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DEPARTMENT OF ENVIRONMENTAL SCIENCE

LECTURE ABSTRACTS

on «Transport Ecology»

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Lecture № 1

The subject and objectives of transport ecology. Basic concepts and definitions. The unified transport system of Ukraine and its integration into the international system of transport corridors.

Lecture plan

1. **Basic concepts and definitions**
2. **Brief description of different kinds of transport**

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Lecture content

Basic concepts and definitions

The transport complex is a technical and economic structure designed for the transportation of goods and people, and includes:

- system of design, construction, reconstruction, repair, maintenance of roads, bridges, tunnels, railways, runways and other structures;

- automobile, aviation, shipbuilding, car-building industry, construction-road and transport engineering;

- the scope of operation and repair of these machines, maintenance of rolling stock, road management, traffic management services, etc .;

- production of building materials, tires, fuels and oils, electrical devices, spare parts, operating fluids.

Brief description of different modes of transport

Road transport is the main mode of transport mainly for intercity transport, as well as long-distance and inter-district transport over relatively short distances.

The *advantages* of this type of transport include:

- high speed of cargo delivery;

- in the case of short-distance transportation, this speed is higher than by rail and water transport;

- the ability to carry out transportation from the starting point to the destination without overloading the cargo due to the high maneuverability of cars;

- relatively small capital costs for the organization of transportation of small quantities of goods over short distances.

The *disadvantages* of road transport include higher than other modes of transport specific cost of transportation.

Rail transport is the main mode of transport for the transportation of large quantities of goods over long distances (mass transportation).

The *advantages* of rail transport include:

- independence of the transportation schedule from the season and climatic factors;

- shorter routes compared to water and road transport;

- reliability and regularity of transportation at high capacity (up to 80 - 90 million tons of cargo per year by double-track or 20 - 30 million tons per year by single-track railway);

- low transportation costs and low specific energy costs;

- high speed of transportation at mass transportation on long distances. Recently, high-speed railways (second-generation railways) have become increasingly popular, where rolling stock moves at an average speed of over 200 km / h. Such railways can compete with air transport in terms of freight delivery speed;

- high traffic safety and high level of environmental safety are also advantages;

- the possibility of creating a direct connection between large enterprises by railways and ensuring the delivery of goods on a door-to-door basis without costly transshipments.

The *disadvantages* of rail transport include:

- high specific cost of track construction (high level of capital costs) and relatively slow return on investment (6-8 years, and sometimes more), in addition, the payback of capital costs of railway construction depends largely on the capacity of the freight and passenger flows on the new line ;

- high metal content - almost 200 tons of metal are needed for 1 km of railway;

- productivity on rail transport is lower than on pipeline, sea and air (but higher than on road).

Air transport is mainly used for fast long-distance transportation.

The *advantages* of this mode of transport include:

- the ability to deliver goods over long distances and in areas that are inaccessible or inaccessible to other modes of transport;

- lower capital costs compared to rail and road transport (construction in off-road areas of two airports at the exit and entry points of the route requires little time, and capital investment is many times less than for the construction of rail or road roads);

- high average speed of transportation, which makes it possible to transport perishable goods over long distances, as well as goods whose delivery is very urgent;

- great organizational maneuverability and the ability to create direct connections.

Disadvantages include the relatively high cost of transportation, limited weight and

dimensions of the goods transported.

Water transport can be divided into two groups: river and sea.

River transport is efficient when performing large volumes of seasonal cargo (grain, coal, ore).

The main *advantages* of river transport include:

- low capital costs and relatively low specific metal content (ready natural ways, use of water flow);

- low cost of transportation (maintenance of waterways requires much less capital investment);

- high capacity (possibility of simultaneous transportation of large loads and passengers).

Disadvantages include the mismatch of riverbeds and, accordingly, the trajectories of traffic with the directions of cargo flows. Low speed of cargo delivery. In many cases, the seasonality of traffic.

Maritime transport is used mainly for the transportation of goods over long distances between ports of one country, or for international transport. It is one of the main factors in the foreign trade relations of most countries.

The *advantages* of maritime transport include:

- low capital costs in the organization of mass transportation over long distances;

- regularity of transportation;

- low specific cost of transportation (for long-distance transportation, the cost is lower than for all other modes of transport.

The *disadvantages* include the irregularity of traffic in certain periods, such as fog, storm and so on.

Lecture № 2

Lecture topic: Global environmental issues and air transport in the context of sustainable development.

Lecture plan

1. Global climate trends and their changes under the influence of aviation.

2. Forecasting the development of climate change in connection with the activities of aviation

3. The contribution of aviation in the formation of acid rain

4. The impact of aviation on the ozone layer

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1. Транспортна екологія: навчальний посібник / О. І. Запорожець, С. В. Бойченко, О. Л. Матвєєва, С. Й. Шаманський, Т. І. Дмитруха, С. М. Маджд; за заг. редакцією С. В. Бойченка. – К.: НАУ, 2017. – 507 с.

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Lecture content

Global climate trends and their changes under the influence of aviation. The International Commission on Climate Change (ICCC) uses the term "radiation impact" to assess the relative and absolute value and effects of different processes and emissions of aircraft on the climate. This concept is informative because it shows that the average global ambient temperature varies approximately in proportion to the radiation exposure.

