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TABLE OF CONTENTS

	Israel Embassy	Innovation
10.	Ms. Rutuja Pawar - Mott MacDonald	Navigating Global Water crisis: Insights from case studies
11.	Ar. Aditi V. Sontakke - Thakur School of Architecture and Planning, Mumbai	Sustainable Lake Conservation: Need, Objectives and Approach
12.	Mr. Sanjay L. Lalan - TATA Consulting Engineers Ltd. Mumbai	Sustainable and Climate resilient 24x7 water supply system in Leh city
13.	Mr. Harish Kumar Mittapalli - Arcadis Consulting India Pvt Ltd	Sustainable Approach to Reduce Treatment Plant Capital and Operational Costs to Encourage Water Reuse
14.	Mr. Dipak Dahake - Aquaindica Techno Solutions Pvt. Ltd.	Challenges and Solutions in achieving 24/7 water supply for Smart Cities
15.	Mr. Ajit Savadi – NJSEI	Circular Economy: Used Water Reuse
16.	Mr. B B Singh – NSF	Drinking Water Treatment Standards from Source to Tap
DAY TWO – 20th September 2024		
1.	Dr. Indra N. Mitra – Cambi	Advanced Anaerobic Digestion (AAD) of Sludge: Thermal Hydrolysis Process (THP)
2.	Dr. Neeraj Sharma - Envision Enviro Tech Pvt. Ltd.	Optimizing Wastewater Treatment: Retrofitting with Membrane Bioreactors
3.	Mr. Rick Bacon – AMS	Real-time Online Water Quality Monitoring
4.	Mr. Anil Rai – AECOM	Global Insights and India's Challenges: Per- and Polyfluoroalkyl Substances (PFAS) in water
5.	Mr. Prasad Patil- NJSEI, Mumbai	Sustainable Rural Water Supply in the Konkan Area of Maharashtra

6.	Mr. Abhishek Jadhav - Ws2epl	Packaged Treatment Plants, A Boon to Individual WS Schemes – A Case Study of Rajapur Village in Maharashtra
7.	Dr. Sanil Kumar - NIO, Goa	Design Consideration for Sea water Intake & Marine Outfall
8.	Dr. Shanmukha Rao Ganta - IIT Bombay	The Evolution of Desalination Techniques: A Global and National Perspective
9.	Mr. Amir Basha Syed – Wabag	Advancement and Innovation in SWRO Desalination Technologies
10.	Mr. Ahswani Vishwanath – NIOT	Analysis of Deep-Sea HDPE Pipeline for High-Capacity Offshore Desalination Plant
11.	Mr. Narendra Singh Bisht - Aquatech Pune	Achieving Consistent Low Energy Consumption in SWRO Based Desalination Plants
12.	Mr. Chema Nebot – Xylem	Intelligent Water Systems - Utilizing IoT and AI
13.	Mr. Biren Pattanik - NIOT, Chennai	IOT Based Smart automation of Open cycle OTEC desalination
14.	Ms. Sutanu Maiti - IIT, Kharagpur	Kinetics of Reduction of Hexavalent Chromium with CMC-nFeS in Aqueous Medium

INTRODUCTION

The American Water Works Association (AWWA) is an oldest and leading organization dedicated to improving water quality and infrastructure.

AWWAIndia Association (AIA) is the first international and independent registered Association in India of AWWA, focused on addressing India's unique water challenges.

In November 2021, “AWWAIndia Association” was established as a not-for-profit organization with its own membership, Board of Directors and Committee Structures for India water professionals residing in India.

AIA works with water practitioners, public and private utilities and authorities on advocacy related to promoting sustainable practices in water management and technological advances in India including capacity building.

AIA conducted its 3rd Annual International Conference & Exhibition in September, 2024 at Goa which was attended by more than 300 water professionals from various sectors.

First and Second International Conferences were conducted in Varanasi and Jaipur respectively.

ABSTRACTS

Water Quality Index and Treatment Process Efficiency analyses of a Large Capacity Drinking Water Treatment Plant in Goa, India

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Abstract

Detailed analyses of water quality parameters and treatment train process efficiency were carried out at Salauli water treatment plant (WTP) in Goa. This WTP, designed on a conventional water treatment technology of capacity 160 MLD caters to over 45% of the drinking water supply in the state of Goa. Study was carried out for providing basic data on water quality parameters and especially on heavy metals removal. Water quality index (WQI) for raw water and evaluating the process efficiency was established in this large volume processing WTP. Based on a continuous sampling and analyses, the CCME Water Quality Index of the Salauli impoundment reservoir which forms the source of raw water could be categorised as 'Good' with a WQI of 91.93. The pH increased from 6.75 in raw water to 8.37 post-coagulation with alum and lime. While the dissolved oxygen concentrations increased post-aeration and remained high throughout the treatment train. In contrast, colour, turbidity and total suspended solids (TSS) decreased post-coagulation indicating adequate functionality of the clarrifloculator and the filter units. Coliform and *E-coli* counts were nullified after disinfection with chlorine. However, both Iron and Manganese concentrations were 0.4 mg/l and 0.27 mg/l respectively, which remained above the permissible limits even after the entire treatment process. The Overall Parametric Equation Calculator reveals that the Salauli WTP is 100% efficient in achieving safe permissible standards of drinking waters in all the physico-chemical and bacteriological parameters examined. However, the treatment process is about 70% efficient in reducing the concentrations of Iron and ~ 41% for Manganese.

Keywords: Water quality index, Process efficiency, Heavy metal, Water treatment plant.

1. Introduction

As a "*resource*", drinking water is valuable globally. In scenarios of imminent climate change, ever growing population, intense domestic, agricultural and industrial activities, this processed commodity like many other natural resources is getting scarcer by day. This is so as the source

of water has been depleting over years due to increased loads of pollutants making the treatment technologies very challenging. The safety and security of water has been a concern for healthy living. The quality of potable water has been prime importance in present context of human health. The quick check for assessment of quality has been its colour, odour and taste. However, other important physical, chemical and biological parameters are required to be checked and monitored on daily basis. Ultimately it speaks for water quality index and overall assessment of quality and adopting right treatment technology for its safety.

To establish as well as to obtain 'better' indices of water quality, Wolowiec et al. (2019) studied the ability of by-product residuals to adsorb heavy metals and metalloids and reported that the residual waste material by-products were found to be very effective. Similarly, Ibrahim et al. (2019) studied water treatment plant efficiency by assessing certain physico-chemical and bacteriological parameters for raw and treated water and concluded that the source water was contaminated to moderate extent.

Heavy metal remediation from drinking water processing systems pose many challenges. Many studies have aimed at developing strategies for its removal (Asif et al. 2015; Felter and Robinson, 2021; Onyancha et al. 2022; Sodhi et al. 2022; Soon et al. 2022). Manganese and Iron removal through a combination of chemicals from a WTP led to pungent odour and yellow colouration which changed to brown to black precipitate (Khadse et al. 2015). From these analyses, it was evidenced that soluble and insoluble heavy metals need to be dealt with by using bioremediation, green-sustainable technology with minimal use of chemical reagents, application of plant-based amyloid from food-wastes and magnet-mediated recyclable adsorbents as environmentally sustainable approaches. However, affordability, flexibility and optimal efficiency in processing large volumes of water for domestic uses are often inhibitory in most of the established conventional WTPs.

Maximising the process efficiency primarily depends on the quality of raw water processing it adequately through a combination of physical and chemical treatment steps would be essential to achieve desired potable water. In essence, to thwart many deficiencies and to optimize conventional drinking WTP to attain high efficiency through effective steps are to be in place. As the main objectives of this study, derivation of water quality indices and an evaluation of the treatment process efficiency across different stages of treatment were carried out.

2. Methodology

Study site: Salauli water treatment plant located at 15°12'25" N and 74°10'10" E with an elevation of 110 m above mean sea level chosen for this analysis is the largest water treatment facility in the State of Goa as shown in Figure 1. It draws raw water from the Salauli dam impoundage. Catering to over 45% of the present 1.5 million residents and over 3 million tourists visiting Goa annually. Since its inception, the presence of Iron and Manganese in raw and treated water has always been a point of concern. But, the ever-growing demand for drinking water had let this crucial problem unaddressed.

Figure 1 Salauli 160 MLD water treatment plant

From its commissioning in 1989, the water treatment process in Salauli WTP is based on conventional treatment technology which involves aeration followed by coagulation, and clarriflocculation (flocculation and clarification). The clarified water is then led to the rapid sand gravity filtration process followed by disinfection. The potable water is then stored in a Master Balancing Reservoir (MBR) before supplying to the end consumers. Hence a study of process efficiencies was carried out to determine the functioning of various units of the water treatment plant in treatment of raw water, especially with the presence of Iron and Manganese in raw water.

Water sampling and analyses

The spot sampling method (Basu, 2017) was used for the purpose of this study. The sampling for the study purpose was carried from different locations in the treatment train including the raw water at the intake point. All analyses were carried out in the WTP laboratory within 8 hrs

of collection. The data were used for deriving water quality index (WQI) especially for the raw water collected during different seasons namely pre-monsoon (February-May) monsoon (June-September) and post monsoon (October-January) seasonal basis. The process efficiency of the treatment train was evaluated by sampling in month of June 2022 on a daily basis at the below mentioned six locations namely station **S1** at Salauli Dam, **S2** at aerated water leaving aerator, **S3** at coagulated water entering clarrifloculator, **S4** at clarified water leaving clarrifloculator, **S5** at filtered water after filtration and **S6** at treated water leaving storage reservoir as shown in Figure 2. Different physiochemical characteristics such as colour, turbidity, pH, total dissolved solids, total hardness, total alkalinity, biochemical oxygen demand and microbial characteristics such as most probable number (MPN) of coliform bacteria as per the Standard Methods (APHA, 2017) were analysed. Soluble fractions of Iron and Manganese –prominent dissolved metals in the state of Goa –were also measured from raw and treated water as per *IS: 3025: Part 53:2003 and IS: 3025: Part 59:2006*.

