Water Optimization - 2020

Organizer

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Speaker

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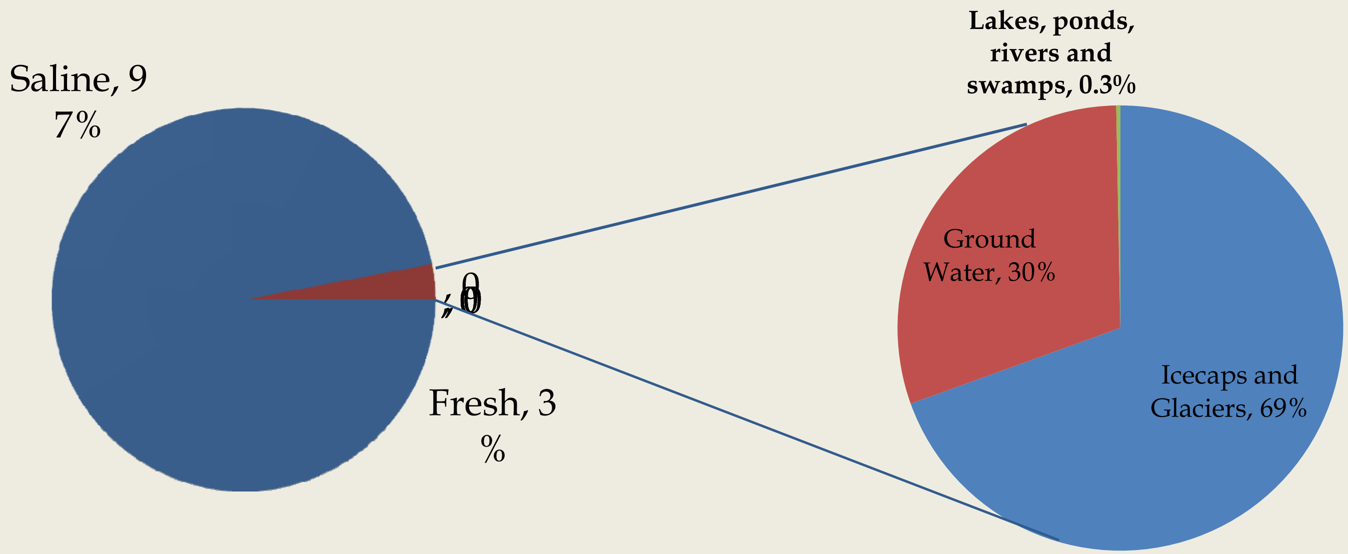
Presentation Structure

1. Water Scenario – It's availability and utilization in India
2. Industrial cooling water consumption
3. Focus areas for reducing water consumption
4. Technology and improvement in waste water treatment
5. Conclusion

The Water Scenario

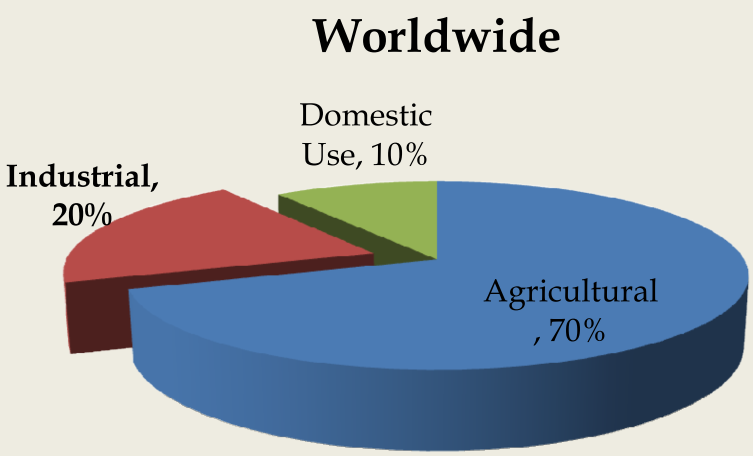
Availability and Utilization

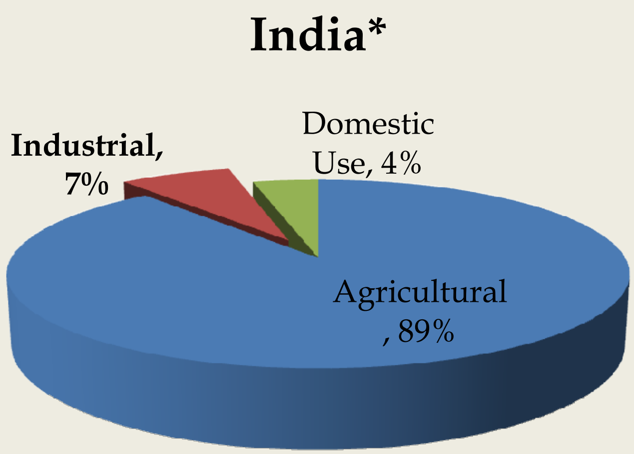
Availability of Water on Earth



- Only 3% of water on earth is Freshwater
- Out of this 3%, only 0.3% is available through Lakes, Ponds, Rivers and Swamps

