Industrial Chemistry

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Introduction

Dear students!

You hold a study support for the subject Industrial chemistry. It is intended for students of Masaryk University, Faculty of Education, field of study Teaching of Chemistry. This is not a textbook in the true sense of the word.

All the texts used in this study support have been prepared by native speakers. But, the majority of them is a part of a textbook R. Gallagher and P. Ingram: *Chemistry Made Clear* (Oxford University Press). No part of that publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, without the prior permission in writing of Oxford University Press.

That is why this study support contains mainly links to the necessary parts in the textbook *Chemistry Made Clear*. An integral part of the study support is made by links to exercises. Again, these are links to the *Chemistry Made Clear* textbook. The textbook can be borrowed from the library of Faculty of Education, Masaryk University.

A Czech-English and English-Czech vocabulary had been prepared in accordance with the textbook Chemistry Made Clear, containing also sound recordings spoken by native speakers (Cídlová, Ptáček, Šustr: *Chemistry – Vocabulary and Reading*; available from https://is.muni.cz/elportal/?id=1356790). Our study support contains also links to this vocabulary.

The third part of this study support contains texts for listening to spoken English. The texts are taken from English-written Wikipedia and they are spoken by native speakers.

We wish you a pleasant study.

Brno, 2018

The authors

Part I:
Texts from
GALLAGHER, R. a P. INGRAM. *Chemistry Made Clear*.
GCSE ed. Oxford: Oxford University Press, 1987.

Air, nitrogen, oxygen, noble gases

Textbook pages 100-103

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-8.html

Questions: 101/1, 103/2

Exercises: 114/1 – 2

Water

Textbook pages 106-113

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-8.html

Questions: 105/1 – 3

Exercise: 115/8a

Industrial uses of electrolysis

Textbook pages 82-83

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-6.html

Questions: 83/1 – 3

Exercises: 84/1 – 12

Metals

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-10.html

Exercises: 151/8a, d, f, 10, 11, 12

Occurrence in the Earth's crust

Textbook pages 138-139

Question: 139/7, 8

Extracting and recycling

Textbook pages 140-141

Questions: 141/1, 2, 4, 6

Use of metals and alloys

Textbook pages 142-143

Questions: 143/2, 3, 5

Aluminium

Textbook pages 144-145

Questions: 145/1 – 5

Iron

Textbook pages 146-147

Questions: 147/1 – 9

Corrosion
Textbook pages 148-149

Questions: 149/2, 149/7

Hydrogen
Textbook pages 152-153

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-11.html

Questions: 153/1, 2

Chlorine
Textbook pages 174-175

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-12.html

Question: 175/1

Ammonia, nitric acid
Textbook pages 158-159

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-11.html

Questions: 159/1, 2

Exercises:164/4, 5, 8, 9

Fertilisers
Textbook pages 160-163

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-11.html

Questions: 163/1 – 6

Sulphur, sulphur dioxide, sulphuric acid
Textbook pages 170-173

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-12.html

Questions: 171/1, 173/1, 2

Exercise: 178/5

Carbonates
Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-13.html

Textbook pages 180-181

Coal, oil, gas
Textbook pages 186-187

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-13.html

Questions: 187/2, 5

Substances from oil

Textbook pages 196-197

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-13.html

Questions: 197/1-4

Exercises: 201/10, 11

Ethanol

Textbook pages 195

Vocabulary https://is.muni.cz/do/rect/el/estud/pedf/ps16/chemistry/web/pages/chapter-13.html

Questions: 195/3, 4

Exercise: 201/8c, d – i

Part II:
Texts from Wikipedia: the free encyclopedia

Copper

Most copper is mined or extracted as copper sulphides from large open pit mines in porphyry copper deposits that contain 0.4 to 1.0 % copper. Sites include Chuquicamata in Chile, Bingham Canyon Mine in Utah, United States and El Chino Mine in New Mexico, United States. According to the British Geological Survey in 2005, Chile[1] was the top producer of copper with at least one-third world share followed by the United States, Indonesia and Peru. Copper can also be recovered through the in-situ leach process. Several sites in the state of Arizona are considered prime candidates for this method. The amount of copper in use is increasing and the quantity available is barely sufficient to allow all countries to reach developed world levels of usage.

