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Research Article

THE INTERACTION FORCES BETWEEN MOLECULES

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ABSTRACT

This article discusses all the laws considered for an ideal gas, taking into account the interactions of real gas molecules and their individual sizes.

KEYWORDS

Ideal gas, radius, molecule, temperature, wave, enthalpy, pressure, volume.

INTRODUCTION

When we studied molecular-kinetic theory, we dealt with ideal gases. In this, the molecules were simplified to the point that they did not interact with each other and their sizes and volumes were incalculably small [1,2,3,4].

When working with real gases, it is necessary to take into account the specific volumes of molecules. The size of one molecule $V' = \frac{4}{3}\pi r^3 \approx 4\cdot 10^{-30}\,\text{м}^3$. The specific volume of molecules in 1 m^3 volume under normal conditions.

$nV' = 2,69 \cdot 10^{25} \cdot 4 \cdot 10^{-30}\ m^3$

This is a very small volume, but when the pressure increases several thousand times, the specific volume of the molecules becomes comparable to the volume occupied by the gas. Failure to take into account the specific volume of molecules in such cases leads to large errors [5,6,7,8,9].

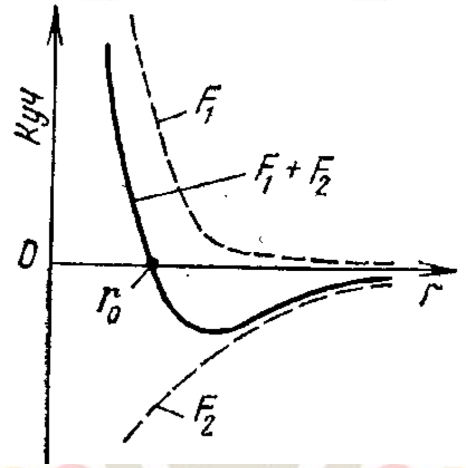

Figure 1

The second simplification in an ideal gas was the assumption that there are no interaction forces between the molecules. In real gases, there are mutual attraction and repulsion forces between molecules

The values of these forces depend on the distance between the molecules. The repulsive force F_1 and the repulsive force F_2 act simultaneously. Repulsive forces are positive and attractive forces are negative. The sum of these two forces is equal to F shown by the continuous line in the figure, at $r = r_0$ F_1 and F_2 balance each other and the resultant force is zero [10-15].

At $r < r_0$, the resultant force is repulsive, and at $r > r_0$, it is attractive. When the molecules approach each other to the distance d_{eff} (the distance between the centres of the molecules), they begin to move away from each other due to mutual repulsion forces.

Thus, taking into account the interactions of real gas molecules and their individual sizes makes all the laws considered for an ideal gas invalid for a real gas.

van der Waals equation.

If we recall the equation of the state of one mole of an ideal gas, that is, the Mendeleev-Clapeyron equation

$$P = \frac{RT}{V_M}$$

were expressed in relation.

In order to derive the "mass equation" of a real gas, corrections must be made to this equation to take into account the specific volumes of the molecules and the forces of attraction and repulsion [16-18].

When a real gas is under the influence of very strong pressure, the molecules condense and form some kind of "forbidden" "*b*" in the container corresponding to the nature of this gas. *b*" occupies the volume. Because two molecules of a real gas can approach each other only up to a certain distance where the forces of mutual repulsion become apparent. In other words, the size of a sphere d_{ef} whose radius is $\left(\frac{4}{3}\pi d^3_{эфф}\right)$ there is a "forbidden size" for the centres of two interacting molecules. This volume is the specific volume V of the molecule′is 4 times greater than *b* = 4NAV′ will be. The total volume through which molecules can move is V_m-*b* will appear. Using this, we write in the following form:

$$P = \frac{RT}{V_M - b}$$

the expression is the pressure exerted by the real gas molecules on the container wall.

Now let's determine the effect of mutual attraction between molecules.

The pressure exerted by real gas molecules on the container wall is smaller than the pressure exerted by ideal gas molecules. The number of molecules approaching the container wall and colliding with it is proportional to n, and the number of molecules pulling molecules approaching the container wall to the inside of the container is also proportional to n. So, the reduced part of the real gas pressure due to the effect of the mutual attraction of molecules is $R_i \sim n^2$ will be proportional. The number of molecules per unit volume is $n \sim \frac{1}{V_M}$ if we take into account that ($n=N_A/V_M$) and introduce a coefficient in order to convert proportionality into equality, the internal pressure caused by gravity is determined as follows:

$$P_i = -\frac{a}{V_M^2}$$

in this, (–) indicates that the internal pressure is in the opposite direction to the real gas pressure R.

