TERMODINAMIKANING IKKINCHI QONUNI. ENTROPIYAGA DOIR MASALALAR YECHISH METODLARI.

Otaqulova Iroda Abdurashid qizi
Nizomiy nomidagi Toshkent davlat pedagogika universiteti,
Fizika-matematika fakulteti Fizika va astronomiya yo‘nalishi 301-guruh talabasi
Xo‘janov Fozil Xolto‘ra o‘g‘li
Nizomiy nomidagi Toshkent davlat pedagogika universiteti,
Fizika-matematika fakulteti Fizika va astronomiya yo‘nalishi 204-guruh talabasi
Umarova Madina Sodiqjon qizi
Nizomiy nomidagi Toshkent davlat pedagogika universiteti,
Fizika-matematika fakulteti Fizika va astronomiya yo‘nalishi 201-guruh talabasi

Annotatsiya. *Ushbu maqolada “Termodinamikaning ikkinchi qonuni. Entropiya” ga doir masalalar va ularni qanday yechish kerakligi chuqurroq yoritilib berilgan*.

Kalit so‘zlar: *Entropiya, masalalar yechish metodikasi, differensial tenglamalar*.

Аннотация. *В этой статье " Второй закон термодинамики. Вопросы, касающиеся” энтропии " и способов их решения, освещаются более подробно*.

Ключевые слова: *энтропия, методика решения задач, дифференциальные уравнения.*

Annotation. *In this article, “The Second Law of thermodynamics. Entropy” with deeper coverage of issues and how to solve them.*

Keywords: *entropy, problem solving methodology, differential equations.*

Dolzarbligi. Bugungi glaballashuv jarayonida jahon standartlariga javob beraoladigan, raqobatbardosh kadrlarga ta’lab doimgidan oshgan. Nazariy va amaliy bilimlarni keng o‘zlashtirgan fizik mutaxasislar tayyorlash esa bugungi kunning dolzarb vazifalaridan.

Fizikaning molekulyar fizika bo‘limida Termodinamika qonunlari alohida o‘rin egallaydi. Entropiyaga doir masalarni yechish talabalarda mavzuni yanada yaxshiroq o‘zlashtirishga yordam beradi.

Biz Termodinamikaning 2-qonuni, Entropiyaga doir bir nechta masalalarni yechilish metodlari bilan tanishamiz:

1-masala. Harorati T_1=280 K haroratdagi m_1= 5 kg massali suvni T_2=350 K haroratdagi m_2=8 kg massali suv bilan aralashtirdilar. 1) Aralashmaning harorati θ; 2) aralashtirishda entropiyaning o`zgarishi ΔS topilsin.

Berilgan:

T_1=280 K
m_1= 5 kg
T_2=350 K
m_2=8 kg

Topish kerak:

θ=?

ΔS=?

Yechilishi:

Aralashmaning temperaturasini topish uchun Q=Q_1+Q_2 (1) formuladan foydalanamiz. Ya’ni 2 ta holatdagi issiqlik miqdorlari yig’indisini umumiy issiqlik miqdoriga tenglaymiz.

Q-umumiy issiqlik miqdori

$Q_1=m_1c_1T_1$ (2)

$Q_2=m_2c_2T_2$ (3)

$Q=(m_1+m_2)\,c_3\,\theta$ (4)

2 holatda ham suvni aralashtirayotganimiz uchun solishtirma issiqlik sig’imlari teng bo’ladi, ya’ni $c_1=c_2=c_3=c=4200$ J/(kg·K)

(2) , (3) va (4) formulalarni (1) formulaga olib borib qo’yamiz va solishtirma issiqlik sig’imlari bir xil bo’lgani uchun ularni qisqartiramiz:

$(m_1+m_2)\,c_3\,\theta=m_1c_1T_1+m_2c_2T_2$

$(m_1+m_2)\theta=m_1T_1+m_2T_2$

Bu formuladan aralashmaning haroratini topamiz:

$\theta=\frac{m_1T_1+m_2T_2}{m_1+m_2}$ (5)

(5) formuladan foydalanib aralashmaning temperaturasi hisoblaymiz:

$\theta=\frac{m_1T_1+m_2T_2}{m_1+m_2}=\frac{5\cdot280+8\cdot350}{5+8}$=323K

Entropiyaning differensial ko’rinishini yozamiz:

$dS=\frac{dQ}{T}$ (6)

Bu formuladagi dQ ning o’rniga issiqlik miqdorining differensial ko’rinishi olib borib qo’yamiz:

dQ=mcdT

$dS=\frac{mcdT}{T}$ (7)

Holatlar uchun entropiyaning o’zgarishini topish uchun tenglikning 2-tomonini T dan θ gacha integrallaymiz:

$\Delta S=\int_T^{\theta}\frac{mcdT}{T}=mc\ln\frac{\theta}{T}$ (8)

(8) formulani 2 ta holat uchun yozamiz:

$\Delta S_1=m_1c\ln\frac{\theta}{T_1}$ (9)

$\Delta S_2=m_2c\ln\frac{\theta}{T_2}$ (10)

Entropiyaning o’zgarishini topish uchun 2 ta holatdagi entropiyaning o’zgarishlarini qo’shamiz va hisoblaymiz:

$\Delta S=m_1c\ln\frac{\theta}{T_1}+m_2c\ln\frac{\theta}{T_2}=5\cdot4200\cdot ln\frac{323}{280}+8\cdot4200\cdot ln\frac{323}{350}=$

=300 J/K=0,3 kJ/K.

J: ΔS=0,3 kJ/K.

2-masala. Massasi m=1g bo`lgan vodorodni izoxorik qizdirish natijasida gazning bosimi ikki marta ortdi. Gaz entropiyasining o`zgarishi ΔS aniqlansin.