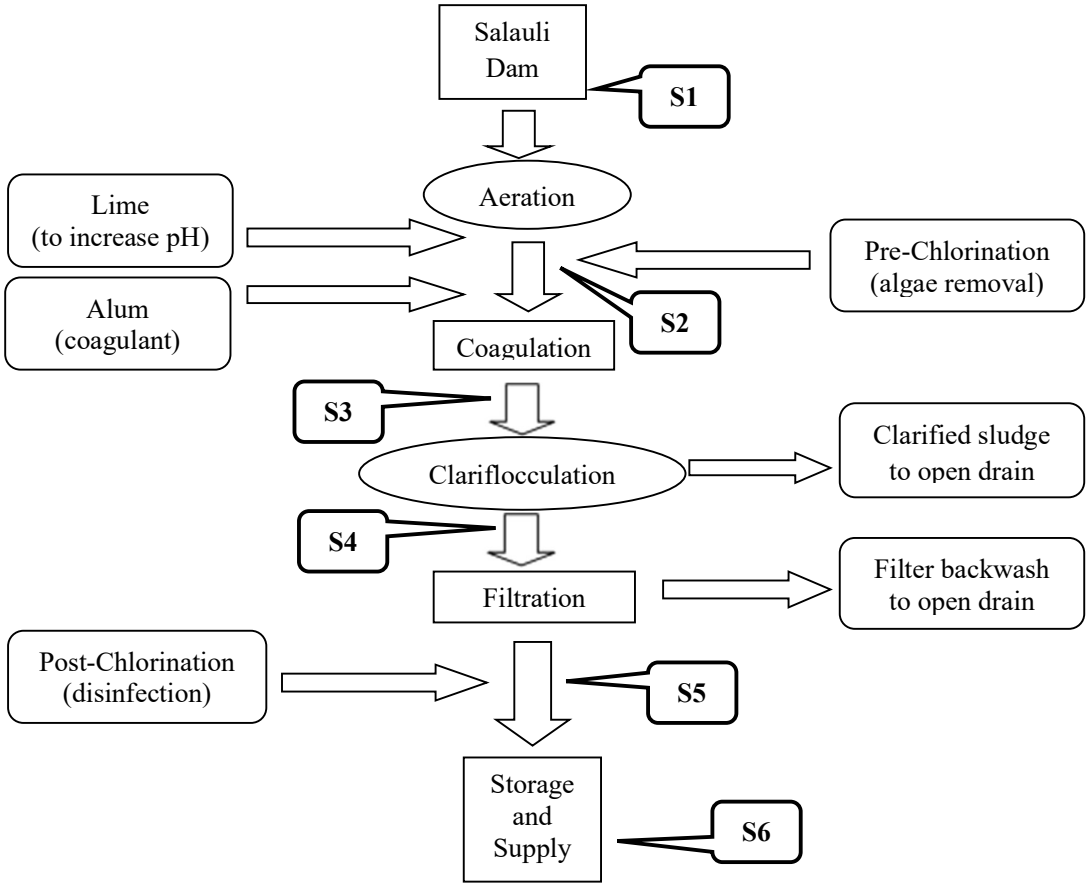

Figure 2 Sampling locations (S1 to S6) along the treatment train of Salauli WTP

Assessment of water quality index (WQI)

Water quality index was evaluated on qualitative basis using the CCME Water Quality Index (Shah and Joshi, 2015) which is based on a formula developed by the British Columbia Ministry of Environment, Lands and Parks and modified by Alberta Environment. Calculation of CCME Index was based on the following inputs.

F_1(***Scope***) represents the percentage of parameters that do not meet their guidelines at least once during the time period under consideration ("failed parameters"), relative to the total number of parameters measured:

F_1= (Number of failed parameters/Total number of parameters) x 100

F_2 (***Frequency***) represents the percentage of individual tests that do not meet guidelines ("failed tests"):

F_2= (Number of failed tests /Total number of tests) x 100

F_3 (***Amplitude***) represents the amount by which failed test values do not meet their guidelines. F_3 is calculated in three steps.

i) The number of times by which an individual concentration is greater than (or less than, when the guideline is a minimum) the guidelines is termed as "excursion" and is expressed as follows. When the test value must not exceed the guidelines:

$$\text{excursion}_i = (\text{Failed Test value}_i / \text{Objective})\text{-}1$$

For the cases in which the test value must not fall below the guideline:

$$\text{excursion}_i = (\text{Objective} / \text{Failed Test value})\text{-}1$$

ii) The collective amount by which individual tests are out of compliance is calculated by summing the excursions of individual tests from their guidelines and dividing by the total number of tests (both those meeting guidelines and those not meeting guidelines). This parameter, referred to as the normalized sum of excursions, or nse, is calculated as:

$$\text{nse} = \sum_{i=1}^{n} \text{excursion}_i / \text{ Total no. of tests}$$

iii) F_3 is then calculated by an asymptotic function that scales the normalized sum of the excursions from guidelines (nse) to yield a range between 0 and 100.

F_3= (nse) / (0.01nse + 0.01)

Once the factors were obtained, the index was calculated by summing up the outputs from three factors as if they were vectors and using the Pythagoras theorem. The sum of the squares of

each factor is therefore equal to the square of the CCME WQI. This approach treats the index as a three-dimensional space defined by each factor along one axis. With this model, the index changes directly proportionate to changes in all three factors.

$$\text{CCME WQI} = 100 - (\sqrt{F_1^2 + F_2^2 + F_3^2}) / (1.732) \quad \text{..... Eqn 1}$$

The divisor 1.732 normalizes the resultant values to a range between 0 and 100, where 0 represents the "worst" water quality and 100 represents the "best" water quality.

Process efficiency calculations

To assess the efficiency of water treatment process train. Relevant water quality parameters namely pH, colour, turbidity, TDS, TSS, Specific conductivity and DO and the presence of heavy metals particularly Iron and Manganese were analysed. The United States Environmental Protection Agency (US EPA) Water/ Wastewater Math Online Calculator (WMOC) was used for determining the Process efficiencies.

The Formula for calculation of treatment unit process efficiency is as follows,

Influent Qty = (Treatment unit flow rate x Influent concentration) x 8.34

Effluent Qty = (Treatment unit flow rate x Effluent concentration) x 8.34

Therefore,

$$\text{Removal Efficiency \%} = \frac{\text{(Effluent Qty – Influent Qty)}}{\text{(Influent Qty)}} \times 100 \quad \text{..... Eqn 2}$$

The overall efficiency of the water treatment plant for treatment of a particular parameter was also calculated as follows,

$$\text{WTP Efficiency (parameter)} = \frac{\text{(Influent concentration —Effluent concentration)}}{\text{(Influent concentration –Permissible concentration)}} \times 100 \text{.. Eqn 3}$$

The Disinfection process efficiency was calculated using the Log Reduction Calculation:

$$\text{Percentage Reduction} = \frac{\text{(A—B) x 100}}{\text{A}}$$

where,

A is the number of viable microorganisms before treatment and

B is the number of viable microorganisms after treatment

Log Removal Value calculation,

$$\text{Log Removal Value (LRV)} = \log_{10} (A/B) \quad \text{..... Eqn 4}$$

Percentage Reduction using Log Removal Value,

Percentage Reduction of Microorganisms (P) = $(1-10^{-LRV}) \times 100$ ……Eqn 5

3. Results and Discussion

Characteristics of water quality

The mean values of 30 samples for physico-chemical, bacteriological characteristics, Iron and Manganese at every stage of the treatment process are presented in Table 1.

Table 1 Mean values of various water quality parameters at different treatment stages

Parameters	Permissible Limits for Treated Water	Sampling points					
		S1	S2	S3	S4	S5	S6
pH	6.5 - 8.5	6.75	7.36	8.37	8.03	7.73	7.38
Colour (Unit)	≤ 15	2.79	2.77	2.74	2.00	2.00	1.95
Turbidity (NTU)	≤ 5	3.46	3.31	3.17	2.68	1.82	1.41
TDS (mg/l)	≤ 2000	30.43	30.66	33.38	36.27	38.36	39.83
TSS (mg/l)	≤ 500	0.12	0.10	0.06	0.03	0.01	0.01
Sp conductivity (mg/l)	≤ 800	47.13	49.00	53.21	55.99	58.91	61.56
DO (mg/l)	6.5-8.0	5.72	7.06	7.08	7.09	7.10	7.11
Residual Cl (mg/l)	0.2	0.00	0.00	0.00	0.00	0.00	0.60
MPN Coliform (per100ml)	0	208	208	208	208	208	0.00
MPN E-coli (per 100ml)	0	29	29	29	29	29	0.00
Fe (mg/l)	≤ 0.3	0.40	0.37	0.36	0.34	0.33	0.33
Mn (mg/l)	≤ 0.1	0.27	0.27	0.26	0.24	0.21	0.20

The average pH in the raw water sample (S1) was 6.75 which increased to 8.37 at S3. Then on it gradually reduced in the treated water to 7.38 falling within the permissible limits of drinking water. Maximum average values of colour, turbidity, TDS, TSS and conductivity detected at stage S1 were all well within the permissible limit. The DO concentrations increased from 5.72 mg/l at S1 to 7.11 mg/l at S2. Coliforms and E-coli were present in the entire treatment train – albeit in lower counts– both of them were completely removed after the post chlorinated process at S6. The 30-day mean concentrations 0.40 mg/l of Iron at S1 reduced marginally to 0.33 mg/l at S6. Similarly, the Manganese concentrations was 0.27 mg/l at S1 decreased to 0.20 mg/l at S6. Although marginal decrease in the concentrations of both Iron and Manganese through the treatment process was evident, their concentrations were above the permissible standards for drinking water.

