

Dear Water Warriors,

The expensive assets available need to deliver. Safety, Performance & ROI. 100% Plant Availability, 100% Capacity Utilization, 100% SHE Compliance at the lowest cost needs a well-defined O&M strategy.

While all may be available management still might be looking for a structure MIS that ensures sustainability & De-risking of Core Business.



This issue of 'Waughter', we discuss method to have a O&M Strategy & MIS Structure for control.

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Editor Waughter

While Knowledge is important, Tools are necessary for O&M professionals to deliver reports and MISs that help all stake holders understand the objectives of Compliance, Assets Management & Operation Cost Optimization:

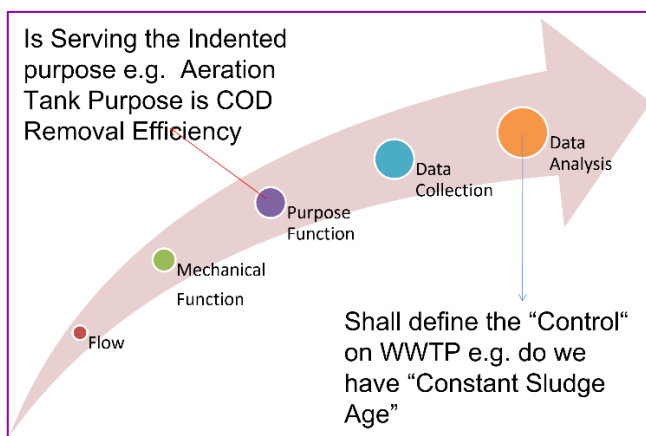
- [01 Log Sheet Master till Secondary.xls](#)
- [02 Individual Process Equipment Performance Monitor.xls](#)
- [03 Operating Expense Evaluation per m³ of Treatment.xls](#)

Feel Free to ask more Tools to suit your individual process scheme.



Operation & Maintenance_The System?

Without defining O&M that everyone knows, lets quickly understand the sequence in which we progress.



1. First Establish **Flow** – Design Vs Actual and just ignore performance. Ensure Plant is “Continuous” e.g., Clarifiers or Cyclic e.g., PSF, Softener, MBR etc.
2. Establish **Mechanical Function** – No leakages, No overheating of motors, No unnecessary Vibrations, No Noise and Healthy Stand By if available.

3. **Purpose Function** provides focus on delivery of individual unit operation e.g., the prime objective of Clarifier is TSS removal and not pH Control.
4. **Data Collection** Focus on logging (Just logging not worrying) of everything available through instruments. A whole lot of offline Lab analysis and some Analysis in external NABL accredited labs shall be handy.
5. **Data Analysis** need knowledge and experience. Till one is not intelligent enough, simple reference to design Vs Actual values can at-least indicate signs of early trouble that can be discussed with others.

Remember, the above 5 steps are like levels. You should not jump a level without satisfactory compliance to previous level.

To sump up, these 5 levers shall lead to 2 new dimensions that one expects from a O&M operator:

1. Efficiency
2. Readiness to move to Green with low CO₂ emission

Is **COD** in your waste water a challenge?

Pure Water Enterprises can help reduce your **COD** load by using **SUEZ NF membranes**.



BENEFITS OF USING SUEZ NF MEMBRANES



Used for **COD and Colour reduction**.



Dramatically **reduces discharge costs**.

TRIAL RESULTS - SUEZ NF MEMBRANES

TRIAL - 1

FEED COD(ppm)	PERMEATE COD(ppm)	COD REDUCTION
56000	8640	85%

TRIAL - 2

FEED COD(ppm)	PERMEATE COD(ppm)	COD REDUCTION
8200	1460	82%

Want to carry out pilot trials?

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Respect SHE?

Safety 20 plus team members in three shift or may be more need to reach home safe. O&M operators assumes this role to be their doctor.

Health would you like your operators to breath HCl Fumes? Off-course not. O&M Managers ensures minimum health hazard at workplace.

Environment when you walk in the premises, no smell, greenery all around, no object on walkways, proper signages and enough Trees.

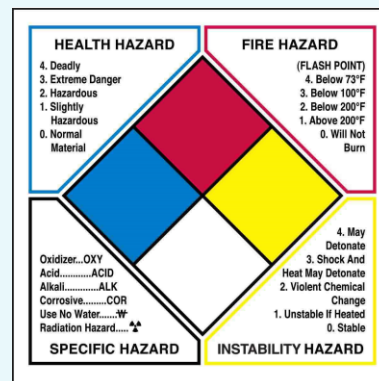
Respect of co-workers as assets and treating them equality while accessing Risk of task shall be fundamental mind set of an O&M Advisor.

