# TRAINING OF TRAINERS PROGRAMME ON CAPACITY DEVELOPMENT OF ETP OPERATORS

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

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

**Day 1: Presentation 4**

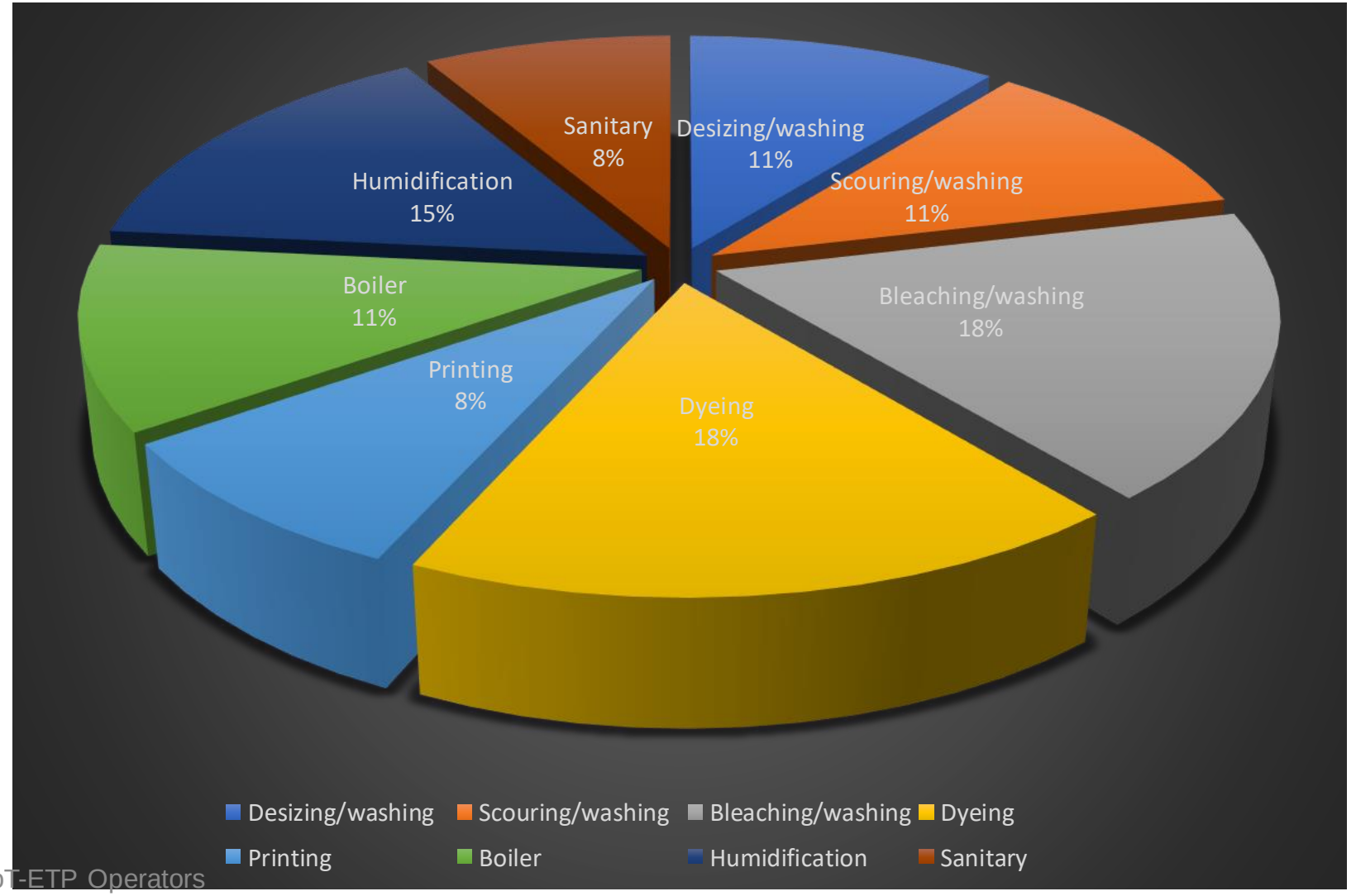
# Pollution in Textile Industry

# Contents

# Water consumption in textile processing

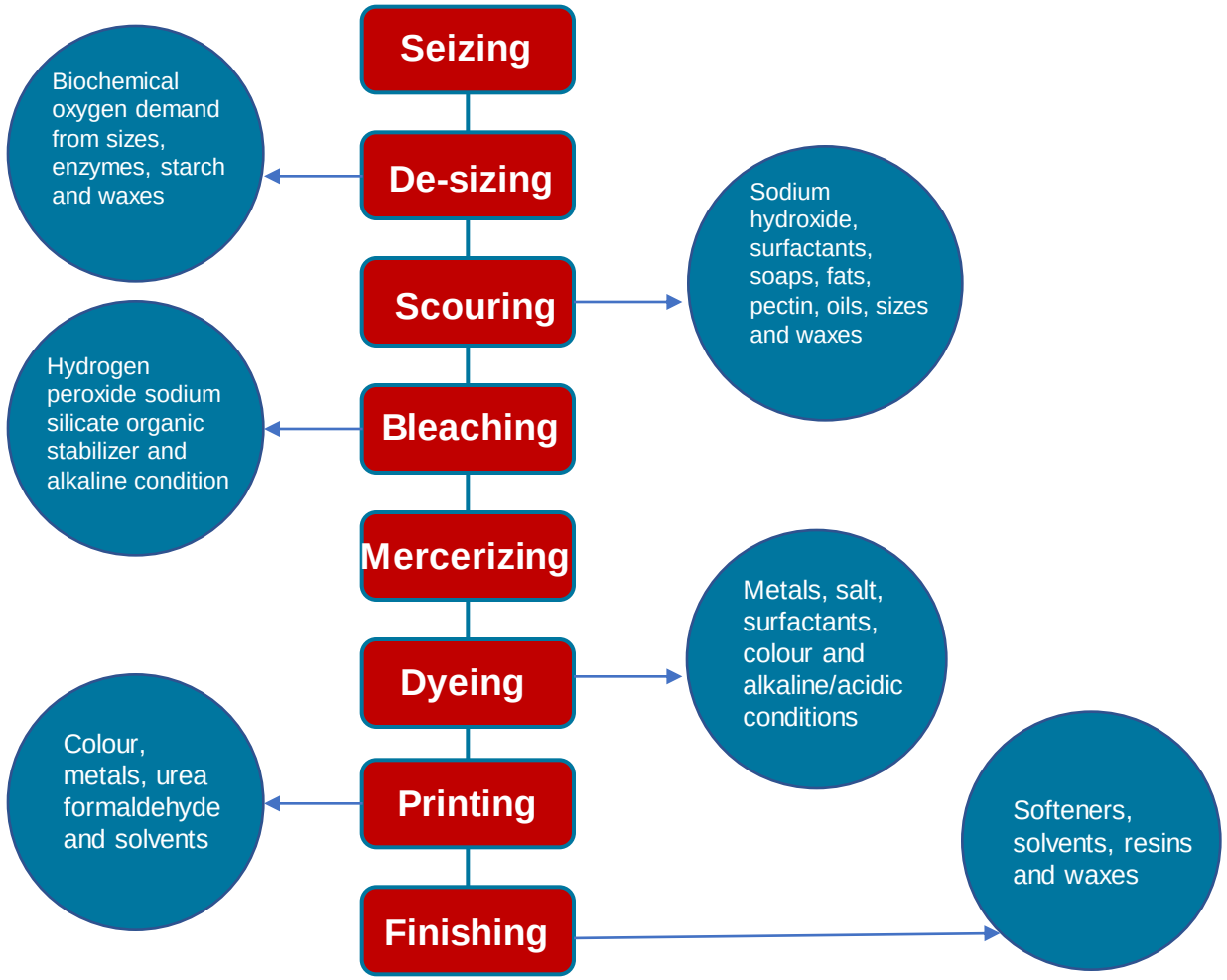
- Water consumption in the factory depends on the material processed (cotton, wool, Nylon, Rayon etc.).
- In Bangladesh, the normal water consumption varies from 90-160 litres per kg of material processed.
- Operations upto bleaching consumes about 40% of total water needed. Dyeing & printing another 25%.
- Boiler and humidification 25% and about 8% for sanitary applications. Most of these water comes out as effluent.

