

Température, pression, potentiel chimique

[illegible]

Systèmes homogène, uniforme, simple



- Système homogène :

Fonctions d'état scalaires intensives identiques (valeur) pour tout sous-système.

- Système uniforme :

Fonctions d'état vectorielles intensives identiques (norme et orientation) pour tout sous-système.

- Système simple :

Etat défini par une seule variable d'état extensive entropie S « globale ».

Thermodynamique

Hello and welcome to make fun of thermodynamics. This lesson is devoted to the following magnitudes temperature, pressure and chemical potential. First, we will define different types of systems a homogeneous system, a uniform system and a simple system. In a second step, we will characterize extensive quantities. These quantities are entropy, volume and quantity of matter. Then, we will characterize the intensive quantities which are the quantities conjugated to the extensive quantities that we have just characterized. These quantities are the temperature, the pressure and the chemical potential and we will end by defining the stationary state of a system. A system is said to be homogeneous if the intensive scalar state functions that characterize it are identical for all subsystems, i.e. they have the same value. This is true for any subsystem, regardless of its size. This is true in every respect. Secondly, a system is said to be uniform if the intensive vector state functions that characterize it are identical for all subsystems, i.e. they have the same standard and the same orientation for all subsystems. So it's true in every way. And finally, a system is said to be simple if the state of this system is defined by a single extensive state variable which is entropy s . And this variable is defined globally.

Notes

Summary



0m 05s

Entropie, volume, quantité de substance



- Système simple :
 - Variables d'état scalaires extensives :
$$\{X_0, X_1, \dots, X_{r+1}\}$$
 - Entropie :
$$S \equiv X_0$$
 - Volume :
$$V \equiv X_1$$
 - Quantité de substance A (nombre de moles) :
$$N_A \equiv X_{A+1} \quad \text{où } A = 1, \dots, r$$

Thermodynamique

We will now characterize a simple system. the state of a simple system is defined by a set of state variables. We consider that this simple system is in a reference frame or if its center of mass is at rest, and there is no rotational motion and therefore the scalar state variables and extensives that characterize this system are internal variables. According to the convention we have chosen, these variables are. X_0, X_1 etc. up to x_{r+1} plus one. A simple system is characterized by the fact that there is only one entropy variable for this system, so the first variable x_0 . We will identify it with the entropy S and the system necessarily has a certain volume. Therefore, the second variable x_1 we will identify it with the volume V and finally, the simple system is made up of r chemical substances that we will denote by the index A which can vary between one and r . And for each chemical substance, we will need to specify the amount of substance in the system. And so we will take as a state variable the number of moles of the substance in question. Therefore, the state variable x_{A+1} has plus one. We will identify it with the number of moles n_A of the substance a .

Notes

Summary



1m 51s



- Système simple :

- Fonctions d'état scalaires intensives :

$$\{Y_0, Y_1, \dots, Y_{r+1}\}$$

- Température : $T \equiv Y_0$

$$T(S, V, N_1, \dots, N_r) \equiv \frac{\partial U(S, V, N_1, \dots, N_r)}{\partial S}$$

- Pression : $p \equiv -Y_1$

$$p(S, V, N_1, \dots, N_r) \equiv - \frac{\partial U(S, V, N_1, \dots, N_r)}{\partial V}$$

- Potentiel chimique (substance A) : $\mu_A \equiv Y_{A+1}$

$$\mu_A(S, V, N_1, \dots, N_r) \equiv \frac{\partial U(S, V, N_1, \dots, N_r)}{\partial N_A}$$

Thermodynamique

The simple system is also characterized by intensive scalar state functions. That one denotes by convention of the Greek zero μ , Greek one etc until μ Greek r more. The first school state function intensive, it is the temperature, the temperature T . Which is the variable that is conjugated to the entropy S . Therefore, we identify to μ zero. The term temperature is a state function. It is therefore a function of the state variables. It is therefore a function of the entropy of the volume V and the number of mol of each chemical substance. It is defined as the quantity conjugated to the entropy, which is expressed mathematically as follows. The temperature is equal to the derivative partial of the internal energy U compared to the entropy S . The second school state function intensive that we will introduce is the pressure P . The pressure P is defined. As the opposite of the size conjugated to the volume. Therefore, we identify p with minus μ . The pressure p is a state function, it is thus a function of the state variables of the system, namely the entropy S , the volume V and the number of moles associated with each chemical substance.

