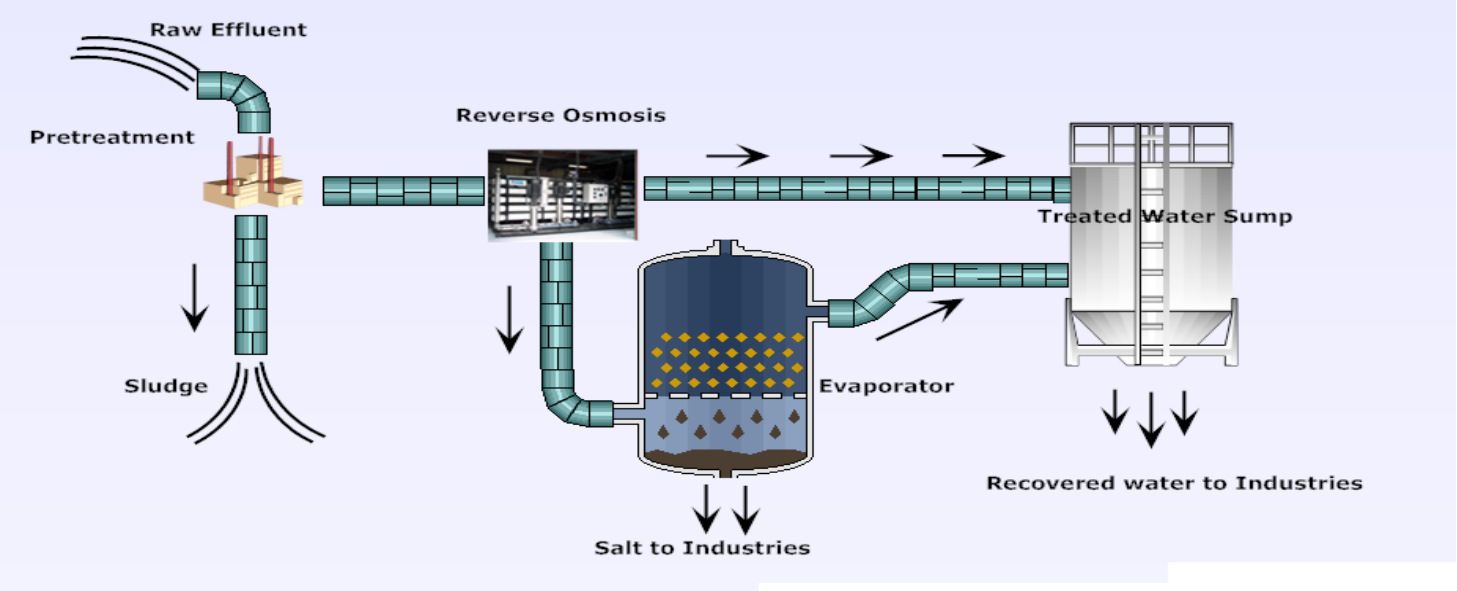
TECHNO-ECONOMIC CHALLENGES OF ZERO LIQUID DISCHARGE (ZLD) IN TEXTILE INDUSTRIES



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OVERVIEW

- TEXTILE INDUSTRY IN INDIA
- ISSUES IN TEXTILE INDUSTRY & ZLD
- INITIATIVES OF REGULATORY DIRECTIONS & NEW STANDARDS
- STUDIES OF CPCB/CHALLENGES
- WAY AHEAD

PART A

TEXTILE INDUSTRY IN INDIA

TEXTILE INDUSTRY IN INDIA

- **Installed capacity: 43.13 million spindles & 52,000 looms**
- **Woven cloth production/annum: 88,745 lakhs meters**
- **Knitted cloth production/annum: 3,40,100 tonnes**
- **Earns 27% Foreign Exchange**
- **14% Total Industrial Production**
- **4% of GDP**
- **35 Million workers**
- **21% Total Employment generation**
- **Skilled man power, Large domestic market**
- **Second largest producer of textiles and cotton after China**

