REPORT ON ENERGY AUDIT

RAW WATER PUMPING STATIONS OF KAKKAD WATER TREATMENT PLANTS (16 AND 9 mld s) PIRAVOM

ENERGY AUDIT TEAM-KWA

JALABHAVAN Thiruvananthapuram

OCTOBER 2021

AKNOWLEDGEMENT

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 Sri. Sabu Thomas, AEE, PH Subdivision, Piravom, and Sri. Hari Krishnan, AE PH Section Piravom who is in charge of this plant. We also thank all the staff of Piravom subdivision, especially the operating staff at the water treatment plant and pumping stations.

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.

On behalf of team energy audit, KWA

Team Leader

Energy Audit, KWA

TABLE OF CONTENT

NOMENCLATURE

KWA : Kerala Water Authoriy

PSU : Public Sector Undertaking

TOD : Time of Delay

kVA : kiloVoltAmpere

kWh : kiloWatthour

FCMA : Flux compensated magnetic amplifier

hp : horsepower

η : efficiency

VFD : Variable frequency drive

WTP : Water Treatment Plant

PF : Power Factor

ORWH : Old Raw Water Pump House

NRWPH: New Raw Water Pump House

EXECUTIVE SUMMARY

Executive Summary						
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects						
KWA WATER TREATMENT PLANT, PIRAVAM						
Sl. No.	**Projects**	**Investment in Lakhs Rs.**	**Cost savings in Rs. per year**	**Payback period**		**Energy saved in Kwh per year**
				Year	Month	
1	Supply and fixing of VFD with 250 HP motor at ORWPH	8.5	3762432	0.23	2.7	654336
2	Interconnection work to connect delivery line of circular GLSR with the delivery line of rectangular GLSR.	6.5	2145527	0.303	3.64	373135
3	Supply and fixing of PF capacitors to improve PF	0.05	39346	0.13	1.5	0
4	Mechanical work to smoothen pumping main inside the ORWPH	0.5	10154	4.92	59.1	1766

CHAPTER 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 favor 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 programme 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. At this juncture, the officer’s organisation put forward a suggestion that these hurdles can be overcome by utilising the service of experts and interested professionals from KWA to conduct energy and water audit. 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.

1.1 VISION

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

1.2 MISSION

Implement energy optimisation technologies.

Adopt bench marking for energy consumption centres of KWA

1.3 SLOGAN

Measure before leave

1.4 SCOPE

Energy audit is concentrating in two aspects viz.

1) Operational optimisation

   This can be achieved by giving proper training to the staff, implementing 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 upgradation

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 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 Execuitve Engineer, Project Division, Alappuzha

Date of Audit: 29.09.2021 to 31.10.2021

1.6 ABOUT ENERGY AUDIT TEAM, KWA

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

1.7 Major activities of Team Energy Audit, KWA.

1) Carry out 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) Conducting sensitisation programmes and making consensus for implementing zero investment recommendations.
8) Preparation of draft energy audit report including cost benefit analysis.
9) Conducting discussions on draft report with stake holders.
10) Answering queries.
11) Preparation of final report.
12) Implementing phase by the competent authority.

CHAPTER 2

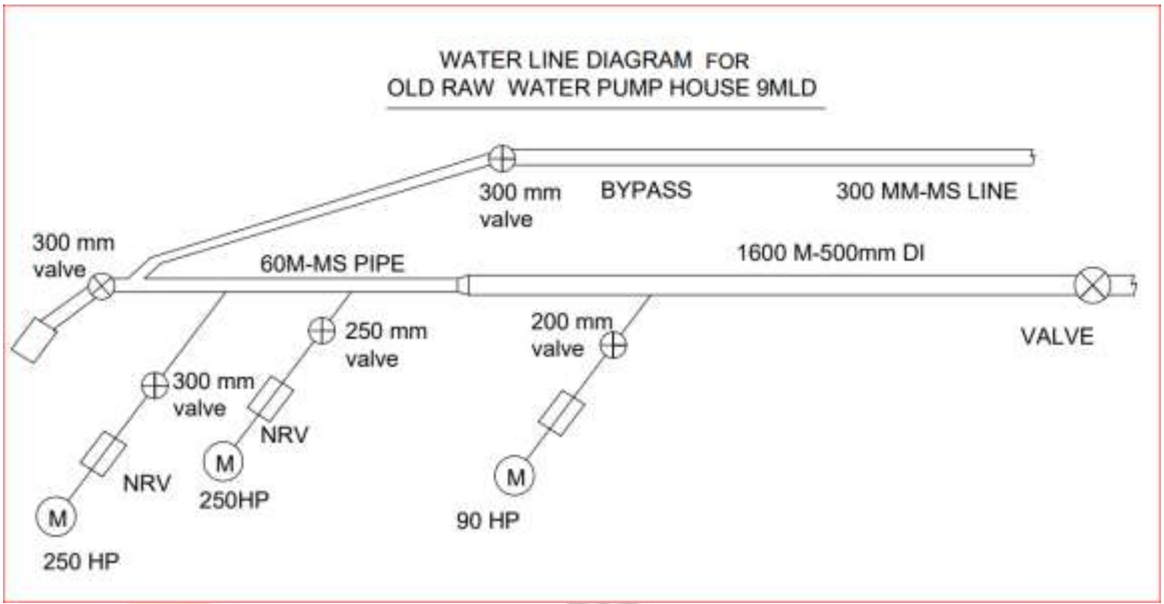
WATER TREATMENT PLANTS AT KAKKAD

There are two wtps located at Kakkad (Latitude N 09-53-37.1 - & Longitude E 076-29-13.2-) under Piravom subdivision @ 9 MLD and @16 MLD, both are feeding by two raw water pump houses located at Kakkad as Moovattupuzha river as the source. (Latitude N 09-54-02.9- & Longitude E 076-28-53.1-). The detailed narration which shows the line diagram of components from raw water to clear water pumping is attached herewith. The HT connection for both raw water pumping stations as consumer number is LCN: 6/634 as 641 KVA is the Contract demand. One LT connection is maintained to run the electrical equipment at WTP having consumer number is 1155979009857 as contract demand 75 KVA. This plant is under the administrative control of P H Division Moovattupuzha.

