Chemical Reuse, Recycling and Recovery in the textile value chain

Promotion of Sustainability in the Textile and Garment Industry in Asia-FABRIC

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

1. Chemicals used in Textile processing mills
10.00– 11:00

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Agenda

- Auxiliary Chemicals
- Acids
- Salts
- Bases / (Caustic)

Importance of Chemical Management

- Chemicals are crucial components of major process industries (*e.g.* textiles)
- Effectively managed chemicals can deliver financial and environmental benefits.
- Chemicals are necessary to achieve characteristics and qualities in a product,
- However,
  - ✓ There is growing concern about harmful chemicals in the products and their adverse effects on health and environment.
  - ✓ the frameworks for standards, legal and other requirements become increasingly demanding

Chemical Inventory Template

Template 1: Chemical Inventory List

Factory Location:

Location:

Updated by: **Date:**

Area/ Process	Chemical/ Trade name	Manufacturer name	Formulator /Supplier name	Purchase information			CAS/ EC number	MRSL/RSL compliant (Yes/No)	SDS available (Yes/ No)	Function/ Use of the chemical	R-phrases/ Hazard statement	Hazard type			PPE required (as per SDS)	Storage condition (as per SDS)	Chemical In-stock	Chemical Used
				Date of purchase	Date of expiration	Batch/Lot number						P	H	E				

Elements of Inventories

Eco-map:

- ✓ **Type and location of chemicals and chemical (containing) waste**

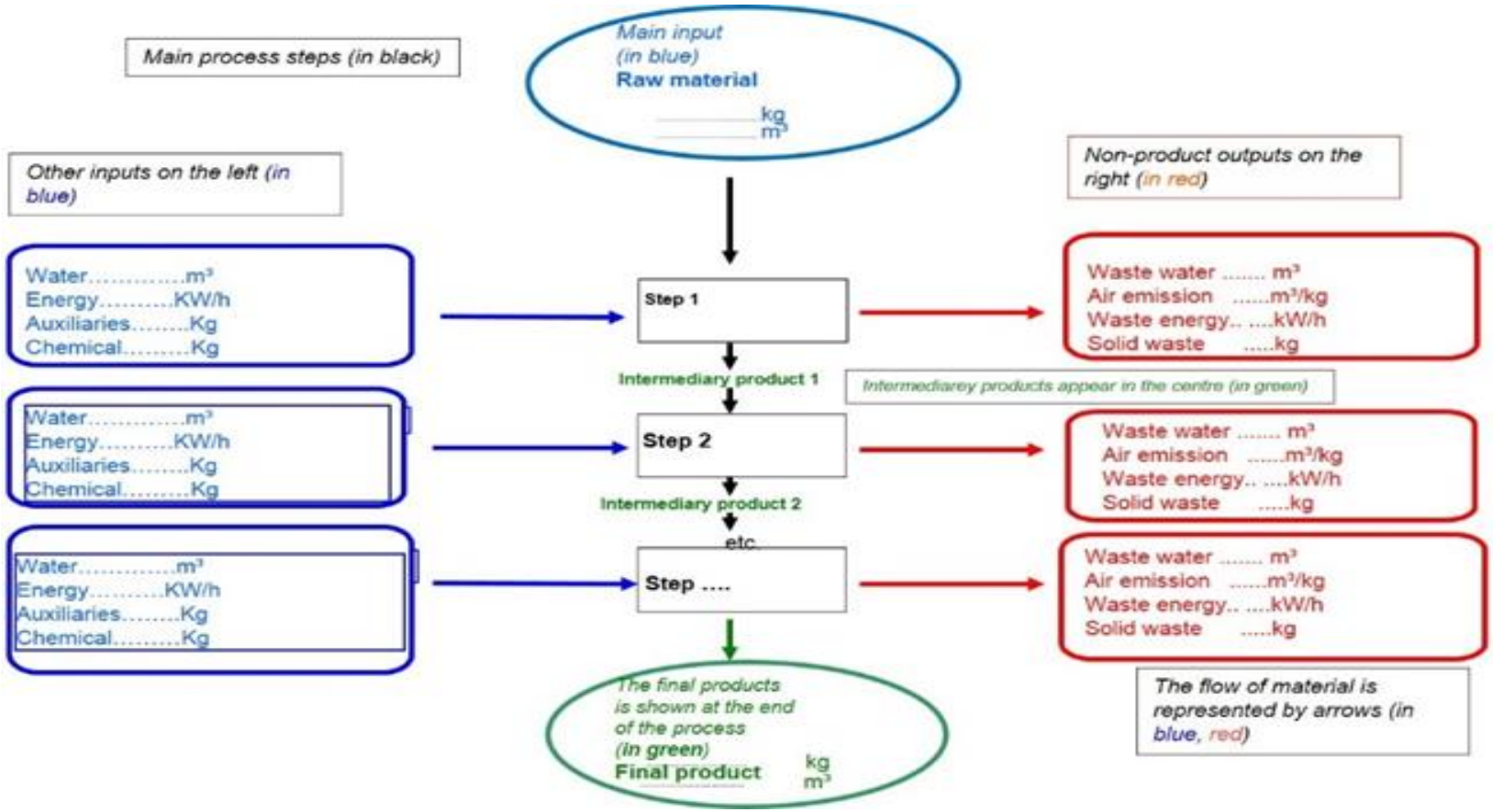
Process flow diagram and mass-balancing

- ✓ **Types of chemicals**
- ✓ **Processes involving chemicals**
- ✓ **Quantities of inputs and non-product outputs**

Safety data sheets/technical data sheets/labels and markings

- ✓ **Hazardous/non-hazardous**
- ✓ **Type of hazards**

Concept of Process Flow Mapping



Source: e-REMC toolkit by Deutsche Gesellschaf für Internationale Zusammenarbeit (GIZ)

Textile Chemicals and Auxiliaries with Their Functions 1:

The process of conversion of natural and man-made fibers is according to end uses and attractive qualities as per the need of customers who involving the uses of a large number of organic and inorganic textile chemicals. Some chemicals are used in textile auxiliaries or textiles are given below:
(source 2020 by textile-tutorials)

1.Wetting Agent:
The chemical which is used for quickly moistening or watering the textile materials is termed as the wetting agent.

2. Detergent:
Detergents are nothing but a chemical that is used for clearing the textile materials or to remove fats, oil, and wax.

3. Emulsifier:
The chemical which is used to mix up the oil and water is called an emulsifier.

4. Sizing Components:
The components which are used for sizing are termed as sizing components, .

Textile Chemicals and Auxiliaries with Their Functions 2:

5. De-sizing Agents:

The chemicals which are used to remove the size materials of fabric in **wet processing** is termed as de-sizing. Example: Enzyme.

6. Dye Retarding or Leveling Agents:

The chemicals which are used for dyeing just to give level shade or even dyeing is called the leveling agent.

7. Dye Carrier:

The dye carrier is not a chemical that will help to transfer the dye particle towards the outer surface or curiosity of the fiber.

8. Dye Fixing Agent:

Dye fixing agent is not anything but a chemical that helps to fix up the dye particle into the inner position of the fiber with the bondage.

9. Rubbing Fastness Agents:

Rubbing fastness agent is a chemical that will help to improve rubbing resistance power, this type of agent is used. It is nothing but color permanency agents. It is in three types. Such as **washing** fastness, light fastness, and rubbing fastness.

Textile Chemicals and Auxiliaries with Their Functions :

10. Printing Thickener:

Thickener is a thick mass that imparts stickiness and plasticity to the printing paste, so that it may be applied on the fabric surface without bleeding or spreading and be capable of maintaining the design outlines. It is the main part of the **printing**. Example: Potato paste, rice, carboxy-methyl cellulose.

11. Hygroscopic Agents:

The materials which absorb water from the moisture is termed as the hygroscopic agent. It is one type of electrolytic which sucks up the water and is soluble. Example: NaCl

12. Oxidizing and Reducing Agents:

The chemicals which help to increase oxygen or electronegative part release the hydrogen are termed as oxidizing and reducing agents respectively. Example: Hydrogen, Ozone, etc.

13. De-foaming Agents:

The chemicals which help to prevent foam formation is termed as de-foaming agents. Example: De-foamer, Anti-foam, etc.

14. Softening Agents:

The chemicals which are used to soften the textile materials is called softening agents. Example: Control oil, Parafin.

Textile Chemicals and Auxiliaries with Their Functions 4:

15. Stiffing Agents:

The chemicals which help to increase the soft materials into the harder one are termed as stiffing agents. Example: Resin.

16. Water Repellent or Proofing Agents:

The chemicals which can fully be resistant to penetrate by water are termed as water repellent or proofing agents. Example: Rubber

17. Fire Proofing Agents:

The chemical which has more resistance to burn out is called fireproofing agents.

18. Anti-mildew Agents:

The agents which are used to protect the fiber-like cellulosic fiber is termed, anti-mildew agents. Example: $ZnCl_2$

19. Moth Proofing Agents:

Mothproofing agents are the type of agents that help to resist the moth is called. Example: Naphthalene type of chemicals.

