Міністерство освіти і науки України

НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ
«ОДЕСЬКА ПОЛІТЕХНІКА»

ІНОЗЕМНА (АНГЛІЙСЬКА) МОВА

МЕТОДИЧНІ ВКАЗІВКИ ДО ПРАКТИЧНИХ ЗАНЯТЬ З АНГЛІЙСЬКОЇ МОВИ ДЛЯ ЗДОБУВАЧІВ І КУРСУ СПЕЦІАЛЬНОСТІ G4.02 Енерговиробництво «Теплоенергетика та енергоефективні технології»

2 семестр

Одеса НУОП 2025

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2 семестр

Затверджено на засіданні кафедри
іноземних мов
Протокол № 4 від 9.12.2025

Одеса НУОП 2025

Методичні вказівки до практичних занять з англійської мови для здобувачів 1 курсу спеціальності G4.02 Енерговиробництво «Теплоенергетика та енергоефективні технології» 2 семестр /Укл. Л.М.Шапа, Борисенко Т.І. – Одеса: НУОП, 2025.

G4.02 Енерговиробництво «Теплоенергетика та енергоефективні технології»

Укладачі: Л.М.Шапа кандидат філол. наук, доцент,

Т.І.Борисенко, к.філ.н., доцент

Передмова

Методичні вказівки для роботи зі здобувачами 1 курсу укладено відповідно до Програми вивчення іноземних мов у нефілологічному ВНЗ і спрямовано на розвиток у здобувачів немовних спеціальностей навичок читання та перекладу загально-технічних та науково-технічних текстів, збагачення словникового запасу і оволодіння навичками письма та говоріння.

Практичне володіння іноземною мовою в рамках даного курсу припускає наявність таких умінь, які дають можливість:

- вільно читати оригінальну літературу іноземною мовою у відповідній галузі знань;
- оформляти витягнуту з іноземних джерел інформацію у вигляді перекладу або резюме;
- робити повідомлення і доповіді іноземною мовою на теми, пов'язані з науковою роботою майбутнього фахівця;
- вести бесіду за фахом.

Кожний урок складається з тексту й комплексу мовних вправ, які розраховані на удосконалення навичок активізації словарного і граматичного мінімуму професійного спрямування.

“Методичні вказівки” забезпечують підготовку до міжнародного усного спілкування англійською мовою для спеціальних цілей, а саме - оволодіння лексичними, граматичними і стилістичними навичками, а також умінням читати, перекладати, згортати і розгортати усну англомовну інформацію наукового функціонального стилю.

Lesson 1

Мета заняття: Знати і розуміти математику, фізику, хімію на рівні, необхідному для досягнення результатів освітньої програми українською мовою та хоча б однією із поширених європейських мов

What is thermal engineering

Thermal engineering is a broad field of engineering that encompasses technologies dealing with heating and cooling systems, transfer of heat, and fluid mechanics. Instruments that control temperature are essential in many areas, including the electric power industry; the automobile industry; and the heating, ventilation, and air conditioning industry. The principles of thermal engineering are also crucial to the operation of vehicles and other machines.

Heat transfer is a major concern within the field. The transfer of energy, in the form of heat, across different physical regions is heat transfer. When an area of high temperature is next to an area of lower temperature, heat naturally flows from the higher-temperature region to the lower-temperature region. This principle, known as conduction, is used in many thermal engineering settings to increase or decrease the temperature of a system. Insulation, for example, minimizes the conduction of heat and keeps temperature regions relatively distinct.

The heating and cooling of liquids is important in many industrial settings, and constitutes another branch of thermal engineering. An engineer in this field must also understand fluid dynamics. Coolant, a cooling substance, is used to reduce the temperature of processes and prevent overheating. Boiling is another method used to create a pour which may be condensed in refining a chemical product. The study of these processes helps thermal engineers determine the optimal regulation of temperature in each case.

Thermal engineering has applications outside industrial plants as well. An example is the HVAC industry, which deals with refrigeration, ventilation, and temperature regulation within buildings. An office building in a hot, humid climate may need more ventilation and air conditioning to promote cooling than the same building in a cold climate. Commercial establishments such as restaurants may require extensive refrigeration systems for the storage of food. All of these technical considerations would be within the realm of this type of engineering.

On a smaller scale, vehicles such as cars use thermal engineering in their everyday function. The heating and cooling of the car are controlled by thermal management systems integrated into the design. Heat transfer, fluid dynamics, and other principles of engineering are at work in cooling the engine and maintaining oil flow.

Thermal engineering is important to the design of almost any machine. Mechanical elements and electric circuits generate heat during operation, and the build-up of heat can often threaten the device. Cooling mechanisms, usually fans or liquid circulators, are added to compensate and help regulate the machine’s internal temperature. Devices that use this principle include computers and car batteries.

Thermal engineers must know about the economics of the components and processes they design to make sure they not only provide an improvement over the existing solutions but also don’t lose the company money. Thermal Engineers are not limited in areas of specialisation and can work in numerous fields. Below is only a brief example of areas a Thermal Engineer can work in:

- Heating, Ventilation and Air Conditioning (HVAC) systems in small and large-scale residential, commercial or industrial buildings.
- Renewable energy systems.
- Military and defence equipment.
- Electronics and electrical component and systems.
- Aerospace components.
- Boiler, heat exchanger, and pump design, amongst others.

Common industries that regularly employ Thermal Engineers include power companies, the automotive industry and commercial construction. While Thermal Engineers will generally spend most of their time working in an office they are often required to travel to the site of their current project.

Exercise 1. Answer the questions after the text.

1. Who is a thermal engineer?
2. What branches can thermal engineering be applied in?
3. What is heat transfer?
4. What are the main principales of thermal engineering?
5. What thermal engineering principles are used in modern cars?
6. What are the expertise areas of a thermal engineer?

Exercise 2. Match the words with their definitions.

1) heating system
2) cooling system
3) overheating c) the study of fluids and how forces affect them;
4) storage d) a system or means of providing fresh air;
5) ventilation
6) vehicle
restaurant, private office, fitness club, oil rig,retail store;
7) heat transfer
8) fluid dynamics
9) commercial establishment
10) prevent j) a means of carrying or transporting something.
a) space or a place for storing;
b) is a phenomenon of rising temperatures thatcan cause damage and fire;
c) the study of fluids and how forces affect them;
d) a system or means of providing fresh air;
e) is a mechanism for maintaining temperatures atan acceptable level;
f) means an establishment used for commercial purposes, such as a bar,
g) a system that keeps air cool and dry;
h) to keep from happening or existing;
i) the flow of heat (thermal energy) due to temperature differences

Exercise 3. Complete the text with the given phrases.

electricity customers transmission and
distribution
fossil fuels rapid increase
power generation located in reduced demand radical change

The European power sector is undergoing 1_________. The decades-old architecture of large generators 2_______ relatively few locations and mainly run on 3 ________, nuclear and hydro is being transformed as renewable power generation, distributed generation and demand response come to play an increasing role. 4 ________ are becoming presumers, and emerging value pools further down the electricity value chain – that is, closer to customers – are becoming increasingly central to the business. In the meantime, the system has witnessed a 5 ________ in renewables with low variable cost, while the economic crisis has 6 ________. Taken together, these two developments have seriously affected the business case for 7 __________. Wholesale prices have fallen and running hours of thermal generation have decreased. Efficient 8 __________ of electricity is a fundamental requirement for providing societies and economies with essential energy resources.

Exercise 4. Translate the following sentences into English.
1. З кожним роком зростає вартість енергоресурсів.
2. Найкращим способом економії є енергозберігаючі системи.
3. Теплоізоляція приміщення дозволить заощадити на опаленні.
4. Однією з важливих порад є встановлювати охолоджувальні прилади подалі від опалювальних.
5.Теплоенергетика переважає серед традиційних видів електроенергетики
6. Розвиток теплової енергетики сприяє підвищенню енергозабезпечення промисловості та інших галузей господарства
7. Ціна електроенергії для промисловості в Україні є на 33% нижчою, ніж у середньому по країнах ЄС,
8. Вентиляція громадських будівель має велике значення і повинна відповідати встановленим нормам.
9. Принцип дії вентиляційної системи заснований на заміні відпрацьованого повітря в приміщення повітрям з вулиці.
10. Вентиляційні установки з рекуператором є найбільш ефективнішими на сьогоднішні, адже вони мають досить високий ККД.

