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VETENSKAP FÖR PROFESSION

Environmental impact and toxicity of chemicals used at the University College of Borås

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Chemicals impact on environment and sustainable development in University College of Borås

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Abstract:

Chemicals play an important role in our daily lives, so the use of chemicals infuses modern life. They are important for economic and sustainable development as well as poverty eradication and achieving the millennium development goals. They can at the same time pose significant risk to human health and the environment in the absence of good management practices. Some chemicals can affect human and ecological health when released into air, water and soil. Generally we cannot omit them from our daily life, so we should learn how to manage them and their wastes.

In this report we assessed the most consumed chemicals in the chemistry laboratory at the school of engineering, University College of Boras in 2006. Our work is based on sustainable development and the importance of the environment. As we know, nature and the environment are very important for living species, so there are some regulations and laws for consumers (factories and laboratories) to use chemicals in a proper way and to prevent their waste entering into the environment.

The properties and implementation of these chemicals have been explained briefly. In addition the properties of a variety of ranges of each chemical have been mentioned. This contribution focuses on the impact of chemicals waste on the environment and their health hazards, and suggestions for decreasing these effects are given where relevant.

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1. Introduction

1.1 Background

With growing population around the world, demand of chemicals is increasing every day. As a result of this fact factories should enhance producing useful chemicals. For better production of these chemicals, they need professional experts. Experts not only should consider about high quality of these chemicals, but also their wastes and their impact on environment. Nowadays the most considerable topic is about sustainable development that focuses on environment and future generations, so suppliers should produce chemicals with the lowest impact on environment.

All people have the right of using resources while, at the same time, living in a safe environment. Human being is in a direct way in action and reaction with environment, because of that future generation have this right to use resources and live in a safe environment.

1.2 University College of Borås

For having professional and educated experts, education with high quality is necessary that universities play an important role in this field by training students.

University College of Borås is one of the universities with high level of knowledgeable teachers and professors. According to this it gives this opportunity to students to have different and high level educational programs.

The chemical engineering department at the university with its facilities has a role in training future experts. In addition it presents courses and programs that teach students how to behave with environment and decrease the negative impacts of human behavior on environment.

1.3 Objective

The main goal for this project is assessing sustainable development aspects and chemicals' impact on environment in the chemistry laboratory at the school of engineering, University College of Borås and presenting possible solutions for improved management of some chemicals that are dangerous for the environment.

In the second step the wastes of chemicals and the way of handling them should be considered but because of limitation of time in this report, it will be done by future students.

Chemicals are used for two purposes in the university; for research and education. Here the chemicals used in education will be considered.

In addition the definition for sustainable development, chemicals and legal aspect about chemical policies in Sweden will be explained.

2. Theoretical frame of reference

2.1 Sustainable Development

Sustainable development is an important topic which these days are considered a lot. Sustainable development is a pattern of resource use that aims to meet human needs while preserving the natural environment so that these needs can be met not only in the present, but in the indefinite future. The term was used by the Brundtland commission which coined what has become the most often – quoted definition of sustainable development as development that “meets the needs of the present without compromising the ability of future generations to meet their own needs”[1].

As part of sustainable development it is important to recognize the importance of all people that their lives and health are important as much as our life and health and that we share one earth. Also we need to use natural resources in best way so that they can be stable for future and future generations. Future generations are important as current generation is. We also need a safe environment and healthy life in addition to economical development. The environment is the most important and basic element for every living being such as animals, plants and humans. If there is no healthy environment none of them can live safely and well [2].

For example there are organic pollutants as a result of some chemicals that human activities produce and release them into the environment. Some of them are used as pesticides, some as industrial chemicals and others are the unwanted by-products of chemical or burning processes. Organic pollutants have significant impacts on human health and the environment because they persist in the environment, bioaccumulation in human and animal fatty tissue, biomagnified in food chains, and can be passed from mother to fetus [2].

Another example is some human manufactures that damage the ozone layer such as some material that used for cups for serving coffee; they called Styrofoam, and some deodorants which used for scent. Not only these activities but also a lot of activities occur every day that cause to damaging and thinning the ozone layer. This affects human health with higher rates of skin cancer, eye cataracts and damaged immune systems and also harms the environment, resulting in reduced food crop productivity and oceanic plankton levels [2].

And also there are a number of threats for aquatic ecosystems, including pollution, over fishing, and the introduction of invasive species and overuse of freshwater resources. As a result of poorly urban and industrial wastewater, pesticide and fertilizer run-off from agriculture, spills and other ship-related releases, mining, and other sources; chemical pollution occurs. Over a billion people have lack of access to safe drinking water because of these chemical pollutions [2].

These are just three out of thousands examples that cause to damaging environment and in many cases have irreparable effect on living beings. It is important to consider them for having healthy environment and improving sustainable development. And all of these problems that exist in the way of having healthy and safety environment force everyone to think about this subject and we can see in every association and gatherings a lot of solutions are presented about environmental protections. In this field knowledgeable people are trying to announce others about environment and the hazards that threat it.

The university as a place which presents education in sustainable development and that trains students as future generation, has an important role for taking apart this major and improves the sustainable development. In this contribution we assess the usage of some chemicals at the university and the methodology for prevention dangerous chemicals and the activities are done for prevention wasting and using chemicals in best way. We attempt to differ our understanding, as well as that of other students and even the university, about our environment and the impact of our activities on the environment.

As mentioned above, this research focuses on the use of chemicals at the university and assesses its impact on environment, and present possible solutions for decreasing chemical hazards, enhancing chemical management and decreasing economical losses.

2.2 Chemicals

Chemicals are substances obtained using a chemical process to produce a chemical based compound or element [3].

We are aware that the chemicals are very much part of all our daily lives. They are important for many aspects of sustainable development such as poverty eradication and achieving the millennium development goals. The use of chemicals infuses modern life while chemicals play an important role with respect to human development; they can at the same time pose significant risk to human health and the environment in absence of good management practices. Some chemicals can affect human and ecological health when released into air, water and soil. In some cases even small quantities they can cause nervous system damage immune system diseases, reproductive or developmental disorders and cancers. Whenever chemicals are not properly managed they can put human health, ecosystems and natural economics at risk. In addition impact of chemicals can cause to a lot of financial problems, too. The need for effective management of chemicals throughout their lifecycle of production and use is under scored both by the sustainable contribution that chemicals make to social and economical development and the significant threats to human and the environment that arise from their improper use and management[4].

2.3 Legal aspect regarding chemicals in Sweden

If chemicals are not handled safety, their risk damages both health and the environment. Consumers have a responsibility to help prevent damage to humans and the environment by storing and handling chemicals in a safe way in their everyday lives [5]. The most hazardous ones are toxic and ectopic chemicals that the ministry of environment is trying to disappear them from market [5].

The Swedish chemical strategy is the basis of Swedish efforts to pursue a renewal of European Union chemical legislation and its forthcoming work on drawing up a global chemicals strategy which should be completed by 2005 [5].

Particularly hazardous substances may only be used to a very limited extent and only when it is not possible to replace them. The most important objective for Sweden is that these aspects are considered for the group of substances that are persistent, bioaccumulable and carcinogenic [5].

In addition Sweden was one of the promoters of the Stockholm Convention. In 2001 Stockholm in an intergovernmental conference signed a convention on persistent organic pollutants. Furthermore in 2003 Sweden had international efforts for preventing the production and usage of chemicals that remain in the environment. These kinds of chemicals are toxic such as DDT (Dichlorodiphenyl-trichloroethane), PCB (Polychlorinated biphenyl) and dioxins and persistent organic pollutant [2].

Sweden is supporting new chemical laws that have been established recently in European Union. Sweden believes that REACH (registration, evaluation, authorization of chemicals) is the framework of this law which represents an important and necessary development of European legislation in chemicals field.

In September 2003 the Swedish government confirmed the Rotterdam convention to export and import hazardous chemicals for improving knowledge about hazardous chemicals that are prevented or are subject to severe limitation.

3. Methods

3.1 Data collection

It is important that correct and relevant data is collected in order to achieve valid results. In this research mainly sustainable development theory considered. After that because our work is researching about chemicals and their effects on environment we should know them and go through the detail of them. Organic and inorganic chemicals should be known and we categorize all chemicals in five groups.

Our contact person at the university was Jonas Hanson, who is responsible for the chemicals used in the laboratories at the school of engineering. Main data has been got from him and the chemistry data base program at the University College.

This software consists of all chemicals data.

This research is only on chemicals used for education (and not those used for research) for year 2006. This is because information of chemicals used in research has not been gathered previously.

3.2 Categorizing chemicals with most usage

The most used chemicals in chemistry lab were chosen, and then they were categorized in five main groups:

1. Metals (Metaller, pb m fl):

2. Organic solvents, with out halogens (organiska lösningsmedel, ej halogenårade)

3. Organic solvent, with halogens (organiska lösningsmedel, halogenårade)

4. Ethanol, Methanol, Acetone (Etanol, Metanol, Aceton)

5. Other chemicals (ovriga kemikalier)

These groups were selected since they are selected on previous work (available in the chemistry laboratory of school of engineering of University College of Borås) done at the school of engineering, and since allows comparison with that work.

4. Empirical work

As it is mentioned before, all existent the chemicals in chemistry laboratory were considered (see Appendix I). However only the chemicals used in 2006 were chosen for the work in the last step chemicals with the highest consumption were identified. They were categorized in five groups that stated before.

The main use, storage, range, waste, health hazard and environmental effect of these chemicals were assessed. The most important point is the environmental impact of these chemicals.

The amount of consumption of chemicals in each group was also calculated.

4.1 Metals

In the right concentrations, many metals are essential to life. Small amounts of these elements are common in the environment. And diet is actually necessary for good health but large amount of them may cause chronic toxicity. Similarly, low exposures to heavy metals over long periods can have serious health effects in the long run.

We live in a toxic world. Every day we are exposed to hundreds of toxic metals and chemicals such as mercury, lead, aluminum, food additives, pesticides, radiation toxins and etc. There are 23 heavy metal elements: antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium and zinc [6].

Effect of Metals on environment:

Heavy metals are belonging to the most dangerous environmental stress factors, as oxidative stresses, and can inhibit the basic physical functions of plants. Heavy metals are the most toxic pollutants to living organisms in aquatic and terrestrial environments [7].

For instance, different heavy metals can interfere with various step of the photosynthetic electron transport chain.

Mercury accumulates at the top of aquatic and marine food chains and fish is the measured source of dietary exposure. The principle health risks associated with mercury are damage to the nervous system.

Heavy metal poisoning and chemical toxicity leads to the accumulation of toxins in our tissue and organs causing nutritional deficiencies, hormonal imbalances, and neurological disorders and can even lead to autoimmune disorders and other debilitating chronic conditions.

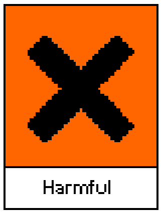
Cadmium exposure occurs mainly through cereals and vegetables grown on soils contaminated by mining activities and use of phosphorus fertilizers. Shellfish and animal organs also contain high levels. Cadmium accumulates in the kidneys and is implicated in a range of kidney diseases.

It takes anywhere from many months to several years for chelation trapy to remove toxic metals and can cost several hundred to several thousand dollars [8].

4.1.1 Potassium hexacyanoferrate (III) (Kaliumhexacyanoferrat (III)):

It is red crystal which is soluble in water. It reacts violently with NH_3 and CrO_3.It is used as food additive and in galvanic technique industry.

Since it is a health hazard substance, it should be a stored away from children and food.



- Range 100-25%: harmful, dangerous for environment.
- Range 25-1%: safety data sheet available for professional user on request (see reference[9] for more information)

Dangerous waste:

Waste salts and their solutions containing cyanides
Waste containing more than 25 % of this substance is hazardous waste with properties H5 (see Appendix II).

Health hazard:

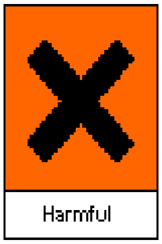
The substance is markedly less toxic than the potassium cyanide.
Inhalation: Coughing, sore throat.
Skin contact: Reddening, pain.
Eye contact: Reddening, pain.
Ingestion: Stomach pains, nausea, vomiting [9].

Effect of Potassium hexacyanoferrate (III) on Environment:

Cyanides are usually readily oxidized in aqueous solutions. However, they are dangerous for the environment even at low concentrations, and therefore the oxidation must be complete. One should avoid chlorine and chlorinated compounds as oxidizing agents.
It has the feature of ecotoxicity (the toxic effect on environmental organisms other than human). It has the risk for both water and land environment. Other possible effect on environment is dangerous for drinking water, soils and water channels [9] [10].

4.1.2 Potassium iodide (Kaliumjodid):

It is colorless or white crystal. It is soluble in water. The main use of it is as disinfectant in cosmetic, photo chemistry and pharmaceutical use (against poisoning). It may cause damage to potassium hydrogen phthalate peripheral nervous system. It should be stored at room temperature. Products posing a health hazard should be stored away from children and food.



- Range (100-25%): harmful
- Range (25-1%): safety data sheet available for professional user on request (see reference[9] for more information)

Waste:
Waste containing more than 25 % of Potassium iodide is hazardous waste with properties H5 (see Appendix II).

Health hazard:
Long-term exposures to iodides may cause skin rashes, headache and irritated mucous membranes. Lethargy, anaemia and weight loss may also occur.
Ingestion: Long-term exposures to iodides may cause skin rashes, headache and irritated mucous membranes. Lethargy, anemia and weight loss may also occur [9].

Effect of Potassium iodide on environment:

This substance is dangerous for soil, water supplies, drinking water and drains. This chemical should not enter to soil and water channels [11].

4.1.3 Potassium hydrogen phthalate (Kaliumväteftalat):

Often called simply KHP, is a white or colorless, ionic solid that is the mono-potassium salt of phthalic acid. The hydrogen is slightly acidic, and it is often used as a primary standard for acid-base titrations because it is solid and air-stable, making it easy to weigh accurately. It is, however, slightly hygroscopic and is generally kept in a desiccators before use. It is also used as a primary standard for calibrating pH meters because, besides the properties just mentioned, its pH in solution is very stable.

KHP can be used as a buffering agent (in combination with HCl or NaOH depending on which side of pH 4.0 the buffer is to be) but should not be used as a buffer for decarboxylation reactions, as these will degrade the KHP and mop up the conjugation groups.

