

Experiences in implementation of ZLD for the Tirupur Textile dyeing cluster -challenges, achievements and way forward



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Concept of ZLD

- ZLD – meaning zero discharge of wastewater from Industries.
- A ZLD system involves a range of advanced wastewater treatment technologies to recycle, recovery and re-use of the 'treated' wastewater and thereby ensure there is no discharge of wastewater to the environment.
- A typical ZLD system comprises of the following components:
  - Pre-treatment *(Primary Secondary and Tertiary treatment)*
  - Reverse Osmosis
  - Evaporator & Crystallizer
- Land application & Deep well disposal of treated effluent is not permitted (Tamilnadu). Land irrigation with effluent a failure.
- ZLD based on directions from the Courts and the SPCB.
- No national level standards formulated for ZLD as yet.

Need for ZLD…1

- **MAIN MOTIVATORS-**

1. **Water Scarcity,**
2. **water economics,**
3. **Pollution & regulatory pressure.**

Need for ZLD…1/4

- **Water Scarcity**

1. Several states in India including Tamilnadu are water stressed.
2. 54% of India faces High to extremely high water stress and 54% of ground water wells are decreasing– WRI.
3. No ground water for irrigation by 2025 in Delhi, Rajasthan and Haryana.
4. India No.1 in Annual Ground water extraction at 251 cu.Km as against 112 cu.km in China and USA, a distant second- UNESCO Report.
5. Competing demands for water from agriculture and domestic use has limited industrial growth.
6. TN has taken a lead on ZLD due to absence of fully flowing Perennial River. Most rivers originate from neighboring states and water sharing is enmeshed in disputes.

Need for ZLD …2/4

Pollution issues & Regulatory pressure

1. Industrial Effluents with high salinity/TDS- polluting industries such as Pharma, Pulp& Paper, Tanneries, Textile Dyeing, Chemicals , Power Plants etc.
2. The TDS content is well above the statutory limit of 2100 mg/l.
3. Draft ZLD notification dropped by MoEF but the revised notification speaks of exhausting recycling and reuse options.
4. Conventional 'Physico-chemical-biological' treatment does not remove salinity in the treated effluent.
5. Discharge of saline but treated wastewater pollutes ground and surface waters.

Need for ZLD …3/4

Pollution issues & Regulatory pressure..2

6. 189 CETPs in the country and non-compliance is a major issue. No incentives for treatment for CETP/ STP/ETP. Recovery and reuse of water is seen to be major incentive.
7. Most rivers in the country are polluted.
8. Several landmark pollution cases and court battles -Vellore and Tirupur court cases.
9. NGT actively perusing pollution cases and prohibiting discharge to rivers.
10. Poor experience with marine discharge and effluent channels polluting enroute and the sea, affecting coastal communities are also known.
11. ZLD is easy to monitor for compliance, any discharge from the factory 24 x7 means non-compliant.

Need for ZLD …4/4

Water Economics

1. Indiscriminate withdrawal of ground water 'free of cost' in most parts of the country. Water priced low in many parts.
2. However, cost of fresh water for Industry is rising due to scarcity, Tirupur it is Rs.78/m3, Vellore –Rs.50/m3, Pali- Rs. 100/m3.
3. Location of industries in 'Inland areas' therefore marine discharge may not feasible. Cost of marine discharge increases with distance from shore and if the cost of fresh water is high (say Rs. 50/m3) then beyond 20 KM distance, ZLD becomes competitive.
4. More states such as Andhra, Telangana, Rajasthan, and Karnataka are also now enforcing ZLD in many cases.
5. Internationally ZLD is gaining prominence – China, Ethiopia Bangladesh, USA, Germany etc.

Benefits of ZLD

1. Installing **ZLD** technology is beneficial for the plant's water management; encouraging close monitoring of water usage, avoiding wastage and promotes recycling by conventional and far less expensive solutions.
2. High operating costs can be justified by high recovery of water (>90-95%) and recovering of several by products from the salt.
3. A more sustainable growth of the industry while meeting most stringent regulatory norms.
4. Reduction in water demand from the Industry, frees up water for Agriculture and Domestic demands.
5. With ZLD the industry can be located in barren and low water potential or low water quality areas.
6. Industrial Production is not affected even during drought years.

Barriers / Challenges in ZLD

1. ZLD results in generation of hazardous solid wastes creating disposal challenges- need to think of Zero Waste Disposal (ZWD) Plants. Generate products/ by-products out of the waste.
2. Economic viability- cost and availability of water, regulatory pressure are the real driving force.
3. High Carbon foot print- is this environmentally sustainable?
4. High Operating cost and financial impact on the industry and its Regional/ National/Global competitiveness.
5. Technology shortcomings.