According to the ICCC, in 2012 aviation was responsible for 5% of carbon dioxide emissions from fossil fuel combustion. In general, transport is responsible for 13% of emissions containing products of combustion of hydrocarbon fuels. However, the full impact of greenhouse gases was more significant than expected

Forecasting the development of climate change in connection with the activities of aviation. The International Commission on Climate Change has analyzed various scenarios for the growth of services provided by air transport, and two technical scenarios for forecasting fuel consumption and combustion products for the period 1990-2050. scenarios predict a potential increase in carbon dioxide emissions in the range of 0.5-9%. ICRC experts have found that emissions from supersonic aircraft operating in the 17-20 km range, including nitrogen oxides, will increase ozone levels, which will have a radiation effect equal to the same value as carbon dioxide, but against. Changes in methane content at this level are not significant, and inversion traces of aircraft and cirrus clouds are not formed. As a result, the radiation impact is completely formed due to water vapor formed due to fuel combustion: its radiation impact is positive and 10 times greater than carbon dioxide.

The contribution of aviation to the formation of acid precipitation. The entry into the atmosphere of oxides of sulfur and nitrogen in the exhaust gases of aircraft affects the intensity of acid precipitation and acidification of soil and aquatic ecosystems caused by them.

The reason for the formation of acid precipitation is the formation of vapors of sulfuric and nitric acids from oxides of sulfur and nitrogen, which enter the atmosphere as part of anthropogenic emissions. The interaction of the vapor of these acids with moist air leads to acid rain and other acid rain.

Vapors of strong acids formed in the atmosphere and the precipitation of acid rain directly have a negative impact not only on humans, flora and fauna, but also cause the destruction of buildings, structures, etc. As a result of acid precipitation entering the soil and water bodies, their acidification develops. This leads to the degradation of terrestrial and aquatic ecosystems, to reduced soil fertility, to the death of microflora, certain species of fish and other aquatic organisms, to reduced forest growth and dehydration in large areas.

The problem of acid rainfall and acidification of the environment is becoming more urgent every year and becomes global. The main contribution to air pollution by sulfur and nitrogen oxides, which leads to acidification of the environment, is made by world energy, industry and land transport, and the role of civil aviation in these anthropogenic processes is still secondary.

The impact of aviation on the ozone layer is a factor that affects the state of the ozone layer and is directly related to aviation, air pollution by nitrogen oxides. Emissions of nitrogen oxides in the troposphere increase the amount of ozone and, consequently, reduce external ultraviolet radiation, while emissions at an altitude of 20 km in the stratosphere have the opposite effect.

Ozone molecules are destroyed by interaction with nitrogen oxides (NO, NO_2, N_2O_5, etc.) entering the stratosphere. They are contained in large quantities in industrial, energy and transport emissions, which pollute mainly the surface layers of the atmosphere [9].

However, almost all nitrogen oxides (except N_2O) have a short lifespan in the troposphere, as they are rapidly destroyed in the air due to chemical reactions, forming nitrates and nitric acid vapors. Therefore, the amount of nitrogen oxides from terrestrial sources entering the stratosphere from the lower troposphere is relatively small. Indeed, the concentration of ozone is significantly affected by nitrogen oxides entering the upper atmosphere during aircraft flights as part of aircraft engine emissions.

Lecture № 3

Lecture topic: Characteristics of the impact on the natural environment of air transport. Comprehensive assessment of airports as a source of negative impact on the environment

Lecture plan

1. Technical and operational properties of air transport

2. Comprehensive assessment of airports as a source of negative impact on the environment.

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Lecture content

1. Technical and operational properties of air transport. The technical basis of air transport consists of: fleet of aircraft (airplanes and helicopters), airports and air lines (routes).

An aircraft is an aircraft whose flight is made possible by the interaction of the thrust of

the engine and the lift of the wing, which occurs during movement. The aircraft consists of: glider, traction engines, chassis and a set of units, devices that ensure the functioning of all aircraft systems and controls.

Helicopter - a device, the rise and flight of which is carried out using an air propeller with blades mounted on a vertical shaft.

An aerodrome is an area of the earth's surface (or water for an aerodrome), including buildings, structures and equipment located on it, which is wholly or partly intended for dispatch, arrival, movement on this surface, standing and maintenance of the PC.

The airport serves for the rational organization of the movement of passengers and cargo during transfers from land vehicles to air transport and vice versa.

The network of state airports has 31 units, one third of which operate as independent enterprises, the rest are part of state airlines and airlines. Most of them are national property, and only Kyiv, Kramatorsk (Donetsk region), and Severodonetsk (Luhansk region) are municipal property.

There is also an alternative network of airports based on military airfields and airfields of some departments. In total, about 70 airfields are registered in the civil aviation of Ukraine.

The largest airports in Ukraine include: Boryspil, Zhulyany, Kharkiv, Donetsk, Dnipropetrovsk, Odessa, Vinnytsia, Lviv, Luhansk, Zaporizhia, Simferopol, Chernivtsi, Kherson, Mykolaiv, Ivano-Frankivsk.