Water Quality Index (WQI)

The CCME WQI adopted for evaluation of raw water quality index of Salauli water treatment plant (WTP) considering mean of various parameters viz. colour, turbidity, pH, TDS, total hardness, total alkalinity, BOD and MPN of coliform is 91.93 which could be rated as 'Good'. The sample calculation of raw water WQI for Salauli WTP is as shown in Figure 3.

Calculation of CCME WQI (Raw Water) : SALAULI WATER WORKS

	Parameters	Colour (units on pt.co. scale)	Turbidity (NTU)	pH (pH Scale)	TDS (mg/l)	Total Hardness as CaCO3 (mg/l)	Total Alkalinity as CaCO3 (mg/l)	BOD (mg/l)	MPN of Coliform organisams (per 100 ml)
	Quality Standards (As per IS:2296) 1992 **Class 'C'**	**300**	**55**	**6.5 to 8.5**	**6000**	**600**	**600**	**3**	**5000**
SALAULI WTP	W	0.00	1.40	6.25	30.10	15.67	16.00	0.30	57.00
	Pre	0.00	2.10	6.50	29.12	15.17	16.50	0.40	43.00
	Mon	0.00	3.25	6.62	27.23	17.17	17.50	0.43	661.67
	Post	0.00	2.22	6.25	25.55	12.83	17.67	0.30	233.33

	CODE	CCME DATA					
No. of failed Variables (Parameters):	X	1	F1 =	No. of FAILED Variables / Total No. of Variables	X 100	F1 =	12.5
Total No. of Variables (Parameters):	Y	8					
			F2 =	No. of FAILED Tests / Total No. of Tests	X 100	F2 =	6.25
Total No. of Tests:	Z	32					
Total No. of Failed Tests (Parameters excess):	E	2					

EXCURSION	$excursion_i$ =	Failed Test Value$_i$ / Objective1	-1	
Failed Test Values:	A	6.25	6.25	
Objectives:	B	6.500	6.500	
EXCURSION:	C	0.038461538	0.038461538	0.076923077

NORMALISED SUM EXCURSION	$excursion_{nse}$ =	Σ EXCURSION / Total No. of Tests	
	nse =	0.002403846	
	F3 =	nse / 0.01nse + 0.01	
	F3 =	0.239808153	
CCME WQI			
	CCME WQI =	100 - SQRT ($F1^2 + F2^2 + F3^2$) / 1.732	
	CCME WQI =	91.92986018	
	CCME WQI RANKING =	**GOOD**	

Figure 3 Calculation of CCME WQI of raw water at Salauli water works

The CCME method used to accertain WQI at Salauli is similar to studies of WQI with CCME method carried out by Munna et al. (2013) and Bhat et al. (2019) who reported that parameters get contaminated with ingress of domestic, industrial, agricultural effluent into source. Also the water quality index of 91.93 calculated for the raw water parameters at Salauli WTP as 'Good' are similar to the observations in the qualitative studies carried out by Felter and Robinson (2021) elsewhere.

Process Efficiency Analysis

The efficiencies achieved in the Salauli WTP treatment train beginning from raw water to the processed water storage unit for various physico-chemical parameters using the United States Environmental Protection Agency (US EPA) Water/ Wastewater Math Online Calculator (WMOC) shows that because of the rise in DO content from 5.72 mg/l to 7.06 mg/l post-aeration, depicted an aeration process efficiency of upto 23.43%. The pre and post coagulation concentrations of TSS indicate 40% coagulation process efficiency in eliminating the TSS which decreased sharply from 0.10 mg/l pre-coagulation to 0.06 mg/l post-coagulation. The TSS decreasing further to 0.03 mg/l post-clarriflocculation signifies its substantial removal in the clarriflocculator unit with a clarification process efficiency of upto 50%. Apparently, clarriflocculation process further reduces colour and turbidity with a process efficiency of 27.01% and 15.46% respectively. Post-filtration the TSS concentrations were 0.01 mg/l thus enhancing the filtration process efficiency to 66.67%. The filtration units were also efficient in removing turbidity from 2.68 mg/l to 1.82 mg/l with a process efficiency of 32.09%. The disinfection process efficiency determined based on LRV was 100% which is indicative of the fact that both MPN coliform and MPN E-coli reduced to Nil post-disinfection with chlorine whose counts through the treatment train prior to disinfection were up to 208 and 29.33 per 100ml respectively.

Whereas when the individual process efficiencies are calculated when subjected to presence of soluble Iron and Manganese in process water it is observed that the aeration process efficiency in removal of the iron was 7.50% owing to a marginal decrease from 0.40 mg/l to 0.37 mg/l post aeration. Whilst there was absolutely no variation in the manganese content. After coagulation the dissolved Iron and Manganese values slightly decreased respectively from 0.37 mg/l to 0.36 mg/l (coagulation process efficiency of 2.70%) and from 0.27 mg/l to 0.26 mg/l (coagulation process efficiency of 3.70%). Further, the dissolved Iron showed minor decrease from 0.36 mg/l to 0.34 mg/l, with a process efficiency of 5.56% and that of dissolved manganese from 0.26 mg/l to 0.24 mg/l, with a process efficiency of 7.69% post clarification. The values of dissolved Iron showed a minor decrease from 0.34 mg/l to 0.33 mg/l post filtration, with a process efficiency of 2.94%. The values of dissolved manganese showed substantial reduction from 0.24 mg/l to 0.21 mg/l with a process efficiency of 12.50% in removal of dissolved manganese post filtration.

The data on overall treatment efficiency at Salauli WTP is presented in Table 2 below. It was observed that post treatment at various stages of the water treatment process at the Salauli water treatment plant, all the units of the water treatment train brought about necessary reduction in the physico chemical parameters of the raw water such that the treated water parameters were within the permissible standards (IS 10500: 2012).

However, the treatment process in Salauli WTP could barely reduce the dissolved Iron in raw water from 0.40 mg/l to 0.33 mg/l in treated water, which was above the permissible standards. Similarly, reduction of Manganese in raw water detected at 0.27 mg/l was brought down to 0.20 mg/l in treated water, which was also above the permissible standards of drinking water. The overall process efficiency of Salauli WTP in removal of Iron and Manganese was found to be 70% and 41.18% respectively.

Table 2 Overall treatment process efficiency of Salauli WTP

	Parameters	**Permissible limits**	**S1 (Raw water)**	**S6 (Treated water)**	**Process efficiency (%)**
Physico-chemical	pH[#]	6.5 – 8.5	6.75	7.38	100
	Colour[#]	≤ 15	2.79	1.95	100
	Turbidity	≤ 5	3.46	1.41	100
	TDS*	≤ 2000	30.43	39.83	100
	TSS*	≤ 500	0.12	0.01	100
	Specific conductivity[#]	≤ 800	47.13	61.56	100
	DO*	6.5 – 8.0	5.72	7.11	100
Heavy Metals	Fe^{++}*	≤ 0.3	0.40	0.33	70
	Mn^{++}*	≤ 0.1	0.27	0.20	41.18
Bacteriological	MPN coliforms[@]	0	208	0	100
	MPN Ecoli[@]	0	29.33	0	100

units: [#] pH units; [*]mg/l; [@] counts/100ml

The process efficiency analysis for the 160 MLD Salauli WTP were intended to evaluate the sustainability of the conventional treatment process for what it was designed. Results from this study indicate that the conventional water treatment plant is quite effective in achieving 100% efficiency to make the treated water to be within the safe limits in most physico-chemical and

bacteriological parameters. Yet, the process deficiencies were observed in complete elimination of heavy metals such as Fe and Mn. Desye et al., (2021) evaluated the treatment train process efficiency from a WTP in Gondar city in Ethiopia presents removal/reduction efficiency of 94.4% for turbidity, 52.5% for total hardness, and 88.7% for nitrate at different sampling points. Also, the removal efficiency was 91.6% for coliforms and 99% for fecal coliforms. Similar reports are made by Selmon et al. (2015) from Al-Rumaitha Treatment Plant and by Ibrahim et al. (2019) on the Lower Usma water treatment plant in Abuja Metropolis, Nigeria. Kalvani et al. (2021) in his study on evaluation of Iron and Manganese removal effectiveness, states that the conventional treatment plants are not designed for removal of heavy metals such as Fe and Mn and hence there is a need for oxidising coagulants such as pre-chlorination or addition of Potassium permanganate ($KmNO_4$). It may be noted that no oxidising agent is added during coagulation process at Salauli which limits the treatment process efficiency of Fe and Mn to 2.70% and 3.70% respectively in Flash mixers, 5.56% and 7.69% respectively in Clarriflocculators and 2.94% and 12.50% respectively in Filters. Khadse et al. (2015) used chlorine and potassium permanganate as oxidants for Fe and Mn reduction and concluded that use of $KmNO_4$ as an oxidant is a reliable treatment option for removal of Fe and Mn from drinking water.

4. Conclusion

CCME method used to determine the quality of raw water at Salauli water works indicated a water quality index (WQI) of 91.93 which is 'Good'. However, presence of heavy metals especially iron and manganese in raw water exceeding the safe permissible threshold limits pose a serious problem. The process efficiency study of the Salauli water treatment plant (WTP) using the United States Environmental Protection Agency (US EPA) Water/ Wastewater Math Online Calculator (WMOC) showed that all the units of the WTP are 100% efficient in treatment of physico-chemical characteristics of raw water. However, it was found only 70% efficient in removal of Iron and 41.18% efficient in removal of Manganese. As such, the conventional water treatment process at Salauli proved to be inefficient in the treatment of dissolved Iron and Manganese. Incorporation of a suitable method in an existing operational conventional water treatment plant, apparently is the key to success.

