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**Lecture – 52**
**Tutorial on compression**

Welcome. After learning about compressor and compression today in this lecture we shall be looking at some problems on the compression.

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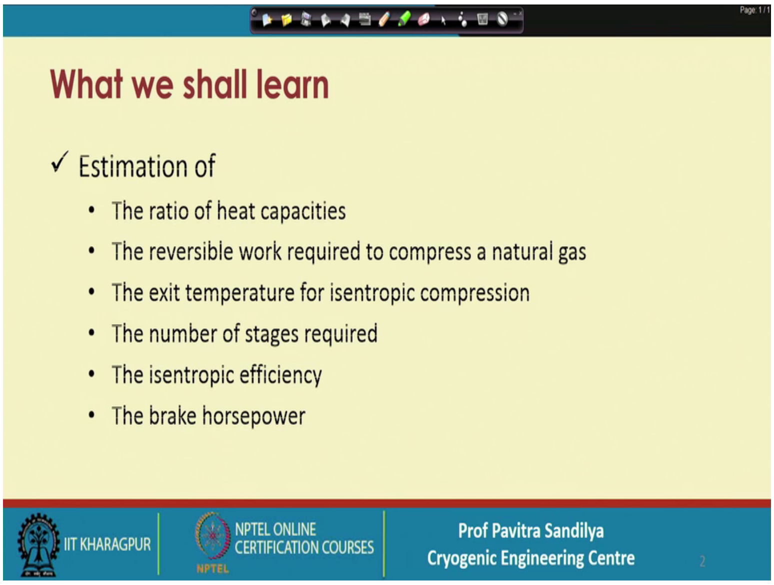


So, in this particular lecture what we shall learn. We shall be running to estimate the ratio of the heat capacities which are necessary for the finding the performance of the compressors. The reversible work required to compress natural gas, exit temperature, for isentropic compression, the number of stages, isentropic efficiency and brake horse power.

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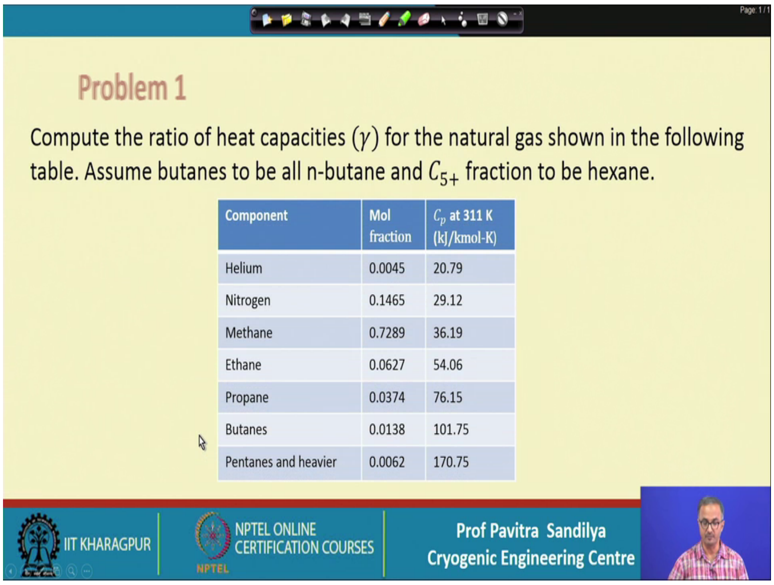


So, first let us see the problem in which we have been asked to find out the ratio of the heat capacities for natural gas shown in the following table. So, here in this particular table, what we find that here are the various components of the natural gas. And here in this column we are given the mole fractions and in this column we are given the specific heat at 311 K of the various components of the natural gas.

