Fundamentals of Gas Dynamics
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Week – 01
Lecture – 03
Tutorial 1

We will do two problems with the topics which we have discussed in the last class. So, this is going to be very short tutorial.

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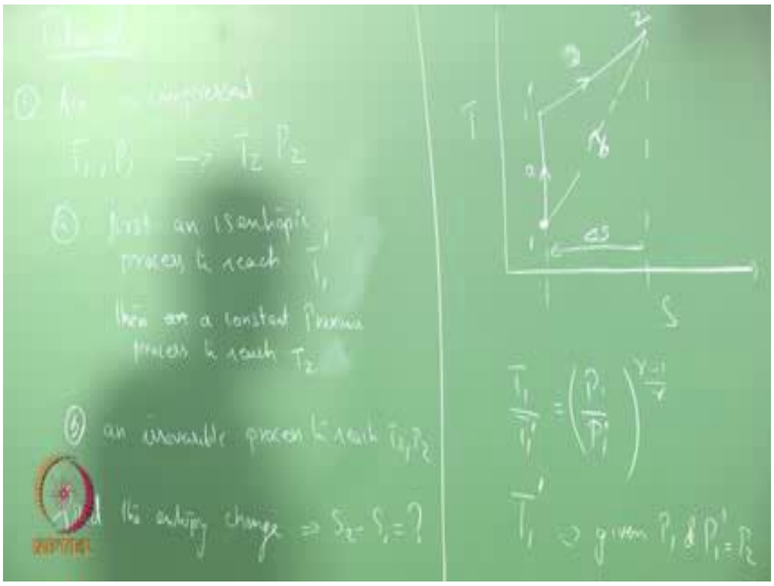

We will try to see what property changes that happen, what are the kinds of property changes that happens in a fluid that undergoes some process with the very specific process that we have discussed in the last class. So, the first question is say, a fluid let us take air is compressed and you know the T 1 and P 1 and you also know the T 2 and P 2.

So, it takes two paths - one is, first an isentropic process to reach an intermediate state T 1 prime and P 1 prime then constant pressure process to reach T 2 and P 2. B, an irreversible process to reach T 2 and P 2, how do we go about doing this? So, an isentropic process to reach say T 1 and then a constant process to reach P 2, so obviously, this process should have reached P 2 here and with constant pressure it will reach P 2, fine. So, there is two rise of reaching the state two. So, let us drop this process in (Refer Time: 03:20) diagram first. So, any problem like this should be attempted with PV diagram or a T-s diagram, drawn and process clearly understood.

T, S, so let us take the process A. So, from point 1 it goes to an intermediate state and isentropic process which means the entropy is constant, entropy does not change. So, this is your 1 dash and then you have a constant pressure process to reach 2. So, the question is - find the entropy change essentially it comprise S 2 minus S 1? Find S 2 minus S 1 or delta S of the process. So, this is my delta S. So, this is process a, process b is an irreversible process which goes here that is your b. How do we do this? It is a constant isentropic process; so we know the relations, what are the relations? T 1 by T 1 dash equals P 1 by P 1 dash to the power gamma minus 1 by gamma. So, you will get T 1.

So, for a given P 1 and T 1 dash this is also a P 2 because after that it is an isentropic process, so P 1 dash is same as P 2 for a given gas here we have taken air so the gamma is 1.4. So, you could find T 1 dash. So, once you know T 1 dash. So, these two quantities have given.

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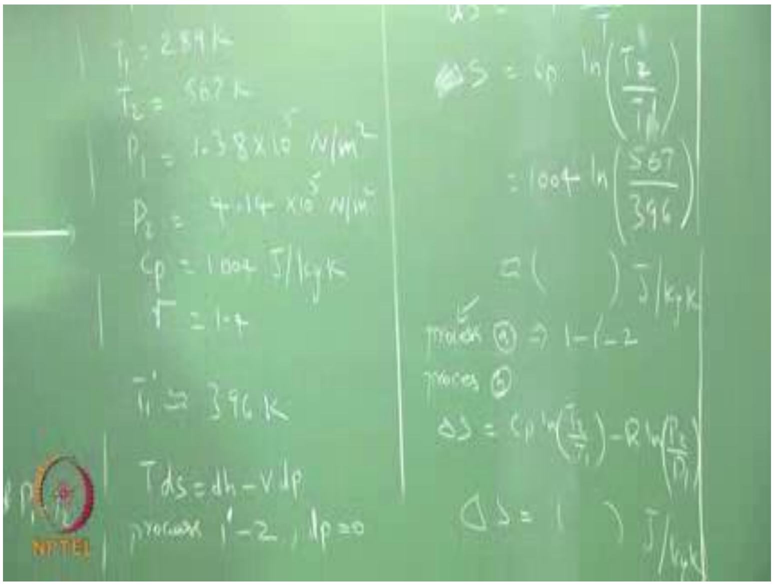

So T 1, P 1, T 2, P 2 is given quantities. So, let us take some numerical value, what I have here is T 1 is 289 Kelvin, T 2 is 567 Kelvin, P 1 is 1.38 into 10 power 5 Newton per meter square, P 2 is 4.14 into 10 power 5 Newton power meter square and your C p is 1.004 Joule per kg Kelvin and you can take gamma to be 1.4.

