TOMSK POLYTECHNIC UNIVERSITY

PROFESSIONAL COURSE IN ENGLISH

"PROCESS TECHNOLOGY. EQUIPMENT AND SYSTEMS"

Unit 10. Basic Laboratory Glassware and Equipment

Research Associate, Candidate of Engineering Sciences
Belinskaya Nataliya Segeevna

2021

Outline

1. Basic laboratory glassware
2. Basic laboratory equipment

Introduction

Laboratory glassware refers to a variety of equipment used in scientific work, and traditionally made of glass.

Glassware used in a chemistry laboratory is special:

- It needs to resist chemical attack.
- Some glassware has to withstand sterilization.
- Other glassware is used to measure specific volumes, so it can't change its size appreciably over room temperatures.
- Chemicals may be heated and cooled so the glass needs to resist shattering from thermal shock.

Each piece of glassware has a name and purpose.

Beakers

No lab would be complete without **beakers**.

- Beakers are used for routine measuring and mixing in the lab.
- They are used to measure volumes to within 10% accuracy.
- Most beakers are made from borosilicate glass, though other materials may be used.
- The flat bottom and spout allow this piece of glassware to be stable on the lab bench or hot plate, plus it's easy to pour a liquid without making a mess.
- Beakers are also easy to clean.
- Beakers are commonly made of glass (usually borosilicate glass), but can also be in metal (such as stainless steel or aluminum) or certain plastics.

Beaker tongs are used to pick up beakers.

Beakers

Beaker tongs

Flasks

Flasks come in a number of shapes and a wide range of sizes, but a common distinguishing aspect in their shapes is a wider vessel "body" and one (or sometimes more) narrower tubular sections at the top called necks which have an opening at the top.

Laboratory flask sizes are specified by the volume they can hold, typically in metric units such as milliliters (mL or ml) or liters (L or l).

Laboratory flasks have traditionally been made of glass, but can also be made of plastic.

Flasks

Flasks can be used

- for making solutions
- for holding, containing, collecting, sometimes volumetrically measuring chemicals, samples, solutions, etc.
- for chemical reactions or other processes such as mixing, heating, cooling, dissolving, precipitation, boiling (as in distillation),or analysis.

There are several types of laboratory flasks, all of which have different functions within the laboratory.

Flasks

Reaction flasks

Reaction flasks are usually spherical (i.e. round-bottom flask) and are accompanied by their necks, at the ends of which are ground glass joints to quickly and tightly connect to the rest of the apparatus (such as a reflux condenser or dropping funnel).

The reaction flask is usually made of thick glass and can tolerate large pressure differences, with the result that one can be kept both in a reaction under vacuum, and pressure, sometimes simultaneously.

Flasks

Reaction flasks

Some varieties of the reaction flasks are:

- Multiple neck flask
- Schlenk flask

Multiple neck flasks, which can have two to five, and less commonly, six necks, each topped by ground glass connections which are used in more complex reactions that require the controlled mixing of multiple reagents.

Multiple neck flasks

Schlenk flask, which is a flask with a ground glass opening and a hose outlet and a vacuum stopcock.

The tap makes it easy to connect the flask to a vacuum-nitrogen line through the hose and to facilitate the carrying out of a reaction either in vacuum or in an atmosphere of nitrogen.

Schlenk flasks

Flasks

Distillation flasks

Distillation flasks, which are intended to contain mixtures that are subject to distillation, as well as to receive the products of distillation.

Distillation flasks are available in various shapes.

Distillation flask

Similar to the reaction flasks, the distillation flasks usually have only one narrow neck and a ground glass joint and are made of thinner glass than the reaction flask, so that they are easier to heat.

Kjeldahl flask

They are sometimes spherical, test tube shaped or pear-shaped, also known as Kjeldahl flasks.

Flasks

Reagent flasks

Reagent flasks are usually flat-bottomed flasks, which can thus be conveniently placed on the table or in a cabinet.

These flasks cannot withstand too much pressure or temperature differences, due to the stresses which arise in a flat bottom; these flasks are usually made of weaker glass than reaction flasks.

Certain types of flasks are supplied with a ground glass stopper in them, and others that have threaded necks close with an appropriate nut or automatic dispenser.