20. Weighting Agents:

Some chemicals which provide some weight to the fabric are termed as weighting agents. Example: Chalk, $CaCO_3$, etc.

Surfactants

Surfactants are widely used in textile wet processes for the purpose of wetting, dispersing, emulsifying and cleaning. When they are used at a sufficient concentration, the surface/interface tension of the solution is lowered and micelles are formed, which give the solution extra properties.

According to their ionic properties in aqueous solution, traditional surfactants can be divided into four categories: anionic, cationic, amphoteric and non-ionic.

Surfactants are four types:

1. Anionic surfactants,
2. Cationic surfactants,
3. Non-ionic surfactants and
4. Amphoteric surfactants

Amphoteric surfactants:

Amphoteric surfactants contain both anions and cations.

Oxidising agents and reducing agents

Oxidising agents are mainly used for **bleaching** and reducing agents are mainly used for vat dyeing in textile wet processes. These agents are often strong chemicals and need to be handled with care.

Oxidising Agents:

Hydrogen peroxide Hydrogen peroxide (H_2O_2)

Sodium Hypochlorite
In hypochlorite bleaching of textiles, active chlorine is the species measured for the control of the **bleaching process**.

Sodium perborate

Reducing Agents

Sodium hydrosulphite ($Na_2S_2O_4$)
It is the Dilute of 10 ml 40% formaldehyde with 50 ml distilled water.

Glucose
Glucose ($C_6H_{12}O_6$) can be used as a reducing agent in vat and **sulphur dye** applications.

Sodium thiosulphate
Sodium thiosulphate ($Na_2S_2O_3 \cdot 5H_2O$)

Acid

An acid is a substance which reacts with a base. Commonly, acids can be identified as tasting sour, reacting with metals such as calcium, and reacting with bases such as sodium carbonate. Aqueous acids have a pH under 7, with acidity increasing the lower the pH.

There are two types of acid:

1.Inorganic acid
2.Organic acid

Inorganic Acid:

Inorganic acid are Sulphuric acid (H_2SO_4), Hydrochloric acid (HCl), Nitric acid (HNO3), Phosphoric acid (H_3PO_4), etc.

Sulphuric Acid (H_2SO_4):

The concentration of sulphuric acid (H_2SO_4) can be determined by using Baume's (ºBé) hydrometer. The titration of sulphuric acid is carried out using sodium hydroxide in the presence of phenolphthalein as an indicator. The end point is reached when a faint pink color is persistent.

Organic Acids

2. Organic Acids:
Organic acids are HCOOH (formic acid), Acetic acid etc.

HCOOH
HCOOH (formic acid) is the simplest organic acid in terms of its organic structure. Concentrated HCOOH is usually 88% in strength. Since formic acid is a volatile acid, precautions should be taken to prevent loss of strength.

CH_3COOH
Acetic acid is a weak acid. It is available at different concentrations. Highly concentrated acetic acid at 98% and above is called glacial acetic acid because its freezing point range is between 13.3ºC (98%) and 16.7ºC (100%). Glacial acetic acid is flammable.

Salts

Function of Salt in the Textile Wet Processing

The textile substrate and dye molecule, not necessarily should have of homogeneous characteristics to combine with each other. In such case, we require some catalyst to facilitate dyeing action on fabric. Salt plays this crucial role of catalyst. Salt has an extremely high affinity for water.

Salt is necessary in three ways, firstly, to drive dye into textile during the **dyeing process in textile**.

Secondly, use of salt leads to maximum exhaustion of dye molecules during dyeing process in textiles.

Thirdly it is used as an electrolyte for migration, adsorption and fixation of the dyestuff to the cellulose material. The salt is used to attract dyes to the fiber before they become permanently fixed by the addition of alkali.

Salts

Role of Inorganic Salt in Reactive Dyeing:

Inorganic salts have two main functions in exhaustion dyeing with **reactive dyestuffs**:

1. Improving the affinity of the dyestuff.
2. Acceleration of the dyestuff's association and lowering of its solubility.

Generally reactive dyes contains sulphonic acid ($-SO_3H$) group which is insoluble in water. During the manufacturing of the **reactive dyes** these sulphonic acid groups are converted into the sodium salt of sulphonic acid ($-SO_3Na$) which is soluble in water.

Reactive dye $– SO_3H + Na^+ \rightarrow$ Reactive dye SO_3Na

Function of Salt in the Dyeing Process:

1. The salt in the reactive dyeing increases the affinity of the dye towards the Cellulosic substrate.
2. Salt increases the exhaustion rate of reactive dyestuffs.
3. As reactive dyestuffs have a lower affinity, more inorganic salt is required when using reactive dyestuffs in order to accelerate absorption.
4. While the amount of inorganic salt used varies according to the type of dyestuff used, recently developed high-fixation dyestuffs with improved affinity allow the amount of inorganic salt to be reduced.