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Abstract for

AWWA India ASSOCIATION'S (AIA) INTERNATIONAL CONFERENCE & EXHIBITION ON TRANSFORMING INDIA'S WATER FUTURE, 19th & 20th SEPTEMBER 2024 AT CARAVELA BEACH RESORT, GOA.

Authors: **1. Shri Pallav Gopal Jha, IAS,**
Managing Director, GMDW&SB
2. Ms. Panchami Choudhury, ACS,
Secretary, GMDW&SB
3. Nupur Choudhury Nath
IEC Expert, GMDW&SB

Title: Jal Sakhi Initiative under Guwahati Metropolitan Drinking Water & Water Sewerage Board.

Objective: The objective of the initiative is to foster Inclusive Water Management and Women empowerment.

Scope: The scope of the paper is to depict the unique role of women from Self Help Groups (SHG) for inclusive water management in the Guwahati City.

Methodology and Approach: A pivotal collaboration was forged with the Guwahati Metropolitan Drinking Water & Sewerage Board and DAY-NULM, marked by an MoU executed on 28th September 2022. This collaboration has birthed the **Jal Sakhi Initiative**, wherein SHG members are trained in IT and soft skills to serve as facilitators for house service connections under the JICA assisted Guwahati Water Supply Project.

The Jal Sakhis plays crucial role in several aspects of this convergence initiative:

- Conducting Public Awareness and IEC Activities
- Mobilizing Consumer Applications for House Service Connections
- Performing Meter Reading and Bill Collection using POS machines
- Collecting Water Samples for Quality Testing
- Acting as a vital communication link between consumers and the water board for swift grievance redressal.

Findings: For GMDW&SB, the involvement of Jal Sakhis has bolstered operational efficiency. Their direct engagement in billing and revenue collection has streamlined processes and enhanced transparency in financial transactions related to water services. They have helped the Guwahati Jal Board by mobilizing house service connection & earning revenue to the tune of Rs. 4.5 crore. Moreover, their role in identifying and reporting issues like leakages has expedited problem-solving, fostering closer ties between the board and citizens.

Jal Sakhis have received remuneration amounting approx. 35 lakhs within a span of 1 & half year which have contributed to socio economic upliftment of the SHG members. Through rigorous training and capacity building, we continue to prepare SHG members to excel in their roles as Jal Sakhis, ensuring sustained progress and service excellence.

Title: Study on prospects of reuse of treated water in India – Best Practices & Challenges

Author: Faraz Ahmad & Dr. Sumita Singhal

Centre for Science and Environment, New Delhi

The Centre for Science and Environment (CSE) conducted a study on treated water reuse in seven Indian states, focusing on the effectiveness, potential, challenges, and opportunities of these initiatives. The objective of the study was to analyse the effectiveness of reuse initiatives in India, identifying what has worked and what has not in terms of reusing treated water in different states. The study also presents analysis on the national level Policy and Programs supporting re use of waste water in India.

Based on an analysis of 35 case studies conducted in 16 cities across 7 states in northern and southern India, the study findings (CSE's visit to different STPs) indicate that major reuse is happening in agriculture which is 46% based on followed by Industry which is 20%, Lake revival/recharge 17%, construction and thermal power stations 7% and green belt development 3%.

Despite the numerous benefits associated with wastewater reuse and national and state level policies, our study reveals that its implementation is still not widespread throughout India. Only a limited number of states have made significant progress in promoting reuse practices that too in big cities.

Also, the study reveals that there is a need to prioritise reuse of treated wastewater, the predominant focus of the state's treated water reuse policy is majorly directed towards the agricultural and industrial sector. However, the feasibility of the solution for reusing treated wastewater may vary across cases due to factors such as site suitability, infrastructure, social acceptability, and economics.

Through the study, an attempt is made to identify the enablers that have contributed to successful water reuse initiatives, as well as the hindrances that have impeded progress in this area.

Planning the Transformation of ULBs towards NRW reduction
Case study- Chennai metro water & sewerage board

Author : K. Ashok Natarajan Task force committee member , Mohua
CEO Steady-Taps Consulting Private Ltd

1. INTRODUCTION

Chennai is the fourth-most populous urban agglomeration in India and 36th largest urban area by population in the world. The total population of Chennai for the year 2022 is about 8.5 million. The total water Demand in 1655 MLD. The existing Water Treatment capacity of the CMWSS Board is 1,494 MLD. The treated water is being distributed from 16 major Water Distribution Stations and 92 subsidiary head works through a pipeline network of 5,247 km .

The Government of Tamil Nadu (GoTN), through its Finance Department is implementing the Chennai City Partnership (CCP) programme focusing on the institutional and financial changes that can drive significant improvements in the delivery of services in the fifteen administrative areas in the CMA that currently fall under the Greater Chennai Corporation (GCC)*.The Program - known as the Chennai Sustainable Urban Services Program–focuses on select urban services namely, municipal governance, urban mobility and water supply and services. It is being implemented as a Program-for-Results (PforR) operation of the World Bank and involves financing of USD 150 million each from the World Bank and the Asian Infrastructure Investment Bank (AIIB), which shall be released by the World Bank upon the achievement of the Disbursement Linked Indicators (DLIs). Under the Program, it is agreed that CMWSSB will achieve DLIs related to (i) improving service performance and operational efficiency/ reduction of NRW (ii) use of performance-based operator contracts; (iii) expansion of network coverage, household connections and regular water supply; and (iv) improve operations and maintenance cost recovery from user charges

2. THE PROJECT

Steady-Taps Consulting was awarded the work for the preparation of RFP and Bid documents for effecting water House Service Connection (HSC), Supply, installation and management of Metering program, maintenance and long term performance based KPI of approx 9,00,000 existing consumers in the core and in the added areas of CMWSSB under HAM (Hybrid Annuity Model) model and to assist the utility in the market sounding workshop to be undertaken by the utility . Installing the meter in present and new connections associated civil works, monthly meter reading, billing and customer management is the main scope of the proposed tender under HAM and this can be done efficiently by the private sector and executed under long term KPI.

3. THE DELIVERABLE

Steady-Taps Consulting completed the study , meter solution and came out with an unique model of Metering as a service (MaaS) which includes deployment , operation , remote meter reading and maintenance under a long term 12 year HAM PPP contract structure where the Federal / State Govt provides Viability gap funding of 50% and balance funding comes from concessionaire who is repaid

this amount during the concession period as annuity . This unique model is will help to address the reduction of NRW and help the Chennai Utility to achieve the world bank disbursement linked indicators as given below .

DLI	Description	Potential Data Sources
DLI 7.3	Metering of 90% high-rise and commercial connections completed by year 3 in added areas and by year 5 in core city	Utility database validated and updated as needed using data from property tax of Corporation and other sources.
DLI 7.5	Increase in metering of low-rise (Ground+2 and below) domestic connections	Utility database validated and expanded if needed using data from Corporation or other administrative sources
DLI 7.6	Reduction in Non-Revenue Water or Unaccounted Water	Utility database on water production and bulk water supply, water flows data at critical points along the piped water distribution network and water consumption at household level
DLI 8.1	Establish service level benchmark (SLB) baseline through survey including baseline household connections and hours of supply within 15 months of project effectiveness.	Combination of Utility data, other administrative data, geo-spatial data, field measurements and household survey
DLI 8.3	At least 5% additional HHs are connected and receiving assured 1 hour of water supply daily (Year 2-5) in the added areas, while maintaining the 1 hour of assured daily supply for HHs from the previous year.	Combination of administrative data, geo-spatial data, field measurements and household survey
DLI 10	Increase in cost recovery from user charges	Utility financial reports and accounting system

WORLD BANK DISBURSEMENT LINKED INDICATOR FOR CORE AND ADDED AREA

This project is being implemented in the first phase with an unique model of metering as a service (MaaS) under 12 year PPP , HAM contract by deployment of Advanced metering Infrastructure and digital platform for water consuming commercial and high rise buildings where only partial investment is being brought in by the government and the balance investment is brought in by the private concessionaire with KPI based deliverables . This contract is expected to be a win -win situation for commercial consumers by way of better service , authority with better accountability of revenue, water loss reduction by deployment of digital infrastructure and concessionaire with technical and financial innovation and assured return based on model concession document .

The Ministry of housing and urban affairs under the Amrut 2.0 guideline 5.5 facilitates Public Private Partnership and provides viability gap funding if any ULB takes up such projects in Hybrid Annuity model or any other suitable model . These project can enable ULBs to bring accountability with NRW reduction is shorter time frame compared to long term water management concession contracts .

Climate change & its impact on future water policy of India

The paper presents principles of water policy in India and its evolution over time forming National water policy in 1987 & its subsequent revision in 2002 & 2012. In specific, it introspects the state water policy of Maharashtra (2019) focusing on its concern & challenges in water supply chain of Mumbai. It addresses the need of water resource planning due to uncertain climate changes & its impact in future water policy by Ministry of Jal Shakti.

Securing Water for Unplanned Settlements in a Climate Risk Era: A case of Sangam Vihar, Delhi

Author: Umra Anees

Objective:
What it takes to provide improved water supply in large, dense unplanned settlements through inclusive water and stormwater infrastructure planning and execution.

Scope:
Examining the impact of climate change on water and stormwater management in Asia's largest unauthorized colony- Sangam Vihar, Delhi

Methodology:

Four field survey teams conducted over 200 household surveys and 25+ Focused Group Discussions in 13 blocks of Sangam Vihar over four months. The findings were analyzed to identify potential long-term and immediate sustainability interventions.

Background and Findings:

In early June 2024, Delhi faced extreme heatwaves with temperatures reaching 52°C, followed by record-breaking rainfall by month's end, highlighting the impacts of climate change. The people residing in unplanned settlements, are often the hardest hit by these extreme weather events.

