Chemical Engineering Thermodynamics
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Lec_06
Driving force for the matter flow

So welcome back, so in the last class we talked about the definition of the temperature and pressure and how the definition which relates is entropy to the other variables, which appears to be abstracts, fulfils the observation which we know about the pressure and temperature okay and also be related to the temperature difference to the heat flow, pressure difference to the volume flow okay.

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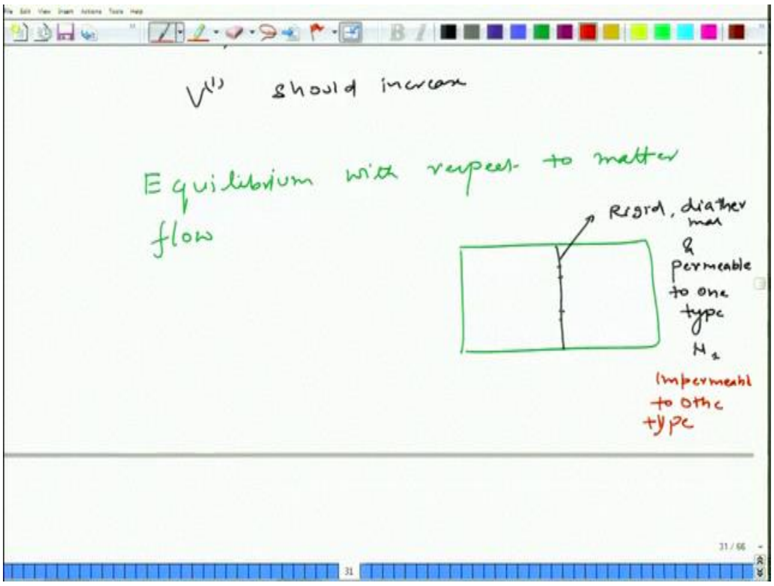

Now our focus on the equilibrium with respect to the matter flow would okay, now what we are interested is the flow of matter, let say from one compartment to the another compartment by considering, let say rigid here, partition, but diathermal and as well as permeable, so they are basically (())(1:42) in nature, which allows particle to exchange from one compartment to another compartment, so what we are going to consider is permeable to one type, let say of N1 okay.

So, this particular partition allows only one types of species but for other species is in permeable so that is the assumption which we are having here. Now the reason why we are considering this because the matter flow will provide insight to the chemical potential which we have considered in our basic thermodynamic functions for entropy or internal energy okay.

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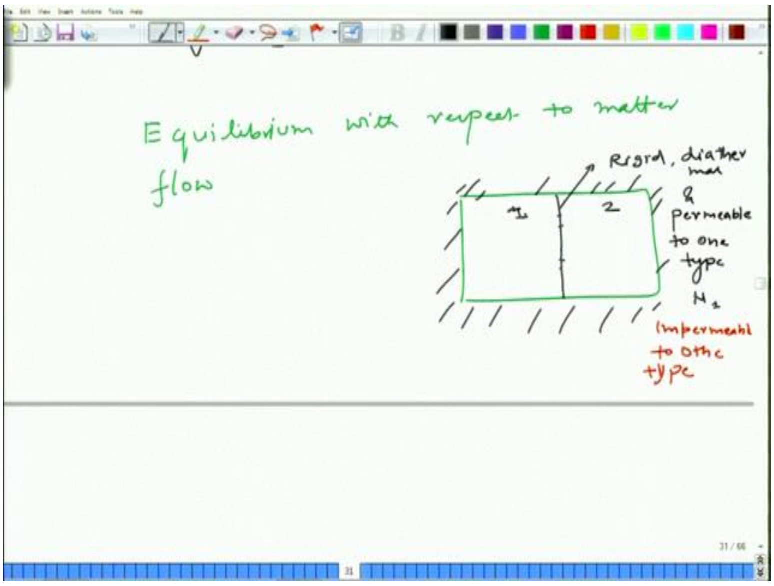

