# REPORT ON ENERGY AUDIT OF 73 MLD WTP AT PANAMKUTTYMALA UNDER KOTTARAKKARA DIVISION, KWA

**TEAM ENERGY AUDIT, KWA NOVEMBER 2021**

**ACKNOWLEDGMENT**

We, the team members take this opportunity to express our sincere gratitude to Sri. Venkiteshpathy.S, IAS, MD KWA, who entrusted this assignment and gave timely directions to complete the audit as per schedule. We at KWA consider his leadership and inspiration a privilege.

We would like to express our thanks to Smt. SINDHU J S, AEE, PH Subdivision, Valakom, and Smt. Haisal Harison, AE HW Section, Panamkuttymala, who is in charge of this plant. We also thank all the staff of HW Section, Panamkuttymala, especially the operating staff at the water treatment plant.

We do not have any hesitation that to say, there are very many initiatives is shown from the operations wing at HO to address the energy issues faced by KWA, under the leadership of CE operations and his team. We take the privilege to express our gratitude to them.

As the team leader, I would like to express my gratitude to Sri. Manoj M, EE Sulthan Bathery and Smt. Sreelatha B.V, EE Kollam, who kindly spared their team members so that we could finish the audit on time.

## TABLE OF CONTENTS

# EXECUTIVE SUMMARY

| Executive Summary | | | | | | |
|---|---|---|---|---|---|---|
| Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects | | | | | | |
| KWA WATER TREATMENT PLANT, PANAMKUTTY MALA | | | | | | |
| **Sl. No.** | **Projects** | **Investment in Lakhs Rs.** | **Cost savings in Rs. per year** | **Pay back period** | | **Energy saved in Kwh per year** |
| | | | | Year | Month | |
| 1 | OPERATIONAL OPTIMISATION OF TRANSFORMERS- ONE KEEP AS STANDBY | 0 | 110814 | 0 | 0 | 19272 |
| 2 | MAINTAINE 3.8 m WATER LEVEL AT TWR | 0 | 272637 | 0 | 0 | 47415 |
| 3 | REPLACING LESS EFFICIENT BACK WASH WATER MOTOR PUMPSET BY EFFICIENT ONE HAVING 25HP CAPACITY | 380000 | 545568 | 0.70 | 8.4 | 94881 |
| 4 | SUPPLY AND FIXING OF NEW RE CYCLING MOTOR PUMP SETS FOR WASH WATER @ 30 HP SUBMERSIBLE | 600000 | 1904257 | 0.32 | 3.8 | 331175 |
| 5 | REPLACING LESS EFFICIENT No.301 TREATED WATER MOTOR PUMPSET BY EFFICIENT ONE @ 300 HP | 4800000 | 2840460 | 1.69 | 20.3 | 493993 |
| 6 | REPLACING LESS EFFICIENT No.201 TREATED WATER MOTOR PUMPSET BY EFFICIENT ONE @ 300 HP | 4800000 | 1742830 | 2.75 | 33.0 | 303101 |

# 1. INTRODUCTION

KWA is a PSU under the Govt. of Kerala which is empowered to construct and run the water supply schemes to cater potable water to the public and to construct and run the sewerage schemes in favour of LSGDs. In both cases, the electrical equipment which comes across the different operations in the plant and pumping stations is consuming a tremendous quantity of electricity directly and indirectly. There are 277 HT and more than 2000 LT connections associated with KWA at different pumping stations and WTPs all over Kerala by which more than 3300 MLD water is produced. M/s KWA is liable to pay Rs.3600 million per year to M/s Kerala State Electricity Board Limited. On preliminary study indicates that even the basic principle of energy conservation methodology has not been implemented in our pumping stations owing to a lack of awareness in energy conservation activities. For KWA, the energy audit and water audit are complimentary as both are having the potential to contribute to the existence of KWA. The Govt. of Kerala has formulated the autonomous body to look into the energy audit program in Kerala as the nodal agency, the Energy Management Centre (EMC) is continuously demanding to implement the corrective steps to avoid energy wastages in pumping stations as it is very essential for the financial sustainability of the organization and the prosperity of our nation. It is also realized that the energy audit through the empanelled agencies are more concentrated on energy aspects rather than water wastages as they were less expertise in the latter still it consumes more money and time. The main locations can be identified by audit in both cases viz. the places where less efficiency was reported due to the procedural (operational) errors and the place where losses occurred due to the implementation of outdated technology. It is also taken into consideration that the implementation of advanced technology in this sector will improve the service stability of KWA. The Honourable Managing Director has issued an order to create a team by selecting experienced hands from KWA itself to conduct energy and water audit. The Assistant Engineer in charge of 73 mld WTP at Panamkuttymala had been demanded to conduct the audit at the WTP under her jurisdiction once the order for constituting the audit team by the MD was issued. This is the second assignment of Team, energy audit, Kwa.

## 1.1 VISION

Promoting good energy management practices in KWA through water and energy audit

## 1.2 MISSION

Implement energy optimization technologies.

Adopt benchmarking for energy consumption canters of KWA

## 1.3 SLOGAN

Measure before leave

## 1.4 SCOPE

The energy audit is concentrating on two aspects viz.

1) Operational optimization
   This can be achieved by giving proper training to the staff, implementing a procedural system to fix the responsibility and target the culprits those who are negligent in optimum operation, Transferring technical knowhow to the concerned, which improves the morale also.
2) Technology up gradation

There is high scope for implementing advanced technology in KWA since the energy conservations methodologies are vastly developed in the recent era but still, M/s KWA is running with the conventional mechanism.

## 1.5 ENERGY AUDIT TEAM

The team members of the energy audit constituted as per order number KWA/JB/EW/EMC/EA/7813/2019 dated 17.09.21 by Managing Director KWA

1) Sri. Venkiteswaran B, Head Office Vellayambalam
2) Sri. Sajan,S , PH Sub Division, Chavara
3) Sri. Salmanul Farisi, P H Sub Division, Chavara
4) Sri. Jilson Devasia, P H Section, Sulthanbathery
5) Sri. Thomson M. C., P H Section, Mananthavady
6) Sri. Sajith K., P H Section, Sulthanbathery

Headed by Sri. Thampy.S, Assistant Executive Engineer, Project Division, Alappuzha

Date of Audit: 25.10.2021 to 30.11.2021

### 1.6 ABOUT THE ENERGY AUDIT TEAM, KWA

This team consists of six operating staff are having more experience in the water and energy sector with academic qualifications @ M Tech, and B Tech. of mechanical and electrical disciplines and they are working under the leadership of a registered Energy Manager.

### 1.7 MAJOR ACTIVITIES OF ENERGY AUDIT TEAM, KWA.

1) Carry out an energy audit in favour of KWA
2) Carry out water audit in favour of KWA
3) Study and evaluation of energy audit reports submitted by certified energy auditors.
4) Inspect the pumping stations for rectification work on energy related issues.
5) Technical support to water authority officers on energy related issues.

### 1.8 METHODOLOGY

1) Survey for requirement
2) Data collection
3) Planning of audit
4) Site observation
5) Auditing
   Power measurement
   Flow measurement
   Energy balancing
   Water balancing
6) Determination of opportunities for energy reduction and conservation options.
7) Exploiting the possibilities to encourage introducing the technology advancement in water and energy related sector at KWA from the R & D institutions.
8) Conducting sensitization programs and making consensus for implementing zero investment recommendations.
9) Preparation of draft energy audit report including cost benefit analysis.
10) Conducting discussions on the draft report with stakeholders.
11) Answering queries.

12) Preparation of final report.
13) Implementing phase by the competent authority.
14) Promoting feedback for further corrective actions.

## 2. WTP PANAMKUTTYMALA

### 2.1 SOURCE

The source for the Water Supply Scheme is the river Kallada at Tholikode near Punalur in Kollam district. The source is assured due to the K.I.P dam constructed at 22 km upstream of the abstraction point. The 71 Ml/d WTP is located at Panamkuttimala, on a hillock at about 1.6 km from the intake works. ( Lattitude 9.0024819, and Longitude 76.9188076 )

### 2.2 WORKS CAPACITY

The 2 Ml/d difference between input and output is due to an allowance for water discharged to waste in desludging clarifiers. Filter wash water will be recycled to the head of the works.

## 2.3. RAW WATER QUALITY

Details of the raw water analyses taken during the design phase are presented in the table below:

### 2.3.1 Results of Raw Water Analysis

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Name of the Scheme** | Meenad and adjoining Villages | | | | | | |
| **Source** | Kallada River at Proposed intake works | | | | | | |
| **Sampling Location** | 15 m from the riverbank collected from the surface | | | | | | |
| | **Date of Sampling** | | | | | | |
| **Parameters** | **Units** | 25/10/2021 | 25/10/2021 | 25/10/2021 | 25/10/2021 | 25/10/2021 | 25/10/2021 |
| Colour (True) | Pt-Co Scale | | | | | <5 | <10 |
| Turbidity | (NTU) | 2.6 | 2.4 | 5.1 | 1.4 | 2.7 | 1.5 |
| pH | | 7.0 | 6.8 | 6.9 | 6.7 | 7.0 | 6.4 |
| Conductivity | ( micro Siemens/$cm^2$) | 38 | 37 | 39 | 37 | 44 | 36 |
| Alkalinity | (mg/l as $CaCO_3$) | 12 | 16 | 14 | 10 | 14 | 13 |
| Total hardness | (mg/l as $CaCO_3$) | 10 | 10 | 8 | 11 | 11 | 7 |
| Calcium | (mg/l as | 6 | 4 | 2 | 3 | 2 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| hardness | $CaCO_3$) | | | | | | |
| Chloride | (mg/l as Cl) | 13 | 14 | 14 | 12 | 13 | |
| Sulphate | (mg/l/ as $SO_4$) | 2 | 3 | 4 | 1 | 5 | |
| Total Iron | (mg/l as Fe) | 1.0 | 0.8 | 1.3 | 1.3 | 1.0 | 0.2 |
| Total Manganese | (mg/l as Mn) | 0.008 | 0.006 | 0.0072 | 0.0078 | 0.082 | |
| Ammonia | (mg/l as N) | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | |
| Nitrate | (µg/l) | 25 | 469 | 498 | 722 | 157 | |
| Phosphate | (µg/l) | 7 | 16 | 115 | 110 | 97 | |
| Permanganate value | (mg/l as O) | 0.04 | 0.12 | 3.5 | 0.9 | 2.8 | |
| UV absorbance | (at 254nm) | 0.04 | 0.04 | 0.03 | 0.042 | 0.046 | |
| Mercury | (mg/l as Hg) | 0.00009 | ND | ND | ND | ND | |
| Cadmium | (mg/l as Cd) | ND | ND | ND | ND | ND | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lead | (mg/l as Pb) | 0.029 | 0.036 | 0.031 | 0.034 | 0.03 | |
| Total Coliform | (No/100ml) | NS | 21 & 22 | 28 & 31 | 19 & 20 | 15 & 14 | |
| Faecal Coliform | (No/100ml) | NS | 2&2 | 2 & 2 | 3 & 3 | 4 & 4 | |
| Dissolved Oxygen | (mg/l) | | | | 6.4 | 7.0 | |
| **Note :** | | | | | | | |

| |
|---|
| *1. Dissolved Oxygen values are only indicative* |
| *2. pH measured in Lab and not at the site, Site value may have been a few decimal points lesser* |
| *3. NS- No Sample, ND- Not Detected* |