Copper has been in use at least 10,000 years, but more than 95 % of all copper ever mined and smelted has been extracted since 1900, and more than half was extracted the last 24 years. As with many natural resources, the total amount of copper on Earth is vast, with around 1014 tons in the top kilometer of Earth's crust, which is about 5 million years' worth at the current rate of extraction. However, only a tiny fraction of these reserves is economically viable with present-day prices and technologies.

Estimates of copper reserves available for mining vary from 25 years to 60 years, depending on core assumptions such as the growth rate. Recycling is a major source of copper in the modern world. Because of these and other factors, the future of copper production and supply is the subject of much debate, including the concept of peak copper, analogous to peak oil.

The concentration of copper in ores averages only 0.6 %, and most commercial ores are sulphides, especially chalcopyrite ($CuFeS_2$) and to a lesser extent chalcocite (Cu_2S). These minerals are concentrated from crushed ores to the level of 10–15 % copper by froth flotation or bioleaching. Heating this material with silica in flash smelting removes much of the iron as slag. The process exploits the greater ease of converting iron sulphides into oxides, which in turn react with the silica to form the silicate slag that floats on top of the heated mass. The resulting copper matte, consisting of Cu_2S, is roasted to convert all sulphides into oxides:

$2\ Cu_2S + 3\ O_2 \rightarrow 2\ Cu_2O + 2\ SO_2$

The cuprous oxide is converted to blister copper upon heating:

$2\ Cu_2O \rightarrow 4\ Cu + O_2$

[1] Chyba rodilého mluvčího. Patří „Chile“, nahráno je „copper“.

The Sudbury matte process converted only half the sulphide to oxide and then used this oxide to remove the rest of the sulphur as oxide. It was then electrolytically refined and the anode mud exploited for the platinum and gold it contained. This step exploits the relatively easy reduction of copper oxides to copper metal. Natural gas is blown across the blister to remove most of the remaining oxygen and electrorefining is performed on the resulting material to produce pure copper:

$Cu^{2+} + 2\ e^- \rightarrow Cu$

Like aluminium, copper is recyclable without any loss of quality, both from raw state and from manufactured products. In volume, copper is the third most recycled metal after iron and aluminium. An estimated 80 % of all copper ever mined is still in use today. According to the International Resource Panel's Metal Stocks in Society report, the global per capita stock of copper in use in society is 35–55 kg. Much of this is in more-developed countries (140–300 kg per capita) rather than less-developed countries (30–40 kg per capita).

The process of recycling copper is roughly the same as is used to extract copper but requires fewer steps. High-purity scrap copper is melted in a furnace and then reduced and cast into billets and ingots; lower-purity scrap is refined by electroplating in a bath of sulphuric acid.

Numerous copper alloys have been formulated, many with important uses. Brass is an alloy of copper and zinc. Bronze usually refers to copper-tin alloys, but can refer to any alloy of copper such as aluminium bronze. Copper is one of the most important constituents of silver and carat gold and carat solders used in the jewelry industry, modifying the color, hardness and melting point of the resulting alloys. Some lead-free solders consist of tin alloyed with a small proportion of copper and other metals.

The alloy of copper and nickel, called cupronickel, is used in low-denomination coins, often for the outer cladding. The US 5-cent coin (currently called a nickel) consists of 75 % copper and 25 % nickel in homogeneous composition. The alloy o 90 % copper and 10 % nickel, remarkable for its resistance to corrosion, is used for various objects exposed to seawater, though it is vulnerable to the sulphides sometimes found in polluted harbors and estuaries. Alloys of copper with aluminium (about 7 %) have a golden color and are used in decorations. Shakudō is a Japanese decorative alloy of copper containing a low percentage of gold, typically 4–10 %, that can be patinated to a dark blue or black color.

