

Dear Water Warriors,

Ever since the invention by James Watt that the steam power can be converted in mechanical energy, the mankind has seen inventions like locomotive and steam turbine. Turbines further could cut the magnetic flux and produce electricity.



Steam, Cooling Water, Process water as Ingredient, Wash water; other miscellaneous water thus became very important.

The issue of 'Waughter', walks the Industrial Water Journey

Nidhi Jain – Civil Engineer

You think about Process application of water treatment...Right?

The Only answer is : yes...So, This magazine is all about other fundamentals:

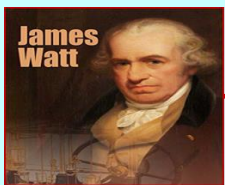
- ⊗ Heating
- ⊗ Cooling
- ⊗ Process ingredient
- ⊗ Wash water

Do you know about benefits of industrial water treatment?

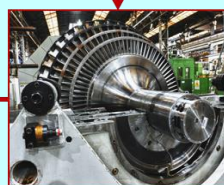
- ⊗ Provides Reusable Water
- ⊗ Preserve the Environment
- ⊗ Supports the Economy
- ⊗ Provides a Source of Energy

Why Purify Industrial water?

Water is used as makeup source for steam production and the piping and equipment, such as boiler, turbines coming in contact with water shall be protected from scaling and corrosion caused by it's ingredients (impurities). The terminal unit turbine produces electricity.



Engine



Turbine

Electricity

As you know, this journey to produce electricity which was responsible for Industrialization was not easy.

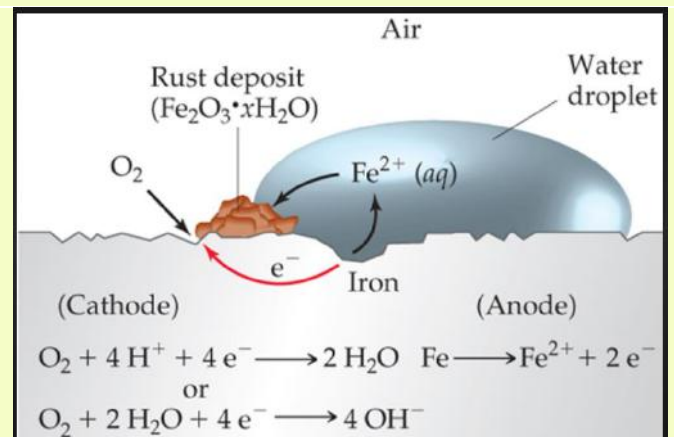
Nowadays Water is everything for Industry.

Let's find out why?

If you go deep in heating process application, then terms **scaling** and **corrosion** are important as they relate to Money.

Corrosion: is decay of metal. Fe if leaves surface as Fe^{2+} leaving $2e^-$ to find some other friend that's corrosion.

Cl^- , O_2 are the electron accepters and thus aggravate the situation and more and more Fe is dissolved. Simplest way to avoid corrosion therefore is : No O_2 and minimize Cl^- in feed water.



LEVAPOR MBBR/IFAS MEDIA

WHAT IS LEVAPOR MBBR/IFAS MEDIA?

Levapor media is an advanced MBBR/IFAS technology which utilises first synthetically modified porous PU foam carriers impregnated with activated carbon for biological wastewater treatment.

BENEFITS

- 50-400% higher performance compared to conventional technologies
- High surface area (>20000m²/m³), high absorption & low degree of filling
- Reduced, well settled sludge production & improved clarifier performance



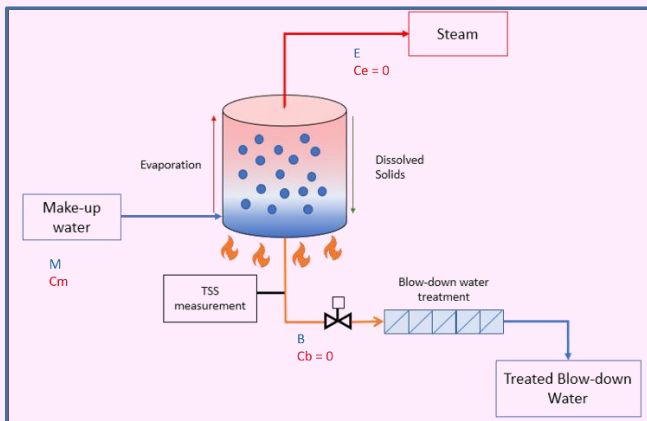
APPLICATIONS

- Biological nutrient removal (BNR) for municipal wastewater treatment
- Improved performance in existing infrastructure
- Post treatment of sewage and industrial effluent for further organic removal and nitrification.