CHAPTER 3

WATER FLOW DIAGRAMS

3.1 Schematic diagram of 9 mld Raw water pumping

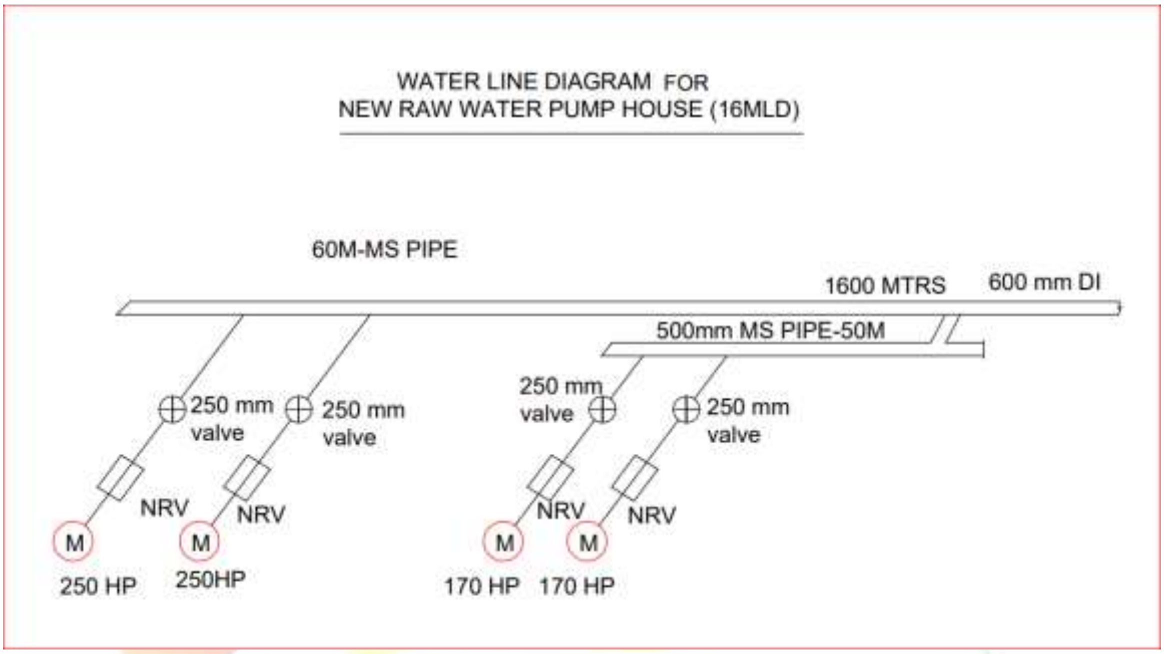


This pump house in circular shape is constructed in 1984 which consists of two numbers of motor pump sets on working mode, rest of the motor sets are not in operating status due to different reasons. The pump sets available under working modes are 250 hp and 90 hp in capacities

Filter station for 9 mld plant

This is the very old (Commissioned on 1984) plant consisting 4 numbers combined aerators and cascade filters instead of the separate aerator and filter beds. In this system, there is only water assisted backwashing and no backwashing with compressed air as the quality of raw water was much better on those days and there is no pumping mechanism at the plant as the distribution network is catered by gravity only except pumping for backwashing. However, some portion of pumped water to backwash OH tank is utilized to cater to local areas.