Vocabulary

alloy	slitina
aluminium	hliník

billet	předlitek; ubytovat
bioleaching	bioloužení
blister copper	blistr mědi
brass	mosaz, žesťové hudební nástroje
bronze	bronz
carat gold	karátové zlato
carat solder	pájka
composition	chemické složení; esej; hudební skladba
concentration	koncentrace
constituent	složka
copper	měď
copper sulphides	sulfidy mědi
copper-tin alloy	slitina mědi a cínu
corrosion	koroze
cupronickel	kupronikl (10–30 % Ni + do 1,5 % Fe, zbytek Cu)
cuprous oxide	oxid měďný
electrolytically	elektrolyticky
electrorefining	elektrorafinace
extracted	těžený, získávaný
extraction	extrakce
froth floating	pěnová flotace
furnace	pec
gold	zlato
hardness	tvrdost
heating	zahřívání
homogenous	homogenní
chalcocite	chalkocit (sulfid měďný)
chalcopyrite	chalkopyrit
ingot	ingot, odlitek
iron	železo
iron sulphides	sulfidy železa
jewelry	klenotnictví
leach process	proces loužení
manufactured	vyrobený
matte	lech (měděný), kamínek
melted	rozpuštěný
melting point	bod tání
metal	kov
mine	důl; moje; mina
mud	kal (anodový); bláto
natural gas	zemní plyn
ore	ruda
oxides	oxidy
oxygen	kyslík
pit	šachta, důl
platinum	platina
polluted	znečištěný
porphyry	porfyr
product	produkt

production	výroba, těžba
raw	surový; syrový
recyclable	recyklovatelný
recycling	recyklace
reduction	redukce
resistance	odolnost; odpor
resource	zdroj, zásoba
scrap	zbytek; šrot
silica	křemen, oxid křemičitý
silver	stříbro
slag	struska
smelted	tavený
source	zdroj, pramen; příčina
sulphuric acid	kyselina sírová
supply	zásoba; nabídka
volume	objem
zinc	zinek

Exercises

1) What is a major source of copper in the modern world?

2) What is the most known ore of copper?

3) Match each alloy with its composition:

Alloy	**Composition**
a) Brass	A) 75 % copper, 25 % nickel
b) Bronze	B) 70 % copper, 30 % zinc
c) Cupronickel	C) 90-96 % copper, 4-10 % gold
d) Shakudō	D) 88 % copper, 12 % tin

Zinc

Brass, an alloy of copper and zinc in various proportions, was used as early as the third millennium BC. Zinc metal was not produced on a large scale until the 12th century in India, though it was known to the ancient Romans and Greeks. To date, the oldest evidence of pure zinc comes from Zawar, in Rajasthan, as early as the 9th century AD when a distillation process was employed to make pure zinc. Alchemists burned zinc in air to form what they called "philosopher's wool" or "white snow".

The element was probably named by the alchemist Paracelsus after the German word *Zinke* (prong, tooth). German chemist Andreas Sigismund Marggraf is credited with discovering pure metallic zinc in 1746. Work by Luigi Galvani and Alessandro Volta uncovered the electrochemical properties of zinc by 1800. Corrosion-resistant zinc plating of iron is the major application for zinc. Other applications are in electrical batteries, small non-structural castings, and alloys such as brass.

A variety of zinc compounds are commonly used, such as zinc carbonate and zinc gluconate (as dietary supplements), zinc chloride (in deodorants), zinc pyrithione (anti-dandruff shampoos), zinc sulphide (in luminescent paints), and zinc methyl or zinc diethyl in the organic laboratory.