## 3. WATER TREATMENT PROCESS

Raw water is treated to remove dissolved natural color, suspended solids, and iron and to produce water free of pathogenic organisms indicated by the absence of coliform bacteria.

Another requirement is the low aluminium concentration that originates from the aluminium sulphate coagulant when coagulation pH is not within an optimum pre-set range.

As a minimum, the treated water quality will comply with the ‘desirable limiting’ values given in the Indian Drinking Water Quality Standards, the Manual on Water Supply and Treatment, Ministry of Urban Development, Government of India, 1999.

The treatment processes will be designed to produce treated water that is equal to, if not in many respects, better than the desirable limiting values in the Indian Drinking Water Quality Standards. These will be specified as performance criteria for the takeover of the treatment works following completion. Therefore the works should be operated to achieve these performance standards most of the time, with the ‘desirable limiting’ values in Indian Drinking Water Quality Standards being satisfied all the time.

Table 2 below lists the treated water quality requirements for assessing the performance of the work, and corresponding 'desirable limiting values' in the Indian Drinking Water Quality Standards (IDWQS). The values are given only for those parameters which are affected by the treatment process in place. Values of other parameters except those which occur in particulate form would be equal to those in the raw water. For comparison, guideline values given by World Health Organisation (WHO) (1993), which are the same as those proposed in the 2004 Guidelines are also listed.

## 3.1. Treated Water Quality Criteria (Limiting Values)

| Parameter | Performance Standard to be met in 95% of the sample analyzed. | Indian Drinking Water Quality Standard (Desirable Limit) to be met all the time | WHO Guideline Values (1993) and those proposed in 2004 Guideline Values |
|---|---|---|---|
| Colour ($^{o}$ Hazen) | 5 $^{o}$ Hazen | 5 | Should be colourless |
| Turbidity (NTU) | 1.0 | 1.0 | 1.0 |
| Taste and Odour | Unobjectionable | Unobjectionable | Not offensive to consumers |
| Iron as Fe (mg/l) | 0.1 | 0.3 | 0.3 |
| Manganese as Mn (mg/l) | 0.05 | 0.1# | 0.4 |
| Aluminium as Al (mg/l) | 0.1 | 0.2# | 0.2 |
| pH | pHs ±0.4,pHs being the saturation pH value | 6.5 to 8.5 | <8.0 (for disinfection) |
| Total coliform (per 100ml) | Nil | Nil | Nil |
| Faecal coliform (per 100ml) | Nil | Nil | Nil |
| Free chlorine (after 30 minutes of effective contact time) (mg/l) | >0.5 | 0.2* | >0.5** |

*# Iron, manganese, and aluminium values of 0.1 mg/l as Fe, 0.05 mg/l as Mn, and 0.03 mg/l as Al gave in IDWQS are too low to comply with. Less stringent values equal to the WHO values will be used.*

** The proposed value is low for disinfection. A value of greater than 0.5 mg/l is proposed for 100%ile.*

*** Ct (C – free residual chlorine concentration in mg/l after a contact time t in minutes) > 15 mg.min/l*

The above treated water quality criteria also represent the filter performance except for turbidity, pH, bacteriological quality, and final free chlorine residual. They are influenced by the post filtration treatment. Filtered water turbidity standards will be set at 0.5 NTU (95%ile compliance) and 1 NTU (100%ile compliance).

The performance of clarifiers is defined by the following clarified water quality criteria:

| | |
|---|---|
| Turbidity: | 5 NTU |
| Colour | 5 $^{o}$ Hazen |
| Aluminium as Al: | 0.5 mg/l |

A conventional treatment process using coagulation, flocculation, clarification, rapid sand filtration, and disinfection will be used.

Detailed below are brief descriptions of the adopted treatment process.

- Coagulation by dosing aluminium sulphate,
- Flocculation under moderate intensity mixing conditions,
- Clarification of flocculated water with sludge blanket / Lamella clarifiers,
- Filtration of clarified water by rapid gravity sand filters,
- Disinfection of filtered water by chlorine dosing,
- Final pH-correction by dosing lime,
- Clarifier sludge thickening and settlement in sludge lagoons.

The plant items for the treatment process are briefly described below.

### 3.2. INLET WORKS

The inlet works will comprise an inlet pipe equipped with a magnetic flow meter feeding a cascade aerator with stilling basing. Hydrated lime will be dosed at the aerator inlet. The outlet from the aerator will connect to a channel.

### 3.3. MIXING FLUME

The channel from the aerator will be provided with a flume where chlorine and hydrated aluminium sulphate flocculants will be dosed. Mixing will be by hydraulic means.

There is a flow division chamber to divide the flow emerging from the flume equally between the clarifiers.

### 3.4. CLARIFLOCULATION

Clarifiers are the lamella sedimentation type with mechanical flocculates.

The Lamella clarifiers have a settling rate of 0.85 $m^3/h/m^2$ of the projected plate area.

In sludge blanket clarifiers, sludge is collected in a series of hoppers placed at the top level of the blanket. The hoppers of each clarifier have separate manifolds.

Lamella sedimentation tanks are provided with sludge scrapers.

Desludging of clarifiers is under the hydrostatic head; the desludging valves are fitted with pneumatic actuators to allow for automatic desludging on timer control

.

### 3.5. RAPID GRAVITY FILTERS

After clarification, the clarified water will flow to the rapid gravity sand filters for the removal of residual suspended solids. The filtration unit will consist of six individual filters, which can be operated independently via motorized valves fitted with electric or pneumatic actuators.

### 3.6. WASH WATER REUSE

Used wash water from the filters is collected in a tank and pumped to the works inlet chamber, the rate will be less than 5% of maximum works inflow. The tank is provided with two compartments to allow one to be taken out for cleaning.

Two pumps (1 duty, 1 standby) of the Submersible type are provided. The used wash water flow to the works inlet is not carried out since the motor is under repair.

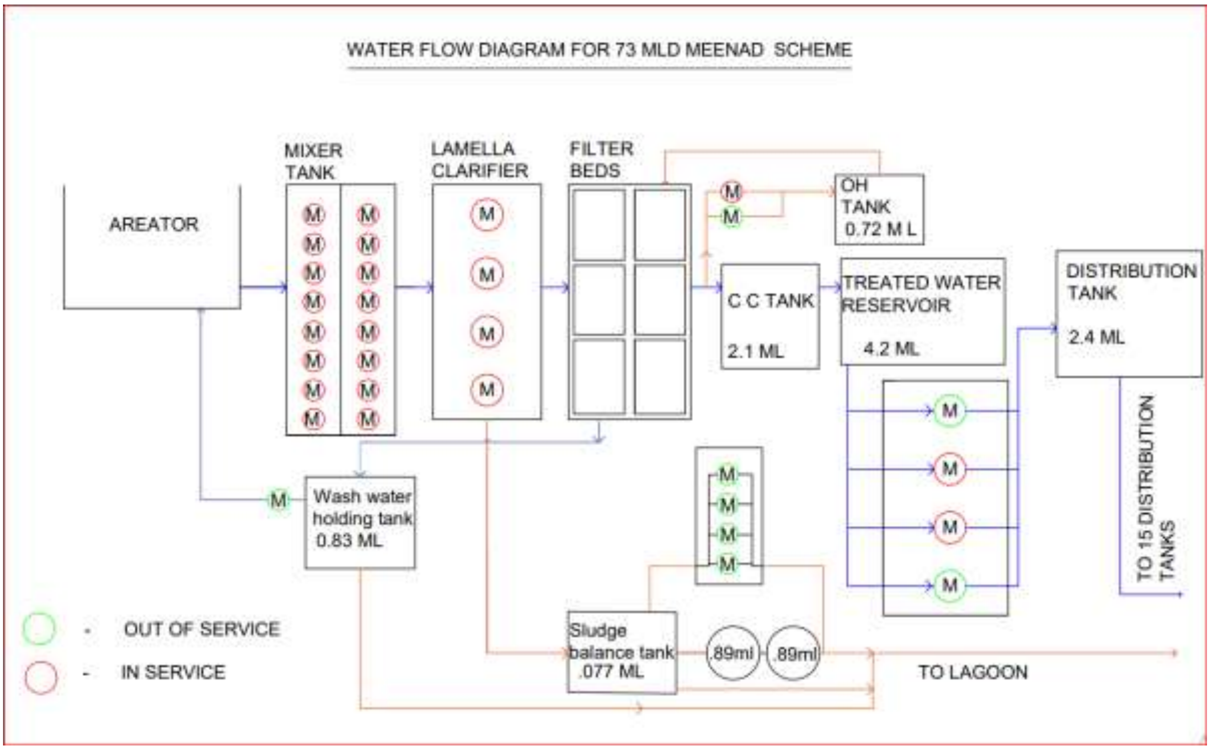
## 4. CONTROL AND MONITORING SYSTEMS

The treatment works are provided with modern facilities to operate the treatment plant items. A central computer based Supervisory Control and Data Acquisition (SCADA) system will be provided at the water treatment works to monitor alarms, plant status, and analogue signals.