Source: Census of Textile Power Processing, Ministry of Textiles, Government of India, Annual Report, Ministry of Textiles (2012-13)

Process based characteristics of Effluent

Process	Effluent composition	Nature
Sizing	Starch, waxes, carboxymethyl cellulose (CMC), Polyvinyl alcohol (PVA), wetting agents.	High in BOD, COD
Desizing	Starch, CMC, PVA, fats, waxes, pectins	High in BOD, COD, SS, dissolved solids (DS)
Bleaching	Sodium hypochlorite, Cl2, NaOH, H2O2, acids, surfactants, NaSiO3, sodium phosphate, short cotton fibre	High alkalinity, high SS
Mercerizing	Sodium hydroxide, cotton wax	High pH and DS, low COD
Dyeing	Dyestuffs urea, reducing agents, oxidizing agents, Acetic acid, detergents, wetting agents.	Strongly colored, high BOD, DS, low SS, heavy metals
Printing	Pastes,urea,starches,gums,oils,binders,acids , Thickeners, cross-linkers, reducing agents, alkali.	Highly colored, high BOD, oily appearance, SS slightly alkaline, low BOD

Textile – Typical waste water characteristics

Constituents	Values (mg/l expt pH)
pH	9-12
TDS	1000 – 7500
Suspended solids	300 – 1000
BOD	250 - 700
COD	400 – 1600
Chlorides	420 – 2500
Total Chromium (as Cr)	4.5
Zinc	0.8-1
Oils and grease	15 -20
Colour – Hazen units	100 - 1500
Temperature	35 -50^{o} C

Textile processing – Water consumption

- **Water consumption for 1 case (100 Kg) of cloth**

  - Sizing – 8000 to 9000 L
  - Desizing – 10000 to 11000 L
  - Kier boiling – 10000 to 11000 L
  - Bleaching – 6000 to 8000 L
  - Mercerizing – 8000 to 9000 L
  - Dyeing – 12000 to 13000 L

References: *– Industrial effluents – origin, Characteristics, Effects by N. Manivasakam, Sakthi Publications, Coimbatore.*

PART B

ISSUES IN TEXTILE INDUSTRY & ZLD

ISSUES RELATING TO TEXTILE INDUSTRY

- **Colour in effluents**

  Colour is not easily removed by conventional treatment processes like biological treatment process.

- **Dissolved solids in effluents**

  Textile industry use large quantity of salts in dyeing operation, which increase TDS content in effluents.

- **Solid waste disposal**

  Effluent treatment process sludge to the tune of 0.60- 1.20 kg/m3 of effluent. Its disposal is a problem for textile industry.

- **Remediation of degraded land**

  Due to discharge of polluted water on land several hectares of land has been degraded at Tirupur, Pali etc. Remediation of such land is an issue.

- **Concept of Zero Liquid Discharge**

WHAT IS ZERO LIQUID DISCHARGE ?

- Installation of facilities and system to enable industrial effluent for absolute recycling of permeate and converting solute (dissolved organic and in-organic compounds/salts) into residue in the solid form by adopting method of concentration and thermal evaporation.

- **ZLD will work based on two broad parameters:**

  a) Water consumption versus waste water re-used or recycled (permeate).

  b) Corresponding solids recovered (percent total dissolved / suspended solids in effluents).

ZERO LIQUID DISCHARGE SYSTEM

I. Primary & Secondary treatment system

Raw effluent is subjected to primary treatment for removal of colour and to reduce BOD/COD by physio-chemical treatment followed by biological treatment or direct biological treatment or direct chlorination treatment.