There is no single universal approach to the classification of civil aviation airports. The classification currently used in most CIS countries mainly reflects the operational characteristics of airports. This classification is based on the annual volume of passenger traffic, which means the total number of all passengers arriving and departing, including passengers in transit; destination of airports, which reflects their administrative-territorial location and the nature of traffic.

This classification is operational in nature and does not reflect a sufficient number of features that can determine the objectives and objectives of airports from the standpoint of their operation.

2. **Comprehensive assessment of airports as a source of negative impact on the environment.** Aircraft pollute the atmosphere as a result of the emission of harmful substances from the exhaust gases of aircraft engines.

Aircraft in the process of flight move from one airport to another and the atmosphere is polluted on a global scale, ie significant pollution occurs both in the areas of airports and on the routes of flight. Moreover, if on the flight paths (at an altitude of 8 - 12 km) the risk of this pollution is small (flights of aircraft at high altitudes and at high speeds cause the scattering of combustion products in the upper atmosphere and large areas, which reduces their impact on living organisms), it is impossible not to take into account such pollution in the airport area.

Gases are emitted into the atmosphere by nozzles and exhaust pipes of engines. This process is called the emission of aircraft engines.

Gases from aviation engines account for *87% of all civil aviation emissions*, which also include emissions from special vehicles and stationary sources.

The most unfavorable modes of operation are low speeds and "idling" of the engine, when pollutants are emitted into the atmosphere in quantities significantly exceeding the emission at load modes.

The chemical composition of emissions from fuel combustion mainly depends on the type and quality of fuel, production technology, method of combustion in the engine and its technical condition.

The main components of the exhaust gases of modern aircraft engines that pollute the atmosphere:

- sulfur oxides SO_x;

- nitrogen oxides NO_x;

- carbon monoxide CO;

- hydrocarbons that are not completely burned C_xH_y (methane CH_4, acetylene C_2H_2, ethane C_2H_6, benzene C_6H_6, etc.);

- aldehydes (formaldehyde $HCHO$, acrolein $CH_2 = CH = CHO$, acetaldehyde CH_3CHO, etc.);

- gasoline (α) pyrene - is released in the amount of 2 ... 4 mg per 1 min of engine operation (although the permissible level of pollution is 0.0001 mg per 100 m^2 of area);

- soot (fine particles of pure carbon) - is released in the form of a train behind the engine nozzles during takeoff (soot is released in general a little).

The NO_x content in the exhaust gases of an aircraft engine depends on:

- the temperature of the mixture in the combustion chamber (the higher it is, the more NO_x is formed), and it is the maximum (2500 ... 3000 K) in takeoff mode;

- the residence time of the mixture in the combustion chamber (the larger it is, the more NOx is formed), and this occurs at low aircraft speeds.

That is, the maximum NO_x emission occurs in the take-off mode of the engine and modes close to it (when taking off and taking off the aircraft altitude).

Hydrocarbons (C_xH_y) are the main component of liquid and gaseous fuels. Aviation fuels - gasoline, kerosene - differ in the content of paraffin, petroleum and aromatic hydrocarbons, as well as sulfur compounds.

One of the most dangerous for humans is carcinogenic benzene (α) pyrene when it is emitted directly into the surface layer, ie at the level of human respiratory organs.

In the runway, approximately 50% of microparticle emissions, including many heavy metals, are immediately dissipated in areas adjacent to the airport. The rest is in the air for several hours in the form of aerosols, and then settles on the ground.

Each engine developed (for aircraft) undergoes a series of tests (certification) before being put into series production, including environmental safety studies, so the International Civil Aviation Organization (ICAO) has developed strict emission standards for aircraft engines.

The quantitative characteristic of emissions of harmful substances by aircraft engines is the emission index (EI), which shows how many grams of this harmful substance are emitted into the air when burning 1 kg of fuel in the engine. The dimension of the emission index is g / kg. There are EI_{CO}, EIC_xH_y, $EINO_x$ and others.

In what follows, we will consider only these three ingredients, as they are the most polluting and emitting the most.

EI characterizes the quality of the organization of the combustion process in the combustion chamber of each model of the engine and is related to the design and operational characteristics of the chamber. Therefore, it is often called the emission characteristic of the engine.

Emission indices are determined in the process of their certification tests. The content of CO and C_xH_y ingredients in the exhaust gases of aircraft engines is due to incomplete combustion of fuel in the engine, and this process, in turn, depends on the characteristics of its combustion parameters, ie, the value of combustion coefficient ή and engine operation.

The maximum completeness of fuel combustion in the engine takes place in the design mode - takeoff (maximum engine thrust mode).

In this mode, modern engines have ή = 0.97 ... 0.99, (ή = 1.0 with absolutely complete combustion, which in reality is impossible to achieve).

In all other modes ή is lower, ie, the completeness of combustion is less (ή = 0.75 .. .0.85), the engine releases more incomplete combustion products into the atmosphere and, accordingly, air pollution increases.

The airport area is understood as the space limited by the height of 1000 m and the size of the aerodrome.

Obviously, the emission of harmful substances (emission of an aircraft engine) depends on the mode of its operation and the duration of work in this mode.

Ground operations are starting engines, warming them up, taxiing aircraft before takeoff and after landing.

