INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563
eISSN 2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 10, issue 12 (2023)

HEAT PHYSICAL MEANING AND ORIGIN OF DIFFUSION EQUATIONS

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Abstract: Fraction in order equations of solving scientists by one how much types by learning developedOur life during many fields basically physics , chemistry , biology and etc in the fields processes fraction in order equations with expressing themin learning to us fraction in order equations help will give . In life many in processes them manage important importance occupation is enough For example , heat spread in the process something from the border the heat management. Let's assume that an air conditioner is installed in the room, and let's consider the problem of finding the minimum time to raise the room temperature to a given level. Of course, if we set the air conditioner to a certain temperature and leave it on at night, when we arrive in the morning, the room temperature may meet our requirements, but we will have used a lot of energy. We need to find such a time, as a result, the air conditioner will have to work for a minimum time to bring the average temperature of the room to the required level at the minimum time we choose.

Keywords: Gauss — Ostrogradsky, Fourier law, Nernst law, diffusion.

The processes of heat spread in a given body or environment, diffusion of particles into the environment are as follows

$$\rho\frac{\partial u}{\partial t} = div(pgradu) - qu + F(x,t) \tag{1.1}$$

is reduced to a general diffusion equation of the form The unknown function $x = (x_1, x_2, x_3)$ in Eq $u(x,t)$ t to time depends .

In the process of heat dissipation, $u(x,t)$ the unknown function $x = (x_1, x_2, x_3)$ represents the temperature of the medium ρ, p, q at a point in time. t - the coefficients are determined depending on the properties of the heat source and the environment in which heat is distributed. $F(x,t)$ and the free term depends on the properties of the heat-dissipating or absorbing source inside the body or environment. Now we derive the equation of heat dissipation. We are given a solid body, or medium, of volume $x = (x_1; x_2; x_3)$ V *, and let be* the temperature of its $u(x,t)$ point at time t . Let S denote the surface bounding this object. It is known that if the temperature of different parts of the environment is different, then heat movement occurs from the more heated part to the less heated part. V in volume (t_1, t_2) time between heat change we will check .

Four to the law mainly , [4] S D S of the surface from the part D t at the time passing heat quantity $\Delta Q_1 - \Delta S,\ \ \Delta t$ t and $\frac{\partial u}{\partial n}$ (according to normal temperature derivative) to proportional will be , that is

$$\Delta Q_1 = -k(x)\cdot\Delta S\cdot\Delta t\cdot\frac{\partial u}{\partial n} = -k(x)\cdot\Delta S\cdot\Delta t\cdot grad_n u \quad (1.2)$$

this on the ground $k(x) > 0$ function - of the body internal heat conductivity coefficient , n is heat movement direction on D S to conducted normal.

Checking environment we consider isotropic , i.e heat conductivity coefficient k only of the environment $x = (x_1, x_2, x_3)$ to the point depends is Sof the surface normal direction depends no , different so to speak heat spreading direction depends it's not . Surface together from an even $(\Delta S = 1)$ surface $(\Delta t = 1)$ unity at the time passing heat amount to (1.3). according to :

$$q_1 = -k(x)\cdot\frac{\partial u}{\partial n} \quad (1.3)$$

to equal to In that case S surface through (t_1, t_2) time between V to volume entering heat amount to formula (2.3) and (2.2). basically

$$Q_1 = -\int_{t_1}^{t_2} dt \iint_S k(x)\frac{\partial u(x,t)}{\partial n}\, dS \quad (1.4)$$

to equal , n — S to the surface held internal normal because heat S of into is entering

V of volume D of part V temperature D t at the time $\Delta u = u(x,t+\Delta t) - u(x,t)$ to change for spend to be done heat quantity

$$\Delta Q_2 = \left[u(x,t+\Delta t) - u(x,t)\right]\rho(x)\gamma(x)\Delta V \quad (1.5)$$

to equal to , in this $\rho(x), \gamma(x)$ - environment density and heat capacity (given the body 1 °C to heating for necessary has been heat quantity). In that case of the body volume together equal to in the part the temperature (t_1, t_2) time between $\Delta u = u(x,t_2) - u(x,t_1)$ to change for spend to be done heat quantity

$$q_2 = \left[u(x,t_2) - u(x,t_1)\right]\rho(x)\gamma(x) \quad (1.6)$$

So , volume V temperature $\Delta u = u(x,t_2) - u(x,t_1)$ to change for necessary has been heat quantity

$$Q_2 = \iiint\limits_V \left[u(x,t_2) - u(x,t_1)\right] \cdot \gamma(x)\rho(x)dV \quad (1.7)$$

to equal to If

$$u(x,t_2) - u(x,t_1) = \int_{t_1}^{t_2} \frac{\partial u(x,t)}{\partial t} dt$$

that account if we get (1.7) equality this in appearance is written :

$$Q_2 = \int_{t_2}^{t_1} dt \iiint\limits_V \gamma(x)\rho(x) \frac{\partial u(x,t)}{\partial t} dV \quad (1.8)$$