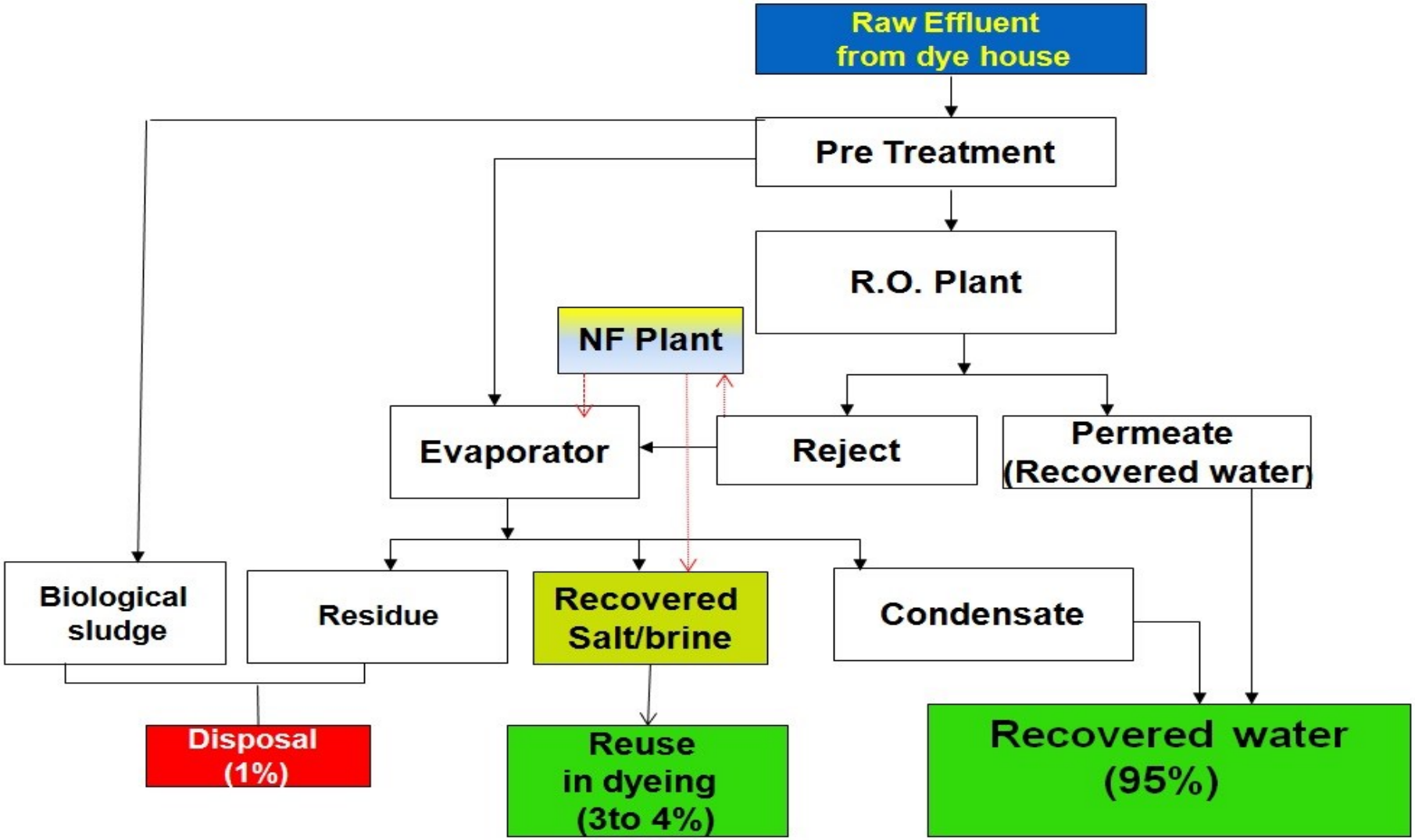
II. Reverse osmosis treatment system

Water recovery through RO treatment.

III. RO reject management system

Recovery of brine solution from NF treatment (or) recovery of salt and water from evaporators/ solar evaporation systems.