Exercise 5. Compose an essay on the following topics:
"The characteristics of heating and cooling liquids"
"Heat generation of mechanical element and electric circuit"

Lesson 2

Мета заняття: Вміти знаходити необхідну інформацію в технічній літературі, наукових базах даних та інших джерелах інформації, критично оцінювати і аналізувати її.

Renewable recourses

Geothermal energy has been used for thousands of years in some countries forcooking and heating. It is simply power derived from the Earth's internal heat. This thermal energy is contained in the rock and fluids beneath Earth's crust. It can be found from the shallow ground to several miles below the surface, and even farther down to the extremely hot molten rock called magma.

These underground reservoirs of steam and hot water can be tapped to generate electricity or to heat and cool buildings directly.

A geothermal heat pump system can take advantage of the constant temperature of the upper ten feet (three meters) of the Earth's surface to heat a home in the winter while extracting heat from the building and transferring it back to the relatively cooler ground in the summer.

Geothermal water from deeper in the Earth can be used directly for heating homes and offices, or for growing plants in greenhouses. Some U.S. cities pipe geothermal hot water under roads and side-walks to melt snow.

To produce geothermal-generated electricity, wells, sometimes a mile (1.6 kilometres) deep or more, are drilled into underground reservoirs to tap steam and very hot water that drive turbines linked to electricity generators. The first geothermally generated electricity was produced in Larderello, Italy, in 1904.

There are three types of geothermal power plants: dry steam, flash, and binary. Dry steam, the oldest geothermal technology, takes the steam out of fractures in the ground and uses it to directly drive a turbine. Flash plants pull deep, high-pressure hot water into cooler, low-pressure water. The steam that results from this process isused to drive the turbine. In binary plants, the hot water is passed by a secondary
fluid with a much lower boiling point than water. This causes the secondary fluid to turn to vapour, which then drives a turbine. Most geothermal power plants in the future will be binary plants.

Geothermal energy is generated in over 20 countries. The United States is the world's largest producer, and the largest geothermal development in the world is The Geysers north of San Francisco in California. In Iceland, many of the buildings and even swimming pools are heated with geothermal hot water. Iceland has at least 25 active volcanoes and many hot springs and geysers.

There are many advantages of geothermal energy. It can be extracted without burning a fossil fuel such as coal, gas, or oil. Geothermal fields produce only about one-sixth of the carbon dioxide that a relatively clean natural-gas-fueled power plant produces. Binary plants release essentially no emissions. Unlike solar and wind energy, geothermal energy is always available, 365 days a year. It's also relatively inexpensive; savings from direct use can be as much as 80 per cent over fossil fuels.

But it has some environmental problems. The main concern is the release of hydrogen sulfide, a gas that smells like a rotten egg at low concentrations. Another concern is the disposal of some geothermal fluids, which may contain low levels of toxic materials. Although geothermal sites are capable of providing heat for many decades, eventually specific locations may cool down.

Exercise 2. Answer the questions to the text.
1. What is geothermal energy?
2. How does the heat pump system work?
3. How is geothermal-generated electricity produced?
4. What are the advantages of geothermal energy?
5. What is a geothermal impact on the climate?

Exercise 3. Match terms and their definitions
1) Earth crust
2) Magma
3) Heat pump system
4) Extract
5) Greenhouse
6) Cooler
7) Turbine
8) Boiling point
9) Geothermal field
10) Hydrogen sulfide

a) a device that transfers heat energy from a source of heat to what is called a thermal reservoir;
b) a container or apparatus, as an insulated chest, in which something may be cooled or kept cool;
c) a rotary mechanical device that extractsenergy from a fluid flow and converts it into useful work;

d) temperature at which the pressure exerted by the surroundings upon a liquid is equaled by the pressure exerted by the vapour of the liquid;
e) a thin shell on the outside of Earth, accounting for less than 1% of Earth's volume;
f) the space occupied by the installation of geothermal system, wells are dug in the ground at a regular interval;
g) remove or take out, especially by effort or force;
h) a colourless chalcogen hydride gas with the characteristic foul odour of rotten eggs;
i) hot fluid or semi-fluid material below or within the earth's crust from which lava and other igneous rock is formed on cooling;

j) a glass building in which plants that need protection from cold weather are grown

Exercise 3. Translate the following sentences into English.
1. Найбільша гідроелектростанція в Україні, Дніпровська ГЕС, введена в експлуатацію у 1968 році.
2. Будівництво гідроелектростанцій вирішило проблему безперебійного забезпечення електроенергією і водою населення, промисловості та сільського господарства.
3. Українські ГЕС технічно застарілі, а зношені механізми можуть спричиняти аварії.
4. Геотермальна енергія — це енергія, що отримується від природного тепла Землі з її глибинних шарів.
5. На початку XX століття, зростання попиту на електроенергію призвело до розгляду геотермальної енергії як джерела для генерування електричної енергії.
6. Геотермальні електростанції до недавнього часу будувались виключно у місцях де високотемпературні геотермальні ресурси були доступні біля поверхні
7. Підвищення ефективності роботи геоТЕС вимагає вищої температури геотермальних ресурсів та розробки спеціалізованих термодинамічних циклів
8. Геотермальні станції мають відносно простий рівень автоматизації.
9. Техніко-економічні показники таких електростанцій зазвичай перевищують показники електростанцій такої ж потужності, що працюють на рідкому паливі чи вугіллі.
10. Основні обсяги української електроенергії виробляють на атомних (близько 50%) і теплоелектростанціях (близько 40%).

Exercise 4. Compose an essay on the following topics:
"The positive impact of renewable sources on environment"
"Advantages of geothermal energy"

Lesson 3

Мета заняття: Знати і розуміти математику, фізику, хімію на рівні, необхідному для досягнення результатів освітньої програми українською мовою та хоча б однією із поширених європейських мов.

Why energy efficiency matters. Part 1

Global energy demand is increasing at a steady pace. To meet that demand and sustain economic development, trillions of dollars will be invested over the coming decades. As demand grows, energy subsidies, government transfers, guarantees to state-owned utilities, and energy imports will also increase, placing enormous fiscal burdens on governments. But phasing out energy subsidies and introducing new energy and environmental taxes to curb demand will provoke social tensions and adversely affect the poor and most vulnerable. Concerns over energy security have led to a growth in domestic resource exploitation, including fossil fuels.

Energy efficiency should be the “first fuel” of energy policymakers and governments around the globe. It can help meet growing energy demands cleanly and cheaply, increase competitiveness, generate employment, secure energy, reduce poverty, and benefit development. Harnessing energy efficiency can facilitate a more efficient allocation of resources across the global economy, potentially boosting economic output by US$18 trillion through 2035. Improved energy efficiency in industry modernizes factories, increasing productivity and competitiveness. This fosters economic growth and creates and protects long-term employment opportunities. In the urban and public infrastructure sectors, energy efficiency can help local governments provide more reliable public services, such as heating, power, public lighting, and water, while reducing costs. Freed up fiscal resources can then be used for socioeconomic development and for programs benefitting people living in poverty. Energy efficiency mitigates the impact of ongoing tariff reforms, which adversely affect poorer households, and it is a relatively inexpensive method for reducing global and local pollution.

Back in 2017, energy efficiency campaigners had reasons to be cheerful. The government’s new Clean Growth Strategy adopted their aspirations to significantly upgrade the efficiency of existing homes, establish green mortgages to incentivise enhancements, and raise energy standards for all new developments.

The strategy outlined an overall approach to linking emissions reductions in buildings, industry, power and transport while growing jobs and the economy. Energy efficiency was a key part of the plan.

Energy use in the home accounts for 20% of the UK’s carbon emissions, according to the government, meaning that improving energy efficiency has huge potential in helping reach its target of net-zero emissions by 2050. It would also help the estimated 2.55 million people in the UK who live in fuel poverty.

Exercise 1. Answer the following quextions:

1.What modern tendencies are the fiscal burden for the government?

2. Why is energy efficiency considered the first fuel?

3. Is heating power more reliable public services?

Exercise 2. Match the words with their definitions.

1) Strategy
2) Incentive
3) Financial rebate
4) Efficiency
5) Employment

a) negotiated return of a portion of the interest earned by the lender of stock to a short

b) a device that transfers heat from a colder area to a hotter area by using mechanical energy, as in a refrigerator;seller;

c) a rule or directive made and maintained by an authority;

d) a thing that motivates or encourages someone to do something;

e) a plan of action designed to achieve a longterm or overall aim

Exercise 3. Compose an essay on the following topics:
"Global energy demand"
"The preferences to the fuel"

Lesson 4

Мета заняття: Вміти знаходити необхідну інформацію в технічній літературі, наукових базах даних та інших джерелах інформації, критично оцінювати і аналізувати її.