Section B- Brief experience with ZLD in Textile CETPs in Tirupur



Textile Dyeing CETPs in Tirupur

- 18 CETPs established based on ZLD.
- Most CETPs are based in treated brine reuse technology and Sodium Sulfate salt crystallization and reuse.
- Design Capacities range from 1.5 MLD to 12 MLD.
- Currently operating at 30 -90% capacity (average 50%).
- 95-98% recovery of water and 80% recovery of salt.
- Operating costs at Rs. 200-225 Rs/m3. Expected to go down to Rs. 180/m3 with further project modifications.
- Net operating cost after salt and water recovery at ~ Rs. 100-150 per m3.
- Financial Impact: 5 to 6% on production cost. Rs. 4 to Rs. 5 per Kg of dyed fabric.

Tirupur Video

https://www.youtube.com/watch?v=rv7Zt0mSlzw&feature=youtu.be

Technology Challenges..1

- Thermal Evaporation of RO concentrated brine (MVR & MEE)
  - Energy guzzling
  - High Operating Costs (Rs. 450- Rs. 600 per M3).
  - Contributes to ~50% of Opex of a ZLD Plant.
  - Scaling & Corrosion.
  - Frequent Down Time.

Fig (Top) MVR brine concentrators

Fig (Bottom): MEE type Evaporators & Crystallizers

Alternative to Thermal Evaporation of RO concentrated brine (MVR & MEE)

- Implemented Treated Brine Reuse Technology- use of liquid brine instead of crystallized salt.
- Treated brine piped to member units.
- Low volume of excess Brine only sent to MVR & MEE reducing costs & other issues.

Fig (Top): Brine before and after treatment

Fig (Bottom): Fabric dyed using treated brine vs. Fresh salt

Technology Challenges…2

- **Disposal of Waste Mixed Salt**

1. 80% salt recovered in the wastewater. High quality (98-99% purity, Nil Hardness). Reused in the dyeing process. No fresh salt required.
2. The remaining salt (20%) is waste mixed salt with contaminants and is being stored (1.5 to 2 tons per MLD).

Fig 1: Waste Salt storage yard

Fig2 : Heaps of waste salt at CETP

Zero Waste Salt Technology

1. ZLD – ZWS Technology :- Improved brine reuse technology with NF, Membrane Distillation (MD) based on Solar thermal energy for Zero Liquid Discharge (ZLD) with Zero Waste Salt (ZWS) generation.
2. Sodium Chloride and Sodium Sulphate recovered.
3. Technology developed to achieve zero waste salt, plant under erection in one CETP.
4. Pilot trials to recover pure salt from accumulated waste salt is also under way for sale to detergent industry.