Safety Tools?

- Safety Helmet** are used to protect head
- Safety Shoes** are effective in keeping the feet of industrial workers safe from sharp and heavy objects
- Safety Gloves** provides high safety limit to the hands
- Safety Belts** are broadly used while working at height.
- Safety Goggles** are very effective in keeping eyes safe from harmful objects.



Chemical Hazard?



Chemical hazard are present when you are exposed to any chemical preparation (Solid, Liquid or gas) in the workplace.

It can come in several forms such as liquids, vapours, gases, mists, fumes, or solids.

Sludge Management?

4 Steps:
Sludge Management

- Sludge Thickening
- Sludge Digestion
- Dewatering
- Disposal

Flow _ Batch, Cyclic & Continuous?

1.

The unit operation involved in WTP & WWTP can be classified in three categories:

- A. Batch: Where something is performed in batch e.g., preparation of 6% lime for injection for pH Control.
- B. Cyclic: where normal operation is performed for certain time and restoration/maintenance is performed either manually or automatically for some time. e.g., Sand Filter 23.5 h operation and 30 min backwash, Rinse etc. or in case of membrane-based plant e.g., MBR that is 9 min Filtration and 1 min back pulse.
- C. Continuous: the most ignored mode in ETP & STPs and one of the trouble creators to O&M professionals. Many processes need steadiness rather than stagnation e.g., Clarifiers, imaging when they don't have flow? Can you say *STATUE* to particles that are suspended? No.

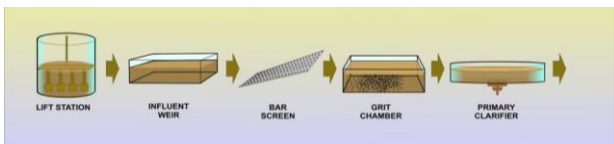


Fig 1. ETP Scheme

And the settled solids increase compactness of Sludge bed and in case that clarifier happens to be a secondary clarifier, gases will attach the settled sludge and in few hours everything will float. Same is the case if any biological reactor e.g., aeration tank is stagnated. Such equipment shall always have Flow.

The ETPs & STPs O&M practices are different then that of conventional WTP. An ETP or STP operator actually can not control what comes to them and when!

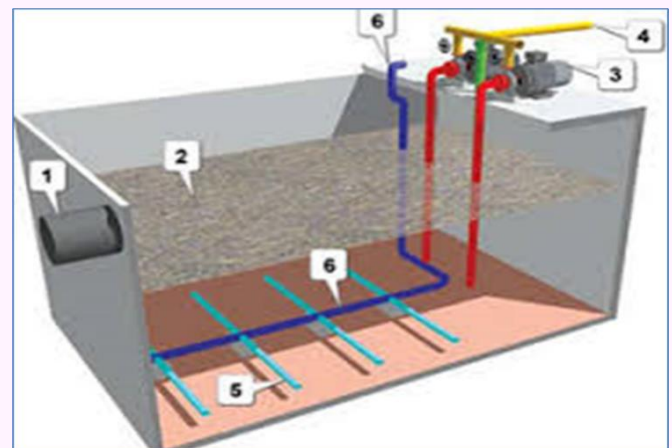
Therefore, we have two flows in ETP.

1. Peak Flow
2. Average Flow

Typically Head Works – 1. Lift Station 2. Screens 3. Grit Removal etc. is designed for maximum flow possible and O&M operator must be willing to accept what comes in.

Equalization... How and What for?

Plays an important role to harmonize everything that comes in peak of Flow, pH, TSS, TDS, COD, FOG etc to blend a feed that shall be fed to downstream plant e.g., usually a Primary Settler.



- 1 Inlet
- 2 Bulk Effluent stream
- 3 Suction of Homogenized Effluent
- 4 Effluent Discharge
- 5 Laterals with hole for Coarse bubble
- 6 Aeration for Mixing

Mixing can be achieved by :

For readily biodegradable wastes use surface aerators
 $\rightarrow 0.003 - 0.004 \text{ kW / m}^3$

Air requirement for diffused air aeration $\rightarrow 3.5 - 4.0 \text{ m}^3 \text{ air / m}^3 \text{ waste or}$

Simply by recirculation in a very small plant.