# Water consumption in textile processing



# Now, let us have a look at the effluent generated..

# Characteristics of effluent from textile processing



# QUIZ

**What are the pollutants in textile effluents?**

# Pollutants in textile effluent

- **Organic pollutants:** residues of organic material used both as raw material and process ingredients.
- **Salt:** Most chemicals used in textile processing contributes to salts.
- **Suspended particles:** mostly fine fibers and residues of chemicals.
- **Heavy metals & hazardous substances:** Normally present in dyeing & printing chemicals and discharged in these effluents.
- **Colour & temperature:** caused by the remnants of the dyes & printing agents. The operation is done at high temperature.

# Nature of pollutants in textile effluent - Inorganic

- Only small portion of chemicals used in manufacturing is consumed and most comes out in effluent.
- Alkalis, mineral acids, neutral salts (chlorides, sulphates, phosphates and silicates) and oxidizing agents like peroxides, chlorine and chlorine dioxide.
- Residuals of these chemicals mostly emerge as salts: direct salts or salts formed due to inter-reaction of alkali and acids,
- Other inorganic compounds in effluent include heavy metals in chemicals used in manufacturing.
- Major heavy metals : Copper, Chromium, Nickel, Zinc, Cadmium, Mercury, Antimony etc.

# Nature of Pollutant in textile effluent-Organics

## Medium organic load, but difficult to biodegrade

starch sizes, vegetable oils, fats and waxes, biodegradable surfactants, organic acids and reducing agents

## High Organic load, but difficult to degrade

dyes and fluorescent brighteners, fibres and polymeric impurities, polyacrylate sizes, synthetic polymer finishes and silicons

## Moderate to high organic load but readily degradable

wool grease, PVA sizes, starch ethers and esters, mineral oil (spin finish), surfactants, anionic /non-ionic softeners

## Low organic load but very difficult to degrade

formaldehyde, N-methylol reactants, chlorinated solvents and carriers, cationic retarding and softening agents, biocides, sequestering agents.

# Polluants in textile effluent: Colour & Odour

- Color not included in the Environment Conservation Rules specified by DoE, but it is an aesthetic issue
- Colour removal is generally difficult & often produces unwanted issues such as sludge to dispose.
- Textile effluent give foul smell if we keep it for some time. It is due to chemicals and due to degradation of organics and Sulphur containing compounds.
- Sulphur comes from sodium sulphate used in dying and some other Sulphur containing chemicals
- Sulphur degradation generates foul smelling (rotten egg smell) and poisonous hydrogen sulphide.

# For common man, pollution is just colour and smell!

# General pollutants in textile effluent - pH


- pH indicates how acidic or alkaline the wastewater is. pH is measure of hydrogen atoms present in the water.
- Pure water has pH 7 - neutral. pH below 7 is acidic and above 7 is alkaline.
- Different effluent streams from textile processing are either acidic or alkaline.
- Composite effluent from cotton processing is generally alkaline - large quantity of caustic soda used in the process.
- To operate our ETP is satisfactorily, we need to bring down the pH, preferably in the range of 7.5-8.5 to allow micro-organisms in ETP to strive.

# General pollutants in textile effluent - Suspended Solids

- Suspended solids in effluent is visible solid particles - will settle in the bottom if we keep the effluent for long time.
- Textile effluent contains suspended solids, generated from minute fiber particles, remnants of chemicals used..
- The SS, especially the not readily degradable ones, need to be removed before aeration tank.
- This is because they will retard the growth of micro-organisms and clog diffusers.
- SS will also settle in tanks and pipes and create blockages.