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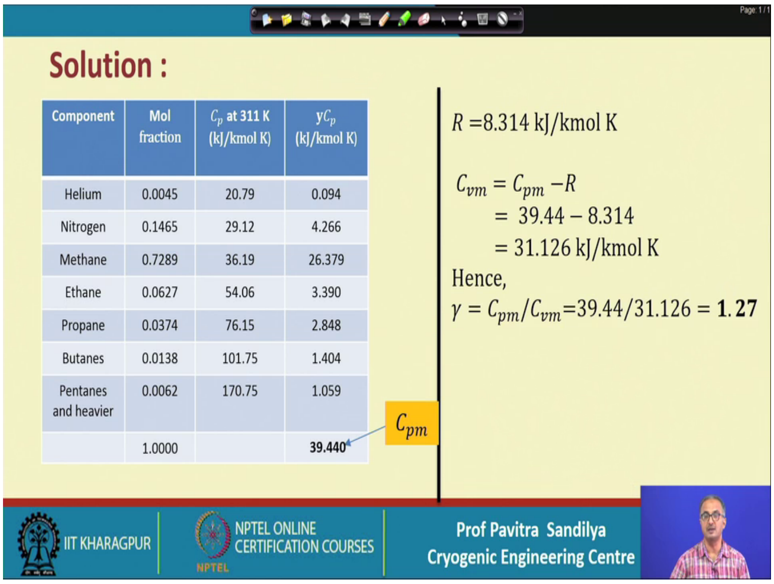


So, do the solution what we do we again put this table but only if the thing what we do that we put another column, in this column we put the product of the mole fraction and the specific heat. So, we do this product and write these products in this particular column and we sum it up. So, this is the summation of this y C p and this is the value of the average specific heat of the mixture. After finding the specific heat value of the mixture then we find out the specific heat value at of the same mixture for a constant volume, this is C p at constant pressure, this is at constant volume.

So, this is found by ideal gas assumption and with subtract the value of the R from the C pm C p value and we get the value of the C v and to find the value of the heat capacity ratio we simply take the ratio of the C p to C v and get the value of the gamma. So, this is a very straight forward problem to find out the specific heat capacity ratio.

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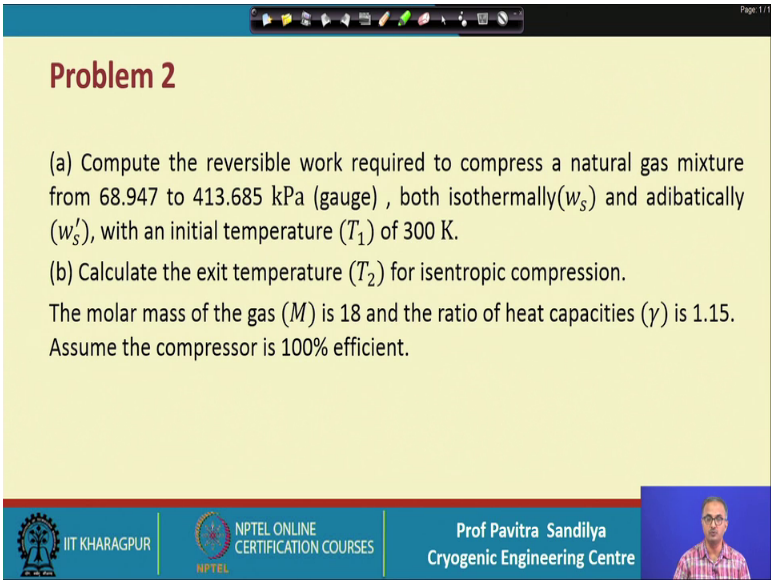


Next we come to a problem, in which we have been asked to compute the reversible work required to compress a natural gas mixture from this to this particular pressure which are given in gauge, both isothermally and adiabatically at an initial temperature of 300 K. And we have also asked to determine the exit temperature for the isentropic compression. It is given the molar mass of the gas as 18 these are this is the ratio of the heat capacity and it is to be assumed that the compressor is 100 percent efficient.