Bases (Caustic)

A base in chemistry is a substance that can accept hydrogen cations (protons) or more generally, donate a pair of valence electrons.

Bases are two types:
1.Inorganic and
2.Organic bases

1. Inorganic Bases:
Inorganic bases are Sodium hydroxide (NaOH), Sodium carbonate (Na_2CO_3), Ammonium hydroxide (NH_4OH) etc.

NaOH
Sodium hydroxide (NaOH) is also called caustic soda. It is available in solution at different concentrations or in solid form. Commercial NaOH often contains a little sodium carbonate (Na_2CO_3) as a by-product of the manufacturing process. This small amount of Na_2CO_3 will usually not influence its use in textile wet processes.
Owing to its strong alkalinity, NaOH can react with CO_2 in air easily. It can also absorb water very quickly.

Bases (Caustic)

Na_2CO_3

Sodium carbonate (Na_2CO_3) is also called soda ash. In textile wet processes, it is often available in anhydrous form. Its purity can be > 99% Na_2CO_3 (58% Na_2O).

NH_4OH

Ammonium hydroxide (NH_4OH) is a water solution of ammonia gas (NH_3). It can also be called aqua ammonia or ammonia water.

Organic Bases

Organic bases are Triethanolamine, $N(CH_2CH_2OH)_3$, Ethylenediamine $(H_2NCH_2)_2$ etc.

Triethanolamine

Triethanolamine, $N(CH_2CH_2OH)_3$, is a strong organic base miscible with water, methanol and acetone. The pH of its 0.1N aqueous solution is 10.5. Analytical grade $N(CH_2CH_2OH)_3$ is a highly hygroscopic and viscous liquid with a pale yellow or no colour. Its melting point is between 18 and 21ºC. Its density is about 1.12.

