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# Ask Tom! Column

## Practical Aspects of an Effluent Recycle System

Guest article by Shrikant Deshpande, Thermax

**Introduction**

One of the most important topic being discussed all across the industry today is," The Effluent Recycle". There are several reasons due to which it becomes imperative for the industry to consider the recycle of the wastewater generated by it. The reasons are normally of two types. The internal reasons like future expansion needing more water for various usages and external reasons like revision of Pollution Control Board norms towards immediate or eventual, "Zero Liquid Discharge". It is very common observation that the fresh water available all around is being allocated to the community consumption and industries are asked to manage on its own. This leaves the choice of tapping a water source like river, borewell or sea. There are fresh regulations in some areas for restricting the withdrawal of water from river or deepwell.

It is observed that the lowering of water table has reduced the availability of ground water and deteriorated its quality. In some areas it is simply not available. Because of such and other reasons today industries are actively considering a recycle of wastewater. There are already some effluent recycle installations in India and abroad working in various industries. There is enough data on operation and maintenance of such system. This paper is intended to share the practical technical aspect of Effluent Recycle System.

**Feasibility Studies**

It is very important to carry out the Feasibility Studies of Effluent Recycle System right upfront. The Feasibility Studies will normally consider the following aspects:

- Capital cost for ETP modification, Recycle system and reject disposal.
- Evaluation need for recycle.
- Present WWTP Practices.
- Long term planning for water consumption in future.
- Reject disposal arrangements.

The Effluent Recycle usually makes an in-house, reliable, good quality additional water source available for the industry. Hence, even if today it is not required, the Effluent Recycle plant can be planned for future. It is obvious that with time all the industries will be asked to go for, "Zero Liquid Discharge". With present practices of Effluent Recycle, the cost of Recycle water is higher than the fresh water available. (It ranges from Rs. 20 - 30 per M3). But the recycled water quality is usually much better for common applications like boiler feed, cooling tower make up, some parts of process.

Reject disposal is one of the most important deterrents in the Feasibility study of recycle system with Reverse Osmosis. The system generates the reject, which is high in total dissolved solids, COD & BOD. Some of the ways of disposal of reject are as follows:

1. Mixing with other effluent to dilute and disposal.
2. Evaporation by solar ponds.
3. Thermal Evaporation.
4. Direct disposal to sea.

Presently, most of the industries are using option 1 & 2. For reject disposal by solar ponds the area requirement is one of the constraint (usually 5 mm / M3 / day.). However, as this is one time investment with negligible operation and maintenance cost, hence widely in use. The salt after evaporation is filled in the bags and dumped at a suitable location.

Thermal evaporation is also becoming popular. This is usually with evaporator & crystallizer. The major advantage of Thermal Evaporation is drastic reduction in solar evaporation pond size, thus needing less area for overall reject handling system. At present the capital cost of Thermal Evaporation is prohibitively high and hence becomes one of the deterrents of feasibility of Effluent Recycle System.

There are some innovative approaches being actively considered throughout the industries for tackling the issues of reject disposal. In the industry where salt is used as filler in process, the reject can be directly used, hence consumed in house. It may be worthwhile for an industry to check, if they can use the RO reject somewhere in there process. The Evaporated salt from solar pond or thermal evaporator can be sold to the other industries for their usage.

Many times the overall feasibility of Effluent Recycle System does not fit in, in spite of careful evaluation of all the options.

**Factors for Successful Recycle System**

After the Feasibility Study is over, it may be worthwhile to consider some of the factors, which will affect the successful, recycle system. The major ones are as follows:

1. **Existing ETP design:** Effluent Recycle system is usually after the tertiary treatment. The design of existing ETP system is the most important factor. It is high time that the ETP system suppliers realize the difference in design of ETP for, “ meeting PCB norms for Disposal” and, “ feed to recycle system”. The Recycle System requires the consistency of parameters at all times. There are several aspects of ETP design, which can be improved to achieve consistent and better-treated effluent parameters. It is recommended to recheck the existing ETP design and the trend of parameters before going for Recycle.
2. **Recycle Design Basis:** It is recommended to carry out the analysis of treated effluent several times in different seasons for varied production practices and tabulate the results. It may be worthwhile to separate a highly polluting stream to ETP to achieve better-treated effluent parameter. Similarly, it may be worthwhile to consider a not so contaminated stream directly for recycle without feeding to WWTP. This exercise is necessary to achieve the consistency of recycle feed parameters.
3. **Good Tertiary Treatment:** Many ETP’s do not have adequate tertiary treatment. This needs to be incorporated.

**Use of Recycled Water**

The recycling of treated effluent does not necessarily need treatment by RO. The recycled effluent without TDS reduction (if not required) can be considered for usages like gardening, floor washing, toilets etc. It may become worthwhile in long term to install a separate pumping and piping system for this usage.

The recycle with Reverse Osmosis is becoming more and more popular as the treated water quality is far better for most of the critical application in the industry.