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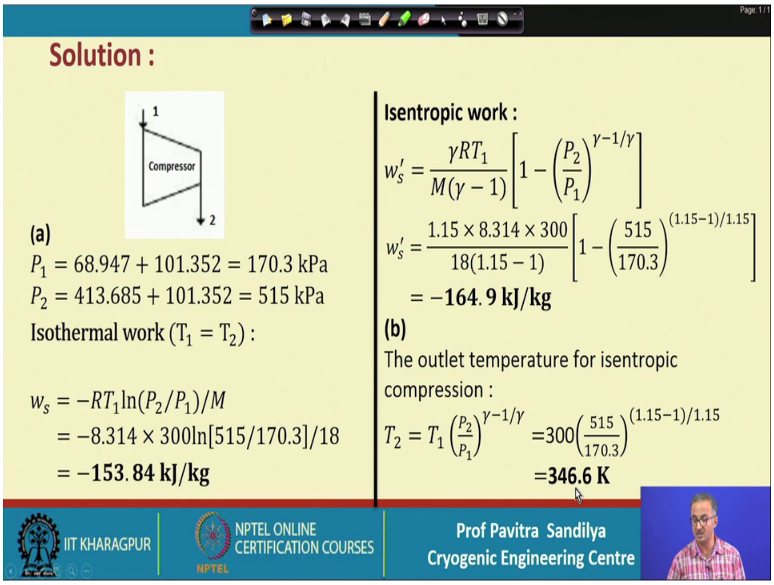


With this now, we see this is a typical compressor this one and two represent the inlet and the outlet of the compressor. So, when I say P 1 that is the pressure at this point inlet. So, P 1 is this is the pressure gauge pressure to this we add the atmospheric pressure we get the absolute pressure and this P 2 we get the with the gauge pressure we at that positive pressure to get the P 2 value.

And with this P 1 P 2 value because it isothermal work. So, T 1 is equal to T 2 and the formula we have studied earlier we get the expression for the work done and for isothermal compression and we this is general or in the numerator is in terms of mole. So, we multiply this divide it by the molecular weight in to get in terms of the mass and this is how we plug in the values of the various variables and get at this value as the isothermal work of compression.

To find the isentropic work compression we use this particular formula for the work and again plug in the values of the various variable given in this particular problem and we get obtain this value as the isentropic work of compression. And we can see here with isentropic work is more than the work of isothermal compression.

And in the next part we have been asked to determine the outlet temperature for isentropic compression and this is the particular formula we saw earlier to find out the outlet temperature again we plug in the values of the various variable in this expression and we get the value of the outlet temperature as 346.6. So, we will find that there is about 47 Kelvin in increase in the temperature due to this particular compression.

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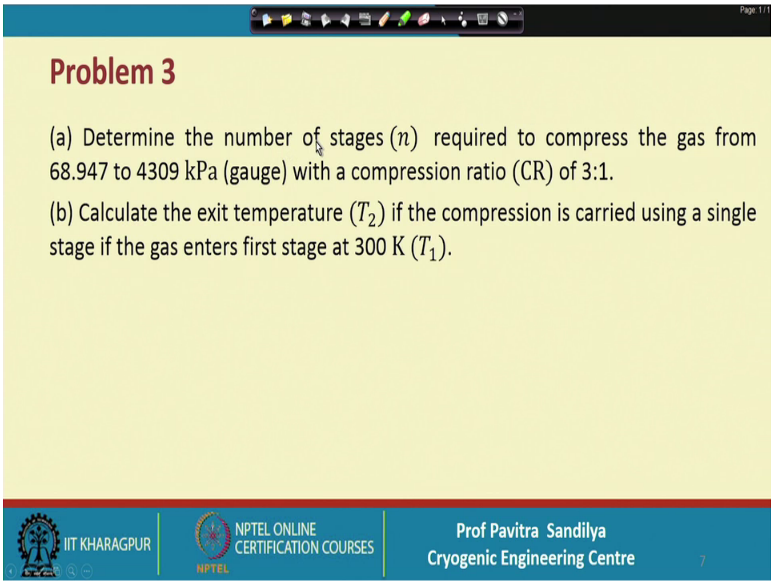


So, in this problem we have been asked to determine the number of stages required to compress a gas from this to this particular pressure in terms of gauge pressure and the compression ratio is given as 3 is to 1. And then next part we have to find out the exit temperature if we carry out the compression using a single stage only and with the same user temperature of the gas.

