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THE PROBLEM OF TEACHING HEAT TRANSFER AND HEAT EXCHANGE IN SCHOOLS AND LYCEUMS

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ABSTRACT:

In this study, the causes and methods of teaching school and high school students knowledge about heat transfer and heat transfer processes were studied. In the study, the types of heat transfer, methods of lighting the elements of heat exchange were systematically studied. The issue of explaining the general and different aspects of heat transfer types in educational technologies was also discussed.

KEYWORDS: methods of teaching, transfer processes, types of heat transfer, educational technologies, elements of thermodynamics leads.

INTRODUCTION:

The formation of students understanding of the elements of thermodynamics leads to certain difficulties. Because in the thermodynamic process several parameters change at the same time (P, V, T, E). However, an in-depth study of this section will provide a basis for understanding the full nature of other branches of physics. That is why it is important to fully form the elements of thermodynamics in students. One of the fastest growing areas today is the use of non-conventional energy sources. In order to participate in practical work in this area, it is important for the student to have additional knowledge about thermal processes.

LITERATURE REVIEW:

To heat different substances to the same temperature requires different amounts of heat energy to be transferred to each of them. It depends on the state and structure of the substance. The amount of 1^0 heat required to heat a unit mass of a substance is called the heat capacity of that substance. In this case, as a result of the absorption Δq of heat by the substance, its temperature T_2 increases from T_1 [3]. The average heat capacity of a substance is expressed as follows:

$$C = \frac{\Delta q}{T_2 - T_1} \quad (1)$$

The amount of 1^0 heat required to heat a substance is assumed to be its actual heat capacity

$$C = \frac{\Delta q}{\Delta T} \quad (2)$$

The amount of heat required to change the unit mass temperature of a substance by one degree is called the specific heat capacity. Specific heat capacity can be expressed in terms of mass, volume and other units of measurement.

1. Specific mass heat capacity:

$$C_m = \frac{1}{m}\frac{\Delta q}{\Delta T}\, J/kg\cdot K \quad (3)$$

2. The physical volume is the specific heat capacity, which is the ratio of the amount of

heat transferred to a substance of constant volume ($1м^3$) to the change in temperature of this mode by one degree:

$$C_v = \frac{1}{V}\frac{\Delta q}{\Delta T} \qquad (4)$$

SI is measured $C_v, J/m^3K$ in units of measurement. The specific heat capacity of a system (gas) in a thermodynamic process of constant volume can be expressed in the form of a specific product obtained from the internal energy of this system at absolute temperature:

$$C_T = (U)' \qquad (5)$$

3. Specific heat capacity:

$$C_\mu = \frac{\mu}{m}\frac{\Delta q}{\Delta T}, \left[\frac{J}{kmol \cdot K}\right] \qquad (6)$$

ANALYSIS:

The heat capacity of a substance depends on the thermodynamic process in which the substance participates as a system. This is because the change in temperature of a system (substance) depends only on the type of thermodynamic process when the amount of heat transferred to it does not change.

The amount of heat transferred depends on the size of the surface to be touched and the heat transfer time. In thermodynamics, this quantity is called the heat flux, and it is measured in $\frac{J}{c}, Vt$ in the SI unit system.

A surface with the same temperature at all points is called an isothermal surface. The vector of the temperature field is perpendicular to the isothermal surface. The greatest change in temperature is observed in the normal direction.

According to the French scientist Fourier's law, the vector of heat flux density in terms of thermal conductivity is proportional to the temperature gradient [13]:

$$q = -\lambda \frac{\Delta T}{\Delta r} \qquad (7)$$

In this case, the thermal conductivity of the λ -body, $\left[\frac{\mathrm{Vt}}{\mathrm{m \cdot K}}\right]$; The r-heat dissipation length [m] represents the thermal conductivity of the λ -coefficient substance, and the negative sign in the equation indicates that the directions of the temperature gradient vectors are opposite to the heat flux, i.e., the direction of maximum temperature drop.