The main feature of these operations (in terms of calculating the emission of aircraft engines) is that the aircraft engines operate in one mode - low gas (idle) - and over time it is the longest operation in the airport area. This fact simplifies the calculation.

Take-off and landing operations are take-off, set at a height of 1000 m, descent from a height of 1000 m and landing.

In this case, to calculate the emission of aircraft engines in the air, the emission characteristic is the mass emission rate Wi, ($q_{ingredient}$ / h), (not the emission index), which shows how much of this harmful substance is released in this mode of operation of the engine unit of time.

Lecture № 4

Lecture topic: Assessment of the state of the atmosphere in the airport. Protection technologies.

Lecture plan

1. Assessment of the atmosphere in the area of the airport by precipitation analysis

2. Emissions of harmful substances during the operation of aviation fuel supply companies.

3. Means to prevent pollution of the surface layer of the atmosphere at airports

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1. Транспортна екологія: навчальний посібник / О. І. Запорожець, С. В. Бойченко, О. Л. Матвєєва, С. Й. Шаманський, Т. І. Дмитруха, С. М. Маджд; за заг. редакцією С. В. Бойченка. – К.: НАУ, 2017. – 507 с.

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Lecture content

Assessment of the atmosphere in the airport area by precipitation analysis. In the study of issues related to air pollution, transport, resistance of pollutants, it is important to remove pollutants from the atmosphere, which affects the level of their content in the surface layer. This process characterizes her ability to self-clean.

Because most pollutants are adsorbed on solid particles or dissolved in moisture droplets, precipitation is an important step in removing them from the atmosphere. It is not costly and cost-effective to assess the state of the atmosphere based on the analysis of precipitation.

The concentration of chemical impurities in precipitation is usually relatively small, however, if we take into account the total amount of precipitation over long periods (season, year), the amount of substances that fell with them will be significant, which should be taken into account.

Precipitation (rain or snow) is a mechanism for removing pollutants from the atmosphere.

Snow is in longer contact with the air than rain, and therefore in his research the probability of detecting pollutants in the atmosphere is higher. Therefore, the use of snow cover as an indicator of environmental pollution, can significantly increase the effectiveness of control of pollution of the atmosphere, water, soil in areas affected by air transport.

Pollution of snow cover occurs in two stages:

- pollution of snowflakes during their formation in the cloud and falling on the ground - the so-called wet falling of pollutants with snow;

- pollution of already fallen snow as a result of dry precipitation of pollutants from the atmosphere.

When studying snow as an indicator of air pollution, it should be borne in mind that only 15 - 20% of chemical elements fall out with precipitation, the main part of them settles in the form of dry aerosols.

The concentration of heavy metals in precipitation in the warm and cold seasons depends on the location of sources of air pollution and meteorological conditions. In winter conditions, when surface temperature inversions are observed and, consequently, the vertical exchange of air masses is complicated, industrial pollution accumulates in the surface layer of the atmosphere, while the concentration of pollution in the air and precipitation increases.

Emissions of harmful substances during the operation of aviation fuel supply companies. Emissions of harmful substances during the operation of aviation fuel supply companies.

Terrestrial sources of pollution can be divided into those located inside the airport and those located outside the airport. The latter include, first of all, thermal power plants that run on different types of local fuel, so the nature of pollution is determined by the type of fuel, methods of combustion and ways to dispose of emissions.

Intraport sources of environment pollution include:

- ventilation systems used in certain areas of aircraft maintenance;

- warehouses of fuels and lubricants;

- special vehicles.

If necessary, when the air removed from the workplace contains harmful substances in large quantities, before being released into the atmosphere, it is cleaned in dust collection and gas treatment plants.

Atmospheric air from the *production facilities* of the airport receives:

- vapors of oil products, solvents, paints, alkalis, acids;

- aerosols of aqueous solutions of caustic, carbonate and phosphate sodium, sulfur dioxide, nitrogen oxides, carbon monoxide, dust.

The amount of harmful substances entering the air from the production facilities of the airport or aircraft repair plant through ventilation systems may exceed the maximum permissible values, which cause exceeding the maximum permissible concentrations (MPC) of these harmful substances. This can be especially the case with group arrangement of ventilation shafts, when there is an effect of summation of harmful emissions and even the formation of new harmful substances of greater toxicity.

Warehouses of fuels and lubricants pollute the air at the airport with aviation fuel, lubricants and special fluids.

The atmosphere of aviation fuel vapor enters:

- when squeezing them out of tanks, refueling tanks and PC tanks in the process of filling them with fuel;

- in the process of "small breathing" of tanks;

- in case of evaporation of spilled fuel due to leaky connections or non-compliance with the rules of refueling, storage, transportation and filling of tanks with fuel and lubricants.

Some production sites for maintenance and repair of aircraft emit new compounds into the air, which did not exist in nature before. Emissions of heavy metals and their compounds - lead, copper, chromium, beryllium, cobalt, arsenic - are increasing. Getting such substances into the human body is dangerous to human health, because firstly, in the process of evolution the human body has not acquired protective functions against the action of these substances, and secondly, they can accumulate in the human body and gradually destroy it, causing severe diseases of certain organs.

Means to prevent pollution of the surface layer of the atmosphere at airports.

