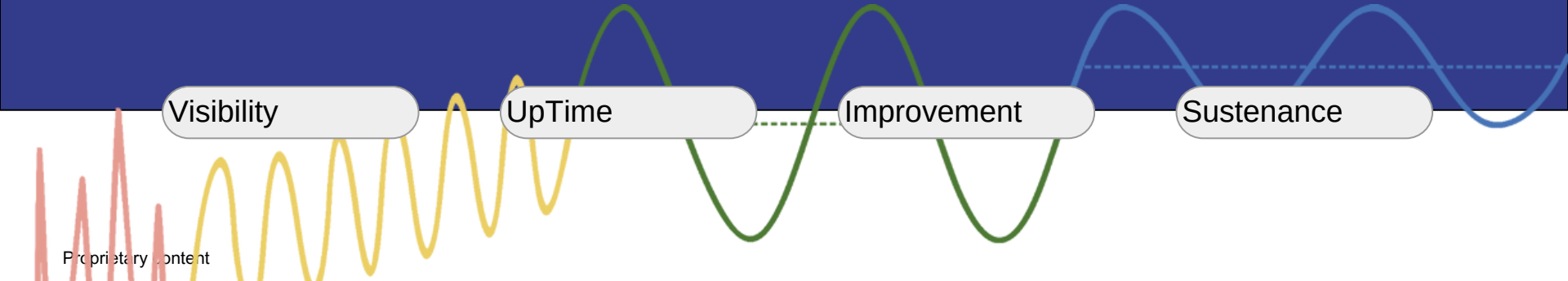
# Forbes Marshall

Energising Businesses and Communities Worldwide

## Improvement and Sustenance of plant KPIs

DIGITAL

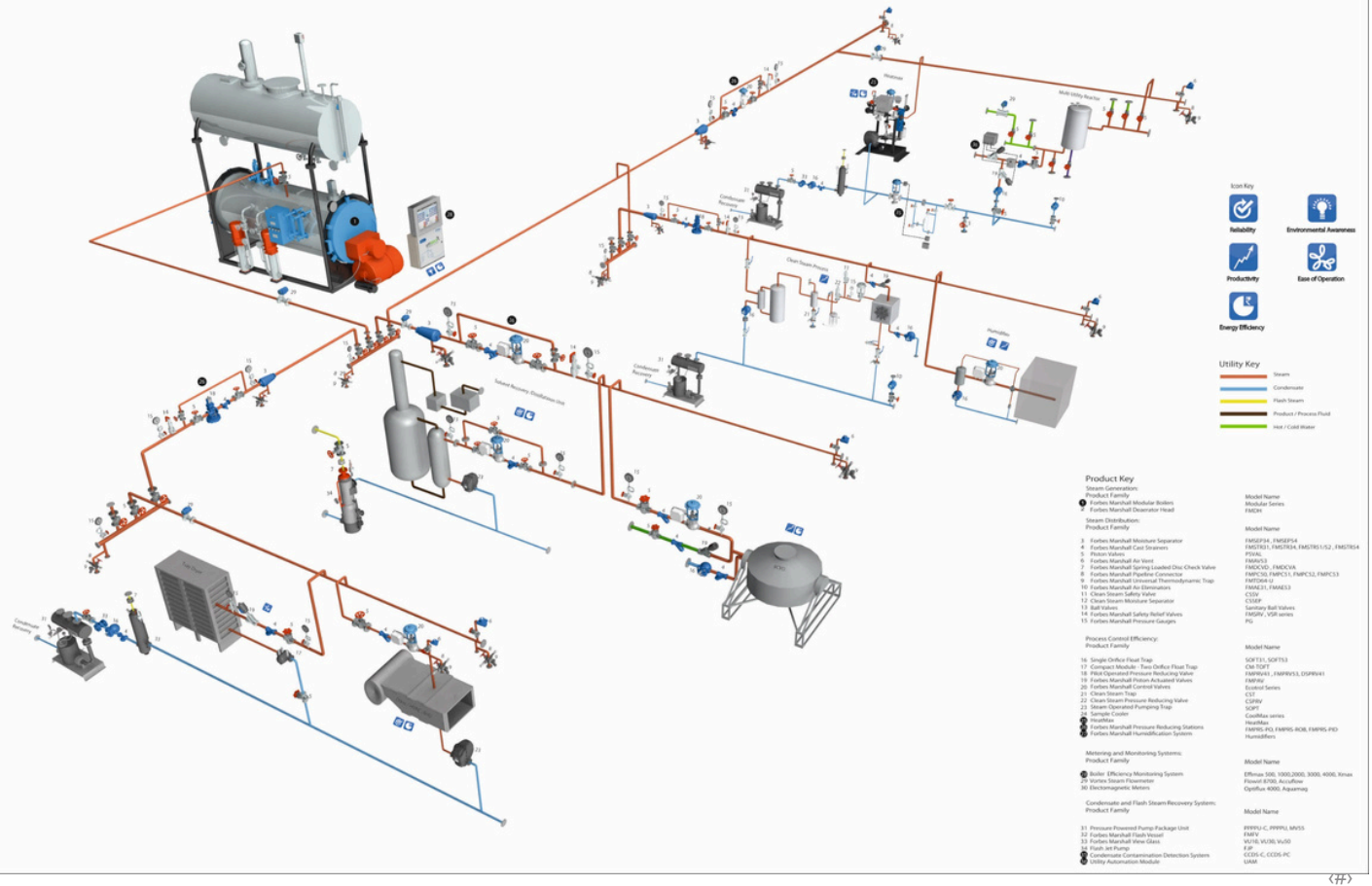


# Energy Conservation

## Focus and Importance

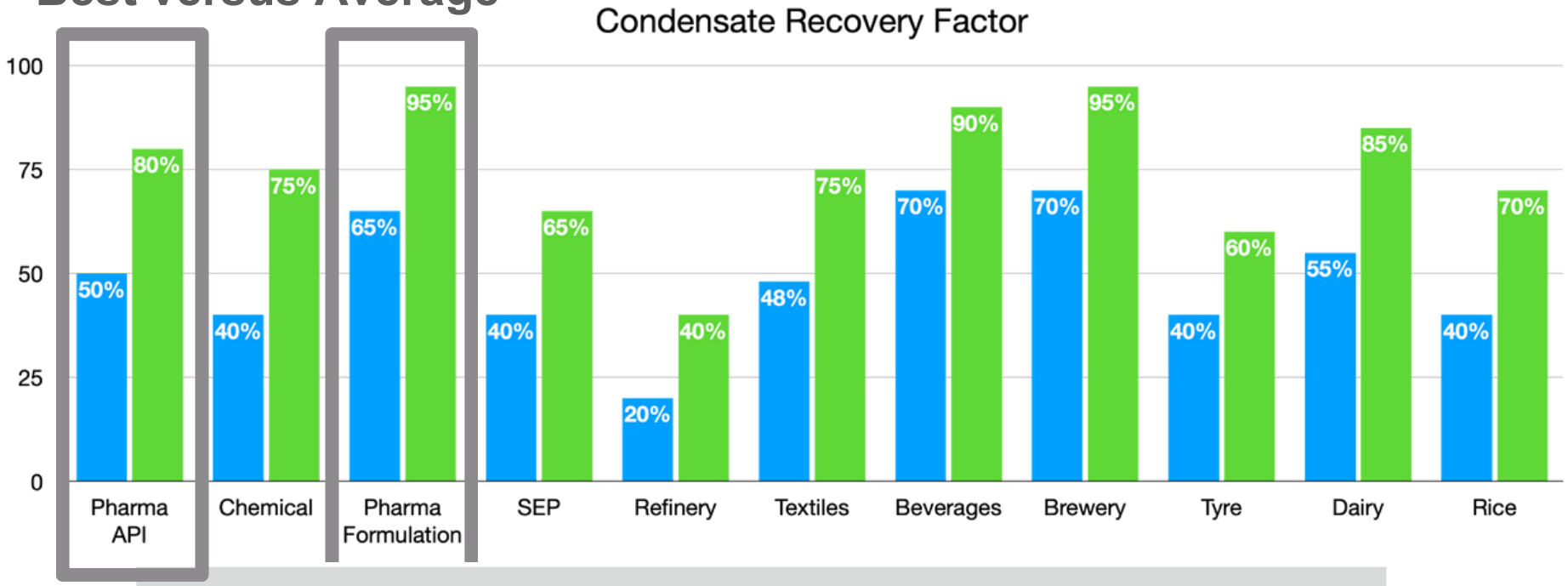
| Parameters | | Briquette | Rice Husk | Indonesian Coal | NG | Furnace Oil |
|---|---|---|---|---|---|---|
| Boiler Operating Pressure | Bar Abs | 9 | 9 | 9 | 9 | 9 |
| Boiler Efficency | % | 65 | 65 | 55 | 85 | 84 |
| Feed water temperature | °C | 75 | 55 | 65 | 70 | 55 |
| S:F | | 3-3.5 | 3-3.5 | 5-6 | 13-14 | 13 |
| Fuel GCV | KCal/Kg | 3700 | 2800 | 5000 | 9350 | 10200 |
| **Cost of Fuel Rs/Kg (Previous)** | **Rs/unit** | **4.5** | **4** | **6** | **38** | **42** |
| **Cost of Steam-Rs/Kg (Previous)** | | **1.10** | **1.33** | **1.30** | **2.83** | **2.98** |
| **Cost of Fuel (Current)** | | **7** | **6** | **13** | **64** | **62** |
| **Cost of Steam-Rs/Kg (Current)** | | **1.71** | **2.00** | **2.82** | **4.77** | **4.39** |
| **% increase in cost of steam** | | **56%** | **50%** | **117%** | **68%** | **48%** |

# New Generation Solutions



# Variations in CRF- A Key KPI

## Best versus Average




**Reasons for Variations in CRF**

- Poor trap uptime
- Condensate evacuation through bypass valves
- Improper steam system design
- Inadequate capacity utiliation
- Inconsistency of throughput and product mix
- Preventive maintenance schedules not followed

# Impact of Condensate Recovery

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**Water Charges :** Any condensate not recovered to boiler feed water tank has to be made up in the form of make-up water, thereby make water cost increases