3.2 Schematic diagram of 16 mld Raw water pumping

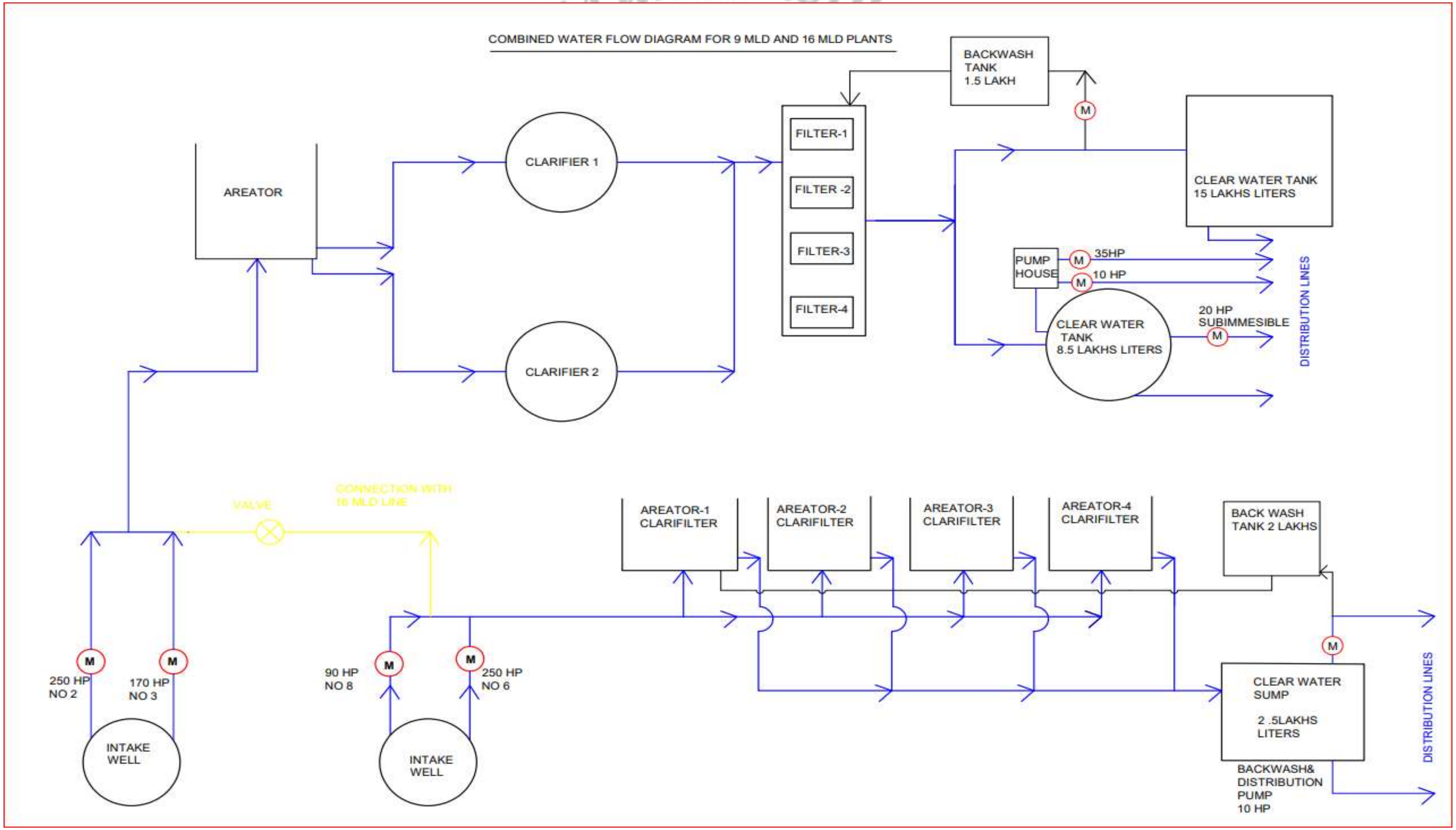


This pump house in circular shape is constructed on 1996 which consist one 250 hp and one 170 hp motor pump sets in operating mode, the rest of motor pump sets are under out of usage.

Filter station for 16 MLD wtp

This plant has separate aerator and filter beds with air assisted backwashing mechanism. A major quantity of water filtered through this plant is also distributed through gravity and a comparatively lesser quantity is catering through pumping. Two separate reservoirs are attached with this plant for storage.

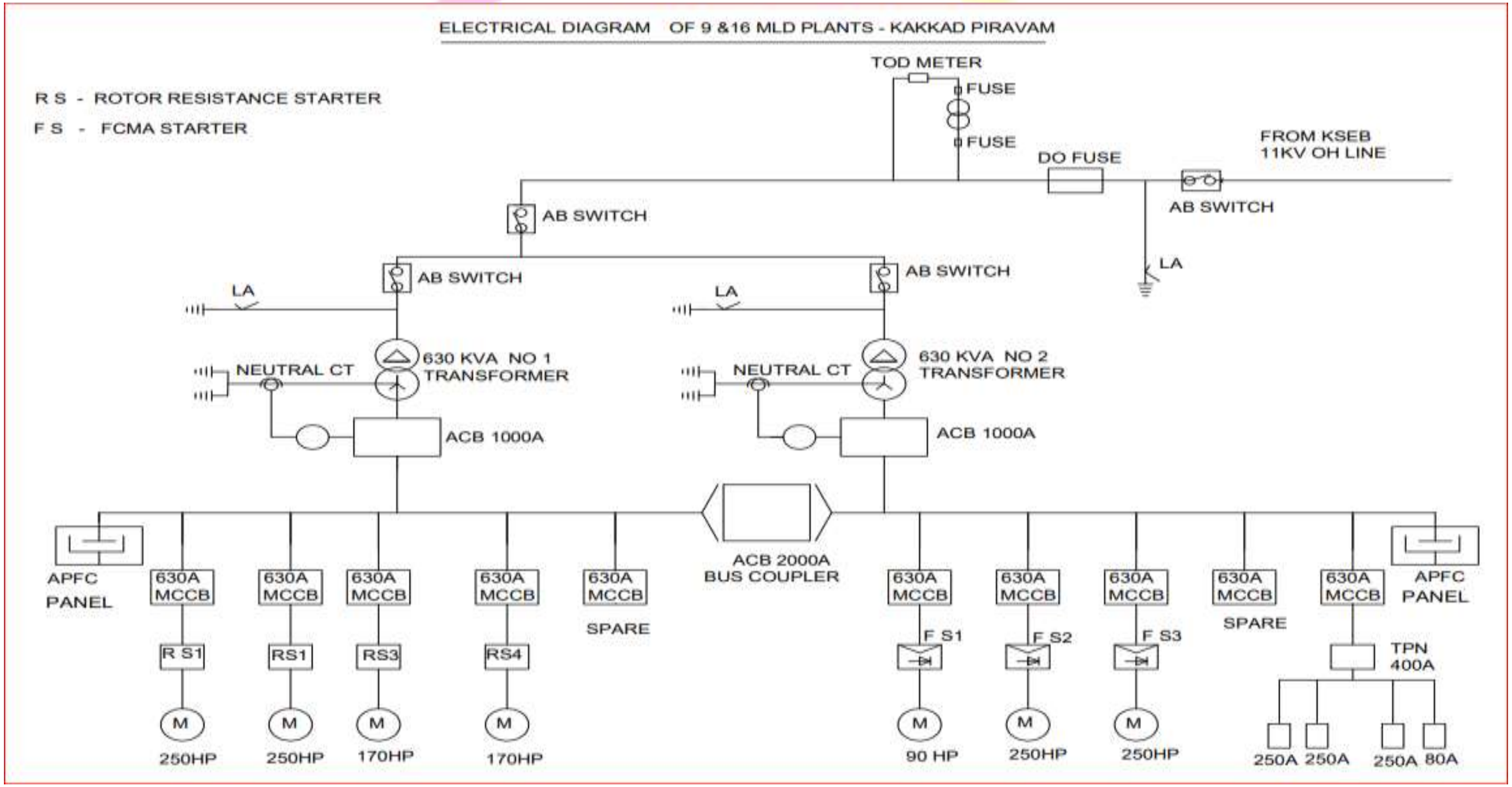
3.3 COMBINED WATER FLOW DIAGRAM FOR BOTH PUMP HOUSES