Zinc is the fourth most common metal in use, trailing only iron, aluminium, and copper with an annual production of about 13 million tonnes. About 70 % of the world's zinc originates from mining, while the remaining 30 % comes from recycling secondary zinc.

Worldwide, 95 % of new zinc is mined from sulphidic ore deposits, in which sphalerite (ZnS) is nearly always mixed with the sulphides of copper, lead and iron. Zinc mines are scattered throughout the world, with the main areas being China, Australia, and Peru. China produced 38 % of the global zinc output in 2014.

Zinc metal is produced using extractive metallurgy. The ore is finely ground, then put through froth flotation to get a zinc sulphide ore concentrate consisting of about 50 % zinc, 32 % sulphur, 13 % iron, and 5 % SiO_2.

Roasting converts the zinc sulphide concentrate to zinc oxide:

$$2\ ZnS + 3\ O_2 \rightarrow 2\ ZnO + 2\ SO_2$$

The sulphur dioxide is used for the production of sulphuric acid, which is necessary for the leaching process. If deposits of zinc carbonate, zinc silicate, or zinc spinel are used for zinc production, the roasting can be omitted.

For further processing two basic methods are used: pyrometallurgy or electrowinning. Pyrometallurgy reduces zinc oxide with carbon or carbon monoxide

at 950 °C (1.740 °F) into the metal, which is distilled as zinc vapour to separate it from other metals, which are not volatile at these temperatures. The zinc vapour is collected in a condenser. The equations below describe this process:

$$2\ ZnO + C \rightarrow 2\ Zn + CO_2$$

$$ZnO + CO \rightarrow Zn + CO_2$$

In electrowinning, zinc is leached from the ore concentrate by sulphuric acid:

$$ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$$

Finally, the zinc is reduced by electrolysis.

$$2\ ZnSO_4 + 2\ H_2O \rightarrow 2\ Zn + 2\ H_2SO_4 + O_2$$

The sulphuric acid is regenerated and recycled to the leaching step.

Refinement of sulphidic zinc ores produces large volumes of sulphur dioxide and cadmium vapour. Smelter slag and other residues contain significant quantities of metals. Zinc in rivers flowing through industrial and mining areas can be as high as 20 ppm. Effective sewage treatment greatly reduces this; treatment along the Rhine, for example, has decreased zinc levels to 50 ppb. Concentrations of zinc as low as 2 ppm adversely affects the amount of oxygen that fish can carry in their blood.

Vocabulary

alchemist	alchymista
alloy	slitina
aluminium	hliník
brass	mosaz, žesťové hudební nástroje
cadmium	kadmium
carbon	uhlík
carbon monoxide	oxid uhelnatý
casting	odlitek; konkurz
concentrate	koncentrát; soustředit se
concentration	koncentrace
copper	měď
corrosion	koroze
distillation	destilace
electrochemical properties	elektrochemické vlastnosti
electrolysis	elektrolýza
electrowinning	elektolytické získávání
element	prvek
equation	rovnice
flotation	flotace

iron	železo
laboratory	laboratoř
lead	olovo; vést, řídit
leaching process	proces loužení
luminescent paint	luminescenční barva
metallurgy	metalurgie
mining	hornictví, dolování
ore	ruda
oxygen	kyslík
pure	čistý
pyrometallurgy	pyrometalurgie
recycling	recyklace
reduced	redukováno
refinement	čištění; vylepšení
residue	zbytek
resistant	odolnost; odpor
roasting	pražení
scattered	rozptýlený
separate	oddělit, separovat
sewage	odpadní voda, splašky
sphalerite	sfalerit
sulphur	síra
sulphur dioxide	oxid siřičitý
sulphuric acid	kyselina sírová
temperature	teplota
vapour	pára
volatile	těkavý
zinc	zinek
zinc carbonate	uhličitan zinečnatý
zinc diethyl	diethylzinek
zinc gluconate	glukonát zinečnatý
zinc chloride	chlorid zinečnatý
zinc methyl	dimethylzinek
zinc oxide	oxid zinečnatý
zinc plating	zinkování
zinc pyrithione	pyrithion zinečnatý
zinc silicate	křemičitan zinečnatý
zinc spinel	zinečnatý spinel
zinc sulphide	sulfid zinečnatý