The SCADA system is situated in a dedicated control room in the works administrative building (filter building). The SCADA system receives the data from the works monitoring and control systems, and the raw water pumping station. The raw water pumps are operable from the works control room. Data from the works is relayed to the Regional Control Centre, located at the scheme administrative building.

# 5. WATER FLOW DIAGRAMS AND PHOTOS

## 5.1 WATER FLOW DIAGRAM



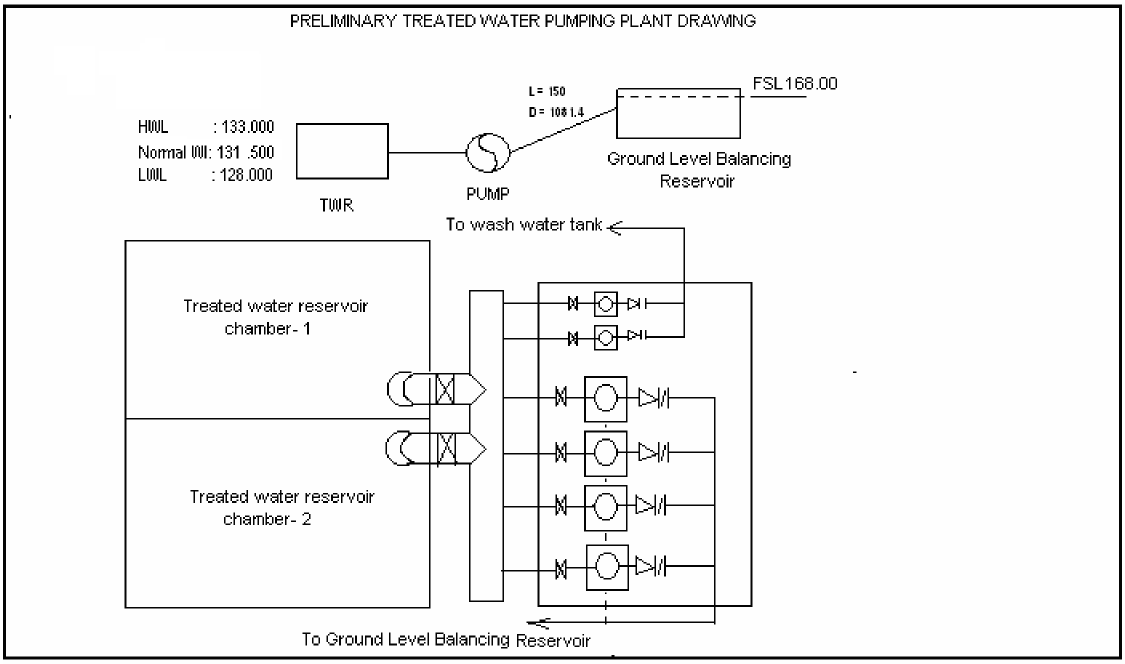

Water flow diagram for 73 mld meenad scheme

## 5.2. AERATOR

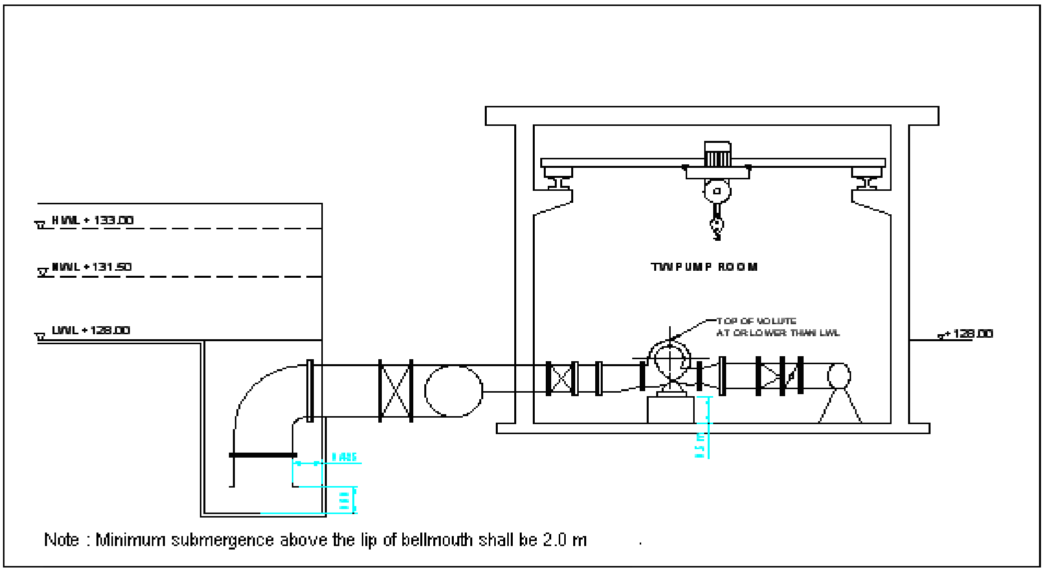
## 5.3. LAMELLAE CLARIFIER

## 5.4. CLEAR WATER PUMP HOUSE

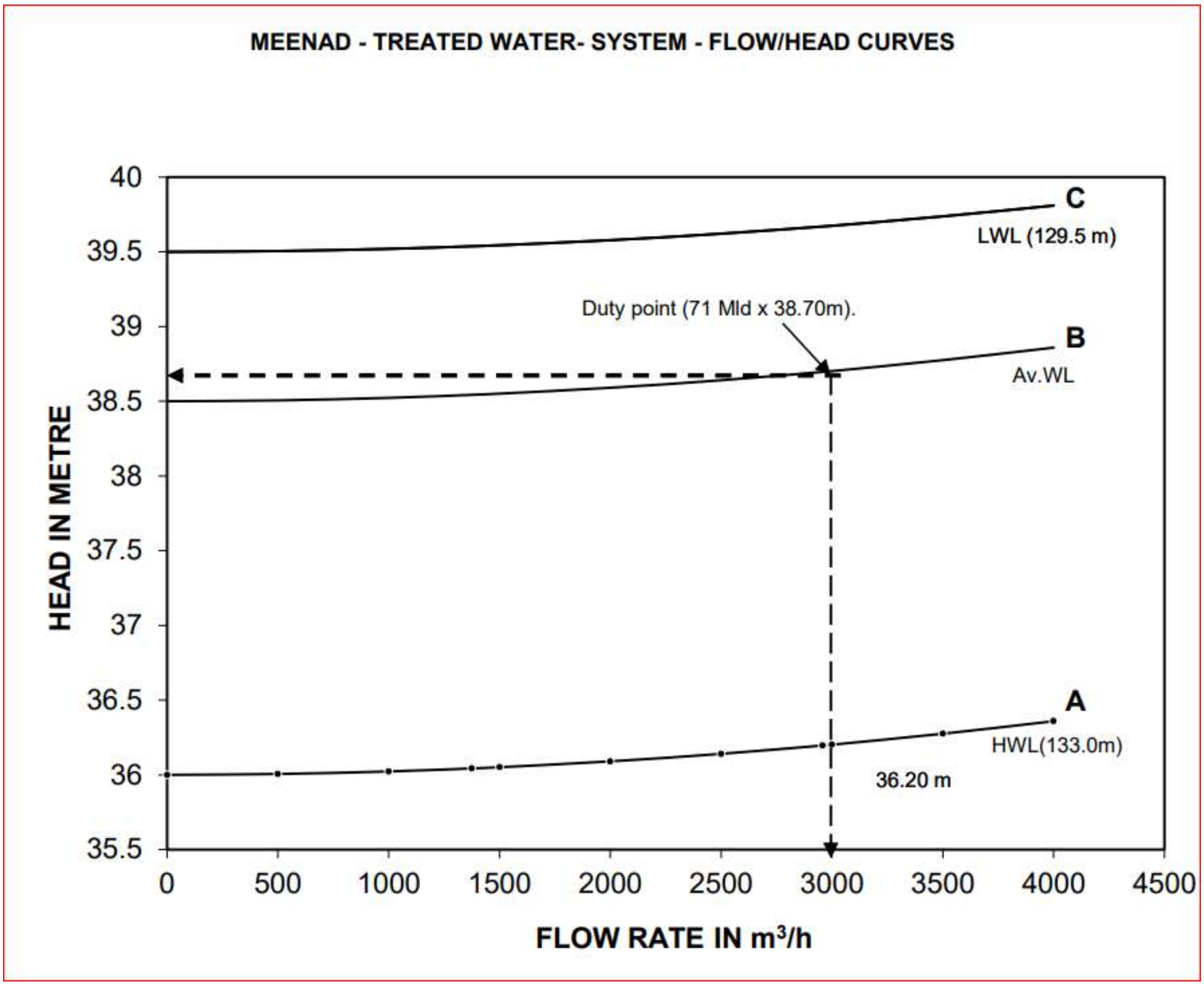
## 5.5 Preliminary treated water pumping plant drawing (A)