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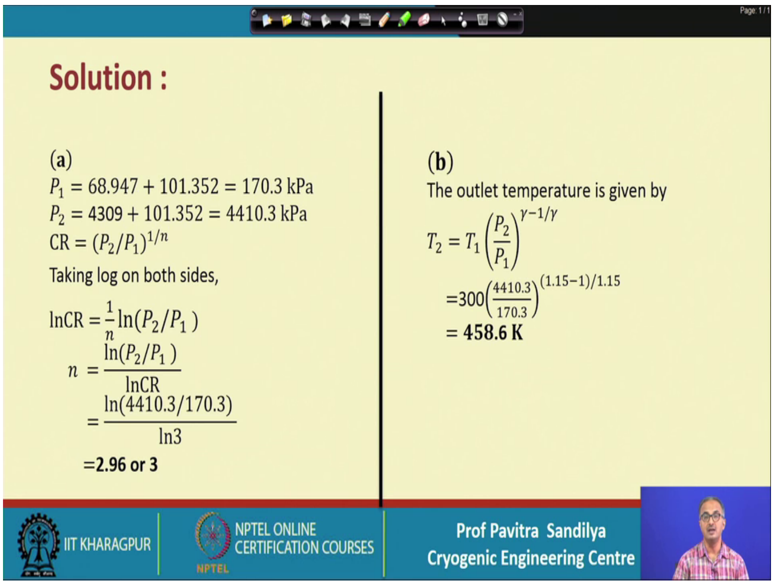

So, for the first part what we do, that we first find out the absolute pressures at the two ends of the compressor like this. And this is the overall value of the pressure increased and from the, this particular formula compression ratio for n number of stages we can just take the log of this particular expression.

So, this is the expression for the number of stages for the overall increase in the pressure and we plug in the values of the various variables to find that that 2.96 number of stages is required. So, we have to take the next higher whole number that is 3. So, we need 3 stages to do carry out this particular compression. And to have an idea that why we need multiple stages and not a single stage. What we do? We have been asked to find out that if we are using a single stage and what would be the temperature rise.

So, for this, what we do with to take the total compression necessary and in this with plug in the values of the inlet temperature and the final pressure and the initial pressure we find that this is the temperature reached. So, what we find? There will be about a rise of about 160 Kelvin temperature if you are using a single stage. So, this is the reason why we are suggested to use multiple stages and not a single stage.

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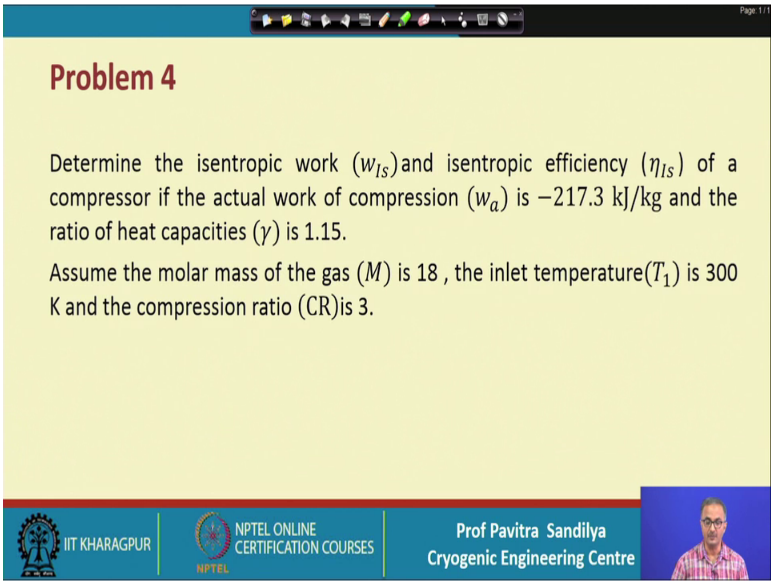


In the next problem we are asked to determine the isentropic work. And the isentropic efficiency of a compressor and if the actual work is given like this and the ratio of the heat capacities is given like this, this is the molecular mass of the particular gas and these are initial temperature and this is the compression ratio.