Q. Why we should treat water that is Fed to Boilers?

Let's then try to understand about heating process 🧐

Solids (Impurities) and water go to boiler. Steam carries pure H₂O and leaves solids behind. These solids concentrate in boiling pot. **How long can they concentrate?** Till it's allowed by the Boiler manufacturer as per metallurgy. Beyond that point we must blow down solids.



Let's apply Mass Balance on above:

$$\begin{aligned} \text{Liquid Balance} &: M = E + B \\ \text{Solid Balance} &: M \cdot C_m = E \cdot C_e + B \cdot C_b \end{aligned}$$

Since C_e is 0, solving above will mean Blow down is dependent on allowed Cycle of Concentration:

$$B = E \div (C-1), \text{ where } C = C_b \div C_m$$

So, in a case where 100 T/h steam is to be generated, if Makeup Water TDS is 1000 and allowed TDS in boiler is 2000, C will be 2. That means B will be = $100 \div (2-1) = 100$ and Make up would be 200 T i.e.

- 🧐 100 T to produce steam
- 🧐 Another 100 T to flush the TDS that's concentrating.

It's no problems as you may have plenty of water. Real problem is that some impurities stick to surface of boiler tubes and reduces steam production.

Scaling: If any impurity precipitates on a metal surface at elevated temperature, it will stick to it (remember fluid mechanics the velocity of water touching surface is 0 Zero). That's Scaling.

Typically, all Cations of period table Column 2, Ca⁺⁺ Mg⁺⁺, Ba⁺⁺, Sr⁺⁺ & SiO₂, V₂O₅ exhibit a behaviour of Inverse Solubility i.e. solubility decreases with increase in temperature of water.

Not a problem, just put a Softening plant and eliminate Ca⁺⁺ & Mg⁺⁺ as monovalent feed with Anions and SiO₂ can not cause much problem for low pressure boilers.

Now, you think about what is responsible to change the state of water i.e. water turns into steam.

Latent heat.

- 🧐 Latent heat can be understood as energy in hidden form which is supplied or extracted to change the state of a substance without changing its temperature.
- 🧐 Example: a substance condensing or vaporizing at a specified temperature and pressure.

Specific Latent heat: A specific latent heat (L) expresses the amount of energy in the form of heat (Q) required to completely effect a phase change of a unit of mass (m), usually 1kg, of a substance as an intensive property:

$$L = Q \div M$$

Money the Motivator:

Since we heat the water to a point where we can supply additional Q to effect the phase change explained above, the water (Blow down) temperature is almost 100 deg C. **So we lose energy = $m C_p \Delta T = 100 * C_p * (100 - 25)$** , if feed water temperature is 25 deg C.

Energy lost in raising 100 T water to boiling temperature means poor economics of Boiler operation.

Thus, Industry wants to reduce TDS of feed water to say 10 or 1 mg/l to achieve higher COC and loose practically no energy in blow down.

Table of Specific Latent heat:

The following table shows the specific latent heats and change of phase temperatures (at standard pressure) of some common fluids and gases. Water is a wonder material, excellent thermal property and very low cost hence 1st choice of Industry as the carrier of energy from one place to another; in form of steam.

Table 1. Specific Latent heat

Substance	SLH of fusion (kJ/kg)	Melting point (°C)	SLH of vaporization (kJ/kg)	Boiling point (°C)
Water	334	0	2264.705	100
Turpentine			293	
Toluene	72.1	-93	351	110.6
Silicon	1790	1414	12800	3265
Refrigerant R152a		-116	326.5	-25
Refrigerant R134a		-101	215.9	-26.6
Oxygen	13.9	-219	213	-183
Nitrogen	25.7	-210	200	-196
Lead	23.0	327.5	871	1750
Hydrogen	58	-259	455	-253
Helium			21	-268.93
Ethyl alcohol	108	-114	855	78.3
Carbon Dioxide	184	-78	574	-57
Ammonia	332.17	-77.74	1369	-33.34

Q. What is Cooling water treatment System?

Industrial machines, gets heated up and they need to be cooled. When we use water as Cooling medium in a heat exchanger, we worry about raising its temperature; remember at elevated temperature Scaling can cause problems. A layer of scale is far less conductive than the Fe surface. Scale control is done by 2 methods:

