Concepts of Thermodynamics
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Lecture – 45
Supplementary Lecture: Problem Solving with the Aid of a Computer

Hello everyone and welcome to this session in which we will solve some problems pertaining to entropy by means of the Aid of a Computer.

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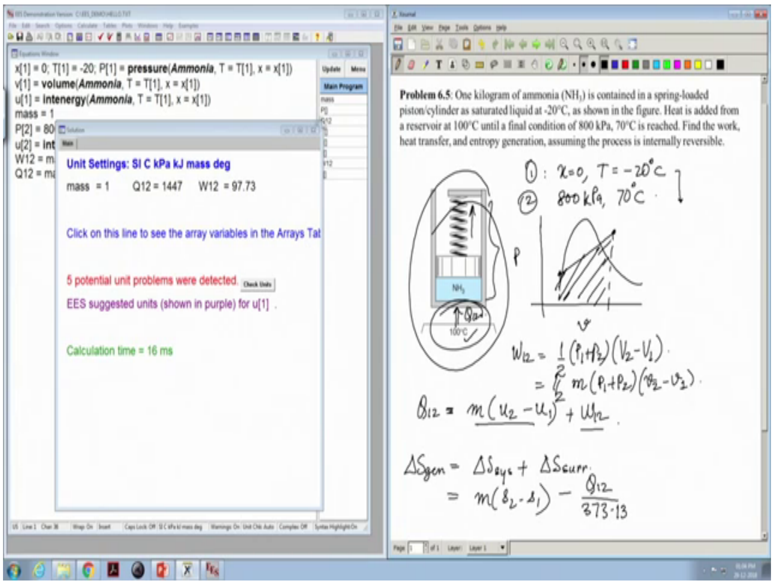

So, in this problem, we have 1 kg of ammonia contained in a spring loaded piston cylinder arrangement as a saturated liquid at 20 degree Celsius. So, the state 1 is x equal to 0 and T equal to minus 20 degree Celsius. Heat is added from reservoir at 100 degree Celsius until the final condition 800 kilo Pascal and 70 degree Celsius is reached.

So, the question is find the work done heat transfer and entropy generation assuming that the process is internally reversible. So, for this particular process going from 1 to 2, there is no entropy generation. The meaning of internal reversible is this. So, how would the process look like it is a spring mass? It is a spring loaded piston cylinder. So, how what do you think the process looks like? The process is a straight line in the P V diagram. So, given this linear characteristics, it is a linear curve. So, going from one state to other state, the work done is rather easy, it is simply the area under the trapezium.

So, work done during 1 to 2 is half P 1 plus P 2 find the total volume minus initial volume. This is also half mass times P 1 plus P 2 times the specific volume difference, all right. So, let us first quickly get that out of the way. So, x 1 is 0, T 1 is equal to minus 20 and P 1 is equal to pressure of ammonia, T equal to T 1 x equal to x 1 and similarly, P 2 is 800 T 2 is 70 and V 2 is volume ammonia T equal to T 2.

And V equal to P 2 we also have V 1 is equal to volume ammonia equal to T 1 and x equal to x 1. And the mass is given as 1. So, the work done simply the mass times half times P 1 plus P 2 multiplied by V 2 minus V 1. So, let us see what that comes out to be?

So, the work done is 97.73 kilo Joule. Let me just fix this window. So, the next question is what is the heat transfer? And so, to find out the heat transfer, we invoke the first law of thermodynamics in which we have the heat transfer to the system is equal to the change in the internal energy. So, here we assume the kinetic energy and potential energy difference in the internal energy are negligible plus the work done by the system.

So, here work is done by the system and there is a change in internal energy. So, let us find out what the heat transfer is. So, well, now we have to define what the user say u 1 equal to, so there we go and similarly u 2 equal to.

So, the amount of heat transfer to the system is 1447 kilo Joule. So, now, we recall that this is the heat transfer to the system. So, the entropy generation is now a contribution from the system and this particular heat transfer.

So, for the system delta S, then I will not repeat the derivation of this because this is obtained by assuming that this is a single control mass. So, this is equal to delta S of the system plus delta S of the surrounding. Delta the system is equal to mass times S 2 minus S 1 because of the very simple fact that entropy is a state function.

And for the surroundings, so if the system receives and I want to heat Q 1 2 the surrounding as lost and I want of it minus Q 1 2. So, this will be minus Q 1 2 divided by the temperature of surroundings which is 100 degree Celsius. That has to be converted to Kelvin so, this will become 373.1.

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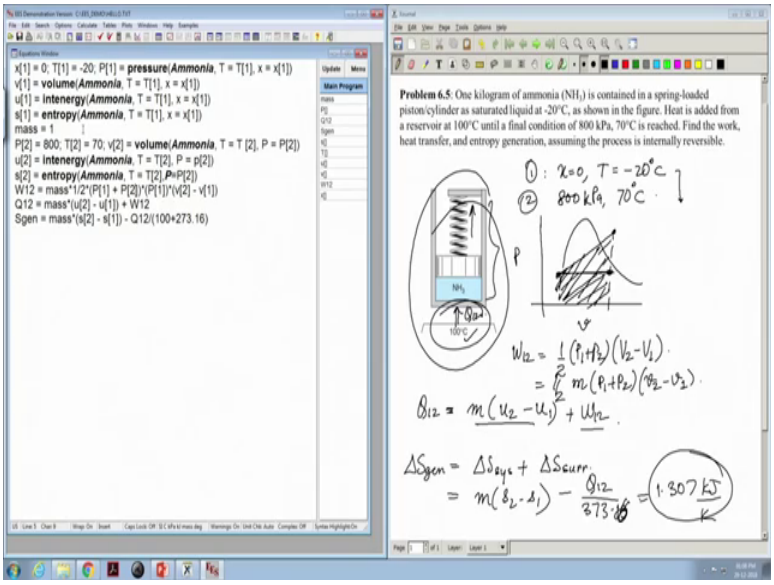

So, then this write down minus Q 1 2 divided by has to be converted to Kelvin. So, let us see what the S gen is. So, we have obviously, forgotten to define the entropy. So, we use the independent quantities T and x to find out the entropy at the first point. After that, we can use the entropy by, we can find out the entropy by using the internal the independent properties temperature and pressure.

I mean, you can also use internal energy. It does not make a difference. Basically, I could have used u equal to u 2 over here, a hardly makes a difference. Alternately, I could have also used V equal to V 2. You need two independent properties to find out the entropy ok. So, let us see ok. So, S gen is 1.307 kilo Joule per Kelvin ok. In fact, let us see what happens if the work done, I mean somehow the spring does not do that much amount of work, does it create more entropy, does it lead to less entropy, what happens?

So, let us say it is simply P 1 times delta V, just hypothetics. So, S gen has increased slightly. So, if the process were to go on, I mean it would not go on, but I leave it as a small task to you. So, if this spring were not there do find out what the final state will be the pressure will be constant and then find out the change in entropy. And see whether it is larger or smaller than 1.307 and then try to draw some try to assess what is going on ok.

So, with this, we finished this particular problem. It was a rather straightforward problem in which we recall some of our old concepts where the linear spring leads to a process which is a straight line in the P V diagram. Here, we do not need to really evaluate the slope because both the points are known and you simply join it by a straight line. Once the work is known, the heat transfer was determined using the first law.

And then, the second law was invoked to find out the entropy generated. We have made use of the concept that to find out the S gen for the whole process, you can consider the whole system the surrounding to be the control mass. In that case, the delta S is also the entropy generation and that is founded using whatever is shown on the screen over here. So, with this, we conclude this particular session and I will be back next time with another problem.

Thank you.