It should be kept in a tightly closed container, protected from physical damage and stored in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

Waste:

Whatever it cannot be saved for recovery or recycling it should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination by this product may change the waste management options [9].

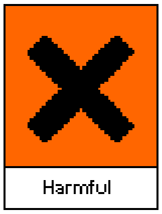
Effect of potassium hydrogen phthalate on environment:

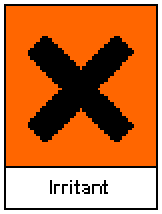
If it is heated it will be decomposed to carbon dioxide and carbon monoxide, which are hazardous decomposition products [12].

4.1.4 Copper (II) sulphate - 5 hydrate (Koppar (II) sulfat-5-hydrat):

Crystals that exist as a series of compounds that is differ in their degree of hydration. They are used in galvanic technique industry, wood preservatives, disinfectant for products in jars, fiber, leather, rubber and polymerized materials preservatives and metal surface treatment.

It should be stored in a tightly closed container and should be protected from light.





- Range (100-25%): It is harmful, dangerous for environment- harmful if swallowed, irritating to eyes and skin. Vary toxic to aquatic organisms. It may cause long term adverse effects in the aquatic environment.
- Range (25-20%): It is irritant, dangerous for environment.
- Range (20-2.5%): It is dangerous for environment.
- Range 2.5-0.25%: It is harmful for aquatic organisms.

Waste:

The ions of several heavy metals can preferably be precipitated and removed by filtration and sulfides or other insoluble compounds. The waste of it is not flammable.

Health hazard:

Ingestion: Copper compounds can cause nausea, vomiting, diarrhea.
Inhalation: Fumes/smoke can cause "metal fume fever" (illness caused primarily by exposure to certain metal fumes. Chemicals such as zinc oxide or magnesium oxide, often cause this through breathing fumes created by heating or welding certain metals, such as galvanized steel. Cadmium, present in silver brazing flux can, in extreme cases, cause loss of consciousness within a matter of minutes.) [9].

Effect of copper (II) sulphate - 5 hydrates on Environment:

It is very toxic to aquatic organisms and may cause long-term damage in the environment [13]. It should be avoided from air and heat because it will be decomposed to sulfuric oxides that are hazardous decomposition products.

When this chemical released to soil, it will hydrolyze into ammonium in a matter of days to several weeks. Then it may leach into groundwater.

When released into water, this material may biodegrade to a moderate extent. When released into water, this material is not expected to evaporate significantly [14].

4.1.5Magnesium sulphate dehydrate (Magnesiumsulfat vattenfri):

It is a white crystalline powder. The powder is hygroscopic and it can form magnesium sulphatheptahydrate in humid air. It can be used as a fertilizer, additive in food, cosmetics and hygiene products. It can be stored at room temperature and the slight acidity of magnesium sulphate can re arrange ether solutions to acrylesthers, followed by polymerization or explosions.

Waste:

It is not flammable. Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility.

Health hazard:

For magnesium compounds the health hazards are mainly related to the anion, i.e. the magnesium-free part.
Magnesium is an essential trace element in the diet. It is necessary for nerve and

muscle functions as well as for a large number of the enzymes vital for cell function. Lack of magnesium leads to difficulties in concentration , causes confusion, depressions, cramps, numbness, a prickling sensation, constipation and diarrhoea.
Inhalation: Coughing. It causes burning in the nose, mouth and throat. Possibly, a raised temperature and ague (malarial fever).
Skin contact: Burning, reddening, and possibly, corrosive damage.
Eye contact: Burning, reddening, pain, and possibly, corrosive damage.
Ingestion: Burning in the mouth and throat. Stomach pains, diarrhoea. It leads to possibly, corrosive damage and risk of systemic effects [9].

Effects of Magnesium Sulphate dehydrate on Environment:

Magnesium's effect on the environment results from the emission of hazardous air pollutants from magnesium industrial plants. Recycling can significantly reduce magnesium's impact on the environment (like in contact with air producing irritating or toxic fumes, causing fire and explosion hazard and also it is toxic or poisonous for nature.) [15].

4.1.6 Sodium acetate (Natriumacetat):

It is white, granular powder or colorless crystals, odorless and freely soluble in water. It is used in emulsifier, fixer, photo chemistry, pigment, pH buffer in cosmetics and preservative for food. It finely pulverized substance mixed with air and cause dust explosion. Proper storage of this chemical is therefore important.

Waste:

The waste should be treated according to 2000 /76/EC (see reference [9] for more information).

It is used to neutralized sulfuric acid waste whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facilities.

Health hazard:

Inhalation: Coughing, sore throat.
Skin contact: Reddening.
Eye contact: Reddening [9].

Effect of Sodium acetate on Environment:

It has environmental disturbance in both aquatic and terrestrial ecosystems.

Processing, use or contamination by this product may change the waste management options. [16].

4.1.7 Sodium chloride (Natriumklorid):

It is colorless crystals or a white powder, odorless and freely soluble in water. It reacts with burning lithium and librates sodium. It is not flammable.

Mainly it is used as an additive in food, viscosity regulator in cosmetics, domestic detergent and detergent for textiles, detergent for tableware, veterinary hygiene biocidal products and food and feed area disinfectants.

Health hazard:

Inhalation: Coughing, sore throat.
Skin contact: Reddening.
Eye contact: Reddening [9].

Effect of Sodium chloride on Environment:

In USA every winter most communities pour thousands of tons of salt and other deicing materials on roads and highways. Rock salt, or sodium chloride (NaCl), is the most commonly used deicing agent. It was first used to control snow and ice on roadways to improve transportation safety in the 1930s, and became widespread by the 1960s. The salt works by dissolving into precipitation on roadways and lowering the freezing point, thereby melting ice and snow.

Eliminating the ice has enormous safety benefits, but depending on the amount of chemicals used, the dissolved salt can have negative effects on the surrounding environment.

The melting snow and ice carries deicing chemicals onto vegetation and into soils along the roadside where they eventually enter local waterways. Elevated salt levels in soils can inhibit the ability of vegetation to absorb both water and nutrients, which can slow plant growth and ultimately affect animal habitats. This degradation also affects the ability of these areas to act as buffers to slow the runoff of other contaminants into the watershed. Once the salt enters freshwater it can build up to concentration levels that further affect aquatic plants and other organisms. Salt deposits along roadways also attract birds, deer, and other animals which increases the chance of animal-vehicle accidents [17].

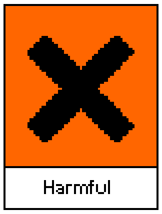
4.1.8 Sodium Disulphide (Natriumdisulfit):

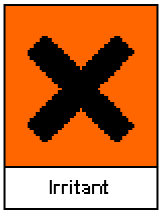
It is colorless crystals or white powder with a faint pungent smell and freely soluble in water.

It mainly use as preservative for food, cosmetics and hygiene products, insecticides, acaricides and products to control other arthropods. Also it is used as drinking water disinfectants, photochemistry, developer and fixer.

It should be handled in a well ventilated place.
Sodium Disulphide should be stored away from children and food.

It can react violently with sodium nitrite, oxidizing agents and acids





- Range (100-25%): Harmful if swallowed. There is risk of serious damage to eyes.
- Range (25-10%): Risk of serious damage to eyes.
- Range (10-5%): Irritating to eyes.
- Range (5-1%): Safety data sheet available for professional user on request(see reference[9] for more information)

Waste:
The deposit in the container should be removed (and be cleaned with water).
Discharging of large volumes of this chemical into the drain should be prevented.

Health hazard:
This substance can cause allergy, especially irritation of the skin near the mouth.
Inhalation: Burning in the eyes, nose, mouth and throat, coughing, and breathing difficulties.
Skin contact: Burning, reddening.
Eyes: Splashes cause burning.
Ingestion: Burning in the mouth and throat, nausea, vomiting, and stomach pains [9].

Effect of Sodium Disulphide on Environment:

Testing for the endpoint of biodegradability is not appropriate due the chemical not being an organic chemical. Also, bioaccumulation is not expected. The product may lead chemical consumption of oxygen in biological sewage treatment plants or in natural water. Inhibition of degradation activities in sewage treatment plants is not to be expected from the introduction of low concentrations. Sodium disulphide dissolves in water and forms sodium Cations, disulfite anions, and sulfur dioxide. Photo degradation of disodium disulphite in water is not relevant because it is quickly ionized in water.

There is almost no data available on the terrestrial organisms. A study showed that treatment of tomato leaves with different concentrations of disodium disulphite induced degradation of green pigments and protein. The author suggested that SO_2 might be responsible for the decreased protein content of treated leaves. Therefore given the low potential for exposure in terrestrial compartment, significant toxicity in terrestrial organism is unlikely [18].

4.1.9 Sodium hydrogen carbonate (Natriumvätekarbonat):

It is white heavy crystalline powder or granules that are odorless. This chemical is insoluble in alcohol, vegetable and ethereal oils. It is always readily soluble in water.

This chemical is sensitive to moisture and reacts with various metals and it is not flammable.

It mainly uses as an additive in food, pH buffer in cosmetics, developer, infusion concentrates and drinking water disinfectants.

Health hazard:

Inhalation: Irritation, coughing, and, possibly, breathing difficulties after inhalation of large amounts of powder or dust.
Skin contact: Possibly, irritation after long-term contact.
Eyes: Splashes cause burning, and irritation.
Ingestion: Stomach pains, swollenness. Large amounts can also cause e g vomiting, headache and dizziness [9].

Effect of Sodium hydrogen carbonate on Environment:

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options [19].

4.1.10 Zinc chloride (Zinkklorid):

It is a white crystal and freely soluble in water. It is used as catalyst, fluxing agent, corrosion inhibitors, used in Galvan technique industry, non-shrink and non-iron treatment of textiles and disinfectant.

It should be stored dry in a tightly closed container.

- Range (100-25%): corrosive, dangerous for environment. Causes burns, harmful if swallowed. Very toxic to aquatic organisms may cause long0term adverse effects in the aquatic environment.
- Range(25-10%): corrosive, dangerous for environment
- Range (10-5%): irritant, dangerous for environment
- Range (5-2.5%): dangerous for environment
- Range (2.5-0.25%): harmful to aquatic organisms

Waste:

The ions of Zinc chloride can preferably be removed by filtration as sulphides or other insoluble compounds.

Wastes containing this substance are classified as hazardous waste.

Health hazard:

The substance is dangerous due to its corrosive properties. It causes wounds when in contact with eyes, skin and mucous membranes.
Inhalation: Irritating to the respiratory system, and can cause headache, coughing, nausea, a temperature, chest pains, and, at high exposures, severe lung damage. The symptoms can be delayed.

Skin contact: Corrosive to the skin and may cause wounds.
Eye contact: Very corrosive to the eyes.
Ingestion: Burning pain, vomiting, stomach pains, and corrosive damage. There is risk of severe systemic effects (shock) [9].

Effect of Zinc chloride on Environment:

Zinc chloride is very toxic to aquatic organism; it may cause long-term adverse effects in the aquatic environment. The adverse effects of zinc chloride upon plants may causes disturbances in plant metabolisms, which consequently lead to a reduction of photosynthetic and some related activities [20].

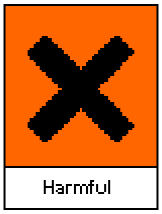
4.1.11 Zinc oxide (zinkoxide):

This substance occurs naturally in zinc ore and can be annealed from these odourless and tasteless white to yellowish fine powder, temporarily turning yellow when heated. Insoluble in water or oil, but can be suspended in either.

Its main use is activator in rubber industry. It is dye in cosmetic and hygiene products preservative, wood preservatives lubricants in the engineering industry, disfectant and glue.

It can be stored at room temperature. It may be explode if mixed with chlorinated rubber. It is not flammable.

In work place it is necessary to use face mask, and the substance should be handled in the fume hood.



- Range (100-25%): dangerous for environment. It is very toxic to aquatic organisms, may cause long-term adverse effect in aquatic environment.
- Range(25-2.5%): dangerous for environment
- Range(2.5-0.25%): harmful to aquatic organisms

Waste:

The ions of Zinc oxide can preferably be precipitated and removed by filtration as sulphides or other insoluble compounds. The precipitates are sent to an authorized recipient of hazardous waste, recovery operation R4 (see Appendix II).

Health hazard:

Zinc oxide itself is non-toxic; however it is hazardous to breathe non-toxic fumes. Fumes of zinc oxide are generated when zinc or zinc alloys are melted and oxidize at high temperature.

Exposure to zinc in the air, which also occurs while welding galvanized steel, can result in sickness that affects the nervous system called metal fume fever. For these reasons, typically galvanized steel is not welded or the zinc is removed first.

Inhalation: Burning of the eyes, nose, mouth and throat. Can cause metal fume fever (with symptoms similar to influenza) including coughing and a temperature. The symptoms usually pass within 1-2 days.
Skin contact: Burning, reddening.
Eyes: Splashes cause burning.

Ingestion: Burning of the mouth and throat. It leads to nausea, vomiting, stomach pains, and diarrhea [9].

Effect of Zinc oxide on Environment:

It is a hazardous substance release as any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of hazardous substances [21]. It's not just the trees and rivers, but the food we eat, the air we breathe and the water we drink [22]. It attaches to soil, sediments, and dust particles in the air. Depending on the type of soil, some zinc compounds can move into the groundwater and into lakes, streams, and rivers. Most of the zinc in soil stays bound to soil particles and does not dissolve in water [23].

4.1.12 Zinc powder (Zinc pulver):

It is a blue soft metal with a limited conductivity when cast, the metal is rather brittle.

It is mostly used for galvanizing steel and other types of protection against corrosion. Other uses are brass products, cast products, paints, activators for vulcanizing of rubber types, dry cell batteries, anodes and fodder additives.

It should be stores dry in a well ventilated place, finely pulverized substances mixed with air may cause dust explosion. It reacts with oxidants e.g. Ammonium nitrate, nitric acid, potassium chlorate. Zinc dust liberties hydrogen gas in contact with oxygen and water. It reacts violently with water, forming hydrogen gas. It forms "white rust" in humid air.