Sangam Vihar is one such settlement where a million plus population resides crammed in 5 sq.km area. Its water demand is of 35 MGD as against the total water supply of 11.8 MGD. Residents rely on water tankers, borewells, limited piped supply, and 20L bottles for potable and non-potable purposes spending up to Rs 1,000-1,200 monthly for purchase of water for meeting their day-to-day needs.

Groundwater is the main source, and declining levels could cause severe scarcity and economic strain. Limited potential for in-situ water conservation necessitates planning for decentralized ex-situ water supply augmentation.

Recommendations:

To enhance water supply in Sangam Vihar, decentralized options should be considered:

1. Four lakes within 15 km, near STPs, can be recharged and used as water sources after treatment.
2. Redirecting stormwater to minimum four decentralized STPs offers a sustainable, climate-proof solution.

Decentralized STPs will help recharge groundwater, improve water security by diverting water to shallow waterbodies, and reduce flooding risk.

India AICE 2024 Abstract
Submit to: aice@awwa-india.org

Name: Rick Bacon
Position: CEO
Organization: AMS
Email: rbacon@ams-h2o.com

Title: Technology Breakthrough Enables the On-Site Generation of Ferrate Reagents

Abstract (Max 300 words):
AMS has made a breakthrough in the on-site generation of ferrate, a very powerful anti-microbial and anti-biofilm reagent for difficult-to-treat industrial wastewater (e.g., produced water, refineries, textile) or for contaminant destruction such as PFAS, microplastics, endocrine disruptors, and azoles. Ferrate offers treatment advantages in these applications because of its high oxidation potential, non-toxic end products, and low byproduct formation. AMS has developed an innovative method for generating ferrate onsite and on demand. The SafeGuard™ H2O system is a patented and fully automated system that generates a ferrate reagent through the electrolytic dissolution of steel electrodes under tightly controlled conditions. It produces industrial volumes of ferrate with a higher redox potential than any other oxidant, making it safer and more effective. The system's small footprint, high level of automation, and remote monitoring ensure ease of use and reliability. Field demonstrations for the on-site ferrate reagent and the electrochemical ferrate generation process have shown this novel method to be highly effective and efficient. An overview of the ferrate on-site generation process and results from field demonstrations using this powerful reagent for advanced water treatment will be provided.

What are PFAs? Why should we care?

By Priyanka Doddapaneni and Mridula Deshpande

Civil Engineer, Mott Macdonald

Technical Principal, Mott MacDonald

The contaminant that's all the rage now for the environmental industry is PFAs, even though they have been around from the 1930s-40s. It is increasingly gaining in notoriety for its adverse effects on the world and all its encompassing living entities.

PFAs, hailed for their versatile properties in industrial and consumer applications, have become a double-edged sword. Their resilience against heat, water, and oil has revolutionized non-stick cookware, stain-resistant fabrics, and firefighting foams. Yet, their persistence in the environment and bio-accumulative nature raises alarms.

Linked to health risks from developmental effects to cancer, PFAs demands global acknowledgement and scrutiny, which lead countries like USA, France, Australia, the EU, and Japan, to increase regulations against the same. As we navigate this chemical landscape, the quest for balance between innovation and safeguarding our health and environment intensifies.

This paper will delve into the 3 major questions we face, "What? How? What next?"

What? – What are PFAs?

How? – How are they adversely affecting the world and us?

What next? – What are we doing to understand and tackle this emerging contaminant?

Hi Team,

Water Security and Management: A UN World Water Development Perspective

The global water crisis, marked by increasing scarcity, pollution, and climate change impacts, poses significant threats to sustainable development and human welfare. This presentation will explore the crisis, drawing on findings from the UN World Water Development Report. We will discuss the water shortages affecting two to three billion people worldwide, the uneven distribution of water resources, and the urgent need for innovative water management strategies. We will also explore the role of technology in addressing water scarcity and pollution. In conclusion, we will highlight the need for a paradigm shift in water management, focusing on demand management and conservation. Our aim is to stimulate dialogue and inspire action towards a water-secure future.

Hi Team,

I hope you are doing well. Please find below our abstract for the AICE24 annual conference:

Title:- Navigating Global Water crisis: Insights from case studies

Abstract:- The escalating global water crisis, characterized by increasing scarcity, pollution, and the impacts of climate change, presents substantial

challenges to both sustainable development and human well-being. This presentation aims to delve into the intricacies of this crisis, drawing insights from the findings of the UN World Water Development Report. Through various case studies, we will shed light on the unequal distribution of water resources and underscore the pressing need for innovative strategies in water management. The role of technology in tackling global water issues will also be explored. In our conclusion, we will emphasize the necessity for a shift in our approach to water management, with a focus on demand management and conservation. Our ultimate goal is to spark a dialogue and inspire actions that lead us towards a future where water security is a reality.

The authors/presenters for the above topic will be Rutuja Pawar, Srushti Dudhankar, and Mridula Deshpande (cc'd in the email). We look forward to hearing back from you.

Thanks & Regards,
Rutuja Pawar

Sustainable Lake Conservation: Need, Objectives and Approach

Abstract

"A lake is a landscape's most beautiful and expressive feature. It is Earth's eye; looking into which the beholder measures the depth of his own nature."

Henry David Thoreau

Lakes are important features of local, regional and continental landscape. Their role is significant in maintaining air quality, aquifers, ecosystems, flood management, social wellbeing and Ecosystem Services. Lakes are vulnerable to pollution and exploitation due to anthropogenic activities which cause great threat to the local and regional environmental systems, social affairs and economic matters.

Lakes are facing adversities resulting qualitative degradation and quantitative reduction of water. Waste water discharge, dumping of organic and inorganic waste, non-maintenance of their feeder channels resulted in lake pollution. Many lakes are shrunk or dried due to over-exploitation of water, disturbances in the flow of feeders, minimization of green cover. To mitigate these challenges some measures need to be taken for management of lakes in terms of qualitative parameters and quantitative optimization.

Improving the environmental quality, social wellbeing and economic benefits are main objectives of lake conservation. Pollution prevention and abatement measures, cleaning and desilting of lakes, strengthening bunding, catchment area management, lake front developments are the major components of lake conservation. These objectives can be achieved by organizational initiatives, social awareness, inclusive and participatory approach, capacity building, involving and empowering women for their active participation.

Lake conservation involves multidisciplinary interventions. Those are institutional drive, ecological acquaintances, engineering solutions, architectural endorsements, people's participation are the major interventions for lake conservation efforts. Integrating these disciplines will lead to sustainable conservation of lakes.

Case Example: **Kaikondrahalli Lake, Bangalore, India**
This is a success story of transformation of the lake.
Two decades back the lake was in a state of dying as a result of encroachment, dumping of waste, severe inflow of sewage, silting and settled deposits. Today this is a thriving social-ecological place, where interaction between human and nature is safeguarded. The success of this transformation lies between inclusive and participatory approach with all stakeholders.

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Sustainable and Climate resilient 24x7 water supply system in Leh city

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ABSTRACT

The administration of Union Territory of Ladakh has developed the Ladakh vision 2050. The goal is to make winters more comfortable, safe, and productive for all people. The town Leh is spreading over an area of 17.6 sq.km and is a cold desert with temperature rising to 35^0C in the summers and dropping to around minus (-) 30^0C in the winters. Directorate of Urban Local Bodies (DULB) is the implementing agency, and it undertakes several development projects in the urban areas of Ladakh. DULB is undertaking such project, **"**24x7 water supply and storm water drainage system for Leh city area". In this regard, DULB has entrusted *Tata Consulting Engineers Limited (TCE*) for preparation of DPR and tender document 24x7 water supply and storm water drain for Leh city area along with its construction supervision during implementation phase.

The water supply system of the city is dependent on ground water sources mainly from tube wells and natural springs. The city does not have any perennial surface source throughout the year, due to the freezing of surface flow in Indus River during the winter season. Due to cold climatic conditions and irregular terrain of the study area, maintaining adequate temperatures in water treatment & distribution piping is highly challenging to ensure that water always remains above freezing temperature and intake is free of ice. Prevention of freezing can be accomplished by many methods such as combination of insulation, heat trace, circulation, steam or hot water thawing, service line thawing etc., HSC pipes are the most vulnerable portion of the system and will usually freeze first. Thawing capability is mandatory for these small diameter pipes. Thus, with the help of insulation the freezing time of the pipe can be increased.

The population forecasted for 2055 of Leh town is 1,15,000 with water demand of 19 MLD. In proposed sustainable and climate resilient scheme based on surface water source (*Infiltration well at Indus River*). The pipes in the proposed scheme will be laid below frost line (*1.5m-2m*) as per the field survey (*Frost line survey*) and locations where pipeline cannot be laid below frost line considering site specific conditions, adequate insulation of water transmission and distribution pipes has been recommended. DI K9 class double chamber restraint joints pipes are proposed for transmission system and DI K7 class double chamber restraint joints pipes are proposed for distribution system to handle the thrust and prevention of leakages in hilly terrain. A self-regulating heat tracing cable followed by EPDM with glass cloth and finally covered with aluminium sheet has been proposed as an insulation for surface protection for all the pipes to be laid above frost line including house service connections which are proposed with Polypropylene Random Copolymer pipes (PPR), a type of plastic pipe made from a blend of polypropylene and ethylene copolymers.