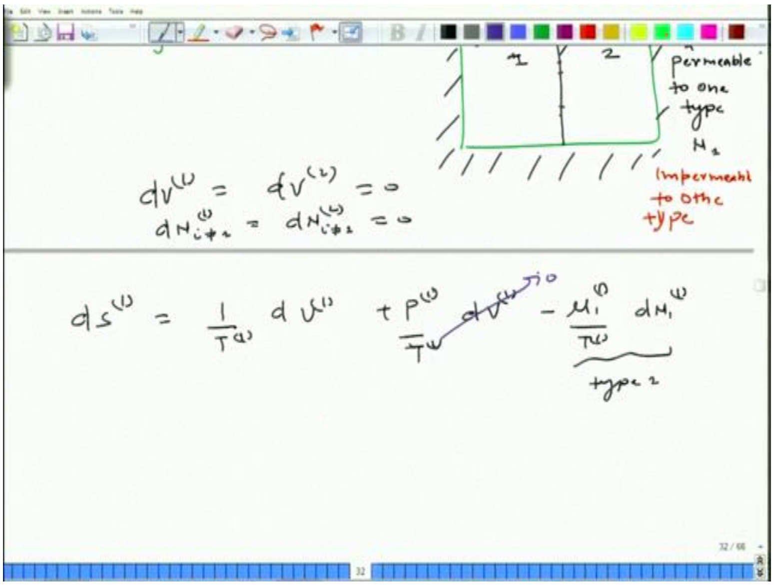

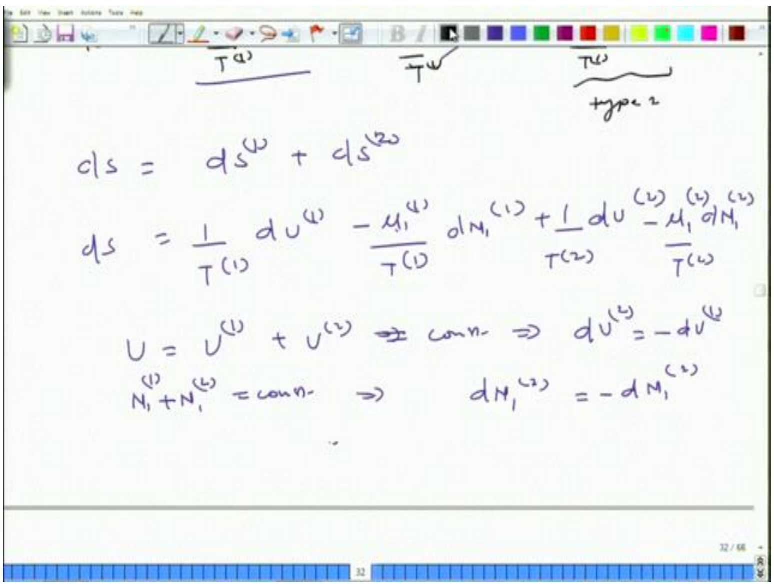

So, let me write down the basic equations here, but before that, since we are going to apply the entropy in maximum criteria, we have to make sure this is so isolated completely, so you have compartment 1 and this is 2 okay, so let us write down the basic entropy in terms of differential values or differential terms, so considering that this is rigid, this two compartment, your DV 1 is 0, as well as DV 2, so with that the terms which are going to be relevant was, I can write down this terms. Okay.

Since it is impermeable to other type that means the moles of all other species in compartment 1 or 2 is going to be 0. So this term is only for type 1 species. Similarly, I can write for second compartment, now considering this to be 0 DS 1 is going to be only this plus this term, so we can write DS as DS 1 plus DS 2. And, now I can simplify this as a writing the expression for DS 2 to here and directly putting the expression in this final expression. Okay.

$$dS = \left(\frac{1}{T^{(1)}} - \frac{1}{T^{(2)}}\right) dU^{(1)} - \left(\frac{\mu_1^{(1)}}{T^{(1)}} - \frac{\mu_1^{(2)}}{T^{(2)}}\right) dN_1{}^{(1)}$$