**Essentials of a Good Recycle System**

In case Reverse Osmosis is part of effluent recycle system the pretreatment of tertiary treated effluent becomes very essential. Most of the Reverse Osmosis membranes are delicate and prone to fouling by COD /

BOD, oil and grease, colloids, heavy metals etc, hence after careful evaluation of the recycle feed water, the appropriate units must be incorporated as a pretreatment to Reverse Osmosis. Pretreatment is usually for the following parameters:

1. **COD & BOD:** Most of the ETP's are designed to reduce the BOD and COD up to the PCB disposal norms (250 / 30). However, for Reverse Osmosis these values have to be much lesser.
2. **Oil & Grease:** The RO membranes are prone to fouling / choking with oil and grease. The desired value for RO feed is nil.
3. **Heavy Metals:** They tend to foul the membranes and affect irreversibly. This needs to be reduced to nil.
4. **Dissolved/Colloidal Silica:** The dissolved silica is one of the major parameter in deciding the recovery of Reverse Osmosis system. Hence it is preferable to reduce it as low as possible. Colloidal Silica usually slips from most of media filtration system hence needs to be reduced.
5. **Excessive Hardness**: The excessive hardness in the feed water limits the Reverse Osmosis recovery severely; hence this needs to be removed upfront.

The success of a good recycle system is in efficient pretreatment of various foulants. Hence it is advised not to compromise on pretreatment system to reduce the initial capital cost. An inadequate pretreatment will result in enormous problems in future thus proving costlier.

**Pretreatment Units for Recycle RO**

With the advancement in technology in water treatment over a period of time there are several options available for pretreatment to Reverse Osmosis. A combination of various units can be considered on case-to-case basis. Some of the unit operations are as below:

1. **Media Filtration:** A good media filtration is very essential to reduce the suspended parameters and colloids. There are options like sand filtration, anthracite filtration or garnet filtration. The design of the media filter for recycle pretreatment is usually different from regular water treatment filters.
2. **Carbon Filtration:** A good activated carbon filter with high quality carbon goes a long way in polishing the effluent and making it more suitable for RO feed. Here the quality and size of carbon has to be different from regular filters.
3. **Disinfectant by Oxidants:** It becomes inevitable to dose chlorine (liquid or gas), ozone, H2O2 for reduction of organic matter. The dosages of these chemicals need to be correctly selected. The dosing equipment should be adequately sized and provided with necessary interlocks and alarms. The retention time for adequate reaction of oxidant is very essential for good results.
4. **Advanced Oxidation Technology (Photo Chemical Oxidation):** There are some evidences of successful usage of advance oxidation technology for reduction of COD. However, in absence of adequate data these usually needs pilot testing.
5. **Organic Scavenger (Resin Based):** It is observed that the incorporation of resin based organic scavenger after the filtration is effective in further polishing of organic matter and reduction of SDI. There is enough past data for use of this technology for effluent recycle.
6. **Reactivator-Type Clarifier:** A sludge recirculation type clarifier is being increasingly used as the first unit in a recycle system. This helps in reduction of dissolved silica and hardness, precipitation of heavy metals and other ions and control of colloids in addition to effective removal of suspended matter. This also helps in reduction, of organic impurities associated with suspended matter.
7. **Ultrafiltration (Dead End Tubular):** Popularly known as "UF". It is becoming the best choice as a pretreatment for recycle RO system. This effectively reduces the colloids and organic matter and helps in maintaining the constant SDI to RO feed. This enhances the life and operating cost of RO substantially. The tubular UF systems are usually back-washable hence does not get fouled easily. If UF is incorporated in pretreatment, the carbon filtration, micron filtration etc can be eliminated. There are certain evidences that due to the constant good quality of water after UF the RO block size can be optimized.

The UF is becoming popular in India recently and is being actively offered by various OEM's in the Water Treatment Industry. The capital cost of the UF system is presently high due to heavy import components but is likely to reduce over a period of time.

**RO Design**

The RO block for an effluent recycle system needs to be designed differently as compared to normal brackish water. It is understood that in spite of all the precautions in pre treatment some of the impurities will slip into the RO block thus causing fouling to the membranes. To make the RO block safer in design following factors needs to be considered.

1. **Surface Area:** Adequate membrane surface area to be provided (GFD of 8- 10).
2. **Choice of Correct Membrane:** The RO membrane should be fouling resistance, smooth surface with enough feed spacer thickness. The past data on a particular membrane module for similar application must be collected. It is also important that the membrane selected is "Tough". It should be able to regain its performance ever after repeated cleaning.
3. **Membrane Cleaning/Flushing System:** It is very essential to have adequate membrane flushing and cleaning system. This helps in keeping the membrane surface clean and extend the life. Additional disinfectant dosing system can also be incorporated.
4. **Control & Interlocks:** IT is essential to provide the system with adequate instrumentation, controls, interlocks to facilitate the smooth operation and timely corrective actions.

In addition to all the above good operation and maintaining practices shall go a long way in success of an Effluent Recycle System.

**About the Author**

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