For WTP, water recirculation system is proposed for preventing freezing of water in winter season during non-operation hours. All the plant buildings and units are proposed to be covered and maintaining room temperature of 20^0C. For service reservoirs and WTP Buildings, outer walls will be insulated by spraying thick impervious Polyurethane Foam (PUF). The insulation will be a 3 layered setup with outer layer as a CC Block joined with Cement Mortar followed by PU spray insulation and inner side as CC block joined with adhesive. Roof will be insulated with spraying closed cell free Rigid Polyurethane foam over deck insulation, over a coat of polyurethane primer applied, laying 400 G polythene sheet over PUF spray and providing a wearing course of 40 mm thick cement screed, in panels and embedded with wire netting and sealing the joints with polymerized with wire netting and sealing the joints with polymerized mastic. The insulation technique effectively addresses this challenge by providing thermal protection to critical water infrastructure components, preventing water from freezing and ensuring uninterrupted 24x7 water supply even in freezing conditions. The Final DPR and Draft Tender document is submitted to DULB. As per project schedule, the proposed 24x7 water supply project will be awarded within 6 months for implementation.

Key Words*: 24x7 Water supply, Sustainable, Climate Resilience, Frost Line, Insulation, Heat Tracing Cabl*e, Polyurethane Foam.

Title: Sustainable Approach to Reduce Treatment Plant Capital and Operational Costs to Encourage Water Reuse

Authors: **Jaydeep Vekariya & Harish Mittapalli**
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The rapid growth in population and urban development has posed challenges for urban municipalities in providing adequate water supply and has emphasized the need for a robust water reuse infrastructure to meet the shortfall in demand. In this context, achieving a lower cost of wastewater treatment while upholding high effluent quality is crucial for industries looking to utilize treated wastewater at a large scale.

This case study delves into the economic and environmental advantages of efficient wastewater treatment processes that enable industries to harness treated wastewater as a sustainable resource. Through the optimization of treatment technologies, industries can drive cost reductions and comply with stringent effluent quality regulations, fostering a sustainable water management approach. The adoption of technologies like Biological Nutrient Removal with Anoxic and aerobic zones can lead to reduced power consumption and costs by lowering compressed air demand, and cloth media filter for tertiary treatment offers solid handling and hydraulics loading with small footprint to flow ratio and consumes less power which helps in lowering capital & operational cost.

Additionally, utilizing a vertical turbine pump with a closed bottom can design offers an economically efficient pumping solution with lower capital expenditure.

This case study examines a sustainable approach aimed at reducing operational and capital investment costs in wastewater treatment to promote widespread water reuse by industries and municipalities. Innovative strategies, technologies and optimization of operational practices implemented at a wastewater treatment plant to enhance efficiency and cost-effectiveness of treatment will be discussed in detail. The findings will demonstrate the feasibility and benefits of adopting a sustainable approach to water reuse and encouraging industry-wide implementation of environmentally responsible practices.

3rd Annual International Conference & Exhibition 2024 (AICE24)

30th September'24 & 1st October'24 at Caravela Beach Resort, Goa

Topic- "Challenges in 24/7 WSS and Water Solutions for Smart Cities"

Title of paper - Challenges and Solutions in achieving 24/7 water supply for Smart Cities.

Abstract: The existing water distribution infrastructures in most of the urban areas are aging and encountering difficulties in coping up increasing demand with significant water losses & very high NRW. Most of the systems have interrupted gravity feed supply. The water supply systems are facing various **operational challenges** such as manual control of equipments & sub systems, lack of real time status on process parameters at one centralised place, time consuming decentralised operations, lack of trainings & capacity building of system operators, potential human error, negligence on timely required actions/maintenance. Whenever any major failure/breakdown occurs within the system, the utilities must be able to identify and resolve the problem with minimal disruption in water supply. As far as possible, limited customers should be affected in 24/7 water supply. However, for any routine maintenance activities of reservoirs, treatment plants and electromechanical systems, water supply to the customers should not be interrupted. There are also **design challenges**, utilities to adopt best engineering practices for design the system with high reliability suitable for 24/7 supply. Redundancy, standby philosophy, and availability of key equipments/sub-systems plays a major role in system reliability. Sometimes, water quality management becomes severe due to higher chlorine dosing, higher decay, and **Disinfection by Product (DBP)** issues.

To overcome these challenges, utilities need to enhance system reliability while designing the system with redundancy for critical assets, adopt an integrated operations management through SCADA and implement sustainable practices in WSS. This paper will highlight the best engineering practices and solutions for efficient system operation, reduction in non-revenue water, controlling DBPs, and improving overall service quality to the customers for getting **24/7 continuous water supply at right quantity, right pressure, and right quality.**

AUTHOR AND PRESENTER:

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Profile: A versatile water utility management professional having 30+ years of hands-on experience in India and abroad, on the gravity feed as well as fully automated direct feed 24/7 distribution network systems, which include 930 Km of water transmission & 7800 Km of distribution networks, 40 Pumping stations and 270+ Pump sets with LV/MV VFD Motors

supplying more than 400,000 connections through 256 DMAs having average daily average demand of 1500 MLD. Managed strategic storage 6500 ML (1421 MIG) at primary reservoirs and 4500 ML (975 MIG) at secondary reservoirs, while complying water quality above 99% KPI with booster chlorination systems. Designed and implemented Smart Pump Control Philosophy to meet variable network demand vis-à-vis maintaining uniform residual pressure at critical points in the direct feed network: which saved 35% energy costs; reduced the water-leakages by 60% and enhanced pumps operation above 70% of efficiency through some unmanned/remotely controlled pumping stations and some remotely monitored/locally SCADA/DCS controlled pumping stations. Passionate about sustainability practices in water management.

Experience: Engineering, Project Management, Water Treatment, Hydraulics & Pumping System, Smart Pump Control for 24/7 supply, Testing & Commissioning, Water Network Management, Customer Billing, Operation & Maintenance, Water Balance & Energy Audit, Pressure Management & NRW control, System Optimization, Value Engineering, Shutdown Management, Projects Taking Over, ISO 9001:2015 Quality Management System.

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- Fellow of the Institution of Engineers (India), F-1236268
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- Member of International Water Association (IWA), 1508132
- Certified Chartered Engineer from the Institution of Engineers (India)
- Certified Energy Manager (EA-6984) by Bureau of Energy Efficiency Certificate No 4221
- Life Member of Indian Association of Energy Management Professionals (IAEMP), MH/LM/0015

Technical Paper Published:

• Paper on, “Hydraulic Modelling of Distribution Network of 24X7 Water Supply Using Variable Frequency Drive Pump” by Dr. Sanjay Dahasahasra, Dr. Rajesh Gupta and Er. Dipak Dahake, published in the Journal of Indian Water Works Association, ISSN 0970-275X, April-June 2023, Vol. LV No.2.

Technical Papers Presentations:

- ❖ “System Reliability Approach in designing 24/7 water supply distribution systems” 56th IWWA Annual Convention held at Coimbatore on 19th Jan 2024.
- ❖ “Direct Feed Networks for 24/7 Water Supply with Smart Control Philosophy using VFD”, at IWA Water and Development Congress & Exhibition held on 10-14 December 2023 at Kigali-Rwanda.
- ❖ “Implementing 24x7 Water Supply with Energy Efficient Direct Feed Networks” (a paradigm shift in conventional gravity feed design approach), selected at AWWA India International Conference & Exhibition 2023 on Water Security & Sustainability on 6th & 7th October, 2023 At Hotel Lalit, Jaipur.
- ❖ “Energy Conservation Opportunities in Direct Feed Networks for 24/7 Water Supply with Smart Control Philosophy using VFD”, 55th IWWA Annual Convention held at Pune on 21st Jan 2023.
- ❖ “Smart Pump Control for Direct Feed Water Distribution Network”, Seminar, Institution of Engineers (India), Qatar Chapter, 22nd October 2014.
- ❖ “Smart Water Network: A Global Trend”, Seminar, Institution of Engineers (India), Qatar Chapter, 18th Jan 2014
- ❖ “Selection of Pumps based on Efficiency Loading for evaluation of Bids”, Seminar, Institution of Engineers (India), Pune Centre, Jan 2007
- ❖ “Energy Conservation by Segregation of Pumping”, Seminar, Institution of Engineers (India), Pune Centre, Oct 2002.

Circular Economy : Used Water Reuse

Mr Vidyadhar Sontakke[1], Mr Keshav Kamat[1], Mr Shirish Sadekar[1], Ajit Savadi[1] CEng FICE and Dr. Uday G. Kelkar[1], P.E., BCEE.

1) NJS Engineers India Pvt. Ltd

Welspun city, is situated in Kutch, one of most arid regions in India. The city of about 1000 Ha accommodates multiple companies of Welspun group. The area faces acute water shortage with no water available for the industry, it was facing relocation. Welspun, then tied up with nearby towns of Anjar and Gandhidham to set up a sewage Treatment Plant using sustainable technology to recycle used water for process and possible potable requirements. This would meet the industrial water demand and also facilitate fresh water conservation and prevention of pollution of water sources due to sewage. Welspun buys raw sewage from the local bodies and helps them generate revenue. The economy of the entire region is now centred around Welspun. This would not have been possible without the recycling of used water. This project was recognised by Ministry of Jalshakti with a National Award.

RCF, a large Fertilizer plant in Mumbai lifts raw sewage with a 45 MLD pumping station and transfer it to the plant about 5.5 Km away. The sewage is treated using advanced treatments including RO and BNR. The treated water is reused as Process Water for the plant. In addition, RCF supplies the treated water to nearby BPCL refinery. RCF pays to BMC for raw sewage. This not only generates revenue for BMC but also helps to reduce the consumption of fresh water and reduce load on their STPs. RCF saves on fresh water charges and at the same time generates revenue by selling the treated water to BPCL.

This paper will provide the insight into these projects. In both the cases, reuse of used water has played an important role in making the plant operations feasible and sustainable. It will also cover trends to achieve circular economy as well as meeting the SDG 6 goals.