Berilgan:

m=1g=10^{-3}kg

V=const

P_2=$2P_1$

Topish kerak:

ΔS=?

Yechilishi:

Izoxorik jarayonda hajm o’zgarmas bo’lgani uchun quyidagi formuladan temperaturalar nisbatini topamiz:

$\frac{P_1}{T_1}=\frac{P_2}{T_2}$ $\frac{T_2}{T_1}=\frac{P_2}{P_1}$ (1)

Termodinamikaning 2-qonuni quyidagicha edi:

dQ=dU+dA (2)

Izoxorik jarayonda hajm o’zgarmas bo’lgani uchun bajarilgan ish nolga teng bo’lgani uchun (2) formula quyidagi ko’rinishga keladi:

dA=0 dQ=dU (3)

Issiqlik miqdori ichki energiya o’zgarishiga teng bo’lgani uchun (3) formula quyidagicha ko’rinishga keladi:

dQ=$\frac{i}{2}\frac{m}{\mu}$RdT (4)

Bu formulada i-erkinlik darajasi vodorod 2 atomli bo’lgani uchun qiymati 5 ga (i=5), μ-vodorodning molyar massasi qiymati 2g/mol ga (μ=2g/mol) teng, R-universal gaz doimiysi (R=8,31 J/(mol·K)).

Entropiyaning differensial ko’rinishini yozamiz:

dS=$\frac{dQ}{T}$ (5)

(4) formulani (5) formulaga qo’yamiz:

dS=$\frac{\frac{im}{2\mu}\mathrm{RdT}}{T}$ (6)

Entropiyaning o’zgarishini topish uchun tenglikning 2-tomonini T_1 dan T_2 gacha integrallaymiz:

ΔS= $\int_{T_1}^{T_2}\frac{\frac{im}{2\mu}\mathrm{RdT}}{T}=\frac{i}{2}\frac{m}{\mu}\mathrm{R}\ln\frac{T_2}{T_1}$ (7)

(1) formulani (7) formulaga qo’yamiz va entropiyaning o’zgarishini hisoblaymiz:

ΔS=$\frac{i}{2}\frac{m}{\mu}\mathrm{R}\ln\frac{P_2}{P_1}=\frac{5}{2}\cdot\frac{10^{-3}}{2\cdot10^{-3}}\cdot 8{,}31\cdot\ln\frac{2P_1}{P_1}$=7,2 J/K.

J: ΔS=7,2 J/K.

3-masala. Massasi m=4g massali azotning V_1=5 l hajmdan to V_2= 9 l hajmgacha izobarik kengayishida entropiyaning o`zgarishi ΔS topilsin.

Berilgan:

m=4g=$4 \cdot 10^{-3}$kg

V_1=5 l=$5 \cdot 10^{-3} m^3$

V_2=9 l=$9 \cdot 10^{-3} m^3$

P=const

Topish kerak:

ΔS=?

Yechilishi:

Izobarik jarayonda bosim o’zgarmas bo’lgani uchun quyidagi formuladan temperaturalar nisbatini topamiz:

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{T_2}{T_1} = \frac{V_2}{V_1}$ (1)

Termodinamikaning 2-qonuni quyidagicha edi:

dQ=dU+dA (2)

Ichki energiya o’zgarishi quyidagiga teng:

$dU=\frac{i}{2}\frac{m}{\mu}RdT$ (3)

Bajarilgan ishni topish formulasi quyidagicha:

dA=PdV (4)

Mendeleyev-Klapeyron formulasini differensialab yozamiz:

$PdV=\frac{m}{\mu}RdT$ (5)

(5) formulani (4) formuladadi PdV ni o’rniga qo’ysak:

$dA=\frac{m}{\mu}RdT$ (6)

(3) va (6) formulalarni (2) formulaga olib borib qo’yamiz:

$dQ=\frac{i}{2}\frac{m}{\mu}RdT+\frac{m}{\mu}RdT=\frac{i+2}{2}\frac{m}{\mu}RdT$ (7)

Bu formulada i-erkinlik darajasi azot 2 atomli bo’lgani uchun qiymati 5 ga (i=5), μ-azotning molyar massasi qiymati 28g/mol ga (μ=28g/mol) teng, R-universal gaz doimiysi (R=8,31 J/(mol·K)).

Entropiyaning differensial ko’rinishini yozamiz:

$dS=\frac{dQ}{T}$ (8)

(7) formulani (8) formulaga qo’yamiz:

$dS=\frac{\frac{i+2}{2}\frac{m}{\mu}RdT}{T}$ (9)

Entropiyaning o’zgarishini topish uchun tenglikning 2-tomonini T_1 dan T_2 gacha integrallaymiz:

$\Delta S= \int_{T_1}^{T_2} \frac{\frac{i+2}{2}\frac{m}{\mu}RdT}{T} = \frac{i+2}{2}\frac{m}{\mu} R\ln\frac{T_2}{T_1}$ (10)

(1) formulani (10) formulaga qo’yamiz va entropiyaning o’zgarishini hisoblaymiz:

$\Delta S=\frac{i+2}{2}\frac{m}{\mu}R\ln\frac{V_2}{V_1}=\frac{5+2}{2}\cdot\frac{4\cdot10^{-3}}{28\cdot10^{-3}}\cdot 8{,}31\cdot\ln\frac{9\cdot10^{-3}}{5\cdot10^{-3}}=2{,}44$ J/K.

J: $\Delta S=2{,}44$ J/K

FOYDALANILGAN ADABIYOTLAR RO‘YXATI

1. Savelev I. V., Umumiy fizika kursi II tom, O‘qituvchi, Toshkent, 1976-yil.
2. Kikoin A.K., Kikoin I.K., Molekulyar fizika, O‘qituvchi, Toshkent, 1978-yil.