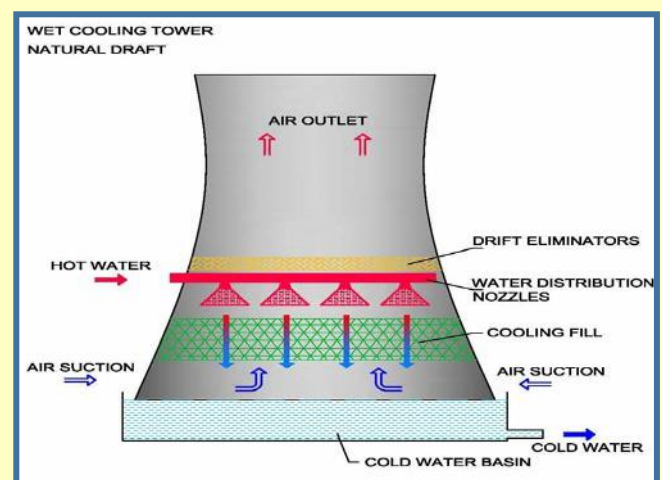
1. Have an External Cooling tower and reduce the temperature of Cooling water within limits of design by losing its heat to environment.
2. Manage Ca⁺⁺, Mg⁺⁺ & Alkalinity in the Recirculating cooling water.

A cooling tower is a heat removal device that uses water to transfer process waste heat into the atmosphere. All cooling towers operate on the principle of removing heat from water by evaporating a small portion of water that is recirculated through the unit. (Increasing relative humidity of air; Mass transfer) e.g. Dessert Coolers

If we achieve objective of losing the heat of water to Air, and Air carries that heat to atmosphere, our 1st object is achieved.

How Does a cooling Tower Work?

This is the schematic figure which depicts above procedure:



But this means we have an additional ingredient Air coming into this system (oxygen) and thus the Cooling tower recirculating water shall be managed with blow down for control of Ca⁺⁺, Mg⁺⁺ & in a few case SiO₂.

Formula for blow down, is same as in boiler $B = E \div (C - 1)$, here C is cycle of concentration which is usually calculated as

$$C = \frac{Cl \text{ in Re-circulation water}}{C^h \text{ in Make up Water}}$$

Air also brings in CO₂ and that can effect pH and Alkalinity relations, refresh the same with [Waughter Vol1 Edition 1](#).

Since Cooling Tower is open to atmosphere we have water droplets loss (with TDS) in form of Drift losses and therefore engineer must make up water including the drift losses.

$$M = E + B + \text{Drift Loss}$$

Open to Sun & Air, cool place attract Bio growth and thus cooling water system needs additional Bio Control along with Scaling & serious Corrosion control as O₂ is present

Q. Industrial water treatment Process:

Majority of the water is used for:

- ☞ Process water.
- ☞ Steam Generation
- ☞ Cooling or condensation

There are **two major methods** used in Industry:

1. Where you make water clean at the end of filtration. (TSS Removal)
2. Where you remove all the impurities in water dissolved impurities also removes, so that steam can produce. (TDS Removal)

Below we present a new schematic a combination of Water & Wastewater management together as most industry do not have a fresh water.

Thus, we encourage industry to forget Water & aim at Waughter, created by treating and recycling effluent.

New Dimensions by Editor:

In a modern world where authorities put a lot of pressure on Industry wrt to Recycle and reuse, some authorities have gone to more pleasing to ear word

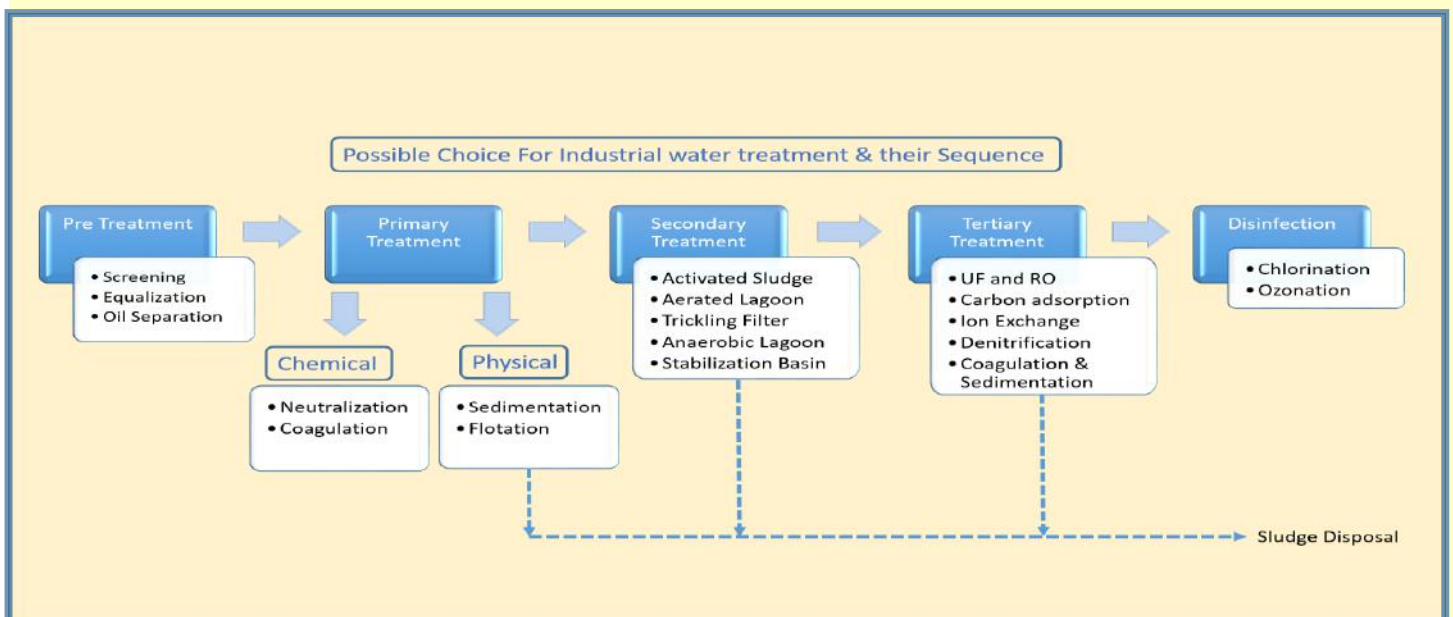
(Zero Liquid Discharge)