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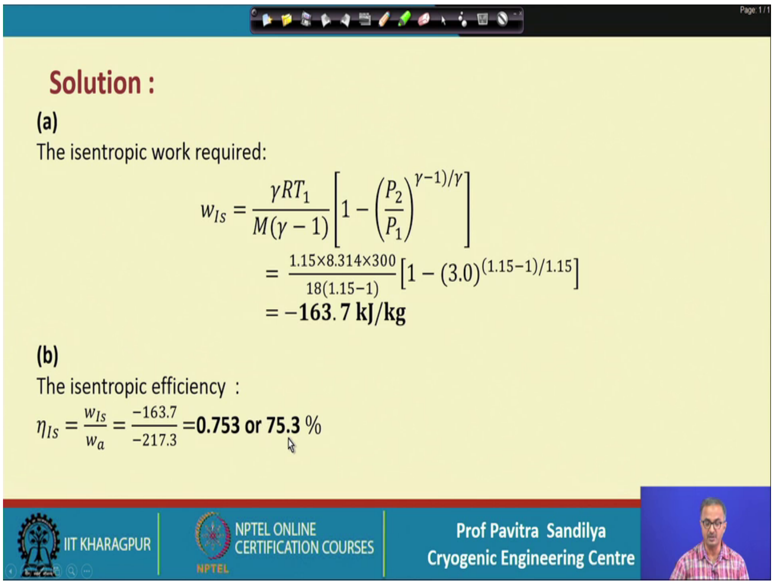


So, with this information we use the expression for the isentropic work and we plug in the values of the various variables in this expression and we will find the value of the isentropic work. Now, for the isentropic efficiency what we do? We take the ratio of the isentropic work to the actual work and we find this is coming about 75.3 percent isentropic efficiency.

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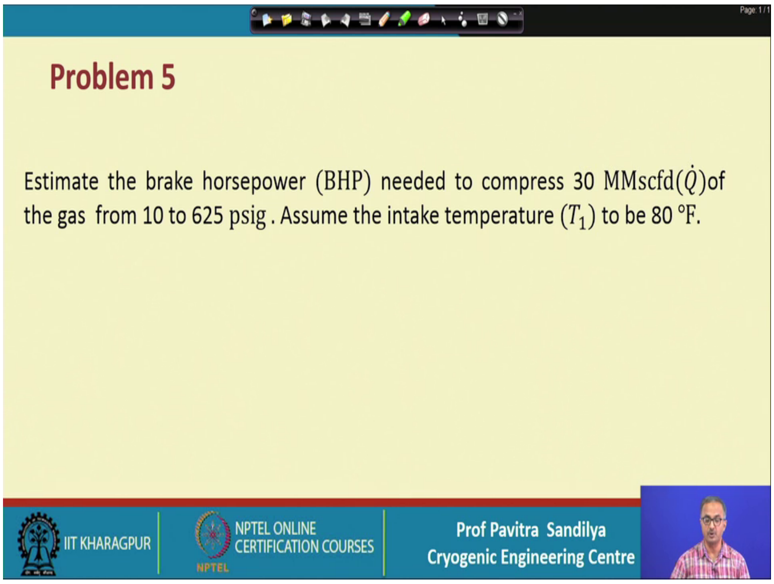

In the next problem what we do? We have to find out the brake horsepower needed to compress this much amount of a gas from 10 to 625 psig and the intake temperature is 80 degree Fahrenheit.