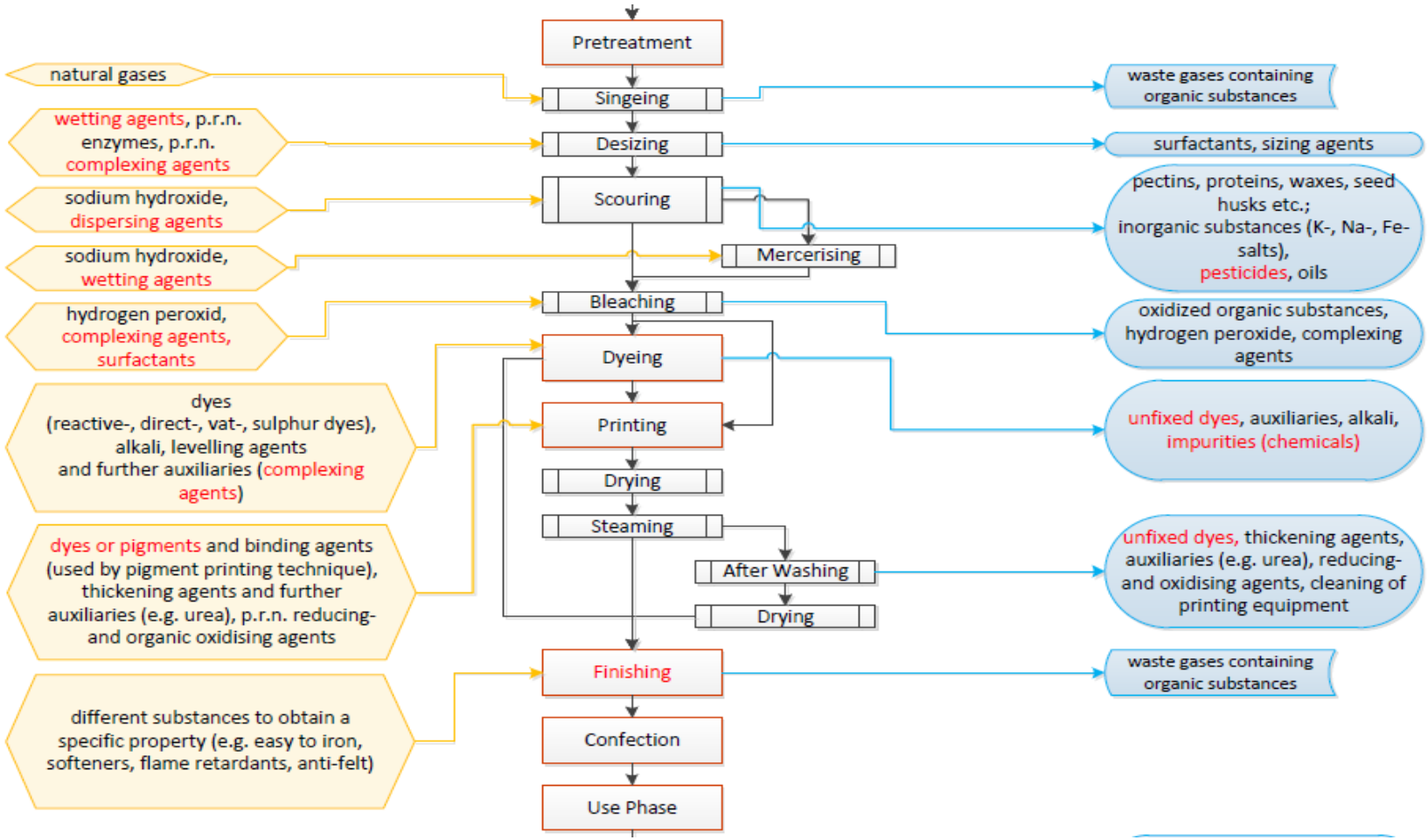
Ethylenediamine

Ethylenediamine, $(H_2NCH_2)_2$, is a strong organic base miscible with water and alcohol. It is a colourless and viscous liquid with a density of 0.898 and a melting point of 8ºC. The pH of a 25% aqueous solution is 11.5. Like triethanolamine, it is an aliphatic amine soluble in water.