Exercises

4) Decide whether the following statements are true or false.

a) Zinc was known to the ancient Romans and Greeks. TRUE / FALSE

b) Zinc was named by Andreas Sigismund Marggraf after the German word "*zinke*". TRUE / FALSE

c) The major application for zinc is zinc plating of iron. TRUE / FALSE

d) We can find zinc chloride and zinc pyrithione in some cosmetics. TRUE / FALSE

e) Zinc is the most common metal in use. TRUE / FALSE

f) Chemical formula of sphalerite is FeS_2. TRUE / FALSE

g) Pyrometallurgy and electrowinning are part of a zinc production process. TRUE / FALSE

Plaster

Plaster is a building material used for the protective and/or decorative coating of walls and ceilings and for moulding and casting decorative elements. In English "plaster" usually means a material used for the interiors of buildings, while "render" commonly refers to external applications. Another imprecise term used for the material is "stucco", which is also often used for plasterwork that is worked in some way to produce relief decoration, rather than flat surfaces.

The most common types of plaster mainly contain either gypsum, lime, or cement, but all work in a similar way. The plaster is manufactured as a dry powder and is mixed with water to form a stiff but workable paste immediately before it is applied to the surface. The reaction with water liberates heat through crystallization and the hydrated plaster then hardens.

Forms of plaster have several other uses. In medicine plaster orthopedic casts are still often used for supporting set broken bones. In dentistry plaster is used to make dental models. Various types of models and moulds are made with plaster. In art, lime plaster is the traditional matrix for fresco painting; the pigments are applied to a thin wet top layer of plaster and fuse with it so that the painting is actually in coloured plaster. In the ancient world, as well as the sort of ornamental designs in plaster relief that are still used, plaster was also widely used to create large figurative reliefs for walls, though few of these have survived.

Gypsum plaster

Gypsum plaster, or **plaster of Paris**, is produced by heating gypsum to about 150 °C:

$CaSO_4 \cdot 2H_2O + \textit{heat} \rightarrow CaSO_4 \cdot 0.5H_2O + 1.5H_2O$ (released as steam).

When the dry plaster powder is mixed with water, it reforms into gypsum. The setting of unmodified plaster starts about 10 minutes after mixing and is complete in about 45 minutes; but not fully set for 72 hours. If plaster or gypsum is heated above 130 °C, hemihydrate is formed, which will also re-form as gypsum if mixed with water.

A large gypsum deposit at Montmartre in Paris led "calcined gypsum" (roasted gypsum or gypsum plaster) to be commonly known as "plaster of Paris".

Plasterers often use gypsum to simulate the appearance of surfaces of wood, stone, or metal, on movie and theatrical sets for example. Nowadays, theatrical plasterers often use expanded polystyrene, although the job title remains unchanged.

Plaster of Paris can be used to impregnate gauze bandages to make a sculpting material called plaster bandages. It is used similarly to clay, as it is easily shaped when wet, yet sets into a resilient and lightweight structure. This is the material that was (and sometimes still is) used to make classic plaster orthopedic casts to protect limbs with broken bones, the artistic use having been partly inspired by the medical use. The hydration of plaster of Paris relies on the reaction of water with the dehydrated or partially hydrated calcium sulphate present in the plaster.

Lime plaster

Lime plaster is a mixture of calcium hydroxide and sand (or other inert fillers). Carbon dioxide in the atmosphere causes the plaster to set by transforming the calcium hydroxide into calcium carbonate (limestone). Whitewash is based on the same chemistry.