Hypothesis let's look at it volume inside heat sources be , that is heat spreader or heat devourer sources (for example : Environment as the room environment inside heat source as air conditioner or batteries get can). Volume inside heat of sources density (unit time inside unity in volume to the part separated heat quantity or to him absorbed gone heat quantity) through $F(x, t)$. set we can In that case volume inside heat of sources V time to volume (t_1, t_2) between separating or to him absorbed going heat quantity

$$Q_3 = \int_{t_2}^{t_1} dt \iiint\limits_V F(x,t)dV$$

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to equal to To us It is known that V in volume heat balance equation $Q_2 = Q_1 + Q_3$ will be because V volume to heating spent Q_2 heat amount , to him incoming Q_1 heat quantity and his inside heat of the source separated or to him broken Q_3 heat of the amount in total equal to In that case

$$\int_{t_1}^{t_2} dt \iiint_V \gamma(x)\rho(x)\frac{\partial u(x,t)}{\partial t} dV =$$

$$= -\int_{t_1}^{t_2} dt \iint_S k(x)\frac{\partial u(x,t)}{\partial n} dS + \int_{t_1}^{t_2} dt \iiint_V F(x,t) dV \qquad (1.9)$$

$u(x,t)$ function $x=(x_1;x_2;x_3)$ spatial coordinates according to two times , t according to one times differentiable and this issues being investigated in the field assuming continuous ,

$$\frac{\partial u}{\partial n} = grad_n u$$

equality attention to the Gauss- Ostrogradsky [5] formula basically

$$\iint_S k(x)\frac{\partial u}{\partial n} dS = -\iiint_V div(k(x)\cdot gradu) dV$$

to equality have we will be Then the formula (1.9) is this in appearance is written :

$$\int_{t_1}^{t} dt \iiint_V \left[\gamma(x)\rho(x)\frac{\partial u(x,t)}{\partial n} - div(k(x)\cdot gradu(x,t)) - F(x,t) \right] dV = 0$$

From this immediately V volume and (t_1, t_2) time range optional that it was three

$$\gamma(x)\rho(x)\frac{\partial u(x,t)}{\partial t} = div(k(x)gradu(x,t)) + F(x,t) \quad (1.10)$$

heat spread equation harvest we do

If the environment one sexual if , that is γ , p and k functions immutable if , equation (1.10)

$$\frac{\partial u}{\partial t} = a^2\Delta u + f(x,t) \quad (1.11)$$

to look comes , in this

$$a^2 = \frac{k}{\gamma\rho}, \quad f = \frac{F}{\gamma\rho}.$$

(2.2.1.11) to Eq heat conductivity is also called the equation (1.11) equation cause in release spatial coordinates the number n to 3considered equalwe were In this equation n Number is optional to be canIf in the environment heat sources if not , that is $F(x,t)=0$ if , one sexual heat conductivity equation harvest will be :

$$\frac{\partial u}{\partial t} = a^2\Delta u.$$

Vibration according to equations , heat spread process full to express for in the environment of temperature initial spread (initial condition) and

of the environment at the border status to be given a must

Primary condition , wave from Eqs different $u(x,t)$ of the function starter t_0 in time value from giving consists of , i.e

$$u|_{t=t_0} = \varphi(x). \quad (1.12)$$

Borderline conditions of temperature on the border mode looking differently to be can

1) If *S* at the border given one different u_0 temperature stored if , then

$$u|_S = u_0 \qquad (1.13)$$

2) If *S* of the border each one *P* at the point t in time temperature given if , then

$$u|_S = \psi(P,t) \qquad (1.14)$$

3) If given in *S* heat flow one different if , then

$$k\frac{\partial u}{\partial n}\Big|_S = u_1 \qquad (1.15)$$

4) If the heat at *C* exchange happen happening if , Newton to the law basically

$$\left[k\frac{\partial u}{\partial n} + h(u-u_0)\right]\Big|_S = 0 \qquad (1.16)$$

will be , in this h— heat exchange coefficient , u_0— of the environment temperature .

Same heat spread to Eq similar particles diffusion equation cause is issued . Onlyin this Four the law instead of unity at the time surface ΔS from the part passing particles flow from Nernst's law for use need

To him basically

$$dQ = -D(x)\frac{\partial u}{\partial n}dS$$

this on the ground *D(x)* is diffusion coefficient , $u(x,t)$ — t at time x at the point particles density . $u(x,t)$ density of the form (1.1) for to Eq have we will be , then *r* porosity coefficient defines , *r=D, q* while of the environment absorb represents(1.11) heat failure equation parabolic type of equations obvious is a representative .

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