



# Transition de phase liquide-vapeur: Modèle de van der Waals



- Equation de van der Waals
- Coexistence de phases et courbe de saturation

Thermodynamique

Hello to all. We will, after studying the liquid transition steam using the Valls bath model. At first, we will rewrite the Van der Valse equation from the law of perfect gases.

Notes

Summary



0m 04s

# Equation de van der Waals



2. Attraction à grande distance → diminution de P

$$\Delta P = A \frac{N^2}{V^2} \rightarrow \text{2ème Correction de la loi des gaz parfaits: } P = \frac{RT}{v-b} - \Delta P$$

$$P + \frac{a}{v^2} = \frac{RT}{v-b} \text{ avec } a = A \frac{N^2}{n^2}$$

o

Thermodynamique

And in a second step, we will use this model to highlight the properties of the liquid-vapor equilibrium, recalling that the Van der Voss equation has been obtained from the law of perfect gases. The two hypotheses that led AP was raised are the following. First, molecules are point masses. Second, the interactions between molecules are weak. Van der Waals returns to the one of his hypotheses. The molecules are modeled by hard spheres, since the police principle prohibits the interpenetration of electronic clouds. The pressure is maximum when the volume of the molecules tends towards the volume of the container here n and the number of mol. This remark allows us to make the following correction. Payroll is equal to FT. Survives less well. The second correction takes into account the interaction between particles. Indeed, at great distances, there is an attraction between particles attraction that moves the molecules away from the walls and decreases the pressure. Therefore, this decrease in pressure is proportional to the density squared. The second collection made to the law of perfect gases gives p equal to rt on V. NB less than delta p.

Notes

Summary



0m 22s



- Point d'inflexion à tangente horizontale

$$\frac{\partial P}{\partial v} \bigg|_{P_C, v_C, T_C} = 0 \quad \text{et} \quad \frac{\partial^2 P}{\partial v^2} \bigg|_{P_C, v_C, T_C} = 0$$

$$-\frac{RT_C}{(v_C - b)^2} + \frac{2a}{v_C^3} = 0 \quad \text{et} \quad \frac{RT_C}{(v_C - b)^3} - \frac{6a}{v_C^4} = 0$$

- avec  $v_C = 3b$ ,  $T_C = \frac{8a}{27Rb}$  et  $P_C = \frac{a}{27b^2}$

Thermodynamique

We obtain the wine law of the vases which is written p plus to lift square equal to rt lift minus b with small A which is equal to A multiplied by the square antenna on small square. We must specify here that V is the molar volume of our gas. The existence of a critical point is characteristic of the liquid-vapor transition. Van Delval's equation effectively indicates that there is the derivative first derivative that cancels and the second derivative that cancels at a point. This point is such that VSC for V critical equal to three b tc equal to eight A on 27 Mb and PC equal to on 27 Decarie.

Notes

Summary



2m 10s

# Modèle de van der Waals: Equation réduite



- $v_r = \frac{v}{v_C}$  soit  $v = 3bv_r$

- de même  $T = \frac{8a}{27Rb}T_r$  et  $P = \frac{P_r}{27}$

- l'équation réduite est :  $P_r = \frac{8T_r}{3v_r - 1} - \frac{3}{v_r^2}$

Thermodynamique

It is much easier to work with the reduced equation, then we write reduced variables.  $V$  is equal to  $V$  on  $V_C$ . Since we have set  $V_C$  equal to three  $B$ , it comes that  $V$  is equal to three  $B$  vs. Proceeding in a similar way, we find  $D$  equal to eight out of 27  $lb$  times  $tr$  and  $p$  equal to  $PF$  out of 27. By replacing the variables  $V$  and  $TP$  by the reduced variables in the Vandervorst equation and previously, we obtain  $P$  is equal to eight  $TF$  on three  $V - 3$  on  $VR$  squared.