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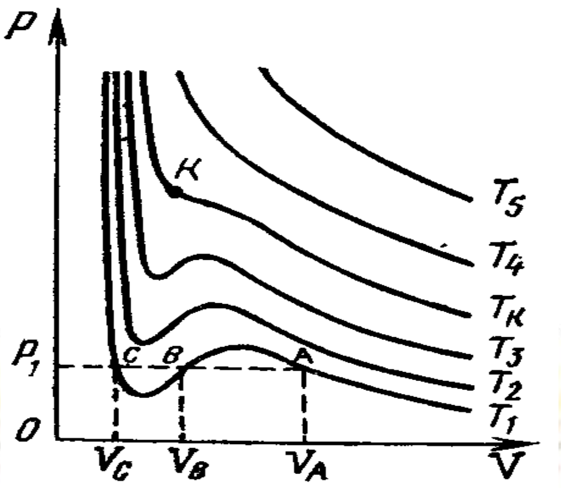

Figure 2.

Thus, the pressure of a real gas based on Eqs

$$P = \frac{RT}{V_M - b} - \frac{a}{V_M^2}$$

is equal to, from which a mole of a real gas is the equation of

$$\left(P + \frac{a}{V_M^2}\right)(V_M - b) = RT$$

can be written in the form. This relationship is called the Van der Walps equation, a and $в$ are constants characterizing certain gas molecules, which are called Van der Walps corrections. since the equation is of the third degree with respect to V_M, it will have three roots, i.e. three volume nets for one pressure (Fig. 2). These graphs are called Van der Walps isotherms. At low temperatures, all three roots of the Van der Walps equation are real but have different values. The isotherm corresponding to the temperature T_1 is cut by a straight line corresponding to R_1 at points A, V, and C. These three points represent different isothermal states.

These conditions are characterized by the R_1 value of pressure, and different V_A, V_V, and V_S values of volume. On the isotherm corresponding to T_k at a higher temperature, all three points overlap. Often, T_k is called the critical temperature, and the isotherm corresponding to it is called the critical isotherm. When the gas volume is reduced below the critical point, it begins to condense. When the gas volume reaches V=b, it goes into the full liquid phase.

If the temperature of the gas is higher than the temperature of the isotherm passing through point K, it will not condense into a liquid. Values of volume and pressure corresponding to the critical point are called critical volume (V_k), and critical pressure (R_k). For example, the critical parameters of nitrogen gas, V_K^N = 9. 10-2 m^3/K.molp; P_K^N =33.5. 105 Pa; T_K^N = 126 K. If we consider that the parameters of one k.moll of nitrogen gas under normal conditions are V_0 = 22,414 m^3/K.molp, r_0 = 105 Pa, T_0 = 273 K, we see that nitrogen gas needs to be strongly cooled in order to transfer it to the liquid phase. If we compare these with the critical parameters, the volume is 250 times smaller, and the pressure is 33.5 times larger. If we continue in the gas at a temperature of 126 K, nitrogen will begin to condense.

The internal energy of a real gas. Joule-Thomson effect

We derived the following expression for the internal energy of one mole of gas assuming that molecules of an ideal gas do not interact with each other

$$U = \frac{i}{2}RT = C_V T$$

Real gas molecules interact with each other except for thermal motion, so their internal energy consists of the sum of the kinetic energy of the thermal motion of molecules and interaction potential energy.

In order to determine the potential energy of molecules, let's determine the work done when the volume of one mole of gas is expanded from V_{M1} to V_{M2}:

$$A = -\int_{V_{M1}}^{V_{M2}} P_M \, dV_M = -\int_{V_{M1}}^{V_{M2}} \frac{a}{V_M^2} dV_M = \frac{a}{V_{M_2}} - \frac{a}{V_{M_1}}$$

This work is equal to the change in the potential energy of the system. Therefore, the potential energy of one mole of gas $\left(-\frac{a}{V_M}\right)$ equal to Given the above, one mole is for the internal energy of a real gas

$$U_{p.m.} = C_V T - \frac{a}{V_M}$$

we form a relationship.