The thermal conductivity of substances varies and, in turn, their thermal conductivity λ takes values over a wide range (from $6 \cdot 10^{-3} Vt/m \cdot K$ to $410 Vt/m \cdot K$). The amount of heat that passes through a unit of surface in a unit of time is:

$$\Delta q = -\lambda \frac{\Delta T}{\Delta n}\Delta S \Delta t \qquad (8)$$

The thermal conductivity of objects depends on their physical properties. If $\lambda < 0{,}2\frac{Vt}{m \cdot K}$ so, such materials are called thermal insulators. Such materials include air, lightweight porous materials: foam, fiberglass, and most electrical insulators.

In such a heat exchange, the heat energy is converted into mechanical energy and the heat is circulated. In this case, the magnitude of the heat flux is proportional to the product of the temperature difference between the heat exchange surface and the surface of the solid and liquid, i.e.

$$q = \alpha \cdot S\left(T_q - T_s\right). \qquad (9)$$

This is called Newton's and Richman's law. Where T_q and T_s are the temperatures of solids and liquids (their absolute values are obtained and the difference between the bonds is always assumed to be positive [5], i.e. the difference between the large and the small is subtracted); α -heat transfer coefficient,

$$\left[\frac{Vt}{m^2 \cdot K}\right].$$

The physical meaning of α the heat transfer coefficient is the rate of heat transfer. Its numerical value is equal to the alternating heat flux per unit surface, where the difference in temperature of the liquid with the surface of the solid is one Kelvin. This coefficient depends on the type of flow in convective motion and other effects.

In convective heat exchange, the motion of a heat-conducting substance (liquid, gas) is both natural and artificial. The phenomenon of natural convection occurs only due to the heat exchange of the liquid (gas) mass with the heat source, which changes its volume near the hot surface and moves upwards. The temperature of the liquid (gas) molecules near the heating surface is high, and as they move away from the heat source, their temperature decreases.

The value of the heat transfer coefficient a gradually decreases in the laminar zone of the convective heat exchange process, then increases from the boundary of the transition zone to the turbulent zone, and then stabilizes.

This means that in a laminar flow, since the heat vector is perpendicular to the direction of flow, its value is not large. In a turbulent flow, the liquid (gas) moves in a coherent manner and they mix well and transfer heat rapidly. Such convection is called forced convection when the mass of liquid (gas) is sucked out of the low-temperature volume by a pump, fan or other machine and directed to the heater, i.e. the movement is forced (open or closed contour). Due to external influences, liquid (gas) particles move in a circular motion without a uniform motion. During the complete mixing of the liquid, heat is exchanged during contact with each other and with the solid wall (pipe, grate, etc.). In forced convection, heat transfer occurs mainly in terms of thermal conductivity when the heat transfer medium touches the environment. Suppose heat is transferred through a pipe wall to a liquid in it. In the boundary part of the liquid flow formed in it [6], that is, a thin film layer is formed between the inner wall of the tube and the liquid. The velocity of this layer is approximately zero.

The boundary layer rubs against the adjacent layers of the liquid, reducing their velocity as well. At the center of such a fluid flow (along the pipe axis), the velocity is greatest, and it is a function of the radius ($v = t(r)$), i.e., the velocity decreases from the axis of the pipe to its wall. The motion of the current in the boundary layer is laminar and the temperature of the particles in it is equal to the temperature of the solid wall. From the solid wall to the center of the tubular flow, the temperature of the liquid decreases. Heat exchange takes place through the boundary layer of the flow. In this layer, heat exchange takes place according to the laws of thermal conductivity, and it resists the movement of heat flux. As a result, the temperature loss in this layer is high.

Depending on the type, design and material of the equipment used in heat exchange, they are used in various heat exchange processes. For example, in the cooling systems of an internal combustion engine, the method of forced convective heat exchange is used. The refrigerant (water, antifreeze) releases the excess heat from the cylinder block into the refrigerator during its forced motion.

The high and low temperature fluid flows used in the heat exchange process are direct, reverse and cross-flow, depending on the direction. Such currents are used in capacitors, economizers, regenerators.