## 5.6. Preliminary treated water pumping plant drawing (B)

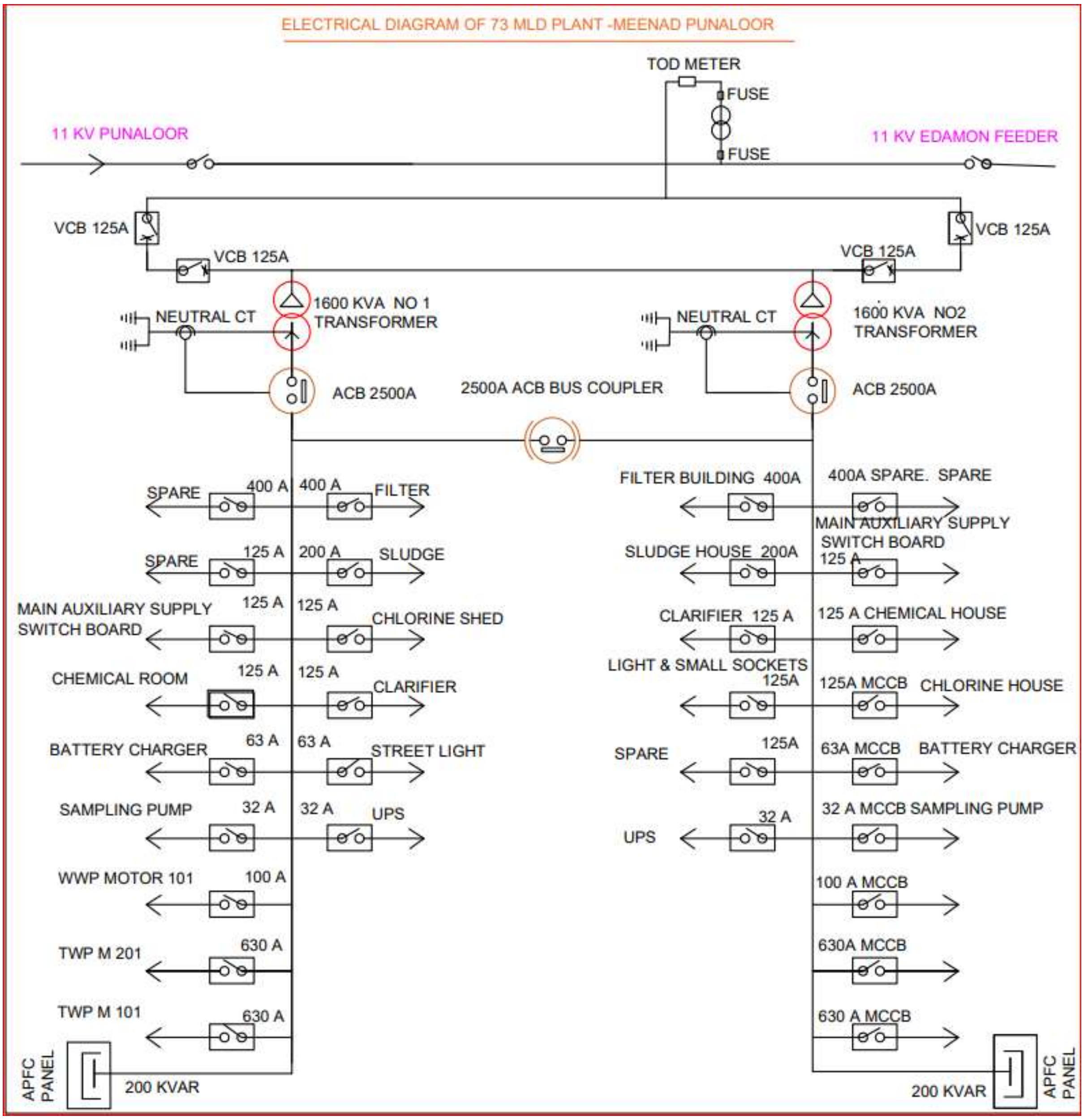


## 5.7. Treated water system flow/head curves



## 5.8. BACKWASH WATER COLLECTION CHAMBER

## 6. ELECTRICAL DIAGRAM OF 73 MLD PLANT




Electrical diagram of 73 mld plant –Meenad Punalur

## 7. POWER CHARGE ANALYSIS

| Electricity Bill Details (2020-2021) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Name of the Consumer | | | KERALA WATER AUTHORITY, KWA, HWS Panamkuttymala | | | | | | | | | | | |
| | CONTRACT LOAD | | | 774 KVA | | 75%=581 | | | CLEAR WATER PUMPING | | | | | | |
| | Tariff | | HT I (A) INDUSTRIAL | | | Consumer number | | LCN 17/5494 | KSEB Section | KARAVALOOR | | | | | |
| Month | KWh @ Rs5.75 | | | | KVA @ Rs.340 | | | | | | | | | | |
| | Z1 | Z2 | Z3 | Total | Z1 | Z2 | Z3 | Max | PF | PF penalty/incentive in Rs. | Total Energy charges in Rs. | Rs/KWh | Monthly production in ML | KWh/MLD | Rs/MLD |
| Sep-20 | 154800 | 51960 | 78660 | 285420 | 494 | 531 | 485 | 531 | 0.98 | -24617 | 1849765 | 6.48 | 1613.66 | 176.88 | 1146.32 |
| Oct-20 | 161060 | 55180 | 75740 | 291980 | 497 | 501 | 483 | 501 | 0.98 | -25183 | 1887739 | 6.47 | 1569.03 | 186.09 | 1203.12 |
| Nov-20 | 133120 | 49120 | 74480 | 256720 | 492 | 514 | 500 | 514 | 0.98 | -22142 | 1683628 | 6.56 | 1552.37 | 165.37 | 1084.55 |
| Dec-20 | 164040 | 53980 | 74960 | 292980 | 507 | 506 | 512 | 512 | 0.98 | -25270 | 1893528 | 6.46 | 1615.51 | 181.35 | 1172.09 |
| Jan-21 | 157480 | 52180 | 80420 | 290080 | 507 | 527 | 505 | 527 | 0.98 | -25019 | 1876740 | 6.47 | 1556.1 | 186.41 | 1206.05 |
| Feb-21 | 142940 | 47440 | 94480 | 284860 | 508 | 517 | 501 | 517 | 0.98 | -24569 | 1846523 | 6.48 | 1520.71 | 187.32 | 1214.25 |
| Mar-21 | 157420 | 53400 | 106080 | 316900 | 509 | 505 | 527 | 527 | 0.97 | -18222 | 2041106 | 6.44 | 1731.76 | 182.99 | 1178.63 |
| Apr-21 | 157100 | 51080 | 105840 | 314020 | 527 | 511 | 530 | 530 | 0.97 | -18056 | 2024351 | 6.45 | 1579.2 | 198.85 | 1281.88 |
| May-21 | 137780 | 49300 | 72920 | 260000 | 599 | 544 | 551 | 599 | 0.97 | -14950 | 1716210 | 6.60 | 1508.48 | 172.36 | 1137.71 |
| Jun-21 | 146100 | 51020 | 76400 | 273520 | 509 | 507 | 499 | 509 | 0.99 | -31454 | 1773015 | 6.48 | 1453.25 | 188.21 | 1220.03 |
| Jul-21 | 158860 | 55940 | 82160 | 296960 | 506 | 525 | 514 | 525 | 0.99 | -34150 | 1908030 | 6.43 | 1525.43 | 194.67 | 1250.81 |
| Aug-21 | 150860 | 51320 | 78540 | 280720 | 517 | 517 | 507 | 517 | 0.98 | -24212 | 1822558 | 6.49 | 1561.33 | 179.80 | 1167.31 |

## 8. KNOW YOUR PLANT STATUS

| **PRODUCTION COST (KNOW YOUR PLANT)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Production cost** | | | | | | | |
| **Yearly production in mld** | | | | | **19048** | | |
| **Sl. No.** | **Components** | **Unit** | **Quantity** | **Rate in Rs.** | **Amount in Rs.** | **Cost in Rs.per mld** | **Cost in Rs.per kl** |
| | Electrical expenses for raw water pumping (LCN: 17/5433) | **Kwh** | | | **66765629** | **3505.13** | |
| 1 | Electrical expenses for clear water pumping and allied (LCN: 17/5494) | Kwh | 3444160 | 6.48 | 22318157 | 1171.68 | |
| 2 | Salaries | | | | 8998566 | 472.4153 | |
| 3 | Wages | | | | 528296 | 27.73499 | |
| 4 | O and M expenditure | | | | 9036648.9 | 474.4146 | |
| | **Chemicals** | | | | | 0 | |
| 5 | Alum | MT | 225.495 | 22243 | 5015685.29 | 263.3182 | |
| 6 | Lime | MT | 37.25 | 12980 | 483505 | 25.3835 | |
| 7 | Chlorine | MT | 36 | 12390 | 446040 | 23.41663 | |
| **Total** | | | | | 46826897.9 | 5963.488 | **5.963488** |

## 9. TRANSFORMERS


TRANSFORMER-1

| TRANSFORMER | | |
|---|---|---|
| | | |
| 1 | MAKE | INDOTECH TRANSFORMERS |
| 2 | RATED KVA | 1600 |
| 3 | RATED VOLTAGE | HV 11000 |
| | | LV 433 |
| 4 | AMPERE | HV 83.98 |
| | | LV 2133.39 |
| 5 | PHASE | 3 |
| 6 | SR NO | IT- 43449 |
| 7 | WORK ORDER NO | IT-3054 |
| 8 | CUSTOMER'S REF | MGB PO 749 DATED 28.4.2009 |
| 9 | CUSTOMER | M/S VA TECH WABAG |
| 10 | YEAR OF MANUFACTURE | 2009 |
| 11 | TYPE OF COOLING | ONAN |
| 12 | FREQUENCY | 50 HZ |
| 13 | IMPEDENCE % | 6.36 |
| 14 | VECTOR GROUP REF NO | DYN11 |
| 15 | CORE &WINDING Kg | 2135 |
| 16 | OIL Kg | 1385 |
| 17 | TOTAL WEIGHT Kg | 5335 |
| 18 | OIL IN LITERS | 1630 |

| 9.1 Calculation for transformer loss of capacity 1600 Kva | | | | | | | |
|---|---|---|---|---|---|---|---|
| No load loss in watts =2200 | | | Full load loss in | | Total load in kVA=694 | | |
| | Total loss= no load loss +(% of load/100)$^{2}$ * full load loss | | | | | | |
| Sl. No. | Status | | Percentage load of | No load loss in Watts | Load loss in Watts | Sub total | Total loss in Watts |
| 1 | Transformer 1 alone in operation | | 43.4 | 2200 | 3951 | | 6151 |
| 2 | Transformer 2 alone in Operation | | 43.4 | 2200 | 3951 | | 6151 |
| 3 | Transformer 1 & 2 are Equally Shared | Transfermer 1 | 21.7 | 2200 | 989 | 3189 | |
| | | Transfermer 2 | 21.7 | 2200 | 989 | 3189 | 6378 |
| 4 | Load is connected anyone and the other one is in on position (existing) | Transfermer 1 | 43.4 | 2200 | 3951 | 6151 | |
| | | Transfermer 2 | 0 | 2200 | 0 | 2200 | 8351 |