That eventually aims at Re-circulating 100% water within plant is a good drive as it appears on paper. In reality industries loses a lot of water in evaporation (white vapors) on top of any Cooling tower and thus would have to bring in that water + TSS + TDS along with it.

So, the TDS must go somewhere as it can not be part of the Final product. Concentrating it and burying it underground as Salts is not a sustainable solution. 10..20..30.100 we do not know in how many years that would be a bigger problem.

Since almost 93% water in industry is lost in evaporative cooling, Industry also should think of cooling without cooling towers e.g. Air Fin Coolers.

Contact Srivastava@aktionindiaa.com for more.



COVID-19, a new challenge to mitigate

Team Aktion realized on April 07, 2021 that we need to perform as well as remain protected. Thus, it was time to shift to Work from Home (WFH) and we organized 2 important events online:

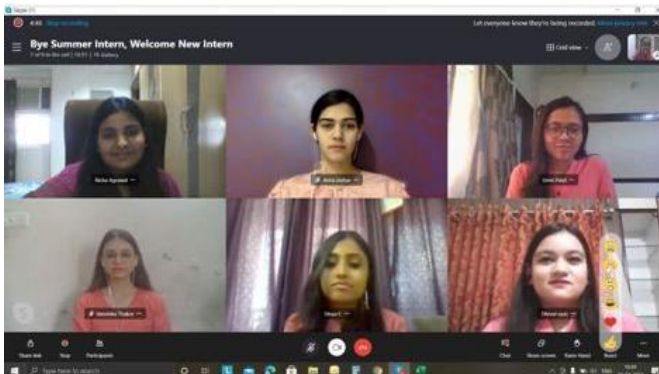
Adieu Intern – 2021, Welcome New Interns.

Adieu Kena Upadhyay Richa Agrawal Divya Chittilanghat

Intern can be that extra sparkle that you need to add to your team. The day was a celebration, online ; thanks to our pledge to a Covid free environment and support initiatives of many COVID worriers.

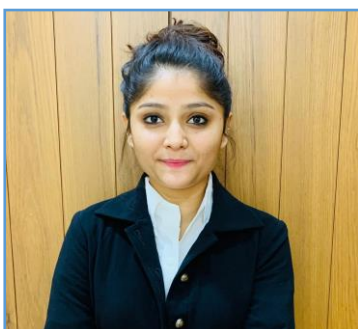
Welcome new Interns, you will have your share of responsibility soon.

#covid #thankyou #intern2021 #watermanagement



New Joiners – 2021, Welcome !!.

Vedanti Patel, Masters in Environment Science became our first member who joined from home JFH. She will work with Govt, NGOs for Community solutions in Drinking Water.



She was to be on board in April and we managed induction, and performance objectives for her via Online meetings.

Testing time does not mean youth of the Nation is deprived of the opportunities.

जल जीवन जननी !!



Annual Day Celebration on 7th April at Aktion focused on the launch of Waughter a perfume made out of recycled Sewage : Yes that's the way to encourage recycled water. Add Waughter to your kit and wear it, spread the fragrance of Water.

#perfume #waterislife #waterconservation
#watermanagement
#recycled #sustainability #ecofriendly
#wastemanagement #wastewatertreatment
#naturalworld #womenempowerment



Our world is Waughter

The technical knowledge share attempt of Aktion Consultancy and the contents in the magazine shall be qualified by Sanjeev Srivastava our Technology Lead.

Our next edition focuses on: **Pre-Treatment Technology, Process & Design Tools**

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