- Range (100-25%): it is dangerous for environment. Very toxic to aquatic organisms may cause long-term adverse effects in the aquatic environment.
- Range (25-2.5%): dangerous for environment, vary toxic to aquatic organisms
- Range (2.5-0.25%): harmful to aquatic organisms

Health hazard:
Zinc has some mutagenic and carcinogenic properties under certain special circumstances, but currently nothing points to that occupational exposure to zinc causes cancer.
Zinc is an essential trace element in the diet. It is necessary for the function of several enzymes, e g those that take part in the transport of carbon dioxide from the tissues to the lungs, duplication of the genes and protein synthesis. Zinc is also bound to the hormone insulin that regulates carbohydrate metabolism in the body. Lack of zinc leads to poor growth in children and teenagers, decreased immune defense, poor wound healing, skin changes and dulled sense of taste.
Inhalation: The most common, harmful effect of zinc is metal fume fever, which is induced by zinc oxide dust or fumes in levels that may occur when welding galvanized metal. The metal fume fever appears within a few hours after the exposure characterized by symptoms similar to those of acute influenza (muscle ache, headache, high body temperature, sweating, etc [9].

Effect of Zinc powder on Environment:

Zinc is one of the major industrial pollutants of terrestrial and aquatic environment. It is caused inhibition of photosynthetic CO_2 in both higher plants and algae. The algal cells zinc caused inhibition of photosynthetic electron transport observed after zinc accumulation by organisms.

The world's zinc production is still rising. This basically means that more and more zinc ends up in the environment.

Water is polluted with zinc, due to the presence of large quantities of zinc in the wastewater of industrial plants. This wastewater is not purified satisfactory. One of the consequences is that rivers are depositing zinc-polluted sludge on their banks. Zinc may also increase the acidity of waters.
Some fish can accumulate zinc in their bodies, when they live in zinc-contaminated waterways. When zinc enters the bodies of these fish it is able to bio magnify up the food chain.
Large quantities of zinc can be found in soils. When the soils of farmland are polluted with zinc, animals will absorb concentrations that are damaging to their health. Water-soluble zinc that is located in soils can contaminate groundwater.
Zinc cannot only be a threat to cattle, but also to plant species. Plants often have a zinc uptake that their systems cannot handle, due to the accumulation of zinc in soils.
On zinc-rich soils only a limited number of plants have a chance of survival. That is why there is not much plant diversity near zinc-disposing factories. Due to the effects upon plants zinc is a serious threat to the productions of farmlands. Despite of this zinc-containing manures are still applied.
Finally, zinc can interrupt the activity in soils, as it negatively influences the activity of microorganisms and earthworms. The breakdown of organic matter may seriously slow down because of this [24].

4.2 Organic solvents

Solvents are used in nearly every phase of electronics manufacturing. They are used primarily for cleaning and degreasing, and for thinning plastics, resins, glues, inks, paints and waxes. There is a wide range of organic solvents, some very toxic and others only mildly toxic. The subgroups should be considered to have a better idea of specific hazard risks and uses. The aromatic compounds and the chlorinated hydrocarbons are perhaps the most dangerous groups of solvents since many of them are known to cause cancer and other serious diseases.

Organic solvents are widely used to dissolve and disperse fats, oils, waxes, pigments, rubber and many other substances. They are frequently used in paints, varnishes, lacquers, thinners, waxes, flow and shoe polishes, glues, fuels, anti freeze and pesticides products. Most organic solvents can be classified into chemical groups based on the configuration of the hydrogen and carbon atoms and the presence of defect functional groups. Chemical groups that are commonly used are straight or branched chains of carbon and hydrogen, cyclic hydrocarbons, esters, aromatic hydro carbons, alcohols, ketones, halogenated hydro carbon, aldehydes, ethers, glycols and nitro-hydro carbons.

The main factors which influence the properties of organic solvents are:

- The number of carbon atoms presents;
- The presences of only single bonds (saturated molecules) or double or triple bonds (unsaturated molecules) between adjacent carbon atoms.
- The configuration of the solvent molecule.
- The presences of functional groups, e.g.; NH_2.

The environmental exposure:

Although widely used environmental exposure levels to organic solvents are usually much lower and of a shorter duration than those encountered in the work place. The use of solvents in household products and in arts, crafts, and hobbies has significantly increased the population that may be affected by the reaped exposure. However, problems are usually only encountered when the product are used incorrectly or in situations where exposure levels may be higher than normally expected [25].

4.3 Organic solvents without halogen

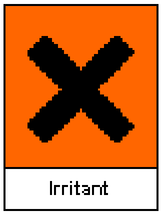
The most comment solvent in everyday life is water. Most other commonly used solvents are organic chemicals. These are called organic solvents. Solvents usually have a low boiling point and evaporate easily. Many solvents can lead to sudden loss of consciousness if inhaled in large amounts. Solvents like diethyl ether and chloroform have been used in medicine. Ethanol is a widely used and abused psychoactive drug.

Most organic solvents are flammable or highly flammable, depending on their volatility. Exceptions are some chlorinated solvents like dichloromethane and chloroform. Mixture of solvent vapors and air can explode. Solvent vapors are heavier than air. They will sink to the bottom and small amounts can travel large distances. Solvent vapors can also be found in supposedly empty drums and cans, posing a flash fired hazard [26].

4.3.1 Tromethamine (tris (hydroxymetyl) aminometan)

It is a crystal mass, freely soluble in water. The most usage of it is in pH buffer in cosmetics, laboratory chemical and in fusion concentrate.

It is a product that has hazards for health so in laboratories face mask, gloves and protective clothing should be used. Tromethamine should be stored away from children and food.



- Range (100-25%): irritant, dangerous for environment, very toxic to aquatics organisms.
- Range(25-20%): irritant
- Range(20-1%): Safety data sheet available for professional user on request

(See reference [9] for more information)

Waste:

Wastes containing this substance are classified as hazardous waste.

Health hazard:

This substance irritates the skin and mucous membranes [9].

Effect of Tromethamine on Environment:

There is no available data for this substance.

4.3.2 Ethyl acetate (Etylacetat):

It is colourless liquid with a fruity pleasant smell.
It is moderately soluble in water. It is miscible with most organic solvents.

It mainly use as a solvent in the rubber industry and in cosmetics.
Also it used for insecticides, acaroids and products to control other arthropods, food and feed area disinfectants, detergent, printing ink,
hardener for paint, hardener for glue.

This chemical should store cool in a tightly closed container in a well ventilated place. Storage of large amounts of flammable liquid may require permission from the local authorities.

Waste:

It should not be mixed with halogenated waste. In companies with suitable apparatus, it is permitted to redistill waste with solvents for renewed use of the solvents, R2 (see Appendix II).
Solvents can be incinerated (R1 (see Appendix II)) only by those having permission.

Health hazards:

Ethyl acetate is irritating to primarily eyes, nose and throat (A&H 1991:7). Long-term exposure to high concentrations may give liver and kidney injuries.
Inhalation: The vapour is irritating to the respiratory system, can cause headache, nausea, dizziness, and has narcotic effects.
Ingestion: Large doses may lead to loss of consciousness, and possibly liver and kidney injuries.
Skin contact: Has a desiccating effect. It may cause chapped skin and wounds.
Eye contact: The vapour and the liquid are irritating. It has rarely permanent damage [9].

Effect of Ethyl acetate on Environment:

There is insufficient data are available to predict the toxicity of ethyl acetate to aquatic life, plants and land animals.

Industrial emissions of ethyl acetate can produce elevated, concentrations in the atmosphere around the source. Ethyl acetate that makes its way into the ground, and does not evaporate, will eventually end up in the ground water.

Ethyl acetate evaporates to a gas if released as a liquid. Ethyl acetate is a volatile organic chemical (VOC) and will contribute to the formation of smog [27].

When this chemical released into the soil, may leach into groundwater. When released into the soil, this material may evaporate to a moderate extent.

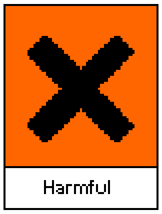
When released into water, this material may biodegrade to a moderate extent. When released to water, this material is expected to quickly evaporate, with a half-life of less than 1 day.

When released into the air, this material is expected to be readily degraded by reaction with photo chemically produced hydroxyl radicals. When released into the air, this material may be moderately degraded by photolysis [28].

4.3.3 Toluene (Toluen)

It is a colourless liquid with an aromatic smell. It is slightly soluble in water and miscible with most organic solvents. It is an aromatic hydrocarbon.
It is used as solvent in the rubber industry and in cosmetics. The solvent is used in a number of products for textiles such as dyes, printing dyes, surface treatments, waterproofing, etc. It is a lubricant and de-greasing agent in the engineering industry and glue.

It may react violently with oxidising agents and may react violently with BrF3 at -80°C. There is the risk of explosion in mixtures with N2O4. It also reacts with nitric acid and tetranitromethane.



- Range (100-20%): harmful, danger of serious damage to health by prolonged exposure through inhalation. It is irritating, and possible risk of harm to the unborn child. It may cause lung damage if swallowed. Vapors may cause of drowsiness and dizziness.
- Range (20-15%): harmful, danger of serious damage to health by prolonged exposure through inhalation. It is irritating, and possible risk of harm to the unborn child. It may cause lung damage if swallowed. Vapors may cause of drowsiness and dizziness.
- Range (15-10%): harmful, danger of serious damage to health by prolonged exposure through inhalation. It is irritating, and possible risk of harm to the unborn child. It may cause lung damage if swallowed.
- Range (10-5%): harmful, possible risk of harm to the unborn child.

Waste:

It should not be mixed with halogenated waste. In companies with suitable apparatus, it is permitted to redistill waste with solvents for renewed use of the solvents, R2 (see Appendix II).
Solvents can be incinerated (R1 (see Appendix II)) only by those having permission.

Health hazard:

The critical effects of exposure to toluene are acute effects on the central nervous system, irritation and spontaneous abortions. Other significant effects are ecotoxicity (toxicity to the ear causing impaired hearing) and chronic toxic encephalopathy (brain suffering). It is believed, however, that an individual must be exposed to toluene for many years before chronic toxic encephalopathy appears. Skin exposure to liquid toluene can lead to significant systemic exposure. This substance has caused birth defects in two different animal species.
Inhalation: Vapour is irritating to the respiratory system, and may have narcotic effects. It causes headache, dizziness, a feeling of intoxication, irritation of the eyes, nose and throat as well as decreased performance in neuropsychological tests.
Skin contact: Can be irritating to the skin. Extracts the lipids of the skin and may lead to wounds and chapped skin. Toluene is taken up through intact skin. Symptoms as when inhaled.
Eye contact: Vapour may be irritating, and the liquid may injure the eyes [9].

Effect of Toluene on Environment:

Toluene can be very mobile when released into the environment. There are four main routes that toluene takes: (i) Toluene easily evaporate from soil into the atmosphere, depending on factors such as temperature and humidity. (ii) Toluene binds well to some soils, especially soils rich in organic matter. Clay minerals also bind toluene. (iii) Toluene is converted into carbon dioxide and water when soil microbes degrade it. Degradation occurs in both oxygen-rich and oxygen-poor conditions. (IV) Toluene is moderately soluble in water, so rainwater leaching through the ground can carry toluene with it into groundwater aquifers.

Toluene has only a weak attraction to fats so has low potential to accumulate in animals [29].

Toluene is reacted into other chemicals in the air it quickly. Toluene has caused membrane damage to the leaves in plants. It has moderate chronic (long-term) toxicity to aquatic life. Chronic and acute effects on birds or land animals have not been determined. Toluene is expected to minimally bioaccumulation [30].

Toluene can enter surface water and groundwater from spills of solvents and petroleum products as well as from leaking underground storage tanks at gasoline stations and other facilities. In the water and soil bacteria break it down. It has moderate acute (short-term) toxicity on aquatic life.

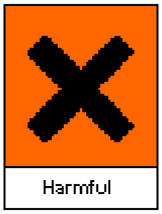
Also when toluene-containing products are placed in landfills or waste disposal sites, the toluene can enter the soil or water near the waste site.

Toluene does not usually stay in the environment long [31].

4.3.4 Xylene (Xylen)

It is a colourless clear liquid with a sweetish aromatic smell. It is slightly soluble in water and miscible with most organic solvents. It is also an aromatic hydrocarbon. It is used as solvent in the rubber industry, in cosmetics, in paints and lacquers. The solvent is used in a number of products for textiles such as dyes, printing dyes, surface treatments, waterproofing and etc.
It is used as hardener for paint, plastics, glue and flooring material.

It should be stored cool in a well ventilated place. Storage of large amounts of flammable liquid may require permission from the local authorities.
It may react violently with potent oxidising agents, e.g. HNO_3.



- Range (100-20%): harmful, harmful by inhalation and in contact with skin. It is irritating to skin.
- Range (20-12.5%): harmful, harmful by inhalation and in contact with skin.
- Range (12.5-1%): safety data sheet available for professional user on request.

Waste:

It should not be mixed with halogenated waste. In companies with suitable apparatus, it is permitted to redistill waste with solvents for renewed use of the solvents, R2 (see Appendix II).
Solvents can be incinerated (R1 (see Appendix II)) only by those having permission.

Health hazard:

The critical effects of occupational exposure to xylenes are assessed to be irritation and effects on the central nervous system (CNS). Increased symptoms of irritation and CNS effects have been reported for exposures to 50 ppm m-Xylene. More pronounced irritation of the eyes; nose and throat have been reported after short exposures to 200 ppm. In studies in man it has been shown that exposures 90 ppm xylene causes decreased performance in neuropsychological tests. Exposure to 70 ppm did not affect the performance in similar tests.
Impaired memory and concentration, depression and tiredness can appear after prolonged and/or high level exposures to xylene in combination with other solvents. Animal studies support the conclusion that chronic effects on the CNS appear at 100-200 ppm.
It effects on the development of the nervous system has been demonstrated in pups to rats exposed to 200 ppm technical grade Xylene during pregnancy.
Skin contact with liquid xylene caused redness and a sense of burning and pricking in the skin. Repeated skin contact leads to defeating and skin irritation. Skin

exposure to liquid xylene can affect the internal organs.
Inhalation: The vapour may lead to headache, dizziness, nausea and it has narcotic effects. The vapour is irritating to the mucous membranes.
Skin contact: Has an irritating and desiccating effect on the skin. Causes chapped skin and wounds. It can be taken up through the skin.
Eye contact: The vapour is irritating to the eyes; liquid in the eyes may lead to damage [9].