ZLD TREATMENT CONCEPT



O & M CHALLENGES IN ZLD

- Providing appropriate pretreatment for increasing the membrane life.
- Maximize renovated water recovery (permeate)
- Recovery of salt for reuse
- Minimize the quantity of rejects and minimize the O&M of reject management
- Disposal of mixed salt.
- High Operating cost and financial impact on the industry and its Regional/ National/Global competitiveness.

PART C

Initiatives of Regulatory authorities/ Directions/ New Standards

Process of Revision of Standards & ZLD

- Standards for the discharge of effluents : Environment (Protection) Rules, 1986.
- A comprehensive Industry Document on Textile : CPCB during 2000.
- Three separate standards earlier: in Schedule-I of E(P)A Rules, 1986.
- Due to major environment degradation, following court intervention & Ganga Rejuvenation: ZLD concept introduced.
- Sector specific action plan, Ganga Rejuvenation
- Ensure water conservation, ZLD in industries having discharge > 25KLD the Directions under Section 18(1)(b) of Water Act, 1974 to Nine Ganga Basin states on February 24, 2015; dated April 24, 2015 and July 16, 2015.

Contd…

- Sectoral meetings in : Haryana (Panipat & Barhi) and U.P (Roomapur, Farrukhabad, Badohi, Tronica City & Mathura) and at CPCB
- Draft standards prepared & notified for public comments in October, 2015.
- Around 60 comments from various stakeholders (26 in favour of proposed standards).
- Stakeholders meeting on Feb 9 2016 at MoEF&CC to discuss draft notification.
- Based on input & discussions: ZLD concept was revised.
- Revised draft standards: Approval of Expert Committee on 10.05.2016 .
- New standard notified on 10-10-2016

New standards

S No	Industry	Parameter	Standard (applicable for all modes of disposal*)
1	2	3	4
6(A)	All Integrated textile units, units of Cotton / Woollen / Carpets / Polyester, Units having Printing / Dyeing / Bleaching process or manufacturing and Garment units.	TREATED EFFLUENTS	Max. concentration values in mg/l except for pH, colour, and SAR
		pH	5.5 to 8.5
		Suspended solids	100
		Colour, P.C.U (Platinum Cobalt units)	150
		Bio-Chemical Oxygen Demand[3days at $27^{o}C$](BOD_3)	30
		Oil and Grease	10
		Chemical Oxygen Demand (COD)	250
		Total Chromium as (Cr)	2.0
		Sulphide (as S)	2.0
		Phenolic Compounds (as C_6H_5OH)	1.0
		Total Dissolved Solids , Inorganic (TDS)	2100**
		Sodium Absorption Ratio (SAR)	26**
		Ammonical Nitrogen (as N)	50

NOTES:

1. *In case of direct disposal into rivers and lakes, the Central Pollution Control Board (CPCB) or State Pollution Control Boards / Pollution Control Committees (SPCBs / PCCs) may specify more stringent standards depending upon the quality of the recipient system.
2. **Standards for TDS and SAR shall not be applicable in case of marine disposal through proper marine outfall.
3. The treated effluent shall be allowed to be discharged in the ambient environment only after exhausting options for reuse in industrial process / irrigation in order to minimise freshwater usage.
4. Any textile unit attached with the Common Effluent Treatment Plant (CETP) shall achieve the inlet and treated effluent quality standards as specified in serial number 55 of Schedule-I to the Environment (Protection) Rules, 1986 and shall also be jointly and severally responsible for ensuring compliance.
5. The standalone Micro, Small and Medium Enterprises (MSMEs) as per the MSME Development Act, 2006 shall meet the values specified above.
6. The standalone large scale units shall meet the values specified above; however, CPCB or SPCBs / PCCs with the approval of CPCB, may mandate Zero Liquid Discharge in Large scale units in environmentally sensitive / critical areas.
7. The TDS value with respect to treated effluent shall be 2100 milligramme per litre; however, in case where TDS in intake water is above 1100 milligramme per litre, a maximum contribution up to 1000 milligramme per litre shall be permitted provided the maximum value of 3100 milligramme per litre is not exceeded in the treated effluent."