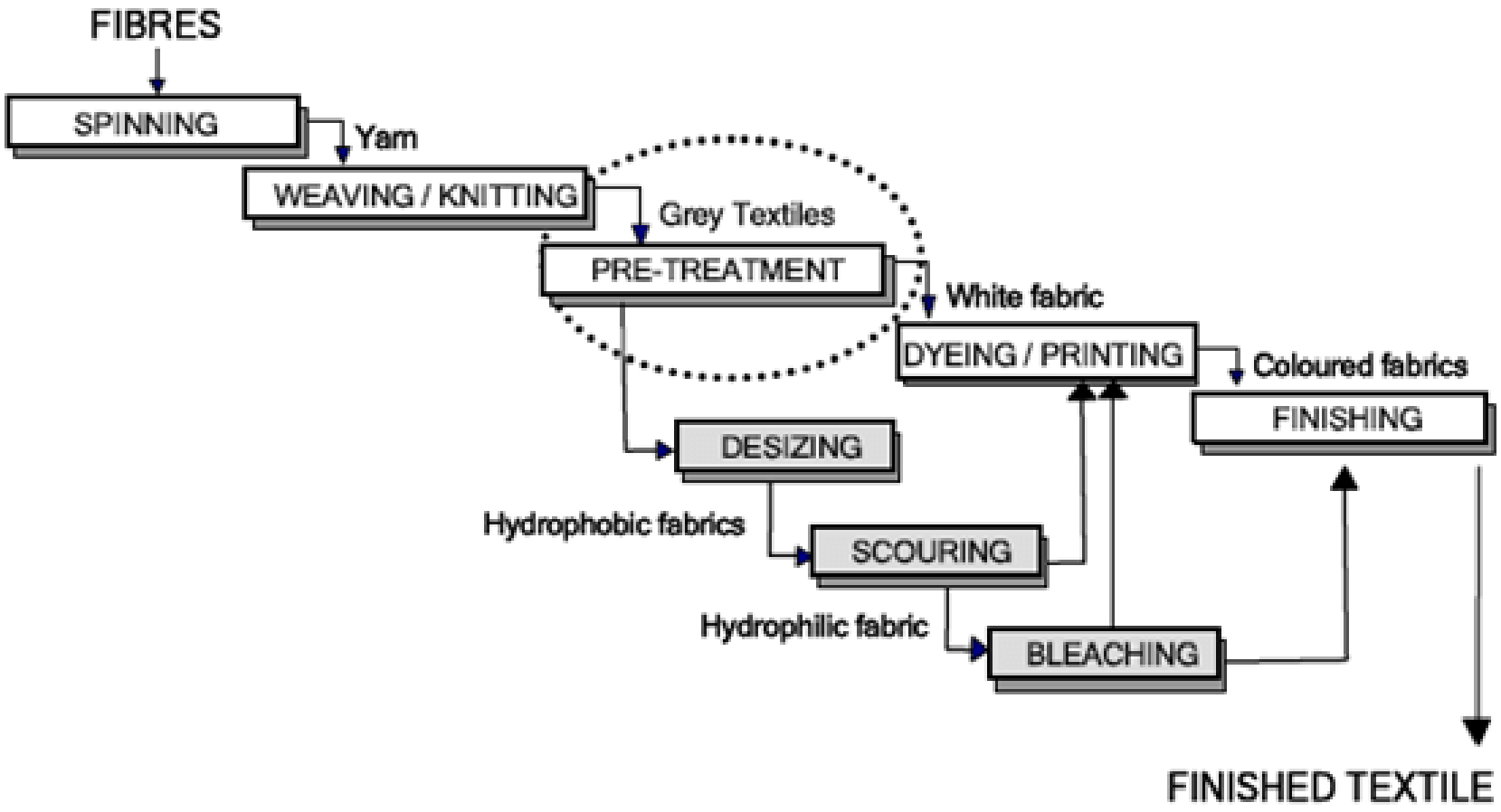
Chemicals inputs to wet processes

- **Sizing** Polyvinyl alcohol, Carboxymethyl Cellulose, Oils, Waxes, Adhesives, Urea, Diethylene glycol, etc
- **Desizing** Enzymes, Sulphuricacid, Detergents and Alkali
- **Scouring** Sodium hydroxide, Sodium Carbonate, surfactants, chlorinated solvents
- **Bleaching** Hypochlorite, hydrogen peroxide, acetic acid.
- **Mercerization** Sodium hydroxide, surfactants, acid, liquid ammonium
- **Dyeing** Dyestuffs, auxiliaries, reductants, oxidants
- **Printing** Dyes (acids or alkalis), pigments, kerosene, binders, ammonia, xylenes.
- **Chemical finishing** Formaldehyde, phosphorus, ammonia, silicone, fluorocarbon, resins, toluene, zircon salts etc.

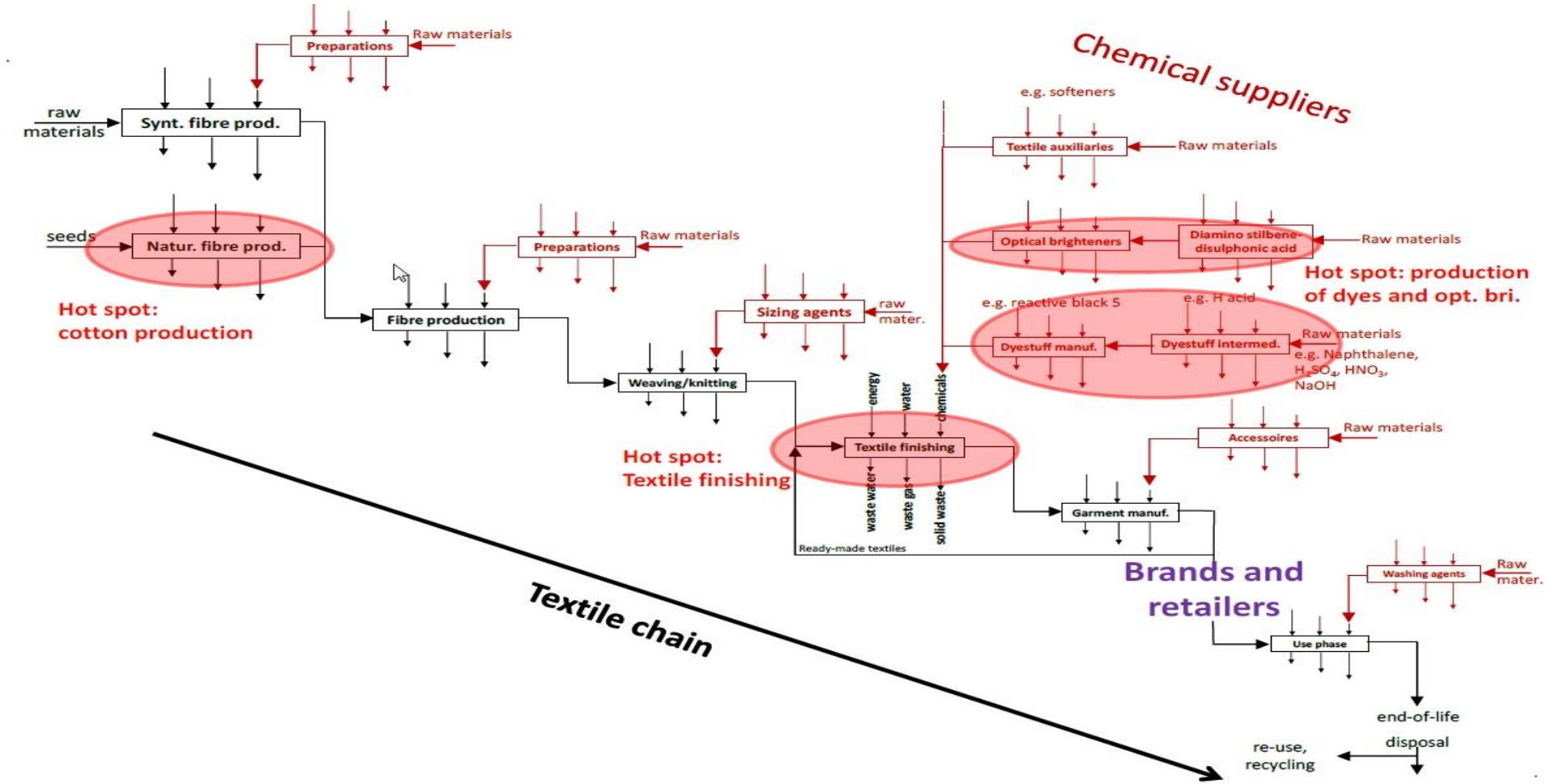
Chemicals Inputs to wet processes-example cotton