CHAPTER 4

ELECTRICAL INSTALLATION AND POWER CHARGE ANALYSIS

4.1 ELECTRICAL INSTALLATION AT RAW WATER PUMP HOUSES



4.2 POWER CHARGE ANALYSIS

	Electricity Bill Details (2020-2021)															
		Name of the Consumer				KERALA WATER AUTHORITY, KWA, SUB DIVISION ,PIRAVOM										
		CONTRACT LOAD				641 KVA		RAW WATER PUMPING								
		Tariff		**HT I (A) INDUSTRIAL**				**Consumer number**	**LCN6/634**		**KSEB Section**	**PIRAVAM**				
	Month	KWh				KVA										
		Z1	**Z2**	**Z3**	**Total**	**Z1**	**Z2**	**Z3**	**Max**	**Fixed charge @Rs.340/KVA**	**PF**	**PF penalty/incentive in Rs.**	**Energy charge in Rs.**	**Rs/KWh**	**KWh/MLD**	**Rs/MLD**
1	Aug-20	169960	59184	118408	**347552**	568.7	561.3	561.83	**569**	**193460**	0.95	0	2235328	**6.99**	463.4	2980.4
2	Sep-20	158800	57080	114904	**330784**	574.9	568.46	567.34	**575**	**195500**	0.94	9510	2148366	**7.09**	441.0	2864.5
3	Oct-20	164648	59144	117936	**341728**	571.46	559.72	564.88	**571**	**194140**	0.95	0	2201792	**7.01**	455.6	2935.7
4	Dec-20	168016	57192	117432	**342640**	559.43	553.1	558.4	**559**	**190060**	0.94	9851	2212921	**7.01**	456.9	2950.6
5	Jan-21	173728	58192	116808	**348728**	555.58	552.79	564.24	**564**	**191760**	0.94	10026	2250563	**7.00**	465.0	3000.8
6	Feb-21	156720	55336	111184	**323240**	546.09	544.66	551.7	**552**	**187680**	0.95	0	2086715	**7.04**	431.0	2782.3
7	Mar-21	170496	57176	122208	**349880**	535.38	534.8	540.26	**540**	**183600**	0.96	-10059	2229086	**6.90**	466.5	2972.1
8	Apr-21	165616	57240	117704	**340560**	535.75	531.9	534.58	**536**	**182240**	0.96	-9791	2173239	**6.92**	454.1	2897.7
9	May-21	165672	55344	120248	**341264**	544.96	542.02	551.14	**551**	**187340**	0.96	-9811	2182455	**6.94**	455.0	2909.9
10	Jun-21	158008	56448	113520	**327976**	542.33	541.26	544.74	**545**	**185300**	0.97	-18859	2093300	**6.95**	437.3	2791.1
11	Jul-21	170360	58320	118024	**346704**	544.5	550.06	547.47	**550**	**187000**	0.97	-19935	2203951	**6.90**	462.3	2938.6
12	Aug-21	169376	58120	121032	**348528**	544.16	543.91	546.13	**546**	**185640**	0.97	-20040	2213202	**6.88**	464.7	2950.9
	Average												**2185910**	**6.97**	**454.4**	**2914.5**
	Total				**4089584**								**26230917**			

Power bill for Aug-2021 is attached

Total MLD produced in Raw water pump house/per month **750**

CHAPTER 5

PRODUCTION COST (KNOW YOUR PLANT)

5.1 Components of energy charge in respect of Blower,Back wash pumping,and light loads

Sl. No.	Components	Rated power in Watts	Corresponding KVA required	No. of hours in operation per day	Kwh per day	Fixed charge @ Rs.197.2/KVA	Energy charge @Rs.5.75per month	Total charge per month in Rs.	Total charge per year in Rs.
1	Blower 16 mld plant	18625		0.09	1.67625				
2	Back wash pumping -9 mld plant	7450		10	74.5				
3	Light load-9 mld plant	230		12	2.76				
4	Back wash pumping - 16 mld plant	3725		20	74.5				
5	Light load-16 mld plant	970		12	11.64				
6	Light load-16 mld RWPH	160		Drawing from HT connection					
7	Light load-9 mld RWPH	160		Drawing from HT connection					
			35		165.076	6902	28475.7	35377.7	424532
8	**KWh per mld = 6.6**								
9	**Rs. Per mld = 47.2**								

KWH/MLD = 165.076/25 = 6.6

5.2 Components of production cost up to Clear water						
Total mld produced per year					**25 x 30 x 12**	**9000**
Sl.No.	**Components**	**Particulars**	**Unit**	**Quantity per year**	**Expenditure per year in Rs.**	**Expenditure per mld in Rs.**
1	Energy charge for raw water pumping	Electricity	KWh	4089584	26004547	2889.4
	Energy charge for raw water pumping (Componenets of fixed charge)		Kva	6658	2263720	251.5
2	Light load including the components of energy utilised in plants	Electricity	KWh	59427.47	424550	47.2
3	Establishment expenditure (Direct employment)	Operators and Workers	No.	14	5947824	660.9
4	Wages	Operators and Workers	No.	2880	1356480	150.7
5	Operation and Maintenance expenditure	Repair works			581688	64.6
6	Alum	Chemicals	MT	1.83	40705	4.5
7	Lime	Chemicals	MT	3.042	39485	4.4
8	Bleaching powder	Chemicals	MT	5.97	176234	19.6
9	Chlorine	Chemicals	MT	21.6	267624	29.7
10	Motor oil and Transformer oil	To run electrical equipments	Liters	60	26400	2.9
	Total					4125.5

CHAPTER 6

TRANSFORMERS

There are two 630 KVA transformers are in raw water pumping stations with equally shared loads to operate both raw water pump houses.

It seems oil leakages through the bushes of No. 1 transformer, more care has to be taken to supplement the same regularly till the repair works are carried out to arrest the leakage permanently.

In addition to the above, normal/routine maintenance for transformers has to be carried out.

Data of Transformers of 11 KV		
Location		Raw water pump house
Make		Resi tech,Aluva
Year		2019
Capacity		630 KVA
Transformer ratio		25.4
Weight of core and winding		1175 Kg
Oil weight		485 Kg
Oil quantity		570 Ltr.
wound		Copper
Model No.		TR-257
Impedance		4.4
No load Voltage	HV	11000
	LV	433
Load current	HV	33 A
	LV	840 A