Florence flask

The reagent flasks are available in two standard shapes:

- Florence flasks

  The flasks are often long neck; sometimes they have the incision on the neck, which precisely defines the volume of flask.

  They can be used in distillations, or in the heating a product.

- Flasks with flat bottom

Flasks with flat bottom

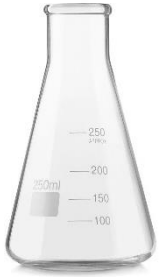
Flasks

Erlenmeyer flasks

An **Erlenmeyer flask**, also known as a **conical flask** or a **titration flask**, is a type of laboratory flask which features a flat bottom, a conical body, and a cylindrical neck.

The slanted sides and narrow neck of this flask allow the contents of the flask to be mixed by swirling, without risk of spillage, making them suitable for titrations by placing it under the burette and adding solvent and the indicator in the flask.

Such features similarly make the flask suitable for boiling liquids. Hot vapor condenses on the upper section of the Erlenmeyer flask, reducing solvent loss.



Erlenmeyer flask

Erlenmeyer flasks' narrow necks can also support filter funnels.

The Erlenmeyer flasks are especially appropriate for recrystallization.

Like beakers, Erlenmeyer flasks are not normally suitable for accurate volumetric measurements.

Their stamped volumes are approximate within about 5% accuracy.

Flasks

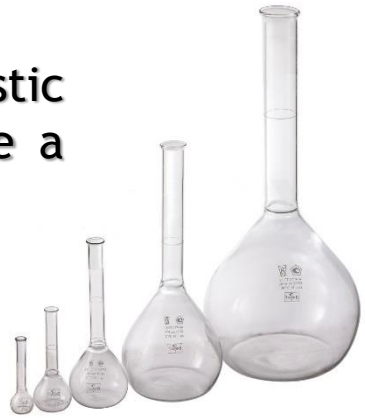
Volumetric flasks

A volumetric flask (measuring flask or graduated flask) is a type of laboratory flask, calibrated to contain a precise volume at a certain temperature. Volumetric flasks are used for precise dilutions and preparation of standard solutions. These flasks are usually pear-shaped, with a flat bottom, and made of glass or plastic.

The flask's opening is either furnished with a plastic snap/screw cap or fitted with a joint to accommodate a PTFE or glass stopper.

The neck of volumetric flasks is elongated and narrow with an etched ring graduation marking.

The marking indicates the volume of liquid contained when filled up to that point.



Measuring flasks

Flasks

Vacuum flasks

A vacuum flask (also known as a Dewar flask, Dewar bottle or thermos) is an insulating storage vessel that greatly lengthens the time over which its contents remain hotter or cooler than the flask's surroundings.

The vacuum flask consists of two flasks, placed one within the other and joined at the neck.

The gap between the two flasks is partially evacuated of air, creating a near-vacuum which significantly reduces heat transfer by conduction or convection.

Vacuum flask

In laboratories and industry, vacuum flasks are often used to hold liquefied gases (often liquid nitrogen) for flash freezing, sample preparation and other processes where maintaining an extreme low temperature is desired.

Larger vacuum flasks store liquids that become gaseous at well below ambient temperature, such as oxygen and nitrogen.

Flasks

Büchner flasks

A Büchner flask, also known as a vacuum flask, filter flask, suction flask, side-arm flask, Kitasato flask or Bunsen flask, is a thick-walled Erlenmeyer flask with a short glass tube and hose barb protruding about an inch from its neck.

Büchner flask

The short tube and hose barb effectively act as an adapter over which the end of a thick-walled flexible hose (tubing) can be fitted to form a connection to the flask.

The other end of the hose can be connected to source of vacuum such as an aspirator, vacuum pump, or house vacuum.

Preferably this is done through a trap, which is designed to prevent the sucking back of water from the aspirator into the Büchner flask.

Flasks

Büchner flasks

The thick wall of the Büchner flask provides it the strength to withstand the pressure difference while holding a vacuum inside.

It is primarily used together with a Büchner funnel fitted through a drilled rubber bung or an elastomer adapter (a Büchner ring) at the neck on top of the flask for the filtration of samples.

The Büchner funnel holds the sample isolated from the suction by a layer of filter paper.

During filtration, the filtrate enters and is held by the flask while the residue remains on the filter paper in the funnel.

