CLEANING UP GANGA RIVER HOW "EASY" IS IT?

WWW.GANGAACTION.ORG

PREPARED BY
KIRAN PANDYA
TECHNICAL CONSULTANT
WATER TREATMENT PROJECTS
GANGA ACTION PARIVAR
For questions email: pandyaken@gmail.com

Introduction

- Being one of the most important ancient rivers in the world, the Ganga serves millions of people including commercial, industrial, and agricultural customers.
- Due to exposure to people, lack of flow, livestock, fertilizers, and highly polluted municipal/industrial effluent streams the Ganga River is severely polluted
- Pollution from municipal sources include: high levels of organics, BOD, COD, oil and grease, TSS, fecal coliform and low oxygen levels.
- Pollution from industrial sources include: BOD, oil and grease, toxic chemicals, metals, very high dissolved solids, and low oxygen levels
- The Ganga River attracts attention from all over the world including: many nations, NGO's, Government of India, citizens of India, and NRI's.
- The Government of India under the leadership of PM Modi has taken a strong initiative to clean up Mother Ganga.

Ganga Action Parivar's Mission

- Ganaga Action Parivar (GAP) under the guidance of Pujya Swami Chidanand Saraswati, plays a very important role in the mission of cleaning the Ganga.
- Gap Mission includes cleaning up the streets, towns, improving sanitation, public education, working with the government, commercial operations, industries, and technology providers.
- Biosand filters and flush-free toilets for the general population.
- For the purpose of this paper, we will limit our discussion to municipal wastewater treatment and industrial wastewater treatment technologies.

Suggested Approach to Cleaning Ganga River (1)

- Evaluate and understand the Ganga river pollution problem from all possible angles.
- Promote public education and awareness related to municipal and industrial wastewater treatment technologies.
- Evaluate and promote cost effective, innovative technologies including pilot demonstration plants for treatment of municipal and industrial wastewater treatment.

Suggested Approach to Cleaning Ganga River (2)

- Recognize that there are no “quick fix” solutions to the highly complex problems including poorly functioning, inadequate or insufficient municipal and industrial wastewater treatment systems.
- Evaluate all technologies that make sense in Indian environment including political climate, and economical realities.
- Consider step-by-step approach with “checks and balances” all the way. Build a solid foundation and robust pretreatment technologies to support more advanced technologies.

Treatment of Municipal Wastewater Streams (1)

- Most of the municipal wastewater treatment plants in India utilize primary and secondary treatment technologies.
- Primary treatment technologies are designed for removal of grit, plastic bags, debris, larger particles, oil, and grease. These technologies include either stationary or moving bar screens, skimmers, etc.
- Secondary treatment technologies utilize biological treatment processes and include forced or natural aeration, floatation, gravity settlement, and clarification technologies. In some cases PH adjustment is used for optimum efficiency.
- Moving BED biofilm reactor (MBBR) technologies are available in India. These technologies are playing a critical role in biological treatment of wastewater streams.
- Effluent from secondary treatment process can e further “polished” by use of gravity or pressure filters, carbon filters, and subject to ozone or UV light for disinfection. These technologies are available in India although mostly used in industrial water treatment plants.

Treatment of Municipal Wastewater Streams (2)

- In the USA, higher efficiency secondary treatment technologies such as **BLUE FROG TECHNOLOGY,** provide highly satisfactory results. They are simple to use require minimum power, maintenance, no chemicals, and no UV or ozone treatment. Effluent is typically discharged directly in a surface water body.
- These technologies achieve us EPA guidelines for surface water bodies (rivers, ponds) or farmland application standards.
- Typical performance of BLUE FROG TECHNOLOGY
  - 30 MG/L BOD
  - 50 MG/L TSS
  - 17.4 MG/L Ammonia
  - Pathogen (E.Coli) <126 MPN
  - No odor
- Advanced treatment, future trends: Membrane Bio reactor (MBR) process that use micro filtration, ultrafiltration and reverse osmosis technologies greatly enhance biological treatment. However, they can be capital intensive projects, will require high operation and maintenance cost, and will require highly skilled operators.