The value of the heat transfer coefficient varies depending on the physical properties of the heat carrier and the receiver. For example, the natural convection of water is α=116 – 1160 $Vt/m^2 \cdot K$, the natural convection in gases is α=5,8 – 34,7 $Vt/m^2 \cdot K$.

The process of transferring heat from one body to another through light is called heat exchange through light (radiation). The propagation of heat rays is the conversion of the body's internal energy into electromagnetic waves.

In this heat exchange, the light energy is converted into heat energy and the heat is distributed along the wave front. All objects with a temperature other than absolute zero emit light. The energy intensity of this electromagnetic light is not the same in all bodies. When these rays interact with other objects, some of them are absorbed by the body. Some go back and the rest go. This physical condition depends on the properties of the body and the energy of the light.

When light energy interacts with and absorbs heat, the internal energy of that medium increases [5]. Light energy has a certain wavelength and frequency and travels at the speed of light in a vacuum. A photon is taken as a particle that carries light energy. A photon has a certain mass as it moves, and at rest its mass is zero.

The energy of light in the form of light interacts with objects in the wavelength range from $5 \cdot 10^{-14} м$ to $10^4 м$. Cosmic radiation λ= $5 \cdot 10^{-14}$ m, Radio waves λ= $10^{-2} - 10^4$ m,
The light-scattering property of an object is expressed as E the amount of light energy of the waves of all frequencies propagating from the surface of the object per unit time at a given temperature:

$$q = \frac{E}{St}. \qquad (10)$$

This means that the energy of light incident on the surface of an object is equal to the sum of the absorbed, reflected, and transmitted rays:

$$E_T = E_A + E_R + E_D, \qquad (11)$$

In this case E_T, E_A, E_R, E_D, it is the energy of light that enters, absorbs, returns and passes through the body, respectively. In order to simplify and reveal the essence of the equation, we divide E_T equation (11) by:

$$\frac{E_A}{E_T} + \frac{E_R}{E_T} + \frac{E_D}{E_T} = 1$$

If we express the ratios in terms of the absorption A, return R, and conversion D coefficients, respectively, the equation looks like this:

$$A + R + D = 1, \qquad (12)$$

The resulting equation is called the heat balance equation. If $R = D = 0$ so, the absorption coefficient is equal, that is, all the wavelengths of light incident on the surface of the body are completely absorbed. Such a body is called an absolute black body.

An absolutely black body is invisible because it absorbs light of all wavelengths. Absolute black matter does not exist in nature. But there are those who are closer to it in some respects. For example, the light absorption coefficient for a structure $A = 0{,}9 - 0{,}96$. There are objects in nature that absorb heat, but absorb and reflect visible light well. Examples include ice, snow, and glass.

If $A = D = 0$ the condition, that is, the reflection coefficient, is equal, all the rays of the same wavelength incident on the surface of the body will return. The diffusion of light from such an object (Latin for diffusion, meaning leakage) is called a white body.

If $A = R = 0$ the condition, that is, the transmittance, are equal, the light incident on the surface of the body will pass through it. Such a body is called an absolutely transparent body. Transparent bodies are called diathermic, that is, they do not absorb heat rays. From the ideas and considerations set out above, it is clear that there are no absolutely black, white, and transparent bodies in nature, but only those that are closer to them. Heat transfer through light is mainly explained in detail using the laws of M. Planck, W. Vin, Stefan-Bolstman, Kirchhoff [7].

The intensity of the spectrum of light flux at a specific wavelength is expressed as follows:

$$I_{\lambda i} = \frac{\Delta E}{\Delta\lambda}, \qquad (13)$$

Where dE is the electromagnetic wave energy emitted at $d\lambda$ a given wavelength.

The relationship between the temperature of an absolutely black body and the wavelength of the spectrum of light scattering flux was established by M. Planck in 1900 and given a mathematical expression:

$$I_{0_\lambda} = \frac{C_1\lambda^{-3}}{e\frac{C_2}{\lambda T}-1}, \qquad (14)$$

Where $C_1 = 3{,}74\cdot10^{-16} Vt/m^2$ and $C_2 = 1{,}44\cdot10^{-2} m\cdot K$ - radiation constants; λ and T - the wavelength of the propagating light and the absolute temperature of the object at the time of irradiation; e-basis of natural logarithms.