## 10. STUDY OF PUMPS AND MOTORS

## 10.1. OPERATIONAL PERFORMANCE OF PUMP SETS

| **10.1.1. Motor and Pump performance chart** | | | | | |
|---|---|---|---|---|---|
| **Utility** | **Description** | **Parameters** | | **Design/Name plate details** | **Operating details** |
| **General** | Location | MEENAD Jica plant | | | |
| | Application | Clear water pumping | No.201 | | |
| | Location ID | 73MLD -WTP | | | |
| **Pipeline** | Material | | | MS | |
| | Size | | mm | 1000 | |
| | Length | | M | 500 | |
| **Motor** | Make | Marathon Electric | | | |
| | Year of Manufacture | 2000 | | | |
| | Type | CF | | | |
| | ID. No. | 275622520003 | | | |
| | Principle of operation | Squirrel cage induction | | | |
| | Power | | HP | 300 | |
| | Speed | | RPM | 1488 | |
| | Frequency | | Hz | 50 | |
| | Voltage | | Volt | 415 | 401 |
| | Current | | Amps | 368 | 326 |
| | PF | | | | 0.97 |
| | Starting mechanism | Soft starter | | | |
| | Input | | Kw | | 220 |
| | % of loading of on pump | | % | | 100 |
| **Pumps** | **Make** | **Kirlosker Brothers** | | | |
| | **Year of Manufacture** | 2008 | | | |
| | **Type** | CF-HS | | | |
| | **ID. No.** | 1733008008 | | | |
| | **Speed** | | RPM | 1488 | |

| | Description | Parameters | | Design/Name plate details | Operating details |
|---|---|---|---|---|---|
| | **Head** | | M | 38.7 | 39 |
| | **Density** | | Kg/M3 | 1000 | |
| | **Gravitational Constant** | | M/s2 | 9.81 | |
| | **Prime mover rating** | | HP | 300 | |
| | **Type of control** | Throttling | | | |
| | **Status of valve** | Open fully | | | |
| | **Working Hours** | | Hrs | | 16 |
| | **% of loading on head** | | % | | 100.77519 |
| | **% of loading on discharge** | | % | | 89.238753 |
| | **Output** | | kW | | 140 |
| **Combined** | **Efficiency** | | % | | 63.636364 |

| **10.1.2. Motor and Pump performance chart** | | | | | |
|---|---|---|---|---|---|
| **Utility** | **Description** | **Parameters** | | **Design/Name plate details** | **Operating details** |
| **General** | Location | MEENAD Jica plant | | | |
| | Application | clearwater pumping | No. 301 | | |
| | Location ID | 73MLD -WTP | | | |
| **Pipeline** | Material | | | MS | |
| | Size | | mm | 1000 | |
| | Length | | M | 500 | |
| **Motor** | Make | Marathon Electric | | | |
| | Year of Manufacture | 2000 | | | |
| | Type | CF | | | |
| | ID. No. | 2.75623E+11 | | | |
| | Principle of operation | Squirrel cage induction | | | |
| | Power | | HP | 300 | |
| | Speed | | RPM | 1488 | |
| | Frequency | | Hz | 50 | |
| | Voltage | | Volt | 415 | 401 |
| | Current | | Amps | 368 | 340 |
| | PF | | | | 0.97 |
| | Starting mechanism | Soft starter | | | |
| | Input | Kw | | | 229 |
| | % of loading on pump | % | | | 104.0909091 |
| **Pumps** | **Make** | **Kirlosker Brothers** | | | |
| | **Year of Manufacture** | 2008 | | | |
| | **Type** | CF-HS | | | |

| | Description | Parameters | | Design/Name plate details | Operating details |
|---|---|---|---|---|---|
| | **Speed** | | RPM | 1488 | |
| | **Flow/Discharge** | | M3/Hr | 1479.178 | 1265 |
| | **Head** | | M | 38.7 | 39 |
| | **Density** | | Kg/M3 | 1000 | |
| | **Gravitational Constant** | | M/s2 | 9.81 | |
| | **Prime mover rating** | | HP | 300 | |
| | **Type of control** | **Throttling** | | | |
| | **Status of valve** | **Open fully** | | | |
| | **Working Hours** | | Hrs | | 24 |
| | **% of loading on head** | | % | | 100.7751938 |
| | **% of loading on discharge** | | % | | 85.52047151 |
| | **Output** | | Kw | | 134 |
| **Combined** | Efficiency | | | | 58.51528384 |
| | | | | | |

### 10.1.3. Motor and Pump performance chart

| Utility | Description | Parameters | | Design/Name plate details | Operating details |
|---|---|---|---|---|---|
| General | Location | MEENAD Jica plant | | | |
| | Application | Clear water pumping for backwashing | | | |
| | Location ID | 73MLD -WTP | | | |
| Pipeline | Material | | | MS | |
| | Size | | mm | 150 | |
| | Length | | M | 25 | |
| Motor | Make | SEIMENS | | | |
| | Year of Manufacture | 2000 | | | |
| | Type | CF | | | |
| | ID. No. | 64136042 | | | |
| | Principle of operation | Induction | | | |
| | Power | | HP | 25 | |
| | Speed | | RPM | 1463 | |
| | Frequency | | Hz | 50 | |
| | Voltage | | Volt | 415 | 413 |
| | Current | | Amps | 34 | 23 |
| | PF | | | | 0.97 |
| | Starting mechanism | Soft starter | | | |
| | Input | | Kw | | 16 |

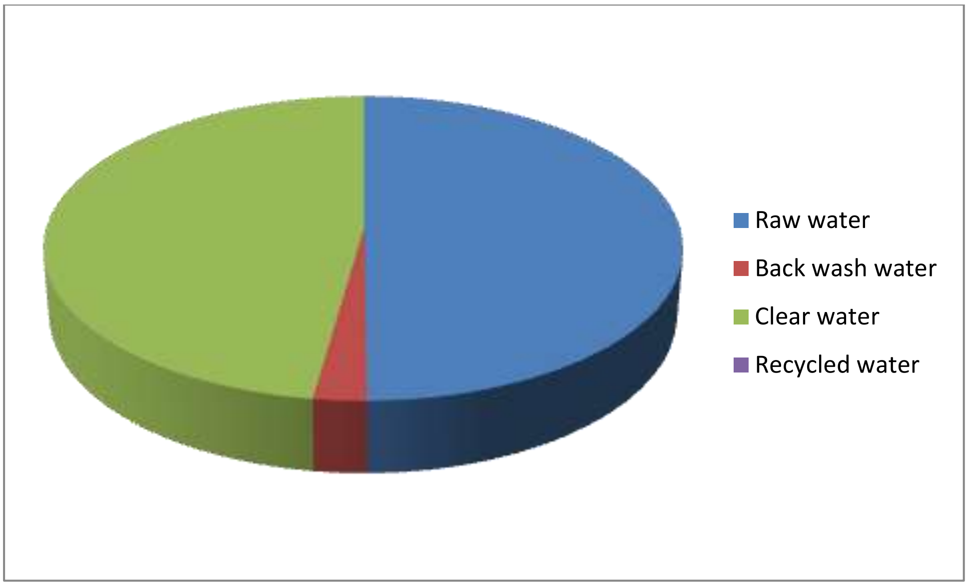
| | Description | Parameters | | Design/Name plate details | Operating details |
|---|---|---|---|---|---|
| Pumps | **Make** | **Kirlosker** | | | |
| | **Year of Manufacture** | | | | |
| | **Type** | **CF-HS** | | | |
| | **ID. No.** | **1745608057** | | | |
| | **Speed** | | RPM | 1450 | |
| | **Flow/Discharge** | | M3/Hr | 165 | 107 |
| | **Head** | | M | 22 | 17 |
| | **Density** | | Kg/M3 | 1000 | |
| | **Gravitational Constant** | | M/s2 | 9.81 | |
| | **Prime mover rating** | | HP | 25 | |
| | **Type of control** | **Throttling** | | | |
| | **Status of valve** | **Open fully** | | | |
| | **Working Hours** | | Hrs | | 9 |
| | **% of loading on head** | | % | | 77.27272727 |
| | **% of loading on discharge** | | | | 64.84848485 |
| | **Output** | | Kw | | 4.9564044 |
| **Combined** | Efficiency | | % | | 30.9775275 |

## 10.2. EFFICIENCY TESTS FOR PUMP SETS

| EFFICIENCY TESTS FOR PUMP SETS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 25-10-2021 | | No. of trial | | 3 | Time | | 11:00:00 to 1.30 pm | | |
| Location | No. | Capacity in HP | INPUT DATAS | | | | OUTPUT DATAS | | | Efficiency in % |
| | | | Voltage in Volts | Current in Amps | PF | INPUT in KW | Discharge in $M^{3/}S$ | Head in m | OUTPUT in KW | |
| TWPH | 201 | 300 | 401 | 326 | 0.97 | 219.62 | 0.367 | 39 | 140.41 | 63.93 |
| TWPH | 301 | 300 | 401 | 340 | 0.97 | 229.06 | 0.3514 | 39 | 134.44 | 58.69 |
| BWPH | 201 | 25 | 413 | 23 | 0.97 | 15.96 | 0.02972 | 17 | 4.96 | 31.06 |

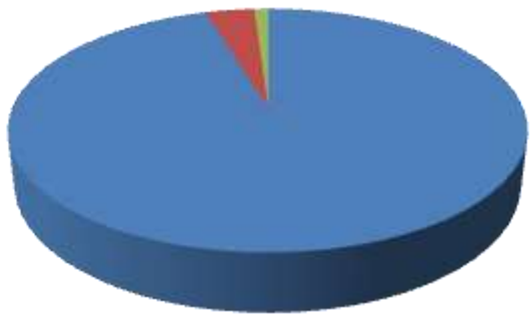
# 11. QUANTITATIVE ANALYSIS (WATER)

| **11.1.Water distribution in mld (Existing) One year average** | | | |
|---|---|---|---|
| Raw water | Backwash water | Clear water | Recycled water |
| 54.473 | 2.568 | 52.18563889 | 0 |