Treatment of Municipal Wastewater Streams (3)

- In the USA there are high levels of interest to reuse the municipal wastewater treatment plant effluent for irrigation purposes, makeup for cooling towers in power plants, makeup for hydraulic fracking industry, etc. Such wastewater treatment plant effluent streams may be purified further by the end user.
- Advanced purification technologies include disinfection, chemical treatment, clarification, lime-soda ash softening, microfiltration, ultrafiltration, reverse osmosis, etc.
- In the USA the municipal wastewater treatment plant managers and operators are held accountable for plant performance and strict compliance with the applicable environmental regulations. Willful non compliance is not tolerated and is subject to processing in the criminal justice system.
- Several smaller communities in the USA consider outsourcing the design, operation, and maintenance of municipal wastewater treatment plants to service providers that specialize in such work.

Treatment of Industrial Wastewater Streams (1)

- There are all types of industries that contribute to the flow (and pollution) to the Ganga river. These include leather manufacturing, pulp and paper, sugar, etc. Each industry is unique which means each wastewater stream is unique.
- Industrial wastewater streams tend to be fairly complicated due to several reasons.
  - Origin of contamination could be suspended solids, colloidal particles, dissolved organics, oil, grease, dissolved inorganics, metals, and gases.
  - Hourly, daily, weekly, and seasonal variations in flows as well as chemistry.
  - The treatment plant must be designed on the worst case scenario changes in manufacturing practices will change in water use, flows, and wastewater composition.

Treatment of Industrial Water Streams (2)

- There are two typical trends in Indian industrial wastewater treatment projects: (A) Treatment at the industrial plants and (B) common effluent treatment plants (CETP)
- Most of the CETP have primary, secondary, and tertiary treatment capabilities.
- Typical Performance of CETP effluent in Kanpur area:
  - COD: 350-400 MG/L, BOD: 20-30 MG/L, TSS: 100 PPM, PH 6.5-8.5
  - NH4: 50 total dissolved solids 8000-10,000 MG/L 80
- CETP are responsible for meeting current effluent standards that have been mandated by the current environmental regulating agencies.
- CETP act as NGO's, work with the contributing industry representatives. CEO's from each industry are board members of the CETP management team.

Treatment of Industrial Water Streams (3)

- CETP are ideal for providing a platform for higher level of wastewater treatment.
- CETP are typically equipped with water testing analytical laboratories.
- CETP play a critical role in Ganga cleaning. Best hope for the future!
  - Provide central location for treating some of the most polluted wastewater streams from several industries including leather industries, chemical plants, pulp and paper plants, and power plants.
  - Provide skilled and trained managers, engineers, operators, and maintenance personnel.
  - Provide better liaison between the industry, the government, and general population.
  - Provide documentation of plant operation including daily effluent flow and water quality monitoring.
  - Provide higher level of accountability and transparency.
  - Provide pilot capability for testing newer technologies.

Zero Liquid Discharge (ZLD) Technologies (1)

- There is a lot of discussion in India about ZLD, both for municipal and industrial effluent treatment plants.
- Environmental laws are existing in India. What about implementation of such laws? That requires “buy in” from all levels.
- Cost of implementing with environmental regulations is substantial, but businesses must understand those costs, be willing to either absorb those costs, or pass it on to their customers.
- It is easy to “talk” about ZLD technologies, but on a practical level, very difficult to accomplish on a global scale.
- Each wastewater stream will be unique in composition and will require custom-engineered solutions.
- Not a good idea to consider “standard design” approach.
- Step-wise approach is highly recommended when approaching these technologies.

Zero Liquid Discharge (ZLD) Technologies (2)

- Strongly recommended ***<u>SITE SPECIFIC PILOT STUDIES</u>*** before committing to specific technologies, particularly pre-treatment.
- These are very expensive technologies. Lots of lessons learned.
- Even for relatively clean surface water, seawater streams the ZLD technologies have experienced challenges.
- For highly polluted industrial wastewaters streams, the challenge will be exponentially higher.
- Huge emphasis on working with laboratories, trainers, consulting companies, equipment fabricators and service providers ***<u>WITH PRIOR ZERO LIQUID DISCHARGE PROJECTS EXPERIENCE</u>***
  - Highly specialized analytical laboratories at plant level, centralized labs, government owned labs for checks and balance.
  - Strong training program for all disciplines
  - Qualified consulting firms to develop specifications, evaluate proposals, and qualify suppliers
  - Adequately trained technicians, engineers, designers, equipment fabricators, service and support network
  - Remember. India has “Made In India” philosophy- could be a challenge!