**Reduced Water Treatment Costs :** Condensate is an ideal boiler feed water.

**Compliance Norms :** Draining of hot condensate is increasingly restricted as most plants are expected to meet Zero Liquid Discharge (ZLD) norms.

**No boiler derating :** Boiler output is maximized

**Reduction in Fuel Bill :** Condensate is a valuable resource, even relatively small quantity, say from even a single steam trap is economically justifiable

**Every 6 Deg C increase in feed water temperature due to recovery of flash steam and condensate recovery reduces the FUEL BILL by 1%**

# Condensate Recovery Overview

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### No Condensate Recovery

- Complete loss of flash steam & condensate
- Low feed water temperature
- Make up water required is high

### Condensate Recovery by Trap Pressure

- Water logged traps
- Increase in batch time
- Frequent opening of trap bypass valve
- Live steam venting from feed water tank

### Condensate Recovery by Flash Vessel & Steam Operated Pump

- Flash steam recovered to low pressure process / boiler feed water tank
- High condensate return temp. (+ 90°C)

### Condensate Recovery by Electrical Pump

- Flash steam loss to atmosphere
- Low condensate return temp.(70-75°C)

# Sustenance of KPIs- An Important Facet

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#BeyondConnectivity

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Why is digital sustenance of Paramters?

At an Existing Plant



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# Why is Digital Sustenance Service Needed?

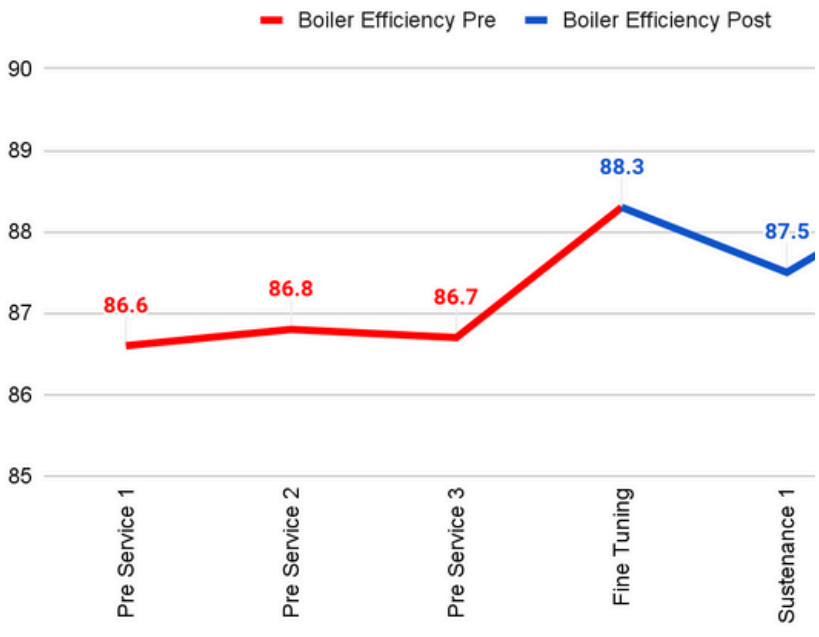
## Performance Variance Over Period of Time @ Embio Pharma

Yash, October 2023

# Equipment Level KPI

Boiler Efficiency

# Equipment Level Success Story
# Boiler Efficiency @ P&C Plant in Baroda




## Analysis, Actions and Interaction


Stack O2 is slightly higher on the side.- We will help you to fine tune Burner operation; give training; guide on corrective action starting from tomorrow with our Boiler Burner expert so that we can increase S:f ratio & start reducing gas Consumption