In order to reduce air pollution in the airport area, it is necessary to implement special measures to reduce emissions of toxic substances from all sources of pollution, both stationary and mobile (land and air transport).

Significantly reduce emissions of harmful substances into the atmosphere from stationary sources can be through the introduction of treatment plants, protective equipment and air pollution control in the production activities of air transport companies. After all, only 13–23% of harmful substances released into the atmosphere by stationary sources are caught at the country's airports. Their equipment with gas cleaning equipment is only 4% of the required level.

Reduction of air pollution in the airport area by land transport can be achieved by streamlining its movement, rational organization of passenger and cargo transportation, which will significantly reduce the intake of exhaust gases from internal combustion engines.

However, the greatest environmental impact should be expected from the development and implementation of comprehensive measures to reduce emissions of aircraft, as the emission of aircraft engines plays a key role in air pollution in the airport area.

In this aspect, ICAO's efforts to develop and implement standards for maximum permissible emissions of harmful substances are of great importance.

Lecture № 5

Lecture topic: Features of water pollution by air transport. Protection technologies.

Lecture plan

1. Pollution of surface waters by air transport

2. Contamination of groundwater by air transport

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Lecture content

Pollution of surface waters by air transport. The problem of the impact of air transport on the state of **surface waters** is more researched and studied. In modern conditions, reservoirs that are in the area of local influence of air transport, are under intense man-made influence, which is accompanied by changes in hydrogeological, hydrochemical and hydrobiological regimes.

On average, when discharging 1 m^3 of industrial wastewater, about 60 m3 of natural water is polluted.

The source of pollution of water bodies of airlines is surface runoff. Formed by rain and melt snow, as well as water from wet cleaning of artificially covered premises, surface runoff from the airport accumulates various pollutants: residues of detergents, disinfectants, anti-icing and anti-icing agents, products of destruction of artificial surfaces and layers aircraft and ground equipment, waste oil, etc.

The main sources of surface runoff include:

- territories of aviation technical bases;

- sites for finishing works, washing and anti-icing treatment of aircraft;

- platform and station area;

- premises of fuel and lubricants services.

For *surface runoff from airports is characterized by the presence of*:

- mineral suspensions;

- oil products;

- phenols;

- dissolved organic mixtures and substances containing nitrogen;

- mixtures for washing aircraft;

- mineral oils.

The main sources of domestic wastewater - buildings and structures for transportation services:

- airport;

- hotels;

- dining rooms;

- boarding services;

- territories of airfields adjacent to airports.

Sources of industrial wastewater at airports are:

- buildings and structures of aircraft maintenance (aviation technical bases, ancillary production);

- buildings and structures of auxiliary premises (warehouses of technical property, motor depots, fire depots, boiler rooms).

In the *wastewater of production areas of airports* and other airlines are contained

- benzene;

- acetone;

- oil products;

- acids and alkalis;

- dissolved compounds of various metals - aluminum, copper, beryllium, chromium, etc.

The composition of wastewater discharged is closely related to the types of production activities, raw materials and various additional products involved in the technological process, and also depends on the course of these processes, the type and perfection of production equipment.

Thus, beryllium compounds are often used in airlines to increase the durability of aircraft parts.

Some metals contained in the industrial wastewater of airlines, entering treatment plants and settling in two-story settling tanks and methane tanks, have a detrimental effect on the microflora involved in the fermentation of sludge, and thus delay its mineralization, and in

methane tanks - and gas formation.

On biofilters and air filters, they have a detrimental effect on microorganisms involved in wastewater treatment, and completely sterilize them or reduce the efficiency of biological wastewater treatment. Chromium, nickel, lead, copper, zinc, silver and mercury have a particularly harmful effect on the microflora of sewage treatment plants.

Therefore, in large airports, surface runoff disposal must be differentiated due to its uneven distribution. First of all, it is necessary to clean the surface runoff from maintenance areas (including sites: washing and treatment against icing of PCs with special fluids; degassing of aircraft and equipment used in aerochemical work; washing of paints and varnishes and painting aircraft; washing vehicles and special vehicles).

Groundwater pollution by air transport. The composition and amount of precipitation in groundwater depends on the season of the year, the amount of precipitation and evaporation conditions. Climate, soil structure, vegetation, terrain, which causes a redistribution of precipitation, also have a significant impact.

When runoff on the earth's surface, atmospheric and meltwater captures organic and mineral substances from the soil, especially during the spring floods, which leads to seasonal deterioration of drinking water quality.

Groundwater pollution is not a local process, it is closely related to environmental pollution.

Groundwater is involved in chemical processes that occur on the earth's surface, destroys rocks and minerals, dissolves salts, recrystallizes precipitation.

Up to 60 chemical elements have been found in groundwater, which in most cases are in the form of ions.

Considering the movement of water under the influence of capillary-sorption forces, it should be noted that in the conditions of long-term feeding from above, the humidification front closes with the capillary border of groundwater. From this moment, the mechanism of capillary assembly begins to operate, which initiates the inflow of water to the groundwater level, ie there is an infiltrative supply of their precipitation.