To make lime plaster, limestone (calcium carbonate) is heated above approximately 850 °C to produce quicklime (calcium oxide). Water is then added to produce slaked lime (calcium hydroxide), which is sold as a wet putty or a white powder. Additional water is added to form a paste prior to use. The paste may be stored in airtight containers. When exposed to the atmosphere, the calcium hydroxide very slowly turns back into calcium carbonate through reaction with atmospheric carbon dioxide, causing the plaster to increase in strength.

Lime plaster was a common building material for wall surfaces in a process known as lath and plaster, whereby a series of wooden strips on a studwork frame was covered with a semi-dry plaster that hardened into a surface. The plaster used in most lath and plaster construction was mainly lime plaster, with a cure time of about a month. To stabilize the lime plaster during curing, small amounts of plaster of Paris were incorporated into the mix. Because plaster of Paris sets quickly, "retardants" were used to slow down setting time enough to allow workers to mix large working quantities of lime putty plaster. A modern form of this method uses expanded metal mesh over wood or metal structures, which allows a great freedom of design as it is adaptable to both simple and compound curves. Today this building method has been partly replaced with drywall, also composed mostly of gypsum plaster. In both these methods, a primary advantage of the material is that it is resistant to a fire within a room and so can assist in reducing or eliminating structural damage or destruction provided the fire is promptly extinguished.

Lime plaster is used for frescoes, where pigments, diluted in water, are applied to the still wet plaster.

Vocabulary

airtight	vzduchootěsný
anhydrous	bezvodý
atmosphere	atmosféra
bondage	obvaz
calcium carbonate	uhličitan vápenatý
calcium hydroxide	hydroxid vápenatý
calcium oxide	oxid vápenatý
calcium sulphate	síran vápenatý
carbon dioxide	oxid uhličitý
$CaSO_4.2H_2O$	$CaSO_4 . 2 H_2O$
cement	cement, tmel
clay	jíl, hlína
coating	vrstva, povlak, nátěr
compound	sloučenina
crystallization	krystalizace
curing	sušení; léčení; vyřešení
dentistry	zubní lékařství
desiccant	vysoušedlo
diluted	zředěný
element	prvek
extinguished	uhašený
fillers	výplně
form	utvořit, vytvořit
fresco	freska
fuse	rozpustit, sloučit; pojistka
gauze	síťka, gáza
gypsum	sádrovec, sádra
harden	tvrdnutí
heat	teplo
heating	zahřívání
hemihydrate	hemihydrát
hydration	hydratace
impregnate	impregnovat, napustit
inert	inertní, netečný
layer	vrstva
lightweight	lehký, odlehčený
lime plaster	vápenná omítka
limestone	vápenec
manufactured	vyrobený
material	látka, hmota
metal	kov
mixed	smíchaný
orthopedic cast	ortopedický odlitek
paste	pasta; přilepit
pigment	pigment, barvivo
plaster	omítka, sádrová malta

polystyrene	polystyren
powder	prášek
putty	tmel
quicklime	nehašené vápno
render	omítka; učinit, poskytnout
resilient	pružný, odolný
retardant	retardér
sand	písek; odvaha
slaked lime	hašené vápno
state	skupenství; stát (země)
steam	vodní pára (nad hladinou vařící vody)
stucco	štuk, štuková omítka
surface	povrch; hladina
water	voda
β-anhydrite	β-anhydrit
γ-anhydrite	γ-anhydrit

Exercises

5) Complete the text.

In English "……" usually means a material used for the interiors of buildings, while "……" commonly refers to external applications. The most common types of plaster mainly contain either ……, ……, or ……, but all work in a similar way.
The plaster is manufactured as a dry …… and is mixed with …… to form a stiff but workable …… immediately before it is applied to the surface..
There are many uses for the plaster:
In medicine ……
In dentistry ……
In art ……
In the ancient world ……

Gypsum plaster is produced by heating gypsum. The chemical equation is:
…… + heat → …… + ……
The nearly water-free form ($CaSO_4 \cdot nH_2O$, n = 0 to 0.05) is called ……
Lime plaster is a mixture of …… and …… . Lime plaster is used for …… .

