Engineering Thermodynamics
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Module 07
Lecture No 45
Analysis of Diesel Cycle

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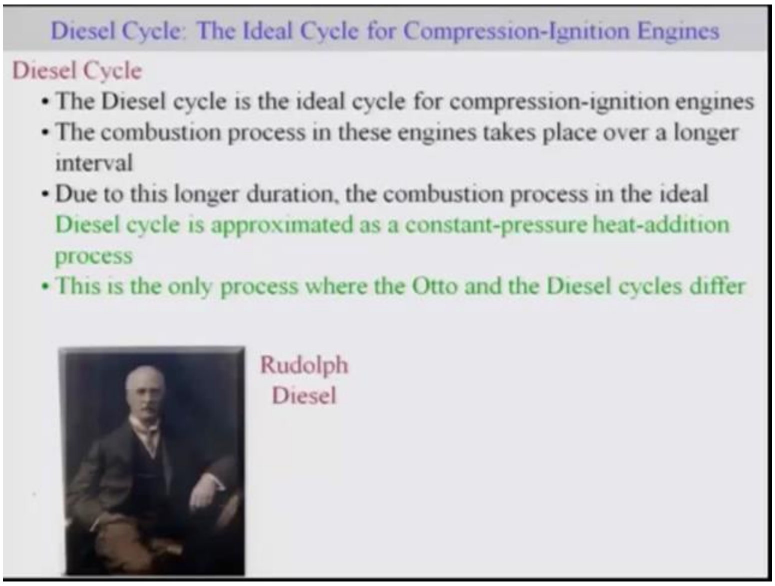

Hi, so what we have done in the last lecture is to describe the ideal otto cycle and particularly making use of air standard assumption. We will continue our discussion on gas power cycle which now we are going to describe the diesel cycle. So diesel cycle is nothing but the ideal cycle for compression ignition engine okay. In this particular engine, the combustion takes over a long period of time and hence we consider or idealize this combustion process as constant pressure heat transfer to the system or constant pressure combustion compared to the case of spark ignition engine where we considered constant volume, so this is the only difference between the otto cycle and diesel cycle.

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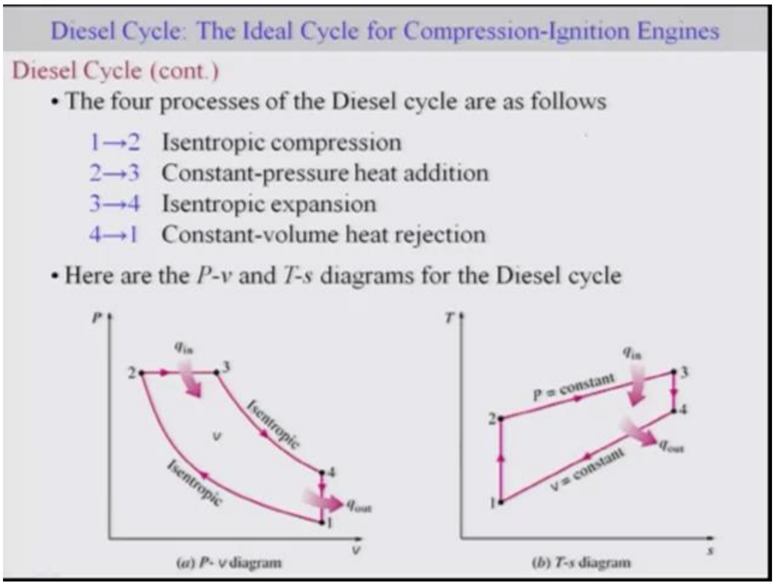

The diesel cycle the combustion or the heat transferred to the system is at constant pressure on the other hand, for otto cycle it is at constant volume. Okay so let us let me just describe the 4 processes of the diesel cycle. So as I said, for the case of otto cycle, you have this kind of process okay. On the other hand, the for the case of diesel cycle, the 1, 2 and 3, which is our heat in is now at constant pressure so this has been shifted this changes from constant volume to constant pressure. So 1 and 2 is still the isentropic compression and 2 or 3 is your constant pressure heat addition instead of constant volume heat addition as was in otto cycle and 3 and 4 is your isentropic expansion and 4 and 1 is constant volume heat rejection, okay.