Constant or Linear Propagating Flow

Flow after equalization shall be constant. Simply putting $\text{m}^3/\text{d} \div 24$

But in some plants based on fluctuating flow from various sections e.g., a Hotel industry of O&M operator are not able to maintain constant flow, they shall propagate the flow, Ramp Up or Ramp Down based on Level Transmitter in EQ Tank. e.g., if tank is at 75% level, the flow shall be max and if level in EQ is just 25%, flow can be ramp down to 20% of design flow. Never STOP flow.

In case of MBR, cycle operation means change in level of the MBBR Tank or Aeration Tank during back pulse operation. Don't ignore levels and avoid overflow.

Mechanical Function?

2.

O is for Operational
 H is healthy
 R in repair
 S is to Scrap

Each asset in your plant from Huge Tank to Simple Name Plate needs attention and must be coded in above 4 categories. The R Coded items need further break-up as to why they are in R (to be repaired Category) It could be

- Spare Not Available
- Skill Not Available
- Method Not Available
- Permission not available



O & H Synergy

If Standby by is available, what's operational need not always operate. For equipment with Moving Parts e.g., Pumps & Blowers 24h operation is enough, and they should leave the duty to H (Healthy) for next 24 h. Repeat it.

If stand by is not available e.g., scraper of a clarifier, it's a good idea to give 15-20 min rest every day or every shift. Operational SOPs must be defined, and allied equipment need to be monitored. e.g., Drain extra sludge before giving scrapper rest to avoid high torque on re-start.

Dosing Pumps O & H Management

Need a special attention as they handle fluids that have chemical reactions with contact part e.g., HCl or SMBS and have choking tendency e.g., Polyelectrolyte. When you shift from Operational to Healthy Pump, ensure washing the pump from suction to discharge point properly.

S is to Scrap:

Our Plants are not Museums. What's not needed must be scrapped, through proper system as the asset is in books of Account. But it is non-functional and hence a Risk at premises.



PM & AM Schedule?

Predictive or Preventive (PM) or Annual Maintenance (AM) is to avoid Break-down. While stand by give us comfort, they are not provided to O&M team as a De-risking strategy of not having a PM AM Schedule.



Simple Things need attention:

1. Vibrations loses nuts and bolts, have routine tightening.
2. Fumes corrode an equipment. Pain nearby area.
3. Lubrication of Key to health of Joints and bearings, use right lubricant.
4. Extending the equipment's maintenance program goes beyond routine servicing intervals.
5. The equipment's owner manual will have the prescribed service intervals whether they be by hours of operation, seasonal or job specific.
6. Checking and tightening electrical terminals and watching for aging wiring is a simple part of daily machine operation.

A Good O & M Manager would have a Calendar to identify:

- Equipment
- When it needs service
- Is his team qualified or he needs external Agency?
- Calibration of Instruments
- Cleaning of electrodes
- Training & Coaching Refresher

Purpose Function?

3.

Well for this to be well understood, we request you to read Waughter Vol 1 Edition 1 to 11, all to understand the “Reason” why a particular Equipment is part of your Process Chain. Let’s have a look at the Table Below:

Degradation or Accidental?

Pay a close Attention to Table below and focus on Aeration Tank. The function defined is C Removal as well as Nitrification. If we look at NH_3-N_{in} and NH_3-N_{out} it gives an indication of Nitrification. But Hang on It’s not true.

Sr No	Equipment Name	Unit	TPI	DAF	Primary Clarifier	Equalization Tank	Bio Tower	Pre-Anoxic Tank	Aeration Tank	Post Anoxic Tank	MBR
1	Location		Head Works	Head Works	Head Works	Homogenous	Homogenous	Homogenous	Homogenous	Homogenous	Homogenous
2	Purpose		FOG	FOG	TSS	Equalization	C Removal	Denitrification	C Removal	Denitrification	TSS (MLSS)
3	Flow rate, Design	m ³ /h	40	40	40		26.5	26.5	26.5	26.5	26.5
4	Flow rate, Actual	m ³ /h	30	30	30		20	20	20	20	20
5	FOG,In	mg/l	200	135							
6	FOG,Out	mg/l	135	82							
7	TSS,In	mg/l			450						2600
8	TSS,Out	mg/l			210	300				2600	2
9	COD,in	mg/l					2500	1000	850	70	70
10	COD,Out	mg/l				2500	1000	850	70	70	70
11	NH_3-N_{in}	mg/l							70		
12	NH_3-N_{out}	mg/l				140			50		
13	NO_3_{in}	mg/l						25		20	
14	NO_3_{out}	mg/l				18		20	20	3	3
15	η , FOG	%	33	39							
16	η , TSS	%			53						
17	η , COD	%					60		92		
18	η , Nitrification	%							29		
19	η , De-Nit	%						20		85	
20	η , Filtration	%									99.92
		1	Need to Fill these Cells								
		1	Autofill Cells, no need to fill								
			Efficiency in Auto %								

Pay attention to Row 2. The purpose for each Equipment is defined e.g., DAF – FOG Removal and Pre-Anoxic Tank – Denitrification. This is called Primary Function.