Why energy efficiency matters. Part 2

But the challenge is huge. The UK has 28 million homes that need retrofitting, many of which are at a very low standard, earning the country the reputation of having some of the least efficient homes in Europe. In addition, the government has a target to build 300,000 homes a year by the mid-2020s to house a growing population. Without stronger standards, the risk is that these new homes will add to the volume of houses that will eventually need retrofitting. In order to start ramping up to this, the government wants to bring in some measures covering energy efficiency and ventilation later this year. It has proposed two options: a 20% reduction in carbon emissions, largely achieved through very high fabric standards such as glazing, walls, floors, and roof materials to limit heat loss; and a 31% reduction through the use of additional technologies such as solar PV panels and heat pumps.

The government has stated a preference for the second option. However, this is problematic for the industry as the UK lacks manufacturing and installation skills for heat pumps. In a market-based economy, the most pain-free and effective way to achieve objectives is to create incentives for actions that support our objectives. To encourage a reduction in fossil fuel use, we need to set specific carbon reduction targets and outline an array of actions needed to reach the objectives. Offering a range of potential actions allows businesses and the public to choose a set of actions they can implement, consistent with their economic and personal situations.

Finally, we need to be sure the actions have a positive return on investment. For example, if we want farmers to rebuild their soils to, they need to be economically rewarded to make this transition. If we want homeowners to install solar panels, their return on investment needs to be not only positive, but rapid. Incentives can be extrinsic (coming from outside), based on regulations, taxes, subsidies, favourable financing, and tax breaks, or intrinsic (coming from within), based on a positive return on investment, or other less tangible benefits such as improved health and comfort. In most cases, all that is needed to get people and businesses to take action based on intrinsic incentives is to provide education and motivational appeal – a commonly recognized strength of the marketplace.

Combining small extrinsic incentives to support intrinsic incentives may create the quickest and most effective road to significant change. State and local governments and utilities have a long history of creating successful financial rebates and educational programs that utilize this strategy
to reduce energy use.

Exercise 1. Answer the following questions:
1. What are the modern incentives for the energy sector development?
2. What energy-efficient technologies are proposed by the government?
3. What incentive for goal reaching are suggested?
4. Why is this problematic for the UK industry?

Exercise 2. Match the words with their definitions.

1) Tax
2) Heat pump
3) Regulation
4) Market economy
5) Implement

a) an economic system in which production and prices are determined by unrestricted competition between privately owned businesses;
b) the state of having paid work
c) a compulsory contribution to state revenue, levied by the government on workers' income and business profits, or added to the cost of some goods, services, an transactions;
d) the ratio of the useful work performed by a machine or in a process to the total energy expended or heat taken in;
e) put (a decision, plan, agreement, etc.) into effect.

Exercise 3. Compose an essay on the topics:
"Reduction in fossil fuel use"
"Storing the carbon"

Lesson 5

Мета заняття: Знати і розуміти математику, фізику, хімію на рівні, необхідному для досягнення результатів освітньої програми українською мовою та хоча б однією із поширених європейських мов.

Heat pumps

For climates with moderate heating and cooling needs, heat pumps offer an energy-efficient alternative to furnaces and air conditioners. Like your refrigerator, heat pumps use electricity to move heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. During the heating season, heat pumps move heat from the cool outdoors into your warm house and during the cooling season, heat pumps move heat from your cool house into the warm outdoors. Because they move heat rather than generate heat, heat pumps can provide equivalent space conditioning at as little as one quarter of the cost of operating conventional heating or cooling appliances.

There are three types of heat pumps: air-to-air, water source, and geothermal. They collect heat from the air, water, or ground outside your home and concentrate it for use inside. The most common type of heat pump is the air-source heat pump, which transfers heat between your house and the outside air. Today's heat pump can reduce your electricity use for heating by approximately 50% compared to electric resistance heating such as furnaces and baseboard heaters. High-efficiency heat pumps also dehumidify better than standard central air conditioners, resulting in less energy usage and more cooling comfort in summer months. Air-source heat pumps have been used for many years in nearly all parts of the United States, but until recently they have not been used in areas that experienced extended periods of subfreezing temperatures. However, in recent years, air-source heat pump technology has advanced so that it now offers a legitimate space heating alternative in colder regions.

For homes without ducts, air-source heat pumps are also available in a ductless version called a mini-split heat pump. In addition, a special type of air-source heat pump called a "reverse cycle chiller" generates hot and cold water rather than air,allowing it to be used with radiant floor heating systems in heating mode. Geothermal (ground-source or water-source) heat pumps achieve higher efficiencies by transferring heat between your house and the ground or a nearby water source. Although they cost more to install, geothermal heat pumps have low operating costs because they take advantage of relatively constant ground or water temperatures.

Geothermal (or ground source) heat pumps have some major advantages. They can reduce energy use by 30%-60%, control humidity, are sturdy and reliable, and fit in a wide variety of homes. Whether a geothermal heat pump is appropriate for you will depend on the size of your lot, the subsoil, and the landscape.

Ground-source or water-source heat pumps can be used in more extreme climates than air-source heat pumps, and customer satisfaction with the systems is very high.

A new type of heat pump for residential systems is the absorption heat pump, also called a gas-fired heat pump. Absorption heat pumps use heat as their energy source, and can be driven with a wide variety of heat sources.

Exercise 1. Answer the following questions.
1. Why are heat pumps so essential in modern industry?
2. How many types of heat pumps exist?
3. What are the main functions of heat pumps?
4. Why are heat pumps so efficient in comparison to standard compressors?

5.What advanced features are typical for modernized samples of heat pumps?

Exercise 2. Find English equivalent in the text.
1. тепловий насос з джерелом
2. автоматичні заслінки
3. працювати на повну швидкість
4. температура замерзання
5. холодоагент
6. працювати на повну потужність
7. осушувати
8. бути оснащеним пальниками
9. типовий поршневий компресор
10. виробляти тепло

Exercise 3. Match the words with their definitions.
1. reliable
2. to reduce
3. customer
4. capacity
5. to operate

a) to break the back of the problem
b) ventilator
c) supply
d) work/run
e) absorb

Exercise 4. Choose the word or word combination from the text above to fill in the gaps.
Air-source heat pumps are also available in a ductless version called a 1_________pump. The most common type of heat pump is the 2 ________, which transfers heat between your house

and the outside air. There are three types of heat pumps: 3 ________, water source, and geothermal. Heat pumps use 4 _______to move heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. Air-source heat pump technology 5 ________so that it now offers a legitimate space heating alternative in colder regions. Geothermal (or ground source) heat pumps can 6 ________energy use by 30%-60%, control 7 _______, are sturdy and reliable, and fit in a wide variety of homes.

Exercise 5. Compose an essay on the following topics:
“The operation of heat pump”
“Types of heat pump”
“Geothermal heat pump”

Lesson 6

Мета заняття: Знати і розуміти математику, фізику, хімію на рівні, необхідному для досягнення результатів освітньої програми українською мовою та хоча б однією із поширених європейських мов.

Advanced Features to Look for in a Heat Pump

A number of innovations are improving the performance of heat pumps. Unlike standard compressors that can only operate at full capacity, two-speed compressors allow heat pumps to operate close to the heating or cooling capacity needed at any particular moment. This saves large amounts of electrical energy and reduces compressor wear. Two-speed heat pumps also work well with zone control systems.

Zone control systems, often found in larger homes, use automatic dampers to allow the heat pump to keep different rooms at different temperatures. Some models of heat pumps are equipped with variable-speed or dual-speed motors on their indoor fans (blowers), outdoor fans, or both. The variable-speed controls for these fans attempt to keep the air moving at a comfortable velocity, minimizing cool drafts and maximizing electrical savings. It also minimizes the noise from the blower running at full speed.

Many high-efficiency heat pumps are equipped with a desuperheater, which recovers waste heat from the heat pump’s cooling mode and uses it to heat water. A desuperheater-equipped heat pump can heat water 2 to 3 times more efficiently than an ordinary electric water heater.

