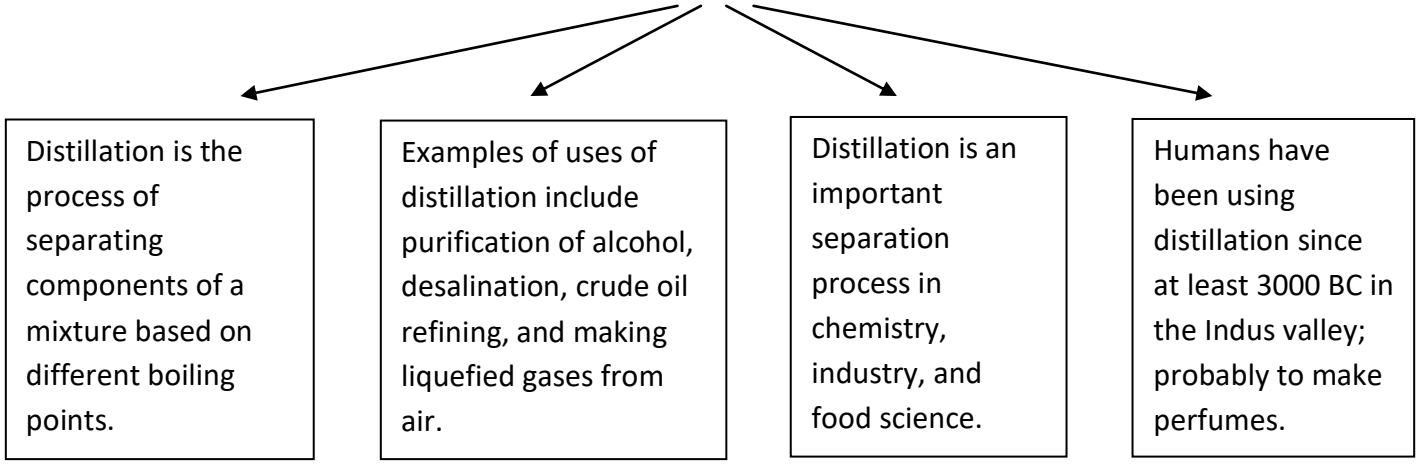
Distillation

KEY FACTS



Distillation is a widely used method for separating mixtures based on differences in the conditions required to change the phase of components of the mixture. To separate a mixture of liquids, the liquid can be heated to force components, which have different boiling points, into the gas phase. The gas is then condensed back into liquid form and collected. Repeating the process on the collected liquid to improve the purity of the product is called double distillation. Although the term is most commonly applied to liquids, the reverse process can be used to separate gases by liquefying components using changes in temperature and/or pressure.

A plant that performs distillation is called a distillery. The apparatus used to perform distillation is called a still.

Uses of Distillation

Distillation is used for many commercial processes, such as the production of gasoline, distilled water, xylene, alcohol, paraffin, kerosene, and many other liquids. Gas may be liquefied and separated. For example: nitrogen, oxygen, and argon are distilled from air.

Types of Distillation

Types of distillation include simple distillation, fractional distillation (different volatile 'fractions' are collected as they are produced), and destructive distillation (usually, a material is heated so that it decomposes into compounds for collection).

- Simple Distillation

Simple distillation may be used when the boiling points of two liquids are significantly different from each other or to separate liquids from solids or nonvolatile components. In simple distillation, a mixture is heated to change the most volatile component from a liquid into vapor. The vapor rises and passes into a condenser. Usually, the condenser is cooled (e.g., by running cold water around it) to promote condensation of the vapor, which is collected.

- Steam Distillation

Steam distillation is used to separate heat-sensitive components. Steam is added to the mixture, causing some of it to vaporize. This vapor is cooled and condensed into two liquid fractions. Sometimes the fractions are collected separately, or they may have different density values, so they separate on their own. An example is steam distillation of flowers to yield essential oil and a water-based distillate.