The Performance of individual Equipment must be measured w.r.t it’s primary function and design specification.

Any incidental removal (Addon Benefit) of an Equipment is welcome but not an evaluation criteria e.g. DAF will also remove Suspended Solids. And Denitrification Tank will also have C Removal.

The amount of NH_3-N reduced (Technically Oxidised) must reflect in equivalent amount of increase in NO_3 . The operator therefore must understand NO_3_{in} and NO_3_{out} as well to qualify the purpose function. The reduction in NH_3-N could be due to:

1. N Assimilation in Bug Body
2. NH_3 Stripping and liberation to Air

The above narration reemphasise the need of study of subject and O & M Managers must adequately train themselves for Performance Function.

Data Collection?

4.

Data collected in three ways as hereunder:

1. Instrument e.g., Pressure, flow, temp etc.
2. Lab e.g., COD, MLSS
3. Calculation based on lab Results e.g., F/M Ratio

Being Dynamic Process and combination of Cyclic and continuous unit processes, Levels and Level Transmission are equally important.

There are 2 Types of Sample available for different different parameters which includes in below Table:

1. Grab Sample
2. Composite Sample

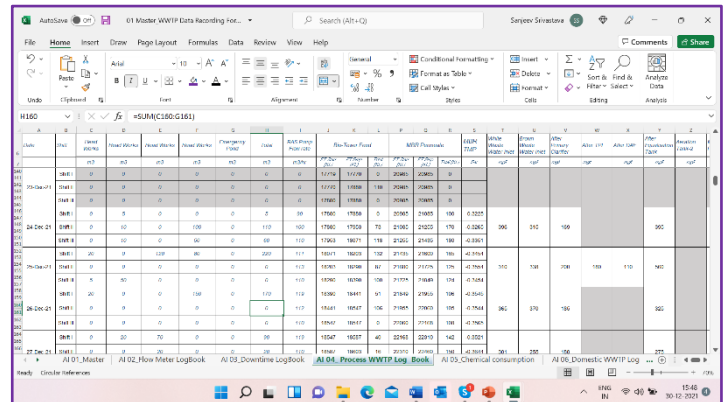
Parameter	Explanation	Sampling
FOG	Fat Oil & Grease	Composite
TSS	Particulates not dissolved - Dust, Fiber,	Composite
TDS	Inorganics Soluble e.g. NaCl, CaCO ₃	Composite
VTSS	Organic Particulates, C ₅ H ₇ NO ₂ , Protein	Composite
COD	Chemical Oxygen Demand - O ₂ Consumed by total C available in waste water	Composite
pH	-	Grab
Conductivity	Alternate of TDS	Grab
MLSS	Mix Liquor Suspended Solids	Grab
Svi	sludge Volume Index	Grab
BOD	Bio-Chemical O ₂ demand of waste water. O ₂ will be consumed by bugs for oxidation, Synthesis & Endogenous Respiration.	Composite
DO	Dissolved Oxygen in Water, The chief aquatic life managing wonder. We work hard to ensure our aquatic bodies have DO.	Grab
NH ₃ -N	Ammoniacal Nitrogen, Inorganic Nitrogen that is in reduced state and will deplete O ₂ if not managed	Composite
TKN	Total Kjeldahl Nitrogen - is the sum of all reduced nitrogen Organic or Inorganic	Composite
Org-N	Organic Nitrogen in reduced state	Composite
NO ₃	Nitrates - Nitrogen in Oxidised form	Composite
P	Phosphorus can be inorganic or Organic, is responsible for Eutrophication (Algae bloom) comes from Detergent & Fertilizer	Composite
Autotrophs	Bacteria that feed on CO ₂ , like tree	Grab
Heterotrophs	Bacteria that feed on Organic Carbon, like Humans	Grab

Based on these Sample, Data filled in Shift Wise manually.

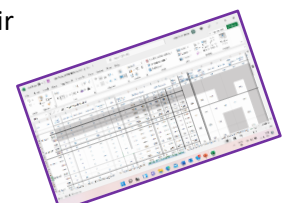
Manually filled data would be transferred to an XLS Sheet calculate daily average, minimum and maximum and repeat the previous data rather than writing 0 if some parameter is not tested that day. Avoid any accidental error in data.