Soap

In chemistry, a soap is a salt of a fatty acid. Household uses for soaps include washing, bathing, and other types of housekeeping, where soaps act as surfactants, emulsifying oils to enable them to be carried away by water. In industry they are also used in textile spinning and are important components of some lubricants. Metal soaps are also included in modern artists' oil paints formulations as a rheology modifier.

Soaps for cleaning are obtained by treating vegetable or animal oils and fats with a strong base, such as sodium hydroxide or potassium hydroxide in an aqueous solution. Fats and oils are composed of triglycerides; three molecules of fatty acids attach to a single molecule of glycerol.

In this reaction, the triglyceride fats first hydrolyze into free fatty acids, and then the latter combine with the alkali to form crude soap: an amalgam of various soap salts, excess fat or alkali, water, and liberated glycerol (glycerin). The glycerin, a useful byproduct, can remain in the soap product as a softening agent, or be isolated for other uses.

Soaps are key components of most lubricating greases, which are usually emulsions of calcium soap or lithium soap and mineral oil. Many other metallic soaps are also useful, including those of aluminium, sodium, and mixtures of them. Such soaps are also used as thickeners to increase the viscosity of oils. In ancient times, lubricating greases were made by the addition of lime to olive oil.

The earliest recorded evidence of the production of soap-like materials dates back to around 2 800 BC in ancient Babylon. A formula for soap consisting of water, alkali, and cassia oil was written on a Babylonian clay tablet around 2 200 BC.

The Ebers papyrus (Egypt, 1 550 BC) indicates the ancient Egyptians bathed regularly and combined animal and vegetable oils with alkaline salts to create a soap-like substance. Egyptian documents mention a soap-like substance was used in the preparation of wool for weaving.

In the reign of Nabonidus (556–539 BC), a recipe for soap consisted of *uhulu* [ashes], cypress [oil] and sesame [seed oil] "for washing the stones for the servant girls".

Vocabulary

alkali	zásada – látka zvyšující koncentraci OH^- iontů v roztoku (hydroxidy, vodný roztok amoniaku)
aluminium	hliník
amalgam	směsice; amalgám
aqueous solution	vodný roztok
byproduct	vedlejší produkt
calcium	vápník
cassia oil	kasiový olej
crude soap	surové mýdlo
emulsifying oil	emulgační olej
emulsion	emulze
fat	tuk, tlustý
fatty acid	mastná kyselina
formula	vzorec, vzorce
glycerin	glycerin, glycerol
glycerol	glycerol, glycerin
grease	mastnota
hydrolyze	hydrolyzovat
lithium	lithium
lubricant	lubrikant, mazivo
mineral oil	minerální olej
mixture	směs
molecule	molekula
potassium hydroxide	hydroxid draselný
rheology modifier	reologický modifikátor
salt	sůl
soap	mýdlo
sodium	sodík
sodium hydroxide	hydroxid sodný
softening agent	změkčovadlo
strong base	silná zásada
substance	látka
surfactant	surfaktant, povrchově aktivní látka
textile spinning	spřádání tkaniny
thickener	zahušťovadlo
triglyceride	triglycerid
viscosity	viskozita
water	voda

Exercise

Connect following words to create a correct sentence.

Example:

- **soap, fatty acid**
  Sentence: *Soap is a salt of a fatty acid.*

- **soap, sodium hydroxide, oils**
  Sentence:……
  ……
  ……

- **crude soap, alkali, oils**
  Sentence:……
  ……
  ……

- **byproduct, softening agent, glycerol**
  Sentence:……
  ……
  ……

- **metallic soap, aluminium, thickener**
  Sentence:……
  ……
  ……

- **history, cassia oil, soap-like substance, cypress oil**
  Sentence:……
  ……
  ……

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