure rather only to have a drop in pressure and that pressure difference will create a driving force to have a flow of liquid fuel from float chamber in to the air intake duct.

So, the flow of liquid from fuel rather float chamber into the duct should not does not follow the same law as the flow of air is attained by the equation that is what we have discussed in the last lecture. So, the simple reason is that the I mean whatever maybe the fuel liquid fuel the fuel viscosity as well as the surface tension we did not take to account while we are calculating those. And that is why, such a simple float type carburetor will not maintain a constant mixture ratio when the pressure at the venturi when pressure at the throat of the venturi assumes various values depending upon the deferent conditions.

So, if I try to forget about you now that because most of the time since engine running runs at the you know cruising zone and only during idling condition and the power zone that is not the most of the time, but we need to supply high fuel air ratio that what we have discussed. But again when you are trying to design a simple float type corroborator; that means, we having a particular you know throat diameter and for that given throat diameter we will have a fixed pressure drop between the you now throat and the free surface of the float chamber.

Now, for a simple float type carburetor thus we cannot maintain a constant value because it is very difficult if we design that carburetor to supply a constant rich you know constant value of rather fuel air ratio that may not be possible to supply the higher requirement of fuel air ratio that is required during idling and the cruising zone idling and power zone. On the other hand, if we try to supply limitedly higher amount of fuel air ratio during you know which is required during cruising during idling condition that we will always try to supply more amount of fuel air ratio and which is not required at all during cruising zone as well as the power zone. So, unnecessary waste of the fuel will be there.

So, that means, why that; that means, using a simple float type carburetor it is very difficult rather simple float type carburetor will not maintain. So, I am writing a simple float type simple float type carburetor. Simple float type carburetor that is what we have discussed in the last lecture simple float type carburetor will not maintain; will not maintain a constant flow rate a constant air fuel ratio or constant you know mixture ratio constant fuel air or mixture ratio mixture ratio. When the pressure at the venturi pressure at the throat of the venturi; throat of the venturi assumes different rather by various values assumes various values you know or pressure various values of pressure under different various operating condition under different or various operating conditions, right.

So, that means, if we design a simple float type carburetor to supply a constant fuel air ratio that is required during cruising zone it is really impossible to get high fuel air ratio that is required during idling and power zone using a same carburetor. On the other hand if we try to design a simple float type carburetor in such way that it will try it will supply high fuel air ratio that is required during idling zone. It may so happen that the fuel air ratio supplied throughout the engine operation will be higher and that is that will be even you know very higher than the requirement during cruising zone and a power zone. So, unnecessary wastage of fuel will be there so, a fuel economy cannot be attained using a simple float type carburetor, right.

In fact, different values of pressure difference you know. So, suppose fine it is important that also it is important because when we try to supply liquid fuel from float chamber into the venturi on account of a pressure difference and that pressure difference is created only because of the flow of air from intake air intake to the venturi then by virtue because of the viscosity of the fluid as well as the surface tension that liquid fuel should not start the movement at which air is coming.

So, there will be a time gap. There will be a gap of I mean it is not possible that the air which is supplied which is coming at the venturi immediately that time liquid will go because of the viscosity liquid will have inertia and also the surface tension that would not allow these two effects would not allow. Because with that this these two effects we did not consider because surface tension because of the surface tension is slightly an that means, delivery of the fuel should not would not begin with initial flow of air.

That means, I am writing that delivery of the fuel would not begin with the initial flow of air; with the initial flow of air; that means, the moment when air is coming from you know or rushed into the venturi that time although we are having pressure difference, but still we are having certain altitude between the what level of the fuel in the float chamber and the venturi.

So, to we need to work on that rather that pressure difference will be sufficient to overcome that height as well as since liquid having viscosity also surface tension. So, these two effects we did not considered where calculating mass flow rate of fuel. So, that because of these two effects and also the fuel needs to overcome that certain altitude the delivery of the fuel would not begin with the initial flow of air that; that means, there will be a little bit time gap.

So, for this reason the flow begins later than that air because of surface tension because this will happen there are two reason one is because of the surface tension; because of the surface tension number 1, to liquid fuel viscosity; liquid fuel viscosity and a difference in height; a difference in height between the you know it is very important between the you know float chamber between the fuel level in the float chamber and the throat of the venturi of the venturi.