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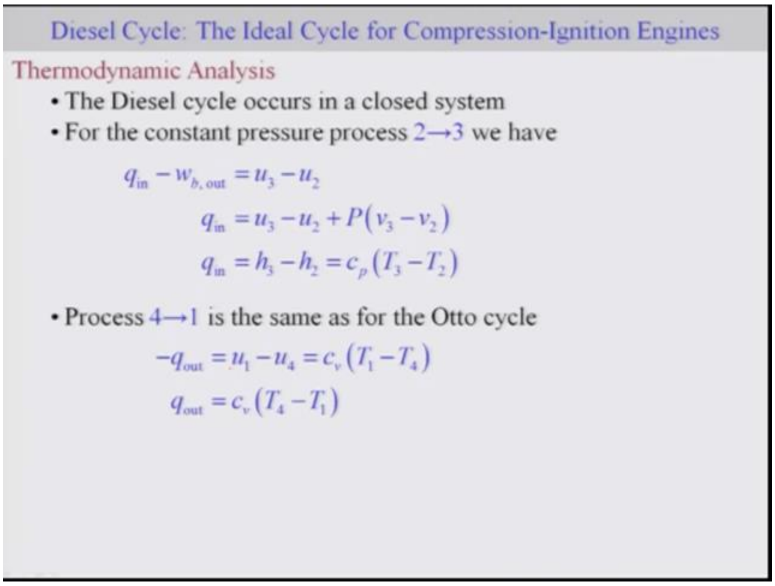

The corresponding TS diagram is as following okay, so 1 and 2 is of course isentropic, this is a constant pressure and then this is your isentropic expansion and this is your constant volume heat rejection. So of course, this means that the volume is going to change during this process 2 and 3, so the energy balance will also include the boundary work and thus for the case of 2 and 3, the energy balance would yield this. So earlier, for the otto cycle we simple used Q in is = change in internal energy and then we replaced the change in internal energy by CV Delta T.

But in this case, boundary work is involved and hence your PV work is included and which essentially means that Q in can be simply written in terms of change in enthalpy. And considering air standard assumption, you can simply replace delta H as CP delta T okay, but for the case of 4-1 there is no boundary work okay because this is at a constant volume which is same as a otto cycle and thus your Q out is simply CV delta as was in the case of otto cycle.

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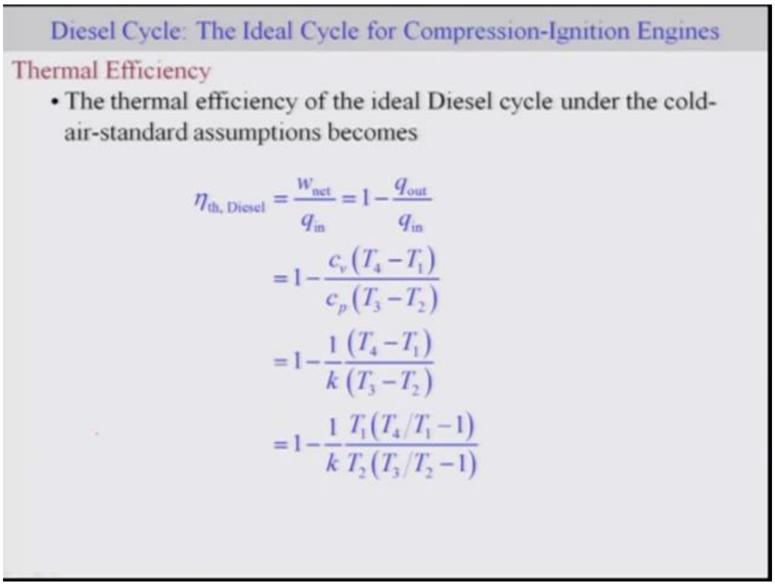

Now your thermal efficiency there, expressions by definition is the same for the case of diesel, so this is your W net by Q in or 1 - Q out by Q in. Q out now includes the same heat rejection is same as in the case of the otto cycle, but heat relation is that now written in terms of CP T3 - T2, which essentially means that now you have to include K also because CP by K, CV is K and thus this expression is little more complicated compared to your otto cycle.