NSF to present on "Drinking Water Treatment Standards from Source to Tap"

Since 1944, NSF has stood at the forefront of global efforts to improve human and planet health. As an independent, internationally recognized organization, we play a pivotal role in the development of robust public health standards. Comprising a dedicated standards team and a team of service professionals, we employ a multi-faceted approach. NSF engages in the rigorous testing, auditing, and certification of an array of products and services. The NSF mark serves as an emblem of assurance, signifying to consumers, retailers, and regulatory bodies that our certified products meet or exceed requisite standards.

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Our "Source to Tap" Solution Areas:

- Municipal Water Systems and Products
- Water Filtration
- Plumbing Products
- Treatment Chemicals and Media
- Water Management and Safety

Advanced Anaerobic Digestion (AAD) of Sludge: Thermal Hydrolysis Process (THP)

Dr. Indra N. Mitra and Harald Kleiven, Cambi, Norway

Wastewater generated from cities and towns are treated in Sewage Treatment Plants (STPs). STPs produce two products: (i) treated wastewater and (ii) sludge. Sludge is treated in anaerobic digesters to stabilize the sludge, produce biogas and reduce the volume of sludge to be disposed of. However, the digested sludge produced from digester contains pathogens (disease causing bacteria) and present a health hazard. So, the digested sludge needs to be further treated to produce pathogen-free biosolids which can be used as a fertilizer or soil conditioner/amendment.

Thermal Hydrolysis Process (THP) is an advanced anaerobic process which is placed ahead of the anaerobic digesters as a pre-treatment process. In THP, the sludge is first subjected to a high pressure of 6-6.5 bar and a high temperature of 160-165 ^{0}C for 20-30 minutes. The pressurized and high temperature sludge is then suddenly exposed to ambient atmospheric pressure and temperature leading to steam explosion, "liquifying" the sludge. Thermal pre-treatment and steam explosion disintegrates the sludge floc and improves the degradability of the sludge, by destroying chemical bonds in the cell wall and membrane of the bacteria and in addition denatures carbohydrates, lipids and proteins which become more accessible to biological degradation in downstream anaerobic digesters.

THP is a sustainable technology that converts waste to wealth, promoting resource recovery and circular economy and which protects the environment and health of the Nation. Using THP as a pre-treatment process for anaerobic digesters: (i) produces a pathogen-free sludge, protecting public health (ii) reduces the digester volume by 60-70%, (ii) increases biogas generation by 20-50%, (iii) reduces the volume of digested sludge to be disposed by 30-50%, (iv) decreases the operational cost of sludge treatment by 30-50% (v) produces a biosolid with no or little odour and (vi) reduces carbon footprint.

Optimizing Wastewater Treatment: Retrofitting with Membrane Bioreactors

Nihar Doctor
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ABSTRACT

Globally, it has been observed that after successfully commissioning wastewater treatment systems in various industries, issues related to design and operational compatibility can prevent these plants from achieving their intended efficiency. Such inefficiencies lead to fluctuations in hydraulic performance and the quality of treated effluent. To address these challenges, retrofitting existing wastewater treatment plants, particularly at the biological treatment level, becomes essential. Among various retrofitting techniques, the Membrane Bioreactor (MBR) stands out as one of the most efficient technologies. MBRs are capable of optimizing flow and improving the quality of treated effluent due to their state of art, compact configuration. Retrofitting wastewater treatment plants with Membrane Bioreactor (MBR) technology enhances efficiency, increases capacity, and improves effluent quality for reuse, while offering a compact footprint and reduced sludge generation. This paper explores the capabilities and compatibility of MBR systems for retrofitting biological treatment systems in wastewater treatment plants, aiming to demonstrate their effectiveness in enhancing plant performance.

Key words:- Membrane Bio Reactor(MBR), Retrofitting, Performance efficiency

Global Insights and India's Challenges: Per- and Polyfluoroalkyl Substances (PFAS) in water

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Abstract

Per- and polyfluoroalkyl substances (PFAS) are a family of fluorinated organic chemicals produced by various industries. These substances have become increasingly worrisome due to their extensive use in various processes and products, combined with their toxic properties that result in widespread spreading and water pollution. Research has detected these compounds in drinking water, air, soil, and plants at concentrations ranging from nanograms to milligrams, often far from their original sources. Recent studies have explored the health impacts of PFAS, resulting in regulatory guidelines for their use and production, particularly in developed countries. However, in many low-to-middle-income countries, especially in Asia, where exposure risks and regulatory enforcement are limited, such guidelines are still lacking. This makes more worrisome for Asia, being the most populated continent, leading to increased consumption and PFAS production, thereby posing a higher risk from these chemicals compared to the Western world. This review aims to provide a comprehensive assessment of current knowledge on PFAS and its precursors in Asian environmental contexts and the regulatory measures to mitigate health risks posed by these substances. Additionally, it critically discusses significant research gaps and proposes solutions to address key uncertainties.

Keywords – Perfluoroalkyl substances; Polyfluoroalkyl substances; PFAS; Environmental pollution; PFOS; PFOA

Sustainable Rural Water Supply in the Konkan Area of Maharashtra

Mr Vidyadhar Sontakke[1], Mr Sunil Joshi[1], Mr Sunil Savardekar[1], Mr Prasad Patil[1], Mr Vijay Pathak[1], Mr Pradeep Limje[1], Ms Komal Thorat[1], Ajit Savadi[1] CEng FICE and Dr. Uday G. Kelkar[1], P.E., BCEE.
1) NJS Engineers India Pvt. Ltd

The 'Konkan' is a narrow strip of coastal area of approximately 30,000 sqkm with 720 km of coast line. The average annual rainfall is about 2900 mm but many of its rural areas faces water shortages.

The area was included in the Government of India's flagship scheme of Jal Jeevan Mission (JJM) with an aim to provide safe drinking water to every house hold. Konkan region is a hilly area and tribal habitats are spread into number of villages and Wadis (Hamlets). It was challenging to plan the water supply schemes for the area covering numerous small remote hamlets by bringing water from sustainable water source over a difficult hilly area.

In the absence of any significant storage reservoirs and with runoff discharging quickly into the sea over the hilly areas, the water retaining capacity is very limited and most of the villages are dependent on local natural water courses that run dry in summer months.

Extensive engineering exercise has been carried out to ensure every household is connected with a Functional Household Tap Connection (FHTP). The project also looked at ensuring sustainability of water supply system including water source, water supply infrastructure, and funds for regular O&M

NJS Engineers India Pvt Ltd (NJSEI) carried out engineering design of the 2725 water supply schemes across five districts of Konkan that included elaborate surveys using advance techniques, preparation of Base Maps, Hydraulic Design using network models, Detailed Project Reports.

This paper presentation will provide the insight into the project carried out for one most difficult and challenging terrains, adoption of innovative solutions and system standardisation to ensure uniform and consistent outputs. This presentation will also discuss the challenges that were encountered and mitigative strategies adopted to ensure successful completion of the schemes to deliver the staggering number of schemes.

Packaged Treatment Plants, A Boon to Individual WS Schemes – A Case Study of Rajapur Village in Maharashtra

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Abstract -

Most of the Water Supply Schemes in Maharashtra are based on the surface water as a source. The state has always embraced the policy of adopting individual water supply schemes even for small communities. All surface waters need full-fledged treatment to make it potable and safe. Construction of small treatment plant rural areas in RCC (in-situ concrete) is challenging. The lack of skilled labour and supervision for construction, operation and maintenance further complicates the effective mass implementation.

The capacity of Water Supply Scheme for Rajapur village, Dist. Nashik, Maharashtra is 1.5 MLD. The raw water is pumped from a "pick-up" weir from Pravara river to the balancing tank. It is then further pumped to the treatment plant. Maharashtra Jeevan Pradhikaran (MJP) has provided a Packaged Water Treatment Plant (PWTP) for purification of water. The treatment units consists of a Cascade Aerator, Mixing cum Measuring Weir, Mechanical Flocculation Tank, Hopper bottom Tube Settling Tank, Rapid sand gravity filter (with hydraulic control), Chlorination unit and Coagulant tank. All unit processes are simple in concept, well established and are recommended by CPHEEO Manual. The uniqueness of this plant is that it is pre-fabricated in mild steel plates and internally lined with FRP (Fibre Reinforced Plastic) to avoid corrosion. The PWTP was transported over truck-trailer from factory to the site. It was erected and commissioned in fifteen days.

The performance over last three years is found to be completely satisfactory. In the wet weather season, the raw water turbidity peaks to 100 NTU. In summer, the plant has to tackle smell and colour issues due algae. However the filtered water turbidity is always less than 1 NTU without smell or colour. The plant is simple to operate and maintain since the only mechanical part is rotating flocculator agitator.

Apart from the consumables, the O & M cost of the plant is almost negligible. The sizing of such PWTPs are made to suit the truck dimensions. The quality of manufacturing is maintained in shop under controlled environment. Thus, PWTP is an appropriate solution for speedy and correct mass application in small W/S schemes. This case study demonstrates the efficacy of PWTPs in enhancing water quality, reliability , sustainability and water related

public health for the rural consumers. Many such plants in JJM and other government scheme are in operation or under execution in Maharashtra.

Keywords: Packaged Water Treatment Plant, Pre-Fabricated,

The Evolution of Desalination Techniques: A Global and National Perspective

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Abstract:

The rapid growth in population and industrialisation has led to a perilous depletion of pure drinking water resources worldwide, posing significant threats to many regions. In response to this crisis, engineers and scientists are increasingly turning to desalination techniques, leveraging the abundant availability of seawater (97%) resources. Desalination is now widely adopted globally due to technological advancements in efficiency and cost-effectiveness. In the desalination technique, various methods such as thermal, crystallisation, membrane, air dehydration, and solvent extraction are used to extract fresh water from seawater. However, significant challenges exist in reducing electricity consumption and managing the brine by-products from desalination plants. This article evaluates the development and implementation of desalination plants worldwide and in India. It highlights the severe scarcity of fresh water in India, particularly in its island regions, and examines the role of low-temperature thermal desalination (LTTD) plants in addressing this issue. Finally, the article presents the challenges and successful establishment of LTTD plants, particularly at UT Lakshadweep Islands, India.