Next Step Would be Design XLS Verification and that Sheet produced for the Management.

We Collected Data and represented it to in a XLS File which include different Sheet which indicate different Data.



1. **Sheet 01 AI 01_Master** represents all the key data that's requested by management for review.
2. **Sheet 02 AI 02_FlowMeter Logbook** includes the flowmeter reading of the Wastewater Treatment Plant. Helps Authorities to validate.
3. **Sheet 03 AI 03_Downtime Logbook** includes plant's Down time with reason for the Down Plant. Is useful for maintenance crew.
4. **Sheet 04 AI 04_Process WWTP Logbook** includes all parameters like Volume, TDS, TSS, MLSS, MLVSS, pH, BOD, COD, FOG etc.
5. **Sheet 05 AI 05_Chemical Consumption** includes which chemical used and how much quantity is used per day and alerts to get fresh stock.
6. **Sheet 06 AI 06_Domestic WWTP Logbook** includes the parameters in Domestic purpose. These days most plant have a separate STP.
7. **Sheet 07 AI 07_Equipment P&ID** lists Equipment with the Remark if it is Operational, Healthy or Repair.
8. **Sheet 08 AI 08_Instrument List** that includes the Instruments with it's Calibration status, Operational, Healthy or Repair need.



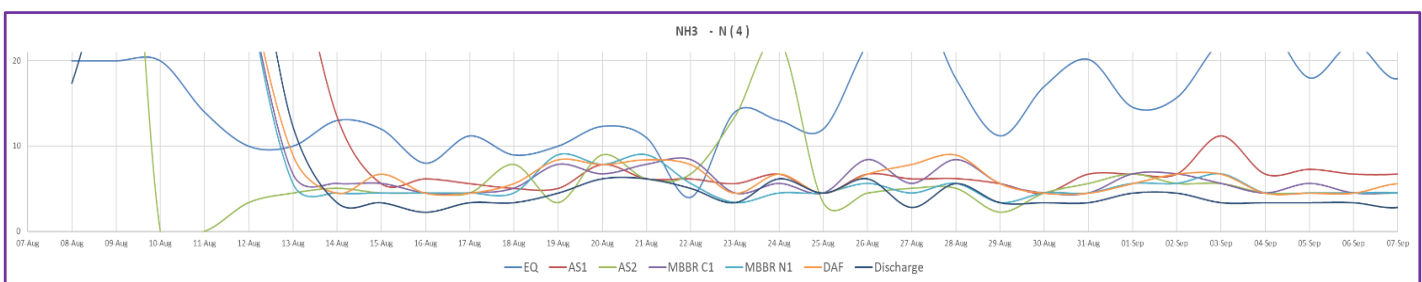
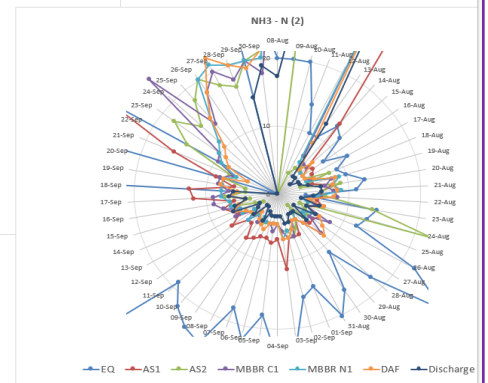
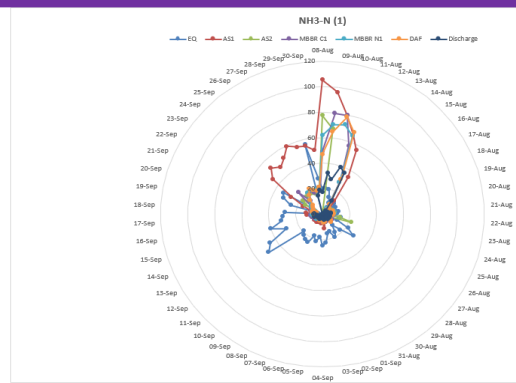
Data Analysis?

5.

The next level of management of plant performance to use these data and convert into information or trends required to compare the same with design numbers.

Based on the performance objective, that parameter that gives more trouble in compliance may be investigated much thoroughly, e.g., in below chart we see a in-depth profiling on NH₃-N in a particular project.