Effect of xylene on Environment:

Xylene can be very mobile when released into the environment. There are four main routes that xylene take: (i) Xylene easily evaporate from soil into the atmosphere, depending on factors such as temperature and humidity. (ii) Xylene bind well to some soils, especially soils rich in organic matter. Clay minerals also bind xylene. (iii) xylene is converted into carbon dioxide and water when soil microbes degrade them. Degradation occurs in both oxygen-rich and oxygen-poor conditions. (IV)xylene are moderately soluble in water, so rainwater leaching through the ground can carry toluene with it.

Xylene have moderate attraction to fats so may accumulate in animals [32].

4.4 Organic solvents with halogen

These solvents have the same characteristics as mentioned in 4.2 but they include halogens.

Halogens or halogen element are a series of non-metal element from group 17 of the periodic table (see table in Appendix I), comprising fluorine, F; chlorine , Cl; bromine, Br, iodine, I and astatine, At. The undiscovered element 117 temporary named ununseptium may also be a halogen. The group of halogen is the only group which contains elements in all three familiar states of matter(a class of materials usually solid, liquid and gas) at standard temperature(0°C or 273.15 K) and pressure(100 kPa)

Halogens are high reactive, and as such can be harmful or lethal to biological organisms in sufficient quantities. Fluorine is the most reactive element. It is corrosive and highly toxic gas.

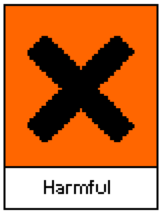
Both chlorine and bromine are used as disinfectants for drinking water swimming pool, fresh wounds, dishes and surfaces. They kill bacteria and other potentially harmful micro organisms [33].

4.4.1 Chloroform (Kloroform)

It is colorless liquid with a sweetish, characteristic smell. Detection by smell cannot be used to avoid adverse effects.
It is slightly soluble in water. It is miscible with most organic solvents.

It mainly use as disinfectant, general anesthetic, intermediate product in the manufacture of $CHCl_3$ and other products. It is solvent for oils, resins and caoutchouc.

It should be stored cool and protected from light. This substance must be in a locked cupboard or in a room which is locked after working hours.
When heated and on fire, toxic gases are liberated. It reacts violently with (acetone base), Al, Li, Mg, (KOH+methanol), Na, (NaOH+methanol), etc.



- Range (100-20%): Limited evidence of a carcinogenic effect.
  Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed. It is irritating to skin and harmful if swallowed.
- Range (20-5%): Limited evidence of a carcinogenic effect.
  Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed and harmful if swallowed.
- Range (5-1%): Limited evidence of a carcinogenic effect.

Waste:

Halogenated solvents are not to be mixed with halogen-free waste.
In companies with suitable apparatus, it is permitted to redistill waste with solvents for renewed use of the solvents, R2 (see Appendix II).
Solvents can be incinerated (R1 (see Appendix II)) only by those having permission.

Health hazard:

This substance has caused birth defects in two different animal species .In acute poisoning; this substance primarily affects the central nervous system. Exposure to low doses over a long period may harm the liver, resulting in fatty liver and necrosis. Acute poisoning may also cause kidney damage.
Inhalation: Irritating when inhaled. Higher concentrations cause dizziness, nausea, disturbed vision, anesthesia, and at high concentrations, loss of consciousness, and effects on the heart. Long-term exposure can cause mental disturbances.

Skin contact: The substance extracts the lipids of the skin and may give red and chapped skin.
Eye contact: The liquid is irritating to the eyes [9].

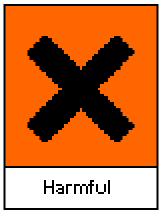
Effect of chloroform on Environment:

This chemical effect on atmospheric ozone, climate change, eco-toxicity and human health. It will only burn when it reaches very high temperatures [36]. It can enter the air directly from factories that make or use it, and by evaporating from water and soil that contain it. It can enter water and soil when waste water that contains it is released into water or soil [37].

4.4.2 Chlorobenzene (Klorbensen)

It is known as a colourless liquid with an aromatic odour similar to almonds.
It is halogenated hydrocarbon. It is mainly used as an insecticide and
carrier for dying and printing of textiles.

It may react violently with oxidising agents, with $AgClO_4$ and DMSO (Dimethyl Sulphoxide) and reacts as an explosive manner with sodium.



- Range (100-25%): Harmful by inhalation. Toxic to aquatic organisms. May cause long-term adverse effects in the aquatic environment.
- Range (25-5%): Harmful by inhalation. Harmful to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

- Range (5-2.5%): Harmful to aquatic organisms. It may causes long-term adverse effects in the aquatic environment.
- Range (2.5-1%): Safety data sheet available for professional user on request.

Waste:

Halogenated solvents are not to be mixed with halogen-free waste. In companies with suitable apparatus, it is permitted to redistill waste with solvents for renewed use of the solvents, R2 (see Appendix II).
Solvents can be incinerated (R1 (see Appendix II)) only by those having permission.

Health hazard:

Increased liver size has been shown in animal experiments, and at higher levels effects on the testes and the kidney. At high doses, this substance also causes effects on the nervous system - tremor, muscle cramps, breathing difficulties, weakness and paralysis.
It is moderately irritating to skin and eyes when tested in guinea pigs.
Chlorobenzene can also affect the bone marrow, but it is not clear whether this occurs at the lowest air concentrations causing liver damage. This substance has caused birth defects in two different animal species.

Inhalation: Burning in the eyes, nose, mouth and throat. It causes dizziness, headache, lethargy, and, possibly, loss of consciousness.
Skin contact: Reddening, and chapped skin
Eyes: Splashes cause burning.
Ingestion: Nausea, vomiting, dizziness, lethargy, and loss of consciousness [9].

Effect of Chlorobenzene on Environment:

The effect of chlorobenzene on human health and the environment depends on how much of it present and the length and frequency of exposure. It is moderately toxic to aquatic organisms. It is a flammable and aromatic liquid. Some of it may dissolve in water, but it readily evaporates into the air and has moderately acute and chronic toxicity to aquatic life.

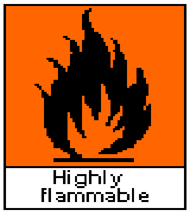
When it is released to air, it slowly broken down by reaction with other chemicals and sunlight or can be removed by rain. If it released to soil it would broken down rapidly by bacteria, but some will evaporate to the air and some may filter into the ground water [38].

4.5 Ethanol , Methanol , Acetone

4.5.1 Ethanol (Etanol):

It is a colorless liquid with characteristic, aromatic odor and is soluble in water. It is used as a solvent in rubber industry and in cosmetic, preservative and disinfectant, domestic detergent, detergent for textiles, detergent for tableware, washer fluid, window cleaning hardener for paint and adhesive.

It should be stored in a ventilated, locked place. Storage of large amounts of flammable liquid may require permission from the local authorities. It reacts violently with several oxidizing agents.



- Range (100-70%): highly flammable
- Range (70-6%): flammable
- Range (6-1%): safety data sheet available for professional user on request. (See reference [9] for more information)

Waste:
It should not be mixed with halogenated waste. In companies with suitable apparatus, it is permitted to redistill waste with solvents for renewed use of the solvents, R2 (see Appendix II).
Solvents can be incinerated (R1 (see Appendix II)) only by those having permission.

Health hazard:
The substance is a well-known intoxicant which in large amounts may cause disturbances of the central nervous system, and lead to paralysis of the respiratory system and damage the liver.
Inhalation: Ethanol vapors primarily causes irritation of the mucous membranes
Ingestion: Leads to intoxication with deteriorating reactivity, dizziness, nausea, and in large doses, reduced consciousness.
Skin contact: Has a desiccating effect on the skin.
Eye contact: Irritating to the eyes [9].

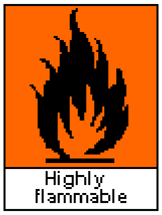
Effect of Ethanol on Environment:

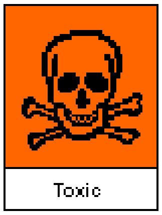
A low concentration and amounts of ethanol is rapidly metabolized without apparent harm. At higher concentrations, such as a result of leaks or spills, ethanol can have acute effects on a wide range of biota, where it may cause microbial death.

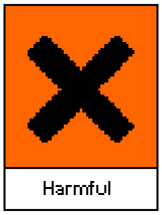
If ethanol ever gains widespread use as a clean alternative fuel to gasoline, people with respiratory illness may be in creating a worse health hazard than gasoline, especially for people with asthma and other respiratory diseases [39].

4.5.2 Methanol (metanol)

It is a colourless liquid with pungent, aromatic odour. It is highly volatile and freely soluble in water. It is mainly used as an additive in denaturing agent for ethanol and isopropanol, in galvanotechnic industry, as a component in glues , lubricants, paint and lacquers in the engineering industry, veterinary hygiene biocidal products and disinfectant.







- Range (100-60%): Highly flammable. Toxic by inhalation, in contact with skin and if swallowed.
  Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

- Range (60-20%): Flammable. Toxic by inhalation, in contact with skin and if swallowed.
  Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

- Range (20-10%): Flammable. Toxic by inhalation, in contact with skin and if swallowed.
  Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

- Range (10-3%): Harmful by inhalation, in contact with skin and if swallowed.
  Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.

- Range (3-1%): Safety data sheet available for professional user on request.

  (See reference [9] for more information)

Waste:

Do not mix with halogenated waste. In companies with suitable apparatus, it is permitted to redistill waste with solvents for renewed use of the solvents, R2 (See Appendix II).
Solvents can be incinerated (R1 (See Appendix II)) only by those having permission.

Health hazard:

This substance is very toxic. Visual nerves, kidneys and liver may be damaged. The substance may cause blindness and death.
This substance has caused birth defects in two different animal species.
It is included in the highest class on the Danish list of neurotoxin substances.
Inhalation: The vapor may be irritating to the respiratory system and leads to headache, drowsiness, and nausea and vomiting.
Ingestion: Intoxication, vomiting, pains. After a while, there is visual disturbances and loss of consciousness. Higher doses lead to blurred vision, nausea and fainting, finally blindness and acidosis.
Skin contact: Repeated and prolonged contact may dry the skin leading to chapped skin and wounds. Other symptoms as when inhaled.
Eye contact: Splashes in the eyes can lead to damage. Methanol primarily causes headaches and irritation of the eyes [9].

Effect of methanol on Environment:

The Effect of methanol on human health and the environment depends on how much methanol are present and length and frequency of exposure [40].

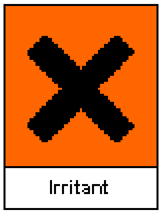
Methanol is not a persistent chemical and is broken down in the environment. Methanol is more harmful than ethanol and drinking it can be very dangerous. This chemical is very toxic by inhalation. Deliberately inhaling methanol is dangerous, can permanently damage eyesight and could cause death. A study by the environmental engineering firm Malcolm Parnie finds far fewer environmental threats from using methanol in fuel cell vehicles, compared to gasoline's use for internal combustion engines [41].

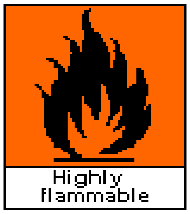
4.5.3 Acetone

It is Colorless liquid with a sweetish smell. It is miscible with water.

It mainly uses as solvent in the rubber industry and in cosmetics, detergent, paints and lacquers. It uses in solvent-based glue, adhesive, diluting (paints and the like), anti-rust paints and solvent.

It should be stored dark and cool in a well ventilated place and storage of large amounts of flammable liquid may require permission from the local authorities. It reacts violently with $CHCl_3$ and bases. This chemical has risk of explosion with potent oxidizing agents.





- Range (100-25%): it is irritating to eyes and repeated exposure may cause skin dryness or cracking. Vapors may cause drowsiness and dizziness.

It is also flammable.

- Range (25-20%): it is irritating to eyes. Vapors may cause drowsiness and dizziness.
- Range (20-15%): Vapors may cause drowsiness and dizziness.
- Range (15-1%): Safety data sheet available for professional user on request.

Waste:

It should not be mixed with halogenated waste. In companies with suitable apparatus, it is permitted to redistill waste with solvents for renewed use of the solvents, R2 (See Appendix II).
Solvents can be incinerated (R1 (See Appendix II).) only by those having permission.

Health hazard:

Acetone primarily causes irritation of the mucous membranes and the eyes. Slight, reversible effects on the central nervous system may also appear. Simultaneous exposure to certain chlorinated carbohydrates may cause liver injuries. The substance is a relatively harmless solvent.
Inhalation: Prolonged inhalation of the vapor may give headache, dizziness, drowsiness, and may have narcotic effects. The vapor is irritating to the mucous membranes.
Ingestion: May cause irritation of the stomach, headache, dizziness, drowsiness, and, in large amounts, loss of consciousness.
Skin contact: Prolonged contact with the skin may cause chapping and risk of eczema.
Eye contact: The liquid is irritating and may cause serious damage the eyes [9].

Effect of acetone on Environment:

This chemical has a slightly toxicity when exposed to aquatic life. It has caused membrance damage a decrease in size and in germination of various agriculture and ornamental plants [42].

The effects on birds and or land animals have not been fully determined.

Large percentage of acetone (97%) released during its manufacture or use goes in to the air [43]. In the air about one half of the total amount breaks down from sunlight or other chemicals every twenty two days. It moves from the atmosphere into the water and soil by rain and snow. It also moves quickly from soil and water back to air. Acetone does not bind to soil or build up in animals. It can move into groundwater from spills or landfills [42].

4.6 Other chemicals

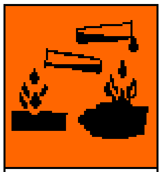
4.6.1 Nitric acid (salpetersyra)

It is colorless to yellow or brownish red liquid. It is freely soluble in water. Nitric acid has an isotropic point at 69.2% but the boiling point is 129.8ºC. Concentrated nitric acid has a concentration above 69.2%. At concentration above 86%, the acid becomes unstable and is called “red fuming nitric acid”. The fumes are released nitrogen dioxide. Red fuming nitric acid dissolves copper, silver, mercury, palladium and osmium.

It is used for doping of metals, metal surface treatment and as a laboratory chemical.