So, the internal energy of a real gas depends on both temperature and volume. When an ideal gas expands adiabatically (dQ=0), the external work done is zero. According to the first law of thermodynamics, the internal energy of the system does not change during such adiabatic expansion, i.e.

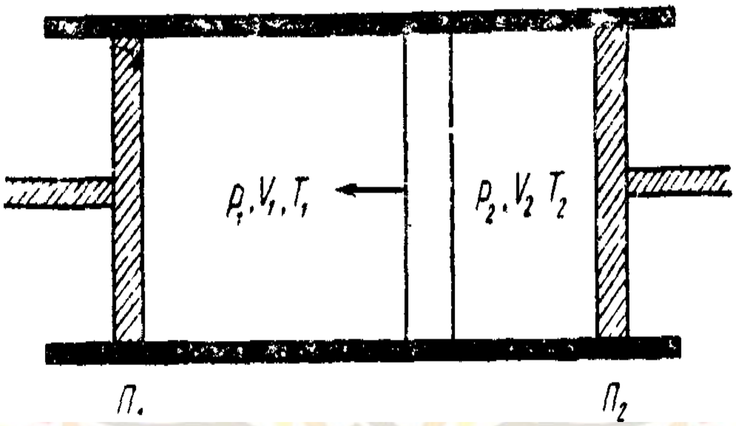

Figure 3.

$$U_1 = U_2$$

In the adiabatic expansion of ideal gases, apart from the internal energy, the temperature also remains unchanged.

In an adiabatic process, when real gases expand without doing work against the external pressure, the gas can heat up or cool down. The change in gas temperature during the adiabatic expansion of a real gas is called the Joulep-Thomson effect.

As the temperature of the gas decreases ($\Delta T<0$) positive Joulep-Thomson effect, on the contrary, in cases of increased temperature ($\Delta T>0$) negative Joulep-Thomson effect occurs. A positive Joulep-Thomson effect is observed for most gases at room temperature. A negative Joulep-Thomson effect was observed only for hydrogen and helium.

Joule and Thomson conducted the following experiment. Two frictionless pistons P_1 and P_2 are placed inside the insulated cylinder. A cotton plug (cotton plug) is placed between the pistons. If the parameters of the gas located on the left side of the barrier are R_1, V_1, and T_1 then the parameters of the gas passing through the open barrier to the right are R_2, V_2, and T_2 respectively. When the first piston moves, the gas passes through the valve to the right and the work done is $A_1 = R_1 V_1$. And the work done when the second piston moves are $A_2 = R_2 V_2$. Putting this work done expressions into the first law of thermodynamics written for an adiabatic process:

$$U_1 + P_1 V_1 = U_2 + P_2 V_2$$

It can be seen that in the Joulep-Thomson experiment, the magnitude of U+RV remains unchanged. This quantity is called the heat function or enthalpy of the gas. Equal enthalpy in real gases does not mean equal temperatures.

CONCLUSION

In conclusion, it should be said that the Linde machine is widely used in technology for the liquefaction of gases. Its working principle can be interpreted as follows. A gas, for example, is compressed to a pressure of about 200 atm in an air compressor and cooled by running water in a cooler, since most gases heat up when compressed. Then two layers of compressed air pass through the inner nozzle of the tube, and in a wide container at the end of the tube, 1 atm in the condenser expands to pressure. In this case, the gas cools down to about 20 °C. Expanded air is sucked back into the compressor through the outer tube of the wave-shaped tube, which in turn cools the second part of the compressed air in the inner tube at the distance to the compressor. Thus, the second part of the gas cools by 20 °C in the corrugated tube itself and then cools another 20 °C as it expands in the condenser. This process is repeated many times. As a result, the air is cooled from the critical temperature to a lower temperature.