DISCUSSION:

The intensity of the light flux emitted by the surface of an absolutely black body is the product of the intensity of $I_{0\lambda i}$ the radiation spectrum and the wavelength of dA that light, i.e.

$$\Delta E_0 = I_{0\lambda i}\cdot\Delta\lambda. \qquad (15)$$

By integrating this equation between zero and infinity, we can find the intensity of the light flux emitted by an absolute black body at a given temperature per unit time, that is, its ability to scatter light:

$$E_0 = \sigma_0 T^4. \qquad (16)$$

This law is named after Stephen-Bolstman. In this case $\sigma_0 = 5{,}67\cdot10^{-8}\frac{\mathrm{Vt}}{\mathrm{m}^2\cdot K}$ -, the radiation constant of an absolutely black body.

Hence, the ability of an absolutely black body to emit light over a unit time (energy at all wavelengths) is proportional to the fourth degree of absolute temperature.

In 1882, G. Kirchhoff studied the relationship between the absorption and distribution of heat rays of absolute black and gray bodies and discovered the following law:

$$\frac{E_1}{A_1} = \frac{E_2}{A_2} = \frac{E_3}{A_3} = \ldots = \frac{E_0}{A_0} = E_0(T), \qquad (17)$$

Where $\frac{E_1}{A_1} = E_0$ - is the ability of an absolutely black body to scatter light.

The more light an object emits, the more it absorbs, that is, the wavelengths of the light it absorbs and emits are the same:

$$\varepsilon_\lambda = A_\lambda, \qquad (18)$$

In various fields of technology it is required to reduce heat transfer by light flux. For example, in some shops it is necessary to protect workers from radiation from high-temperature surfaces. In such cases, the screen can be set. Typically, the screen can be made of thin material with high reflectivity. Installing a single screen halves the radiant heat output.

Also, the installation of two screens reduces the radiant heat output by three times and the installation of n screens (n + 1). The screen setup efficiency is very high when the screen is made of a small amount of black material.

Radiation and light absorption properties of different gases are different. For example, monoatomic and diatomic gases (hydrogen, oxygen, nitrogen, helium, etc.) emit heat rays. Tri- and polyhydric gases (carbon dioxide, water vapor, ammonia, etc.) have stronger radiation and light absorption properties and are widely used in practice. The Venn diagram can be used to give students a deeper understanding of the properties of different types of heat transfer.

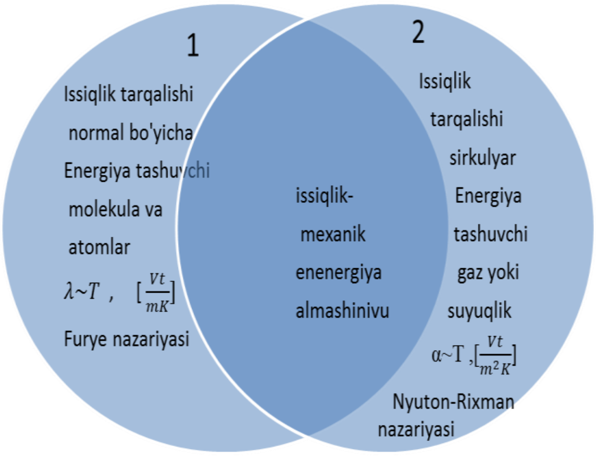
In hot areas, window panes are selected based on the properties of these gases to conduct less heat.

If we give the characteristics of the types of heat exchange in tabular form, the student will gain in-depth knowledge.