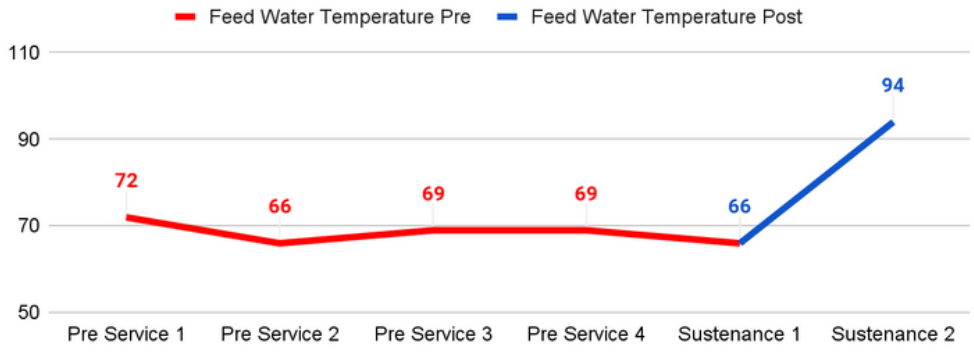
| | Efficiency | S:F | Steam Flow | Steam Pressure | Oxygen | Stack temp. | Drum TDS | Feedwater temp. | On/Off per hour |
|---|---|---|---|---|---|---|---|---|---|
| Yesterday | 88.3 ± 0.5 | 12.1 ± 0.3 | 1468.2 ± 230.4 | 8.2 ± 0.3 | 2.7 ± 0.5 | 201.8 ± 8.1 | 3490.6 ± 29.6 | 68.7 ± 6.6 | 0.0 |
| Last Week | 87.1 ± 0.9 | 12.1 ± 0.4 | 1555.2 ± 211.9 | 7.9 ± 0.6 | 5.1 ± 1.4 | 206.7 ± 6.7 | 3491.6 ± 35.6 | 68.9 ± 5.7 | 0.0 |

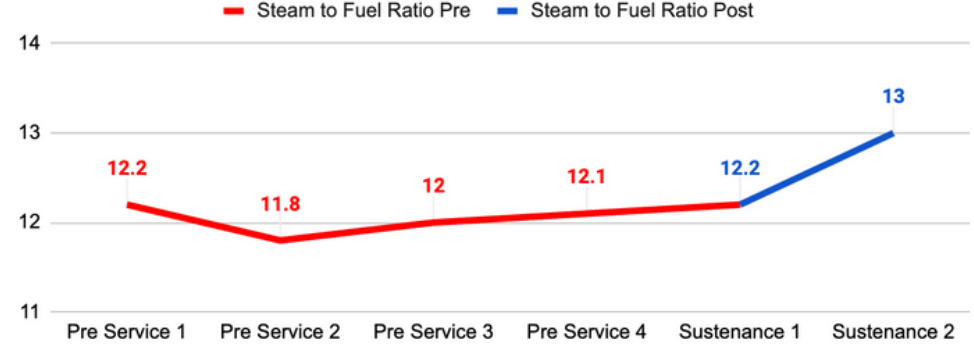
# Plant Level Engagement

Condensate Recovery Factor

Water accountability and Management

# Plant Level Success Story
# Condensate Recovery Factor @ P&C Plant in Baroda




## Analysis, Action and Implementation

- Flash steam recovery from Old plant
- Old pump Recovery is not online & not calculated
- MLT header line Condensate is drained
- PSG MP condensate is flashed in open tank, flash vented & only condensate recovered
- Both Flash steam from PSG via flash vessel & from FJP Steam recovery & inter connection
- Maintain level of 2.5-3 KL instead of 5-5.5 kl
- Deaerator Connection interchange for Condensate & flash steam
- Tapping for FWT bottom to deaerator top recirculation line

# Energy Conservation

## Steam Utilization-KPI At Equipment level

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FBD | Auto coater | Wruster | Solvent Recovery Unit | Stripper + ATFD + MEE | Reactors | PSG

**Typical Losses**

- Production Side
- Equipment Side
- Utility Side
- Environmental Side

**Understanding Root Causes** → **SOP"S**

# Fludised Bed Dryer/Auto Coater/ Wruster

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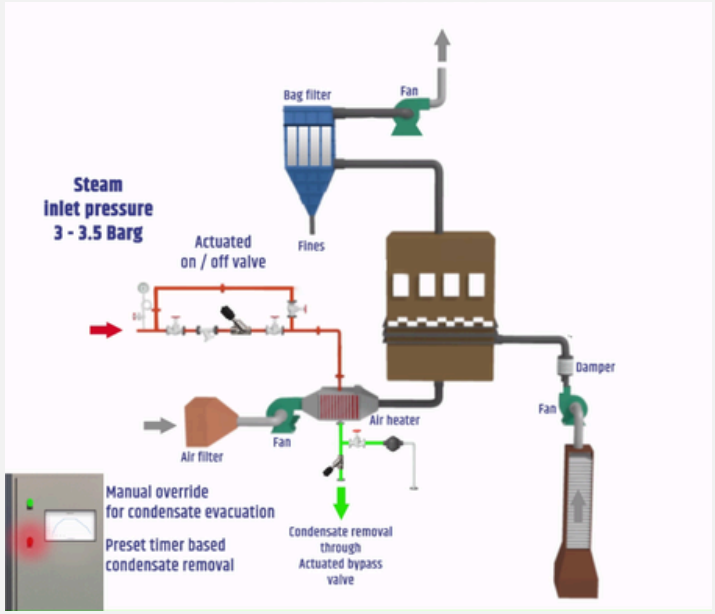


**Production Side**

Higher Batch Time & Startup Time
Degradation of Product – Product Quality?

**Equipment Side**

Radiation Losses
Charging of Air Heater Battery despite no batch
Water hammering

**Utility Side**

Higher Steam Consumption
Loss of Steam through Steam Traps Bypass
Higher Batch timings leading to higher electrical consumption

**Environmental**

ETP load increase due to draining of condensate
Increased Carbon footprint

# Cause,Effect & Control

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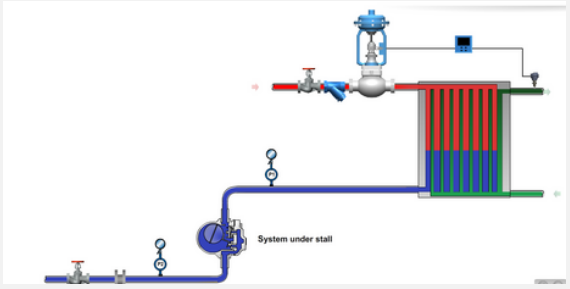
| Typical Losses | Root Cause | Available Patented Technology |
|---|---|---|
| Higher Batch Time & Startup Time<br>Degradation of Product – Product Quality? |  |  Steam Measurement with dryness |
| Radiation Losses<br>Charging of Air Heater Battery despite no batch<br>Water hammering | |  Combo-Pressure, Temperature & Flow monitoring |
| Higher Steam Consumption<br>Loss of Steam through Steam Traps Bypass<br>Higher Batch timings leading to higher electrical consumption | Incorrect Pressure & Temperature control valve selection |  Two Orifice STALL Eliminator* |
| | Incorrect Steam Trap Selection not being able to function under Stall | |
| ETP load increase due to draining of condensate | Redundant (with low load) or bypassed equipment |  Low flow pump |