## 11.2. WATER DISTRIBUTION IN MLD (PROPOSED)

| Water distribution in mld (Proposed) | | | | |
|---|---|---|---|---|
| **Raw water** | **Backwash water** | **Clear water** | **Recycled water** | **Consumed backwash water** |
| | | | | |
| 52.473 | 2.568 | 52.18563889 | 2 | 0.568 |



## 12. LOAD IMPROVEMENTS PROPOSED DUE TO PF & EFFICIENCY CORRECTION

| LOAD IMPROVEMENTS PROPOSED DUE TO PF & EFFICIENCY CORRECTION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SL. No. | MAKE | VOLT | AMPS | HP | KW | dby | P.F | Motor name | AREA | PROPOSED LOAD | Percentage of load sharing |
| 1 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 2 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 3 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 4 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 5 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 6 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 7 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 8 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | FLOCCULATOR | 1.93 | 0.33 |
| 9 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | MOTOR | 1.93 | 0.33 |
| 10 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 11 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 13 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 14 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 15 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 16 | SIEMENS | 415 Δ | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Flocculator | | 1.93 | 0.33 |
| 17 | CROMPTON GREAVES | 415 | 2.0 star | 1 | 0.75 | SERVICE | 0.81 | Clarifier | | 0.63 | 0.11 |
| 18 | CROMPTON GREAVES | 415 | 2.0 star | 1 | 0.75 | SERVICE | 0.81 | Clarifier | | 0.63 | 0.11 |
| 19 | CROMPTON GREAVES | 415 | 2.0 star | 1 | 0.75 | SERVICE | 0.81 | Clarrifier | CLARIFIER MOTOR | 0.63 | 0.11 |
| 20 | CROMPTON GREAVES | 415 | 2.0 star | 1 | 0.75 | SERVICE | 0.81 | Clarifier | | 0.63 | 0.11 |
| 21 | SIEMENS | 415 Δ | 7 | | 3.7 | SERVICE | 0.86 | Air compressor | FILTER HOUSE | 3.28 | 0.56 |
| 22 | SIEMENS | 415 Δ | 7 | | 3.7 | S/B | 0.86 | Air compressor | COMPRESSOR MOTOR | | 0.00 |
| 23 | SIEME | 415 | 96 | 7 | 55 | SERVI | 0. | Air | | 48.20 | 8.26 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NS | | | 4 | | CE | 85 | blower | | | |
| 24 | SIEMENS | 415 | 96 | 74 | 55 | SERVICE | 0.85 | Air blower | FILTER HOUSE BLOWER | 48.20 | 8.26 |
| 25 | SIEMENS | 415 | 96 | 74 | 55 | S/B | 0.85 | Air blower | MOTOR | | 0.00 |
| 26 | SIEMENS | 415 Δ | 34 | 25 | 18.5 | SERVICE | 0.83 | Works water | | 14.97 | 2.57 |
| 27 | SIEMENS | 415 Δ | 34 | 25 | 18.5 | S/B | 0.83 | Works water | WASH WATER MOTOR | | 0.00 |
| 28 | CROMPTON GREAVES | 415 | 2.0 star | 1 | 0.75 | SERVICE | 0.81 | SLUDGE THICKNNER | | 0.63 | 0.11 |
| 29 | CROMPTON GREAVES | 415 | 2.0 star | 1 | 0.75 | SERVICE | 0.81 | SLUDGE THICKNNER | SLUDGE THICKNNER | 0.63 | 0.11 |
| 30 | SIEMENS | 415 | 4.5 | 3 | 2.2 | SERVICE | 0.85 | Sludge feed pump | | 1.93 | 0.33 |
| 31 | SIEMENS | 415 | 4.5 | 3 | 2.2 | SERVICE | 0.85 | Sludge feed pump | | 1.93 | 0.33 |
| 32 | SIEMENS | 415 | 4.5 | 3 | 2.2 | SERVICE | 0.85 | Sludge feed pump | SLUDGE FEED MOTOR | 1.93 | 0.33 |
| 33 | SIEMENS | 415 | 4.5 | 3 | 2.2 | SERVICE | 0.85 | Sludge feed pump | | 1.93 | 0.33 |
| 34 | MARATHON | 415 | 368 | 30 | 220 | SERVICE | 0.87 | Treated water | | 186.65 | 32.00 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0 | | | | pump | | | |
| 35 | MARATHON | 415 | 368 | 300 | 220 | SERVICE | 0.87 | Treated water pump | | 186.65 | 32.00 |
| 36 | MARATHON | 415 | 368 | 300 | 220 | S/B | 0.87 | Treated water pump | TREATED WATER | | 0.00 |
| 37 | MARATHON | 415 | 368 | 300 | 220 | S/B | 0.87 | Treated water pump | PUMP | | 0.00 |
| 38 | KIRSOLKAR BROTHERS LTD | 415 | 4.2 | 3 | 2.2 | SERVICE | 0.87 | Chlorine pre booster pump | | 1.97 | 0.34 |
| 39 | KIRSOLKAR BROTHERS LTD | 415 | 4.2 | 3 | 2.2 | SERVICE | 0.87 | Chlorine post booster pump | CHLORINE PLANT | 1.97 | 0.34 |
| 40 | KIRSOLKAR BROTHERS LTD | 415 | 4.2 | 3 | 2.2 | S/B | 0.87 | Chlorine post booster pump | | | 0.00 |
| 41 | SIEMENS | 415 | 7 | 5 | 3.7 | SERVICE | 0.86 | Alume feed pump | | 3.28 | 0.56 |
| 42 | SIEMENS | 415 | 7 | 5 | 3.7 | S/B | 0.86 | Alume feed pump | ALUM PLANT | | 0.00 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | SIEMENS | 415 | 3.5 | 2 | 1.5 | SERVICE | 0.81 | Alume recirculation pump | | 1.25 | 0.21 |
| 44 | SIEMENS | 415 | 3.5 | 2 | 1.5 | S/B | 0.81 | Alume recirculation pump | | | 0.00 |
| 45 | SIEMENS | 415 | 4.4 | 3 | 2.2 | SERVICE | 0.85 | Lime feed pump | LIME PLANT | 1.93 | 0.33 |
| 46 | SIEMENS | 415 | 4.4 | 3 | 2.2 | S/B | 0.85 | Lime feed pump | | | 0.00 |
| 41 | SIEMENS | 415 | 4.4 | 3 | 2.2 | SERVICE | 0.86 | Alume Agitator | | 1.95 | 0.33 |
| 42 | SIEMENS | 415 | 7 | 5 | 3.7 | SERVICE | 0.86 | Alume Agitator | | 3.28 | 0.56 |
| 43 | SIEMENS | 415 | 3.5 | 2 | 1.1 | SERVICE | 0.81 | Lime agitator | ALUM PLANT | 0.92 | 0.16 |
| 44 | SIEMENS | 415 | 3.5 | 2 | 1.1 | SERVICE | 0.81 | Lime agitator | | 0.92 | 0.16 |
| 45 | KIRLOSKER | 415 | 40.0 | 30 | 22.0 | NOT IN SERVICE | 0.87 | Recycling | **RE CYCLING TANK** | 18.67 | 3.20 |
| 46 | KIRLOSKER | 415 | 40.0 | 30 | 22.0 | NOT IN SERVICE | 0.87 | Recycling | | | 0.00 |
| | LIGHT LOAD | | | | 16.8 | | | | | 16.82 | 2.88 |
| | TOTAL | | | | 12 | | | | | | 0.00 |

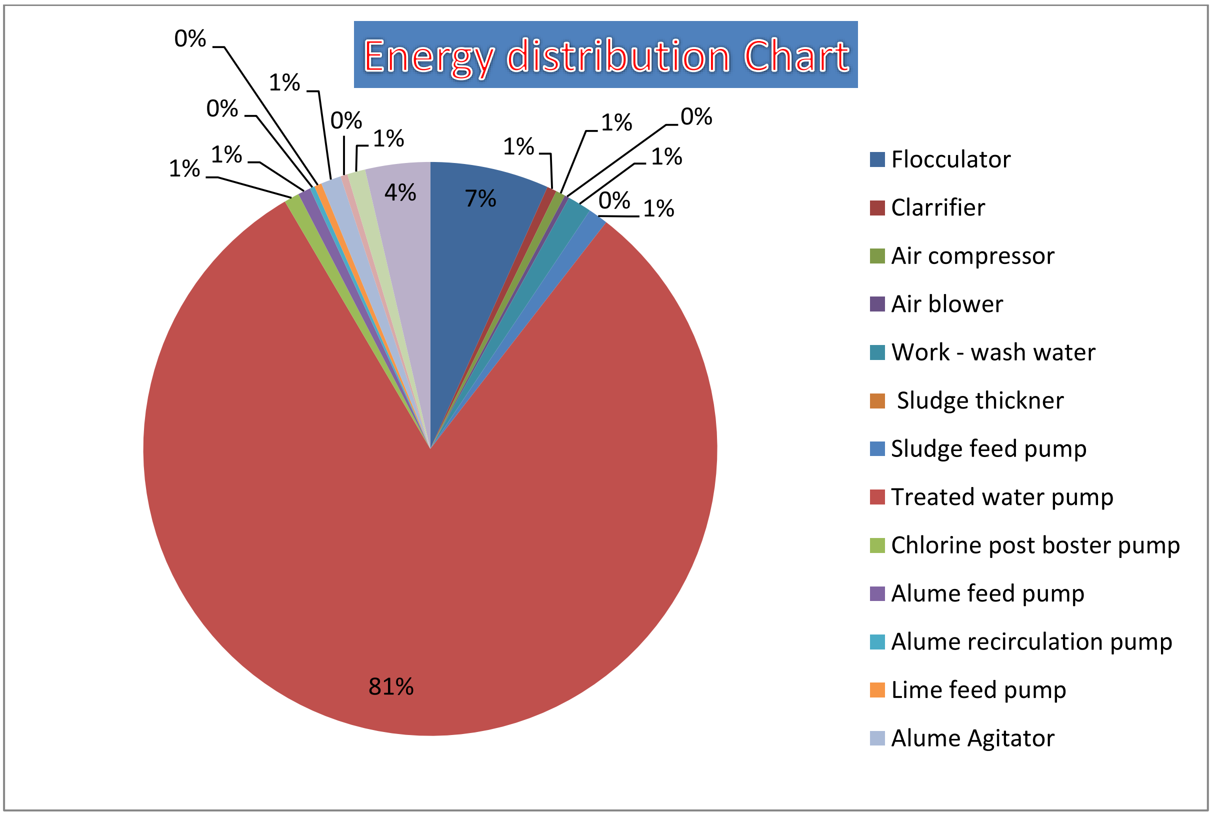
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | KW | | | | 28 | | | | | | |
| | TOTAL KW IN SERVICE | | | | 698 | | | | | **583.23** | 100.00 |