Notes

Summary



3m 03s

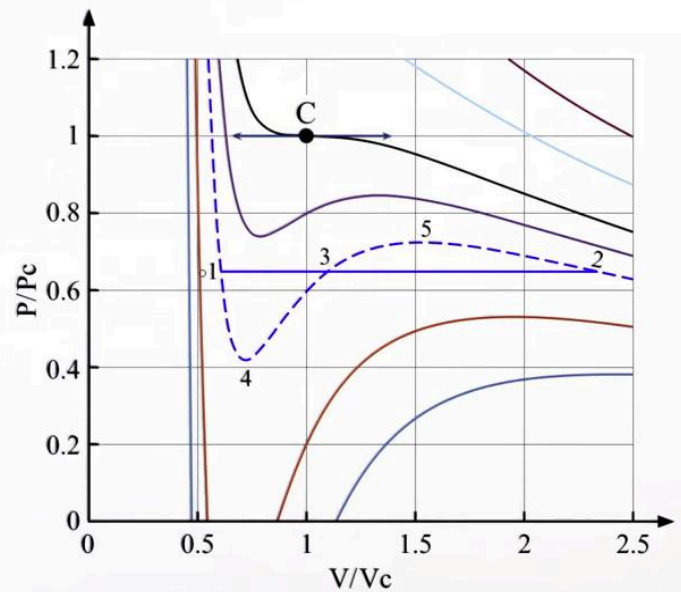
# Isothermes de van der Waals et paliers de transition



- $\frac{\partial P}{\partial V} \big|_{4-3} > 0$        $\frac{\partial P}{\partial V} \big|_{3-5} > 0$

- Trajets 4-3 et 3-5 instables

- La transition à lieu sur le palier 1-2



Thermodynamique

We see here the results of 22 waltzes plotted for reduced temperatures ranging from zero 7 to 1. To one, we have critical autem that present, as it is seen, an inflection point with a horizontal tangent. Beyond that. From this island. At the end, the fluid water is said to be hypercritical or over critical. We also note that there is no phase transition stage as such. In fact, we note that for projects four, three and three five, we have the derivative of the pressure with respect to to the volume at constant temperature above zero. The TAP three and three five routes are therefore unstable since we we have shown that in a SAB system, the derivative of the pressure with respect to to the volume at constant temperature is less than zero. The transition will therefore take place on the landing. One two, he now objects to the question of where to place this tier.

Notes

Summary

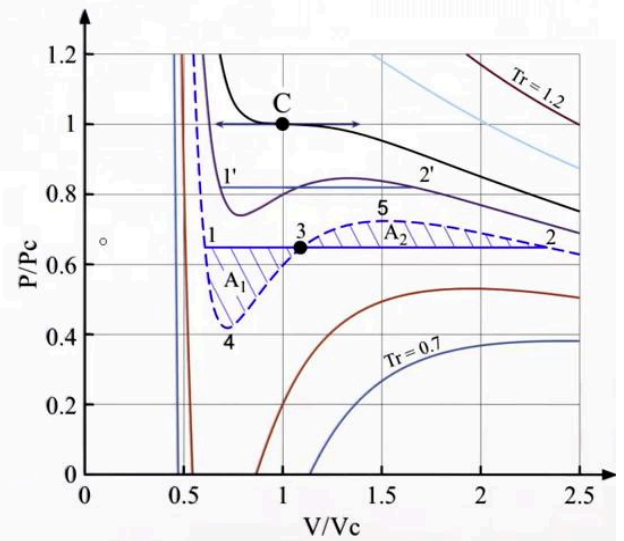


3m 51s

# Isothermes de van der Waals et paliers de transition



- $|\Delta F_{12}| = |\Delta F_{14352}|$
- $|\Delta F_{12}| = |W_{12}| = P_1(v_{r2} - v_{r1})$
- $|\Delta F_{14352}| = \left| - \int_{143} P_r dv_r \right| + \left| - \int_{352} P_r dv \right|$
- $|\Delta F_{14352}| = P_1(v_{r3} - v_{r1}) - A1 + P_1(v_{r2} - v_{r3}) + A2$
- $|\Delta F_{12}| = |\Delta F_{14352}| \rightarrow A1 = A2$



Thermodynamique

We will use the Maxwell construction method to determine the position of the phase change bearing. We start here from the fact that the free energy function is a state function. Therefore, its variation does not depend on the path followed. Delta of F12 is equal to delta of F14352. Delta F12 is equal to the exchanged work between the points one and two, since this is a transformation reversible and to the work exchanged between one and two. In absolute value, is equal to P1 multiplied by. RV two RV. Now calculating the variation of the free energy on the water classified one four three five two. It is equal to the sum of the variation of free energy on the path one four three plus. The change in free energy along the path, which is five two. Since the transformation is reversible, the variation of the energy will be equal to the work exchanged on this root. Work exchanged on the way to a four three is equal to the work to be exchanged on the water. Place a decreased weight of air at one. The work exchanged on the route weight five two it is equal to P1 multiplied by VDSL2. Minus V of R3 plus air to two the initial relationship. Delta F n2 equal to Delta F14352 is verified only if A1 is equal to A2. Numerical calculations can then be used to find the pressure. P1 phase transition for the other terms considered.