# Pollutants in textile effluent - Total dissolved Solids

- Total dissolved solids (TDS) contributed by salts used in production, mainly dyeing.
- TDS is also contributed by salt generated through inter-reactions of chemicals used (acid and alkali).
- TDS may include both organic & inorganic compounds, generally it refers to only inorganic (fixed) salts.
- Most important TDS contributors - sodium chloride and sodium sulphates used in dyeing process. Some chemicals like caustic soda & acid too reacts and produce salts.
- We may think: what is the big deal in having some harmless salt in the effluent? --- pollution due to salts are severe and long lasting, because unlike organics, inorganic salts does not get degraded over time.

# Pollutants in textile effluent - non heavy metal hazardous compounds

- Cotton processing uses many organic chemicals which can also be hazardous.
- They include formaldehyde, N-methylol reactants, azodyes, chlorinated solvents and carriers, cationic retarding and softening agents, biocides (pentachlorophenol, organometal complexes, insecticides), sequestering agents (EDTA, NTA)
- Remnants of these chemicals are discharged along with the effluent and enters the ETP.
- Many of these compounds are also carcinogenic, i.e., cancer causing material when enters the human body.

# QUIZ

**What is the problem if the discharged effluent contains high BOD?**

# Detrimental effects of pollutants : BOD

- Biochemical Oxygen Demand (BOD) is measure of bio-degradable organics in effluent.
- BOD is equal to oxygen consumed when organics in the effluent is degraded by micro-organisms.
- BOD is calculated by measuring oxygen consumed after 5 days at $20^0$ C or 3 days in ambient temp.

# Detrimental effects of pollutants : BOD

- Biodegradable organics in effluent is harmful. When BOD rich effluent joins water body, it reduces dissolved oxygen - essential for fish and aquatic life. If BOD is very high such discharge into river can cause death of fishes.
- BOD is also problematic due to its potential to degrade anaerobically when stagnated causing foul odour.
- Largest source of BOD in textile effluent is desizing effluents. Other streams too contribute to it.

# General pollutants in textile effluent - organics: BOD

# Detrimental effects of pollutants : COD

- Chemical Oxygen Demand (COD) is a measure of oxygen consumed by both organic and some inorganic compounds.
- COD include bio-degradable organics & will be higher than BOD.
- Like BOD, COD is harmful to environment because of its capability to reduce dissolved oxygen in receiving water body.

# Detrimental effects of pollutants : COD

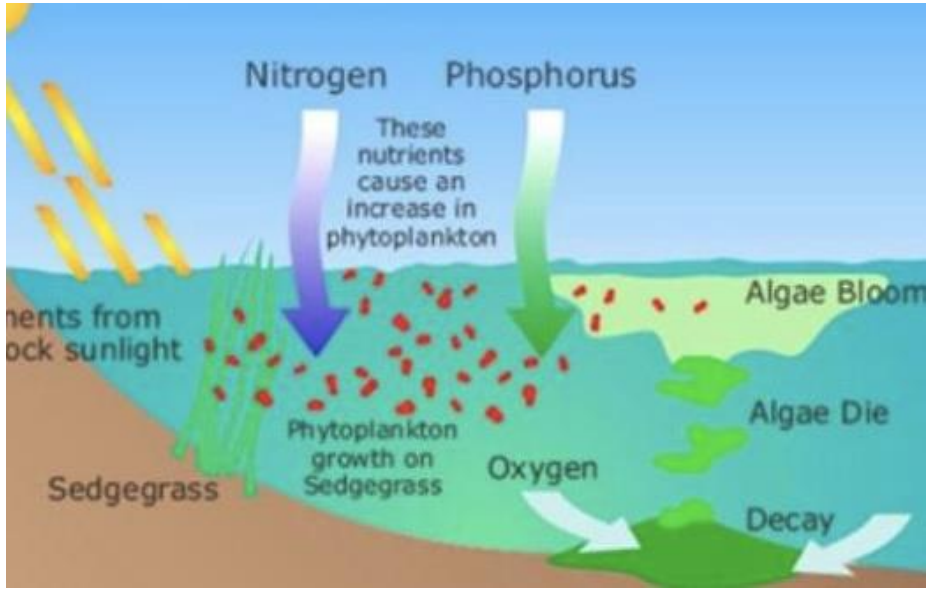
- COD is measured by oxidizing a measured quantity of effluent and then measuring oxygen consumed through chemical analysis.
- Almost all effluent streams in textile effluent contributes COD - more by desizing, scouring and dyeing effluents.
- Unlike BOD tests which need 5 days (3 days minimum), COD tests can be done in 2 hours and is more accurate. Hence more operators take COD as the control parameter for ETP.

