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Sustainable Development of the Textile Industry in Tirupur with ZLD

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Abstract:

Textile exports quota curbs were lifted in 2005, subjecting the Tirupur export industry to the growth path. By the mid of 2007, the exports from Tirupur grew to Rs.110 billion. The industry earnings quickly started hitting a low by 2008-09 and one of the major factors were the environmental issue. In 2011, the Madras high court had ordered the closure of all the wet processing units in Tirupur and ruled that the industries couldn't operate until zero liquid discharge was attained. This led to the revolution in Tirupur, whereby, all the industries, commissioned the tertiary treatments of wastewater using membrane filtration technology and evaporators.

The scope of this paper is to explore the sustainable measures taken in the textile industry in Tirupur and the efficient functioning of the zero liquid discharge mandate that has placed Tirupur on the path of sustainable development. For this study, 2 individual effluent treatment plants (IEPT) and 4 common effluent treatment plants (CETP) were studied. The treated water characteristics were confirming to the standards. The conclusion from the study of the water characteristics analysis is that the CETPs and the IETPs are confirming to the zero liquid discharge regulations norms.

Keywords: *Common Effluent Treatment Plant, Membrane filter, Tirupur, Textile, Zero Liquid Discharge.*

I. INTRODUCTION

Textile exports quota curbs were relaxed in 2005, subjecting the Tirupur export industry to growth path and global competition. With this transformation, the textile exporters in Tirupur flourished. In India, in 2004, one of the primary foreign exchange earnings town was Tirupur and the turnover was in excess of Rs.50 billion. There were about a million people employed across 7000 knitting and garment making factories in Tirupur. Tirupur exported to about 35 countries across the globe and it was the most preferred vendor base for all these international companies. The ease of sourcing products from Tirupur was attributed to its quick delivery of samples, in less than 12 hours and delivery of the bulk orders in a count of few days. Tirupur was called the "Town of Export Excellence" or "Small Japan" (Vetrivel and Manivannan 2011). The early exports from Tirupur were in the 1970s to Italy with no competition what so ever.

By the mid of 2007, the exports from Tirupur developed to Rs.110 billion (AEPC, Tirupur). The industry earnings started hitting a low by 2008-09. The major reasons for these were infrastructure that did not grow with the growing produce, policies and growing competition. One of the major factors were the environmental issue and this affected the business to a great extent. By 2011-12, the industry was hit by another 15% negative growth (AEPC, Tirupur).

Attributed to the inadequate and insignificant environmental regulations, industries in Tirupur were discharging out effluents into the neighboring proximate environment from the early days and this was damaging the agriculture and ground water in the land (Pranawet.al., 2014). Farmers along with environmentalists launched apprehensions and alarms from 1990s in terms of petitions to the government. With regards to this, the first order by the Madras High court on the reduction of discharge into the Noyyalriver was in 1997, as the farming community was affected (Nygaard, 2015).

In 2011, addressing a contempt petition on the pollution of Noyyal river flowing through Tirupur, the Madras high court had ordered the closure of all the bleaching and dyeing units in Tirupur. This was due to the fact that the dyeing and bleaching units were discharging the industrial effluents into the Noyyalriver short of adhering to the Central Pollution Control Board (CPCB) industrial effluent waste water norms. The ruling also directed that the industries couldn't operate until zero liquid discharge (ZLD) was attained. The water of the river Noyyal was unfit for irrigation and domestic usage (Pranawet.al., 2014).

The complications and snags of pollution and water scarcity were noted way back in 2005. The discharge of salts from the industries has polluted the ground water. Total dissolved solids (TDS) levels of ground water were found to be in the range of 5000 – 6000 milligrams per liter (mg/L) (Pranawet.al., 2014).

The situation in the Tirupur textile industrial sector has seen an enormous and pragmatic transformation since the 2011 ruling by the high court. While around 750 dyeing units closed down due to the non-compliance to ZLD in 2011, the industrialists and technologists were keen to reverse the situation and get the business back to operations.

A study conducted in 2009 on the hydro chemical characteristics and groundwater quality assessment in Tirupur region, shows that the groundwater was contaminated with high concentrations of TDS. The water quality was unfit for drinking purposes due to the presence of high salinity. The study also depicts that the water was not suitable for domestic purposes (Pranawet.al., 2014).

The technology for ZLD was not available in Tirupur and there was no trained man power to manage the same.

There was an acceptance among the Industrialists, of both large and small scale, innovative ideas and business models need to upgrade in order to survive in the international market post the court order.

ZLD plants were the logical answer to the situation faced in Tirupur. ZLD eliminates any discharge of wastewater into the surrounding environment and facilitates the recovery and reuse of treated water back into the industries. The State Pollution Control Board (SPCB) mandates the reverse osmosis (RO) reject management as well, since there is no provision for any concentrate discharge either into deep wells or in the sea (Pranaw et.al., 2014). This led to the revolution in Tirupur, whereby, all the industries, commissioned the tertiary treatments in their Effluent Treatment Plants (ETP) along with membrane filtration systems, evaporators for salt recovery, reuse of concentrated brine in the dyeing plants and reuse of the water recovered (Hussain, 2014).

II. METHODS AND MATERIALS

The scope of this paper is to explore the status of the textile industry in Tirupur in the present day and the competent functioning of the ZLD rule that has positioned Tirupur on the path of sustainable development.

The industry of cotton knits in Tirupur is run by the yarn procured generally from large scale mills from Coimbatore. They are taken up for dyeing in Tirupur as the foremost step. There are numerous dyeing units that specialize in cotton dyeing and printing. The various stages in the wet processing of textiles to dye them are de-sizing, scouring, bleaching, mercerization and finally dyeing and printing. In these processes, the chemicals used are desizing agents, bleaching agents, strong alkalis, dye stuff, surfactants, wetting agents and salts. The dye effluent water is rich in biological

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oxygen demand (BOD), Chemical Oxygen Demand (COD), salts, residual dye stuff, alkalis, dissolved and suspended solids (Khatri et.al., 2015). The dyed yarn is taken up for knitting, which is the specialization in Tirupur. Knit fabrics are converted to apparels.

The dyeing units either have their own individual ETPs or are affiliated to the Common Effluent Treatment Plants (CETP). For this study, 2 individual effluent treatment plants (IETP) and 4 CETPs were chosen and analyzed in detail to understand the sustainable model built by the industries in Tirupur for the future of the textile industry.

2.1 Balu exports

Balu exports is a vertically set up manufacturing plant with state of the art facilities of spinning, knitting, dyeing and finishing in a single campus. The exports are primarily to USA and Holland.

The ETP in Balu exports is for the treatment of waste water produced by their own wet processing. The capacity of the ETP is 5 lac liters. The collection tank is provided to store the effluent water from various processes across bleaching, dyeing and finishing. From the collection tank, the effluent is processed through the primary treatment facility where the primary sludge is separated. The secondary treatment with the activated sludge process is done post aeration. The treated water moves from here to the activated carbon filter followed by the 3 stage RO water purification system. There are 31 membranes in the 1st stage, followed by 12 membranes in the 2nd stage and 6 membranes in the 3rd stage. The RO reject is taken to the nano filtration process followed by the Multiple Effect Evaporator (MEE) system. The final concentrated brine is taken back into the dyeing process. 92% of the water is recovered from the ETP process. The balance 8% goes in for solar evaporation. The actual site pictures are as given in Figure (i).

2.1.1 Sustainable performance and features

1. The dried sludge is sent to the cement factories for usage as raw material.
2. 92% water recovery post membrane filtrations and the balance goes into solar evaporation.
3. Confirms to Zero liquid discharge standards

Figure i: Balu Exports Individual ETP – Primary treatment tank, Dual media filters, Multiple effect evaporator system and solar evaporation

2.2 Exim Knits Private Limited (Exim)

Exim is an exporter in Tirupur with a vertical set up and this is an individual ETP set up for managing the treatment of effluent water from the operations of the Exim group.

The primary treatment after the collection and equalization of the effluent is aided by the

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addition of lime and ferrous. The next step is aeration for about 18 – 20 hours. The primary sludge is recovered from the bottom of the tank, while the overflow is passed to the secondary clarifier. The activated sludge is recycled back to react with the fresh water inflow. The secondary sludge collected is moved to the filter press and the overflow is taken to a 3 stage RO process. RO 1 has 18 membranes, RO 2 has 12 membranes and RO 3 has 8 membranes. The permeate recovered is 87-90% of the volume at the completion of RO. The permeate thus recovered is taken back to the plant for usage. The brine is at 60% concentration at this stage. The MEE further increases the concentration of salts to 65-70%. 7-8% of the water is recovered at the MEE. The total recovery of water is 97.5% and the concentration brine separated as dry powder with moisture is taken up for reuse in the wet processing after solar drying.

2.2.1 Sustainable performance and features

1. The dyeing range is set up with machineries that operate with the airflow technology. Conventional hydraulic machines operate with water technology whereas the airflow machines use air for the movement of the fabric in the machine. This reduces the requirement of water for dyeing i.e., the material to liquor ratio (MLR) is 1:1.4 as against the conventional hydraulic machines that function at a MLR of 1:4 to 1:10 (Rade et.al., 2015). The actual site pictures are given in Figure (ii).

2. The finishing machine is of the tubular open width technology which enables lower consumption of water as well.

3. The dyeing lab is set up to be operated automatically. The dyeing machines and the dye lab are completely computerized and the operations for color feed and color mixing are automated through the software. This ensures minimum manual handling and wastage of dye stuff and eliminates the conventional methods of weighing and mixing color manually.

4. Exim generates its own wind power. It has an installed of 1250 Kilo watt (KW) generating 24 lakh units of power per year. The power generated is sufficient to run the complete dye house across the year. The production floors are constructed with solar lighting.

Figure ii: Exim Knits Private Limited – view of the airflow dyeing machines, solar evaporation, RO system and Solar lighting in the factory

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5. Exim uses only Global Organic Textile Standard (GOTS) certified cotton and organic cotton for its cotton apparel production. The surcharge due to this superior raw material is accepted and borne by buyers, since it delivers a better marketable product.

6. The dyeing process is operated at temperatures between 80- 130 degree centigrade (degC), based on the type of fiber being processed. The outlet from the dyeing machines, post completion of the dyeing cycle is directly sent to the heat extraction tanks. The heat extraction system is in place to reuse the heat in the boilers.

7. Online monitoring system of the complete ETP functioning is enabled. This data is accessed by the PCB officials online from their offices.

8. The final brine which is at a concentration of 70% salts is dried in the open. This process is called solar evaporation. The solar beds are built in concrete but the brine is dried on an approved quality of polythene sheet to ensure that not a single drop of water is discharged into the ground. This is to adhere to the ZLD mandate by the court ruling and the PCB standards in Tirupur.

2.3 Chinnakarai Common Effluent Treatment Plant

The capacity of the plant is 8 Million liters per Day (MLD). The Chinnakarai CETP has 29 member units attached to it for waste water treatment.

After the primary collection and equalization process the sludge is separated at the primary clarifier. The water flows through to the secondary treatment which is based on the activated sludge process. The treated water is moved to the resin filters for the ion exchange process followed by a softening filter for reduction of hardness. The next stage is a 3 stage RO purification system. The RO 1 and 2 have 168 membranes each while the 3rd one has 58 membranes. The recovery of water is about 80-85% at this stage.

The reject from the RO is moved to the 2 stage mechanical vapor recompression evaporator, which is a patented technology from Italy. The steam economy in this set up is high due to the usage of polymer bags. The RO reject is circulated over the polymer bags which are heated by steam and evaporates due to the exchange of heat. This is a vacumnised system and 70% recovery from the RO reject is achieved. The concentration of the brine is at 100 grams per liter at this stage. At the 2nd evaporator, which is a multiple film evaporator (MFE), the concentration increases from 100 grams per liter to 300 grams per liter. The next stage is passage through a chiller for 24 / 48 hrs., where salt is recovered. The final liquor from here is sent the solar evaporation. The actual site pictures are as given in Figure (iii).

2.3.1 Sustainable performance and features

1. Each of the 29 member units have 3 underground pipeline connections to the CETP. The first one is for the flow of the incoming effluent water from the member units to the CETP, the second one is for the flow of the RO permeate from the CETP back to the member unit and the third pipeline is for the transportation of the brine from the CETP back to the member units.

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Figure iii: Chinnakarai CETP – view of the entrance of the CETP, Equalization tank, softner filters and real time flow monitoring system

2. The entire transaction of water and brine between the CETP and the member units are electronically monitored through online flow meters and the data is on the web. This data is accessed by the Tirupur pollution control board officials as well, for monitoring the performance of the plant.

3. The efficiency of this process is 97.2%. The balance brine is pumped back to the member units where it is used in the various wet processes based on the need.

4. The water is checked for 46 parameters daily, at 16 different stages across the process. A full-fledged laboratory is operational with trained technicians to carry out the water testing.

5. The biological sludge is tried as a fuel for the boiler and the chemical sludge is sent to the cement factories to be used as raw material.

2.4 Andipalayam Common Effluent Treatment Plant

The capacity of Andipalayam CETP is 4.5 MLD. This plant has 28 member units attached to it for wastewater treatment.

At the collection tank, the effluents from the member units are received and it is allowed thorough mixing. Neutralization takes place here with the addition of acid and mixing is enabled by flow mixers. The effluent is pumped to the aeration tank, which are fitted with blowers at the bottom of the tank. The activated sludge process is enabled for the reduction of the BOD, COD and further reduction of color, suspended solids and turbidity. The effluent is moved to the clarifier, where the sludge is allowed to settle down at the base of the tank. A part of the sludge is recycled back to the aeration tank for fresh effluent biological activity and the balance sludge is pumped out to the sludge well. The overflow from the clarifier is fed into the oxidation-reduction reactor. Here the chlorine contact system reduces the color and this system also helps increase the activity of the decolorant resin filter. The effluent is pumped to the clarifloculator with the addition of acid to allow the sludge to settle. The sludge is pumped out and the overflow is taken to the dual media filters for the removal of suspended solids and turbidity. The next process is activated carbon process for the removal of organic compounds and chlorine. From here the treated water is taken into a 4 stage RO process. RO 1 and 2 are loaded with brackish water membranes and RO 3 and 4 are loaded with sea water membranes. The recovery of water is 85-90% in the RO. The MEE aids further recovery of water and increases the solids concentration. The concentrate is taken to a crystallizer for salt recovery. The final concentrate is taken for solar pan drying.

2.4.1 Sustainable performance and features

1. The total water recovery is at 97% post the tertiary treatments and evaporation.
2. The reuse of salts extracted, permeate water and brine is a cost saving feature for the member units.

2.5 Veerapandi Common Effluent Treatment Plant

The capacity of Veerapandi CETP is 12 MLD and the plant has 70 members. This plant is upgraded to treat sodium sulphate type of effluent as the regulations of the SPCB.

The treatment process consists of common effluent collection, equalization, neutralization and activated sludge process. This is followed by the preparatory processes of ultrafiltration, dual media filtration and activated carbon filters for the 3 stage RO. The RO permeate is circulated back to the member units. The water recovery at this stage is 80 -85%. The RO reject is taken to the Mechanical Vapourrecompressor (MVR) for increasing the solids concentration and then to the MEE. The concentrated effluent is taken to the chiller where the temperature is reduced to 10 degC. The next process is crystallization, for the recovery of salts. The liquor from here is taken to the MEE again and then to the solar evaporation. The final recovery % of water is 97% with the concentrated final brine going in partially for solar evaporation and partially to the member units.

2.6 Murungapalayam Common Effluent Treatment Plant

The capacity of the murungapalayam CETP is 11 MLD and it has 62 member units. This plant is upgraded to treat sodium sulphate salt as the regulations of the SPCB.

The effluent received from the member units through the underground pipeline is equalized in the receiving tank. Here the neutralization takes place by the addition of acid. In the primary clarifier, the biological oxidation takes place, allowing the sludge to settle at the bottom of the tank, which is pumped out. The effluent is taken to the secondary clarifier and then to the hypo chlorination tank, where color is removed by the addition of chlorine. Excess chlorine is removed by the addition of sodium metasulphate. The treated effluent is next taken through the range of filters for the removal of suspended solids, COD, color and turbidity. The hardness is removed by passage through the softner filter prior to RO. The RO is a 4 stage one, and the efficiency of water recovery is 85%. The RO reject is taken to the MVR, where the concentration of solids increases to about 35%. A proportion brine is sent back to the member units, which are rich in salts. The remaining brine is taken up for MEE and finally for solar evaporation. The final water recovery is between 96.5 – 97.5%. The 3% final brine is taken partially to solar evaporation where the salts extracted are impure and the balance quantity is pumped back to the member units for reuse.

3. Results and discussions

3.1 ETP inflow waste water characteristics

The inflow waste water characteristics are given in figure (iv).

1. The inflow effluent characteristics into the CETPs and the IETPs were high in TDS with 8000-12000 mg/L for CETPs and 3000 mg/L for IETPs. The CETPs are designed to take in effluent in the range of 6500 – 8000 mg/L.

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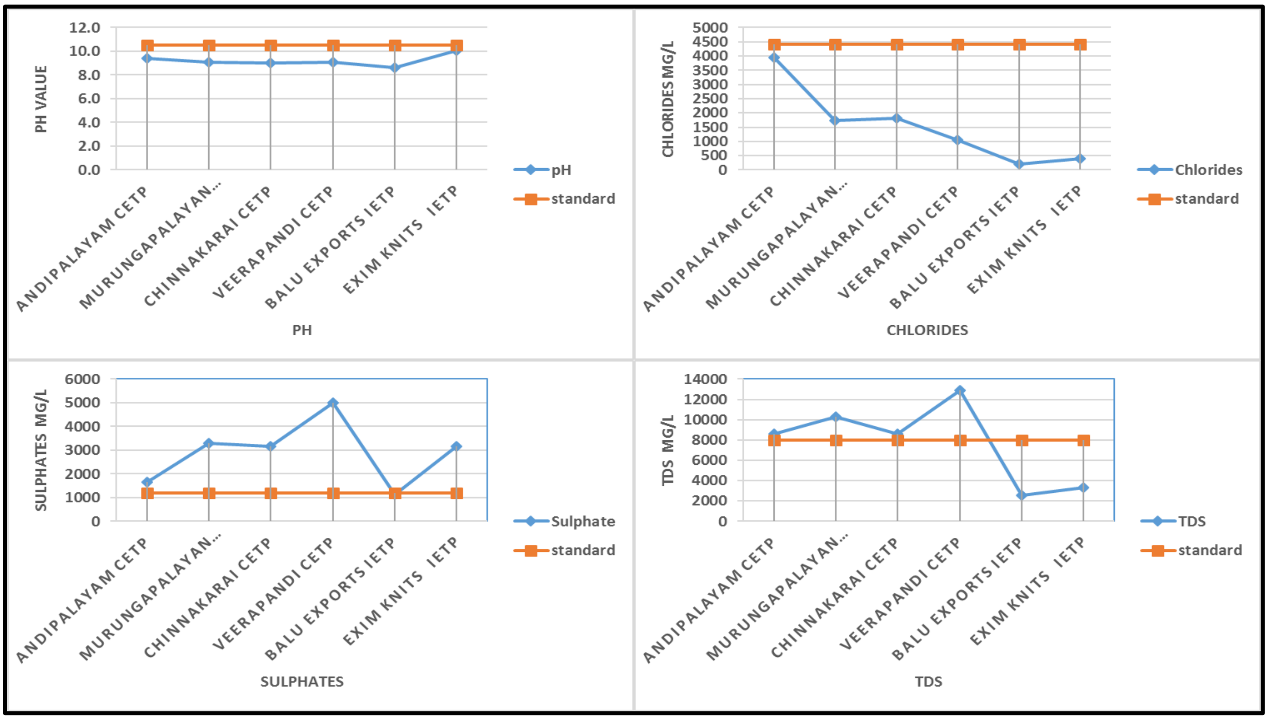
2. The COD is in the range of 800 – 1700 mg/L across the CETPs and 700 – 800 for IETPs. The design range is similar to the inlet effluent range.

Figure iv: Inlet waste water characteristics of CETPs and Individual ETPs



3. The BOD is in the range of 350 – 500 mg/L across the CETPs and 150 – 350 for IETPs. The effluent range confirms to the design.

4. The sulphates are in the range of 1000 – 5000 mg/L across the CETPs and 1000 – 3000 mg/L for IETPs. The effluent inlet range is higher than the norm used to design the ETP. This is due to the regulation change in Tirupur, which mandates the use of sodium sulphate in the dye bath instead of the cheaper and most commonly used sodium chloride.

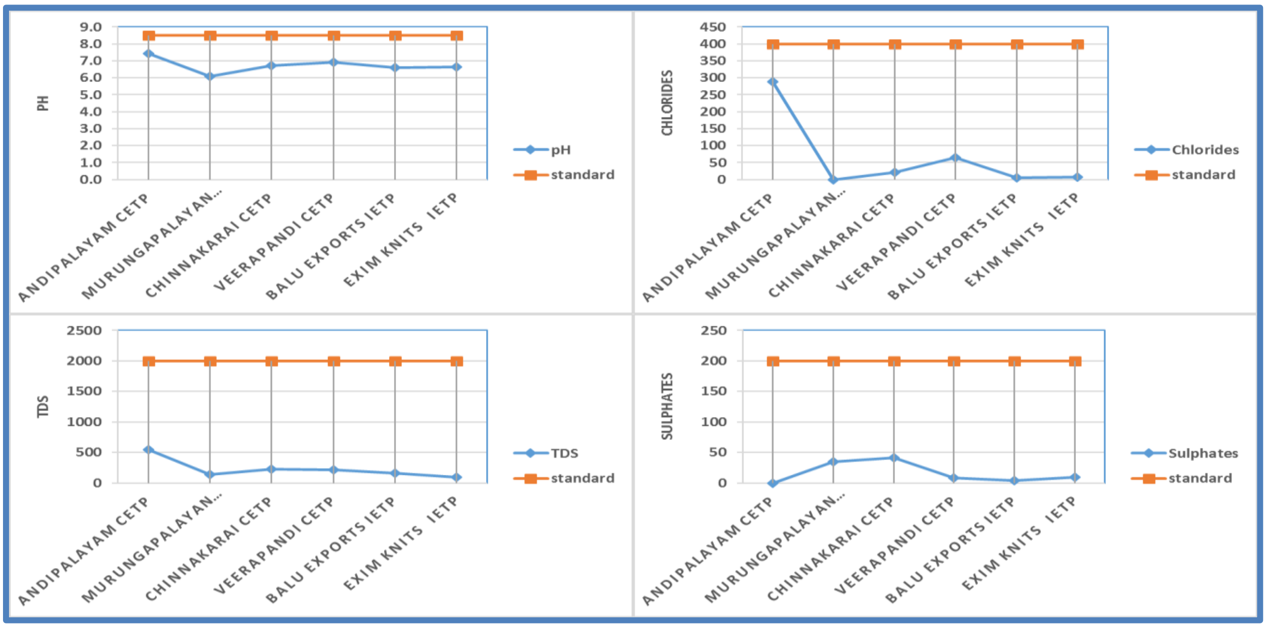
5. The Chlorides are in the range of 1000 – 1700 mg/L for CETPs and 300 – 400 mg/L for IETPs. The design range is 2900 – 4000 mg/L.

6. The CETPs and the IETPs measure numerous other parameters for the analyzing the conformance of the inlet effluent. This is important since the efficiency of the treatment depends on the effluent characteristics at the inlet stage.

3.2 Treated RO Permeate Characteristics

The RO permeate characteristics were studied, since the RO permeate is pumped back to the member units for reuse. The outlet water characteristics are given in figure (v).

Figure v: RO permeate treated water characteristics of CETPs and Individual ETPs



1. The TDS range is 100 – 550 mg/L for the CETPs and IETPs and the TNPCB permissible level is 2100 mg/L.
2. The Chlorides are in the range of 50 – 500 mg/L for the CETPs and less than 50 mg/L for the IETPs.
3. The Sulphates are in the range less than 50 mg/L for both CETPs and IETPs.
4. The total hardness are in the range of less than 80 mg/L across both CETPs and IETPs.
5. The other parameters such as COD, BOD, TSS, turbidity, electric conductivity, calcium, magnesium were minimal or below detectable limits.

The concentrated brine and salts extracted are sent back to the respective member units in the proportion of the inlet effluent water. The treatment efficiency of the CETPs reported was a recovery of 97- 97.5%. This recovery % is reported for the end to end processing at the ETPs. The recovery % range at the RO permeate stage is between 68 – 85%. The CETPs are tracked by the member units and by the SPCB by the online continuous effluent monitoring system, with flow meters and online qualitative measures. The Sludge generated is sent to the cement industries, where they are used as raw materials. The solar evaporised salts are stored within the premises.

IV. CONCLUSIONS

From the analysis of the inlet waste water characteristics into the CETPs, it can be concluded that the member units are adhering to the set standards, except for TDS levels. TDS levels are exceeding by 20%.

The RO permeate water characteristics analysis show that the critical parameters such as TDS, chlorides, sulphates, pH and total hardness are adhering to the SPCB norms. The other parameters such as BOD, COD, turbidity, electric conductivity, calcium, magnesium, alkalinity, acidity and bicarbonate content were all adhering to the norms. Most of these parameters were below detectable limits. The conclusion from the inlet and outlet water characteristics analysis is that the CETPs and the IETPs are able to treat the textile waste water generated by their member plants to the required standards and are confirming to the zero liquid discharge regulations in the region.

It may also be concluded that investment in improved air flow dyeing machineries that require a lower MLR is a sustainable step for reduction in the consumption of water. Such steps reduce the effluent treatment costs. Investment in generation of renewable energy such as wind energy, using solar lighting, and automatic dye dispersal systems are all efficient contributions to building a sustainable way forward.

The contribution of the CETPs and the IETPs in the journey of developing and fostering a sustainable textile industry in Tirupur is unquestionably an enormous one. It may be noted that the setup of the CETPs with tertiary membranes filter as a technology is highly evolved in Tirupur. The skill and learnings in the industry in Tirupur is rich and the complete knowledge to manage the zero liquid discharge was a learning by trial and error, as quoted by the technicians in the ETPs. The movement to recover 97.3% of water from the ETPs is a creditable and admirable achievement.

The SPCB's role in monitoring the performance of the CETPs has also been a key driver in the progress of the industry. The Tirupur PCB has been vigilant and focused on the water issues in Tirupur and has mandated the use of sodium sulphate instead of sodium chloride in the dyeing plants. This is a progressive way forward since the use of sulphate in cotton dyeing increases the biodegradability and decreases acute toxicity of the effluent over the use of sodium chloride. The success of building a sustainable model of business taking care of the environmental parameters in Tirupur can be attributed to the strict and vigilant PCB officials, the ever alert local population and the profound objectives and intent of the industrialists of Tirupur to prosper the business.

REFERENCES

1. Arumugam K &Elangovan K, Environment Ecology, 58(10), 1509, (2009)
2. AwaisKhatri, MazharHussainPeerzada, Muhammad Mohsin, Max White, Journal of Cleaner Production, 87 (1), 50, (2015)
3. Dr. T. Vetrivel& Dr. L. Manivannan, Indian Journal of applied research, 1(11), 99, (2011).
4. Henning Hoy Nygaard., Sustainable textile production in Tirupur, final report from a multi-stakeholder pilot implementation project in Nordic countries and Tirupur, Nordon council of ministers, Denmark, 9, (2015)
5. SajidHussain, Indian case study on ZLD – The Tirupur Textile cluster experience, Tamilnadu Water Investment Company Limited, Tamilnadu, 21, (2014)
6. Kumar Pranaw, PriyankaTripathi, RamakantSahu, PoornimaSaxena, Pollution of surface water in Tirupur and its adjacent areas by textile effluents, Centre for Science and Technology, New Delhi, 5, (2014)
7. Kuldeep A Rade, V A Parande, D R Saini, Thermal Engineering, 89 (12), 36718, (2015)