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But you can compare it with otto by first defining cut off ratio RC, which is the ratio of the cylinder volume after and before the combustion process, so this is going to be V3 by V2, so if you go back your combustion process occurring here so the ratio RC is defined as the volume at V3 divided by volume at V2.

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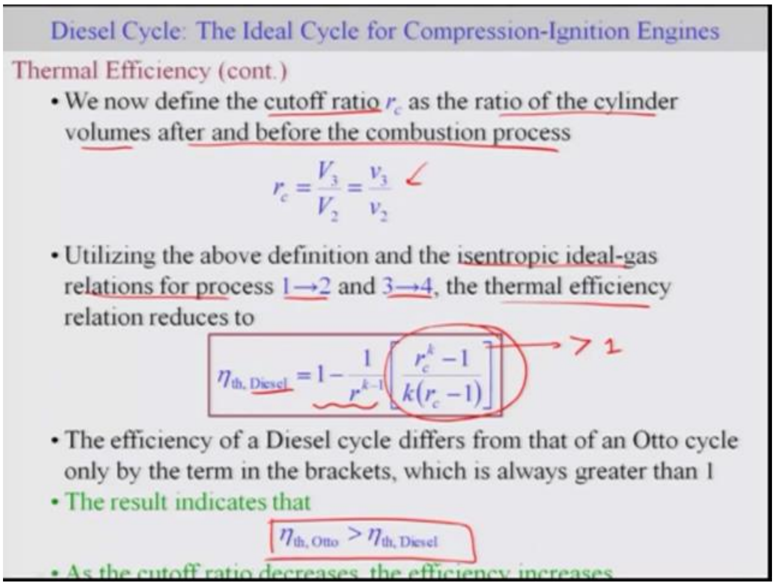

So if you make you make use of this RC just to define it little different from that of otto cycle, we can utilize this definition and the previous expression as well as the isentropic ideal gas relation for the 1, 2 and 3, 4 and we can come up with this relation for thermal efficiency for the diesel engines. And you can see that you have this term which is same as that of your otto cycle. In addition you have this term also, so that means your efficiency of diesel engines differs from that of an otto cycle by only this term which is in the bracket and this is, it turns out to be always greater than 1, which essentially means that your otto cycle efficiency is usually greater than diesel. As we decrease the cut off ratio, the efficiency increases okay and we can consider the limited case when RC tends to 1, the eta diesel tends towards the efficiency of otto cycle.

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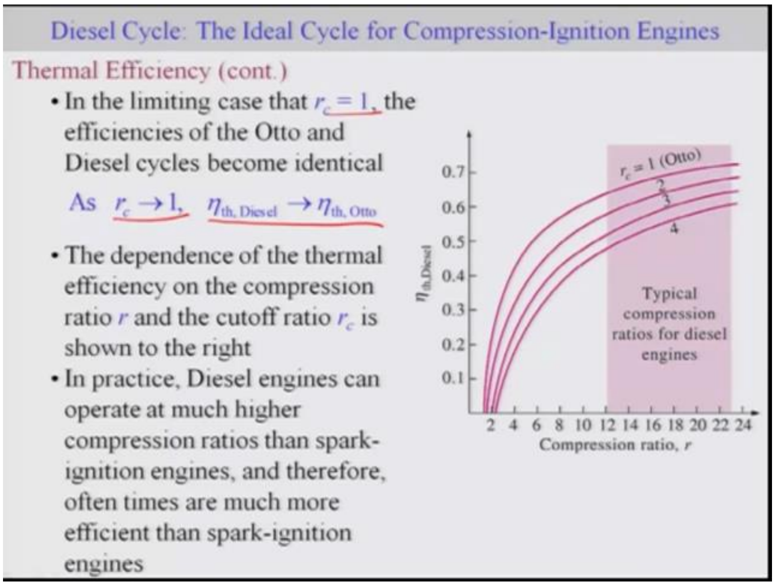