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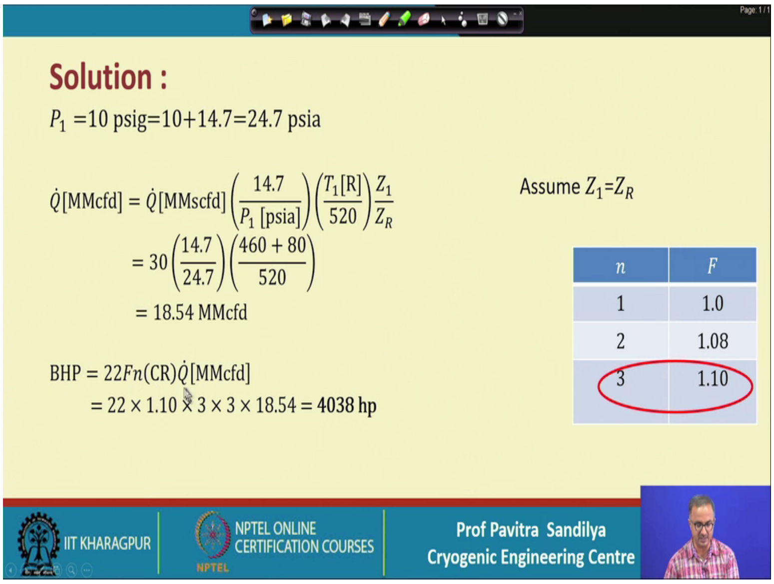


So, for this we use we first again convert the gauge pressure to the absolute pressure by adding ambient pressure that is 14.7. And what we do? This is the expression we learnt earlier to find out the actual flow rate and this is the standard product it is given the actual product of the gas. So, in this case this 14.7 and 250 represent the standard conditions and we assume in this the Z 1 is equal to Z R.

So, assuming this Z o1ne equal to Z R we put these values here this temperature is in Rankin. So, we add 460 to the Fahrenheit to Rankin temperature and this is the value of the actual flow rate of the gas, actual volumetric flow rate of the gas. With the actual volumetric flow rate now we put the this expression of for the BHP that brake horsepower and we find that this particular table we find that for different values of the stages we are given the different values of the F.

So, for this 3 stages we get the value of the F as 1.10, which we plug in here n we take as 3, CR is also given as 3, Q this is taken from this expression and then we find that this is the value of the horsepower brake horsepower of the particular compression.

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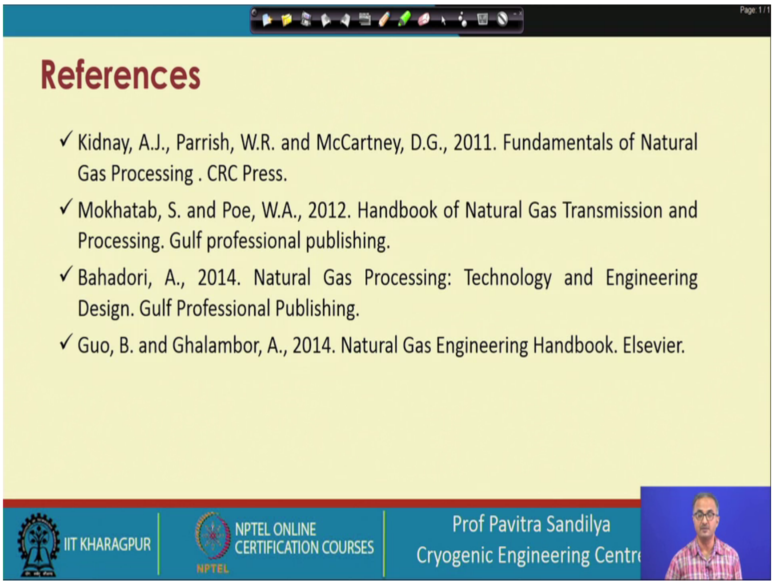


And these are the various references which you can refer for the details of this kind of calculations.

Thank you.