# Multi Utility Reactor

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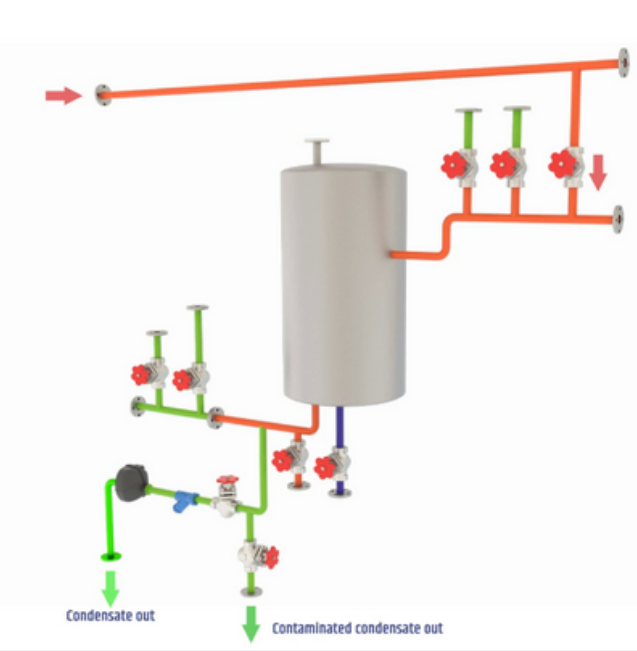


| | |
|---|---|
| **Production Loss** | Higher Batch Time & Startup Time |
| **Equipment Side** | Radiation Losses<br>Charging of Reactor despite no batch<br>Scaling<br>Water hammering |
| **Utility Side** | Higher Steam Consumption<br>Loss of Steam through Steam Traps Bypass<br>Corroded Condensers<br>Utility Mixing<br>Condensate drain due to fear of contamination |
| **Environmental** | ETP/Cooling Tower load increase due to draining of condensate |

# Cause,Effect & Control

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| Typical Losses | Root Cause | Available Patented Technology |
|---|---|---|
| Higher Batch Time & Startup Time | Incorrect Pressure & Temperature control valve selection |  Steam Measurement with dryness |
| Radiation Losses<br>Charging of Reactor despite no batch<br>Scaling<br>Water hammering | Incorrect Steam Trap Selection not being able to function under Stall |  Combo-Pressure & Flow monitoring |
| Higher Steam Consumption<br>Loss of Steam through Steam Traps<br>Bypass<br>Corroded Condensers<br>Utility Mixing<br>Condensate drain due to fear of contamination | Manual Intervention to segregate utilities |  Two Orifice TDS Condensate Separator |
| | Inability to predict fouling rate |  Closed Loop Condensate Recovery |
| ETP/Cooling Tower load increase due to draining of condensate | Bypassed equipment |  FoulingPreditco |

# Smart Process Trap- MuPT

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## Benefits

- **Equipment level** contamination detection and diversion.
- Process equipment failure detection (Heat Exchanger)
- Improved condensate recovery factor
- Utility and condensate **segregation**
- Inbuilt trap monitoring system (detects and indicates system status and failures)
- Compact, Integrated, and online-maintainable design

# FM Partner Plants

## Industries

Pharma & Chem
Food & Beverage
Textiles
Power Plants
Paper
Water
AAC Blocks
Automobiles
Metal & Mines
Plywood & Laminates

Monitoring every Minute

Plants: **451**
Assets: **893**
Parameters: **6000**
Control Loops: **726**

Drop rate
Connected Sites

≅1%

Service Running

287

Across 240 plants

Customer engagements :
Reports & connects

≅600

# How does FM Digital Sustenance Service Work?

## Monitor - FM Cloud


## Analyse

## Report

| Sr No | Parameter | Value |
|---|---|---|
| 1 | Stack O2 % | 0 to 1 |
| 2 | Furnace Pressure mmWc | -8 to -7 |
| 3 | Efficiency % | 78 to 80 |
| 4 | Stack Temprature °C | |
| 5 | ID, FD, Feeder output % | |

| | | |
|---|---|---|
| 1 | Stack O2 % | 0 to 0 |
| | e Pressure | 4 to 5 |
| | cy % | 84 to 86 |
| | Temprature | 198 to 201 |
| | | 1 , 49 to 52 to 48 |

| | | |
|---|---|---|
| 1 | Stack O2 % | 6 to 7 |
| 2 | Furnace Pressure mmWc | -3 to -2 |
| 3 | Efficiency % | 82 to 84 |
| 4 | Stack Temprature °C | 202 to 205 |
| 5 | ID, FD, Feeder output % | 81 to 84 , 53 to 56 and 14 to 17 |

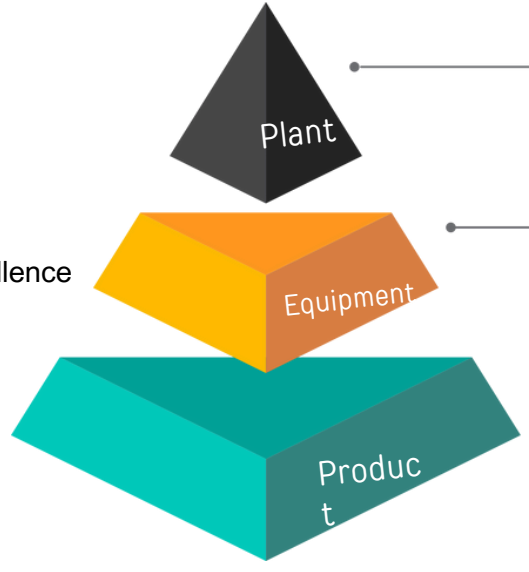
# Services Overview

**IMPACTING USER'S KPI : PRODUCTIVITY, COST, SAFETY, ENVIRONMENT**

**Plant KPI:**
Enhance productivity
reduce the cost of utility

**Equipment KPI:**
Equipment operational excellence

**Product KPI's:**
Product Performance
management




**Plant**

**Plant Performance**
CRF
KPI Dashboards

**Equipment**

**Equipment Efficiency**
EffiMax, Water Pump house, airMAC, DT, Distillation column, Reactor, Process packages

**Device**

**Uptime & availability**
Emissions Monitoring
Effluent monitoring

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# Thank you

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# Product Level Success Story