CHAPTER 7

STUDY OF PUMPS AND MOTORS

7.1 MOTOR PUMP SETS PERFORMANCE CHARTS

1 250 HP No.2-NRWPH

Motor and Pump performance chart					
Utility	Description	Parameters	Unit	Design/Name plate details	Operating details
General	Location	New raw water pump house			
	Application	raw water pumping			
	Location ID	Nrwph,No 2			
Pipe line	Material	MS + DI			
	Size	600mm			
	Length	1600 M			
Motor	Make	Kirlosker			
	Year of Manufature	2001			
	Type	VT			
	ID. No.	20302014-01			
	Priciple of operation	Slip ring induction			
	Power		HP	250	
	Speed		RPM	1470	
	Frequency		Hz	50	
	Voltage		Volt	415	403
	Current		Amps	316	271
	PF				0.98
	Efficiency				
	Starting mechanism	Automatic rotor resistance starter			
	Input		KW		185.3738
	Loading on pump v/s Rated power		%		99.52955
Pumps	Make	Kirlosker			
	Year of Manufature				
	Type	VT			
	ID. No.	1535302010			
	Impeller Diameter			PH/BR/362	
	Column pipe Diameter				
	Speed		RPM	1480	
	Flow/Discharge		M3/Hr	504	504
	Head		M	90.8	82
	Density		Kg/M3	1000	
	Gravitational Constant		m/s^2	9.81	
	Prime mover rating		HP	250	
	Type of control	Throttling			
	Status of valve	Open fully			
	Working Hours	24	Hrs		
	% of loading of on head		%		90.30837
	% of loading of on discharge				100
	Output		KW		112.62
Combined	Efficiency		%		60.75

2) 170 HP No.3-NRWP

Motor and Pump performance chart					
Utility	Description	Parameters	Unit	Design/Name plate details	Operating details
General	Location	New raw water pump house			
	Application	raw water pumping			
	Location ID	Nrwph,No 3			
Pipe line	Material	MS + DI			
	Size	600mm			
	Length	1600 M			
Motor	Make	Kirlosker			
	Year of Manufature				
	Type	VT			
	ID. No.	29812006-1			
	Priciple of operation	Slip ring induction			
	Power		HP	170	
	Speed		RPM	1470	
	Frequency		Hz	50	
	Voltage		Volt	415	400
	Current		Amps	214	160
	PF				0.98
	Efficiency				
	Starting mechanism	Automatic rotor resistance starter			
	Input		KW		108.631
	Loading on pump		%		85.77263
Pumps	Make	Kirlosker			
	Year of Manufature				
	Type	VT			
	ID. No.	1535302011			
	Impeller Diameter			PH/BR/362	
	Column pipe Diameter				
	Speed		RPM	1470	
	Flow/Discharge		M3/Hr	396	306
	Head		M	82	82
	Density		Kg/M3	1000	
	Gravitational Constant		m/s^2	9.81	
	Prime mover rating		HP	170	
	Type of control	Throttling			
	Status of valve	Open fully			
	Working Hours	24	Hrs		
	% of loading of on head		%		100
	% of loading of on discharge		%		77.27273
	Output		KW		68.3757
Combined	Efficiency		%		62.94306

3) 250 HP No.6-ORWPH

Motor and Pump performance chart						
Utility	Description	Parameters	Unit	Design/Name plate details	Operating details	
General	Location	Old raw water pump house				
	Application	raw water pumping				
	Location ID	Orwph,No 6				
Pipe line	Material	CI				
	Size	400 mm				
	Length	1600 M				
Motor	Make	Jyothi Ltd.				
	Year of Manufature					
	Type	VT				
	ID. No.	IS/IEC325-1996				
	Priciple of operation	Squirell guage induction				
	Power		HP	250		
	Speed		RPM	1470		
	Frequency		Hz	50		
	Voltage		Volt	415	393	
	Current		Amps	314.5	317	
	PF				0.98	
	Efficiency					
	Starting mechanism	FCMA				
	Input		KW		211.4588	
	Loading on pump v/s Rated power		%		113.5349	
Pumps	Make	Kirlosker				
	Year of Manufature					
	Type	VT				
	ID. No.	W124235				
	Impeller Diameter			PH/BR/362		
	Column pipe Diameter					
	Speed		RPM	1480		
	Flow/Discharge		M3/Hr	522	522	
	Head		M	90.8	82	
	Density		Kg/M3	1000		
	Gravitational Constant		m/s^2	9.81		
	Prime mover rating		HP	250		
	Type of control	Throttling				
	Status of valve	Open fully				
	Working Hours	24	Hrs			
	% of loading of on head		%		90.30837	
	% of loading of on discharge				100	
	Output		KW		116.6409	
Combined	Efficiency		%		55.16011	

4) 90 HP No.8 ORWPH

Motor and Pump performance chart					
Utility	Description	Parameters	Unit	Design/Name plate details	Operating details
General	Location	Old raw water pump house			
	Application	raw water pumping			
	Location ID	Orwph,No 8			
Pipe line	Material	CI			
	Size	400 mm			
	Length	1600 M			
Motor	Make	Jyothi Ltd.			
	Year of Manufature	2020			
	Type	VT			
	ID. No.	M11200771			
	Priciple of operation	Squirell guage induction			
	Power		HP	90	
	Speed		RPM	1470	
	Frequency		Hz	50	
	Voltage		Volt	415	398
	Current		Amps	146	106
	PF				0.98
	Efficiency				
	Starting mechanism	FCMA			
	Input		KW		71.60822
	Loading on pump v/s Rated power		%		106.7982
Pumps	Make	CHANDRA PUMPS			
	Year of Manufature				
	Type	VT			
	ID. No.	P40633			
	Impeller Diameter			PH/BR/362	
	Column pipe Diameter				
	Speed		RPM	1480	
	Flow/Discharge		M3/Hr	203	207
	Head		M	85	82
	Density		Kg/M3	1000	
	Gravitational Constant		m/s^2	9.81	
	Prime mover rating		HP	90	
	Type of control	Throttling			
	Status of valve	Open fully			
	Working Hours	24	Hrs		
	% of loading of on head		%		96.47059
	% of loading of on discharge				101.9704
	Output		KW		46.25415
Combined	Efficiency		%		64.59335