Another advance in heat pump technology is the scroll compressor, which consists of two spiral-shaped scrolls. One remains stationary, while the other orbits around it, compressing the refrigerant by forcing it into increasingly smaller areas. Compared to the typical piston compressors, scroll compressors have a longer operating life and are quieter. According to some reports, heat pumps with scroll compressors provide 10° to 15°F (5.6° to 8.3°C) warmer air when in the heating mode, compared to existing heat pumps with piston compressors.

Although most heat pumps use electric resistance heaters as a backup for cold weather, heat pumps can also be equipped with burners to supplement the heat pump. Back-up burners help solve the problem of the heat pump delivering relatively cool air during cold weather and reduces its use of electricity. There are few heat pump manufacturers that incorporate both types of heat supply in one box, so these configurations are often two smaller, side-by-side, standard systems sharing the same ductwork.

The combustion fuel half of the system could be propane, natural gas, oil, or even coal and wood. In comparison with a combustion fuel-fired furnace or standard heat pump alone, this type of system is also economical. Actual energy savings depend on therelative costs of the combustion fuel relative to electricity.

Exercise 1. Answer the following questions.
1.Why are two-speed compressors more preferable?
2. What kind of motors are some models of heat pumps equipped?
3. What is scroll-compressor?
4.Should heat pumps be equipped with burners?

Exercise 2. Explain the meaning of the following expressions.
1. scroll compressor
2. desuperheater-equipped heat pump
3. comfortable velocity
4. automatic dampers
5. reduces compressor wear
6. dual-speed motors
7. at any particular moment
8. to improve the performance of heat pumps
9. residential systems
10. absorption heat pump

Exercise 3. Match the words with their definitions.
1. fans
2. to provide
3. to solve
4. to incorporate
5. to depend on

a) client
b) be contingent on
c) dependable
d) volume
e) to lessen

Exercise 4. Translate the following sentences into English.
1. Високоефективні теплові насоси також краще осушують порівняно з стандартними кондиціонерами, що в свою чергу призводить до меншого споживання енергії та більшого комфорту при охолоджені в літній період.
2. Теплові насоси використовують електроенергію для того, щоб перемістити тепло з прохолодного місця в тепле, роблячи холодний простір ще холоднішим, а теплий теплішим.
3. Існує три пити теплових насосів: повітряний, водний та геотермальний.
4. Сучасний тепловий насос може скоротити споживання електроенергііприблизно на 50%
5. Технологія повітряних теплових насосів вдосконалилася, тому в холодних регіонах пропонують уже законну альтернативу опаленню приміщень.
6. Установка геотермальних теплових насосів коштує дорожче, вони характеризуються низькими експлуатаційними затратами оскільки мають переваги при відносно постійній температурі води та повітря.

7. Поглинаючі теплові насоси використовують тепло як джерело енергії та можуть працювати з широким спектром теплових джерел.
8. Ряд певних нововведень служать для покращення роботи теплових насосів.
9. Системи управління зонами, які часто зустрічаються у великих будинках, використовують автоматичні заслінки, щоб дозволити тепловому насосу підтримувати в різних кімнатах різну температуру повітря.
10. Деякі моделі теплових насосів оснащено двигунами зі змінною швидкістюю.

Exercise 5. Compose an essay on the following topics:
"Innovations that improve the performance of heat pump"
"The equipment used in heat pumps"

Lesson 7

Мета заняття: Знати і розуміти інженерні науки, що лежать в основі спеціальності «Теплоенергетика» відповідної спеціалізації, на рівні, необхідному для досягнення інших результатів освітньої програми, в тому числі певна обізнаність в останніх досягненнях науки і техніки у сфері теплоенергетики.

Heat exchangers. Part 1

Have you ever watched wisps of smoke drifting from smokestacks and wondered how much energy they are uselessly pumping into the air? Maybe less than you might think! Saving energy is a huge and costly problem for factory bosses and it's one reason they often install devices called heat exchangers to salvage as much heat as possible from waste gases. Heat exchangers have lots of other familiar uses too. Engines in cars, ships, and planes use heat exchangers to work more efficiently, gas boilers use them to heat up hot water, and if you have a refrigerator or an air conditioner in your home, those are using heat exchangers too. So what exactly are heat exchangers and how do they work? Let's take a closer look!

Suppose you have a gas central heating furnace (boiler) that heats hot-water radiators in various rooms in your home. It works by burning natural gas, making a line or grid of hot gas jets that fire upward over water flowing through a network of pipes. As the water pumps through the pipes, it absorbs the heat energy and heats up. This arrangement is what we mean by a heat exchanger: the gas jets cool down and the water heats up.

A heat exchanger is a device that allows heat from a fluid (a liquid or a gas) to pass to a second fluid (another liquid or gas) without the two fluids having to mix together or come into direct contact. If that is not completely clear, consider this. In theory, we could get the heat from the gas jets just by throwing cold water onto them, but then the flames would go out! The essential principle of a heat exchanger is that it transfers the heat without transferring the fluid that carries the heat.

You can see heat exchangers in all kinds of places, usually working to heat or cool buildings or helping engines and machines to work more efficiently. Refrigerators and air-conditioners, for example, use heat exchangers in the opposite way from central heating systems: they remove heat from a compartment or room where it's not wanted and pump it away in a fluid to some other place where it can be dumped out of the way. The cooling fluid is completely sealed inside a network of pipes, so it never actually comes into contact with the air: it takes heat energy from the air inside and dumps it in the air outside, but it never mixes directly with that air.

In power plants or engines, exhaust gases often contain heat that's heading uselessly away into the open air. That's a waste of energy and something a heat exchanger can certainly reduce (though not eliminate entirely - one heat is always going to be lost).

Exercise 1. Answer the following questions.
1. Why are heat exchangers so essential in modern industry?
2. How many types of heat exchangers exist?
3. Describe the main principle of heat exchangers' operation.
4. Define main functions of heat exchangers.
Exercise 2. Find English equivalent in the text.
1. водонагрівальні радіатори
2. система трубопроводу
3. поглинати теплову енергію
4. полум'я
5. основний принцип роботи теплообмінника
6. система центрального опалення
7. відводити тепло з відсіку чи Кімнати
8. охолоджувальна рідина
9. вихлопні гази
10. підніматися в

Exercise 3. Choose the word or phrases from the text above to fill in the gaps.
1. Saving energy is a huge and ______problem for the factory.
2. As the water pumps through the pipes, it ________the heat energy and heats up.
3. A heat exchanger is a device that allows heat from a_______to pass to a second
4. fluid without the two fluids having to mix together or come into direct contact.
5. You can see heat exchangers in all kinds of places, usually working to heat or_______ buildings or helping engines and machines to work more efficiently.
5. In power plants or engines, _________gases often contain heat that's heading uselessly away into the open air.
6. In buses, fluid used to cool down the diesel ________is often passed through a heat exchanger.

Exercise 4. Translate into English.
1. Усі теплообмінники виконують одну і ту ж роботу – передають тепло відоднієї рідини до іншої – проте всі вони працюють за різним принципом.
2. Ви можете побачити теплообмінники в різноманітних місцях, які зазвичай працюють для обігріву чи охолодження приміщень або допомагають двигунам
та техніці працювати ефективніше.
3. Ці дві речовини можуть текти в одному напрямку (що має назву паралельний потік), або в протилежному (що має назву зустрічний потік або протиструм) чи під прямим кутом (перехресний потік).
4. Вода, яка охолоджує двигун, протікає через радіатор, що має безліч паралельних ребер.
5. На електростанціях або ж у двигунах, відпрацьовані гази часто містять тепло, яке марно виходить у відкрите повітря.

Exercose 5. Compose an essay on the following topics
"Heat exchangers operation"
"Types of heat exchangers"
"The main function of exchangers"

Lesson 8

Мета заняття: Знати і розуміти інженерні науки, що лежать в основі спеціальності «Теплоенергетика» відповідної спеціалізації, на рівні, необхідному для досягнення інших результатів освітньої програми, в тому числі певна обізнаність в останніх досягненнях науки і техніки у сфері теплоенергетики.

Heat exchangers. Part 2

The way to solve this problem is with heat exchangers positioned inside the exhaust tail pipes or smokestacks. As the hot exhaust gases drift upward, they brush past copper fins with water flowing through them. The water carries the heat away, back into the plant.

There, it might be recycled directly, maybe warming the cold gases that feed into the engine or furnace, saving the energy that would otherwise be needed to heat them up. Or it could be put to some other good use, for example, heating an office near the smokestack.