Emissions

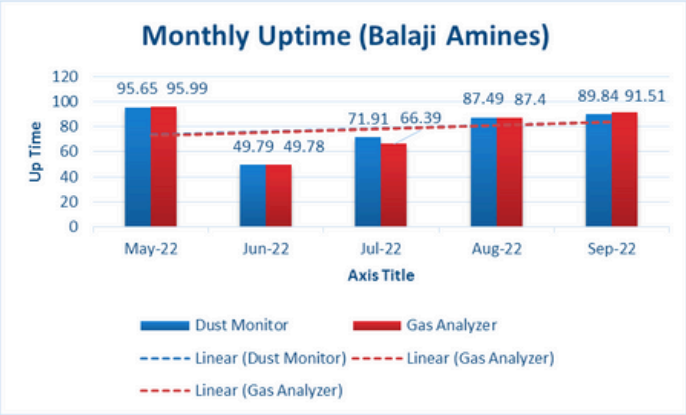
Effluent

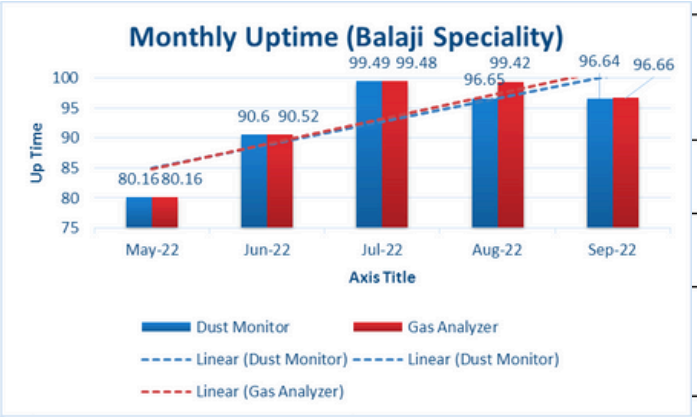
# Product KPI's

## Improve uptime

## Continuous Emission Monitoring System (CEMS)

**From 35 to 90%**

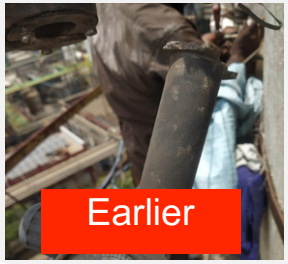



### Gas Analyzer



### Dust Analyzer

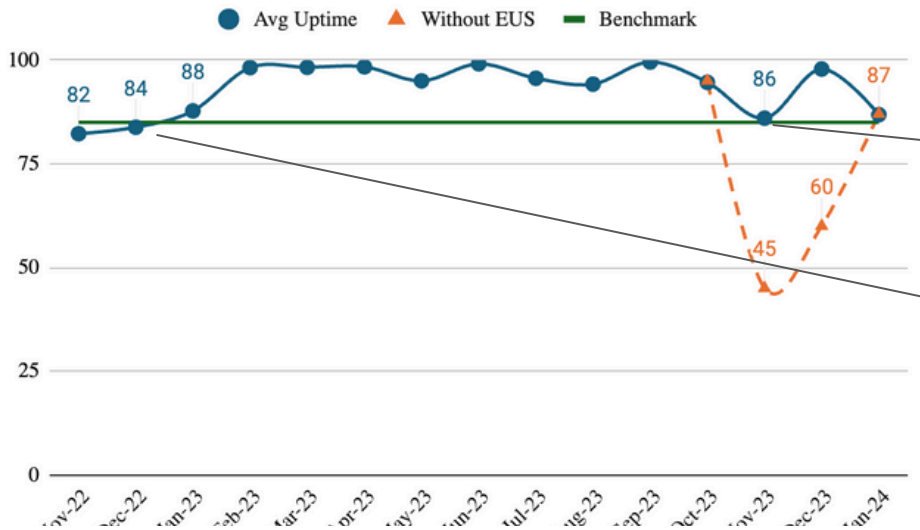



# Success Story

# Product Level

# Emissions

## DVC - Fleet of 8 nos TPP supplying electricity to West Bengal totalling 6.5 GW @Mejia TPS




Proactive Probe Cleaning & Fan replacement

Purge SOV failure

# Industrial water Conservation- Partnering Approach

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**Best Practises** L3

**Optimise water use** L2

**Stop Wastages** L1

Reduction in Process Water and its implied energy costs.
Water back to nature

Reuse

Best operating point for equipment like Pump House, ETP/STP/Cooling Tower
Water performance Ratio and Wastewater efficiency improvement

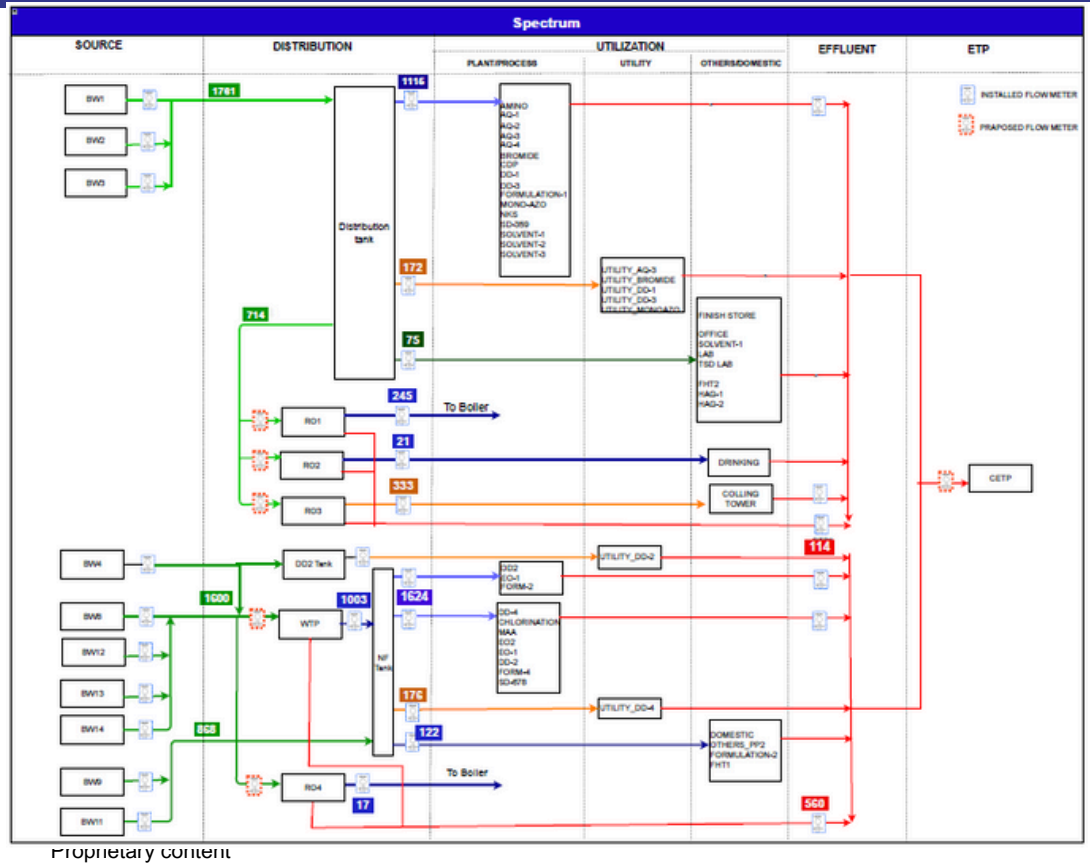
Recycle

Meter performance, Leakages, Wastages, Sectional losses, Theoretical losses, water balance variance, Water Costs, Water Intensity variance

Reduce

## Commit Deliver & Sustain

# Plant Survey , Study and Analysis




**Spectrum** is one of the largest producers of Disperse Dyes in India and catering to almost all commercially available Variants in the segment.