7.2 Efficiency calculation sheet for pump sets

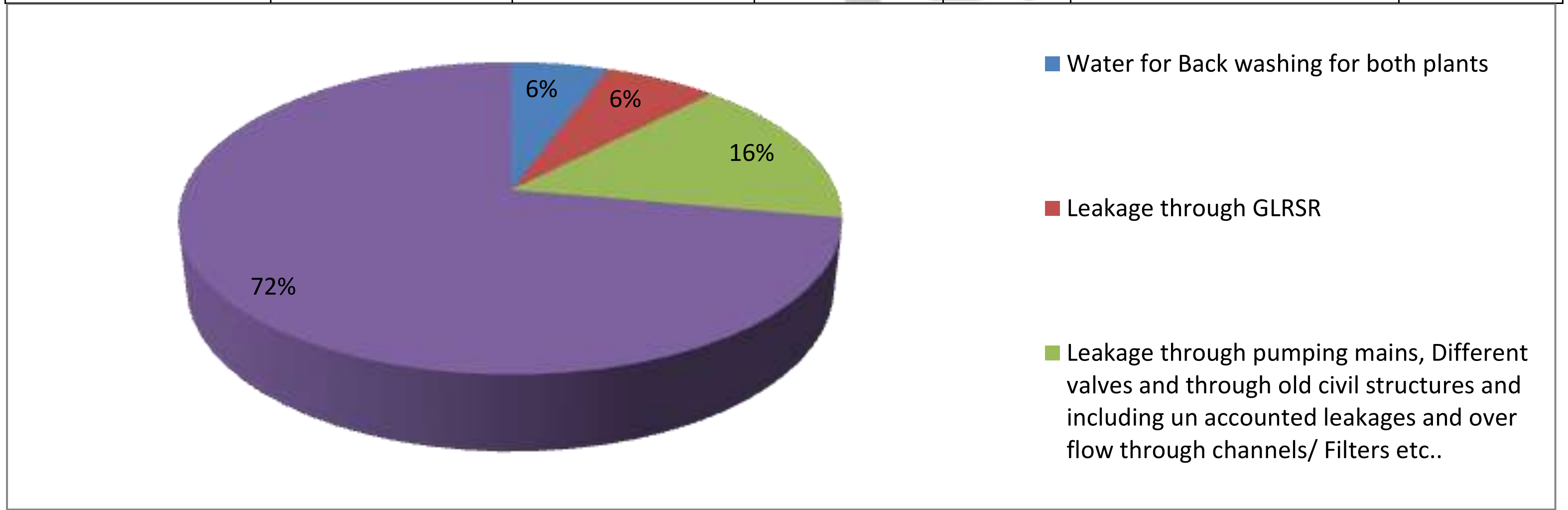
Date of trial			08-10-2021		No. of trial		3	Time	11:00:00 to 1.30 pm		
Sl.No.	Location	No.	Capacity in HP	INPUT DATAS				OUTPUT DATAS			Efficiency in %
				Voltage in Volts	Current in Amps	PF	INPUT in KW	Discharge in M^3/S	Head in m	OUTPUT in KW	
1	NRWPH	2	250	403	271	0.98	185.37	0.140	82	112.62	60.75
2	NRWPH	3	170	400	160	0.98	108.63	0.085	82	68.38	62.94
3	ORWPH	6	250	393	317	0.98	211.46	0.145	82	116.64	55.16
4	ORWPH	8	90	398	106	0.98	71.61	0.0575	82	46.25	64.59

CHAPTER 8

QUANTITATIVE ANALYSIS OF WATER FLOW

8.1 Water balance in mld

Contribution by both pump sets at NRWPH (Combination of 250 hp and 170 hp	Contribution by both pump sets at ORWPH (Combination of 250 hp and 90 hp)	Total Discharge	Water for Back washing for both plants	Leakage through GLRSR	Leakage through pumping mains, Different valves and through old civil structures and including un accounted leakages and over flow through channels/ Filters etc..	Clear water for distribution
18.2	16.45	34.65	1.95	2.281	5.419	25



8.2. COMBINED DISCHARGE DATA

8.2 DISCHARGE DATA OF NEW RAW WATER PUMP HOUSES, AT KAKKAD				
Combinations	Date	Time	Combined Discharge in m^3/hr	Combined Discharge in MLD
Combination of 250 hp and 170 hp at ORPH	29-09-2021	12.40 pm	755	18.2
Combination of 250 hp and 90 hp at NRPH	29-09-2021	02.25 pm	685.26	16.45

8.3 LEAK TEST

8.3 DATA SHEET FOR LEAK TEST OF RESERVIOR							
Status	All inflow and Out flow is arrested						
Location	Near 16 mld wtp		Size				
			Depth	length	Breadth	Volume of water leaked in $M^{3/}$s	Volume of water leaked in MLD
	Shape	Squre	2.3 M	24 M	24M		
Trial No.	**Date**		**Time**	**Water level**			
1	29-09-2021		1.16	2.25 M			
			1.56	2.14 M		0.0264	2.281