In buses, fluid used to cool down the diesel engine is often passed through a heat exchanger and the heat it reclaims is used to warm cold air from outside that is pumped up from the floor of the passenger compartment. That saves the need for having additional, wasteful electric heaters inside the bus.

A car radiator is another kind of heat exchanger. Water that cools the engine flows through the radiator, which has lots of parallel, aluminum fins open to the air. As the car drives along, cold air blowing past the radiator removes some of the heat, cooling the water and heating the air and keeping the engine working efficiently. The radiator's waste heat is used to heat the passenger compartment, just like on a bus.

If you have an energy-efficient shower, it might have a heat exchanger installed in the wastewater outlet. As the water drips past your body and down the plug, it runs through the copper coils of a heat exchanger. Meanwhile, cold water that's feeding into the shower to be heated pumps up past the same coils, not mixing with the dirty water but picking up some of its waste heat and warming slightly – so the shower doesn't need to heat it so much.

All heat exchangers do the same job – passing heat from one fluid to another – but they work in many different ways. The two most common kinds of heat exchanger are the shell-and-tube and plate/fin. In shell and tube heat exchangers, one fluid flows through a set of metal tubes while the second fluid passes through a sealed shell that surrounds them. That's the design shown in our diagram up above.

The two fluids can flow in the same direction (known as parallel flow), in opposite directions (counter flow or counter-current), or at right angles (cross flow). Boilers in steam locomotives work this way. Plate/fin heat exchangers have lots of thin metal plates or fins with a large surface area (because that exchanges more heat more quickly); heat exchangers in gas furnaces (gas boilers) work this way.

Exercise 1.

1.Where is the position of heat exchangers at a power station?
2.What is the operation of car radiator?
3.Where is a heat exchanger in a shower?
4.What is the job of all heat exchangers?

Exercise 2. Explain the meaning of the following expressions.

1. common kinds of heat exchanger
2. shell and tube heat exchanger
3. a sealed shell

4. to flow in the same direction
5. to flow in opposite directions
6. an energy-efficient shower
7. wastewater outlet
8. the copper coils
9. to cool down the diesel engine
10. wasteful electric heater

Exercise 3. Choose the most suitable word to fill in the gaps.

ELECTRIC CIRCUIT

An electric 1_______ is a collection of electrical devices and components connected together for the purpose of processing information or energy in electrical form. An electric circuit may be described mathematically by ordinary differential equations, which may be linear or nonlinear, and which may or may not be time varying.

Electric Charge. In circuit theory, we postulate the existence of an indivisible unit of 2________. There are two kinds of charge, called negative and 3______ charge. The negatively charged particle is called an 4________. Positive charges may be atoms that have lost electrons, called 5_______; in crystalline structures, electron deficiencies, called holes, act as positively charged particles.

Voltage. The 6________of charged particles either requires the expenditure of energy or is accompanied by the release of energy. The voltage, at a point in space, is 7________as the work per unit charge (joules/coulomb) required to 8_______a charge from a point of zero voltage to the point in question.

Sources of Voltage or Electric Potential Difference. A voltage is caused by the 9________ of opposite electric charges and represents the work per unit charge (joules/coulomb) required to move the charges from one point to the other. This separation may be forced by physical motion, or it may be initiated or complemented by thermal, 10________, magnetic, or radiation causes.

Exercise 4. Translate into English

1. Охолоджуюча рідина повністю закрита та знаходиться в системі труб.
2. Наприклад, холодильники та кондиціонери використовують теплообмінники у зворотньому напрямку від системи центрального опалення.
3. Основним принципом роботи теплообмінника є те, що він передає тепло не передаючи рідину, яка несе це тепло.
4. Котел працює, спалюючи природний газ та створюючи лінію чи сітку струменів гарячого газу, що піднімається над водою та тече по всій системі труб.
5. Якщо у вас встановлено енергоефективний душ, він може мати теплообмінник, який встановлено на виході стічних вод.

Exercise 5. Compose an essay on the following topics:

“Use of heat exchangers in traffic”

“Use of heat exchangers at home”

Lesson 9

Мета заняття: Знати і розуміти математику, фізику, хімію на рівні, необхідному для досягнення результатів освітньої програми українською мовою та хоча б однією із поширених європейських мов.

Centrifugal fan. Part 1

Fans are air-blowing machines that create a specific pressure and move air when pressure losses in the ventilation network do not exceed 12 kPa.

Depending on the pressure they generate, fans are divided into the following groups:

- Low pressure – up to 1 kPa with a wheel peripheral speed of 23...55 m/s;
- Medium pressure – 1...3 kPa with a wheel peripheral speed of 40...100 m/s;
- High pressure – 3...12 kPa with a wheel peripheral speed of 100...150 m/s.

Low and medium pressure fans are used in general and local ventilation systems, for dryers and furnaces.

High pressure fans are used primarily for process applications, such as blast blowing in cupola furnaces, in sintering plants, for supplying air to nozzles, in filter cleaning systems, and in pneumatic tube systems.

The most common are axial and centrifugal fans.

An axial fan is a bladed wheel located in a cylindrical casing. As the blades rotate, the air entering the fan is moved axially by the blades.

The advantages of axial fans include simple design, the ability to effectively regulate performance over a wide range by rotating the blades, high air flow, and reversible operation. Disadvantages include relatively low pressure and increased noise. These fans are most often used with low ventilation system resistances (up to approximately 200 Pa), although they can also be used with higher resistances (up to 1 kPa).

A centrifugal fan consists of an impeller with blades, an electric motor mounted on a shaft, an inlet or suction pipe, a discharge pipe, and a fan casing.

The operating principle of a centrifugal fan is as follows. As the impeller rotates, air particles are entrained by the blades into a rotating motion. These air particles are subject to centrifugal forces directed from the center to the walls of the casing. Thus, each air particle undergoes a complex motion: on the one hand, it moves along the blade, and on the other, it rotates with the impeller around its axis. Since the air particles move from the center to the casing wall, a vacuum is created at the center of rotation and in the suction pipe, meaning the air pressure is lower.

Atmospheric pressure. Due to the pressure difference, new air particles from the surrounding atmosphere enter the suction port. This removes contaminated air from any source in mechanical engineering, metallurgy, and other workshops. Air particles, thrown from the center of rotation toward the fan casing, move along the casing and enter the discharge port 5. This compresses the air, increasing its pressure and becoming greater than atmospheric pressure. At a constant rotation speed, the operation of a centrifugal fan is characterized by the following parameters:

1) volume flow rate of the transported gas - capacity V, m3/s;
2) pressure drop ("head") created by the fan - the difference
in the total pressures at the inlet (in the suction port) and outlet (in the discharge port) of the fan.
3) efficiency η the ratio of the power required to move air to the power actually expended by the fan.
4) Fan power consumption Nv, W.

For centrifugal fans, the parameters V, ΔPv, and Nv are interrelated, and a change in one of these quantities changes the others.

The graphical dependencies $\Delta Pv = f1(V)$, $Nv = f2(V)$, $\eta = f3(V)$ are called fan characteristics. They clearly reflect the operating characteristics of the fan and allow the selection of the most efficient fan for a given air duct. These characteristics cannot be obtained with sufficient accuracy based on theoretical calculations. Therefore, in practice, fan characteristics obtained empirically are used. The maximum efficiency value determines the decisive quality of the fan: its efficiency. The fan performance corresponding to maximum efficiency is called optimal, and the corresponding fan operating mode is called optimal.

The most important curve is the pressure-performance curve (P-V)—the so-called pressure characteristic of the fan (the pressure characteristic). To determine this, it is necessary to measure the total pressure at the fan inlet and outlet at various performance values. The total pressure is the algebraic sum of the static and dynamic pressures.

Dynamic, or velocity, pressure depends only on the velocity of the gas and is always positive.

In practice, pipeline pressure can be measured using a U-tube manometer and a pneumometric tube. When measuring pressure with a liquid U-tube manometer, the measured medium with pressure Pa is connected via a metal or rubber tube to one leg of the manometer, and the other leg is connected to the atmosphere, which has a barometric pressure Pb. The height of the liquid column h measures the excess pressure.

Water or alcohol are most often used as the working fluid. The accuracy of a U-tube manometer, provided the liquid levels in the tubes are accurately read, is quite high.

