

LABORATORY 1

SAFETY ENGINEERING, ENVIRONMENTAL, AND FIRE-PREVENTION MEASURES IN CONDUCTING LABORATORY WORK

I. Scope of the work

This laboratory work is designed for 2 academic hours in the classroom and 4 hours of independent study.

II. Objectives

1. To become familiar with safety rules when performing laboratory work related to fuels and lubricating materials.
2. To study the environmental impact of fuels and lubricating materials.
3. To develop practical skills in applying fire-prevention measures when working with fuels and lubricating materials.

III. Brief theoretical information

When carrying out laboratory work on the testing of fuels and lubricating materials, students may have to work with open flames, heating devices, toxic and flammable substances, as well as fragile glassware and chemical containers. All fuels and lubricating materials are fire-hazardous substances, and some of them also belong to explosive materials. Their vapors are toxic and may damage the respiratory system and the skin.

Substances used as solvents or as components of solutions, such as benzene, alcohol, carbon tetrachloride, chloroform, and others, are also toxic. In many cases, it is necessary to use various acids and alkalis, which can cause burns to the skin and mucous membranes. Some measuring instruments, such as thermometers and manometers, may contain mercury; its vapors are extremely hazardous and may cause severe poisoning.

To prevent accidents, it is necessary to strictly follow safety regulations and fire-prevention rules both while being in the laboratory and while performing laboratory work. Before starting laboratory classes, all students must study and understand these rules.

Basic Safety Rules - 2 hours. In the laboratory, all laboratory staff and students must work in special laboratory coats.

When working with substances that may affect the skin, such as liquid acids, alkalis, leaded gasoline, and similar materials, it is necessary to use rubber gloves. Before putting them on, the gloves should be dusted with talc powder. After use,

they must be washed with water, dried, and then sprinkled with talc powder on both the inside and outside surfaces.

In situations where toxic liquids may splash - for example, during the dilution of acids, dissolution of alkalis, or preparation of mixtures - it is essential to wear protective goggles. If acids or alkalis come into contact with the skin, the affected area must be washed immediately with plenty of water.

The laboratory room must not allow the accumulation of vapors from petroleum products and other toxic substances. Therefore, the room must be equipped with reliable exhaust ventilation and must be well lit. If, for any reason, poisoning by petroleum-product vapors occurs, the affected person must be taken into fresh air immediately, and the cause of the poisoning must be eliminated.

The workbench must not contain chemical containers or equipment unrelated to the laboratory task. Students' briefcases, bags, and other personal belongings must be placed in the area designated by the laboratory instructor.

All samples of petroleum products intended for testing must be available in the laboratory. They should be stored in glass or plastic containers that are tightly sealed with stoppers or caps.

Strong toxic substances such as mercury, mercuric chloride, and similar chemicals must be stored in securely locked metal cabinets or in non-combustible safes. They may be issued for use only with special authorization.

Mineral acids and alkalis, organic solvents, and other toxic as well as flammable substances must be stored in hermetically sealed containers. They should be kept outside the main laboratory room or in ventilated cabinets.

During testing, petroleum products (including lubricating materials) that may release toxic vapors or gases must be tested in a ventilated hood. To avoid burn injuries, heating devices must not be handled with bare hands. Special care is required when working with heated petroleum products such as motor oils, other oils, glycerin, and similar materials, because their temperature may exceed 200°C, although this is not always easy to detect by external appearance. Heated porcelain or metal crucibles must be handled with special tongs, and test tubes must be held using holders. If a thermal burn occurs, the burned area must be immediately wiped with cotton moistened in a solution of potassium permanganate or ethyl alcohol. When working with solid alkalis such as KOH and NaOH, alkali pieces must not be touched by hand, and contact with skin or clothing must be prevented. Alkaline solutions should be prepared in porcelain or plastic containers, because when alkalis dissolve, a large amount of heat is released, and a glass container may crack or break. When preparing a cooling medium, cold ice or dry ice (solid carbon dioxide) must not be handled with bare hands in order to avoid cold burns. Tongs or forceps must be used.

When water is added to an acid, especially to a high-concentration acid during dilution, the acid must be poured slowly into the water in small portions. Water must never be poured into acid, because the reaction then proceeds very rapidly, a large amount of heat is released, the water may boil, and the solution may splash in all directions.

Special care must be taken when working with leaded gasoline, because it is highly toxic. It must not be used in soldering lamps, as a solvent for petroleum products, for washing hands, tools, or containers, or for cleaning clothes. It is strictly forbidden to siphon leaded gasoline by mouth through tubes, hoses, or pipettes, because gasoline vapors may enter the respiratory tract and cause severe poisoning. A rubber bulb must be used instead. After working with leaded gasoline, hands must be washed immediately - first thoroughly with kerosene, and then with soap and warm water. If leaded gasoline is accidentally spilled, the contaminated area must be decontaminated. For this purpose, sand is spread over the spill, then collected and burned in a specially designated place. After that, the spilled area is treated with a decontaminating agent and washed with water. For degasification, a mixture of chlorinated lime and water is used (1 part chlorinated lime to 3–5 parts water).

Ethylene glycol and all automotive and tractor materials containing ethylene glycol — such as antifreeze, glycol-based brake fluids, and similar substances that are classified as highly toxic materials. For this reason, when working with ethylene glycol-based liquids, care must be taken to prevent them from entering the digestive tract, the eyes, the mouth, and other parts of the body. After handling such liquids, hands must be washed thoroughly with soap.

When washing, assembling, or separating glass instruments and containers into parts, great care must be taken. Excessive force must not be applied, because glass items may break. If glass breaks, the fragments must be removed immediately from the broken area, the surrounding area must be wiped with cotton moistened with iodine, and a sterile napkin must be placed over the injured area and then bandaged. To provide first aid, the laboratory must always have a first-aid kit available. The kit must be fully equipped with all necessary medical supplies and medications.

Basic fire-prevention measures

In laboratories where fuels and lubricating materials are tested, fire-prevention rules must be followed strictly, because the work involves flammable substances that evaporate easily and may ignite at low temperatures. Only those persons who have been instructed in safety procedures and in fire-prevention measures are allowed to work and take part in laboratory classes.

The laboratory must have a fire safety instruction that clearly states which laboratory worker is responsible for fire prevention, for the immediate elimination of fire, and what duties that person must perform. Before laboratory classes begin, the ventilation system must be switched on. Heating devices may be used only after the air in the room has been fully renewed.

The laboratory must be equipped with fire-fighting equipment and fire-extinguishing means, such as special fire extinguishers, boxes of dry clean sand, blankets, felt mats, and similar items. The location where these fire-fighting tools and fire-extinguishing means are stored must be known to everyone and must

remain unobstructed. In addition, to quickly extinguish small flames, it is recommended to keep glass containers filled with carbon tetrachloride on the work tables.

All electrical wiring in the laboratory must be in good condition, and electric heating devices must also be serviceable. The use of temporary electrical wires and extension devices that do not meet electrical safety requirements is not allowed. Work tables and cabinets in the laboratory must not be crowded with containers filled with petroleum products.

If the laboratory is connected to a gas supply system, the condition of all its elements must be checked regularly in order to prevent gas leakage, which may otherwise cause poisoning or an explosion. When using Bunsen burners, overheating of the burner must not be allowed, because this may cause the burner to explode. Compressed oxygen or carbon dioxide cylinders must be installed on special supports, while compressed and liquefied gas cylinders must be stored in separate rooms. Samples of petroleum products intended for testing must be prepared away from heating devices or with the heating devices switched off. This includes operations such as transferring liquids from one container to another, measuring volume, and similar procedures.

Work involving heating devices, especially work carried out over an open flame, must be performed on tables covered with sheet metal or with a surface made of ceramic tiles or linoleum. Thick asbestos sheets must be placed under heating devices.

Oily wiping cloths, sand, and other auxiliary materials must be stored in metal containers with lids and removed regularly. Highly volatile and fire-hazardous substances must not be stored near burners or other heating devices. Samples of fuels and organic solvents such as benzene and its derivatives, ether, and similar substances must be stored in special cabinets outside the laboratory.

It is forbidden to pour petroleum product residues into the sewage system. Such residues must be collected in a separate container, and the lid of this container must be tightly closed. Heated petroleum products must never be left unattended, even for a short time. In the laboratory, it is forbidden to wash with open flame and to smoke. Easily flammable petroleum products must be heated in a sand bath or water bath, or by using closed-coil electric heaters. Containers filled with flammable substances must not be placed directly on a gas burner, whether with an asbestos pad or without one. It is forbidden to work in the laboratory with petroleum products while wearing clothing contaminated with them, or even to remain in the laboratory in such clothing. After the work is completed, the workplace must be put in order: switch off electric heating devices, close the water and gas valves, extinguish burners and lamps, and tightly seal containers holding petroleum residues with stoppers.

If a flammable liquid ignites at the workplace, the heating devices located near the fire must be switched off immediately, and the gas line valves must be closed. If a flammable liquid catches fire in an exhaust hood, the ventilator must be turned off immediately, and the air duct damper connecting the hood to the

ventilation system must be closed. The flame must then be smothered with felt, a blanket, or other suitable material, covered with a layer of dry sand, or the burning liquid surface must be covered with a foam layer from a fire extinguisher. In such cases, the supply of air stops and the flame is extinguished. If a petroleum product catches fire in an open container, it is strictly forbidden to touch or move the container. The container must be quickly covered with asbestos sheet, sheet metal, felt, hair felt, or a blanket. Care must be taken not to overturn the container. To stop a burning liquid from spreading across the table or floor, a sand barrier must be made around the area, and then the flame must be extinguished.

If a petroleum product spilled on the floor ignites, the spread of the flame under the floor must be prevented. If a person's clothing catches fire, the victim must be covered with a rug, blanket, laboratory coat, or similar item. After extinguishing the fire, the clothing should be cut and removed carefully from the necessary areas. Then an ointment prepared from a 50:50 mixture of linseed oil and lime water should be applied to the burned area. If such an ointment is not available, the burned area may be treated with a strong aqueous solution of potassium permanganate. If the burn is not severe, 95% ethyl alcohol or soap may be applied. Water must not be poured directly onto the burned area, because it intensifies the pain and may cause blister formation.