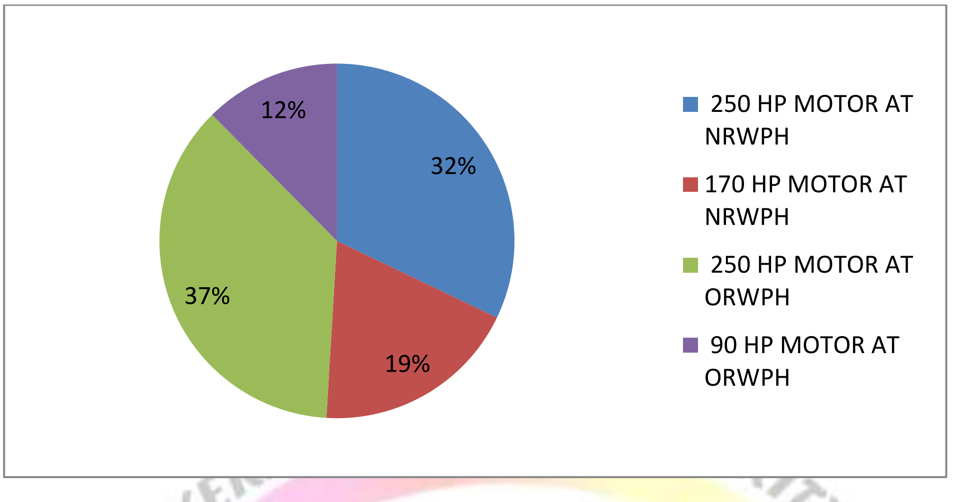
CHAPTER 9

QUANTITATIVE ANALYSIS OF ENERGY FLOW

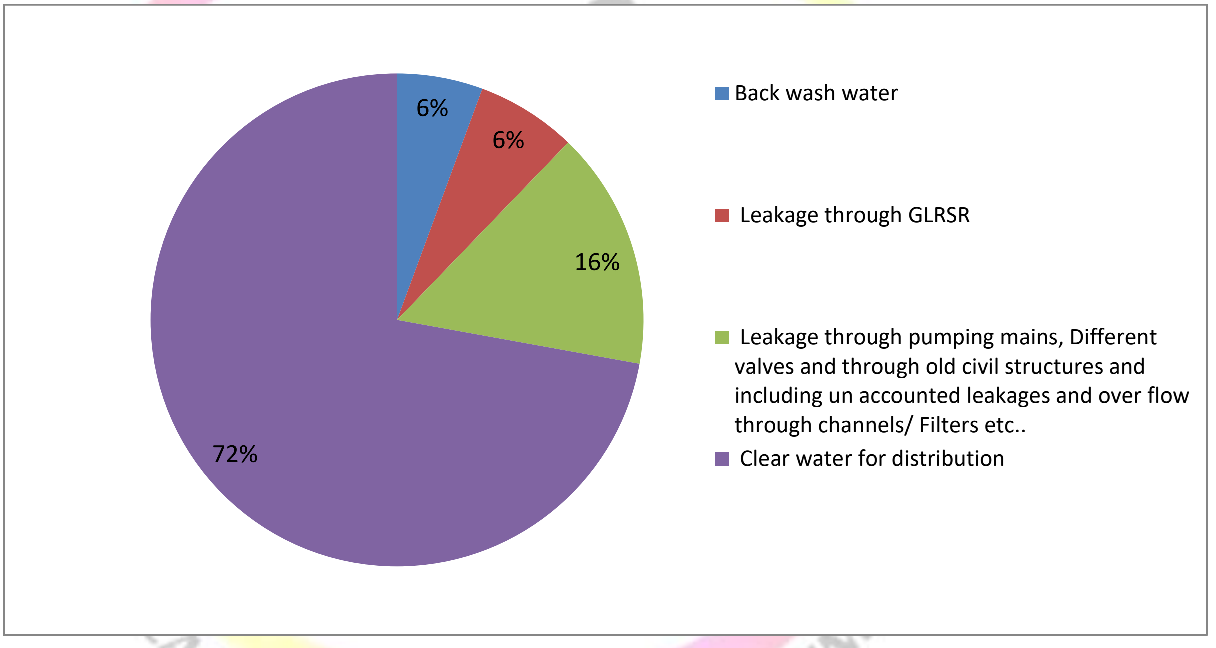
Energy consumption by Raw watermotor pump sets					
	250 HP MOTOR AT NRWPH	**170 HP MOTOR AT NRWPH**	**250 HP MOTOR AT ORWPH**	**90 HP MOTOR AT ORWPH**	**TOTAL INPUT ENERGY IN KWh per Day**
In put power in Kw	185.37	108.63	211.46	71.61	577.07
Operating time per day	24	24	24	24	24
kWh PER DAY	4448.88	2607.12	5075.04	1718.64	13849.68

9.2 Calculation of Energy equivalent of water distribution in kwh per day				
Unit	**Back wash water**	**Leakage through GLRSR**	**Leakage through pumping mains, Different valves and through old civil structures and including un accounted leakages and over flow through channels/ Filters etc..**	**Clear water for distribution**
MLD	**1.95**	**2.281**	**5.419**	**25**
kwh/MLD	**461**	**461**	**461**	**461**
kwh/day	898.95	1051.541	2498.159	11525

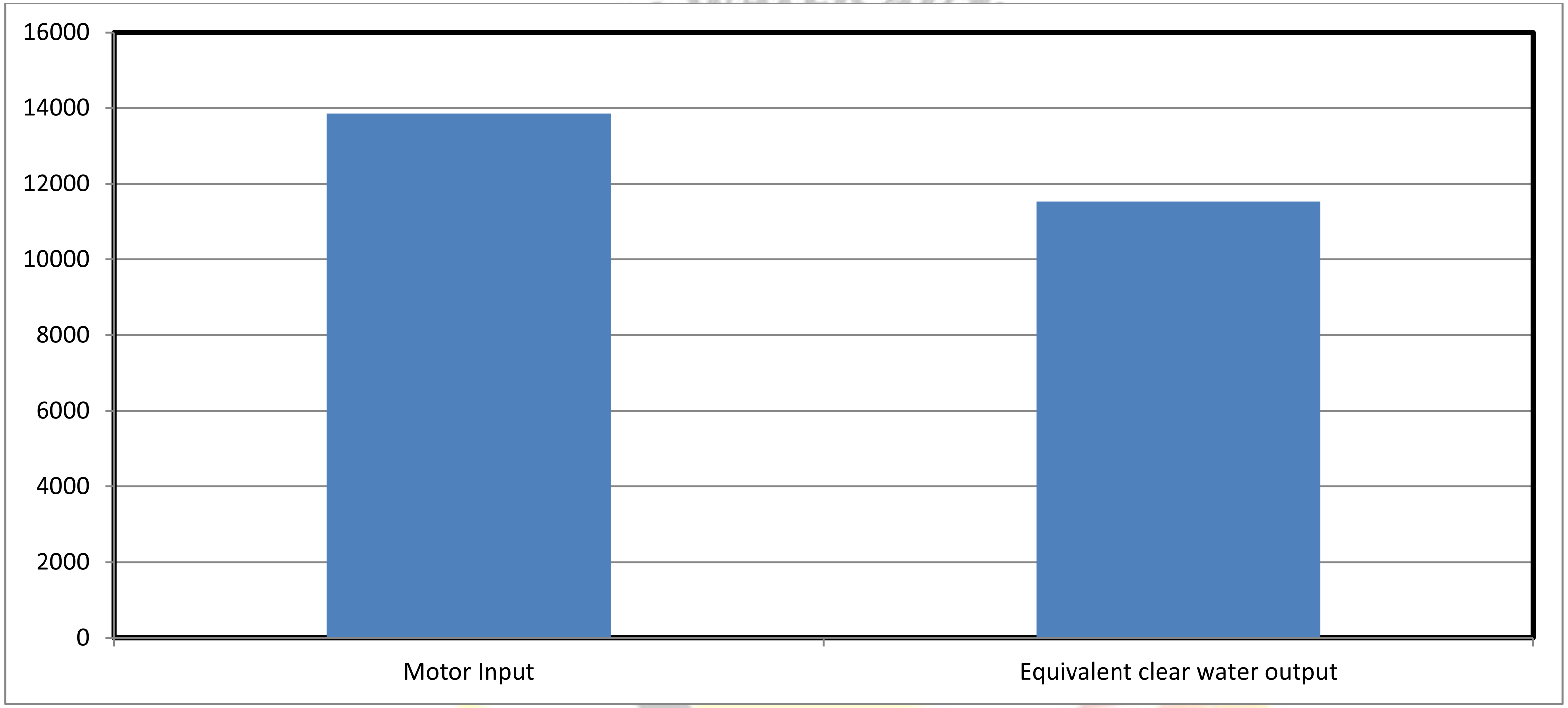
9.3 PIE CHART FOR EQUIVALENT ENERGY OF INFLOW SIDE