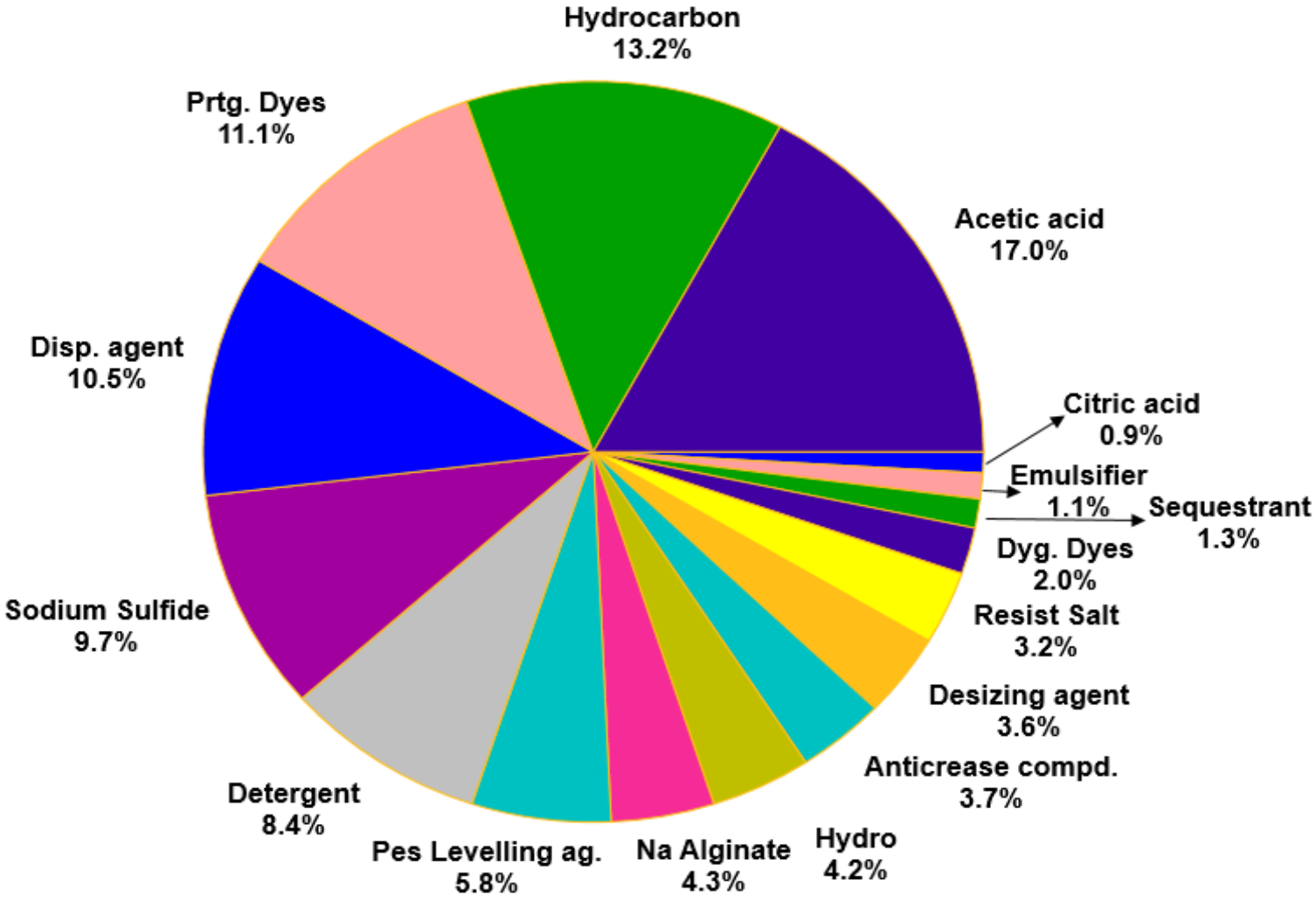
Wet-pretreatment process for the cotton textiles