It should be stored in a tightly, closed container in a cool place protected from light. This substance should be stored away from an authorized accessed. For using this chemical it is better to use face mask, goggles/visor, gloves and protective clothing. Work under a suction fan or in a fume hood. The room where this substance is used should have an emergency shower and means for rinsing the eyes.

Strong nitric acid is a potent oxidizing agent, which reacts violently with a number organic and inorganic chemicals, under formation of nitrogen oxidizes.



Corrosive

- Range (100-70%): corrosive, oxidizing and its risk phrases leads to severe burns. If it contacts with combustible material may cause fire.
- Range (70-20%): corrosive and it causes severe burns.
- Range (20-5%): corrosive and it causes burns.
- Range (5-1%): irritant, it causes irritating to eyes and skin.

Waste:

Using protective mask and gloves are absolutely necessary if there is a major accident. People should be kept at a safe distance, and the acid should be covered with a large amount of Na_2Co_3 and water. The acid should be removed when using water and discharge into the drains with plenty of water. Residues are diluted with water and neutralized before emptied into the drains. Waste containing more than 1% of this substance is hazardous waste with property H8(See Appendix II).

Health hazard:

Reactions with metals and organic compounds release nitrous gases. In halation of nitrous gases can be fatal. Symptoms of poisoning often appear after several hours with difficult breathing, coughing and irritation of the throat.

Inhalation: The vapour or acid mist is very irritating and causes corrosive damage to the respiratory system. The symptoms are burning, coughing and breathing difficulties. It can cause lung damage at high exposure. The symptoms can be delayed. Long-term exposure can cause chronic bronchitis and corrosive damage to the teeth.
Ingestion: Causes corrosive damage in throat and gullet.
Skin contact: The acid is very corrosive to the skin and mucous membranes leading to a yellow and brown discoloration of the skin and concentrated acid can cause severe wounds.
Eyes: The vapour is irritating to the eyes. The liquid can cause severe acid damage and there is risk of blindness [9].

Effect of Nitric acid on Environment:

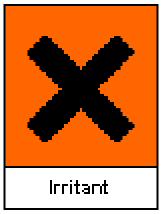
This chemical is very corrosive compound when in concentrated for such as that commonly used in industrial and chemical processes [44].

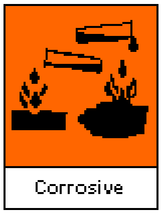
It does not accumulate in the environment and is rapidly neutralised in soil. However, nitric acid maybe formed readily from nitrogen dioxide which is a common air pollutant, in the atmosphere and is one of the constituents of “acid-rain” which can cause environmental damage. Inhalation on air containing high levels of nitric acid can cause dryness of the throat and nasal passages, cough, shortness of the breath, difficulty breathing and chest pain. In some causes the inhalation of high concentration of nitric acid can cause death [45].

4.6.2 Sulphuric acid (Svavelsyra)

It is a clear colourless liquid with a sharp smell. It is threshold for detection by smell. It is freely soluble in water. It is hygroscopic and it marks generation of heat when dissolved. Mainly it is used as an additive in food, pH buffer in cosmetic, veterinary hygiene biocidal products, food and feed area disinfectants, detergent, drinking water disinfectants and corrosion inhibitors.

This substance should be stored away from unauthorized access.





- Range (100-96%): it causes severe burns, irritating to respiratory system and it reacts violently with water.
- Range (96- 15%): corrosive and it causes severe burns
- Range (15-14.99%) : corrosive and it causes severe burns
- Range (14.99 – 5%): irritant and it is irritating to eyes and skin.
- Range (5-1%): safety datasheet available for professional user on request.

(See reference [9] for more information)

Waste:

It should be covered with $NaHCO_3$ or Na_2CO_3, mix well and dilute with water before emptying into the drains and flush down with plenty of water. Residues are diluted with water and neutralized before emptying into the drains.

Health hazards:

Concentrated sulphuric acid is very corrosive and extremely reactive with water, which leads to charring of organic material such as skin, clothes etc.
Ingestion: Sulphuric acid is corrosive to the mouth, throat and gastrointestinal tract.
Inhalation: Vapour/mist is irritating to the respiratory system and can cause burning, coughing, and breathing difficulties. High exposure can cause severe lung damage. Long-term exposure can lead to bronchitis, changes in the lungs, and corrosive damage to the teeth.
Skin contact: Corrosive to the skin.
Eyes: Highly corrosive to the eyes. There is the risk of blindness [9].

Effects on sulphuric acid on environment:

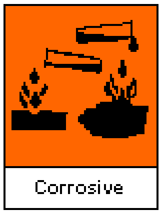
The application of sulphuric acid may result in charging of the soil and reduction of the pH in soil and water, the effect of an application on soil pH is not that large. It is fast-acting and is quickly neutralized in the environment by reacting with the vegetation canopy, soil and water in the soil. This means that the hazards associated with this chemical rapidly decrease from the time of application [46].

It dissolves when mixed with water. It has moderate acute (short term) toxicity on aquatic life. It is very corrosive and would badly burn any plants, birds or land animals exposed bit [47].

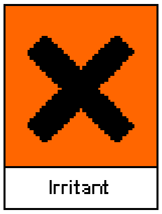
4.6.3 Hydrochloric acid (Saltsyra)

It is a colorless to yellowish liquid, fuming and with a sharp, pungent smell and it is completely soluble in water. It can be used as an additive in food, pH buffer in cosmetics, detergent, veterinary hygiene biocide products, drinking water disinfectants, laboratory chemicals, catalysts, corrosion inhibitors and precipitation agent.

It should be stored in a dry, cool, well ventilated place. Hydrochloric acid reacts violently with several substances, e.g. acetic anhydride, Nh_4OH, H_2So_4.



Corrosive



Irritant

- Range (100-25%): corrosive, it causes burns and irritating to respiratory system.
- Range (25-10%): irritant, irritating the eyes and respiratory system and skin.
- Range (10-1%): safety data sheet available for professional user on request.

Waste:

It should be covered with $NaHCO_3$. It should be mixed well and dilute with water before emptying into the drain; flash down with plenty of water. Residues are diluted with water and neutralized before emptying into the drain. The wastes containing more than 5 % of this substance is hazardous waste with properties H8 (see Appendix II).

Health hazard:

Hydrochloric acid is corrosive in concentrations above 5%. The degree of damage depends on the concentration of the acid and the exposure time.
Ingestion: Corrosive to the mouth, throat and gastrointestinal tract. It may cause death.

Inhalation: The vapour is irritating to the respiratory system, causing coughing, cramps of the throat, and may lead to severe lung damage.
Skin contact: Corrosive to the skin and causes acid burns.
Eye contact: Highly corrosive to the eyes may cause blindness [9].

Effect of Hydrochloric acid on Environment:

This chemical is toxic and poisonous and extremely toxic to aquatic life by lowering the pH below 5.5. When released into the soil, this material may leach into groundwater [34].

This chemical is very soluble in water. When hydrogen chloride or hydrochloric acid is released into the environment, they become widely distributed into air and water. Due to it being highly soluble in water, it is removed by rainwater thereby reducing exposure.

Hydrogen chloride, in the form of hydrochloric acid, may be added to water supplies or swimming pools to change the pH and prevent scale formation. Its use is tightly controlled and due to the acid being neutralized, does not present a health hazard [35].

5. Discussion

5.1Comparing consumption of chemicals in 2006 with 1998

Here is the table of five specified group and the consumption of them:

Type of chemicals	**Consumption in 1998**	**Consumption in 2006**
Metals	50 g	6.92 Kg 0.2 Liter
Organic solvent (without halogen)	5 Liter	2.3461 Kg 6.93 Liter
Organic solvent(with halogen)	2 Liter	0.985 Liter
Ethanol, Methanol, Acetone	15 Liter	11.5 Liter
Other chemicals	Ca 200 St, Ca 10 Kg	0.5149 Kg 6.4 Liter

With comparing consumption of chemicals in chemistry laboratory in 1998 and 2006 increasing in consumption of metals is recognized. And chemistry laboratory should have an especial consideration on the wastes and this chemical.

Also, there is an increasing in consumption of organic solvent without halogen, in 2006 comparing with 1998. (Increasing from 5liter to 6.93liter and 2.34 Kg)

Use of halogen organic solvent has been decreased from 2liters to 0.985 liter in 2006.

Also, the use of Ethanol, methanol, acetone has been decreased from 15 liter to 11.5 liter in 2006.

5.2 Waste

The mark increase in consumption of the chemicals from the year 1998 – 2006 as can be seen in the table above, results in a corresponding increase in waste production. Unfortunately in the chemistry laboratory, there is no instruction pertaining to waste disposal. However, although Borås energy takes charge of the disposal of some waste metals and organic solvents, the non-metals and inorganic solvents are usually washed away into the drainage system. This goes into the environment are pose a potential threat to biodiversity.

6. Suggestion

6.1. Waste

Since it is possible for chemicals waste to enter the environment if waste incinerated, land filled or just drained, it is important to keep them out of municipal waste stream. The majority of chemical wastes are known as hazardous waste and should be handled or recycled, so waste management should be considered from the people who accomplish with the chemicals. In general, the following rules, applying for the chemicals listed below.

Potassium hexacyanoferrate (III):

Collect up with absorbent materials or, if none available, dry sand or earth, and deposit in waste containers for subsequent elimination in accordance with current legislation. Clean any remains with plenty of water.

Copper (II) sulfate 5-hydrate:

It should be avoid from breathing dust, keep container closed, and avoid contact with eyes, skin and clothing.

It should be use only with adequate ventilation and wash thoroughly after handling.

Sodium hydrogen carbonates:

The generation of waste should be avoided or minimized wherever possible. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

6.2. New system

In 2006 data collection was not based on exact measuring for amount of chemicals in chemistry lab. It was like measuring the amount that is left in the container by eye and that made some errors in some calculations for example for some chemicals the consumption was calculated negative and they were not considered in this research. But from 2008, a new system is implementing for measuring the amount of chemicals that it is more precisely than previous method. The system is online and when a chemical will be bought the data will be entered. And the system is designed based on open, closed and finished items. But the problem with this system is there is no specified used amount that shows how much of that chemical was used so it is better to improve this system by consideration about the exact used amounts that can help for the further researchers.

6.3 Suppliers

In the selection of suppliers of chemical to the laboratory, the university needs to set some standards which must be complied with by the suppliers before issue of contract. For example, the university could select her suppliers based on their environmental policies, sources of raw materials and commitment to sustainable development.

7. Conclusion

In this research definition, advantage and disadvantage of chemicals were explained and discussed. And twenty one of them were focused in detail. Generally existent of chemicals in our daily life should be accepted but it is necessary the ways of preventing of entrance of their wastes and pollutants to be learned.

One of the chemicals that were focused in detail was metals. As mentioned above they are the most dangerous environmental stress factors that are toxic pollutant for aquatic and terrestrial environments and plants. Metals derived from anthropogenic sources have caused serious damage to forest ecosystems in areas close to a number of emission sources in the boreal forest zone.

So the ways of preventing of entering metals to rivers, water channels, plants and environment should be improved and invested more. Although investment in this part needs a lot cost but it can be compensated with positive effect on environment, which can ensure heath of people, animals and plants.

One of the ways for not entering of metals in environment is using modern pollution control equipment that can remove the vast majority of the emissions of concern. Research from a wide variety of facilities in the USA and elsewhere has found that, when properly operated, the best air pollution control equipment can potentially remove up to 99% of dioxins and furans, more than 99% of Metals, more than 99% of particulate matter, more than 99% of hydrogen chloride, more than 90% of sulfur dioxide, and up to 65% of nitrogen oxides [48].

Another way is establishing the microbial community as a more sensitive indicator of toxic effects of metals on rivers. In addition it is very difficult to get ecosystem data with insects or fish. With bacteria, it is possible to monitor very small changes in the ecosystem very rapidly [49].

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Appendix I:

Most use chemicals in 2006:

	Swedish Name	English Name	Measure	2006	2007	consumption
1	Aceton	acetone	L	17.5	7.5	10
2	Etylacetat	ethyl acetate	L	3.5	2	1.5
3	Kaliumhexacyanoferrat(III)	potassium hexacyanoferrate(III)	Kg	0.5	0.4	0.3
4	Kaliumjodid	potassium iodide	kg	0.8	0.3	0.5
5	Kaliumväteftalat	potassium hydrogen phthalate	kg	0.4	0.1	0.3
6	Koppar(II)sulfat-5-hydrat	copper sulphate(II)- 5 hydrate	kg	3	2.4	0.6
7	magnesiumsulfat vattenfri	magnesium sulphate dehydrate	kg	1.2	0.8	0.4
8	Metanol	methanol	L	10	8.5	1.5
9	Natriumacetat	sodium acetate	kg	2.3	2.1	0.2
10	Natriumklorid	sodium chloride	kg	6	4	2
11	Natriumsulfit	Disodium Disulfite	kg	1.4	1.2	0.2
12	Natriumvätekarbonat	sodiumhydrogencarbonat	kg	1.3	1	0.3
13	Salpetersyra	nitric acid	L	5	3.5	1.5
14	Saltsyra	chlorhydric acid	L	3.9	1.4	2.5
15	Svavelsyra	sulphuric acid	L	3.1	1.4	1.7
16	Toluen	toluene	L	3.8	2.5	1.3
17	tris(hydroxymetyl)aminometan	Tromethamine	kg	0.4	0.1	0.3
18	Xylen	xylene	L	3.8	1	2.8
19	Zinkklorid	chloride of zinc	kg	2.1	1.5	0.6
20	Zinkoxid	zinkoxide	kg	1.3	1.1	0.2
21	Zinkpulver	powdered zinc	kg	1.3	0.8	0.5