Date	NH ₃ -N (mg/l)						Discharge
	EQ	AS1	AS2	MBBR C1	MBBR N1	DAF	
08-Aug	20	105.28	77.28	49.28	61.6	47.04	17.36
09-Aug	20	96.32	67.44	79.52	70.56	64.93	32.48
10-Aug	20	79.52	0	79.52	72.2	78.4	28
11-Aug	14	86.08	0	57.12	64.96	88.32	39.2
12-Aug	10	96	3.96	28	28	30.24	35.84
13-Aug	10	34.72	4.48	6.72	5.6	8.96	12.32
14-Aug	13	13.44	5.04	5.6	4.48	4.48	3.36
15-Aug	12	5.6	4.48	5.6	4.48	6.72	3.36
16-Aug	8	6.16	4.48	4.48	4.48	4.48	3.24
17-Aug	11.2	5.6	4.48	4.48	4.48	4.48	3.36
18-Aug	8.96	5.04	7.84	5.04	4.48	5.6	3.36
19-Aug	10	5.04	3.96	7.84	8.96	8.4	4.48
20-Aug	12.32	7.84	8.96	6.72	7.84	7.84	6.16
21-Aug	11	6.16	6.16	7.84	8.96	8.4	6.16
22-Aug	4	6.16	6.72	8.4	5.6	7.84	5.04
23-Aug	14	5.6	13.44	4.48	3.96	4.48	3.36
24-Aug	13	6.72	22.4	5.6	4.48	6.72	6.16
25-Aug	12	4.48	3.96	4.48	4.48	4.48	4.48
26-Aug	22	6.72	4.48	8.4	5.6	6.72	6.16
27-Aug	28.56	6.16	5.04	5.6	4.48	7.84	2.8
28-Aug	17.92	6.2	5.04	8.4	3.6	8.96	5.6
29-Aug	11.2	5.6	2.24	5.6	3.96	5.6	3.36
30-Aug	17	4.48	4.48	4.48	4.48	4.48	3.36
31-Aug	20.16	6.72	5.6	4.48	4.48	4.48	3.36
01-Sep	14.56	6.72	6.72	6.72	5.6	5.6	4.48
02-Sep	15.68	6.72	5.6	6.72	5.6	6.72	4.48
03-Sep	22.4	11.2	5.6	5.6	6.72	6.72	3.36
04-Sep	24.64	6.72	4.48	4.48	4.48	4.48	3.36
05-Sep	18	7.28	4.48	5.6	4.48	4.48	3.36
06-Sep	22	6.72	4.48	4.48	4.48	4.48	3.36
07-Sep	17.92	6.72	4.48	4.48	4.48	5.6	2.8
08-Sep	24.64	7.28	5.04	4.48	3.92	5.04	4.48
09-Sep	23.52	7.84	4.48	5.04	4.48	4.48	2.24
10-Sep	21.65	5.6	3.92	3.92	3.92	3.36	2.24
11-Sep	19	5.6	4.48	5.6	5.6	4.48	4.48
12-Sep	50	7.84	4.48	3.92	3.92	4.48	3.36
13-Sep	45	6.16	2.24	6.72	5.6	5.04	2.8
14-Sep	29.12	6.72	3.96	5.6	5.6	6.72	6.72
15-Sep	40	7.84	6.16	7.84	6.72	5.6	6.16
16-Sep	31	6.16	3.92	8.96	6.72	4.48	4.48
17-Sep	29.68	11.76	7.3	8.96	7.84	6.72	6.72
18-Sep	28	12.32	4.48	6.72	7.84	5.6	6.16
19-Sep	0	6.16	4.48	8.4	7.84	8.02	0
20-Sep	24.64	8.96	7.81	8.4	7.84	7.84	0



Such analysis done daily, for each equipment in process chain and then studied over several months in a plant resulted in identification and improvement plans:

1. Feed Variations
2. Different C: N ratio on data to day basis
3. Need to change recirculation rates as variable NO₃ level etc.

Remember, **Data don't speak.** They Smile & rest you need to.

Knowledge is Everything?

Use of information and the taking corrective actions will make the plant in-charge knowledgeable on actions next time they face similar situation.

Sharing their experience and accumulating the concerns for detailing will make an O&M In_charge Intelligent to perform his task better and nurture his team.

Reporting Efficiency? No Text needed.