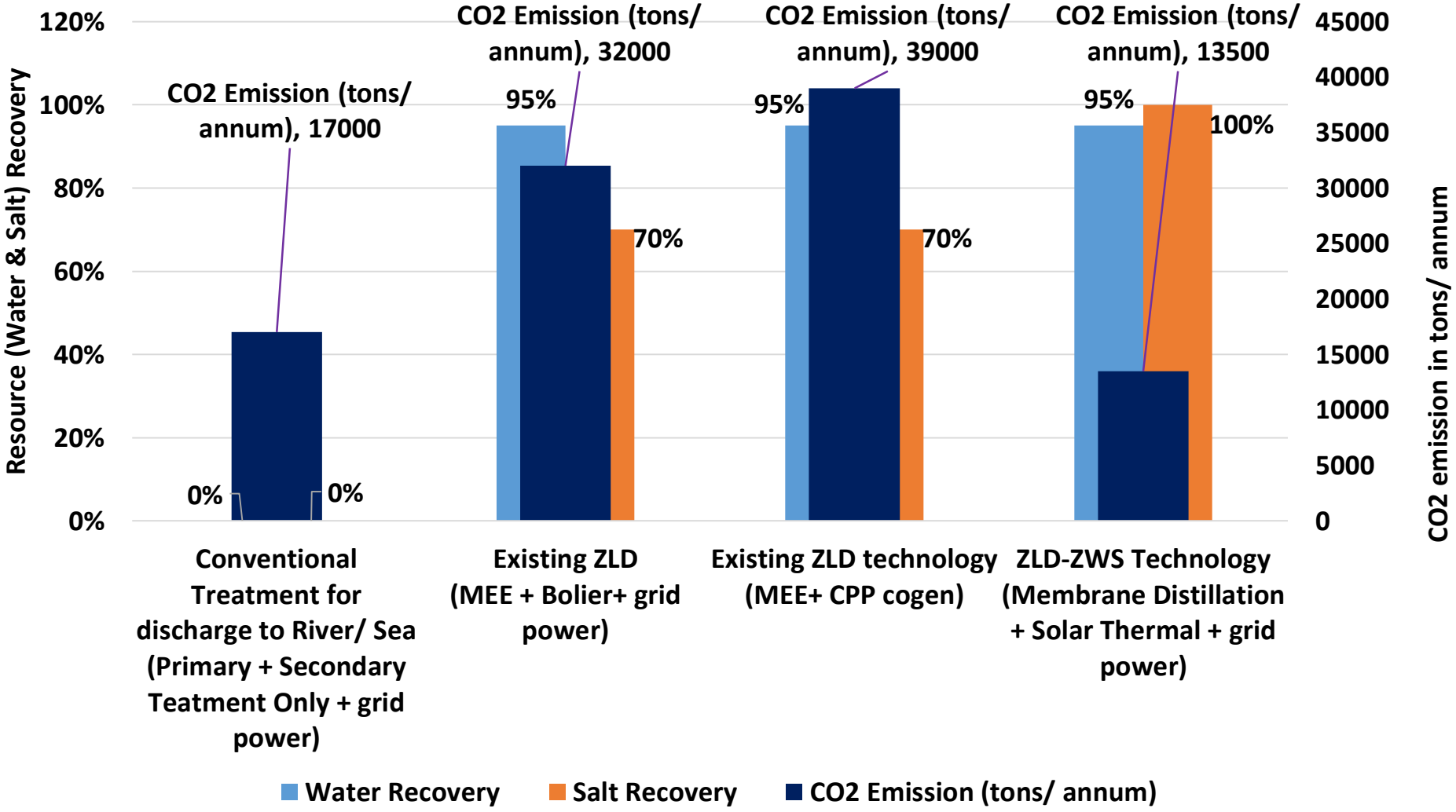
Energy costs and High Carbon Foot print – use of alternative energy source

- Existing systems: Grid Power + Boiler
- Alternative 1: Captive Power Plant with Cogen.
- Alternative 2: Membrane Distillation instead of MEE and use of solar thermal systems.

Fig 1: PTR- Parabolic Trough Reflector

Fig: Membrane Distillation pilot unit

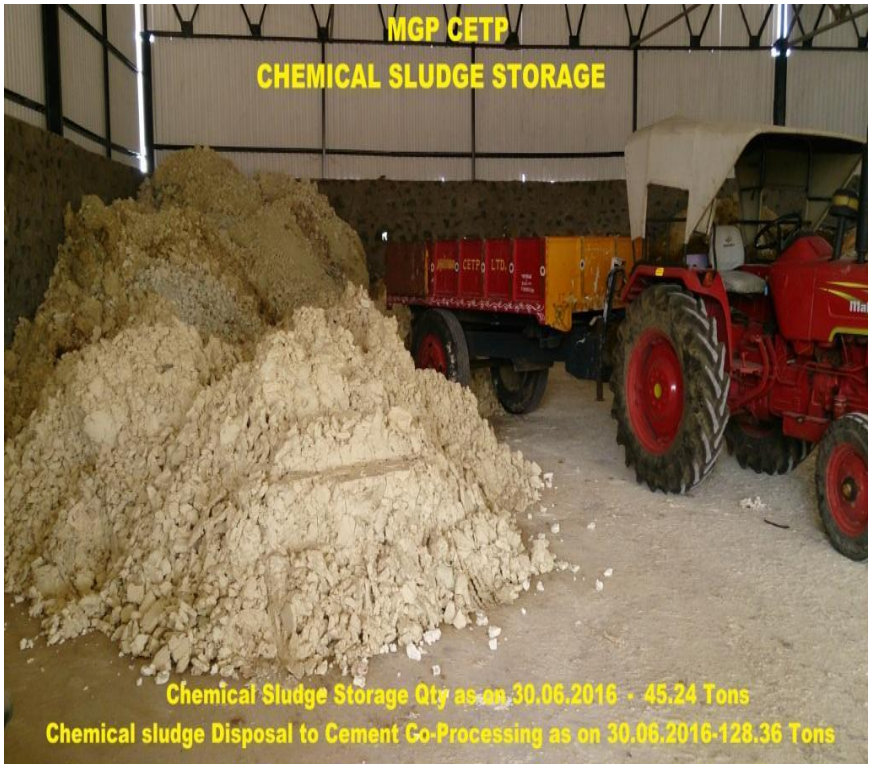
Low Carbon footprint of ZLD-ZWS technology as compared with Conventional treatment & discharge plants and existing ZLD technologies



Note: For Southern Grid power, weighted average emission factor has been taken as 1 MWH = 0.81 Ton of CO2 as per CEA report for FY 2013 -14

Sludge Management

1. Problem common to conventional treatment facilities with up to secondary stage.
2. Chemical sludge basically lime sent to nearby cement industries for Co-processing.
3. Bio-sludge stored,mixed with biomass briquettes made for burning in boilers.
4. For new plants, manufacturing of flyash brick (from the Captive Power Plant) with the lime sludge proposed.



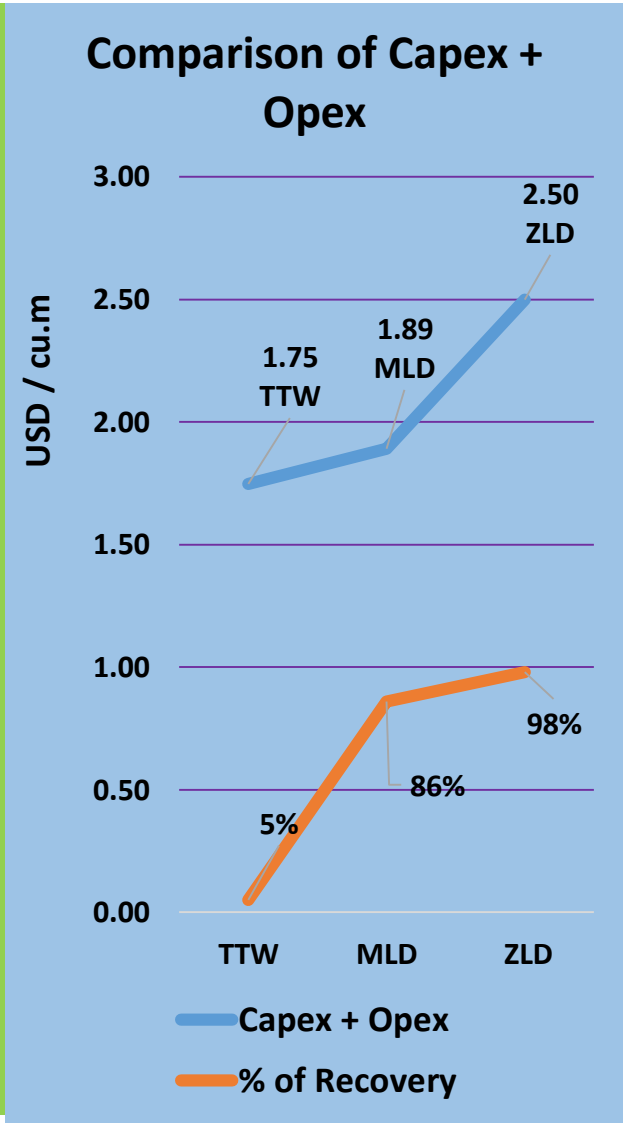
Financial Impact

Item	Cost/Impact on dyed fabric	%
Cost of dyed fabric	Rs. 90 per Kg	
O&M cost (Tirupur)	**Rs. 200 – 225 per m3**	
Cost of ZLD on dyed fabric	**Rs. 11 per Kg**	**12%**
Cost of ZLD based on recovered water & salt	**Rs 4.5/Kg**	**5%**
Cost of ZLD if Captive Power with cogen is employed-	**Rs. 2/Kg**	**2%**

Note: Cost of Water @Rs 78/m3, Cost of Sodium Sulphate @ Rs 10/Kg

New technology improvements can bring the cost to less than Rs. 150 /Kg. This would mean ZLD at near Zero Cost!!!

Tertiary vs MLD vs ZLD



Note:

1. Capex is Cumulative Cost and excluding Collection & Conveyance system cost
2. Net Opex after considering recovery cost of water & salt (Cost of recovered water @ 0.75 USD/cu.m from TTW/MLD/ZLD & Cost of Sodium Sulphate salt @ 0.15 USD / kg & Sodium Chloride @ 0.03 USD / kg)
3. Capex + Opex is calculated based on annuity cost

Conclusions

- ZLD is a Technological Challenge, and the focus must be on Zero Waste Disposal (ZWD).
- Extensive research and piloting necessary for every single case for Technology selection and financial viability.
- Brine Concentration, Evaporation and Crystallization and disposal still a major issue. Focus must be on recovery and reuse of salts.
- Water Scarcity, Water economics and regulatory pressure are the main drivers of ZLD and will determine financial viability.

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