Notes

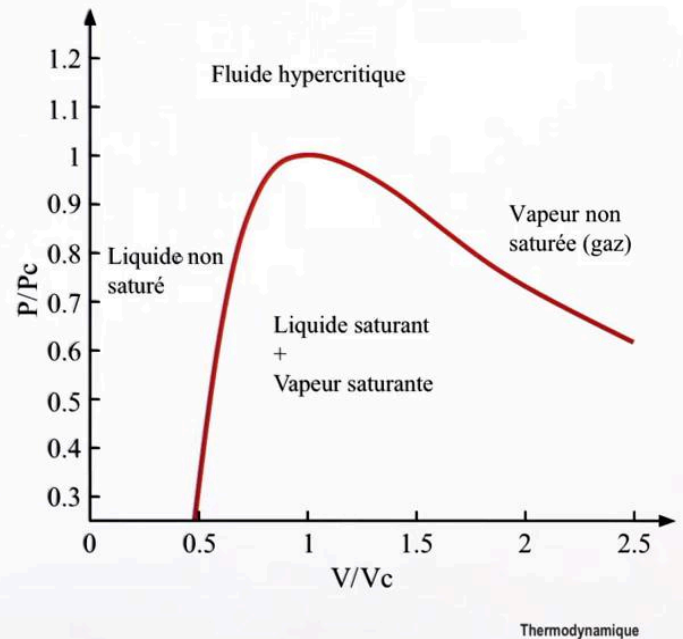
Summary



5m 15s



# Courbe de saturation



The different points. One. A premium or two of premium tells us the limit. The different levels. The red curve, which passes through the critical point and the ends of steps calculated previously, is called saturation curve. The part on the right. From this curve. And called dew curve and the part on the left boiling curve below. From this bell, we have the area of balance. Liquid and steam. To the right of the curve. We have the unsaturated steam domain. To the left of the coop, the unsaturated liquid domain above the bell. We have the domain of the fluid, hyper critical or sub critical.

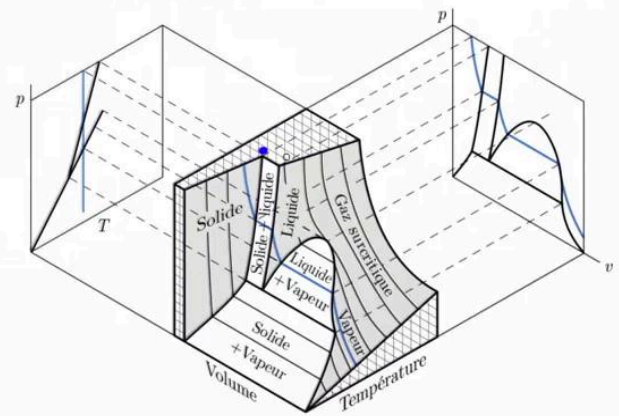
Notes

Summary





# Diagramme de phase tridimensionnel



Thermodynamique

I would like to point out here that there are a much more complex diagram that shows the balance of a body in the three phases liquid, solid and vapor. As part of this course, we have to simply study the PV projections. In the case of the liquid transition steam and we presented the PT state diagram. On this three-dimensional diagram, we see appearing this domain of solid equilibrium liquid with here the liquid-solid transition stage.

Notes

Summary



8m 45s

# Transition de phase liquide-vapeur: Modèle de van der Waals



- Equation de van der Waals
- Coexistence de phases et courbe de saturation

Thermodynamique

In this third module, we have studied the liquid-vapor transition using the 22-phase model. Here we are at the end. From this lesson. I had the pleasure of sharing with you the notions about transitions. Two phases. Thank you for your attention.

Notes

Summary



9m 36s