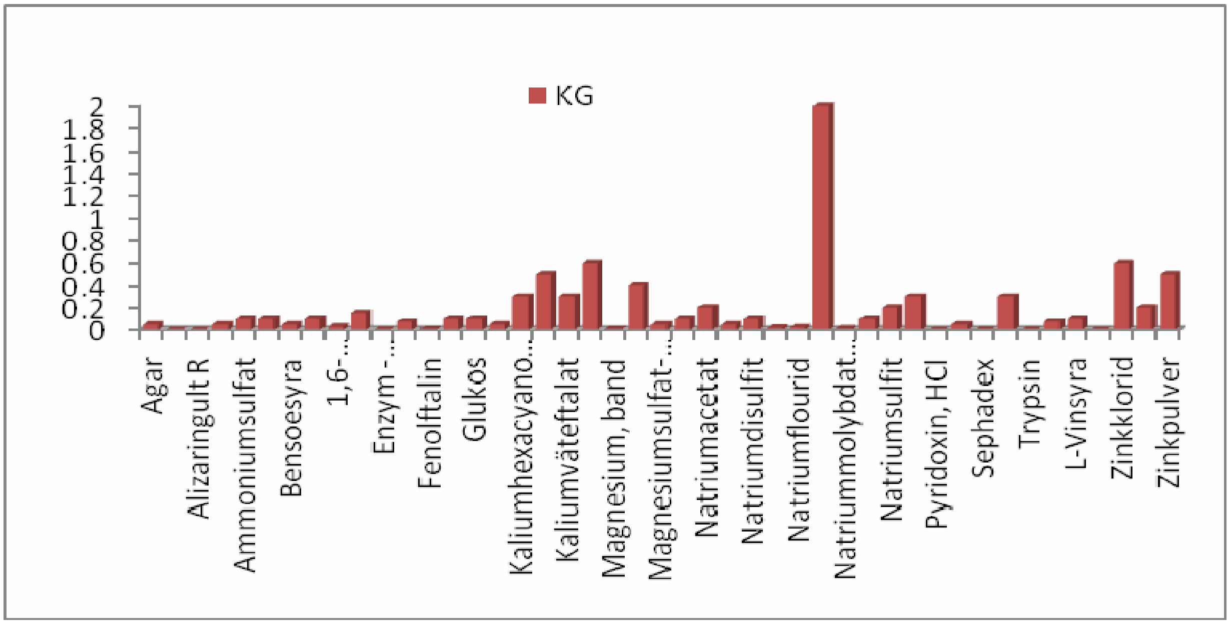


Figure (1). The most used chemicals in the chemistry laboratory (Kg)

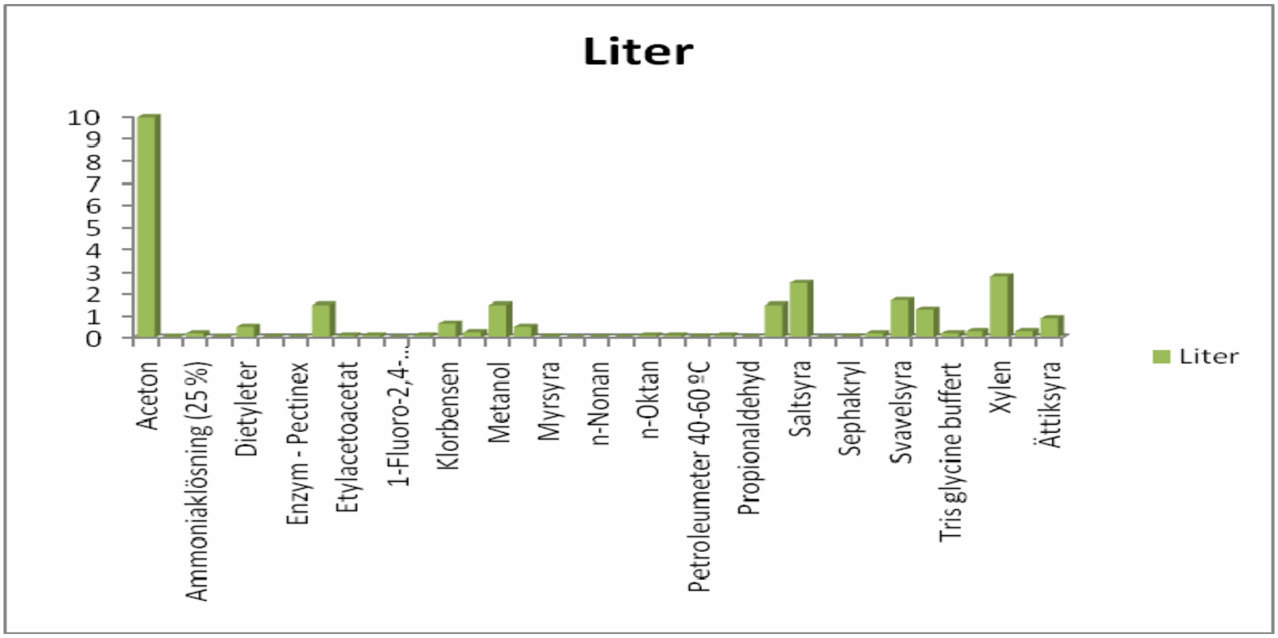


Figure (2). The most used chemicals in the chemistry laboratory (Liter)

Total used chemicals in 2006:

	Swedish name	English name	measure	2006	2007	consumption
1	1,6-Diaminohexan, hexametyldiamin	hexamethylenediamine	Kg	0.1	0.07	0.03
2	1-Fluoro-2,4-dinitrobensen	1-fluorine-2,4-denitrobanzene	L	0.07	0.06	0.005
3	1-Pentanol, *n*-amylalkohol	pentan-1-ol	L	1.4	1.3	0.1
4	2-Brombutan	bromobutane	L	0.07	0.04	0.03
5	2-Naftol	naphthol	kg	0.2	0.1	0.1
6	Aceton	acetone	L	17.5	7.5	10
7	Adipinsyradiklorid, adipoylklorid	adipic acid chloride	L	0.05	0.005	0.045
8	Agar	agar powder(food additive E406)	Kg	0.25	0.2	0.05
9	Alizarin-3-metylamin-N,N-diättiksyradihydrat	3-aminomethylalizarin-N,N-diacetic acid	Kg	0	1E-04	0.0001
10	Alizaringult R	benzoic acid,2-hydroxy-5-((4-nitrophenyl)azo)-	Kg	0.01	0.005	0.001
11	Aluminiumoxid 60 aktivt basisk	alumina	Kg	0.65	0.6	0.05
12	Ammoniaklösning (25 %)	ammonia liquor	L	6.5	6.3	0.2
13	Ammoniumsulfat	ammonium sulphate	Kg	0.1	0	0.1
14	Ättiksyra	acetic acid	L	4.4	3.5	0.9
15	Bariumhydroxid-8-hydrat	barium hydroxide,octahydrate	Kg	0.5	0.4	0.1
16	Bensoesyra	Benzoic acid	Kg	0.55	0.5	0.05
17	Bly(II)nitrat	lead(II) nitrate	Kg	0.2	0.1	0.1
18	Dietyleter	Diethyl ether	L	3.9	3.4	0.5
19	*DL*-Valin	valine	Kg	0.08	2E-04	0.0748
20	EDTA (dinatrium)	EDTA disodium	Kg	1.1	0.95	0.15
21	Enzym - Celluzyme 0,7 T	enzyme	Kg	0.05	0.045	0.005
22	Enzym - Gist-brocades Maxiren		L	0.1	0.07	0.03
23	Enzym - Pectinex		L	0.14	0.13	0.01
24	Etylacetat	ethyl acetate	L	3.5	2	1.5
25	Etylacetoacetat	Etylacetoacetat	L	0.6	0.5	0.1
26	Etylenglykol, 1,2-etandiol	ethylene glyco,1,2-ethandiol	L	1.6	1.5	0.1
27	Fenol	phenol	kg	0.18	0.1	0.075
28	Fenolftalin	phenolphthalein	Kg	0.09	0.08	0.01
29	Formaldehydlösning med metanol	solvent with methanol	L	0.8	0.7	0.1
30	Ftalsyraanydrid		Kg	0.6	0.5	0.1
31	Glukos	glucose	Kg	0.3	0.2	0.1
32	Kalciumklorid	calcium chloride	Kg	1	0.95	0.05

33	Kaliumhexacyanoferrat(III)	potassium hexacyanoferrate(III)	Kg	0.5	0.4	0.3
34	Kaliumjodid	potassium iodide	kg	0.8	0.3	0.5
35	Kaliumväteftalat	Potassium hydrogen phthalate	kg	0.4	0.1	0.3
36	Klorbensen	chlorobanzene	L	0.95	0.3	0.65
37	Kloroform	chloroform	L	1.05	0.8	0.25
38	Koppar(II)sulfat-5-hydrat	copper sulfite(II)- 5 hydrate	kg	3	2.4	0.6
39	*L*-Vinsyra	tartaric acid	kg	0.2	0.1	0.1
40	Magnesium, band	Magnesium	Kg	0.04	0.025	0.01
41	Magnesiumsulfat vattenfri	magnesium sulfate dehydrated	kg	1.2	0.8	0.4
42	Magnesiumsulfat-7-hydrat	Magnesiumsulfat	kg	0.2	0.15	0.05
43	Metanol	methanol	L	10	8.5	1.5
44	Mjölksyra	lactic acid	L	2	1.5	0.5
45	Myrsyra	Aminic acid	L	0.15	0.1	0.05
46	Native sample buffer	native simple buffer	L	0.05	0.04	0.005
47	Natriumacetat	sodium acetate	kg	2.3	2.1	0.2
48	Natriumdikromat-dihydrat	sodium dichromate	kg	1.1	1.05	0.05
49	Natriumdisulfit	sodium sulfite	kg	1	0.9	0.1
50	Natriumdodekylvätesulfat	sodium didodecyl sulfide	kg	0.1	0.08	0.02
51	Natriumflourid	sodium fluoride	kg	0.15	0.125	0.025
52	Natriumklorid	sodium chloride	kg	6	4	2
53	Natriummolybdat-2-hydrat	sodium molybdate	Kg	0.08	0.06	0.015
54	Natriumnitrat	sodium nitrate	kg	0.5	0.4	0.1
55	Natriumsulfit	sodium sulfite	kg	1.4	1.2	0.2
56	Natriumvätekarbonat	sodiumhydrogencarbonat	kg	1.3	1	0.3
57	*n*-Nonan	n-Nonane	L	0.1	0.08	0.02
58	*n*-oktadekan	n-Octadecanol	L	0.1	0.09	0.01
59	*n*-Oktan	*octane*	L	0.8	0.7	0.1
60	Petroleumeter 40-60 ºC	colorless petrol 40-60ºC	L	1.25	1.2	0.05
61	Petroleumeter 60-80 ºC	colorless petrol 60-80ºC	L	1	0.9	0.1
62	Propionaldehyd	propanal	L	0.08	0.07	0.01
63	Pyridoxin, HCl	Pyridoxin	Kg	0	0.003	0.001
64	Sackaros	saccharine	kg	0.25	0.2	0.05
65	Salpetersyra	nitric acid	L	5	3.5	1.5
66	Saltsyra	chlorohydric acid	L	3.9	1.4	2.5
67	Sebacoyldiklorid	Decanedioic dichloride	L	0.03	0.025	0.005
68	Sephadex	Sephadex	Kg	0.11	0.1	0.005
69	Sephakryl		L	0.3	0.25	0.05
70	Standardlösning - Koppar 1000 mg/l	standard solving copper	L	1.1	0.9	0.2
71	Svavelsyra	sulphuric acid	L	3.1	1.4	1.7
72	Toluen	toluene	L	3.8	2.5	1.3

73	Tris glycine buffer	glycine buffer solution	L	1.2	1	0.2
74	Tris glycine SDS buffer	glycine buffer solution(safety data sheet)	L	1.8	1.5	0.3
75	tris(hydroxymetyl)aminometan	Tromethamine	kg	0.4	0.1	0.3
76	Trypsin	Trypsin	Kg	0	1E-04	0.0039
77	Xylen	xylene	L	3.8	1	2.8
78	Xylenorange-Na_4	Orange xylene	Kg	0	8E-04	0.0002
79	Zetaplus 400 base		L	0.8	0.5	0.3
80	Zinkklorid	chloride of zinc	kg	2.1	1.5	0.6
81	Zinkoxid	zinkoxide	kg	1.3	1.1	0.2
82	Zinkpulver	powdered zinc	kg	1.3	0.8	0.5

All existent chemicals in chemistry lab (used and unused chemicals in 2006):

1	*(D)*-Biotin	45	Ampuller - Natriumtiosulfat 0,1 M
2	1,3-Butandiol	46	Ampuller - Saltsyra 1,000 M
3	1,6-Diaminohexan, hexametyldiamin	47	Ampuller - Triplex lösning A
4	1-Butanol	48	Antracenaldehyd
5	2-Brombutan	49	Antranilsyra
6	2-Brompentan	50	*B*-Alanin
7	2-Butanol	51	BAPNA
8	4-Acetamidofenol	52	Bariumhydroxid-8-hydrat
9	Acetaldehyd	53	Bariumkarbonat
10	Acetofenon	54	Bariumklorid
11	Aceton	55	Bariumnitrat
12	Acetonitril	56	Bärnstensyra
13	⍰-Chymotrypsin	57	Bathofenantrolin
14	Adipinsyra	58	Bensaldehyd
15	Adipinsyradiklorid, adipoylklorid	59	Bensen
16	Agar	60	Bensin 95 oktan
17	Albumin (ur ägg)	61	Bensoesyra
18	Aliquat 336	62	Bensofenon
19	Alizarin-3-metylamin-N,N-diättiksyradihydrat	63	Bensoylklorid
20	Alizaringult R	64	Bensoylperoxid
21	Alizarinlantankomplex	65	Bensylalkohol
22	Aluminiumklorid-6-hydrat	66	Bifenyl
23	Aluminiumoxid 60 aktivt basisk	67	Bio-Lyte 3/10
24	Aluminiumoxid kalcinerad	68	Bly(II)nitrat
25	Aluminiumsulfat-18-hydrat	69	Borax, natriumtetraborat
26	Ammoniaklösning (25 %)	70	Borsyra
27	Ammoniumacetat	71	Bortriflourid-metanolkomplex
28	Ammoniumheptamolybdat-tetrahydrat	72	Brom
29	Ammonium-järn(II)-sulfat-hexahydrat	73	Brombensen
30	Ammoniumkarbonat	74	Bromfenolblått
31	Ammoniumklorid	75	Bromkresolgrönt
32	Ammoniumnitrat	76	Bromkresolpurpur
33	Ammoniumperoxodisulfat, ammoniumpersulfat	77	Bromsuccinimid
34	Ammoniumsulfat	78	Bromtymolblått
35	Ammoniumtiocyanat	79	Butyl (tetra-n) ammoniumbromid, tetrabutyl...
36	Ampuller - Aluminium 1000 mg	80	Butylacetat
37	Ampuller - Jod 0,05 M	81	Calcon
38	Ampuller - Kalcium 1,979 g $CaCl_2$	82	Cellulase från Trichderma
39	Ampuller - Kaliumdikromat 4,904 g	83	Cerium-3-nitrat-hexahydrat
40	Ampuller - Kaliumpermanganat 0,02 M	84	Cesiumklorid
41	Ampuller - Koppar 1000 mg	85	Citronsyra-1-hydrat
42	Ampuller - Natrium-EDTA, Titriplex^R III	86	Cyklohexan
43	Ampuller - Natriumhydroxid 0,100 M	87	Cyklohexankarboxylsyra
44	Ampuller - Natriumhydroxid 1,000 M	88	Cyklohexanol