Date	Sample No	Sampling Method	Sampling Time	Clarifier Inlet		Clarifier Outlet		SpH	SpH
				TSS mg/l	FOG mg/l	TSS mg/l	FOG mg/l		
27-12-2021	1	Grab	9:00 AM	5595	114	1685	33.5	70	71
27-12-2021	2	Grab	2:00 PM	4595		1105		76	
28-12-2021	1	Grab	9:00 AM	7205	151	715	47.5	90	69
28-12-2021	2	Grab	12:30 PM	6260		940		85	
28-12-2021	3	Grab	2:00 PM	6845		860		87	
29-12-2021	1	Grab	9:20 AM	7850	391.5	1410	53.5	82	86
29-12-2021	2	Grab	12:40 PM	7875		1060		87	
29-12-2021	3	Grab	3:00 PM	8065		1025		87	
30-12-2021	1	Grab	9:00 AM	5945	656.5	1920	80.5	68	88
30-12-2021	2	Grab	2:00 PM	6860		1320		81	
Avg								81	78



Troubleshooting?

6.

What happens on our day-to-day operation?

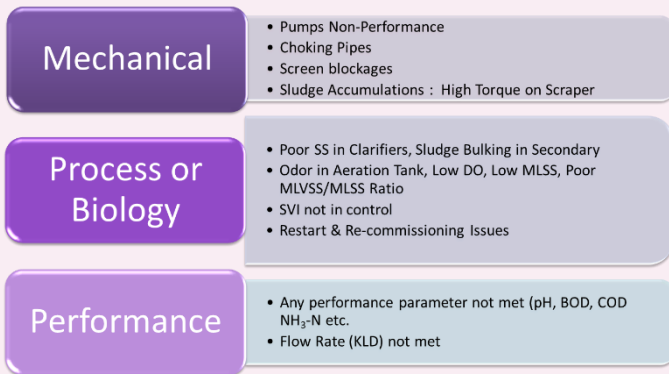


Fig. Issue in day-to-day Operation

1. Mechanical Issue

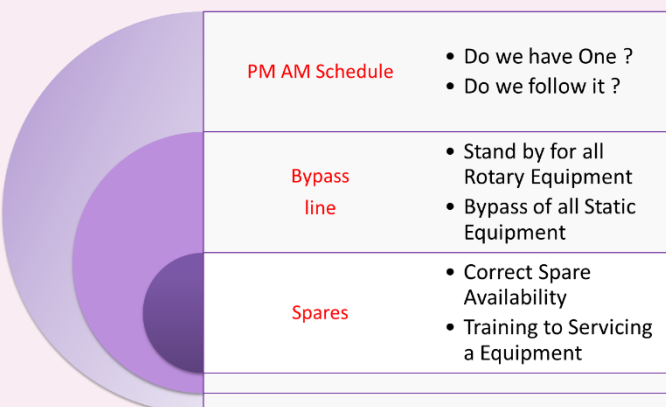
In mechanical issues we face that Pump Not perform well, Chocking of pipes, Screen Blockages, Sludge Accumulations etc.

How to Overcome such Mechanical Issue?

To Solve the Mechanical Issue on Plant First thing is to prepare Preventive maintenance and Annual Maintenance Schedule and Follow it on day-to-day operation.

You have to have Stand By for all Rotary Equipment and Bypass of all Static Equipment.

Correct Spare Availability and Train Operators to Service a Equipment if required.