(b) serial numbers 7 and 92 and the entries relating thereto, shall be omitted;

PART D

Studies of CPCB / Challenges

GUIDANCE FOR INDUSTRIES/ CETPS FOR EMPLOYING SUITABLE TECHNOLOGIES FOR ZLD IN TEXTILE INDUSTRY

Most of textile CETPs having three stages of treatment system:

- **Primary Treatment followed by Secondary treatment**
- **Reverse Osmosis system**
- **Reject Management system**

For organic load reduction, water recovery, and salt recovery:

- **Type I: Treated Brine reuse Technology with Sodium Sulphate Recovery (applicable for those CETPs whose member dyeing units have switched over to using sodium sulphate for dyeing).**
- **Type II: Use of Nano-Filtration membranes for purification and reuse of brine (applicable for Chloride based dyeing units).**
- **Type III: Use of thermal evaporation and crystallization of sodium sulphate salt.**
- **Type IV: Use of MBR system to treat textile dyeing effluent.**
- **Type V: Segregation of Dye bath and Wash water stream.**

CHALLENGES

- Very high evaporation costs (highly energy intensive 20-40 kWh/m^3 as against 2-4 kWh/m^3 for desalination).

- Technical limitations in evaporating mixed salts, which is typical for such industrial wastewaters due to problems in crystallization.

- The mixed salt is contaminated due to concentration of pollutants in R.O rejects and even further during the Evaporation process. The mixed salts are unfit for reuse and create a serious storage and disposal issue. Typical contaminants which make it unfit for reuse are purity of salts, colour, organics (COD), nutrients, silica, heavy metals, hardness caused by calcium and Magnesium salts etc. The salt cake in most cases cannot be disposed off to landfills and require hazardous waste disposal facilities.
- Corrosion and scaling of the evaporators resulting reduced life and efficiency.
- Frequent interruptions and downtime affect processing capacity.

Industries concern

- Blanket ZLD is not feasible for Textile sector as it is very costly. Capital cost of one MLD plant is estimated to be Rs. 15-18 crores without cost of land and captive power plant.
- Land requirement for installation of ZLD system is 1.5 Acre/ MLD.
- Total Dissolved Solids (TDS) standard may not be prescribed.
- RO reject management will be an issue of concern after implementation of ZLD. In one MLD plant 6-7 Tonne of mixed salt will be generated out of which 4-5Tonne of salt will be recovered for use but 1.5-2 Tonne of mixed salt shall have disposal problems.
- Not feasible for individual Micro, Small & Medium Enterprises (MSME) due to high cost involved.
- Policy is not acceptable as it makes industry non-viable in global competition.
- Marine disposal option may be considered.
- Subsidy should be given to individual Textile units to install ZLD system.
- Responsibility of establishing CETP should be of State development corporations on PPP Model.

FINANCIAL IMPACT OF ZLD FOR A TYPICAL TEXTILE INDUSTRY

S.No	Item Description	Value
1	Capacity of the CETP (cu.m/day)	5,500
2	Water consumption for dyeing (Litres/Kg)	50
3	Total Production capacity (Tons /Day)	110
4	Processing cost of dyed fabric (Rs/Kg)	90
5	Processing Cost (Rs.Laksh/day)	99
6	Cost of ZLD system @ Rs. 96 net for 5.5 MLD (Rs. Lac/day)	5.27
7	Cost of ZLD for dyed fabric Rs. /Kg	4.79
8	% of ZLD cost on Processing cost of dyed fabric	5%

Source: TWIC

PART E

INNOVOTIVE AND NEW TECHNOLOGIES

(way ahead)

WAY AHEAD

- Proper pre-treatment before thermal evaporation
- Segregation of chloride and Sulphate salts
- Lower brine volumes for evaporation using high pressure membranes.
- Technologies like Membranes Distillation, Forward Osmosis, Algae based Biotechnology & Closed Mist Evaporation Technology
- R & D

THANK YOU