Notes

Summary



3m 26s



- Système simple :

- Fonctions d'état scalaires intensives :

$$\{Y_0, Y_1, \dots, Y_{r+1}\}$$

- Température : $T \equiv Y_0$

$$T(S, V, N_1, \dots, N_r) \equiv \frac{\partial U(S, V, N_1, \dots, N_r)}{\partial S}$$

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- Potentiel chimique (substance A) : $\mu_A \equiv Y_{A+1}$

$$\mu_A(S, V, N_1, \dots, N_r) \equiv \frac{\partial U(S, V, N_1, \dots, N_r)}{\partial N_A}$$

Thermodynamique

The pressure is defined as less opposite of the variable conjugated to the volume, which is expressed mathematically as follows. P is equal to minus the partial derivative of the internal energy u with respect to the volume v. We are left with the chemical potential associated with each substance, in this case the substance. This chemical potential associated with substance A. It is called mu of A. It is defined as the intensive quantity which is conjugated to the number of moles n a of the substance a. Therefore, we identify mu a and y a plus a chemical potential mu a. The substance a is a state function, so it is a function of. The volume V is the number of moles of each chemical substance. The chemical potential of the substance is defined as the quantity conjugated to the molar number n a of the substance a which is expressed mathematically in the following way. The chemical potential and the partial derivative of the internal energy with respect to a.

Notes

Summary



4m 54s

- Bilan d'énergie interne :

$$\dot{U} = \sum_{i=0}^{r+1} Y_i \dot{X}_i = Y_0 \dot{X}_0 + Y_1 \dot{X}_1 + \sum_{A=1}^r Y_{A+1} \dot{X}_{A+1} \quad \text{où} \quad Y_i = \frac{\partial U}{\partial X_i}$$

- Grandeurs extensives et intensives :

$$X_0 \equiv S \quad X_1 \equiv V \quad X_{A+1} \equiv N_A$$

$$Y_0 \equiv T \quad Y_1 \equiv -p \quad Y_{A+1} \equiv \mu_A$$

- Bilan d'énergie interne :

$$\dot{U} = T \dot{S} - p \dot{V} + \sum_{A=1}^r \mu_A \dot{N}_A$$

- Premier principe :

$$\dot{U} = P_W + P_Q \quad \Rightarrow \quad T \dot{S} - p \dot{V} + \sum_{A=1}^r \mu_A \dot{N}_A = P_W + P_Q$$

Thermodynamique

We can now express the first principle explicitly in terms of the physical state variables of the system. The internal energy balance is expressed as follows. The point is equal to the sum of zero to R plus one. From the product of the derivative of U with respect to what is y y. Exquisite liver. Item. We can now take the two first terms of this sum and take them out. And so we write the point as Y0X0 point plus I1X1 point and the remaining terms plus the sum of one to r of y a plus one times x points of a plus one. Previously, we have identified the extensive and intensive quantities x zero is the entropy. As x is the volume v x a plus one is the number of mol n a of the substance aI0. It is the temperature t i, it is minus the pressure p and there is more one. This is the chemical potential of the substance. Using these identifications, we can express the internal energy balance in the following way a point is equal to T, is this point minus PV points plus the sum of A to R of better A and has not. The first principle also tells us that the time derivative of the internal energy, i.e. of the point. It is the sum of the mechanical power of PW deformation and thermal power. PQ.

Notes

Summary



Deuxième principe

- Dérivée temporelle de l'entropie :

$$\dot{S} = \frac{1}{T} \left(P_W + P_Q + p \dot{V} - \sum_{A=1}^r \mu_A \dot{N}_A \right)$$

- Deuxième principe (système adiabatiquement fermé) :

$$P_Q = 0 \quad \text{et} \quad \dot{S} = \Pi_S \geq 0$$

- Taux de production d'entropie :

$$\Pi_S = \frac{1}{T} \left(P_W + p \dot{V} - \sum_{A=1}^r \mu_A \dot{N}_A \right) \geq 0$$