89	Cyklohexanon	137	Enzym - Sweetzyme T
90	Cyklohexen	138	Enzym - Teramyl 60 T
91	*D(+)*Cellobios	139	Enzym - Teramyl 120 L, Type L
92	Dextran (blå)	140	Enzym - Viscozym L
93	*L(+)*Askorbinsyra	141	Eriokromsvart T
94	*L*-Alanin	142	Etanol
95	*N*-□-bensoyl-L-arginine	143	Etanolamin
96	*N*-Allyltiokarbamid	144	Etylacetat
97	*p*-Aminobensoesyra, 4-aminobensoesyra	145	Etylacetoacetat
98	*t*-Butanol	146	Etylenglykol, 1,2-etandiol
99	Glukos	147	Etylenglykoldimetyleter
100	Irganox 1076	148	*L-3,4*-Dihydroxifenylalanin
101	Kaliumdivätefosfat	149	Etylklorformiat
102	Isobutylmetylketon	150	Etylmetylketon
103	*Hexadecane*	151	Epiklorhydrin
104	*2*-Hydroxiacetofenon	152	Fenol
105	Isoforon	153	Fenolftalin
106	NN-dietylaniline	154	Järn(II)sulfat-7-hydrat
107	Dietanolamin	155	Fenylacetat
108	Dietylbensylfosfonat	156	*L*-Fenylanalin
109	Dietylenglykol	157	Fluorescenium
110	Dietylenglykolmonobutyleter	158	1-Fluoro-2,4-dinitrobensen
111	Kalciumkarbonat	159	Formaldehydlösning med metanol
112	Dietyleter	160	Formalin
113	Dietylkarbonat	161	*o*-Fosforsyra
114	Diethylmalonate, malonsyradietylester	162	*o*-Ftalsyra
115	Dikloretan	163	Fosforpentoid-tetrafosfordekoxid
116	2,6-Diklorofenolindofenolnatriumsalt-dihydrat	164	Ftalsyraanydrid
117	Diklormetan	165	Furan
118	Dikromatlösning COD-mätning, COD	166	*L*-Glutaminsyra
119	Dimetylamin	167	Glutaminsyrahydroklorid
120	Dietylkarbonat	168	Glycerol, glycerin
121	*N,N*-Dimethylparatoluidin	169	Glycin
122	Dimetylsulfoxid	170	Hemoglobin
123	3,5-Dinitro-2-hydroxybensoesyra	171	*n*-Heptan
124	Dipropylenglykol	172	*n*-Hexan
125	Dodecanese	173	*DL*-Histidin
126	EDTA (dinatrium)	174	Hydrokinondimetyleter
127	Enzym - Alkalase 3,0 T	175	Indol
128	Enzym - AMG	176	Irganox1010
129	Enzym - Celluzyme 0,7 T	177	1-Jodpropan
130	Enzym - Gist-brocades Fromase	178	Jod
131	Enzym - Gist-brocades Maxiren	179	Järn(III)klorid
132	Enzym - Lactozym 300 l HP-G	180	Järn(III)nitrat-9-hydrat
133	Enzym - Lipolase 100 T	181	Järn(III) sulfat
134	Enzym - Neutrase	182	Kalciumhydroxid
135	Enzym - Pectinex	183	Kalciumklorid
136	Enzym - Savinase 6,0 T, Type W	184	Kalciumklorid-2-hydrat

185	Kalciumoxid	*234*	*p*-Kresol
186	Kalciumpantothenate	*235*	Krom(III)klorid-hexahydrat
187	Kaliumantimon(III)oxidtartrat-0,5-hydrat	*236*	Krom(VI)oxid
188	Kaliumbromid	*237*	Krotonsyra
189	Järn(III)klorid-hexahydrat	*238*	Kvicksilver(II)klorid
190	Kaliumdikromat	*239*	Kvicksilver(II)sulfat
191	Etylenglykolmonobutyleter	*240*	Lacknafta-Petroleumdestillat
192	1,5-Difenylkarbazid	*241*	Laemmli sample buffer
193	Formamid	*242*	Lantan(III)klorid-heptahydrat
194	*N,N*-Dimetylformamid	*243*	Lantan(III)nitrat
195	1,4-Dioxan	*244*	Litiumklorid
196	Isopentylnitrit (stab.av kaliumkarbonat)s	*245*	Litiumnitrat
197	Kaliumflourid	*246*	*(L-)*Lycinmonoklorid
198	Kaliumhexacyanoferrat(II)-trihydrat	*247*	Magnesium, band
199	3-Metyl-1-butanol, *iso*-amylalkohol	*248*	Kaliumnitrat
200	2-Naftol	*249*	Magnesium, spån
201	Natriumnitrit	*250*	Magnesiumkomplexonat
202	Native sample buffer	*251*	Magnesiumnitrat-6-hydrat
203	Mjölksyra	*252*	Magnesiumoxid
204	N-acetyl-L-tyrosine etyl ester monohydrat	*253*	Magnesiumsulfat vattenfri
205	Natrium	*254*	Natriumborhydrid
206	Kalciumhydroxid	255	Magnesiumsulfat-7-hydrat
207	Kaliumhexacyanoferrat(III)	256	Maleinsyraanhydrid
208	Kaliumjodat	257	Malonsyra
209	Kaliumjodid	258	Mangan(II)klorid-4-hydrat
210	Kalciumkarbonat	259	Mangan(II)sulfat-hydrat
211	Natriumdodekylvätesulfat	260	D(-) Mannitol
212	Kaliumklorat	261	Metenamin, hexametylentetraamin
213	Kaliumklorid	262	Metylamin 40 % lösning
214	Kaliumkromat	263	Metanol
215	Kaliumpermanganat	264	4-Metylbenzoesyra
216	Kaliumperoxodisulfat	265	2-Metyl-2-butanol, t-amylalkohol
217	Kaliumtiocyanat	266	Metylcyklohexan
218	*di*-Kaliumvätefosfat	267	2-Metylcyklohexanol
219	Kaliumväteftalat	268	Metylenblått
220	Kiselgel 60	269	Metylisobutylketon
221	Kiselgel (gulgel)	*270*	Metylorange
222	Klorbensen	*271*	Metylrött Natriumsalt
223	2-Klor-2-metylpropan	*272*	Murexid
224	Kobolt(II)klorid-6-hydrat	*273*	Myo-inositol
225	Kobolt(II)nitrat-6-hydrat	*274*	Myrsyra
226	Koffein	*275*	NAD
227	Kol-aktivt	*276*	Naftalen
228	Koldisulfid	*277*	Natriumazid
229	Koltetraklorid	*278*	Natriumalginat
230	Koppar(II)klorid-2-hydrat	*279*	Natriumbromid
231	Koppar(II)oxid	*280*	Natriumdifosfat-10-hydrat
232	Koppar(II)sulfat-5-hydrat	*281*	Natriumdikromat-dihydrat
233	*m*-Kresolpurpur	*282*	Natriumdisulfit

283	Natriumflourid	330	1-Oktanol
284	Natriumhydroxid	331	Oxalsyra-2-hydrat
285	Natriumjodid	332	Paraffinolja
286	Natriumkarbonat	333	Pentan
287	Natriumklorid	334	1-Pentanol, *n*-amylalkohol
288	Natriummolybdat-2-hydrat	335	Perklorsyra
289	Natriumcitrat-2-hydrat, tri-natriumcitrat	336	Petroleumeter 40-60 ºC
290	Natriumnitrat	337	Petroleumeter 60-80 ºC
291	Magnesium, pulver	338	Polyetylenglykol 400
292	Kaliumnatriumtartrat-4-hydrat	339	1,2-Propandiol
293	Mesityloxid	340	1-Propanol
294	Kasein	341	2-Propanol
295	Kloroform	342	Propionaldehyd
296	Natriumacetat	343	Pyridin
297	Natriumoxalat	344	Pyridinehydrobromide perbromide
298	Natriumperklorat-1-hydrat	345	Pyridoxin, HCl
299	Nikotin	346	Pyrrol
300	Novozyme 188	347	Pyrrolidine-1-ditiokarboxylsyra ammoniumsalt
301	*di*-Natriumvätefosfat-2-hydrat	348	Quinoline Yellow
302	Standardlösning - Silver 1000 mg/l	349	Sackaros
303	Tionylklorid	350	Salicylsyra
304	Xylenorange-Na$_4$	351	Natriumvätekarbonat
305	Toluen	352	Saltsyra
306	Svavel	353	Sebacinsyra
308	Toluen-4-sulfonsyra	354	Sebacoyldiklorid
309	Natriumpropionat, propionsyra Na-salt	355	Semikarbazidhydroklorid
310	Natriumpolyakrylat	356	Sand (hydrofob)
311	Natriumstearat	357	Tris glycine SDS buffer
312	Natriumsulfat	358	Sephadex
313	Natriumsulfit	359	Sephakryl
314	Trypsin	360	Silvernitrat
315	Natriumtetraborat-10-hydrat	364	Standardlösning - Koppar 1000 mg/l
316	Natriumtiosulfat-5-hydrat	365	Standardlösning - Krom 1000 mg/l
317	*di*-Natriumvätefosfat	366	Standardlösning - Kobolt 1000 mg/l
318	Natriumvätesulfat-1-hydrat	361	Smörsyra
319	Natronkalk	362	Standardlösning - Bly 1000 mg/l
320	Nickelklorid	363	Standardlösning - Järn 1000 mg/l
321	Nickelsulfat-6-hydrat	364	Standardlösning - Koppar 1000 mg/l
322	Ninhydrin	371	Standardlösning - Kadmium 1000 mg/l
323	Nikotinsyra	372	Salpetersyra
324	Nitrobensen	373	*trans*-Stilben
325	Nitroetan	374	*Styrén*
326	2-Nitropropan	375	Stärkelse löslig
327	*n*-Nonan	376	Sulfo(5-)salicylsyra-2-hydrat, 5-sulfosalicylsyra
328	*n*-oktadekan	377	Svavelsyra

378	TEMED, N.N.N'. N'-tetrametylendiamin
379	Tennklorid dihydrat
380	Tetrahydrofuran
381	Thiamine
382	Tris glycine buffer
383	Triacontane
384	Trietanolamin
385	Trietylenglykol
386	Trifenylfosfin
387	Toluen-4-sulfonsyra natriumsalt
388	2,2,4-Trimetylpentan, iso-oktan
389	tris(hydroxymetyl)aminometan
390	T-röd
391	Urea
392	*DL*-Valin
393	*L*-Vinsyra
394	Vitamin B_{12}
395	Väteperoxid
396	Xylen
397	Zetaplus 400 base
398	Zinkklorid
399	Zinkoxid
400	Zinkpulver
401	Zinksulfat-7-hydrat
402	*ze*taplus 400 brightner spec
403	Ättiksyra
404	Ättiksyraanhydrid
405	*DL*-Äppelsyra

Metals:

1	Aluminiumoxid 60 aktivt basisk	alumina
2	Bariumhydroxid-8-hydrat	barium hydroxide,octahydrate
3	Bly(II)nitrat	lead(II) nitrate
4	EDTA (dinatrium)	EDTA disodium
5	Kalciumklorid	calcium chloride
6	Kaliumhexacyanoferrat(III)	potassium hexacyanoferrate(III)
7	Kaliumjodid	potassium iodide
8	Kaliumväteftalat	potassium hydrogen phthalate
9	Koppar(II)sulfat-5-hydrat	copper sulphate (II)- 5 hydrate
10	Magnesium, band	Magnesium
11	Magnesiumsulfat vattenfri	magnesium sulphate dehydrated
12	Magnesiumsulfat-7-hydrat	Magnesiumsulfat
13	Natriumacetat	sodium acetate
14	Natriumdikromat-dihydrat	sodium dichromate
15	Natriumdisulfit	Sodium Disulfite
16	Natriumdodekylvätesulfat	sodium didodecyl sulfide
17	Natriumflourid	sodium fluoride
18	Natriumklorid	sodium chloride
19	Natriummolybdat-2-hydrat	sodium molybdate
20	Natriumnitrat	sodium nitrate
21	Natriumsulfit	sodium sulfite
22	Natriumvätekarbonat	sodiumhydrogencarbonat
23	Standardlösning - Koppar 1000 mg/l	standard solving copper
24	Zinkklorid	chloride of zinc
25	Zinkoxid	zinc oxide
26	Zinkpulver	powdered zinc

Organic solvents (without halogen):

1	1,6-Diaminohexan, hexametyldiamin	hexamethylenediamine
2	1-Pentanol, *n*-amylalkohol	pentan-1-ol
3	Alizarin-3-metylamin-N,N-diättiksyradihydrat	3-aminomethylalizarin-N,N-diacetic acid
4	Alizaringult R	benzoic acid,2-hydroxy-5-((4-nitrophenyl)azo)-
5	Ättiksyra	acetic acid
6	Bensoesyra	Benzoic acid
7	Dietyleter	dietyl ether
8	*DL*-Valin	Valine
9	Etylacetat	Ethyl acetate
10	Etylacetoacetat	Etylacetoacetat
11	Etylenglykol, 1,2-etandiol	ethylene glyco,1,2-ethandiol
12	Fenol	Phenol
13	Fenolftalin	Phenolphthalein
14	Formaldehydlösning med metanol	solvent with methanol
15	*L*-Vinsyra	tartaric acid
16	Mjölksyra	lactic acid
17	Myrsyra	Aminic acid
18	Native sample buffer	native simple buffer
19	*n*-Nonan	n-Nonane
20	Petroleumeter 40-60 ºC	colorless petrol 40-60ºC
21	Petroleumeter 60-80 ºC	colorless petrol 60-80ºC
22	Propionaldehyd	Propanal
23	Toluen	Toluene
24	Tris glycine buffert	glycine buffer solution
25	Tris glycine SDS buffert	glycine buffer solution(safety data sheet)
26	tris(hydroxymetyl)aminometan	Tromethamine
27	Xylen	Xylene
28	Xylenorange-Na_4	orange xylene