REFERENCES

1. Nasirov, M. X., Axmadjonov, M. F., Nurmatov, O. R., & Abdullayev, S. (2021). O'lchamli kvantlashgan strukturalarda kvazizarralar. *Oriental renaissance: Innovative, educational, natural and social sciences*, *1*(11), 166-174.
2. Tolaboyev, D. X., Abdullayev, S., & Xidirov, D. S. (2021). Standart ko 'rinishdagi izotrop jismlarning o 'tkazuvchanligi. *Oriental renaissance: Innovative, educational, natural and social sciences*, *1*(11), 565-570.
3. Tolaboyev, D. X. O. G. L., Mirzayev, V. T. L., Axmadjonov, M. F., Abdullayev, S. S. O. G. L., & Raximjonov, J. S. O. G. L. (2022). YARIM o'tkazgichlarda ichki nuqtaviy nuqsonlarining termodinamikasi. *Oriental renaissance: Innovative, educational, natural and social sciences*, *2*(4), 231-240.
4. Rakhimjanov, J. S. O., Mirzarahimov, A. U., Abdullayev, S. S. O., Nematov, H. M. O., & Khidirov, D. S. (2022). Моделирование математического фантома в программном комплексе "fluka" с интерфейсом "flair". *Oriental renaissance: Innovative, educational, natural and social sciences*, *2*(4), 241-250.
5. Нурматов, О. Р., Абдуллаев, Ш. Ш., & Юлдашев, Н. Х. (2021). Временная релаксация фотоэлектретного состояния в фотовольтаических пленках cdte: ag, cd, cu и sb2se3: se. *Central asian journal of theoretical & applied sciences*, *2*(12), 315-322.
6. Гайназарова, К. И., Набиев, М. Б., Усмонов, Я., Усмонов, С., & Абдуллаев, Ш. (2030). Легирование термоэлектрических материалов на основе bi2те3-bi2se3 используемых в термогенераторах концентрированного солнечного излучения. *Янги материаллар ва гелиотехнологиялар*, 69.
7. Sh, A. S., & Meliboyev, I. A. (2022, December). Fizika fani amaliy mashgulotlarida, labaratoriyalarida o'quvchilar mavzuni teranroq anglashi uchun suniy intellekt jihozlardan foydalanish. In *Conference Zone* (pp. 423-428).
8. Teshaboyev, A. M., & Meliboyev, I. A. (2022). Types and Applications of Corrosion-

Resistant Metals. *Central asian journal of theoretical & applied sciences*, *3*(5), 15-22.

9. Mamirov, I., Sobirov, A., Xasanov, A. S., & Meliboyev, I. (2022, September). Raqamlashib Borayotgan Zamonaviy Oliy Ta'limda Pedagogning Kasbiy Kompetentsiyalarini Rivojlantirishning Zamonaviy Mexanizmlari. In *Conference Zone* (pp. 8-11).

10. O'G'Li, M. I. A. (2022). Gazdan xavfli ishlarni xavfsiz olib borishni tashkillashtirish bo 'yicha xavfsizlik tiziml. *Ta'lim fidoyilari*, *4*(7), 36-40.

11. Meliboyev, I. A. (2022). Azot oksidli chiqindi gazlarni katalitik zararsizlantirish usuli. *Pedagog*, *1*(3), 257-261.

12. Meliboyev, i. A. (2022). Oliy ta'lim muassasalarida modulli o 'qitishning axamiyati. *PEDAGOG*, *1*(3), 333-336.

13. Домуладжанова, Ш. И., Мелибоев, И. А., & Мамиров, И. Г. (2022, November). Способы и устройства по производству извести. In *Conference Zone* (pp. 327-337).

14. Abduraxmon o'g'li, M. I. (2022, December). Farzand tarbiyasida ona tiling tutgan o 'rni. In *Conference Zone* (pp. 461-465).

15. Abduraxmon o'g'li, M. I. (2022). Materiallar kristalidagi nuqsonlar va ularni aniqlash usullari. *Pedagog*, *1*(3), 413-415.

16. Fayzullaev, N. I., Akmalaev, K. A., Karjavov, A., Akbarov, H. I., & Qobilov, E. (2020). Catalytic Synthesis Of Acetone And Acetaldehyde From Acetylene In Fluoride-Based Catalysts. *The American Journal of Interdisciplinary Innovations and Research*, *2*(09), 89-100.

17. Abdruraxmon o'g'li, M. I. (2022). A Method of Catalytic Neutralization of Exhaust Gases with Nitrogen Oxides. *Eurasian Research Bulletin*, *14*, 21-24.

18. Abdruraxmon O'g'li, M. I. (2022). Occupational diseases in industrial enterprises: causes, types and principles of prevention. *International Journal of Advance Scientific Research*, *2*(10), 1-9.