Utilization of Water





- India uses only 7% of its water for Industrial purposes against a world average of 20%
- Industrialized Nations use over 50% of their water for industries. Example: Belgium uses 80%

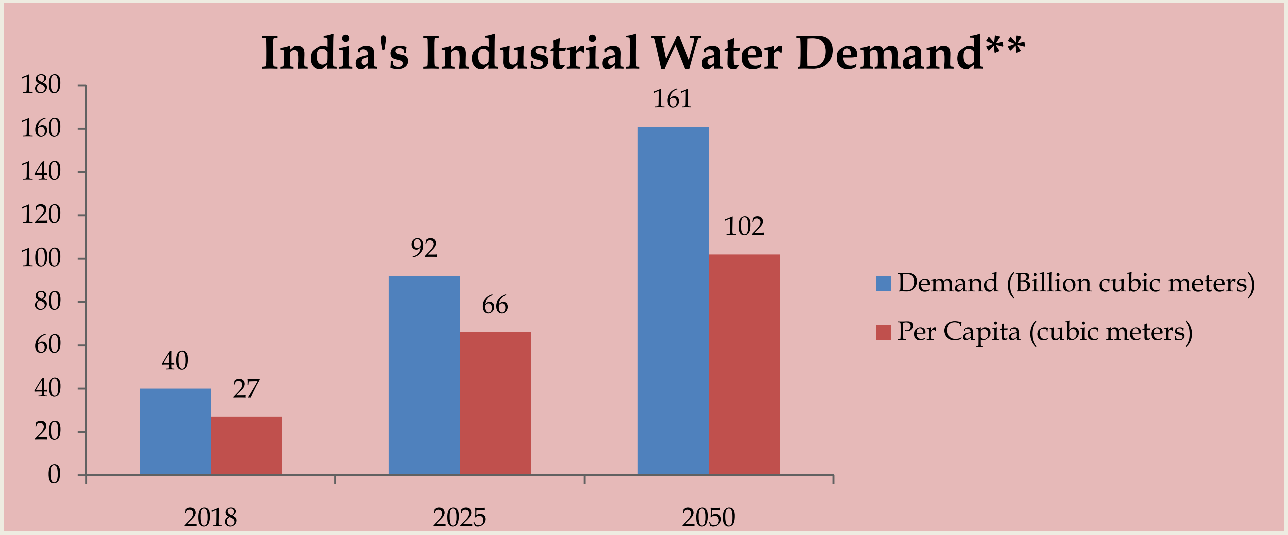
*Source: KPMG

India's Water Burden

India is a Water Scarce Country

- 4% of world's Freshwater
- 16% of world's population
- 2.4% of land

- Low Irrigation Efficiency of **36%***
- This has to be raised to **50%** by 2050 to match Demand - Supply



*Source: World Water Assessment Program, UNESCO
** Industrial Water Management Institute, New Delhi

Industrial Water Consumption

Water Requirement – Industry wise

Type of Industry	Unit of Production	Water Required (m^3 / unit)
Automobile	vehicle	40
Distillery	Kilo Liter	122-170
Fertilizer	Ton	80-200
Leather (Tanned)	100 kg	4
Paper	ton	200-400
Straw Board	ton	75-100
Petroleum Refinery	ton	1-2
Steel	ton	200-250
Sugar	ton	1-2
Textiles	100 kg	8-14
Dairy	1000 liter	6-10

Consumption & Waste Water Generation

Industrial Sector	Water Consumption (million m3 / yr)	Share of Total Industrial Water (%)	Waste Water Discharge (million m3 / yr)
Thermal Power Plants	35,157	87.9%	27,001
Engineering	2,020	5.0%	1,551
Pulp and Paper	906	2.3%	696
Textiles	830	2.1%	637
Steel	517	1.3%	399
Sugar	199	0.5%	150
Fertilizer	74	0.2%	56
Others	314	0.8%	241
Total	40,012	100.0%	30,729