For these numerical values you could actually find T 1. So, T 1 is going to be T 1 dash is approximately for these values, T 1 dash is approximately 396 Kelvin and you could use the equation T ds equals d h minus v dp. So, the process 1 prime to 2 you are dp is 0. So, your ds is C p dT by T or your delta S is C p ln given by T 2 or T 1 prime by T 2 prime. You could get the value to be (Refer Time: 08:52) this T 2 by T 1 prime. So, if this is 1.004 or ln T 2 is, T 2 is what? 567 by T 2 prime is 396 Kelvin. So, it is going to be approximately something, you could evaluate that. So, it is going to be joule per kg Kelvin.

This is for your process a which is from point 1 to state 1 prime to state 2 for irreversible process you could use the equation that we had learnt C p ln T 2 by T 1 minus R ln T 2 by T 1. T 2 is known, P 2 is known, is this. Find your delta S, so if these has these two process gives you essentially the same value because entropy is a point function, entropy is a property you are going to get the difference between these two processes, the entropy change that is occurring in these two process are going to be the same.

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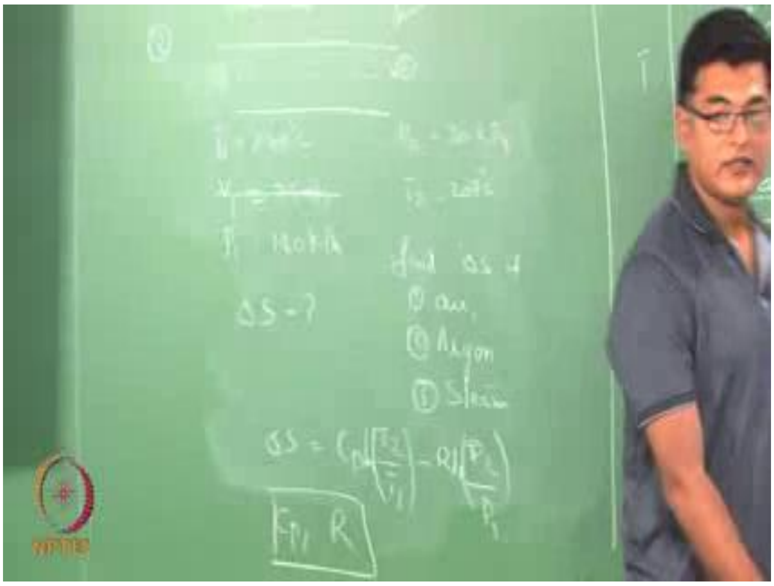

Question 2 - I have at that. So, the fluid goes form state 1 to state 2, your P 1 has 260 degree Celsius, v 1 has 75 meters per second, P 1 has 140 kilo Pascal, P 2 is 30 kilo Pascal and T 2 is 207 degree Celsius.

Let us forget about the velocity for the time being. Find say delta S? So, it is essentially evaluation of this equation; find delta S if the fluid is air then the example I have here is Argon, 3 - steam. So, it is a very symbol substitution. So, you have two quantities P 1, T 1 - the pressure and temperature are two states. So, some process that is happening between state 1 and 2, you have that pressure and temperature here. Use the relation that we had just now written C p T 2 minus T 1 minus R P 2 by P 1 ln.

The only difference here is the fluids. So, only difference here is the value of C p and R. Now the universal gas constant from universal gas constant finds the universal gas constant 8.314 kilo Joule per Kelvin. And the molecular mass of air, molecular mass of argon, molecular mass of steam, if you know this you can find R and substitute R here.

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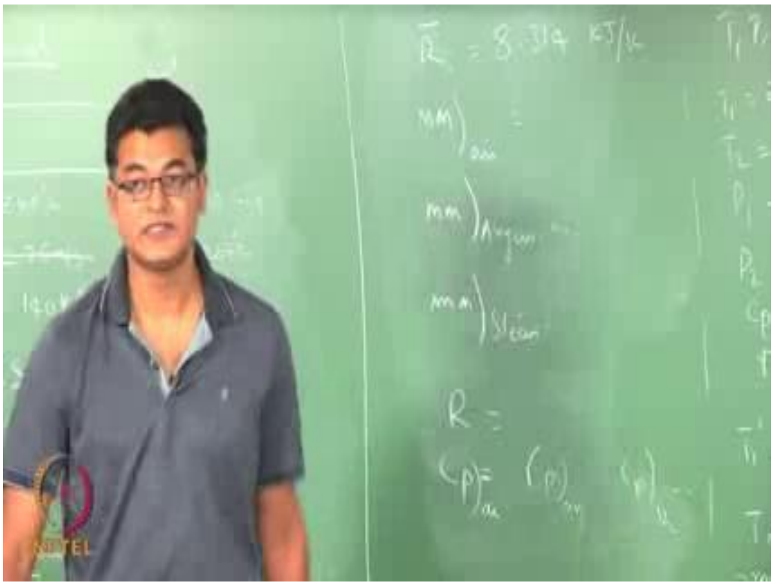

If you know R, then C p value is of air, C p values of argon, C p value of steam, you should get the entropy change essentially. So, it is a symbol substitution. The tutorial for this week would be based on.