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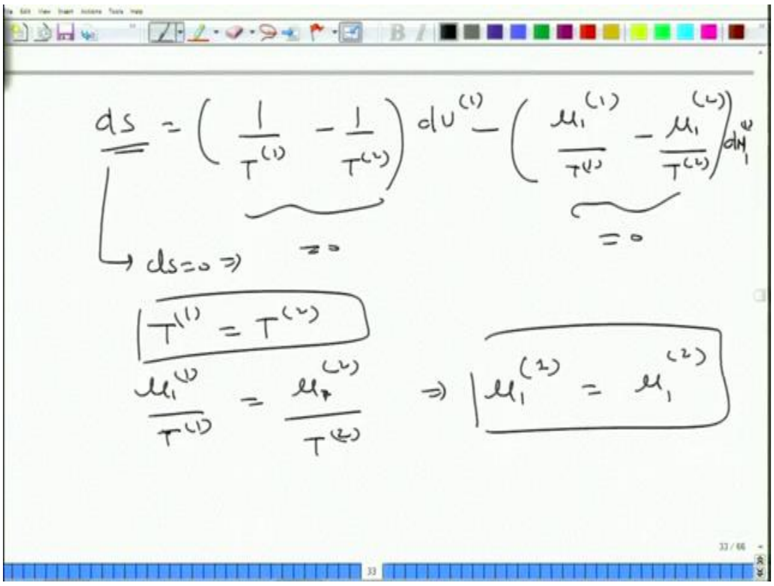
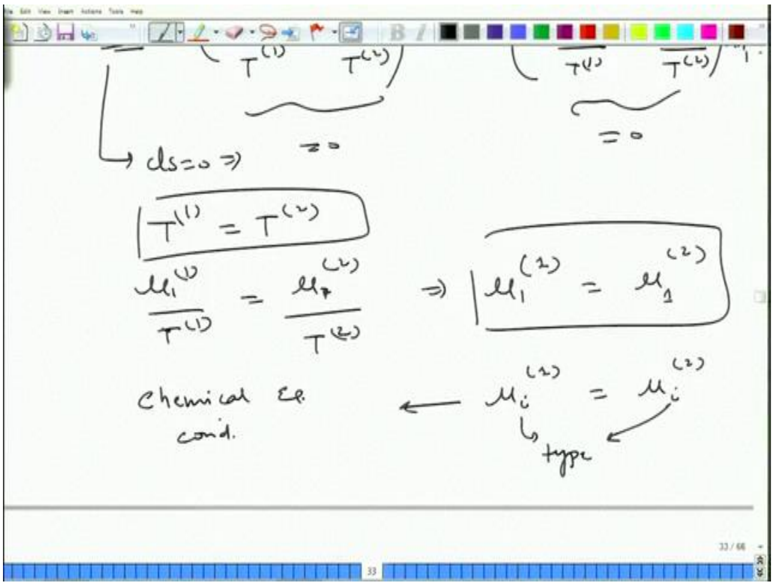


$$T^{(1)} = T^{(2)}$$

$$\frac{\mu_1^{(1)}}{T^{(1)}} = \frac{\mu_1^{(2)}}{T^{(2)}}$$

$$\mu_1^{(1)} = \mu_1^{(2)}$$



So this essentially means that mu 1 chemical potential of type I in 1, will be same as chemical potential of type I in compartment 2. Okay, now note that we have allowed only one particular species to move, what if, if all of this species were moving okay, so essentially can extract these, that if all of them are permeable, then you final compartment will have some chemical potential.

So let me refresh I have again, this is for only one particular species which can pass through the partition, if you have more than one, for example, this extension, this particular definition can be extended to a arbitrary value of type I in compartment 1 should be same as that particular type i in compartment, so for any arbitrary value I or specific species of type I okay, is they can move back and forth through the partition, then the chemical potential in the compartment 1 should be same as chemical potential of that same type in compartment 2, so this is nothing but a chemical equilibrium condition.