Exercise 1. Memorize the following terms:
ventilation network, wheel peripheral speed, medium pressure, axial fan, bladed wheel, rotating the blades, reversible operation, impeller with blades, suction pipe, a discharge pipe, casing, pressure difference, volume flow rate, the ratio, power consumption, operating mode, performance values.

Exercise 2. Answer the following questions:
1.What characteristic divides fans?
2.What is the design of axial fan?
3.What elements does a centrifugal fan include?
4.What are the operating principles of a centrifugal fan?
5.How can you measure atmospheric pressure?
6.Can you obtain sufficient accuracy with the help of theory?
7. What does dynamic, or velocity, pressure depend on?
8.What substances are used as the working fluid?

Exercise 3. Compose an essay on the following topics:
“The basic characteristics of centrifugal fan”
“The structure of centrifugal fan”

Lesson 10

Мета заняття: Знати і розуміти інженерні науки, що лежать в основі спеціальності «Теплоенергетика» відповідної спеціалізації, на рівні, необхідному для досягнення інших результатів освітньої програми, в тому числі певна обізнаність в останніх досягненнях науки і техніки у сфері теплоенергетики.

Centrifugal fan. Part 2

A throttle device (orifice plate) is used to determine air flow. The principle of using throttle devices to measure gas flow can be understood from the graph of pressure distribution when an orifice plate is installed in a pipe.

We place an orifice plate, which is a washer with an opening d, in a pipeline with a diameter D and measure the pipeline pressure upstream and downstream of the orifice plate. As the pipeline narrows, the air velocity increases from ω1 to ω2, resulting in a pressure drop from P1 to P2, according to Bernoulli's law. Downstream of the orifice plate, the air velocity decreases and the pressure rises to P3, but P3 < P1, meaning that there is a pressure drop across the orifice plate ΔPш = P1 - P3, which is proportional to the square of the air velocity. Knowing the diameter d of the orifice plate opening, we can determine the gas flow rate in cubic meters per second.

Fan performance can be regulated in various ways. One of the most cost-effective methods—variable impeller speed—has not yet gained widespread acceptance due to the difficulties associated with changing the electric motor speed. The most widely used method is damper throttling, which is low in efficiency. In this study, performance regulation will be performed using a damper installed on the inlet manifold.

Description of the laboratory device

The device consists of a centrifugal fan, an asynchronous motor, an intake manifold, a damper, a discharge manifold, a pipeline, and a flow orifice. To measure the total pressure drop at the fan inlet and outlet, right-angled pneumometric tubes and are used, secured in the inlet and discharge manifolds and connected to a U-shaped pressure gauge. The static pressure drop across the flow orifice is measured using straight pneumometric tubes and, secured perpendicular to the pipeline before and after orifice and connected to pressure gauge.

How to operate a centrifugal fan

The order of performance.

1. Plug the unit into the power supply.
2. Once the electric motor has reached its full speed, return the damper to its original position (closed).
3. Measure the power consumed by the electric motor, Nдв, and the pressure drops: total pressure – on the fan (the difference in pressure in the inlet Pп
в and discharge Pп
н pipes) and static pressure – on the flow orifice plate (the difference in pressure before orifice P1 and behind orifice P2).
4. Repeat the experiment at different damper positions.

Exercise 1. Memorize the following terms:
air flow, throttle device, pressure distribution, orifice plate, opening, pipeline pressure upstream and downstream, air velocity, proportional to the square, gas flow rate, cost-effective methods, widespread acceptance, damper throttling, inlet manifold, total pressure drop, U-shaped pressure gauge.

Exercise 2. Answer the questions:
1.What do you use to determine air flow?
2. What happens if the the pipeline is narrows?
3.How can you regulate the fan performance?
4.What does the laboratory device consist of?

5.How to operate a centrifugal fan?

Exercise 3. Compose an essay on the following topics:
“The principle of using throttle devices”
“The centrifugal fans used in laboratories”

Lesson 11

Мета заняття: Знати і розуміти математику, фізику, хімію на рівні, необхідному для досягнення результатів освітньої програми українською мовою та хоча б однією із поширених європейських мов.

Gas Ejector. Part 1

Ejecting is the process of setting a gas in motion under the action of a vacuum created by another gas moving at high velocity.

The high-pressure gas that creates the vacuum is called the ejecting (active) gas, while the gas being set in motion is called the ejected (passive) gas. During the ejection process, turbulent mixing results in the transfer of energy from the high-pressure gas to the low-pressure gas, equalizing their velocities and parameters.

Ejection is the principle behind the operation of ejectors (jet fans) and injectors (jet compressors and pumps).

Ejectors are used to remove gas or liquid from the space adjacent to section. The amount of ejecting gas is typically less than the amount of ejected gas, and the static pressure of their mixture at the outlet is equal to the ambient pressure.

Injectors are used to pump gas or liquid into the space adjacent to section, with the volume of ejecting body typically greater than that of ejected. In terms of design and operating principle, ejectors and injectors are identical. An ejector has the following design features: nozzle for high-pressure ejecting gas, and nozzle for low-pressure ejected gas, mixing chamber, and, usually, a diffuser.

The mixing chamber can be cylindrical or flat rectangular. Sometimes, mixing chambers with variable cross-sections are used. The length of the mixing chamber is selected such that the mixing process is practically complete within it, but it should be as short as possible to reduce hydraulic losses and the overall dimensions of the ejector. A sufficiently homogeneous mixture is ensured with a chamber length of $l_3 = (8...12)\ d_3$. In practice, a shorter length of l_3 is adopted; in ejector engine cooling systems, for example, $l_3 = (1.5...2.5)\ d_3$.

Diffusers are channels in which the kinetic energy of the flow is converted into potential energy, i.e., the pressure increases due to a decrease in velocity. The process of gas outflow from nozzle is characterized by two main equations: the continuity equation and the outflow equation. The first equation is derived from the condition that the mass flow rate of gas in any cross-section of the channel is a constant.

The flow velocity is inversely proportional to the cross-sectional area of the channel, i.e., as the channel narrows, the gas velocity increases. The gas flow equation is derived from the first law of thermodynamics for gas flow.

That is, the amount of heat $q_н$ supplied to 1 kg of gas between two arbitrarily selected cross-sections is spent on changing the internal energy ΔU, on the gas performing work (push work) against external forces lt, and on increasing the kinetic energy of the gas. Push work is a function of the gas's state only and depends only on the initial and final states of the gas.

Gas is supplied through nozzle at a pressure P1 greater than the ambient air pressure. As the channel narrows, the gas velocity increases, and the pressure drops in accordance with equations

(2.2) and (2.10). In section, the active gas pressure is lower than the ambient air pressure, so the air surrounding the nozzle, with a pressure P2 = P0, rushes from the space adjacent to section into the mixing chamber, where its velocity increases and its kinetic energy increases.

In the mixing chamber, the active gas velocity decreases due to the transfer of some of its energy to the ejected air. In section, the mixing process of the ejecting and ejected air flows is complete, and the velocity of the gases in the mixture across the section becomes virtually equal. This occurs due to the presence of diffuser, in which the mixture velocity decreases and the pressure increases, i.e., Part of the kinetic energy is converted into potential energy.

To determine the volumetric air flow rate, it is necessary to know the cross-section of the duct f and the gas velocity, which is determined from the dynamic pressure equation.

Exercise 1. Memorize the following terms:
high-pressure gas, turbulent mixing, homogeneous mixture, ambient pressure, nozzle, mixing chamber, cross-sections, overall dimensions, reduce hydraulic losses, equations, mass flow rate, initial and final states, transfer.

Exercise 2. Answer the questions:
1.What is ejecting?
2. What are ejectors used for?
3. Which design features of an ejector do you know?
4.What are diffusers?
5.How is gas supplied?
6.What is the gas velocity in the mixing chamber?

Exercise 3. Compose an essay on the following topics:
“The functions of a gas ejector”
“The design features of a gas ejector”
“The principal performance of a gas ejector”

Lesson 12

Мета заняття: Знати і розуміти інженерні науки, що лежать в основі спеціальності «Теплоенергетика» відповідної спеціалізації, на рівні, необхідному для досягнення інших результатів освітньої програми, в тому числі певна обізнаність в останніх досягненнях науки і техніки у сфері теплоенергетики.

Gas Ejector. Part 2

As gas moves through a channel, its total pressure is composed of two pressures: static and dynamic. Static pressure P is the difference between the gas pressure in the channel and the ambient air pressure. The static pressure is determined using a U-tube manometer. One end of the pressure gauge is vented to the atmosphere, and the outlet of the other end is positioned perpendicular to the direction of gas flow in the channel.