## 13. ENERGY DISTRIBUTION AMONG VARIOUS COMPONENTS OF PLANT

**Energy distribution among the various components of plant**

| | Flocculator | Clarrifier | Air compressor | Air blower | Work - wash water | SLUDGE THICKNNER | Sludge feed pump | Treated water pump | Chlorine post boster pump | Alume feed pump | Alume recirculation pump | Lime feed pump | Alume Agitator | Lime agitator | Re cycling | Light load | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rated power requirement in Kw | 30.85 | 2.51 | 3.28 | 96.39 | 14.97 | 1.25 | 7.71 | 373.31 | 3.95 | 3.28 | 1.25 | 1.93 | 5.23 | 1.84 | 18.67 | 16.82 | |
| Operating time( in hours) per day | 24 | 24 | 18 | 0.3 | 10 | 0 | 16 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 6 | 24 | |
| Energy consumption in kWH per day | 740.29 | 60.12 | 59.05 | 28.92 | 149.74 | 0.00 | 123.38 | 8959.38 | 94.71 | 78.73 | 30.06 | 46.27 | 125.54 | 44.09 | 111.99 | 403.66 | 11055.93 |

## 13.1 ENERGY DISTRIBUTION CHART



## 14. SPECIFIC ENERGY CONSUMPTION

The existing specific energy consumption is 183.36 kWh per mld of water for the entire process of filtration of daily production of 52.19 mld against the rated discharge of 71 mld. The specific energy consumption can be reduced to 150 kWh per mld of water filtration once the recommendation is executed.

## 15. BENCHMARKING

| BENCHMARKING | | |
|---|---|---|
| Existing design load in Kw | Average load in kW | Design load proposed in kW |
| 698 | 539 | 583 |
| Note; It is ascertained that the existing average load is comparatively less due to the operation of the plant in a lesser capacity | | |

## 16. LIGHT LOAD

| LIGHT LOAD | | | | | |
|---|---|---|---|---|---|
| SL NO | | WATT | UNIT | QUANTITY | TOTAL (Watts) |
| | **LIGHT LOAD IN CLARIFIER AND GALLERY** | | | | |
| 1 | MERCURY LAMP | 70 | Nos | 25 | 1750 |
| | **CHLORINE SHED** | | | | 0 |
| 1 | MERCURY LAMP | 70 | Nos | 5 | 350 |
| | **USED WASH WATER TANK** | | | | 0 |
| 1 | MERCURY LAMP | 70 | Nos | 3 | 210 |
| 2 | | 15 | Nos | 3 | 45 |
| | **FILTER BED AND GALLERY** | | | | 0 |
| 1 | MERCURY LAMP | 70 | Nos | 59 | 4130 |
| 2 | TUBE LIGHT | 40 | Nos | 3 | 120 |
| 3 | STREET LIGHT | 200 | Nos | 6 | 1200 |
| | **BLOWER ROOM** | | | | 0 |
| 1 | FLUORESCENT TUBE | 40 | Nos | 7 | 280 |
| | **LAB AND OFFICE ROOM** | | | | 0 |
| 1 | FLOURESENT TUBE | 40 | Nos | 38 | 1520 |
| 2 | FLOURESENT TUBE | 60 | Nos | 3 | 180 |
| | | | | | 0 |
| 1 | **A/C 2 TON** | **3516.85** | Nos | **2** | 7033.7 |
| | **Total** | | | | **16818.7** |

## 17. SENSITIZATION PROGRAM FOR STAFF

There was no wide level of acceptance for energy audit as it was mistakenly interpreted as energy audit is a fault-finding mechanism similar to other audits. The success of any audit is depended on the transparency and the involvement of the stakeholders. The cooperation and coordination among the staff are very essential for the collection of data as well as for the successful implementation of the audit report. During the awareness camp the Assistant Engineer Smt. Haisal Harison and operating staff were present. The discussions were fruitful and the confidence among the staff was improved. The preliminary recommendations were also discussed and ensured cooperation for implementing the same.

## 18. ENERGY CONSERVATION OPTIONS AND RECOMMENDATIONS

### 18.1) OPERATIONAL OPTIMISATION OF TRANSFORMERS- ONE KEEP AS STANDBY

There are two numbers Transformers @1600 KVA each to step down the transmission voltage. On verification, it is understood that both transformers are in the ON position. On comparison of different options of operations with the no-load and load losses, it is realized that it could be better to operate as one must be kept as stand by. The savings in respect of finance and energy is postulated in the calculation sheet of the executive summary. This is the zero investment recommendation. It is also proposed to change over the utilization of each transformer once in two months to ensure both are operating frequently.

### 18.2) INCREASING OF AVERAGE WATER LEVEL TO 0.5 M IN THE TWR

It is observed that the average water level maintained in the Treated water reservoir is below 3 m against the maximum level of 4.3 m. On experiment, it is realized that it could be easy to increase the average water level to 3.5 m to reduce the pumping charge. The savings in respect of finance and energy is postulated in the calculation sheet of the executive summary. This is the zero investment recommendation

### 18.3) REPLACING LESS EFFICIENT BACKWASH WATER MOTOR PUMP SET BY EFFICIENT ONE HAVING 25HP CAPACITY.

On efficiency test of backwash water pump sets, it realized that this mechanism is performing with very low efficiency i.e. 31%. It is recommended to replace the same with a more efficient one. The savings in respect of finance and energy is postulated in the calculation sheet of the executive summary.

### 18.4) SUPPLY AND FIXING OF NEW RECYCLING MOTOR PUMP SETS FOR WASH WATER @ 30 HP SUBMERSIBLE.

The existing mechanism to recycle the wash water @ 2 mld is not working as the motor pump sets are under repair. The water available @ 2 mld at 120 m head is draining out without recycling even the structure for the same is already available. This proposal is to utilize this water to reduce the pumping cost at raw water pumping stations however less quantity energy has to consume additionally at the clear water pumping station. The detailed payback calculation is accompanied by executive summary.

## 18.5) REPLACING LESS EFFICIENT No.301 TREATED WATER MOTOR PUMPSET BY EFFICIENT ONE @ 300 HP.

The motor pump sets for clear water pumping is the main energy drawing machinery in the wtp. On the efficiency test, it is observed that the efficiency is only 59 % for this pump set. It is recommended to replace the same with most efficient on. The savings in respect of finance and energy is postulated in the calculation sheet of the executive summary.

## 18.6) REPLACING LESS EFFICIENT No.201 TREATED WATER MOTOR PUMPSET BY EFFICIENT ONE @ 300 HP

The motor pump sets for clear water pumping is the main energy drawing machinery in the wtp. On the efficiency test, it is observed that the efficiency is only 64 % for this pump set. It is recommended to replace the same with most efficient on. The savings in respect of finance and energy is postulated in the calculation sheet of the executive summary.

## 18.7) GENERAL RECOMMENDATION FOR THE OPERATION MOTORS

Inadequate maintenance of motors can significantly increase losses and lead to unreliable operation. For example, improper lubrication can cause increased friction in both the motor and associated drive transmission equipment. Resistance losses in the motor, which rise with the temperature, would increase. Providing adequate ventilation and keeping motor cooling ducts clean can help dissipate heat to reduce excessive losses. The life of the insulation in the motor would also be longer: for every 10o C increase in motor operating temperature over the recommended peak, the time before rewinding would be needed is estimated to be halved.

A checklist of good maintenance practices to help ensure proper motor operation would include:

1. Inspect motors regularly for wear in bearings and housings (to reduce frictional losses) and for dirt/dust in motor ventilating ducts (to ensure proper heat dissipation).

2. Checking load conditions to ensure that the motor is not over or under-loaded. A change in motor load from the last test indicates a change in the driven load, the cause of which should be understood.

3. Lubricating appropriately. Manufacturers generally give recommendations for how and when to lubricate their motors. Inadequate lubrication can cause problems, as noted above. Over lubrication can also create problems, e.g. excess oil or grease from the motor bearings can enter the motor and saturate the motor insulation, causing premature failure or creating a fire risk.

4. Checking periodically for proper alignment of motor and the driven equipment. This is the zero investment recommendation. Improper alignment can cause shafts and bearings to wear quickly, resulting in damage to both the motor and the drive equipment.

5. Ensuring that supply wiring and terminal box are properly sized and installed. Inspect regularly the connections at the motor and starter to be sure that they are clean and tight.

6. Valve operation has to be ensured on starting and stopping of the motor to ensure the low load on starting and to protect the motor from backpressure respectively.

7. The logbook has to be maintained in such a way that the voltage and current of every hour are documented so that to avail the same for future references.

## **18.8**) SUBSTITUTION BY SOLAR POWER

The possibility for renewable energy (solar) to meet the demand for light load @ 20 KVA can also be explored, depending on the availability of the required intensity of sun rays throughout the day/year.

## 19. CONCLUSION

The objective of the study was to delineate the issues in energy consumption of wtp, to optimize the method of operation, to understand the extent of deviation from the standard of operation, and to explore the possibility of adopting advanced technologies in our sector. On evaluation, it may be realized that each power utility center has a unique optimization need. It is also realized that the present specific energy consumption of wtp is 183.36 kWh per MLD. The kWh per MLD consumption is comparatively low in the filter house as the head creation required is less. Benchmarking for energy use has been proposed and it can be achieved by introducing the proposed operating procedure.