The typical compression ratio for diesel is more than that of a otto cycle, it is in the range of 12 to 22 and if you increase the compression, of course the efficiency will be more so in general your efficiency of diesel engine is more than that of a spark ignition engine, okay. You can now make use of this information of the diesel cycle and as well as the air standard assumption and try to solve this problem at leisure okay and hope you can practically understand the energy balances and how to make use of energy balance for different it is internal reversal process which we have involved in diesel cycle.

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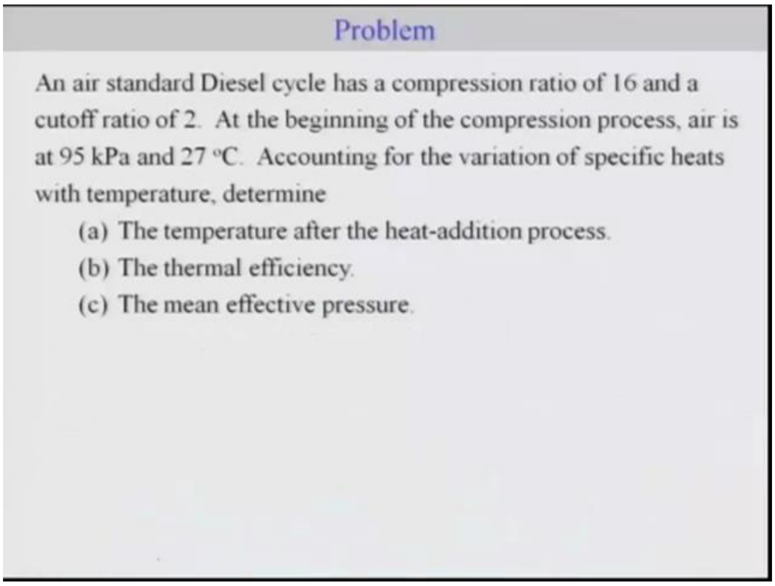

Okay so as I said, you can solve this problem leisure, try to solve the diesel cycle practically.

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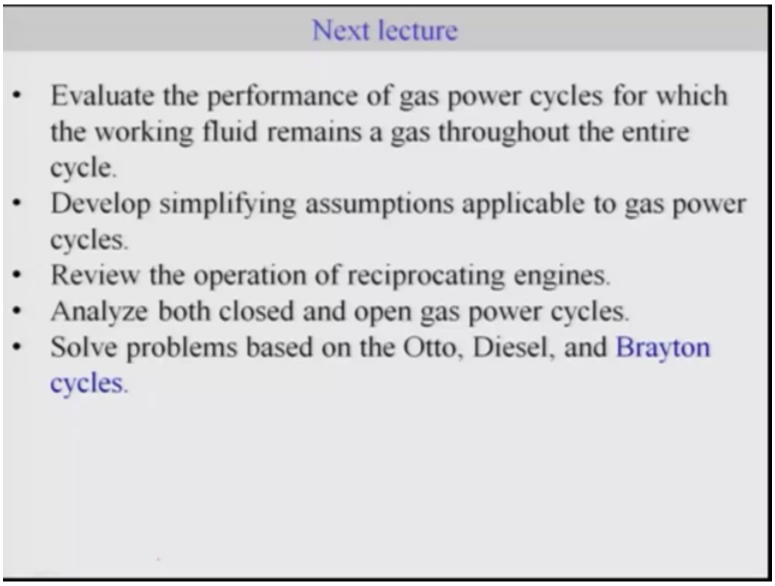

So with this, I will end this lecture and the in the next lecture, we are going to undertake Brayton cycle, okay so I will see you in the next lecture.