Dynamic pressure can also be determined using a U-shaped pressure gauge. For this, one end of the pressure gauge is connected perpendicular to the flow, and the other is connected counter-current to the flowю Dynamic pressure is observed only when the gas is moving and depends on its velocity and density.

Throttle flow meters operate based on the change in pressure of a gas or vapor flow as it passes through a restriction (throttle) device. As the flow passes through the restriction device, according to equation its velocity increases, resulting in a pressure drop according to Bernoulli's law.

By measuring the pressure difference upstream and downstream of the restriction device, one can estimate the gas flow rate, since the pressure difference depends on the velocity and, therefore, on the gas flow rate. The difference, or pressure differential, is measured using a liquid manometer.

Orifice plates (flow orifices) are used as throttling devices. Knowing the orifice diameter, one can determine the gas flow rate.

Ejectors are widely used for ventilation of rooms, in exhaust fans for removing exhaust gases from various installations, in ejector engine cooling systems for drawing atmospheric air through the radiator, for pumping hot gases, for atomizing fuel oil in nozzles installed on kilns, in sprayers, in steam turbine units, and in air conditioners.

They are also used for ventilation of moving objects (train cars, ship cabins, bus interiors, etc.). The air flow moves toward the ejector at the speed of the vehicle. A certain amount of air enters the ejector's confuser (a confuser is a device with design and technical characteristics that are the inverse of those of a diffuser; that is, a confuser is designed to reduce the air or liquid flow pressure and increase its velocity), where, according to equation, the air velocity increases, and, according to equation, the static pressure decreases. Thus, a lower pressure is created in the cylindrical section of ejector than in the room; consequently, air from room rushes through the discharge tube, where it is captured by the ejector flow and removed. The system operates more efficiently with increasing vehicle speed. In steady-state mode, it can operate under wind loads.

Using an ejector to pump liquids using the kinetic energy of a moving air flow. The air flow, forced by some device into a cylindrical tube, creates a vacuum in the suction tube (the pressure is lower than the ambient pressure), causing the liquid to rise through the tube and, upon exiting, is atomized by the air flow. Many whitewashing machines and sprayers operate using this principle.

Injectors are used to increase the pressure of gases and vapors, to pump liquid into tanks and various devices. A special case of an injector is the injection burner used in the burners of household gas stoves.

Gas with an excess pressure of several kilopascals, flowing from the nozzle into a mixer shaped like an ejector, draws in the required amount of air from the surrounding environment and mixes with it. The amount of injected air is roughly proportional to the ejector gas flow rate, so when changing the burner's thermal output (by increasing or decreasing the gas flow rate using a valve or tap), the gas-to-air ratio, or excess air coefficient, remains approximately constant. To change this ratio during burner adjustment, a damper or adjustable resistance washer is installed in the air supply line.

Exercise 1. Memorize the terms:

U-tube manometer, connected counter-current, density, vapor flow, restriction device, Orifice plates, engine cooling systems, steady-state mode, household gas stoves, surrounding environment.

Exercise 2. Answer the questions:

1.What is static pressure P?

2. How can you determine dynamic pressure?

3. How does throttle flow meters operate?

4.Where are ejectors widely used?

Exercise 3. Compose an essay on the topics:
“The objects the ejectors are used in”
“Home and production usage of ejectors”

Lesson 13

Мета заняття: Знати і розуміти інженерні науки, що лежать в основі спеціальності «Теплоенергетика» відповідної спеціалізації, на рівні, необхідному для досягнення інших результатів освітньої програми, в тому числі певна обізнаність в останніх досягненнях науки і техніки у сфері теплоенергетики.

Gas Ejector. Part 3

Description of the laboratory installation

The laboratory installation consists of an active nozzle, which can move along a horizontal axis, a mixing chamber, and a diffuser.

A flow orifice is installed in pipe, which supplies air under positive pressure created by a fan. The pressure difference between the orifice and the orifice is measured by a differential water pressure gauge. The air velocity can be calculated from this pressure difference, and then, using the known flow area of the orifice, the volumetric air flow rate V1. There are openings along the length of the mixing chamber and diffuser for measuring dynamic and static pressures using a U-shaped micromanometer.

In liquid U-tube manometers, the pressure or pressure difference of the measured medium is determined by the height h of the equilibrating liquid column.

The measurement limits of such manometers are determined by their geometric dimensions and the density of the equilibrating liquid and, as a rule, do not exceed 105 Pa (750 mmHg). The measurement error is ±2 mm. A micromanometer senses pressure changes through a U-shaped measuring tube. The pressures at both ends of the measuring tube are sensed in countercurrent motion, so when both ends are connected, the pressure difference is measured. If one of the ends is disconnected, the pressure at the measuring point is recorded.

The pressure gauge used in the laboratory is designed to measure pressure differences between 0 and 240mm H2O. It consists of a measuring tube with a millimeter scale, a connecting hose, and a stand on which the U-shaped measuring tube is fixed. The instrument is filled with colored alcohol so that the liquid level in the measuring tube is fixed at the center of the scale. During measurements, the pressure gauge is positioned vertically.

The pressure sensor is a pneumometric tube, which is made of two welded tubes, one of which has an open end bent, and the other is sealed but has holes drilled on the side. Rubber hoses are used to connect the pneumometric tube to the pressure gauge.

The total flow pressure Pp is measured by a bent tube with an open end, the static pressure Pst is measured by a tube whose end is sealed and communicates with the air flow through side holes drilled at some distance from the end, and the dynamic pressure is measured by connecting both tubes to a U-shaped pressure gauge.

When determining dynamic and static pressures, it should be taken into account that the air flow velocity, and therefore the pressure at different points in the cross-section, are not uniform. Therefore, when measuring the pressures Pst and Pdin, it is necessary to find the average pressure for each cross-section by taking several measurements at different points (near the duct wall, at some distance from it, in the center of the duct, etc.). In the laboratory work, it is recommended to take five velocity pressure measurements in the measurement cross-section and three static pressure measurements in each cross-section.

For a large number of measurements, the average pressure value should be found using the square method. For up to five measurements and a small spread of readings, the arithmetic mean pressure can be found.

Exercise 1. Memorize the terms:
differential water pressure gauge, medium, equilibrating liquid, measurement error, U-shaped measuring tube, colored alcohol, Rubber hoses, two welded tubes, uniform, average pressure value.

Exercise 2. Answer the questions:
1.Where is a flow orifice installed?
2.What are the pressure limits of the monometer?
3.What does the pressure gauge consist of?
4.What is a pressure sensor?
5.How is total flow pressure Pp measured ?
6.What should you take into account while determining dynamic and static pressures?

Exercise 3. Compose an essay on the topics:
“Different kinds of measurements in laboratories with Gas Ejector”
“The devices used to measure different phenomena in heat energy”

Lesson 14

Мета заняття: Знати і розуміти математику, фізику, хімію на рівні, необхідному для досягнення результатів освітньої програми українською мовою та хоча б однією із поширених європейських мов.

Applied thermal engineering. Part 1

Applied thermal engineering focuses on the study and implementation of heat transfer principles in industrial and energy applications. With increasing global energy demand and the need for sustainable thermal management, researchers and engineers continuously develop new technologies to enhance heat transfer efficiency, improve energy conversion, and optimize thermal storage. Traditional thermal systems relied on empirical models and experimental validation to improve performance. However, recent advancements integrate computational fluid dynamics (CFD), artificial intelligence (AI), phase change materials (PCMs), and nanotechnology to enhance heat dissipation and energy utilization. Innovations in heat exchangers, waste heat recovery, and advanced thermal insulation have also contributed to optimizing industrial processes.

This paper provides a comprehensive overview of recent developments in applied thermal engineering, focusing on heat transfer mechanisms, energy-efficient systems, and intelligent thermal management solutions.

Innovations in Heat Transfer and Heat Exchangers

Heat exchangers are essential components in many industrial processes, enabling efficient thermal energy transfer. Conventional shell-and-tube heat exchangers have been enhanced using compact microchannel heat exchangers, improving heat transfer efficiency by 30-50% (Wang et al., 2020).

Additionally, nanofluids—suspensions of nanoparticles in base fluids—have demonstrated superior thermal conductivity, as observed in the studies by Chen et al. (2019).