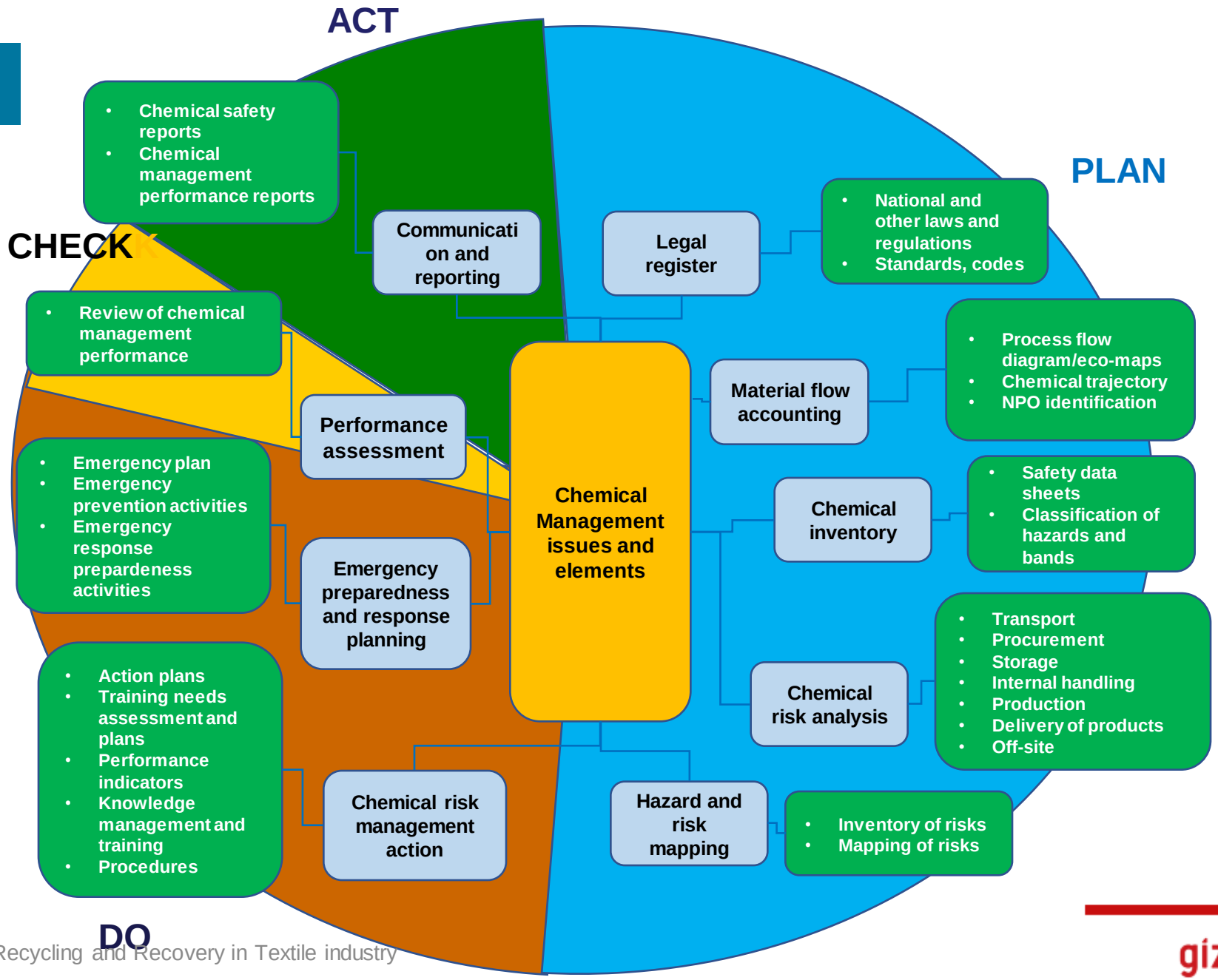
Hotspots in the textile chain



Typical Process Loads



Areas of attention



Conclusion


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

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