Soil aquifer, which lies shallow below the soil layer, is always unsafe in terms of sanitation. Shallow groundwater is significantly different in content of dissolved oxygen from deep groundwater, in which oxygen may be absent because it is spent on the oxidative processes of mineral compounds.

Lecture № 6

Lecture topic: Features of soil pollution by air transport. Protection technologies

Lecture plan

1. General information about the lithosphere. Ecological safety of the lithosphere. Features of lithosphere pollution.

2. Features of soil pollution by air transport. Protection technologies.

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1. Транспортна екологія: навчальний посібник / О. І. Запорожець, С. В. Бойченко, О. Л. Матвєєва, С. Й. Шаманський, Т. І. Дмитруха, С. М. Маджд; за заг. редакцією С. В. Бойченка. – К.: НАУ, 2017. – 507 с.

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Lecture content

1. Soil pollution by air transport. In addition to air pollution, air transport with the equipment assigned to them pollutes the soil with various mechanical, physical and chemical impurities.

Soil pollution occurs as a result of the deposition of pollutants from the air basin on the surface of the soil, which enter the atmosphere with exhaust gases, aircraft, ground aircraft and boiler furnaces.

Ground cover is a less dynamic and more buffer system than atmospheric air or water bodies. One of the features of the soil is that it accumulates information about the processes and changes that occur, and therefore indicates not only the state of the environment at a given time, but also reflects past processes.

Soils play a protective role in relation to natural waters, atmosphere and vegetation. But at the same time, performing protective functions, soils can become a major source of many chemicals that pollute natural waters and are dangerous to plants.

The redistribution of contaminants in the soil, and, consequently, adjacent environments (plants, water, air) is caused by the movement of heavy metals in the soil profile.

Unlike organic chemical pollutants, which decompose over time, heavy metals can only be redistributed between components of the natural environment and their decomposition periods can be many thousands of years.

Surveys of soils near airports have shown an increase in heavy metal content of more than 20 times. Maximum pollution was observed near fuel and lubricant depots, repair shops, platform, as well as along the runways, especially in the places of takeoff and landing of aircraft. In case of heavy and moderate contamination, 8 to 18 mg / kg of heavy metals were found in the soil, the content of which significantly exceeded the permissible norms.

In general, *soils near airports* are contaminated with heavy metals such as zinc, copper, lead, chromium, tin, tungsten, as well as specific metals - cobalt, nickel, cadmium, strontium, silver, lithium.

The most common heavy metal in the airport area is lead, which comes from the air as a result of settling and leaching of precipitation and is formed during the combustion of leaded gasoline. When burned, lead forms small particles with a median size of less than 0.5 μm. Such

aerosols can be transported over long distances, but a significant part of them settles on the plants and soil of the airport.

Less lead is formed when burning other fuels. It is known, for example, that the concentration of lead in coal is 25 μg / kg. The average concentration of lead in soils that are not subject to intensive anthropogenic activity is considered to be 16,000 μg / kg (background level). In the upper layers of the soil near the airport, the concentration of lead is estimated at 60,000 to 550,000 μg / kg, reaching in some cases higher levels. However, it should be noted that lead contamination of soils near airports is local, its concentration decreases rapidly with distance from the source of pollution, and also depends on the class of the airport and the wind rose.

Studies conducted in our country and abroad show that the level of soil contamination in the area of airports and aircraft maintenance companies is quite high. Per 1 m2 of soil there are 200 - 250 g of organic and inorganic chemicals of artificial origin.

There are large areas of airports subject to wind erosion. This process is facilitated by soil contamination with fuels and lubricants, as well as emissions of gases entering the environment as a result of emissions of internal combustion engines and special vehicles.

The most intensive soil pollution in places where vehicles are refueled with fuel and oil, due to accidental spills and intentional spills of waste oil directly on the ground or in water bodies.

Lecture № 7

Lecture topic: Electromagnetic pollution. Electromagnetic pollution in the airport area. Protection technologies

Lecture plan

1. Radio engineering and radar equipment that is part of the air traffic control, navigation and landing control system and is a source of electromagnetic influence.

2. Engineering measures aimed at reducing the intensity of radio waves

References:

1. Транспортна екологія: навчальний посібник / О. І. Запорожець, С. В. Бойченко, О. Л. Матвєєва, С. Й. Шаманський, Т. І. Дмитруха, С. М. Маджд; за заг. редакцією С. В. Бойченка. – К.: НАУ, 2017. – 507 с.

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Lecture content

Radio engineering and radar equipment that is part of the air traffic control, navigation and landing control system and is a source of electromagnetic influence.

The radio engineering and radar equipment, which is part of the air traffic control, navigation and landing control system and is a source of electromagnetic influence on airport employees, passengers and residents of adjacent areas, includes:

- external and internal radio equipment (communication, command and emergency radio stations);

- onboard radio navigation equipment (onboard survey radars, Doppler radars for measuring route speed and angle of descent, altimeters, radio compasses, radio rangefinders);

- ground radio equipment of aircraft landing systems (survey, control and landing radars, direction finders, beacons).

Powerful ground-based radar stations make a major contribution to electromagnetic pollution in the area of airports. They emit radio waves in the ultra-high frequency range (microwaves), ie in the frequency range most dangerous to human health [6; 23]. They are accompanied by radiation from less powerful on-board radars, as well as short and ultrashort radio waves generated by navigation and communication radios.

Ground radar stations use the pulsed radar method, ie radiation is carried out in the form of short pulses lasting about one microsecond. The period of repetition of pulses is a thousand times longer (milliseconds).

Radar antennas are designed for clearly directed radiation (with a width of the radiation pattern of not more than a few degrees). The view of space is provided by scanning, ie by moving the radiation patterns of the antenna. Scanning can be carried out both mechanically (by rotating the antenna) and by special radio methods for a fixed antenna.

The use of powerful radar stations at airports leads to the creation of areas of considerable length in the field with increased intensity of ultra-high frequency electromagnetic radiation, which pose a danger to human health. It is important that not only the territories of airports are irradiated, in particular the workplaces of personnel servicing radio engineering equipment and aircraft, but also the areas adjacent to airports.

Engineering and technical measures aimed at reducing the intensity of radio waves. Radiation and technical measures are aimed at reducing the intensity of radio waves that affect people. They include:

- shielding of irradiated objects;

- removal of radiating devices from the area of workplaces and the area of stay of passengers;

- reduction of the intensity of radiation generated in the direction of the location of settlements.

Shielding of irradiated objects to protect against the harmful effects of electromagnetic radiation is widely used in practice. To do this, obstacles (screens) made of materials that reflect and absorb radiation are installed in the unwanted direction of radio waves.

For example, solid metal sheets, even of small thickness (about 0.5 mm), do not transmit electromagnetic radiation in the radio frequency range. Many others have shielding properties, including building materials.

In the open area of airfields, it is advisable to use screens made of metal mesh, which are relatively cheap, are clearly visible, have low sailability and provide a multiple reduction in the intensity of radio waves (100-1000 times).

The installation of screens at airfields as a means of protection against electromagnetic radiation has certain disadvantages. Screens can significantly reduce the efficiency of radars in terms of airspace. In addition, in order to ensure flight safety for screens, as well as for other structures in the aerodrome area, altitude restrictions are introduced.

Removing radiation devices from workplaces, the passenger area and the residential sector (distance protection) is the most rational way to reduce the intensity of radiation in the case of its implementation.

The size of the necessary sanitary protection zones around the ground radar stations of airports, determined on the basis of current regulations, maximum permissible levels of radiation, is several kilometers.

The danger of strong exposure of airport personnel at workplaces can be eliminated by lifting the antenna or the entire radar station and limiting its operation at negative angles of the radiation pattern (height protection). In this case, a zone of relatively large length is formed on the earth's surface around the locators, where the intensity of electromagnetic radiation is small.

However, this type of radiation protection for airfields is not always used due to the limited height of buildings. In addition, working only at positive angles of the antenna pattern worsens the tactical and technical data of the radar on airspace survey.

A promising method of protecting the population in the vicinity of airports from electromagnetic radiation is to reduce the intensity of radio waves generated by locators, in the case of their radiation in the direction of residential areas. For this purpose, devices are used to automatically turn off radiation sources or reduce their intensity when scanning the area (sector) of the protected space.

Lecture № 8

Lecture topic: Acoustic pollution. Noise pollution in the airport area. New technologies for reducing the acoustic load from aircraft.

Lecture plan

1. Sources of noise on the territory of airlines

2. Engineering measures aimed at reducing the intensity of the noise level

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Lecture content

Sources of noise on the territory of airlines

Sources of noise on the territory of airlines and adjacent areas are:

- aviation power plants with gas turbine and reciprocating engines;

- auxiliary power plants of aircraft and launch units;

- special aerodrome maintenance vehicles for various purposes, including heat and wind machines, created on the basis of aircraft engines that have exhausted the flight resource;

- machine and technological equipment of production processes.

The *acoustic situation* in the airport area is determined by:

- mode of operation of the airline;

- types of PCs operated at the airport;

- current routes of arrival and departure of the PC;

- the location of residential buildings relative to the runway, as well as measures taken by the airport to reduce the adverse effects of aviation noise on the environment.

When a plane is flying at supersonic speeds, a source of noise - a *sound shock* - appears. Perceived sound shock as 2, 3 or more pressure pulses with intervals between them of about 0.1 - 0.2 s.

During ground tests of aircraft engines, takeoffs and landings of PCs, complex acoustic oscillations occur, which include in addition to loud high-frequency noise and low-frequency infrasounds, which enhance the harmful effects on living organisms.

Engineering measures are aimed at reducing the intensity of the noise level.

To reduce aircraft noise, modernization and development of aviation equipment is needed, in particular:

- introduction of less noisy air collectors and exhaust nozzles;

- improvement of aerodynamic shapes and layout of aircraft engines;

- use of sound-absorbing and sound-insulating materials and devices;

- transition from noise turbojet engines of the old model to less noise engines of turbofans and double-circuit, as well as increasing the degree of double-circuit of the latter.

Along with technical methods, operational and organizational methods are also used to reduce aviation noise and its impact on the population and the environment near airports. The use of special piloting techniques during takeoff and landing can reduce the noise level by 5-15 dB.

Lecture № 9

Lecture topic: Radioactive contamination and its impact on the environment.

Lecture plan

1. **Types of ionizing radiation.**
2. **Consequences of radiation for humans.**

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1. Транспортна екологія: навчальний посібник / О. І. Запорожець, С. В. Бойченко, О. Л. Матвєєва, С. Й. Шаманський, Т. І. Дмитруха, С. М. Маджд; за заг. редакцією С. В. Бойченка. – К.: НАУ, 2017. – 507 с.

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Lecture content

Types of ionizing radiation.

Ionizing radiation includes radioactive radiation of various types, which during the passage through matter, are able to ionize or excite atoms and molecules of its chemical elements. There are two types of ionizing radiation - electromagnetic (non-corpuscular) and corpuscular. Electromagnetic radiation is a set of alternating states of electric and magnetic fields that propagate to the environment in the form of waves. Electromagnetic radiation includes ultraviolet rays with a wavelength (A) of 400 to 50 nm, X-rays (A from 50 to 0.01 nm) and gamma radiation (A less than 0.01 nm). Ultraviolet rays are of natural origin and come to the earth's surface from the Sun from outer space. They are harmful to living components of the ecosystem. X-rays are created artificially as a result of inhibition of charged particles in an electric field, which generates this electromagnetic radiation. Corpuscular radiation is a flux of particles that have a nonzero rest mass. This type of radiation includes fluxes of the smallest particles of an atom (electrons, protons), nuclei of various chemical elements (helium, oxygen, etc.), and neutrons - elementary uncharged particles.

Effects of radiation on humans. One of the greatest effects of irradiation of all living things on the planet, including man, was the destruction of protein molecules and the formation of new molecules uncharacteristic of these organisms. In the case of a strong effect of radiation on the human body in his body does not have time to produce antibodies needed to fight foreign proteins, and develops a disease called leukemia or leukemia - a tumor of the blood. Another dangerous consequence of human exposure when receiving small doses of radiation is cancer - a malignant neoplasm in her body. The most common types of cancer are breast and thyroid cancer. Cancer of other organs and tissues among the irradiated population is much less common.

Even the lowest dose increases the likelihood of cancer, and any additional dose of radiation significantly increases the likelihood. The most frightening for the future of mankind is the evidence that radiation disorders (genetic, chromosomal and genomic mutations) are inherited for many generations to come. About 10% of newborns have all sorts of genetic defects caused to varying degrees by exposure to radiation. Irradiation accelerates the aging process of a person and, consequently, significantly reduces its life expectancy.

Lecture № 10

Lecture topic: Ecological and economic methods of environmental protection. Promising areas of modern research in the field of greening of aviation

Lecture plan

1. Promising environmental engines for aviation.

2. The concept of creating new environmentally friendly aviation fuels and lubricants.

References:

1. Транспортна екологія: навчальний посібник / О. І. Запорожець, С. В. Бойченко, О. Л. Матвєєва, С. Й. Шаманський, Т. І. Дмитруха, С. М. Маджд; за заг. редакцією С. В. Бойченка. – К.: НАУ, 2017. – 507 с.

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Lecture content

Promising environmental engines for aviation

The directions of development of ecological characteristics of aircraft engines of different types and industrial gas turbine installations (GTU) on the basis of aircraft gas turbine engines (GTD) correspond to the following modern world priorities:

- development of technologies to reduce noise at the source due to special measures in the air intake, fan, compressor, combustion chamber, turbine and nozzle;

- development of technologies to reduce emissions of harmful substances from SU near airports, taking into account existing developments and current regulations;

- development of technologies to reduce emissions of pollutants during flight and reduce the impact of aviation on the atmosphere and climate change, taking into account the peculiarities of the SU in flight conditions and the developed regulatory indicators;

- development of technologies for environmentally friendly combustion of alternative fuels, which are widely used in aviation and other industries;

- development of basic research and computational methods in the field of aviation ecology, on the basis of which it is possible to develop new constructive and technological solutions for SU and GTU with the necessary environmental indicators;

- development of experimental base for research and testing of SU and GTU and their components, which will perform the necessary research and experimentally test new design and technological solutions in the required range of operating conditions, including high thermodynamic parameters of promising SU and GTU, a wider range of operating conditions;

- development of normative and technical documentation and materials of ICAO, EC and other organizations on aviation ecology with reflection of positions of domestic manufacturers and operators of aviation equipment and the equipment developed on its basis;

- development of technologies for environmentally friendly combustion of various fuels in industrial gas turbines based on aircraft engines.

. The concept of creating new environmentally friendly aviation fuels and lubricants. The task of the concept is the introduction of biofuels and lubricants in the civil aviation of Ukraine. As a raw material for the production of new products it is planned to use a variety of high-oil plants that are traditional for the agricultural sector of the state.

The concept involves the connection of two integral components - theoretical and practical, which should develop and complement each other (Fig. 8.1). The concept of theoretical component has a normative and legal meaning, based on global and national programs and acts designed to stimulate and guide the development of the idea of implementing environmentally friendly aviation fuel.

Accordingly, within the framework of the concept, it is necessary to conduct a nationwide systematic monitoring of the balance of the raw material base and assess the needs of the aviation industry in fuel. This will allow a realistic assessment of the potential and capabilities of Ukraine in the industrial production of alternative aviation fuels.