- 4300 M3/ day water consumptions
- Plant survey done & Milestones identified.
- Step by step improvement planned & implemented.
- Monthly reports & issues were highlighted to Spectrum.

| Type of Water | |
|---|---|
| Raw Water | (Green) |
| Treated + BW | (Dark Blue) |
| Process | (Light Blue) |
| Utility | (Orange) |
| Domestic | (Dark Green) |
| Effluent | (Red) |

# Source - Borewell management services deployed

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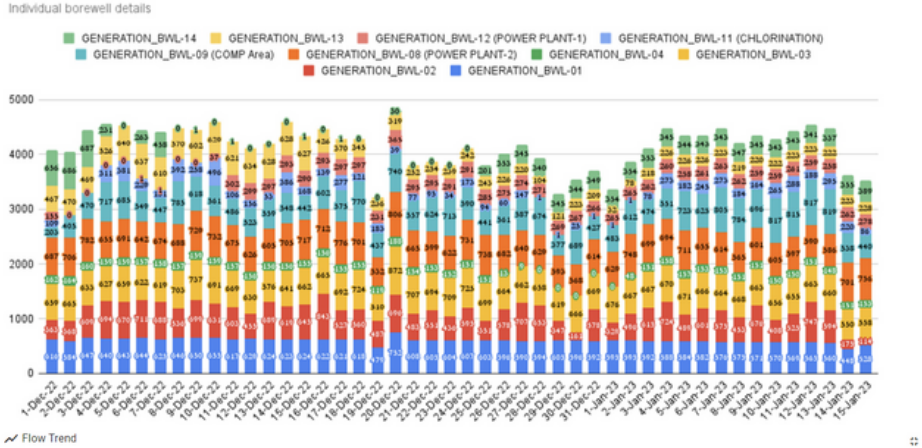


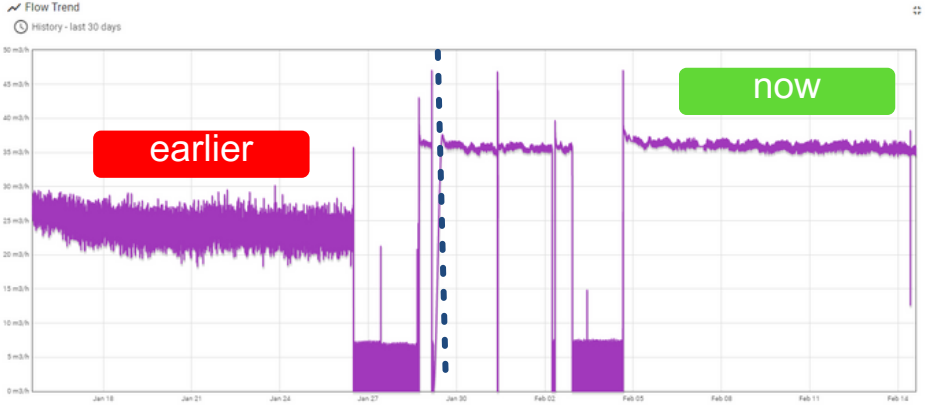


**Observations:**

- **BW 1 –** There was uniform water extraction through this borewell for the stated period. There is slight air movement reported during water extraction. By throttling the isolation valve this issue can be rectified.
- **BW 4 –** There is air movement reported during water extraction. By throttling the isolation valve this issue can be rectified. There was no water extraction through this borewell during the period 26 Dec 2022 to 2nd Jan 2023. There has been a drop in actual ground water level for this borewell. We suggest throttling the isolation valve else it may lead to failure of pump.
- **BW11 –** There has been drift in zero reading by (-4.5m3/hr) for this borewell. It is reading less than actual water extraction.
- **BW12 –** There is a drop in discharge flow rate for this borewell from 19m2/hr in November to 12m3/hr in December and again it dropped to 10.5m3/hr in January. We suggest checking

- Issues: Air movement in the water lines, Zero Drift, Dry run & Drop in discharge flow rate.
- All Observation were validated & rectified.
- Improved water balance from 61% to 88%

# water Balance for Supplier ( ex: Utility dept)

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## Section A : waterbalance

| | (BW1+BW2 +BW3) | (RO per + PTP1) | n "A" | n "B" | n "D" | Total (Total Feed to RO+A+B+D) | Unaccounted water in RAW water section (Source - Consumption) |
|---|---|---|---|---|---|---|---|
| 2-Feb-23 | 1689 | 742 | 1056 | 183 | 70 | 2051 | -362 |
| 3-Feb-23 | 1722 | 830 | 1185 | 200 | 81 | 2296 | -574 |
| 4-Feb-23 | 1496 | 734 | 1219 | 187 | 71 | 2210 | -714 |
| 5-Feb-23 | 2000 | 827 | 1383 | 200 | 70 | 2480 | -480 |
| 6-Feb-23 | 2044 | 848 | 1168 | 202 | 73 | 2291 | -247 |
| 7-Feb-23 | 1930 | 821 | 1199 | 201 | 75 | 2296 | -366 |
| 8-Feb-23 | 1907 | 828 | 1205 | 199 | 78 | 2310 | -403 |
| 9-Feb-23 | 1725 | 822 | 1010 | 190 | 74 | 2096 | -371 |
| 10-Feb-23 | 1937 | 885 | 1175 | 183 | 79 | 2322 | -385 |
| 11-Feb-23 | 1729 | 789 | 1027 | 177 | 76 | 2068 | -339 |
| 12-Feb-23 | 1754 | 848 | 1018 | 175 | 90 | 2132 | -378 |
| 13-Feb-23 | 1914 | 810 | 1166 | 197 | 87 | 2260 | -346 |
| Total | 77492 | 31419 | 49061 | 7567 | 3316 | 91363 | -13871 |
| Average | 1761 | 714 | 1115 | 172 | 75 | 2076 | -315 |