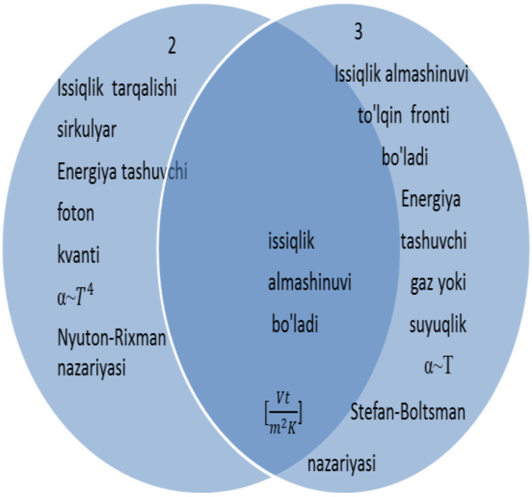
Table 1. Types of heat transfer and their characteristics.

Properties and magnitudes in heat transfer	Thermal conductivity at the expense of heat exchange	Convective heat exchange	By means of light heat exchange
Energy exchange	Heat-mechanical	Heat-mechanical	Light-heat energy
Heat dissipation trajectory	By default	Circular	Wave front
Energy carrier (agent)	Molecules and atoms	Gas or liquid	Electromagnetic waves, photon quantum
Temperature dependence of heat flux	Correctly proportional	Correctly proportional	quadratic parabolic connection
Proportionality coefficient	λ	α	C_0
Participating physical quantities	T, q,Q,V,μ,	T, q,Q,V,μ,	T, q,Q,V,μ,λ, ρ
Units of proportionality coefficient	$\left[\frac{\text{Vt}}{\text{m}\cdot\text{K}}\right]$	$\left[\frac{Vt}{m^2\cdot K}\right]$	$[Vt/m^2\cdot K]$
Authors of the theory of heat transfer	Fourier	Newton , Rixman	Stefan-Bolstman

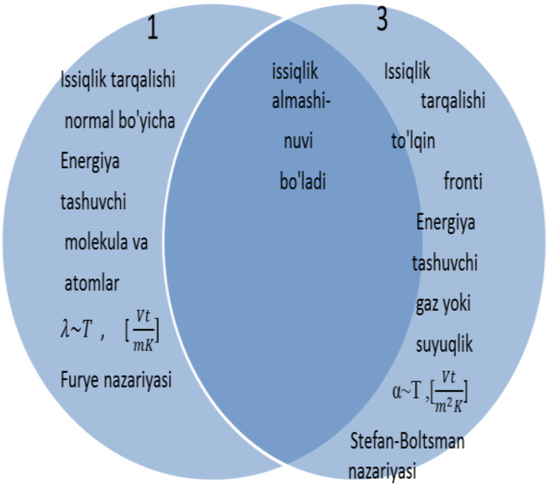
Diagrams are created based on the table



1.Thermal conductivity
2. Convective heat exchange

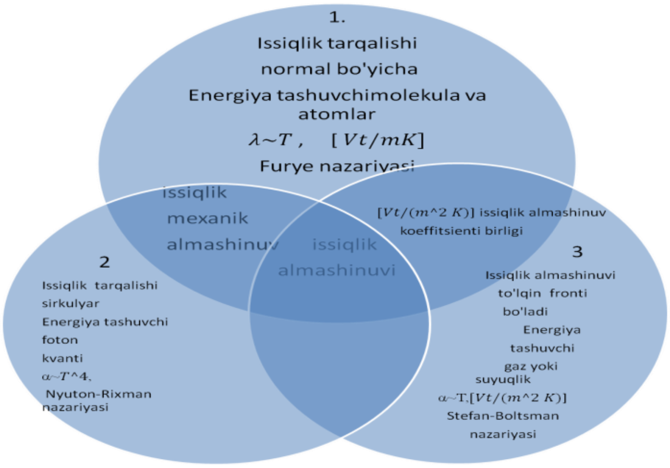


2. Convective heat exchange
3. Exchange through light



1. Thermal conductivity
3. Exchange through light

Combining the above diagrams can result in the following



CONCLUSION:

Disclosure of areas of application and formulas of data on heat transfer and heat transfer can be of practical help for in-depth study of topics related to heat transfer and heat transfer in grades 9-10 of the school. They will have to choose a profession for themselves. By attracting people to this field, it is possible to create a basis for young people to choose a profession.

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