The Büchner flask can also be used as a vacuum trap in a vacuum line to ensure that no fluids are carried over from the aspirator or vacuum pump (or other vacuum source) to the evacuated apparatus or vice versa.

Büchner flask and Büchner funnel

Graduated cylinders

A **graduated cylinder**, also known as measuring cylinder or mixing cylinder is a common piece of laboratory equipment used to measure the volume of a liquid.

It has a narrow cylindrical shape.

Each marked line on the graduated cylinder represents the amount of liquid that has been measured.

Graduated cylinder

Bottles and Jars

Bottles are containers with narrow openings generally used to store reagents or samples.

Small bottles are called vials.

Vials can be used as scientific sample vessels; for instance, in autosampler devices in analytical chromatography.

Bottles

Vials

Jars are cylindrical containers with wide openings that may be sealed.

Bell jars are used to contain vacuums.

Bell Jar

Test tubes

Test tubes intended for general chemical work are usually made of glass, for its relative resistance to heat.

Tubes made from expansion-resistant glasses, mostly borosilicate glass or fused quartz, can withstand high temperatures up to several hundred degrees Celsius.

Test Tubes

A chemistry test tube typically has a flat bottom, a round bottom, or a conical bottom.

Test Tubes with Glass Stoppers

Test Tubes with Screw Caps

Some test tubes are made to accept a ground glass stopper or a screw cap.

Test tubes

Test tubes are widely used by chemists to handle chemicals, especially for qualitative experiments and assays.

Their spherical bottom and vertical sides reduce mass loss when pouring, make them easier to wash out, and allow convenient monitoring of the contents.

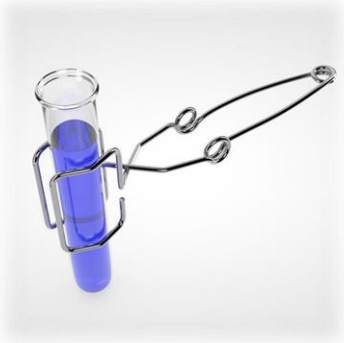
The long, narrow neck of test tube slows down the spreading of gases to the environment.

Test tubes are convenient containers for heating small amounts of liquids or solids with a Bunsen burner or alcohol burner. The tube is usually held by its neck with a clamp or tongs. By tilting the tube, the bottom can be heated to hundreds of degrees in the flame, while the neck remains relatively cool, possibly allowing vapours to condense on its walls.

Test tubes

A test tube filled with water and upturned into a water-filled beaker is often used to capture gases, e.g. in electrolysis demonstrations.

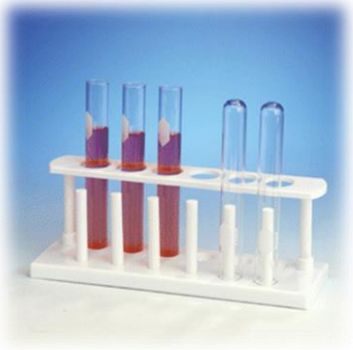
A test tube with a stopper is often used for temporary storage of chemical or biological samples.



Test tube clamp is used to hold a test tube, particularly when hot.

Test Tube Clamp

Test tube rack is used to hold several test tubes at one time.



Test Tube Rack

Burettes

A **burette** is a graduated glass tube with a tap at one end, for delivering known volumes of a liquid, especially in titrations.

It is a long, graduated glass tube, with a stopcock at its lower end and a tapered capillary tube at the stopcock's outlet.

The flow of liquid from the tube to the burette tip is controlled by the stopcock valve.

There are two main **types of burette**:

- the volumetric burette
- the Piston burette or Digital burette

Burette

A **volumetric burette** delivers measured volumes of liquid.

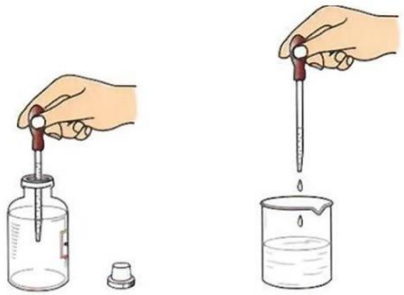
Piston burettes are similar to syringes, but with a precision bore and a plunger. Piston burettes may be manually operated or may be motorized.

Pipette

A **pipette** (sometimes spelled pipet) is a laboratory tool commonly used in chemistry to transport a measured volume of liquid, often as a media dispenser.

Pipettes come in several designs for various purposes with differing levels of accuracy and precision, from single piece glass pipettes to more complex adjustable or electronic pipettes.

Pipette



Glass rods

A glass stirring rod, glass rod, stirring rod or stir rod is a piece of laboratory equipment used to mix chemicals.

They are usually made of solid glass, about the thickness and slightly longer than a drinking straw, with rounded ends.

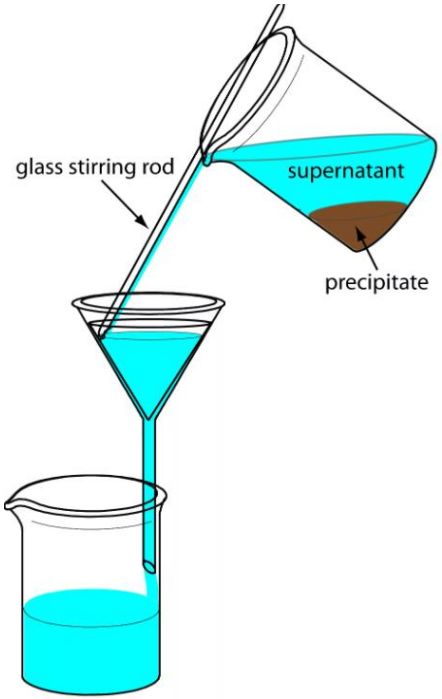
Stir rods are generally made of borosilicate (commonly known as Pyrex) glass or polypropylene plastic. They are usually between 10 and 40 centimeters in length and about half a centimeter in diameter.

Stirring Rod

A stirring rod is used for mixing liquids, or solids and liquids.

Glass rods

Stir rods are used as part of proper laboratory technique when decanting supernatants because the contact helps to negate the adhesion between the side of the glassware and the supernatant that is responsible for the liquid running down the side.



Using a stir rod also grants more control over the rate of flow, which is important in cases where chemicals may react violently.

This process is also used to pour a large-mouthed flask or beaker into a test tube.

Glass rods can also be used to induce crystallization in a recrystallization procedure, when they are used to scratch the inside surface of a test tube or beaker.

They can also break up an emulsion during an extraction.

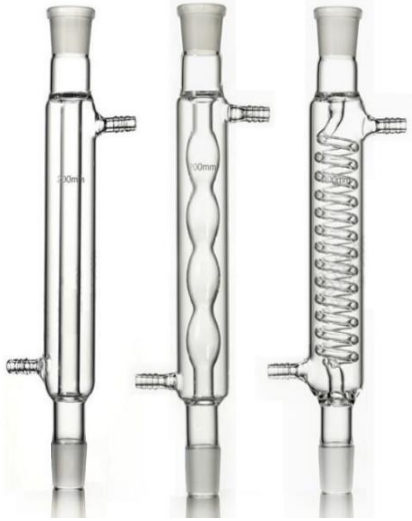
Laboratory condensers

In chemistry, a **condenser** is laboratory apparatus used to condense vapors – that is, turn them into liquids – by cooling them down.

Condensers are routinely used in laboratory operations such as distillation, reflux, and extraction.

Many different types of condensers have been developed for different applications and processing volumes. The simplest and oldest condenser is just a long tube through which the vapors are directed, with the outside air providing the cooling. More commonly, a condenser has a separate tube or outer chamber through which water (or some other fluid) is circulated, to provide a more effective cooling.

Laboratory condensers are usually made of glass for chemical resistance, for ease of cleaning, and to allow visual monitoring of the operation; specifically, borosilicate glass to resist thermal shock and uneven heating by the condensing vapor. Some condensers for dedicated operations (like water distillation) may be made of metal.



Condensers

Desiccators

Desiccators are sealable enclosures containing desiccants used for preserving moisture-sensitive items.

Desiccator

A common use for desiccators is to protect chemicals which are hygroscopic or which react with water from humidity.

Desiccators are sometimes used to remove traces of water from an almost-dry sample.

In laboratory use, the most common desiccators are circular and made of heavy glass.

There is usually a removable platform on which the items to be stored are placed.

The desiccant, usually an otherwise-inert solid such as silica gel, fills the space under the platform.