Organic solvent with halogen:

1	1-Fluoro-2,4-dinitrobensen	1-fluorine-2,4-denitrobanzene
2	2-Brombutan	bromobutane
3	Adipinsyradiklorid, adipoylklorid	adipic acid chloride
4	Klorbensen	chlorobanzene
5	Kloroform	chloroform
6		
7	Sebacoyldiklorid	Decanedioic dichloride

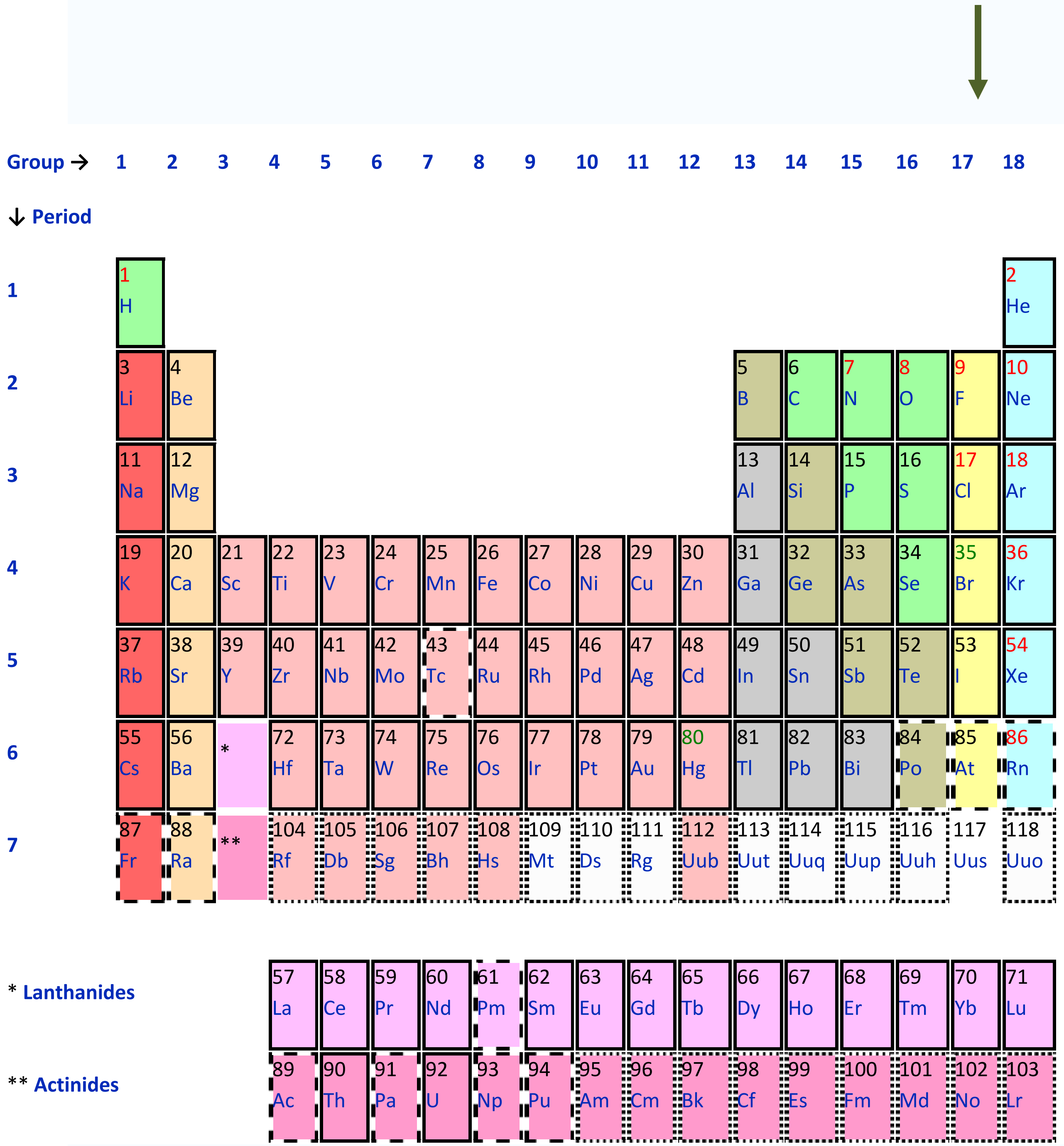
Ethanol, methanol and acetone:

1	Aceton	acetone
2	Metanol	methanol
3	Etanol	Ethanol

Other chemicals:

1	2-Naftol	naphthol
2	Agar	agar powder(food additive E406)
3	Ammoniaklösning (25 %)	ammonia liquor
4	Ammoniumsulfat	ammonium sulphate
5	Enzym - Celluzyme 0,7 T	enzyme
6	Enzym - Gist-brocades Maxiren	
7	Enzym - Pectinex	
8	Ftalsyraanydrid	
9	Glukos	glucose
10	*n*-oktadekan	n-Octadecanol
11	*n*-Oktan	*octane*
12	Pyridoxin, HCl	pyridoxin
13	Sackaros	saccharose
14	Salpetersyra	nitricacid
15	Sephadex	Sephadex
16	Sephakryl	
17	Svavelsyra	sulphuric acid
18	Trypsin	trypsin
19	Zetaplus 400 base	
20	Saltsyra	Hydrochloric acid

Standard periodic table (table 17):



Group →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
↓ Period																		
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
* Lanthanides				57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
** Actinides				89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Appendix II:

Risk phrase:

R 1	Explosive when dry.
R 2	Risk of explosion by shock, friction, fire or other sources of ignition.
R 3	Extreme risk of explosion by shock, friction, fire or other sources of ignition.
R 4	Forms very sensitive explosive metallic compounds.
R 5	Heating may cause an explosion.
R 6	Explosive with or without contact with air.
R 7	May cause fire.
R 8	Contact with combustible material may cause fire.
R 9	Explosive when mixed with combustible material.
R 10	Flammable.
R 11	Highly flammable.
R 12	Extremely flammable.
R 13	Extremely flammable liquefied gas. *The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.*
R 14	Reacts violently with water.
R 14/15	Reacts violently with water, liberating extremely flammable gases.
R 15	Contact with water liberates extremely flammable gases.
R 15/29	Contact with water liberates toxic, extremely flammable gas.
R 16	Explosive when mixed with oxidizing substances.
R 17	Spontaneously flammable in air.

R 18	In use, may form flammable/explosive vapor air-mixture.
R 19	May form explosive peroxides.
R 20	Harmful by inhalation.
R 20/21	Harmful by inhalation and in contact with skin.
R 20/21/22	Harmful by inhalation, in contact with skin and if swallowed.
R 20/22	Harmful by inhalation and if swallowed.
R 21	Harmful in contact with skin.
R 21/22	Harmful in contact with skin and if swallowed.
R 22	Harmful if swallowed.
R 23	Toxic by inhalation.
R 23/24	Toxic by inhalation and in contact with skin.
R 23/24/25	Toxic by inhalation, in contact with skin and if swallowed.
R 23/25	Toxic by inhalation and if swallowed.
R 24	Toxic in contact with skin.
R 24/25	Toxic in contact with skin and if swallowed.
R 25	Toxic if swallowed.
R 26	Very toxic by inhalation.
R 26/27	Very toxic by inhalation and in contact with skin.
R 26/27/28	Very toxic by inhalation, in contact with skin and if swallowed.
R 26/28	Very toxic by inhalation and if swallowed.
R 27	Very toxic in contact with skin.
R 27/28	Very toxic in contact with skin and if swallowed.

R 28	Very toxic if swallowed.
R 29	Contact with water liberates toxic gas.
R 30	Can become highly flammable in use.
R 31	Contact with acids liberates toxic gas.
R 32	Contact with acids liberates very toxic gas.
R 33	Danger of cumulative effects.
R 34	Causes burns.
R 35	Causes severe burns.
R 36	Irritating to eyes.
R 36/37	Irritating to eyes and respiratory system.
R 36/37/38	Irritating to eyes, respiratory system and skin.
R 36/38	Irritating to eyes and skin.
R 37	Irritating to respiratory system.
R 37/38	Irritating to respiratory system and skin.
R 38	Irritating to skin.
R 39	Danger of very serious irreversible effects.
R 39/23	Toxic: danger of very serious irreversible effects through inhalation.
R 39/23/24	Toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R 39/23/24/25	Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
R 39/23/25	Toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R 39/24	Toxic: danger of very serious irreversible effects in contact with skin.

R 39/24/25	Toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R 39/25	Toxic: danger of very serious irreversible effects if swallowed.
R 39/26	Very toxic: danger of very serious irreversible effects through inhalation.
R 39/26/27	Very toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R 39/26/27/28	Very toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
R 39/26/28	Very toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R 39/27	Very toxic: danger of very serious irreversible effects in contact with skin.
R 39/27/28	Very toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R 39/28	Very toxic: danger of very serious irreversible effects if swallowed.
R 40	Limited evidence of a carcinogenic effect. *The phrase has been* ***changed*** *by ATP 28 (6 August 2001). The corresponding phrase used in earlier cards reads:* Possible risk of irreversible effects.
R 40/20	Harmful: possible risk of irreversible effects through inhalation. *The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.*
R 40/20/21	Harmful: possible risk of irreversible effects through inhalation and in contact with skin. *The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.*
R 40/20/21/22	Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.

	The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 40/20/22	Harmful: possible risk of irreversible effects through inhalation and if swallowed. *The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.*
R 40/21	Harmful: possible risk of irreversible effects in contact with skin. *The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.*
R 40/21/22	Harmful: possible risk of irreversible effects in contact with skin and if swallowed. *The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.*
R 40/22	Harmful: possible risk of irreversible effects if swallowed. *The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.*
R 41	Risk of serious damage to eyes.
R 42	May cause sensitization by inhalation.
R 42/43	May cause sensitization by inhalation and skin contact.
R 43	May cause sensitization by skin contact.
R 44	Risk of explosion if heated under confinement.
R 45	May cause cancer.
R 46	May cause heritable genetic damage.
R 47	May cause birth defects. *The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.*
R 48	Danger of serious damage to health by prolonged exposure.
R 48/20	Harmful: danger of serious damage to health by prolonged exposure

	through inhalation.
R 48/20/21	Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R 48/20/21/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.
R 48/20/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.
R 48/21	Harmful: danger of serious damage to health by prolonged exposure in contact with skin.
R 48/21/22	Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R 48/22	Harmful: danger of serious damage to health by prolonged exposure if swallowed.
R 48/23	Toxic: danger of serious damage to health by prolonged exposure through inhalation.
R 48/23/24	Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R 48/23/24/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.
R 48/23/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.
R 48/24	Toxic: danger of serious damage to health by prolonged exposure in contact with skin.
R 48/24/25	Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R 48/25	Toxic: danger of serious damage to health by prolonged exposure if swallowed.
R 49	May cause cancer by inhalation.

R 50	Very toxic to aquatic organisms.
R 50/53	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 51	Toxic to aquatic organisms.
R 51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 52	Harmful to aquatic organisms.
R 52/53	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 53	May cause long-term adverse effects in the aquatic environment.
R 54	Toxic to flora.
R 55	Toxic to fauna.
R 56	Toxic to soil organisms.
R 57	Toxic to bees.
R 58	May cause long-term adverse effects in the environment.
R 59	Dangerous for the ozone layer.
R 60	May impair fertility.
R 61	May cause harm to the unborn child.
R 62	Possible risk of impaired fertility.
R 63	Possible risk of harm to the unborn child.
R 64	May cause harm to breast-fed babies.
R 65	Harmful: may cause lung damage if swallowed.
R 66	Repeated exposure may cause skin dryness or cracking.
R 67	Vapors may cause drowsiness and dizziness.

R 68	Possible risks of irreversible effects.
R 68/20	Harmful: possible risk of irreversible effects through inhalation.
R 68/20/21	Harmful: possible risk of irreversible effects through inhalation and in contact with skin.
R 68/20/21/22	Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.
R 68/20/22	Harmful: possible risk of irreversible effects through inhalation and if swallowed.
R 68/21	Harmful: possible risk of irreversible effects in contact with skin.
R 68/21/22	Harmful: possible risk of irreversible effects in contact with skin and if swallowed.
R 68/22	Harmful: possible risk of irreversible effects if swallowed.

PROPERTIES OF WASTES WHICH RENDER THEM HAZARDOUS:

H1 'Explosive`: substances and preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene.

H2 'Oxidizing`: substances and preparations which exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances.

H3-A 'Highly flammable`:
- Liquid substances and preparations having a flash point below 21 °C (including extremely flammable liquids), or
- Substances and preparations which may become hot and finally catch fire in contact with air at
Ambient temperature without any application of energy, or
- solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or
- Gaseous substances and preparations which are flammable in air at normal pressure, or
- Substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities.

H3-B 'Flammable`: liquid substances and preparations having a flash point equal to or greater than21 °C and less than or equal to 55 °C.

H4 'Irritant`: non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.

H5 'harmful`: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks.

H6 'Toxic`: substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.

H7 'Carcinogenic`: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.

H8 'Corrosive`: substances and preparations which may destroy living tissue on contacts.

H9 'Infectious`: substances containing viable micro-organisms or their toxins which are known or reliably believed to cause disease in man or other living organisms.

H10 'Teratogenic`: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence.

H11 'Mutagenic`: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.

H12 substances and preparations are released as toxic or very toxic gases in contact with water, air or an acid.

H13 Substances and preparations capable by any means, after disposal, of yielding another substance, e.g. a leach ate, which possesses any of the characteristics listed above.

H14 'Ecotoxic`: substances and preparations which present or may present immediate or delayed risks for one or more sectors of the environment.