So, these three effects I mean would not allow the delivery that the delivery of the fuel should start immediately when the air is coming from the upstream to the throat; that means, delivery of the fuel would not begin with the initial flow of air. And, because of that and for this reason the flow of fuel and for this reason flow of fuel will start flow of fuel begins later than that of the air. Flow of fuel starts later than that of the air; later than that of the air and if we try to if I write now this is the delta p that is equal to p A minus p B this is p A minus p B.

So, maybe this is initial pressure drop we require so, may be this is the initial pressure drop. So, this is the initial pressure drop this is initial pressure drop and I mean if I try to this like this so, thus it will start from here. So, maybe if I have a pressure drop then this B prime is the point this B prime is the point when may air may start flowing, but actually in actual practice the flow of fuel that the liquid fuel will start flowing from point B because there will be a gap time gap. And the reason behind this we have discussed that because of the viscosity of the fluid surface tension of the fluid and also the liquid fuel has to overcome certain height. So, due to this three reason the you know flow of fuel start later than that of the air and that is why it will start from B.

Now, if I in this figure actually this is the case because the B and maybe B double prime this will be the actual requirement of supply of fuel air ratio using a simple float type carburetor where I have superimposed the different zones of the engine that is by AB, BC and CD. So, if I have a pressure drop p A minus p B and if I try to draw you know variation of fuel air mixture that is fuel air ratio. Then, the you know curve will be like this I mean B B prime because although the air flow air flow will start from point b prime, but because of this three different effects that is what that we that is what we have discussed now the liquid the flow of liquid fuel will start at a later stage and it will start from B and it will follow a curve B and B prime.

And, if it now if I try to superimpose that is what now I have drawn earlier already although I have drawn earlier on that figure if I try to draws if I try to superimpose the curve AB, BC and CD that is the different zones of engine operation, then it is seen that if I try to use a simple float type carburetor for the operation of engine it is not possible that I mean we will supply the constant flow of fuel air ratio that is a very important requirement is cruising zone. So, maybe we will supply the high fuel ratio then which is required during cruising zone so that is unnecessary wastage of fuel.

Not only that from the curve let say B B prime it is seen that if that curve can be shifted may be this curve can be shifted in different like this may be curve can be shifted up to like this, curve can be shifted up to like this. So, this is very important; that means, if a simple float type carburetor is designed if a simple carburetor is at design or it is adjusting for satisfactory operation maybe if I design simple float type carburetor in such a way that it is supplying maybe this is B this is B triple prime and this is B you know rather I can say this is AB, CD this is E and F. So, if it is E and if it is F so, F prime and this is F prime F double prime.

So, if a simple carburettor is adjusted to supply the desired amount of fuel ratio that is required during idling condition then what is seen from the graph that maybe that is the case F the point that the point indicated by F then it is seen from the graph itself that it will supply a fuel air ratio which is even much much larger than what is required pushing zone as well as the power zone. So, there will be a unnecessary wastage of fuel; that means, the fuel economy should not be there.

On the other hand, if we try to if I try to on the other hand I mean if it is adjusting the satisfactory operation on the other hand your simple float type carburetor designed in such a way that it is adjusting the satisfactory operation under high load; satisfactory under operation the high load maybe I have designed in such a way that it will it is like this maybe it is a maybe G and G double prime so, it is G and G double prime.

So, if a simple float type carburettor design such way that it is adjusting satisfactory operation under high load condition maybe by G prime then the mixture at the idling would be hot pulling. So, the mixture so, will be so, I can write that if a simple float type is a simple float type carburetor is designed in such way that it is adjusting for the other the that I mean it adjust the satisfactory operation during power zone that is by the point G prime maybe it will it one be the good design which is required during idling condition; that means, the mixture during idling would be you know would be hot pulling.

On the other hand if the carburetor is designed for the satisfactory operation during idling condition that is what can be seen from the point F that is indicated point F it would be a good design which is required for the crushing and the power zone. So, that means, a simple float type using a simple float type carburetor, it is very difficult to supplying varying load of failure ratio that is required during variant you know during different zones of operation. That is why nowadays simple carburetor is not used rather it is now obsolete and we need to design a carburetor modern carburetor and there will be a few objectives of when you are designing a modern carburetor and that part we will discuss in the next class. With this I stop here today and we will continue this in the next class.

Thank you very much.