- Thermal power plants use ~88% of the total industrial water in India because of high heating and cooling cycles
- In thermal power plants, wastewater discharge is high due to blow down, evaporation and unavoidable water leakages

Source: CSE

Industrial Water Use Productivity

Country	Industrial Value Added (IVA), 2001 (in billion constant 1995 USD)	Industrial Water Use, 2000 (km^3/yr)	Industrial Water Productivity (IWP), 2000 (USD IVA m^3)
Japan	1,890	16	119.6
Korea, Republic of	286	3	93.7
UK	340	7	47.3
The Netherlands	120	5	25.2
Germany	748	32	23.4
USA	2,148	221	9.7
China	594	162	3.7
India	120	35	3.4

- Water Demand will grow @ 4.2% as per World Bank* for industrial use and energy production
- UNESCO estimates the Industrial Water Productivity (measured in the term of value addition by industries with per unit consumption of water) is only 3.2 USD/m^3 **

*Source: India Infrastructure Report, 2011
** World Water Assessment Program, UNESCO

Focus Areas to reduce Water Consumption

Boiler Related Losses

- Heating Cycle and Cooling Cycles are the main points of water loss
  - Heating cycle - blow down from boiler and steam leakages
  - Cooling cycle - blow down and evaporation
  - For processing of 40 KT/D of crude, 80KT/H water circulation is required mainly for its boilers and cooling towers
    - Works out to 25 bbl of water for every bbl of crude oil processed

- The water blowdown from boiler depends upon the feed water quality (salt content) and pressure
  - Can vary from 5 to 20% of feed
  - The steam loss through steam blowdown and leakages in Indian industries have been reported to be ranging from 16-30% of the steam generated or even higher

Cooling Tower Related Losses

- Cooling Tower operation is a technique as well as an art. Technique of maintaining the parameters and art of adjusting them give the optimal utilization of water and better control.
- Evaporating cooling in cooling towers is the most economical method in transporting the heat away from equipment. Each pound of water evaporated we recover 1000 BTU heat load, the temperature of remaining water is lowered by 10 degree F with 1% evaporation loss.
- Basic parameters for operation and control are pH, Hardness, Alkalinity and Conductivity. For every increase of 1 pH, the alkalinity increases by 10 times. High value of these parameter can lead to precipitation and hence scaling, whereas low value may be corrosive to pipe and equipment.
- The main factors affecting rate of scale formation are Temperature, pH and TDS , which can be prevented by filtration and softening. LSI (Langelier Saturation Index) is maintained in positive side. LSI indicates the degree of saturation or tendency to dissolve or precipitate calcium carbonate in water, thus inhibit or encourage corrosion. The ideal range of LSI is – 0.3 to + 0.3.
- Microbiological fouling is accelerated in high TSS. This gives rise to harmful bacteria and objectionable smell.

- In Cooling Towers, blowdown depends upon the cycle of concentration (CoC) which depends upon the make up and desired quality of circulating water.
  - CoC in Indian industries vary from 3 to 7
  - Raising COC from 3 to 6 cuts blowdown by 50% and makeup by 20%.

- 4 to 6 % of water under circulation is blown down in industries . The evaporation loss depends on atmospheric humidity or wet bulb temp.

- As a rule of thumb, for every 5.5 degree C of water cooling, 1% of total water under circulation is lost due to evaporation and 0.1-0.2 % through drift.
- The Approach depends upon wet bulb temp. Range depends upon heat load capacity and fan speed of CT.

- Evaporation loss from cooling tower depends upon atmospheric condition and steam blow down from boilers is a process safety requirement, hence unavoidable. At the same time it is difficult to capture the loss at these points.

- The loss of water at blow down points can be greatly reduced by filtration/treatment and recycling

Technology for improvement in waste water Treatment

Reducing, Recycling & Re-using

- Reducing, Recycling and Reusing is the key concept and can be achieved only with right and affordable Technology
- The focus area of the reduction can be:
  - Water blow down from both steam boiler as well as cooling tower which are the main source of wastage.
  - High salt content of these streams is key challenge for usability
  - Salt content can be reduced with suitable **physio-chemical and other treatments**
  - Can be then used as fire water
- Effluent treatment can allow re-use for the purpose of irrigation

- Advanced Treatment:
  - By Ion Exchange and Membrane Technology blow down can be made domestically usable.
  - With ion exchange process it can be made usable for boiler feed.