ZLD Technologies: Challenges (1)

- It is absolutely important to have a very thorough understanding of wastewater composition. Example: Full analysis of inorganic, organic, suspended solids, colloidal particles, and microscopic level impurities (down to 0.05 micron particle size)
- Any variations in feedwater temperatures, wastewater analysis, flow rates will impact plant performance- must be considered while designing and building such systems.
- Designing of pretreatment systems is extremely critical If pretreatment system fails, the ZLD system will fail.
- Pretreatment systems typically include robust primary, secondary, and tertiary treatment systems, UF and RO membrane systems.

ZLD Technologies: Challenges (2)

- Classic ZLD system is designed with ultra filtration (UF) and reverse osmosis (RO) membrane processes in the pretreatment loop.
  - Ultrafiltration (UF) systems are typically designed for 90% Recovery -10% of the liquid waste stream containing high concentration of suspended solids, organics, etc.
  - Wastewater RO systems typically will have 50-25% reject stream.
  - RO reject streams will have high concentration of mostly inorganic salts.
  - RO reject typically goes through softening process to remove hardness, then to an evaporative system (evaporator, crystallizer, dryer, brine concentrator, solar ponds, etc.)

ZLD Technologies: Challenges (3)

- Each wastewater evaporative system ahs opportunities and challenges.
  - Opportunities include recovery and recycle pure water.
  - Challenges include
    - Very high capital costs.
    - Very high energy costs (brine concentrators, crystallizers, dryers), massive structures (brine concentrators, evaporators, crystallizer)
    - High cost of maintenance
    - In most cases use of corrosive chemicals for cleaning-further environmental issues
    - Highly trained operators, maintenance staff

ZLD System Costs

- Development of accurate cost model for ZLD systems can be challenging due to several factors
  - Each wastewater composition is different. Even water temperatures have significant impact on the design and cost.
  - Daily, weekly, monthly, seasonal volumes can change rapidly.
  - Must consider standby components to allow cleaning and maintenance.
  - Must allocate space for plant expansion, making changes to the process.
  - Availability of evaporative ponds, pond liners, etc.
  - Availability of energy. If waste heat is available, there will be significant reduction in operating cost indoor vs. outdoor installations.
  - Cost of process components/materials, redundancy for reliable purpose.
  - Typical capital, installed cost for a 1090 M3/day (200 GPM) wastewater thermal process (evaporator/crystallizer), built to US standards
  - Can be in the range of $150 million. Typical operating cost can be in the range of 3-7 times RO membrane process (*Source electrical power research institute-EPRI)*

Design/build or Outsource?

- Owner operated, design/build/operate model is common in the USA.
- For fresh water (ground, surface) treatment plants, many projects are outsourced.
- Outsourcing industrial wastewater ZLD systems in India should be considered, to minimize risk to the owner.
- Outsourcing contractors must evaluate the risks very carefully, including ever-changing composition of wastewater streams, flows, etc.
- Buyers must read “fine print” in the contractual language. Typically there will be plenty of escape clauses to minimize risk to the seller.
- Buyers must carefully evaluate sellers’ capabilities and performance history.
- Key point is to understand wastewater characteristics and variations.
- Owner’s representative– consultant-plays extremely critical role in this process. Be sure to check his qualifications and history of performance!

Closing Thoughts (1)

- Huge challenges for municipal as well as industrial wastewater treatment plants.
- It takes years of experience to build and operate ZLD systems successfully.
- Must have infrastructure in place in India– Including highly advanced analytical labs, training program for the designers, engineers, operators and managers, highly knowledgeable process consultants, equipment manufacturers, system integrators, service network, etc.
- Accountability and compliance to the environmental laws is critical for both municipal and industrial wastewater treatment plant operators.
- ZLD systems must be designed very carefully. Any mistakes will prove to be very costly.
- Properly designed pretreatment/UF systems will remove suspended solids, bacteria, pathogens, most organics, but not minerals.

Closing Thought (2)

- Properly designed UF/RO systems will remove most of impurities including minerals.
  - Concentrate UF and RO reject streams will require careful disposal plan.
  - Will require chemicals management.
  - Very expensive to own and operate. Energy intensive.
- ZLD systems with UF/RO/Evaporator/crystallizer will allow recovery and recycling of pure water.
  - Will require a plan for safe storage/disposal of dry salts.
  - Dry salts will require careful handling and disposal plan.
  - Extremely expensive to own and operate. Entergy intensive.
- Outsourcing to qualified service companies can be a powerful option However, read the "fine print" of the contract. Hire experienced consultant!
- Step-wise approach is highly recommended.
- Lots of lessons learned in the water treatment industry, particularly in the USA.