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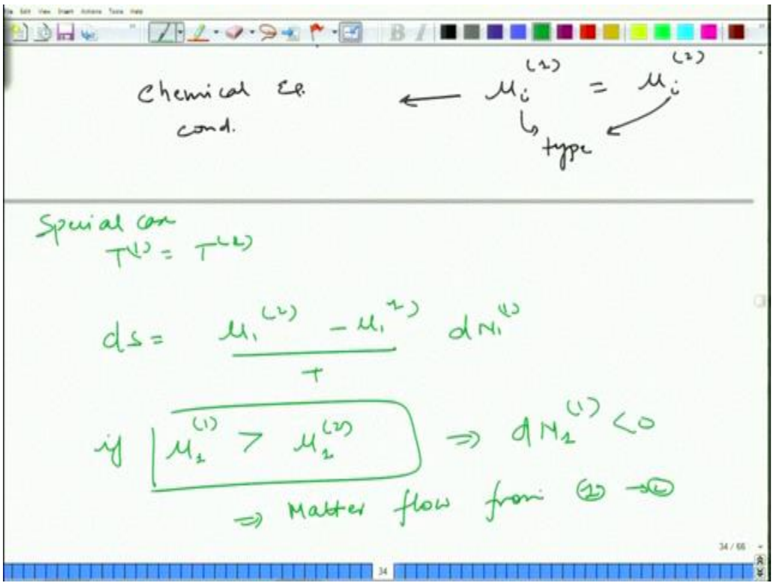

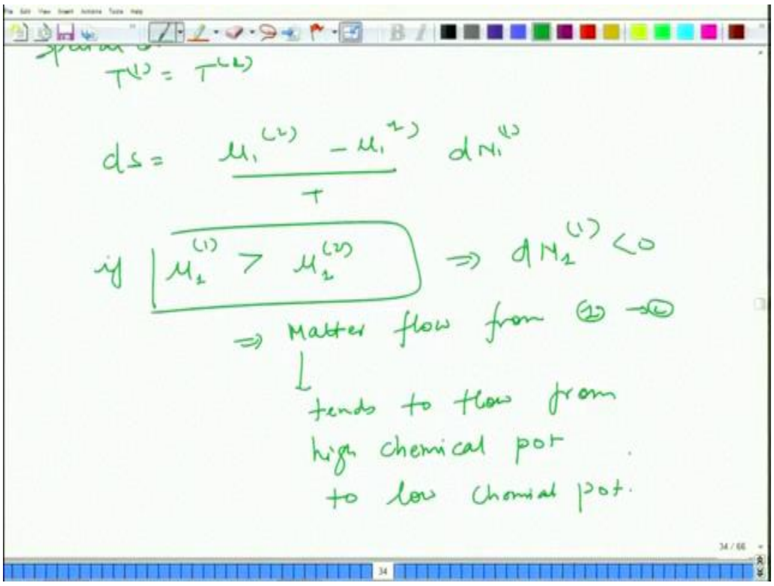

Now you can relate this, this is the condition for a chemical equilibrium, so assuming again, the same way as we have done for the pressure, let us assume that you have considered constant temperature system in both the compartment, in that case your this term is going to be 0. Okay, so only the DS can be related to the difference in new by T, I can write this expression again as assuming that T1 is T2 condition special case.

$$dS = \left(\frac{\mu_1^{(2)} - \mu_1^{(1)}}{T}\right) dN_1{}^{(1)}$$

If chemical potential in compartment 1 is greater than chemical potential of compartment 2, what would be the direction of the flow or of particular matter, that means which compartment will allow the particles to move from itself to another compartment and there something which we can consider based on this.

So if this is the case which is essentially means this is going to be negative, since DS is going to be positive, which essentially means DN 1 is going to be negative. So in this case, matter flow from 1 to 2 or in other word matter flow, so matter tends to flow from high chemical potential to low chemical potential, so that is something which we wanted to discuss here, we have beautifully connected the thermodynamic definition our intuitions to thermal equilibrium, heat flow, pressure equilibrium, volume flow and chemical equilibrium to the matter flow. So with this will stop at this junction and will take up a new topic in the next lecture okay, have a good day.