# General pollutants in textile effluent - COD

# Impact of pollutants in textile effluent - Nutrients

- Nutrients present in the textile effluent are Phosphorous & Nitrogen. Nutrients are also added in the ETP to facilitate biological treatment.
- Excess nutrients in effluent when reaches a water body create a problem called eutrophication.
- Eutrophication occurs when these nutrients produce excess algae,
- Excessive algae growth reduce light penetration & the lack of light stops photosynthesis making algae die in large quantity.
- Due to this all dissolved oxygen in the water is consumed by the decaying algae.
- Then fish & other aquatic life dies due to shortage of oxygen.

# General pollutants in textile effluent - Nutrients




# Impact of pollutants - heavy metals & hazardous compounds

- The colouring processes (dyeing and printing) uses chemicals containing heavy metals to impart the required colour.
- Almost all of these metals are discharged along with the effluent.
- Chemical precipitation in the ETP (primary ETP) removes a part of these metals which ends up in sludge.
- Due to the presence of these metals, the sludge from ETP is considered hazardous by most environmental protection agencies.
- Biological treatment does not remove heavy metals in effluent.
- So, in the first case part of the heavy metals end up in the sludge whereas in the second, it flows out along with the treated effluent.

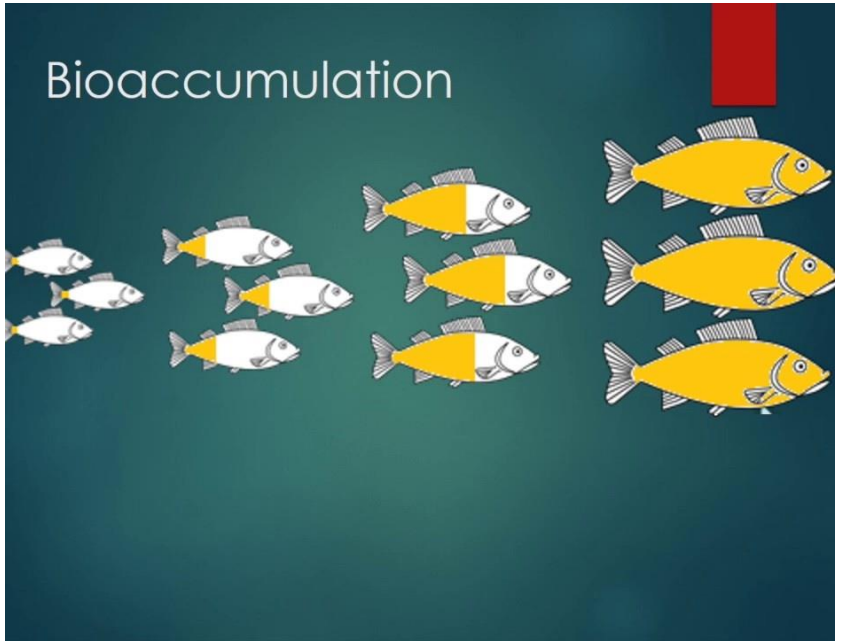
# Pollutants in textile effluent - heavy metals

The following metals are listed in the national environmental quality standards for industrial wastewater and sludge :

- Cadmium
- Chromium
- Manganese
- Copper
- Iron
- Lead
- Mercury
- Boron
- Nickel
- Selenium and
- Zinc.

Heavy metals can be toxic to humans, plants, fish and other aquatic life. They are capable of bio-accumulating in fishes and then reach humans in higher quantities.