Separatory funnels

A separatory funnel, also known as a separation funnel, separating funnel, is a piece of laboratory glassware used in liquid-liquid extractions to separate the components of a mixture into two immiscible solvent phases of different densities.

A separating funnel takes the shape of a cone with a hemispherical end.

It has a stopper at the top and stopcock (tap), at the bottom.

Separating funnels used in laboratories are typically made from borosilicate glass and their stopcocks are made from glass or PTFE.

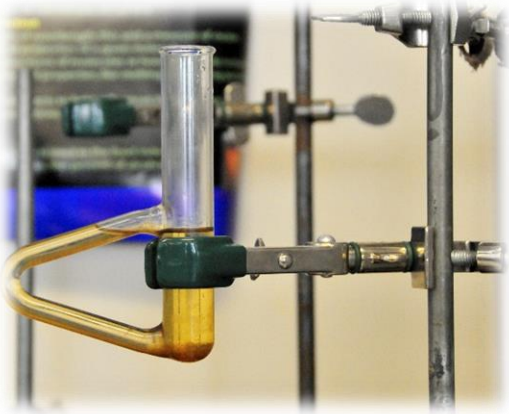
Separation funnel

Thiele tubes

The **Thiele tube**, is a laboratory glassware designed to contain and heat an oil bath.

Such a setup is commonly used in the determination of the melting point of a substance.

The apparatus itself resembles a glass test tube with an attached handle.

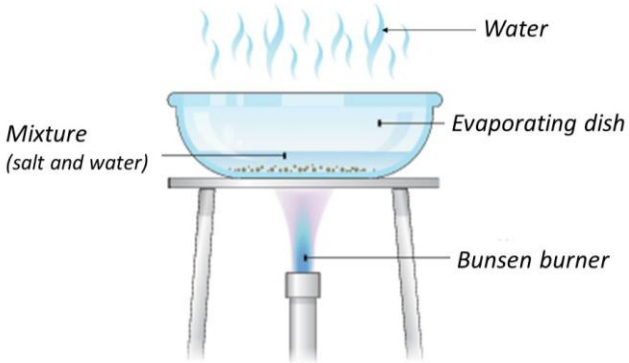


Glass evaporating dishes

An **evaporating dish** is a piece of laboratory glassware used for the evaporation of solutions and supernatant liquids, and sometimes to their melting point.

Evaporating dish

Evaporating dishes are used to evaporate excess solvents – most commonly water – to produce a concentrated solution or a solid precipitate of the dissolved substance.



Evaporation

Most of the evaporating dishes are made of porcelain or borosilicate glass.

Glass Petri dishes

A Petri dish (alternatively known as a Petri plate or cell-culture dish) is a shallow transparent lidded dish that biologists use to hold growth medium in which cells can be cultured, originally, cells of bacteria, fungi and small mosses.

In chemistry, due to their large open surface, Petri dishes are effective containers to evaporate solvents and dry out precipitates, either at room temperature or in ovens and desiccators.

Petri dish

Microscope slides

A **microscope slide** is a thin flat piece of glass, typically 75 by 26 mm (3 by 1 inches) and about 1 mm thick, used to hold objects for examination under a microscope.

Typically, the object is mounted (secured) on the slide, and then both are inserted together in the microscope for viewing.

Microscope slides are often used together with a **cover slip** or **cover glass**, a smaller and thinner sheet of glass that is placed over the specimen.

Other useful laboratory glassware and equipment

Balance is used for measuring mass.

Ring stand is used to hold or clamp laboratory glassware and other equipment in place, so it does not fall down or come apart.

Utility clamp is used to secure glassware to a ring stand.

Ring clamp is used with a ring stand to hold glassware, such as a beaker or a funnel.

Other useful laboratory glassware and equipment

Bunsen burner is frequently used as a heat source in the absence of flammable materials.

Smelting pot (crucible) is used for holding chemicals during heating to very high temperatures.

Crucible tongs are used to hold crucibles.

Other useful laboratory glassware and equipment

Forceps are used to pick up or hold small objects.

Wash bottle is used to rinse pieces of glassware and to add small quantities of water.

Mortar and **pestle** are used to crush and grind materials.

Revision

1. What pieces of laboratory glassware do you know?
2. What pieces of laboratory equipment do you know?
3. What pieces of laboratory glassware and equipment do you use in your scientific work and for what purposes?