- Fractional Distillation

Fractional distillation is used when the boiling points of the components of a mixture are close to each other, as determined using Raoult's law. A fractionating column is used to separate the components used a series of distillations called rectification. In fractional distillation, a mixture is heated so vapor rises and enters the fractionating column. As the vapor cools, it condenses on the packing material of the column. The heat of rising vapor causes this liquid to vaporize again, moving it along the column and eventually yielding a higher purity sample of the more volatile component of the mixture.

- Vacuum Distillation

Vacuum distillation is used to separate components that have high boiling points. Lowering the pressure of the apparatus also lowers boiling points. Otherwise, the process is similar to other forms of distillation. Vacuum distillation is particularly useful when the normal boiling point exceeds the decomposition temperature of a compound.

**History*

The earliest known evidence of distillation comes from a terracotta distillation apparatus dating to 3000 BC in the Indus valley of Pakistan. Distillation was known to be used by the Babylonians of Mesopotamia. Initially, distillation is believed to have been used to make perfumes. Distillation of beverages occurred much later. The Arab chemist Al-Kindi distilled alcohol in 9th century Iraq. Distillation of alcoholic beverages appears common in Italy and China starting in the 12th century.

Glossary:

alcohol (n) - *any of a group of similar chemical substances used as solvents (i.e. substances that dissolve others) and in fuel and medicines.* Alkohol

boiling point (n) - *the temperature at which a liquid becomes a gas.* Temperatura wrzenia

collect (v) - *to get and keep things of one type over a period of time.* Zbierać

condensation (n) - *the change of the physical state of matter from the gas phase into the liquid phase, and is the reverse of vaporization.* Kondensacja

condenser (n) - *an apparatus or item of equipment used to condense (change the physical state of a substance from its gaseous to its liquid state).* Chłodnica

condenser (n) - *is a device or a unit used to condense a gaseous substance into a liquid state through cooling.* Skraplacz

crude oil (n) - *oil in a natural state that has not yet been treated into other products.* Ropa naftowa

decomposition temperature of a compound (phrase) - *the temperature in which organic substances are broken down into simpler organic matter or nonorganic matter.* Temperatura rozkładu związku

density (n)- *the relationship between the mass of something and its size.* Gęstość

desalination (n) - *the process of removing salt and other minerals from water.* Odsalanie

distillation (n) - *the process of separating components of a mixture based on their different boiling points.* Destylacja

distillery (n) – *an industrial plant that produces ethyl alcohol by fermenting natural products (most often cereals).* Gorzelnia

fractionating column (n) - *is an essential item used in distillation of liquid mixtures so as to separate the mixture into its component parts, or fractions, based on the differences in volatilities.* Kolumna rektyfikacyjna

gasoline (n) - *a colorless petroleum-derived flammable liquid that is used primarily as a fuel in spark-ignited internal combustion engines. It consists mostly of organic compounds obtained by the fractional distillation of petroleum, enhanced with a variety of additives.* Benzyna

heating (n) - *the process of making something warm.* Ogrzewanie

high boiling point (phrase) – *Boiling point above 150 degrees Celsius.* Wysoka temperatura wrzenia

liquefied gas (phrase) - *gas that has been cooled and compressed to a liquid form for transport and storage.* Gaz skroplony

method (n) - *a particular form of procedure for accomplishing or approaching something, especially a systematic or established one.* Metoda

mixture (n) - *a substance made from a combination of different substances.* Mieszanina

normal boiling point (phrase) - *the temperature at which a liquid boils at 1 atmosphere of pressure*. Normalna temperatura wrzenia

paraffin (n) - *a very highly refined mineral oil used in cosmetics and medicine. It is transparent, colorless, nearly odorless, and oily and is composed of saturated hydrocarbons derived from petroleum.* Parafina

phase (n) - *one of the forms in which matter can exist, such as solid, liquid, or gas.* Stan

purification (n) - *the act of removing harmful or unwanted substances from something.* Oczyszczenie

refining (n) - *the process of making different products from a basic product, usually oil or sugar*. Rafinacja

required (adj) - *compulsory, or otherwise considered essential; indispensable.* Wymagany

still (n) - *a piece of equipment used for making alcohol* . Aparat destylacyjny

sample (noun) - *a limited quantity of something which is intended to be similar to and represent a larger amount of that thing.* Próbka

separate (v) - *to (cause to) divide into parts.* Rozdzielić

steam distillation (phrase) - *is a special type of distillation (separation process) for temperature-sensitive materials, such as natural aromatics.* Destylacja parą wodną

vacuum (n) - *a space that is completely empty of all gas, especially one from which all the air has been taken away.* próżnia