**Section A**
Source = 1761
Consumption = 2076

Section A Error = -315

**Corrective Action**:
Flowmeter in branches needs upgradation

**Section B**
Source = 2470
Consumption = 1922
Reject = 0560
Error = -12

**Corrective Action:**
2 source flow meter non functional

## Section B : waterbalance

| Date | treatment(BW4 +8+12+13+14) | (NF per +RO4 per) | (PTP2 Effleunet) | Treatment/Total Feed*100) | WTP & RO4 feed Total (Permeate + Reject) | Difference (Source - (Per+Reject)) | Raw water intake to NF permeate Tank (BW9+11) | Total Intake to NF Permeate tank (NF Per + BW9+BW11) | Process Consumption "A" | Utiltiy consumption "B" | Domestic consumption "D" | Total Consmuption NF Tank (A+B+D) | Unaccount NF water se Intake consun |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22-Jan-23 | 1587 | 1056 | 541 | 67 | 1596 | -9 | 763 | 1818 | 1544 | 156 | 135 | 1836 | -1 |
| 23-Jan-23 | 1540 | 934 | 516 | 61 | 1451 | 89 | 760 | 1694 | 1500 | 132 | 109 | 1742 | -4 |
| 24-Jan-23 | 1528 | 1058 | 597 | 69 | 1655 | -128 | 1167 | 2225 | 1657 | 209 | 142 | 2009 | 2 |
| 25-Jan-23 | 1548 | 1099 | 612 | 71 | 1711 | 0 | 0 | 1099 | 1727 | 183 | 136 | 2046 | -9 |
| 26-Jan-23 | 1501 | 1035 | 580 | 69 | 1616 | -114 | 1076 | 2111 | 1640 | 181 | 155 | 1975 | 1 |
| 27-Jan-23 | 1468 | 1061 | 571 | 72 | 1631 | -163 | 962 | 2022 | 1613 | 157 | 152 | 1921 | 1 |
| 28-Jan-23 | 1350 | 1046 | 593 | 78 | 1639 | -290 | 1054 | 2100 | 1619 | 170 | 112 | 1901 | 1 |
| 29-Jan-23 | 1344 | 1135 | 583 | 84 | 1718 | -373 | 777 | 1870 | 1414 | 164 | 99 | 1676 | 1 |
| 30-Jan-23 | 1300 | 1003 | 549 | 77 | 1552 | -252 | 646 | 1649 | 1416 | 112 | 107 | 1636 | 1 |
| 31-Jan-23 | 1330 | 931 | 529 | 70 | 1461 | -130 | 480 | 1411 | 1169 | 108 | 99 | 1376 | 3 |
| Total | 64573 | 44909 | 24646 | 3106 | 69555 | -4819 | 38203 | 82344 | 71459 | 7741 | 5380 | 84581 | -22 |

# Consumption report for consumer ( ex: formulation plant)

PLANT NAME : SPECTRUM PLANT FORMULATION-3

| | PERMISSIBLE LIMIT | LAST 7 DAYS (m3/day) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2023-02-23 | 2023-02-24 | 2023-02-25 | 2023-02-26 | 2023-02-27 | 2023-02-28 | 2023-03-01 |
| PLANT CONSUMPTION | | 32.9 | 66.7 | 76.1 | 62.1 | 73.4 | 50.2 | 61.6 |
| UTILITY CONSUMPTION | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL CONSUMPTION | | 32.9 | 66.7 | 76.1 | 62.1 | 73.4 | 50.2 | 61.6 |
| EFFLUENT DISCHARGED | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

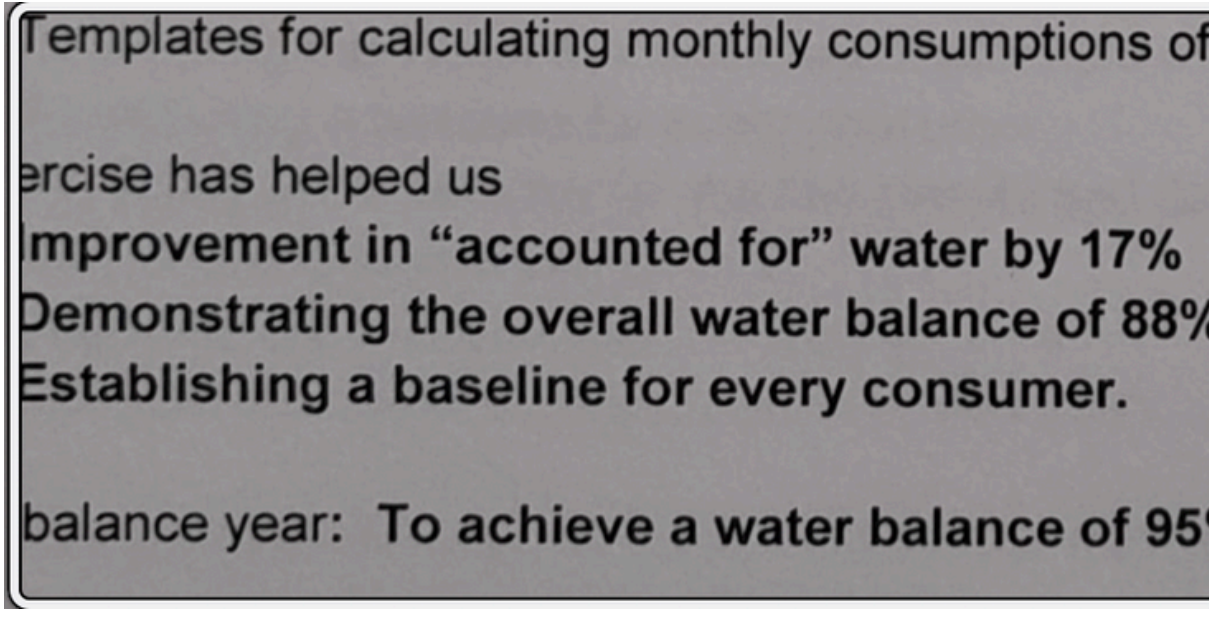
| | PERMISSIBLE LIMIT | LAST 3 MONTHS AVG.(m3/Day) | | | | |
|---|---|---|---|---|---|---|
| | | Current Month (Mar 23) | Feb 23 | Jan 23 | Dec 22 | Nov 22 |
| PLANT CONSUMPTION | | 61.6 | 85.6 | 60.8 | 74.04 | 73.27 |
| UTILITY CONSUMPTION | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL CONSUMPTION | | 61.6 | 85.6 | 60.8 | 74.04 | 73.27 |
| EFFLUENT DISCHARGED | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Establishing Baseline**