Advancement and Innovation in SWRO Desalination Technologies

Abstract:

Seawater Reverse osmosis (SWRO) is now firmly established as the technology for desalination projects. Low Capex and Opex of SWRO has allowed it to eclipse thermal technology and dominate the technology of the desalination sector. Numerous research projects are under study for the advancement and innovation in SWRO.

In Indian SWRO plants 70% of the O&M cost is contributed by the power cost. At present, most desalination plants worldwide are supplied by power generated from fossil fuel. In parallel, exploration of renewable power alternative such as solar, wind, etc. are being successfully implemented in desalination plants, which will drive the O&M cost down considerably due to reduced power cost. The world's leading research centers in the USA, Saudi Arabia, UAE, Singapore and Europe are working on the development of new generation of energy recovery devices, high efficiency pumps, and high flux membranes which aim to bring the total energy use of desalination plants to less than 2.5 kWh/m^3. Recent trend in implementing Artificial Intelligence and Digital Twining in desalination plants is bound to minimize energy consumption, chemical consumption and manpower reduction in O&M of a SWRO plant.

In the quest for lowering the energy use in fresh water production from desalination, is the development of nanostructured, graphene oxide and Aquaporin RO membranes, which provide more increased water transport for a given RO feed pressure, as compared to existing conventional thin-film membrane elements.

All the above advancements will result in the reduction of the total energy use and carbon footprint of desalination plants with over 30%.

The pretreatment system of desalination plant has been improved by introduction of dissolved air floatation (DAF) to manage the algae and traces of oil. Ultra Filtration and Microfiltration are able to supply high quality of feed water to RO, enabling higher flux through membranes and lesser particulate fouling.

Over the last several years the desalination industry has developed a number of brine concentration and mineral extraction technologies which enable the manufacture of commercially valuable products from the brine. Extracting minerals from seawater is a more environmentally friendly enterprise than terrestrial mining.

Following emerging innovations in desalination are promising and going to further bring down the life time water cost of desalinated potable water.

- Membrane distillation (MD)
- Forward osmosis (FO)
- Humidification-dehumidification (HDH)

The advancement and innovations in Desalination Technology will make Desalination more sustainable.

PAPER ABSTRACT:

TITLE:

Achieving consistent low energy consumption in SWRO based desalination plants.

Authors& Speaker: *Narendra Singh Bisht, General manager- R&D, Aquatech*

Co-Author: *Ravi Chidambaran*, *Pavan Raina,*

OBJECTIVE & SCOPE OF PAPER:

Biofouling remains the single most important factor that increases energy consumption as time progresses in the operation of the reverse osmosis (RO) membrane system. One of the challenges with plant operation is that once a plant has been designed for certain energy consumption, it does not remain steady over a period of time. This is mainly due to biofouling and the inability to clean the membrane efficiently. In an effort to maintain healthy operational efficiency in terms of water production and energy consumption, the differential pressure across the RO membranes should remain constant and close to the start-up conditions for multiple years. To achieve sustainable lower energy consumption, it is important to keep the RO membranes clean and then adopt an effective cleaning at the very initial phase of biofouling formation before it becomes a permanent problem.

APPROACH / METHODOLOGY:

This paper describes a novel RO desalination process (LoWatt® —Low Energy Membrane Desalination Process) that focuses on achieving low energy consumption by reducing biofouling on membrane surfaces through process design, integrating the combination of ultrafiltration and bio-foulant removers at the upstream of RO membranes, and adopting a unique osmotic cleaning methodology that prevents the buildup of any residual biofilm on the membrane surface.

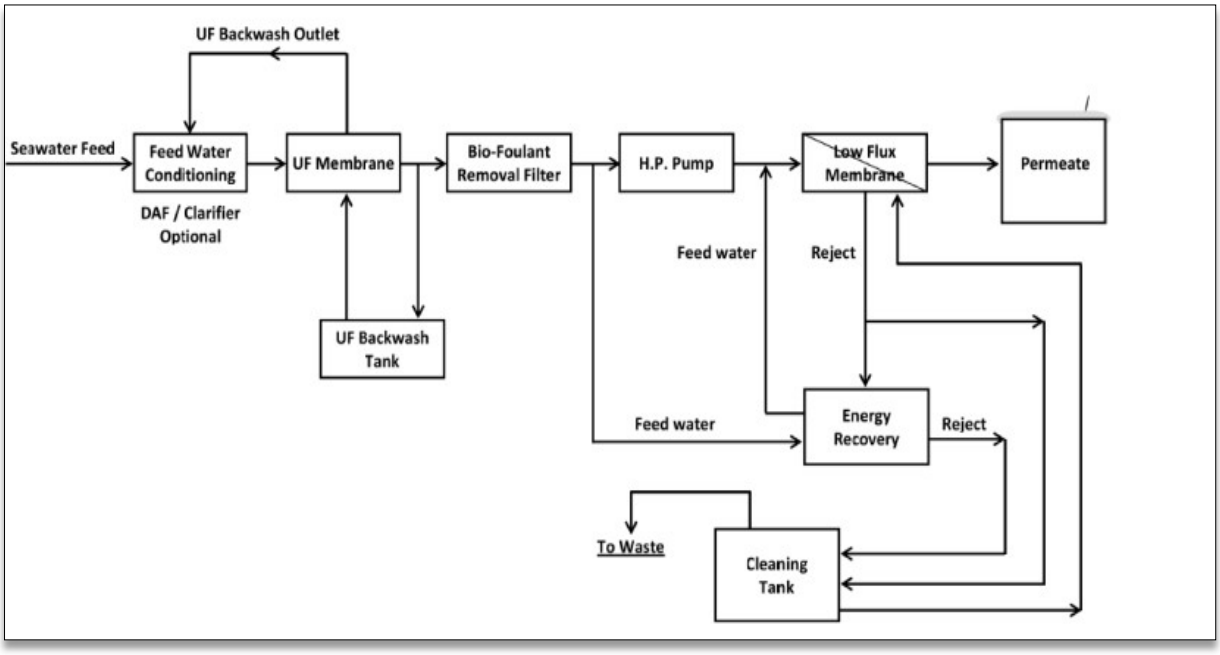

Figure: General Flow Diagram of LoWatt® Process

FINDINGS / RECOMMENDATIONS:

After implementation of each step of the LoWatt® process, it offers several advantages, like Lower energy consumption, especially for surface water and SWRO applications. Optimum flux design for initial and then sustained low-energy operation. Lower biofouling is due to a lower concentration of bacteria and food per unit area of membrane, resulting in a lower membrane replacement rate. Focus on the root cause of biofouling, i.e., bacteria and organics results in reduced chemical consumption.

The developmental studies clearly demonstrate that LoWatt® presents itself as a significant development in lowering the cost of desalinated water by as much as 25% than would be possible with the best-known energy recovery approaches available today. In addition to the lower initial power consumption, the system is also able to sustain the design power consumption without compromising on product quality, thereby providing a predictable life cycle cost for a desalination system. From a plant manager's perspective, this means more system availability and reliable operations without expensive and time-consuming chemical cleaning regimes.

Intelligent Water Systems – Utilizing IOT & AI

Integration of sensors & control systems placed at Intake pump house, Raw Water Transmission main, Water Treatment Plant, Clear water pump house, Clear water Transmission main, Elevated storage Reservoir, District Metering Area, and House Service Connections should be communicated each other based demand-based supply from consumer and Bulk Tapping points. Water Balance will happen component wise as well at specific intervals between the components. Any irregularities / abnormalities particular segment will be highlighted in the dashboard and necessary action should be taken place. More number of sensor placements at strategic locations will be placed to make the successful control and monitoring of the complete water supply system. To locate the probable leak location necessary algorithm will be made by using the field observed data.

Kinetics of Reduction of Hexavalent Chromium with CMC-nFeS in Aqueous Medium

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Abstract

Water contaminated with Cr(VI) poses significant health risks and environmental concerns. As a result, remediation of Cr(VI)-contaminated soil as well as groundwater has become an important environmental issue. The reducing agents that have been used in practice include Fe(II), nanoscale Zero-valent Iron (n-ZVI), sulfur-based compounds, hydrazine, and several organic substances. Out of all the reducing agents, FeS is known for its significant reduction capacity and has been used to reduce Cr(VI) from aqueous solutions. Stabilized FeS nanoparticles were prepared from $FeSO_4$ and Na_2S using CMC, and the average particle size was about 54 nm. The synthesized CMC-nFeS was thoroughly characterized by FESEM, XRD, FTIR, BET, and XPS techniques. The batch kinetics experiments describe the effects of the initial concentration of Cr(VI), mole ratio of reactants, solution pH, and temperature. Almost complete reduction (99.9%) of Cr(VI) was achieved within 3 h with 333% excess stoichiometric dosage of CMC-nFeS event at a solution pH of 8, surpassing the performance of other reductants reported earlier. The reduction kinetic data was satisfactorily fitted to the second-order rate model ($R^2 > 0.98$) via a two-electron transfer route. The activation energy of 31.81 KJ/mol was determined by analyzing the slope of the Arrhenius plot. Further, a mathematical rate model was proposed, and logarithmic second-order rate constant linearly depends on a given pH range. XPS analysis revealed the removal of the Cr(VI) involved reduction, adsorption, and co-precipitation. Ecological investigations were conducted using mung bean to evaluate the toxicity of the reduced solution. The statistical analysis revealed a reduction in toxicity of 99.9%. Overall, the study demonstrates a practical and environmentally friendly solution for Cr(VI) reduction in aqueous medium at natural pH conditions.