This plant is constructed on proper planning and operating with proper procedure, still, we have energy saving options to be implemented which are listed for implementation.

In addition, the effect of the implementation of zero investment recommendations can be viewed by comparing the energy bills of the pre-and post- audit months.

**ANNEXURE 1**

### A.1.1 PAYBACK CALCULATIONS

| **OPERATIONAL OPTIMISATION OF TRANSFORMERS- ONE KEEP AS STANDBY** | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | | **No load loss in Watts** | **Load loss in Watts** | **Total Loss in Watts** | |
| **Load status** | **Load is connected to anyone and the other one is in On position (existing)** | **4400** | **3951** | **8351** | |
| | **Transformer No.1 or No.2 alone in operation latter in the off position** | **2200** | **3951** | **6151** | |
| Savings in kW | | | | | 2.2 |
| No. working Hours per year | | | | | 8760 |
| Energy savings per year in kWh | | | | | 19272 |
| Cost in Rs. per kWh | | | | | 5.75 |
| Amount Savings in Lakhs per year | | | | | 1.10814 |

**A1.2**

| Keeping average water level as 3.5 at TWR | | | | |
|---|---|---|---|---|
| | **Description Unit** | **Unit** | **Old System** | **New System** |
| | **Average Suction level of Treated water Reservoir** | **m** | **3** | **3.5** |
| Requirement | Head | m | 38.7 | 38.2 |
| | Flow | $m^3/s$ | 0.822 | 0.822 |
| | Density of water | kg/m3 | 1000 | 1000 |
| | Gravitational Constant | $m/s^2$ | 9.81 | 9.81 |
| | Hydraulic Power is required to meet the demand by existing pump set | kW | 312.07 | 308.04 |
| | Total Electrical Power drawn to meet the requirement | kW | 418.94 | 413.53 |
| | Unit Cost for power | Rs./kWh | 5.75 | 5.75 |
| | Annual operating Hours | Hours | 8760 | 8760 |
| | Annual energy consumption | kWh /year | 3669931 | 3622516 |
| | Annual power Savings, kWh | kWh | | 47415.1 |
| | Annual Savings | Rs. In Lakhs | | 2.72637 |
| | Investment required in Lakhs | Rs, in lakhs | | 0 |
| | Simple Payback period | In years | | 0 |
| | | In months | | 0 |

**A1.3**

**Energy Efficiency in Existing Pumping system by replacing inefficient motor Pump set for backwash water pumping**

| | **Description Unit** | **Unit** | **Old System** | **New System** |
|---|---|---|---|---|
| | Type of Motor | Induction | | |
| | Class of Motor | | Standard | IE2 |
| | Motor power (rated) | Kw | 18.5 | 18.50 |
| | Efficiency (rated) | % | 95.5 | 95.50 |
| | Combined system efficiency of the system (measured) | % | 31.06 | |
| | Pump efficiency | % | | 78.00 |
| | The combined efficiency of the system (rated) | % | 70 | 74.49 |
| Requirement | Head | m | 22 | 22.00 |
| | Flow | $m^3/s$ | 0.045833 | 0.05 |
| | Density of water | kg/m3 | 1000 | 1000.00 |
| | Gravitational Constant | $m/s^2$ | 9.81 | 9.81 |
| | Hydraulic Power, required to meet the demand by existing pump set | kW | 9.89 | 9.89 |
| | Total Electrical Power drawn to meet the requirement | kW | 31.85 | 13.28 |
| | Unit Cost for power | Rs./kWh | 5.75 | 5.75 |
| | Annual operating Hours @14 hrs per day | Hours | 5110 | 5110.00 |
| | Annual energy consumption | kWh /year | 162738.168 | 67856.73 |
| | Annual power Savings, kWh | kWh | | 94881.44 |
| | Annual Savings | Rs. In Lakhs | | 5.46 |
| | Proposed load | Kw | | 18.50 |
| | Investment required in Lakhs | Rs, in | | 3.80 |

| | | | | |
|---|---|---|---|---|
| | @15225 / hp | lakhs | | |
| | Simple Payback period | In years | | 0.70 |
| | | In months | | 8.36 |

**A1.4**

| SUPPLY AND FIXING OF NEW RECYCLING MOTOR PUMP SETS FOR WASH WATER | | |
|---|---|---|
| **Description Unit** | **Unit** | **Recurring Savings** |
| Head for Raw water pumps | m | 130 |
| Quantity of water required to pump for recycling | mld | 2 |
| Required additional head due to the recycling | m | 10 |
| Head savings | m | 120 |
| Flow | $m^3/s$ | 0.0231 |
| Density of water | kg/m3 | 1000 |
| Gravitational Constant | $m/s^2$ | 9.81 |
| Hydraulic power | kW | 29.52 |
| Electrical power would have been incurred with 70% of the system | kW | 42.17 |
| Energy charge in Rs./kWh | | 5.75 |
| Working hours/year | | 8760 |
| kWh can be saved | kWh | 369430 |
| Energy charge would have been incurred (This will reflect in the power bill of Raw water pumping station) | Rs. | 2124221 |
| The density of recycled water | kg/m3 | 1250 |
| Flow | $m^3/s$ | 0.0231 |
| Additional kWh required to operate recycling pump sets of 30 HP having 65% efficiency | kWh | 38255 |
| The additional amount required to operate recycling pump sets per year (This will reflect in the power charge of WTP) | Rs. | 219964 |
| Investment required in Lakhs | Rs. | 6.00 |

| | | |
|---|---|---|
| Net Savings in kWh per year | kWh | 331175 |
| Savings in Rs.per year | Rs | 1904257 |
| Simple Payback period | In years | 0.32 |
| | In months | 3.78 |

**A1.5**

| **Energy Efficiency in Existing Pumping system by replacing inefficient motor ( No. 301)** | | | | |
|---|---|---|---|---|
| | **Description Unit** | **Unit** | **Old System** | **New System** |
| | Type of Motor | Induction | | |
| | Class of Motor | | Standard | IE2 |
| | Motor power (rated) | Kw | 220 | 210.00 |
| | Efficiency (rated) | % | 95.5 | 95.50 |
| | Combined system efficiency of the system (measured) | % | 58.69 | |
| | Pump efficiency | % | | 78.00 |
| | The combined efficiency of the system (rated) | % | 70 | 74.49 |
| Requirement | Head | m | 38.7 | 38.70 |
| | Flow | $m^3/s$ | 0.411 | 0.41 |
| | Density of water | kg/m3 | 1000 | 1000.00 |
| | Gravitational Constant | $m/s^2$ | 9.81 | 9.81 |
| | Hydraulic Power, required to meet the demand by existing pump set | kW | 156.03 | 156.03 |
| | Total Electrical Power drawn to meet the requirement | kW | 265.86 | 209.47 |

| | | | | |
|---|---|---|---|---|
| | Unit Cost for power | Rs./kWh | 5.75 | 5.75 |
| | Annual operating Hours | Hours | 8760 | 8760.00 |
| | Annual energy consumption | kWh /year | 2328958.72 | 1834965.60 |
| | Annual power Savings, kWh | kWh | | 493993.12 |
| | Annual Savings | Rs. In Lakhs | | 28.40 |
| | Proposed load | Kw | | 210.00 |
| | Investment required in Lakhs | Rs, in lakhs | | 48.00 |
| | Simple Payback period | In years | | 1.69 |
| | | In months | | 20.28 |

**A1.6**

**Energy Efficiency in Existing Pumping system by replacing inefficient motor ( No. 201)**

| | **Description Unit** | **Unit** | **Old System** | **New System** |
|---|---|---|---|---|
| | Type of Motor | Induction | | |
| | Class of Motor | | Standard | IE2 |
| | Motor power (rated) | Kw | 220.00 | 210.00 |
| | Efficiency (rated) | % | 95.50 | 95.50 |
| | Combined system efficiency of the system (measured) | % | 63.93 | |
| | Pump efficiency | % | | 78.00 |
| | The combined efficiency of the system (rated) | % | 70.00 | 74.49 |
| Requirement | Head | m | 38.70 | 38.70 |
| | Flow | $m^3/s$ | 0.41 | 0.41 |
| | Density of water | kg/m3 | 1000.00 | 1000.00 |
| | Gravitational Constant | $m/s^2$ | 9.81 | 9.81 |

| | | | | |
|---|---|---|---|---|
| | Hydraulic Power is required to meet the demand by existing pump set | kW | 156.03 | 156.03 |
| | Total Electrical Power drawn to meet the requirement | kW | 244.07 | 209.47 |
| | Unit Cost for power | Rs./kWh | 5.75 | 5.75 |
| | Annual operating Hours | Hours | 8760.00 | 8760.00 |
| | Annual energy consumption | kWh /year | 2138066.44 | 1834965.60 |
| | Annual power Savings, kWh | kWh | | 303100.84 |
| | Annual Savings | Rs. In Lakhs | | 17.43 |
| | Proposed load | Kw | | 210.00 |
| | Investment required in Lakhs | Rs, in lakhs | | 48.00 |
| | Simple Payback period | In years | | 2.75 |
| | | In months | | 33.05 |

ANNEXURE.2. PRELIMINARY AUDIT NOTE

# KERALA WATER AUTHORITY
# TEAM ENERGY MANAGEMENT UNIT

**Ref: KWA/JB/EW/EMC/EA/7813/2019 Dtd. 17/09/2021**

CAMP OFFICE,PANAMKUTTYMALA.
Mob. : 9447222494, e-mail ID: thampisujana@gmail.com

Date: 31/10/2021

PRIMARY AUDIT NOTE

It is requested that the following changes can be made in the mode of operation of WTP.

1) The water level in the sump has to be maintained at least 4 m during pumping if possible to get an average of 3.5 m.

2) The non-loaded transformer may be kept as a standby and the loading operation may be interchanged once in two or three months.

Team Leader
S/d
(Thampy S)
Energy Audit Team