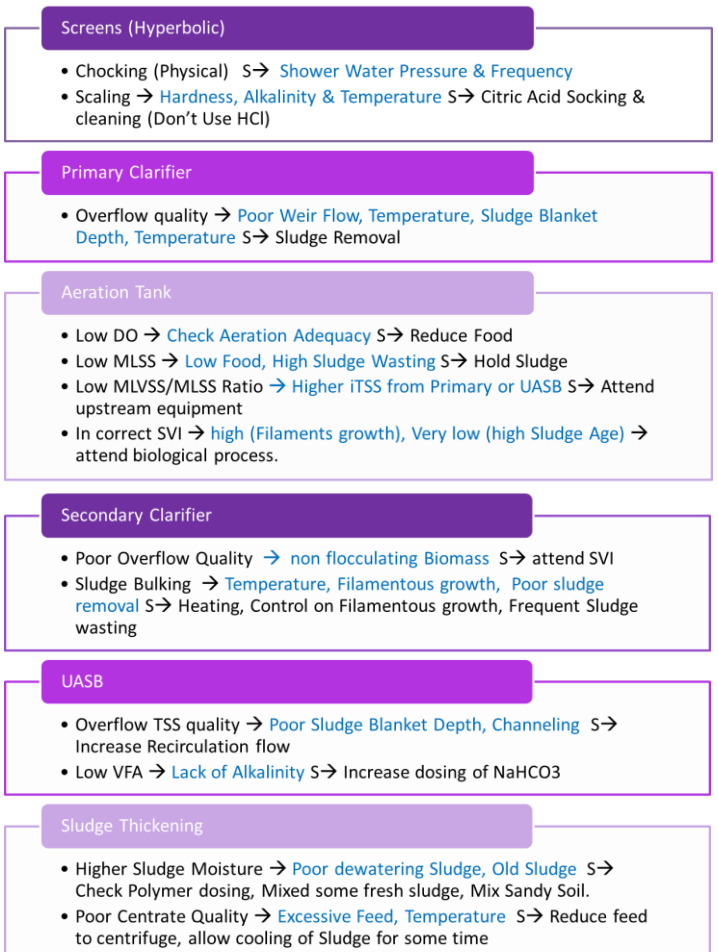
2. Process or Biology Issue

In Process or Biology Issue we face the following problems:

1. Poor Suspended Solids in Clarifier
2. Sludge Bulking in Secondary Clarifier
3. Odour in Aeration Tank
4. Low DO
5. Low MLSS, Poor MLVSS/MLSS Ratio
6. SVI not in control



How to Overcome Process or Biological Issue?



As explained above, every step need attention and reference back to design Vs Actual and related design tools to solve performance issue.

3. Performance Issue

This is the Only Issue on Site which happens due to performance of Equipment that is mentioned below with Suggested Action.

Screen

Cause 1

Solids passing the Screen.

Suggested Action

Clean the Screen & Use correct size of Mesh

Equalization

Cause 1

Poor Mixing and Homogenisation

Suggested Action

1. Check Air Flow Distribution
2. Clean with Water pressure or Citric Acid

Primary Clarifier

Cause 1

Poor Outlet Total Suspended Solids

Suggested Action

1. Increase Sludge Removal Rate
2. Check Temperature and try to increase it
3. Reduce Feed flow for some time
4. Check Flow Distribution at Launder

Aeration Tank

Cause 1

Poor COD or BOD



Suggested Action

1. Check correct MLSS, DO and sludge Age
2. Check N & P Level
3. Observe growth of Bugs and record SVI
4. Check COD Loading rate ~1.0 kg COD/m³ of AT

Cause 2

Poor Nitrification

Suggested Action

Check Sludge Age > 15 days

Secondary Clarifier

Cause 1 & 2

Poor TSS & Sludge Bulking

Suggested Action

For Poor TSS, Action is same as Primary Clarifier and for Sludge Bulking Aktion Suggested is Increase Sludge Removal Rate & Work of Aeration Tank parameters to control SVI

Pressure Sand Filter

Cause 1

High Differential Pressure

Suggested Action

1. Increase Backwash frequency
2. Use Air Scouring

Cause 2

Higher TSS

Action Suggested

Change Media to a Finer Grade Media

Activated Carbon Filter

Cause 1

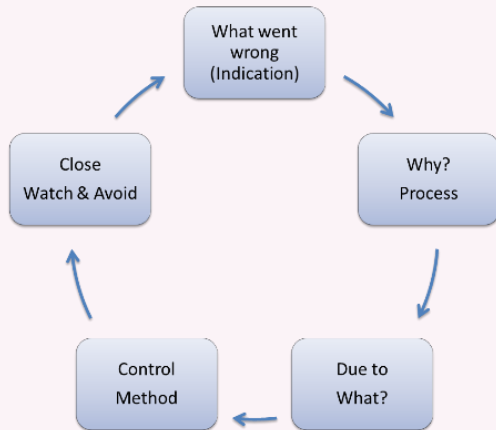
High Colour or TDS

Action Suggested

Backwash ACF with Service Water (Use Hot Water if possible) or Replace Carbon to a New Carbon

Root Cause?

A standard Root cause must be performed even if trouble is small.



For that you must follow below cycle for identify proper root Cause of problem.

WWT is an “Integrated process” with series functions, upset in 1 causes collapse of overall Train.

While investigating trouble, one must have a reasonable knowledge and the basis for the same are the 5 Point O&M Strategy that each O&M Operator must follow.

जल जीवन जननी !!

Glimpse of IFAT Exhibition

Gandhinagar, Dec 05-07, 2021, provided us the opportunity to with fraternity, Customers, Consultants, Vendors, and Associates. The spirit of Aktion does not have **Competition**.



Our world is Waughter

Time Flies! And we have reached the end of year with 12th Edition of Waughter. Hope our efforts added value to your work.

Next Month, would be 1st Edition of Volume 2 and based on reader’s feedback, the next entire year we would have case studies. If you have an interesting case that you wish to share, write to us.

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