Technology being used currently

- The commonly used technologies for waste water treatment:
  - Physiochemical Treatment
  - Biological Treatment
  - Ion Exchange (IX)
  - Reverse Osmosis (RO) -Membrane Technology
- Physiochemical and biological treatment are extensively being used by industries to meet the regulatory requirement for disposal
  - Particles of size above 1 micron are filtered out through mechanical process (microfiltration) and 0.08 – 1 micron, which are in colloidal form are carried out through physiochemical process like coagulation or flocculation followed by settling, called ultrafiltration
- Industry specific treatment required due to varying characteristic of waste water, particularly w.r.t. TSS, TDS and Type of contamination

Technology Innovation by CSIR-NEERI

- Phytorid waste water treatment technology
- Developed by CSIR-NEERI as a wet land technology
- Employs subsurface flow of waste water through porous media and plantation with effective results in reduction in treated effluent up to:
  - 70-80% of TSS
  - 78-84% of BOD
  - 70-75 % of N2
  - 52-64% of phosphorous
  - 90-97 % of coliform
- The area required is approx. 35 sq.mtr. for 20 m^3/d of effluent
- In order to attain the objective of zero discharge, the level of filtration has to be increased to the level of nanofiltration and above, so that it can be recycled for reuse in industries as well as domestic
- The technology has been transferred to Ms General Technology Services

IX and RO (Membrane Technology)

- IX/RO Technology is necessary to achieve Zero Discharge
- It needs higher level of filtration to meet the specification for cooling, steam generation and domestic
- Though Membrane Technology can be applied starting from the stage of microfiltration, but it is economically viable from the stage of nanofiltration and above due to high O&M expenditure
- The capability of Pressure driven membrane technology to filter is as under

Pressure-driven membrane processes in waste water purification

Membrane process	Phase separation	Driving force	Application
Microfiltration	liquid/solid	pressure difference 0,1 – 3 bar	separation of solid matter from suspensions
Ultrafiltration	liquid/liquid	pressure difference 0,5 – 10 bar	separation of macromolecular or colloids, disinfection
Nanofiltration	liquid/liquid	pressure difference 2 – 40 bar	separation of dissolved organic molecules and polyvalent inorganic ions
Reverse osmosis	liquid/liquid	pressure difference 5 – 70 bar in special cases up to 120 bar	separation of organic molecules and of all ions

- Higher salt loading may need multi filtration in series, calling for higher capital and O&M cost

IX and RO (Membrane Technology)

- IX is basically used to remove hardness (Ca &Mg ions), which is used in combination with Membrane Technology (RO) for reducing TDS

- Membrane can be produced with relatively high selectivity for the components to be separated, compared to relative volatilities for distillation
  - **Advantages**: Membrane Technology has Simple flow sheet, low energy requirement (requires no phase separation), more environmental friendly (use of simple and non harmful material)
  - **Challenges**: Chemical incompatibility, Temperature limitation and scaling up of hydraulic capability are the limitations in membrane technology which are yet to be overcome.

IX / RO – Cost Effectiveness

- IX and RO technology is well proven and effective in industrial waste water treatment
  - Cost effectiveness, both in term of capital and O&M has yet to improve
- Operating cost of RO technology has come down in last 20 years from 1.25-1.5 USD/m^3 of treated water to 0.75-0.55 USD/m^3
  - Reasons: Advancement in pre treatment, high efficiency pump and membrane manufacturing.
  - The energy cost is the highest component in total cost
- It has been reported that the Membrane Technology market is expected to reach to 3 Billion USD by 2021 with CAGR OF 16%

R&D Efforts

- R&D on the use of Fullerene Nano-materials to strengthen membrane and modify membrane surface chemistry by Duke University, USA
  - Fullerene Nano-materials are a class of molecules composed entirely of carbon
  - Makes it possible to in-situ generate oxidants to destroy trace organic compounds, disinfection and reduce bio fouling
- R&D on ESIX (Electrically switched ion exchange technology) Technology by PNWN Lab, Richland, USA
  - A combination of electrochemistry and ion exchange
  - Utilizes the redox reaction of electrically conductive material for the elution of various ions to/from aqueous solution
  - Advantage over conventional system in waste water treatment is **selectivity** and **reversibility** for ion separation that lowers cost and minimizes secondary waste treatment

Conclusion

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- Blowdown points in boiler and cooling tower are the major source of wastage, which can be recycled for the use of fire water, agriculture and domestic purpose with advancement in RO and IX technology

- Technology must be economically viable
  - A system which is socially desirable, ecologically sustainable and economically viable can only ensure a sustainable development

- Environment Regulating Body can simultaneously look at the generation of contaminants apart from disposal level. This can help in cost effectiveness of treatment

- Membrane technology can lead in industrial water treatment to achieve the objective

Thank You

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