Phase Change Materials (PCMs) for Thermal Energy Storage

Phase change materials (PCMs) provide efficient thermal energy storage by utilizing latent heat absorption and release. Studies have shown that incorporating microencapsulated PCMs in building materials reduces peak energy loads by up to 40%, improving energy efficiency in HVAC applications. Furthermore, PCMs integrated into electronic cooling systems enhance temperature regulation in high-performance computing (Patel et al., 2021).

Computational Fluid Dynamics (CFD) and AI in Thermal Engineering

The use of CFD simulations and AI-driven optimization has revolutionized thermal engineering, reducing the need for extensive experimental testing. CFD-based models accurately predict fluid flow and heat transfer performance in complex geometries, as demonstrated by Li et al. (2018). AIbased models, including deep learning, further enhance thermal predictions, optimizing heat exchanger designs with high accuracy.

Exercise 1. Memorize the terms:
heat transfer, sustainable thermal management, experimental validation, computational fluid dynamics (CFD), heat dissipation, waste heat recovery, thermal insulation, intelligent thermal management solutions, shell-and-tube heat exchangers, thermal energy storage, cooling systems, CFD simulations.

Exercise 2. Answer the questions:
1.Which new technologies are developed by researchers and engineers nowadays?
2.How do new technologies assist thermal engineering processes?
3.What are the new principals used in heat exchangers?
4.What are the principals of storing the thermal energy?
5.How is thermal engineering revolutionized?

Exercise 3. Compose an essay on the topics:
“Artificial intelligence in thermal engineering”
“Computation in the production of thermal power”
‘New accents in using thermal power”

Lesson 15

Мета заняття: Знати і розуміти інженерні науки, що лежать в основі спеціальності «Теплоенергетика» відповідної спеціалізації, на рівні, необхідному для досягнення інших результатів освітньої програми, в тому числі певна обізнаність в останніх досягненнях науки і техніки у сфері теплоенергетики.

Applied thermal engineering. Part 2

Advanced Heat Transfer Mechanisms

Innovations in heat transfer mechanisms focus on improving energy efficiency and thermal performance.

• Nanofluids in Heat Exchangers: Nanoparticle-enhanced fluids (such as Al2O3 and CuO nanofluids) increase thermal conductivity by 15-30%.

• Microchannel Cooling Systems: Used in electronics and aerospace applications for enhanced heat dissipation.

Despite these advancements, challenges such as nanoparticle stability and high fabrication costs remain.

Technology: Nanofluids, Microchannel Cooling
Application: Industrial cooling systems; Microchannel Cooling Electronics & Aerospace
Efficiency Improvement: 15-30%, 25-40%

AI and Computational Fluid Dynamics in Thermal System Design

CFD-assisted modeling provides accurate heat transfer simulations, reducing experimental costs.

AI-based predictive models optimize thermal designs, minimizing energy losses in power plants and industrial processes.

• AI-Optimized Thermal Systems: Machine learning algorithms enhance heat exchanger performance.
• CFD for HVAC and Renewable Energy: Used in wind turbine cooling and solar panel temperature regulation.

These advancements enable real-time optimization of thermal processes, reducing energy consumption and increasing sustainability.

Thermal Energy Storage Solutions

Thermal energy storage (TES) plays a crucial role in renewable energy integration and industrial heat recovery.

• Latent Heat Storage: PCMs store and release thermal energy during phase transitions.
• Sensible Heat Storage: Uses solid materials (such as molten salts) to retain heat for extended periods.

TES systems improve the efficiency of solar power plants and waste heat recovery systems in industrial applications.

Case Study: Optimization of a Heat Exchanger Using AI and CFD

A case study is conducted to evaluate the impact of AI and CFD-assisted optimization on heat exchanger efficiency

Optimization Method: Traditional Design; CFD-Based Optimization; AI-Assisted Design
Efficiency Improvement (%): 10%, 15%, 20
Computational Cost (CPU) hours: 600, 30, 250

Results indicate that AI-optimized heat exchangers achieve the highest efficiency gains with reduced computational costs.

Advancements in applied thermal engineering have led to significant improvements in heat transfer, energy systems, and thermal management technologies. Innovations in nanofluids, AI-driven CFD simulations, and phase change materials have optimized energy efficiency across industries.

Future research should explore quantum computing for thermal simulations and digital twin technology to enhance real-time monitoring of thermal systems.

Exercise 1. Memorize the terms:

heat transfer mechanisms, Microchannel Cooling Systems, high fabrication costs, CFD-assisted modeling, AI-Optimized Thermal Systems, Renewable Energy, renewable energy integration, heat recovery systems, highest efficiency gains.

Exercise 2. Answer the questions:

1.Which innovations in heat transfer mechanisms focus on?

2.Where are nanotechnologies used?
3.How is AI used in thermal industry?
4.Is thermal energy storage of high importance?
5.How is it possible to optimize heat exchanger?

Exercise 3. Compose an essay on the following topics:
“Computation and AI use in thermal engineering”
“Th methods used in heat exchanger efficiency”
“Nanofluids, Microchannel Cooling Technologies”

Lesson 16

Chips working power density

With the development of processing and packing technology, chips working power density is growing rapidly. Chips’ thermal management becomes more and more important. For decades, the cooling devices such as heat pipes, forced air cooling and thermo-electron coolers were developed. However, some of these cooling devices are so complicated for no easy machining and stably work. After Tuckerman and Pease firstly introduced microchannel heat sink to solve the related problems in 1981, it became one of the most promising technologies to solve the chips‘ thermal management problems.

Over the years, related researches can be mainly divided into two directions: coolant optimization and heat sink’s structure optimization. In order to reduce the thermal resistance, researchers raised a high efficient heat removal ideas of pin-fin structure, and this structure was proved to have a high heat conductivity, low pressure drop and economy use of cooling water. Vanapalli and Brake studied 6 different pin fins with the same cross section which affected the pressure drop in a microchannel. Abas Abdoli and Gianni Jimenez studied the changing of pin-fin shape corresponding changing of cross section that affected the heat removal capacity in a microchannel heat sink. However, there was no systematic research with detailed experimental verification about the influence of pin-fin shape on cooling characteristics including heat removal capacity and pressure drop.

Micro-channel heat sinks with five different pin fins were designed, fabricated and tested in this study. Triangle, square, pentagon, hexagon and circle geometries were chosen as the cross sections of the pin fins. The thermo-fluid characteristics of the five different micro-channel heat sinks were presented by using computational fluid dynamics (CFD) software. These typical samples were fabricated through UV-LIGA micromachining technology. An infrared imaging testing system was set up to test these samples. The temperature distributions on the top surface of the microchannel heat sinks were obtained for comparison with simulations. The effects of the pin-fin shapes on cooling performance of the single-phase array microchannel heat sinks were given numerically and experimentally.

Overall design

The researches taken in the field of pin fins arrangement can be divided into two categories: inline way and staggered way. Most of them point out that the inline arrangement has a lower pressure drop, while the staggered arrangement has a lower thermal resistance [18]. Because heat removal capacity is a key consideration, the staggered arrangement was adopted in this study. In order to obtain the main effect of pin-fin shapes, the pin fins keep the same cross-section area and the same height,

Theory

Inlet and outlet diameter are 1 mm, which are the narrowest parts of the flow path. When the maximum flow rate of 100 ml/min is conducted into the heat sink, the coolant flow velocity is 2.122 m/s, and the corresponding Reynolds number (Re) calculated by the Eq. (2) is 2122. The flow rate is determined to be the laminar flow.

The heat removal performance of the heat sink is presented by the thermal resistance Rt in Eq. (3).

The total thermal resistance of the microchannel heat sinks Rt

Governing equations

The temperature distribution of the microchannel heat sink is described by solving Eqs. (7), (8), (9), which are respectively continuity, conservation of momentum and energy equations.

The energy equation for the solid parts:

The heat flux between the interface of the water and the solid walls of the heat sink is coupled and its continuity equation is given as:

Boundary condition and mesh optimization

In order to achieve an accurate solution for the governing equations,

Fabrication

The micro-channel heat sink consists of three parts: chip, top baseplate and bottom baseplate. Micromachining process flow is shown in Fig. 8. The top baseplate is made of aluminum nitride. As is shown in Fig. 8(a)–(d), a nickel coil heating source was electroplated on the top surface heating as a simulative chip, a thin layer of tin was electroplated on another surface for bonding.

The bottom baseplate was made of copper, which micro-machined by Cu electroplating in the SU-8 mold made on the