In absence of a Baseline
Every consumer is asked to sign this report

After 90 days the average with be the baseline

# Benefits documented


Templates for calculating monthly consumptions of

ercise has helped us

mprovement in "accounted for" water by 17%

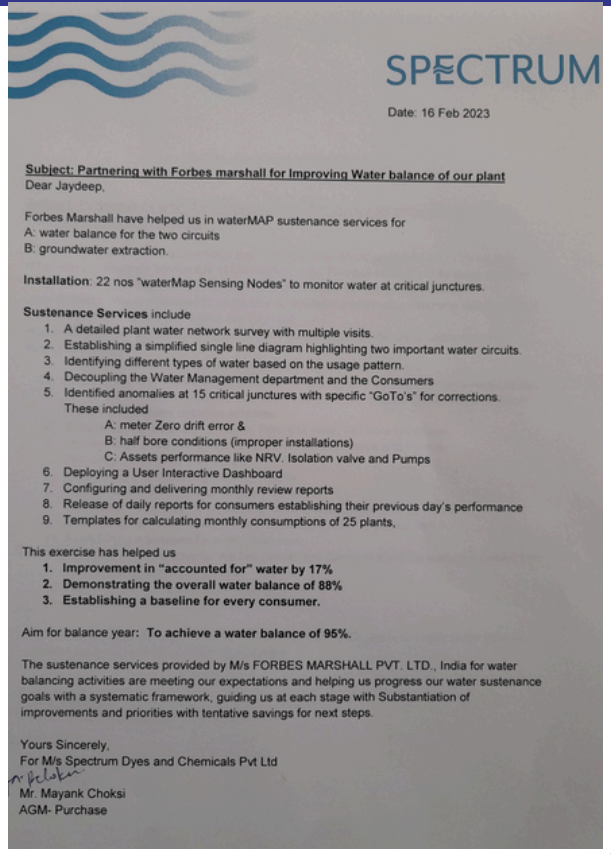
Demonstrating the overall water balance of 88%

Establishing a baseline for every consumer.

balance year: To achieve a water balance of 95

Next goal: To achieve 95% water balance

Nest Year : Implement opportunity of Reduce, Reuse and Recycle


SPECTRUM

Date: 16 Feb 2023

**Subject: Partnering with Forbes marshall for Improving Water balance of our plant**

Dear Jaydeep,

Forbes Marshall have helped us in waterMAP sustenance services for
A: water balance for the two circuits
B: groundwater extraction.

**Installation**: 22 nos "waterMap Sensing Nodes" to monitor water at critical junctures.

**Sustenance Services** include

1. A detailed plant water network survey with multiple visits.
2. Establishing a simplified single line diagram highlighting two important water circuits.
3. Identifying different types of water based on the usage pattern.
4. Decoupling the Water Management department and the Consumers
5. Identified anomalies at 15 critical junctures with specific "GoTo's" for corrections. These included
   - A: meter Zero drift error &
   - B: half bore conditions (improper installations)
   - C: Assets performance like NRV. Isolation valve and Pumps
6. Deploying a User Interactive Dashboard
7. Configuring and delivering monthly review reports
8. Release of daily reports for consumers establishing their previous day's performance
9. Templates for calculating monthly consumptions of 25 plants,

This exercise has helped us

1. **Improvement in "accounted for" water by 17%**
2. **Demonstrating the overall water balance of 88%**
3. **Establishing a baseline for every consumer.**

Aim for balance year: **To achieve a water balance of 95%.**

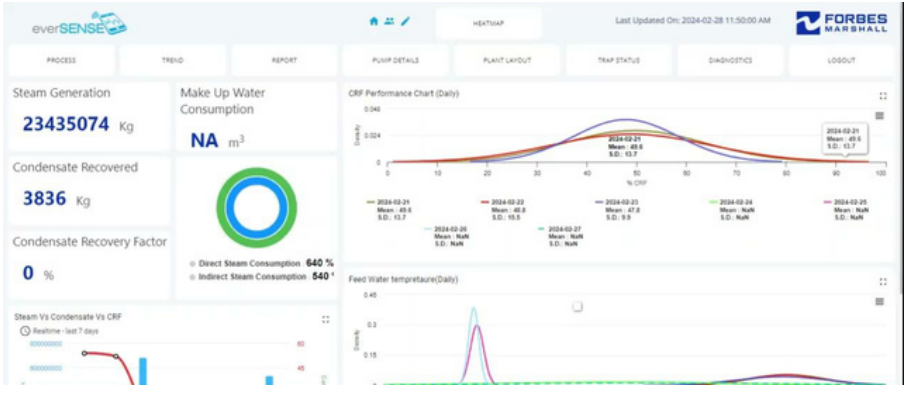
The sustenance services provided by M/s FORBES MARSHALL PVT. LTD., India for water balancing activities are meeting our expectations and helping us progress our water sustenance goals with a systematic framework, guiding us at each stage with Substantiation of improvements and priorities with tentative savings for next steps.

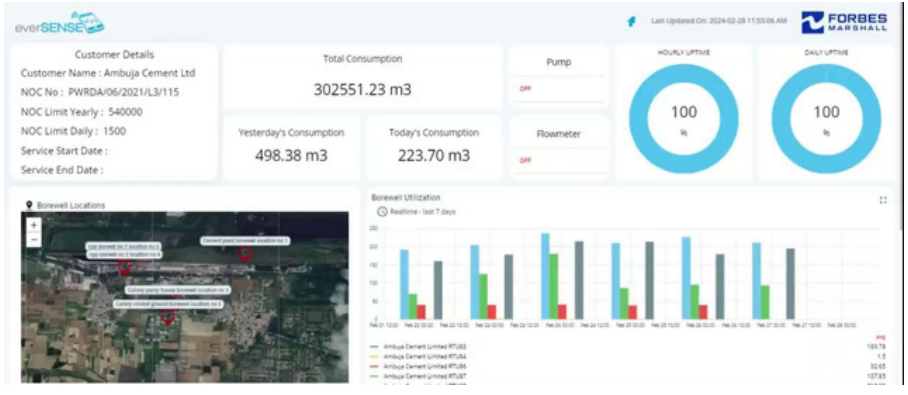
Yours Sincerely,
For M/s Spectrum Dyes and Chemicals Pvt Ltd

Mr. Mayank Choksi
AGM- Purchase

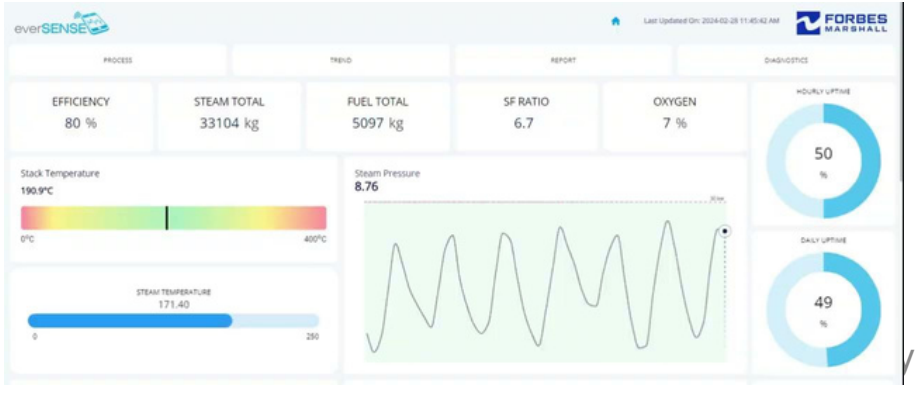
# On FM Cloud - EverSENSE Platform

## Domain knowledge driving performance







# FM is happy to partner with you for..

- Analysis of present performance
- Improvements through domain knowledge, products and systems
- Sustenance through ongoing digital and on-site engagement

#BeyondConnectivity