- Bilan d'entropie :

$$\dot{S} = \Pi_S + \frac{P_Q}{T} \quad \text{où} \quad P_Q = T I_S$$

Thermodynamique

By identifying the right-hand members of these two expressions, namely this right member, one with this right member. Yes, it is. We obtain the following equation $\dot{S} = \Pi_S + \frac{P_Q}{T}$ where Π_S is equal to $\frac{1}{T} (P_W + p \dot{V} - \sum_{A=1}^r \mu_A \dot{N}_A)$. Now. We want to be able to apply the second principle of thermodynamics. What we're going to have to do, is to establish an explicit expression for the time derivative. Entropy, that is, we want an explicit expression for \dot{S} . What we will have to do is to take the last two terms that are in the left belly of this equation it has passed into the right world. And then we divide the asset by the temperature. We then obtain the time derivative of the entropy. Is this point equal to one safety that multiplies $p \dot{V}$ plus $\sum_{A=1}^r \mu_A \dot{N}_A$ plus P_Q divided by T . Armed did not. To obtain the expression of the entropy production rate. We will apply the second principle for a closed adiabatic system. The system is adiabatically closed. The thermal power P_Q is zero and. The time derivative of entropy is then reduced to the rate of entropy production Π_S of positive or null \dot{S} .

Notes

Summary



8m 11s

Deuxième principe

- Dérivée temporelle de l'entropie :

$$\dot{S} = \frac{1}{T} \left(P_W + P_Q + p \dot{V} - \sum_{A=1}^r \mu_A \dot{N}_A \right)$$

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- Taux de production d'entropie :

$$\Pi_S = \frac{1}{T} \left(P_W + p \dot{V} - \sum_{A=1}^r \mu_A \dot{N}_A \right) \geq 0$$

- Bilan d'entropie :

$$\dot{S} = \Pi_S + \frac{P_Q}{T} \quad \text{où} \quad P_Q = T I_S$$

Thermodynamique

So we can obtain the expression of the rates of entropy production starting from the expression of the temporal derivative of entropy, and we impose the condition that P_Q equals zero and therefore the entropy production rate is expressed as a safety which multiplies P_W , P_V , points months the sum of one to R of better A and has not. This entropy production rate can be positive or zero. Using the expression for this point and the expression of pathos, we are now able to to write the entropy balance explicitly as a function of the thermal power P_Q . This entropy balance is the following is this point has of primary cause? This is the entropy production rate of Hess and the second, is the Hess entropy exchange rate which is expressed as the ratio of the thermal power P_Q on the temperature T . Therefore, the thermal power P_Q is related to the entropy exchange rate of Hess in the following way P_Q is equal to T yes. Therefore, if there is heat exchange, there will be entropy exchange.

Notes

Summary



9m 47s



- Etat stationnaire :

Variables d'état indépendantes du temps

- Entropie constante :

$$\dot{S} = 0$$

- Bilan d'entropie et deuxième principe :

$$\dot{S} = \Pi_S + \frac{P_Q}{T} \quad \text{où} \quad \Pi_S \geq 0$$

- Puissance thermique :

$$P_Q = -T \Pi_S \leq 0$$

Thermodynamique

We can now define the steady state of a system. A thermodynamic system is in a stationary state. If these state variables are independent of time. Example entropy. The entropy is constant. Is this point equal? Zero. We can now take into account explicitly from the entropy balance and the second principle. The entropy balance sheet tells us fifteen things is the sum of two contributions on the one hand and PQ safety on the other hand. The second principle tells us that pi of s is greater than or equal to zero. Therefore, since entropy is constant, this point is zero. We derive an explicit expression for the thermal power PQ is then equal to minus the product of the temperature times Pi of s. This is smaller than or equal to zero. We must now distinguish two types of processes that take place on a system that is in a stationary state. The first type of process is a reversible process. If we have a reversible process, it must cancel itself, which means that PQ is zero and therefore there can be no of heat exchange between the system and the outside. For a reversible process when the system is in a stationary state. In the second case, we have an irreversible process.

Notes

Summary



11m 08s



- Etat stationnaire :

Variables d'état indépendantes du temps

- Entropie constante :

$$\dot{S} = 0$$

- Bilan d'entropie et deuxième principe :

$$\dot{S} = \Pi_S + \frac{P_Q}{T} \quad \text{où} \quad \Pi_S \geq 0$$

- Puissance thermique :

$$P_Q = -T \Pi_S \leq 0$$

Thermodynamique

If the process is irreversible, it is positive. This necessarily implies that P_Q is negative. And so, if we have an irreversible process for a system that is in a stationary state, there is a heat exchange between the system and the outside, and this heat exchange is in fact a heat removal. Why? If the system undergoes an irreversible process, heat will be generated within the system itself for the system to be in a stationary state, i.e. that these state variables are independent of time. This system will then need to remove heat. Its thermal power must be negative.

Notes

Summary



12m 32s