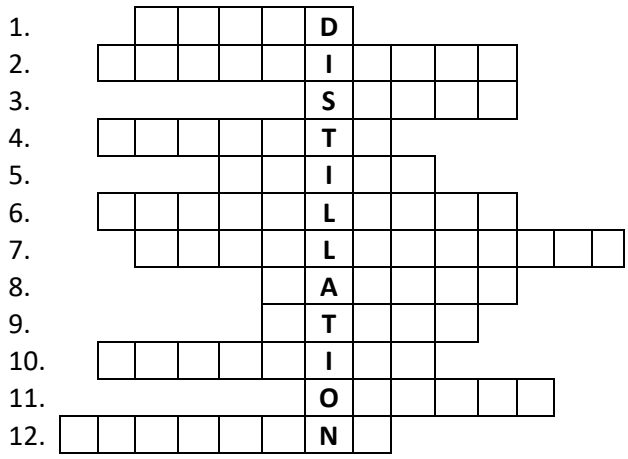
volatile (adj)- *a liquid or a substance which can easily change into a gas.* Lotny

EXERCISE 1.

Are the following statements true or false?	**TRUE**	**FALSE**
1. Distillation is the process of connecting substances with different boiling points into a mixture	**T**	**F**
2. To separate a mixture of liquids, the liquids must be cooled to force the components, which have different freezing points, into the gas phase.	**T**	**F**
3. Repeating the process of distillation on the collected liquid to improve the purity of the product is called vacuum distillation.	**T**	**F**
4. Simple distillation may be used when the boiling points of the components of a mixture are close to each other.	**T**	**F**
5. Lowering the pressure of the apparatus also lowers boiling points.	**T**	**F**

EXERCISE 2.

Do the crossword:



1. Simple distillation may be used to separate a liquid from a ……. .

2. Type of distillation which is used when the boiling points of the components of a mixture are close to each other.

3. the hot gas that is produced when water boils

4. Mass divided by volume.

5. Boiling ……. is a temperature at which a substance boils

6. a factory where strong alcoholic drinks are produced by the process of distilling

7. the process of removing salt and other minerals from water

8. Type of distillation which is used to separate components that have high boiling points.

9. The name of an apparatus used to perform distillation.

10. such a substance easily changes into a gas

11. a chemical element that is a gas with no smell or color and is needed by animals and plants to live

12. a kind of fuel, often used in cars

EXERCISE 3.

Translate the phrases in brackets into English:

1. Distillation is the process of separating components of a mixture based on different ……. ……. (temperatury wrzenia).

2. Gas may be …… (skroplony) and separated.

3.In simple distillation, a mixture is heated to change the ……. …….. (najbardziej lotny) component from a liquid into vapor.

4.Vapor is cooled and condensed into two ……. ……. (płynne frakcje).

5. A ……. ……. (kolumna rektyfikacyjna) is an essential item used in distillation of liquid mixtures so as to separate the mixture into its component parts, or fractions, based on the differences in volatilities.

6. The heat of rising vapor causes this liquid to vaporize again, moving it along the column and eventually yielding a …… ……. (wyższej czystości) sample of the more volatile component of the mixture.

7. (Obniżenie ciśnienia) …… …….. of the apparatus also lowers boiling points of the components.

8. Distillation of (napojów alkoholowych) ……. ……. appears common in Italy and China starting in the 12th century.

EXERCISE 4.

Match

1. fractionating	a. refining
2. reverse	b. column
3. crude oil	c. phase
4. destructive	d. process
5. nonvolatile	e. components
6. gas	f. distillation

Discuss:

- What types of distillation do you know? Briefly describe each of them.
- Where are the applications of distillation ?
- Do you know any other separation methods? Name them.