# Bioaccumulation of heavy metals & hazardous compounds



# Pollutants in textile effluent - High Temperature


- Many of the processes in the cotton processing such as scouring, bleaching & dyeing is done at high temperature.
- The composite raw effluent comes out at a high temperature (often > $60^0$C). Hot water creates thermal pollution.
- Dissolution of oxygen in water is dependent on temperature of water. Higher the temperature, lower the solubility of oxygen.
- If the hot water joins a water body, the dissolved oxygen in that water falls drastically and kills aquatic life.
- Also, high temperature (i.e, say **>$40^0$C) affects activity of micro-organisms.** Hence cooling towers are often used in ETP after equalization to ensure effectiveness in all-biological ETPs.

# QUIZ

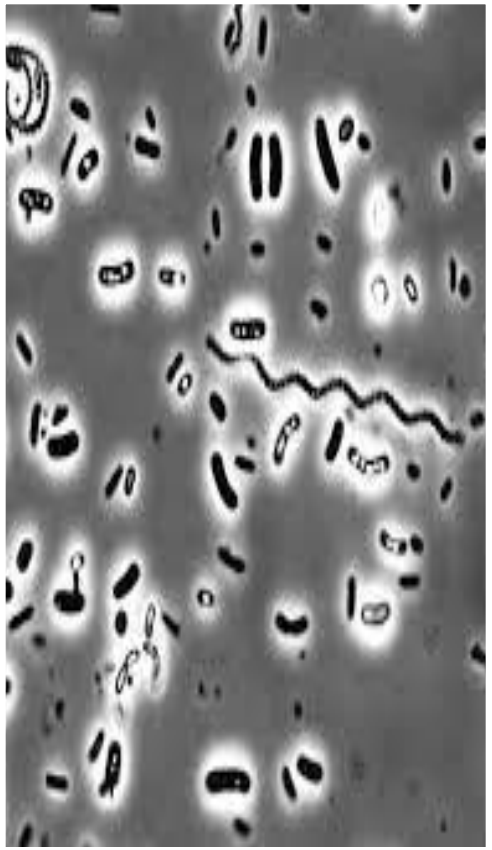
**Can there be a problem if the treated effluent has high salts?**

# Pollutants in textile effluent - Total dissolved Solids

- Most international environmental standards fix upper limit of TDS as 2100 mg/l in treated effluent, 1000 mg/l for chloride (600 mg/l if discharge s into land) and 1000 mg/l for sulphate.
- For marine discharge, TDS limit is normally not insisted upon.
- High TDS in water makes it unfit for drinking. The desirable limit of TDS in domestic water is less than 500 mg/l.
- Sodium salts increases blood pressure and high salt level contributes to many health issues including kidney damages.
- Salt rich water is also unsuitable for construction.
- High TDS in water is also detrimental to vegetation. Many crops & plants can have stunted growth and lower yield.

# High salt concentration cause stunted growth of vegetation

# Effect of Pollutants - non heavy metal hazardous compounds



- Being less biodegradable, these organic compounds do not show much BOD, but show COD or Total organic carbon readings.
- Due to the above reason, they are not easily removed in biological treatment.
- But if the ETP operator succeeds to maintain a steady level of these compounds in effluent and keep a high MLSS in aeration, the bacteria which can degrade these would form naturally and removes these toxic organics.
- This process involves ‘acclimatization’ of bacteria with these organic compounds, *persuading* the bacteria to ‘eat’ it though it is not a favourite food for them.

# Conclusion


- It is very evident that textile effluents are high in almost all kinds of pollution parameters.
- The effluent is rich in pollutants such as colour, odour, organics, heavy metals, inorganic salts, toxic compounds…..etc.
- Hitherto the focus of effluent treatment was mostly limited to removal of colour and treat the organics.
- Issue of heavy metals, hazardous compounds and salt is getting more attention of late.
- Control of these pollutants need a comprehensive approach and more information on adverse impacts.

**Deutsche Gesellschaft für**
**Internationale Zusammenarbeit (GIZ) GmbH**

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60 - 0
F +49 228 44 60 - 17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Germany
T +49 61 96 79 - 0
F +49 61 96 79 - 11 15

E info@giz.de
I www.giz.de

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH