केन्द्रीय प्रदूषण नियंत्रण बोर्ड
CENTRAL POLLUTION CONTROL BOARD
(पर्यावरण एवं वन मंत्रालय, भारत सरकार)
(MINISTRY OF ENVIRONMENT & FORESTS, GOVT. OF INDIA)

B-400/PCI-III/2014-15

19-01-2015

To

The Member Secretary
All State PCBs/PCCs/Zonal officers

Sub: Guidelines on Techno-Economic Feasibility of implementation of Zero Liquid Discharge (ZLD) for Water Polluting Industries. reg.

Sir,

Implementation of Zero Liquid Discharge (ZLD) in all types of industrial sectors is an important issue and in many sectors, technology wise it is possible and can be achieved. In many cases, Hon'ble Courts/ Tribunal are also seeking opinion from regulators about the feasibility and possibilities of its total implementation. Technically in many parts of the country and in many sectors it is being practiced/demonstrated successfully, though the economic aspects are in question.

In view of this Central Pollution Control Board is in the process of preparing 'Guidelines on Techno-Economic Feasibility of implementation of Zero Liquid Discharge (ZLD) for Water Polluting Industries'. It is requested that the draft may be reviewed and the consolidated suggestions/modifications may be forwarded to this office by 27-01-2015 to email adaba.cpcb@nic.in

Yours faithfully,

Encl: as above

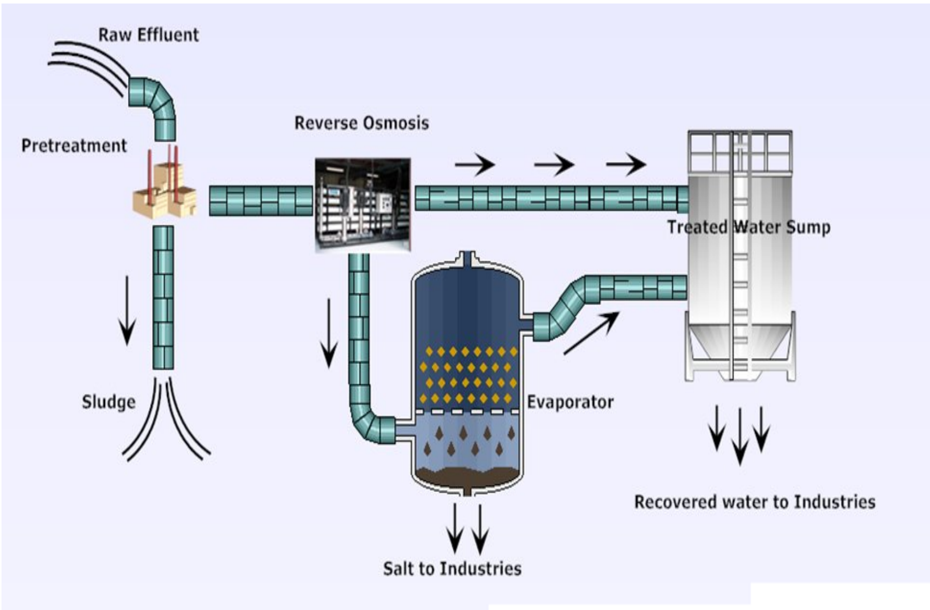
(A.B. Akolkar)
Member Secretary 19.1

'परिवेश भवन' पूर्वी अर्जुन नगर, दिल्ली–110032
'Parivesh Bhawan', East Arjun Nagar, Delhi - 110032
दूरभाष / Tel. : 43102030, फैक्स / Fax : 22305793, 22307078, 22307079, 22301932, 22304948
ई–मेल / e-mail :cpcb@nic.in वेबसाईट / Website : www.cpcb.nic.in

GUIDELINES

ON

TECHNO – ECONOMIC FEASIBILITY OF IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) FOR WATER POLLUTING INDUSTRIES



CENTRAL POLLUTION CONTROL BOARD

(Ministry of Environment, Forests & Climate Change)

'Parivesh Bhawan', East Arjun Nagar, Delhi- 110 032

JANUARY 2015

CONTENT

GUIDELINES ON TECHNO-ECONOMIC FEASIBILITY OF IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) FOR WATER POLLUTING INDUSTRIES

1.0 Introduction

It has been estimated that 501 MLD of industrial effluent is being discharged by water polluting industries through drains of tributaries into River Ganga.

Water polluting industries (GPI), are mainly of industries discharging effluents having BOD load of 500kg/day or having toxic / hazardous chemicals. There are 2535 industries identified in Ganga basin which includes states of Uttarakhand [74] Uttar Pradesh [993], Bihar [40], Jharkhand [94] and West Bengal [147], Delhi [5], Madhya Pradesh [19], Chhattisgarh [26].

The industries have been persuaded to set-up effluent treatment plants & CETPs and operate them to meet with prescribed standards.

2.0 Water Polluting Industries

The industries identified as water polluting industries are: - Sugar, Distilleries, Pulp and Paper, Tanneries, Chemicals, Dyeing and Textiles, Refineries, Food, Dairy and Beverages, Electroplating and others. The water polluting industries discharge their effluent having high organic contents measured in-terms of bio-chemical oxygen demand (BOD), and other toxic constituents like metals, organic and in-organic compounds.

3.0 Effluent Treatment Plants (ETPs)

The systems available of treating industrial effluent are based on Physico-chemical and biological principles. The operation of effluent treatment plants requires technical skill and regular attention so to achieve compliance to standards for 24 hrs x 365 days.

4.0 Standards for Compliance

Standards for compliance have been notified under the Environment Protection Act, 1986. The notified standards permit industries to discharge the effluents only after compliance. However, CPCB and SPCBs / PCCs now, are insisting industries to reduce water consumption and also take measures to not-to-discharge effluents. But, it has been observed that industries are not able to meet all time compliance standards and as a result, rivers like Ganga and its tributaries is carrying high pollution load and it is the dilution available in river water which helps in minimizing pollution load.

5.0 Necessity for Zero Liquid Discharge (ZLD)

After having recognition of problems that many industrial sectors are not able to achieve standards and this ultimately necessitates to work towards Zero Liquid / effluent discharge standard.

6.0 Definition of ZLD

Zero Liquid discharge refers to installation of facilities and system which will 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 be recognized and certified based on two broad parameters that is, water consumption versus waste water re-used or recycled (permeate) and corresponding solids recovered (percent total dissolved / suspended solids in effluents).

7.0 Technical needs for ZLD – The guidelines

Adoption of Zero Liquid Discharge system will be applicable to zero-down organic load, recover metals and other constituents. Direct installation of ZLD facilities may have technical constraints to operate specialized system.

Pre-requisite for ZLD accomplishment would need physical and chemical treatment and followed by biological system to remove organic load. The treated effluents can be then subjected for concentration and evaporation. The concentration process as applicable can be adopted at appropriate stage. The concentration method quite often involves the adoption of Reverse Osmosis (RO) and Nano Filtration (NF) methods. The evaporation methods involve incineration/ drying / evaporation of effluent in multi effect evaporators (MEE).

In the process of achieving ZLD, solids recovered and these are to be utilized. However, in case of not used, they will have to be stored. Cost-wise, achieving ZLD will be costly proposition but, now becoming necessity because rivers need to be rejuvenated. A typical cost indicates that a CETP treating 1 MLD of waste water with conventional physico-chemical and biological treatment is around Rs. 3.0 to 4.0 Crores with operation and maintenance cost of Rs. 300-350 per cubic meter (M^3), Whereas, cost of combination of conventional ETP with ZLD facilities costs around Rs. 12.0 to 15.0 Crores per MLD.

Now, the ZLD adoption is becoming essential rather than imposition.

8.0 Application of ZLD in Industries

The significant industrial sectors like Sugar, Distilleries, Tanneries, Pulp & Paper, Textile, Dyeing, and Dairy would need special emphasis for enforcement of ZLD. It is important to mention that in the name of ZLD, no forceful injection into ground water table is to be tried nor utilizing effluents / permeate for irrigation / or horticulture. ZLD would strictly means recycling treated effluent back for re-use in industrial / or domestic purpose but, exclude use / disposed in ambient environment.

ZLD is applicable to industries having high BOD and COD load, colour bearing effluents, having metals, pesticides and other toxic / hazardous constituents.

9.0 Technical Route for Achieving ZLD

ZLD can be achieved by adopting conventional primary, secondary and tertiary effluent treatment and polishing by filtration and using clean water back into process / or domestic use. In some case, Reverse Osmosis, Micro/Nano Filtration and concentrating with Multiple Effect Evaporators (MEE) can be employed. It has been quite often debated that employing ZLD route is energy intensive and having exorbitant cost / financial burden. But, it cannot be denied that in the present circumstances when ground water table is getting depleted and there is diminishing flow in rivers, permitting industries to discharge even treated effluents, does not seems to be environmentally acceptable proposition. However, industries will be at their technical wisdom and expertise to search for better ZLD achieving practice but with a caution that there will stern actions if, on the name of ZLD, un-acceptable practices are adopted.

In some cases, if any industry feels that a given process needs modification, stopped or substituted, they can do so but, in longer run, treated effluents cannot be disposed. It is also to be understood that in absence of ZLD, industry has to meet compliance with standards and the results through on-line effluent monitoring devices will be available with regulatory authorities and also in public domain.

10.0 Adoption of ZLD in Distilleries, Pulp & Paper, Tanneries, Textiles, and CETPs

Many industries which include Distilleries, Pulp & Paper (waste paper pulping), Textiles and Tanneries clusters operating through Common Effluent Treatment Plants (CETPs) have implemented ZLD systems.

CPCB has also carried out consultation with Pulp & Paper and Tanneries and the strategy / guidelines emerged are given in Annexure-I, II, III, IV, V, VI, VII, VIII & IX

11.0 Conclusion and Way Forward

i. The industries having high organic load and other refractory nature of pollutants will be requiring to adopt ZLD system.

ii. ZLD refers to a system which would enable and industry to recover clean water using back into industrial processes or domestic use and not subjecting to be disposed in ambient environment including use in industrial premises.

iii. Industries will have options to select technical system facilitating to achieve ZLD.

iv. Industries are liable to face closures if found violating the prescribed standards and not having installed on-line effluent monitoring devices where data will have to be available with regulatory bodies and also in public domain.

v. Sectors like Pulp & Paper will immediately adopt charter which will facilitate them to reduce pollution load and maximize reduction in water usage / consumption as well as reducing in quantity of effluent disposed. However, such industries shall be subjected to regular vigilance and followed by stern action in case of their non-compliance to the existing stipulated / notified standards.

****

Annexure -1

ZERO LIQUID DISCHARGE IN DISTILLERY

1. INTRODUCTION

Distilleries generate large volume of high strength effluent called "spent wash", which is one of the recalcitrant effluent having extremely high COD (80,000-1,20,000 mg/l), BOD (40,000-60,000 mg/l), SS, inorganic solids, low pH, strong odour and dark brown colour.

As per the effluent standards notified under the Environment (protection) Rules, 1986, treated effluent from distillery shall have BOD- 30 mg/l for disposal into surface water bodies, or 100 mg/l for disposal on land for irrigation.

Most of the molasses based distilleries have installed anaerobic digesters and adopted following practices for spent wash management.

1. Ferti-irrigation
2. One time application before sowing of crop (Pre-sown irrigation)
3. Bio-composting of pre-treated spent wash

2. CPCB'S EARLIER ISSUED GUIDELINES (2008)

The problems associated with distilleries due to the currently used treatment methods of composting, ferti-irrigation and one time land application of spent wash vis-à-vis advanced technologies including evaporation, concentration, incineration of concentrated spent wash for power generation were discussed and made following recommendations:

A. Proposal for establishing stand alone distilleries involving comprising, ferti-irrigation and one time land application of spent wash may not be considered henceforth by SPCB/MoEF/PCC.
B. Proposal for establishing distilleries attached with sugar unit may be considered if they followed one of the following options:
   - Bio-methanation followed by bio-composting; or
   - Reboiler/Evaporation/Concentration followed by incineration of concentrated spent wash in boiler (for power generation).
C. The proposals of existing stand alone distilleries for increase of production/expansion based on composting, ferti-irrigation and one time land application of spent wash may not be considered henceforth by SPCB/MoEF.
D. The proposals of existing distilleries (both stand alone and those attached with sugar units) that not complying with the required environmental standards may be asked to switch over to emerging technologies from existing technologies of

composting, ferti-irrigation and one time land application of spent wash in a time bound manner.

3. PRESENT SENARIO/FACTS

During the last few years CPCB have made surprise visits under ESS programme in the molasses based distilleries in the Country, covering distilleries spread over the entire country and in different seasons. The outcome of this surprise monitoring of distilleries indicates abysmal environmental performance of distilleries adopting ferti-irrigation, one time land application and bio-composting with more than 60% cases of serious non-compliances. Ground water contamination, river water pollution and soil degradation due to mismanagement of spent wash with these practices have been reported across the country.

In view of these continuous non-compliance Central Board is insisting all the existing distilleries (both stand alone and those attached with sugar units) that not complying with the required environmental standards be switch over to emerging technologies from existing technologies of composting, ferti-irrigation and one time land application of spent wash in a time bound manner.

4. Technologies for concentration of Spent wash

(i) Anaerobic digestion – Biogas
(ii) Reverse osmosis RO) - Permeate/Reject
(iii) Multiple effect evaporation (MEE) – Concentrate/Process condensate

(i) Anaerobic digestion:

- Well established technology. Almost all distilleries have anaerobic digesters.
- Digesters designed for COD loading rate of 5 kg/m3/day has given best performance. CSTR and UASB based digesters are more suitable for molasses based distilleries.
- BOD removal efficiency- 85-90%, COD removal efficiency- 55-65%, Specific biogas generation (NM^3/kg of COD consumed)-0.45-0.55, Methane content of biogas- 55-65%, H_2S content of biogas- 2-4%

(ii) Reverse osmosis (RO) System:

- Spent wash volume can be reduced by 45-55% for BSW & 35-45% for RSW.
- Permeate can be used after pH correction. Hence, fresh process & non-process water requirement is reduced.
- Permeate recovery- BMSW: Average - 45 -55%, Raw SW: Average - 35 - 45 %
- Permeate can be recycled after proper treatment as make- up water in CTs or for molasses dilution.
- Operational cost (about Rs.0.60 per cum) is slightly lesser than MEE plants.

(iii) Multi Effects Evaporator (MEE):

- Well established technology for concentration up to 40 % solids, which can result in substantial SW volume reduction.
- Some MEE plants are susceptible to scaling above 2000 ppm SS in the feed.
- Process condensate requires polishing treatment before reuse in process and non-process applications.
- Integrated RSW evaporation can result in reduction of final SW volume to 3.5 to 6.5 lit./lit. without additional steam requirement depending on fermentation technology employed.
- Scaling is severe when product concentration is above 50% solids and it is extremely difficult to remove the scaling.

4.1 Technologies for drying/ incineration of concentrated Spent wash

(i) Spray dryer / Rotary dryer
(ii) Slop fired boiler

(i) Spray dryer/ Rotary dryer:

- Calorific value of dried powder is about 2200 Kcal/Kg, moisture content 4-5%.
- Disposal of dried power is not standardized. At some distilleries, it is used as supplementary fuel along with agro based fuel in boilers where as at some of the distilleries being sold as fertilizer.
- Distilleries with capacity of about 30 KLD to 45 KLD have been reported operating dryer system successfully and therefore viable option for small scale distilleries with capacities < 60 KLD.

(ii) Slop fired boiler:

- 55 to 60 % solids concentrate or spent wash powder is fired in a specially designed boiler with or without subsidiary fuel. Steam generated runs a TG set to generate electricity. Exhaust steam is used in distillery and evaporation plant operations
- Overall system is supposed to be self-sustaining in terms of steam and power balance after initial stabilization period.
- Potash rich ash as a by-product.
- Slop fired boilers are in operation in India since 2006 and distilleries/ technology suppliers have reported addressing various bottle necks through improved design/ innovative technologies.

4.2 Co-processing of concentrated spent wash:

Spent wash can be effectively disposed off in the cement kiln system through co-processing route to substitute coal up to 5% without adversely affecting the kiln performance and product quality. Co-processing of spent wash concentrate in cement kiln have successfully been put to trial run and can be adopted by distilleries, in lieu of captive slop fired boiler, for spent wash management to achieve zero liquid discharge, subject to the availability of adequate kiln capacity and necessary logistic arrangements. Co-processing could be a cost effective alternate option for attainment of ZLD by distilleries which have already installed evaporation-concentration facilities, depending upon their location suitability. However many cement plants are not keen in accepting the SW due to transportation/handling/storage/scaling/distance etc.

5. The suggested Technological Options for Achieving ZLD may include:

- Bio-methanation followed by R.O/MEE followed by incineration (slop fired).
- Bio-methanation followed by R.O/MEE followed by drying (spray/rotary).
- Concentration through MEE followed by co-processing in cement/thermal power plant.
- Bio-methanation and RO followed by MEE followed by bio-composting.

ANNEXURE - II

ZERO LIQUID DISCHARGE (ZLD) SYSTEMS FOR TANNERIES

1. Common Effluent Treatment Plant (CETP) effluent standards for discharge into surface waters and on land have norms for Total Dissolved Solids (TDS) also having a maximum permissible limit of 2100 mg/L. Tannery effluent contains TDS in concentration several times higher than this prescribed limit which is contributed by the common salt used for preservation of hides and skins as well as by the inorganic salts and chemicals used in the tanning process. The conventional treatment methods used for effluent treatment are largely aimed to treat organic matter and do not help in reduction of inorganic TDS due to inorganic constituents. Therefore, tanneries clusters are required to adopt extra measures to meet the CETP effluent standard for TDS. The tanneries clusters in Tamil Nadu have adopted ZLD systems in order to comply with TDS norms. ZLD systems have been implemented for all 12 tanneries CETPs in Tamil Nadu and some of them are already operating successfully for quite some time while others are under stabilization. However, tanneries' clusters in northern India, which include Kanpur and Unnao clusters in Ganga basin are yet to take measures to meet the CETP effluent standard for TDS.

2. From the technical interaction with experts having experience with ZLD systems for tanneries clusters in Tamil Nadu it has been noted that;

   I. The ZLD concept has been demonstrated to be technically feasible by currently operational units in Tamil Nadu. The ZLD system for tanneries clusters is a technologically viable proposition in spite of high capital and operational cost and sophisticated.

   II. The RO/evaporators are sophisticated needing great care in O & M. The project should be implemented with proper technical guidance. The CETP is required to engage adequately qualified and experienced personnel to operate the system.

   III. The resultant salt from evaporators, which is mixed in nature, is currently stored in safe impervious covered storage yards.

3. Capital Cost of ZLD

   I. Cost of 1 MLD (CETP + ZLD) requires 12 to 15 Crore for ZLD alone

II. Cost of CETP without ZLD 3 to 4 Crore/ MLD

III. O & M cost per m^3 = Rs 300 to 350/m^3

IV. Water recovery 80 to 85% and cost of RO recovered water can compensate the Raw water cost

- Salt - TS 95% VS 10 to 12 % of Raw to wet blue and 10 to 25% for Wet blue to finish. Salt recovery 8 to 12 tons/MLD of permeate

Conclusion

(i) ZLD has been implemented in Tamil Nadu and whereas urgent steps will have to be taken in Ganga basin due to the commitment to clean Ganga river.

(ii) It was concluded that ZLD can be implemented in tanneries in Ganga basin on the lines of Tamil Nadu where the recovered salt is currently being stored in safe impervious covered storage yards, and subsequently as and when some better solutions for reject and salt management are achieved, these can be incorporated into the installed systems.

(iii) The ZLD system for tanneries will comprise - proper collection of effluent, primary treatment, secondary treatment, further preparatory treatment for ZLD system, Reverse Osmosis for reducing effluent quantity for evaporation, reuse of the recovered RO permeate in tanneries' process, evaporation of the RO concentrate in evaporator, reuse of the recovered condensate in tanneries process, recovery of crystallised salt, recycle of un-crystallised salt for evaporation with RO concentrate, and storage of the recovered salt in safe impervious covered storage facility.

***

Annexure-III

ZERO LIQUID DISCHARGE (ZLD) IN PULP AND PAPER INDUSTRY

1. Pulp and paper industry, worldwide, has been exploring the ZLD concept over the last two decades and has however, not been able to identify a technically feasible, and sustainable, technology to achieve ZLD. The two possible options which have been explored are:

   a. Close up all process water loops by total recycling inside a process sequence or into a different process sequence within the mill.
   b. Treat the effluent in a stand-alone facility to render it suitable for process reuse & volume reduction.

   Closing up the process water loops by extensive recycling has been tried out in different combinations and found to be impracticable, even in the short term, on account of uncontrollable build-up of chlorides, salts and non-product elements in the system; deterioration in product quality; reduced effectiveness of process chemicals; and scaling and corrosion of machinery leading to breakdowns.

2. An ideal stand-alone facility would require conventional wastewater treatment (primary, secondary and tertiary) to reduce the suspended solids and organic loads, followed by a quaternary treatment (typically, multi-stage reverse osmosis (RO) sequences) to maximise recovery of reusable process water and reduce the volumes requiring subsequent treatment such as evaporation, crystallisation and environmentally acceptable management and/or disposal of solids.

3. Techno feasibility of ZLD:

For the present, Zero Liquid Discharge is, techno-economically, not feasible for most mill categories. No country has, therefore, imposed a ZLD condition for the paper industry.

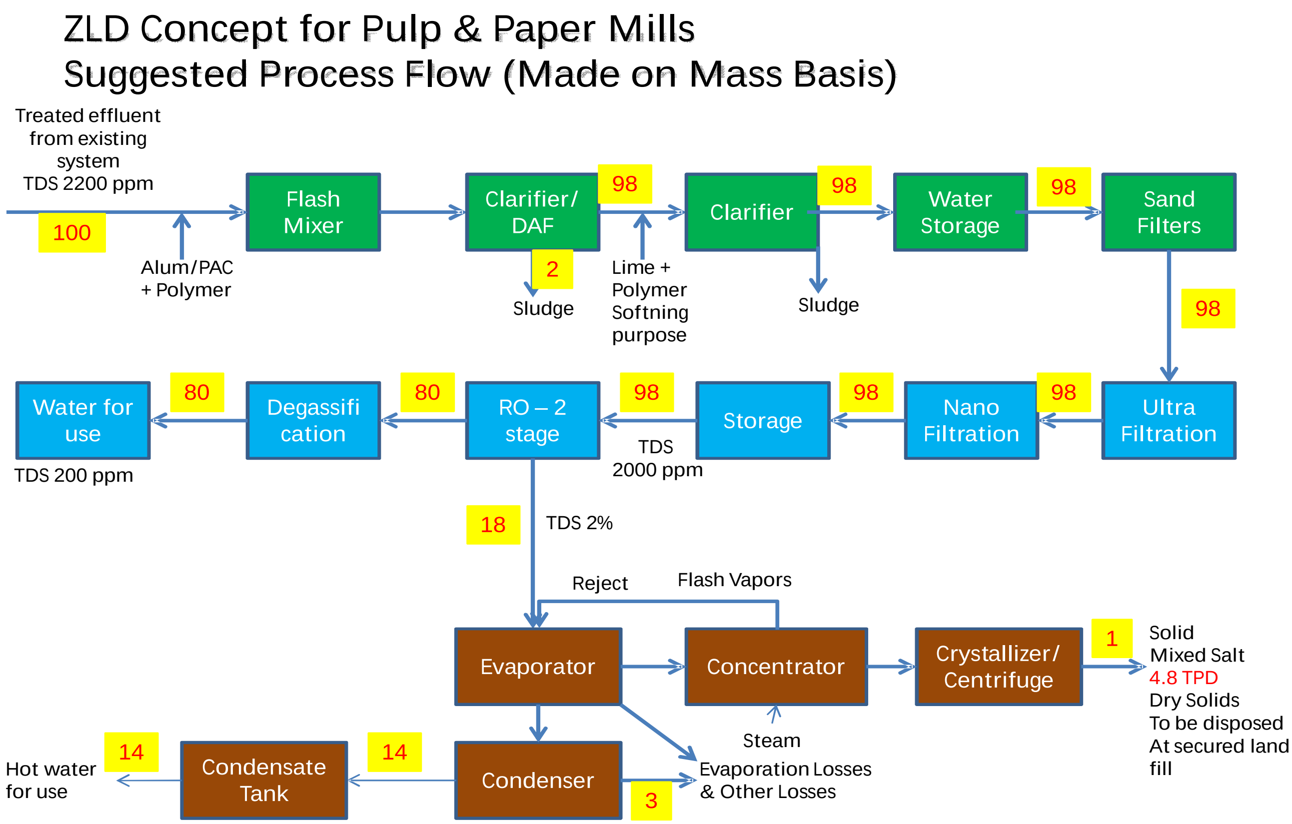
The current state of art technology routes to achieving ZLD, have the following issues:

- Sustained 24×7 operation is not dependable.
- Life cycle costs of ZLD enabling systems are estimated to be too high to be sustained by the economics governing the industry.
- Concentrated mixed salts, or brine, and the mother liquor will constitute unacceptable cross-media environmental impacts.
- Available technologies are either power-intensive or steam intensive, or both. Since steam and power have to be generated on site, emissions to air

(boiler stacks) and land (boiler ash) will add to the cross-media impacts, besides worsening the carbon foot print of the mill.

4. Economic Feasibility of ZLD:

A typical suggested flow diagram of ideal standalone effluent treatment facility could be as under:



Estimated Cost for 100 m3/hr Treated Effluent

Particulars	UoM	Value
Effluent Volume	m^3/hr	100
RO Treatment output	m^3/hr	80
RO Reject feed for evaporation & crystallization	m^3/hr	20
Capital Cost		
RO Plant for 100 m3/hr capacity	Rs.Cr	5.0

Evaporator, Crystallizer & Centrifuge	Rs.Cr	19.0
Civil work pipelines etc.	Rs.Cr	1.0
Total Cost	Rs.Cr	25.0

Investment & Operating Costs

Particulars	Units	Case 1
Mill Capacity	TPD	100
Effluent Volume	M^3/day	4000
Capital cost for RO & Evaporation	Rs.Cr.	45
Power Requirement for ZLD	MWH	1.0
Capital cost for Power Plant	Rs.Cr.	4.0
Total Capital Cost	Rs.Cr.	49
Operating Cost (@127 Rs/M3)	Rs/Mt paper	5000
Interest Cost (@10%)	Rs/Mt paper	1342
Total Operating Cost	Rs/Mt paper	6342
Annual Operating Cost	Rs.Cr.	23.0

The investment and operative cost based on the suggested flow sheet, for 100 MT per day capacity paper mill has been estimated as above. Post-Charter scenario after implementation of CPCB's proposed Charter was assumed and discharge volume as per the Charter's stringent norms was considered for calculations. For a 100 tpd paper production the additional cost for ZLD has been estimated to be more than Rs 6,342 per tonne of paper. These estimates are very conservative due to the fact that current water consumption level is two times of the norms as proposed under the CPCB's Charter. Huge investment, and implementation time, would be required to reduce the current level of water consumption, and wastewater discharge, to the Charter norms. If cost of Charter implementation is also included, the operative cost of ZLD would be much higher. Further, if the same system is used for small mills (less than 100 tpd) the operative cost will be higher due to lack of economics of scale.

CAPEX & OPEX costs of potential ZLD solutions appear to be prohibitive and unviable. The implementation of ZLD concept through standalone effluent treatment facility would render the mills unviable to operate.

5.0 Road map:

Ideal way is to optimize recycling by process technology optimization to minimize the pollution load at source. The proposed 'Charter for Water Recycling & Pollution Prevention in Pulp & Paper Industry' is based on BAT (European Union's BREF Document yet to be mandated) and has included all the aspects for pollution reduction, which is the accepted principle of pollution control globally. Thus the implementation of charter should be the first step and further control should be through continuous infusion of state of the art production technology and pollution abatement techniques. A concept like ZLD can only be implemented through a long term planning and R&D exercises. Implementation of ZLD would need vast changes in the process of production, which cannot be carried out at this first instance.

The most progressive way forward would be to:

a. Notify, and firmly enforce, the proposed CPCB's 'Charter on Water Recycling and Pollution Prevention in Pulp & Paper Industry' since it will:

    i. raise the effluent related environmental performance of Indian pulp & paper industry in general, and the industry in the Ganges River Basin in particular, comparable to the world's best mandated practices.
    ii. reduce the Ganges River Basin Paper Industry's effluent discharges, and hence the water-borne pollution loads, by more than 50%.
    iii. would make the pursuit of ZLD development options more manageable and economically meaningful on account of the reduction in effluent generation volumes

b. Establish full scale ZLD pilot plants (with entire range of unit operations up to solids handling) at versatile host mills and undertake real-time operations to determine:
    i. Extent of water recovery possible
    ii. Sustainability of 24x7 operations over long periods
    iii. O&M costs
    iv. Upstream changes required
    v. Cross-media environmental impacts

    Ideally at least three such pilot plant facilities would be required, one each, for RCF mills producing brown grades, for RCF mills producing white grades and for fully integrated pulp and paper mills. Enabling Government incentives would help to jump start such pilot plant and related R&D efforts.

Since the ZLD concept and its technology development worldwide is a "work in progress", it should be periodically reviewed, perhaps midway during the Charter implementation, to introduce additional and appropriate regulatory initiatives.

****

ANNEXURE - IV

ZERO LIQUID DISCHARGE' (ZLD) SYSTEMS FOR SUGAR SECTOR

1.0 Sugar Sector

Sugar sector is the second largest agro based sector in India. A total of 603 industries are presently operating in different states of India and Uttar Pradesh and Maharashtra accounting maximum numbers. Sugar mills are seasonal industries, thus ETPs are not operated in off season. Large quantity of water is consumed and wastewater is generated in this sector. It is estimated that raw water consumption is about 150-200 lit/T of cane crushed and water generation is around 100 to 300 lit/T of cane crushed. As per CREP industry have to reduce waste water generation to 100 l/T and also allowed to practice zero discharge to in inland surface body by irrigation etc. Strength of wastewater is not very high but due to pollution load, (BOD = 800-1200 mg/l, COD = 2000 -3000 mg/l) sugar sector is classified as highly polluting industrial sector.
The treatment system (suggested as anaerobic as primary and aerobic as secondary) is also well defined and is able to achieve the regulatory standards if the ETP is operated properly.

2.0 Guidelines to achieve water conservation

- The CREP guidelines for restricting effluent generation to 100 Liters/ton cane crushed to be implemented by all sugar units.
- Water consumption also to be restricted to 100 liters / ton initially and further to 50 Liters/ton cane crushed in a time bound manner.
- Installing condensate polishing unit mandatory to reduce temperature and recycle excess condensate to process or ancillary units.
- Water management/audit to reduce spray pond/cooling tower blow downs and excess condensate.
- Irrigation protocol for disposal into land applications.

Regulatory control to insist for ZLD in sugar sector may be discouraged. No sugar plant in the country has been so far attempted to go for a ZLD system, in its true sense. Most of the time industries are misrepresented/publicized the practice of irrigation as ZLD.

****

ANNEXURE - V

ZERO LIQUID DISCHARGE (ZLD) SYSTEMS FOR PHARMACEUTICALS

1.0 Pharmaceutical Sector

In this sector most of the industries are operating based on partial ZLD system and partially treating effluent in the conventional way. In most of the cases domestic effluent is treated separately or mixed with either low or high TDS effluent. The mixed salt recovery and no takers of salt generated is one of the problems of the industry since there is no reuse of same by the industry. In pharmaceuticals the reuse of by products are not encouraged much since it is following very high quality standards for each raw materials. The effluent is generally segregated based on the strength of the pollutants in the early stages itself.

2.0 Low TDS Effluent treatment system

Common collection tanks, Neutralization tanks, tubular settler, Aeration followed by clarifier, tertiary chemical treatment to reduce TDS followed by Pressure sand filter, Activated Carbon filter and filter press for dewatering of sludge generated from clarifloculation are the major components. The secondary treated effluent is being treated through Disk membrane type R.O. The R.O. permeate is utilized as cooling tower makeup water and R.O. reject is treated through Multi effect evaporator. In case of high COD and TDS in RO permeate the same is treated through Spiral type RO, to meet the requirement of cooling tower.

1.2 High TDS Effluent treatment system

The treatment of High TDS effluent consists of Common Collection tanks, Settling tank followed by filter press, stripper to remove VOC, 3 stages Multi Effect Evaporator (forced circulation) and a Agitator Thin Film Drier (ATFD). The MEE condensate is being taken along with Low TDS effluent for further treatment. MEE concentrate is being dried through ATFD and salt is collected and stored in Hazardous storage yard and the same being sent to TSDF or stored in the industry.

*****

ZERO LIQUID DISCHARGE IN TEXTILE SECTOR

INTRODUCTION

The implementation of ZLD in textile sector was a long process but due to court interventions and strict regulatory norms in Tamilnadu in almost 13 CETPs and many IETPs are following the ZLD system.

HIGHLIGHTS OF ZLD IN TEXTILE SECTOR

- ✓ CETPs receives effluent through pipeline from member units.
- ✓ Member units are strictly using sodium sulphate salt in the process.
- ✓ 50% of the member units are exporters and remaining 50% are domestic suppliers.
- ✓ The RO efficiency is worked out as 80 to 85 %.
- ✓ Steam consumption at MVR is 1000 kg/hr,
- ✓ CETP charges 4 paise per liter of permeate while the fresh water charges is 7 paise per liter and Rs 5/- per kg of CETP salt whereas outside price for salt is Rs. 14 per kg. Around 5-6 tons/day of sodium sulphate (example of one CETP) is recovered and given back to the member units for reuse.
- ✓ 1.5 tons/day mixed salt recovered from solar evaporation pond.
- ✓ Solid concentration has increased from 6.68 to 10.9% through MVR and further it was increased upto 43.4% through MEE falling film.

ENVIRONMENTAL CHALLENGES

- 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.

OPTIONS AND TECHNOLOGIES

a) Ozonation + bio-oxidation + sand filtration + activated carbon adsorption + micro filtration + reverse osmosis(3 stage) + multiple effect evaporator

b) Chemical precipitation + bio-oxidation + chemical precipitation + sand filtration + Activated carbon adsorption + micron filtration + reverse osmosis (3 stages) + multiple effect evaporator

c) Chemical precipitation + bio-oxidation + sand filtration + dual media filtration + micron filtration + reverse osmosis (3 stages) + multiple effect evaporators.

****

Annexure VII

ZERO LIQUID DISCHARGE IN REFINERIES

Introduction

There are 21 refineries in India with crude processing of 210MMTPA and most of the refineries are located in coastal areas. The water consumption is around 2.0m^3/ton of crude and waste water generation is around 0.8 to 1.2m^3/ton of crude. The major parameters are oil & grease and dissolved salts. The fresh water requirement for processes, availability of fresh water in the region mainly governs the waste water recycling practices adopted by each industry.

Based on the necessity of soft water most of the refineries in coastal areas are achieving Zero Liquid Discharge and other refineries are recycling up to 85%. The treated wastewater is mostly utilized as make up water, for firefighting purposes, green belt development and other maintenance works.

Control Measures

The steam condensate in process plants is being recycled back to the boilers as feed water for steam generation thereby resulting in reduction in the fresh water consumption. The stripped water from sour water strippers is recycled to make up water to the desalting process in crude units. The VOC adsorption system as per the new standards has improved the treatment efficiency.

Treatment Methodologies

Most of the refineries have provided API, primary treatment, secondary treatment and tertiary treatment. The tertiary treatment is mainly Reverse Osmosis and permeate is utilized and rejects are discharged into cooling tower. In some of the coastal refineries the sea water is used as cooling water and this itself is having higher TDS and RO rejects are having lesser TDS.

In some of the Refineries High Efficiency Reverse Osmosis are provided as these operate at elevated pH resulting in significant advantages over conventional Reverse Osmosis which operates at neutral pH and efficiency is 86% thereby reducing the cost of desalination.

****

Annexure VIII

ZERO LIQUID DISCHARGE IN FERTILIZERS

Introduction

There are around 35 nitrogenous & complex fertilizer units in India and 95 Single Super Phosphates units. During last two decades there has been reduction in water usage for fertilizer manufacturing operations and increase in reuse of treated effluent like in most of Urea manufacturing plants, process condensate from NH_3 and urea plant are treated in urea hydrolyser stripper and reused.

The water consumption has reduced from 5.0m^3/ton of urea to 4.0m^3/ton of Urea. The effluent generation is in the range of 0.80-1.33m^3/ton of Urea achieved through in plant control measures. Depending upon the availability of water and social obligation the waste water is recycled and also utilized for irrigation purposes.

Nitrogenous Fertilizers

The major parameters in waste water are pH and ammonical nitrogen. The waste water treatment comprises of neutralization, ammonia stripper and settling tanks. The treated effluent is further treated in Reverse Osmosis and permeate is reused in the process and rejects are utilized as filler material in custom made fertilizers as these are mainly salts.

Complex Fertilizers

The major sources are cooling tower blow down, regeneration effluent from water treatment plant &the major parameters are high TDS, pH and are treated in primary treatment comprising mainly lamella clarifier , multi grade filter , bio-filter followed by Reverse Osmosis. The RO permeate are used in process and RO rejects are utilized as filler in DAP plant.

****

ZERO LIQUID DISCHARGE IN DYES & DYE INTERMEDIATES

Introduction

H- Acid

The manufacturing process of H acid generates highly concentrate acidic effluent stream @ 15-18 ltrs / kg of product, having High COD and TDS values as Mother Liquor. The Mother liquor waste water generated is passed through crystallizer to recover Glauber salt that is reused in H acid manufacturing, whereas the waste water which is acidic is then neutralized. The neutralized effluent is passed through the quadruple effect Multiple Effect Evaporator , where in condensate @10 ltrs/kg generated is reused back in the process for hot water wash /cooling tower make up, and the concentrate Mother Liquor having specific gravity 1.3-1.35 , is high in organics , is incinerated, spray dried .

The said system results in:

a. Recovery of Glauber salt which is reused in H acid manufacturing.
b. Reduction of salt in waste water to smoothen the MEE operation
c. Reuse of condensate water from MEE reducing the water requirement.

Vinyl Sulphone

The manufacturing process of Vinyl Sulphone generates two effluent streams.

[A]. Acidic waste water i.e. 20-28 % acidity sulfuric acid@ 6 ltrs/kg is generated from drowning of sulpho mass in Ice chilled water in ASC manufacturing. The unit has gone for ice less dumping, reducing the acidic waste water generation and increasing the % acidity of the spent acid generated. The spent acid generated is used in H acid manufacturing.

[B].The other stream is Ethoxylation waste water generated during the condensation stage of reduction mass with Ethylene oxide. The Ethoxylation waste water generated @ 6-6.5 ltrs/kg is having high COD/TDS. The Ethoxylation waste water [20% solids] is passed through the quadruple effect, Multiple Effect Evaporator to recover sodium sulphate which is used in dyes manufacturing, where as condensate water is used back in condense washings and cooling tower makeup.

****

Table -1 Concept of ZLD and Treatment Options, Sector wise

S.N	Sector	Treatment options	Remarks
1	Distillery	1. Bio-methanation followed by R.O/MEE followed by incineration (slop fired). 2. Bio-methanation followed by R.O/MEE followed by drying (spray/rotary). 3. Concentration through MEE followed by co-processing in cement/thermal power plant. 4. Bio-methanation and RO followed by MEE followed by bio-composting. (As per new protocol)	ZLD achievable
2	Tannery	Primary treatment + secondary treatment+ pre- treatment for RO + Reverse Osmosis +, MEE (recovery of permeate, crystallised salt, reuse of the recovered condensate)	ZLD achievable
3	Pulp & Paper	Primary treatment + Degasification + RO, 2 stage + NF and UF + Evaporator, Concentrator/Crystallizer	Black Liquor totally to be ZLD in any plant. Other plants ZLD as per charter concept
4	Sugar	Restricting effluent generation to 100 Liters/ton cane crushed. Water consumption to be restricted to 100 liters / ton initially and further to 50 Liters/ton cane crushed. Condensate polishing unit mandatory Recycle of excess condensate to process or ancillary units. Water management/audit to reduce spray pond/cooling tower blow downs and excess condensate. Irrigation protocol for disposal into land applications	Water conservation & irrigation protocol as alternate to ZLD
5	Pharmaceuticals	Low TDS Effluent treatment system Primary treatment+ Secondary treatment + tertiary chemical treatment to reduce TDS (Pressure sand filter, Activated Carbon filter and filter press for dewatering of sludge). RO	ZLD achievable

		system (permeate is utilized as cooling tower makeup water) + Multi effect evaporator/incinerators. High TDS Effluent treatment system Primary treatment + stripper to remove VOC + 3 stages Multi Effect Evaporator (forced circulation) Agitator Thin Film Drier (ATFD)+(MEE condensate is being taken along with Low TDS effluent for further treatment)+ MEE/incineration.	
6	Textiles	1.Ozonation + bio-oxidation + sand filtration + activated carbon adsorption + micro filtration + reverse osmosis(3 stage) + multiple effect evaporator 2. Chemical precipitation + bio-oxidation + chemical precipitation + sand filtration + Activated carbon adsorption + micron filtration + reverse osmosis (3 stages) + multiple effect evaporator 3. Chemical precipitation + bio-oxidation + sand filtration + dual media filtration + micron filtration + reverse osmosis (3 stages) + multiple effect evaporators	ZLD achievable
8	Refineries	API, primary treatment, secondary treatment and tertiary treatment. The tertiary treatment is mainly Reverse Osmosis and permeate is utilized and rejects are discharged into cooling tower	Water conservation, Reuse & partial ZLD
7	Fertilizer	Chemical treatment+ Reverse Osmosis (Rejects as filler material and permeate in the process)	Water conservation, Reuse & partial ZLD
9	Dye & Dye intermediates	Chemical Treatment+ MEE	ZLD achievable