9.4 PIE CHART FOR EQUIVALENT ENERGY OF OUTFLOW SIDE



9.5 MOTOR INPUT VS EQUIVALENT WATER OUTPUT IN KWH PER DAY



CHAPTER 10

SPECIFIC ENERGY CONSUMPTION-BENCHMARKING

10.1 SPECIFIC ENERGY CONSUMPTION OF EXISTING PUMPING PROCEDURE

Four pumps are on working mode having a total rated capacity(504+306+522+207) of 1539 m3/hr. so that to feed both filter houses, which is equal to 36.936 mld. On evaluation, it is realised that there is no successful combination of pump sets to be operated on synchronised mode to feed both plants @25 mld. The excess water pumped is caused for overflow and one portion of the same is utilised to compensate for the heavy leakage through one of the GLSR.

10.2 Bench marking evaluation		
Particulars	**Existing mechanism**	**Proposed mechanism**
Kwh/mld for raw water	454.4	422
Kwh/mld for clear water	461	428.6
Operation schedule	760 hp	500 hp/670 hp with VFD

CHAPTER 11

SENSITIZATION PROGRAMME 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 Executive Engineer Sri. Sabu Thomas, Assistant Engineer Sri. Harikrishnan and operating staff were present. The discussions were fruitful and the confidence among the staff were improved. The preliminary recommendations were also discussed and ensured cooperation for implementing the same.

CHAPTER 12

ENERGY CONSERVATION OPTIONS AND RECOMMENDATIONS

1) **Supply and fixing of VFD with 250 HP motor at ORWPH**

It has been observed that an average of 35 mld water is pumped against the 25 mld requirements for both plants from raw water pumping stations as there is no successive combination for existing pumps to produce a rated discharge of 25 mld. The motors available in the new raw water pumping station in the working mode are slip ring induction motors having capacity of 250 and 170 hp of rated discharge @ 12.096 mld and 9.5 mld respectively and there are two squirrel cage induction motors having capacity 250 and 90 hps of discharge @ 12.528 mld and 4.872 mld respectively in the old raw water pump house. It could have been better to pump two 250 hp one each from both pumping stations and 90 hp at old pumping station simultaneously to get more close value of rated required discharge. However, it was habituated to operate all pumps simultaneously to feed water not only for the requirement but to satisfy the leakages and overflows. It has been discussed this issue with the concerned on sensitization meetings and communicated to operate only the required pumps as per the situations. It is also noted no mechanism is there to control the flow requirement except throttling valves, which is not desirable as there is no conservation of energy. It has been recommended to procure a VFD to operate 250 hp motor in place of existing FCM at the old raw water pump house to throttle the discharge

.

Small variable-frequency drive

VFDs are used in applications ranging from small appliances to large compressors. About 25% of the world's electrical energy is consumed by electric motors in industrial applications. Systems using VFDs can be more efficient than those using throttling control of fluid flow, such as in systems with pumps and damper control for fans. However, the global market penetration for all applications of VFDs is relatively small.

Over the last four decades, power electronics technology has reduced VFD cost and size and has improved performance through advances in semiconductor switching devices, drive topologies, simulation and control techniques, and control hardware and software.

Benefits

Energy savings

Many fixed-speed motor load applications that are supplied direct from AC line power can save energy when they are operated at variable speed using VFD. Such energy cost savings are especially pronounced in variable-torque centrifugal fan and pump applications, where the load's torque and power vary with the square and cube, respectively, of the speed. This change gives a large power reduction compared to fixed-speed operation for a relatively small speed reduction. For example, at 63% speed, a motor load consumes only 25% of its full-speed power. This reduction is following affinity laws that define the relationship between various centrifugal load variables.

2) **Interconnecting the circular GLSR with rectangular GLSR to isolate latter.**
   It has been observed that heavy leakage through the sidewall of rectangular GLSR and the same has been measured as 2.281 mld, which is equal to 453.75 KWh per day the same can be arrested by executing this work. The heavy leakage through the rectangular GLSR can only be arrested by grouting (if possible). The existing feeding area from this tank can also be catered from the circular GLSR by interconnecting both delivery lines.

3) **Supply and fixing of PF capacitors to improve PF**

   On evaluating the energy bills, it has been realized that there is no major penalty for low PF ratings and also noted that capacitors were having sufficient KVAR ratings in the available APFC panels. The noted PF in the power bills is an average of 0.97 only, against the requirements of unity to get the maximum incentive. On examination, it is realized that the available sizes of capacitors are bigger @25 kvar which is not sufficient to add automatically for smaller increments in PF. It is recommended to add two numbers of capacitors @ 5 KVAR each.

The benefits of power factor correction

Savings on the electricity bill

Power factor correction eliminates penalties on reactive energy, decreases demand on kVA, and reduces power losses generated in the transformers and conductors of the installation.

Increased available power

Fitting PFC equipment on the low voltage side increases the power available at the secondary of an MV/LV transformer. A high power factor optimises an electrical installation by allowing better use of the components.

Reduced installation size

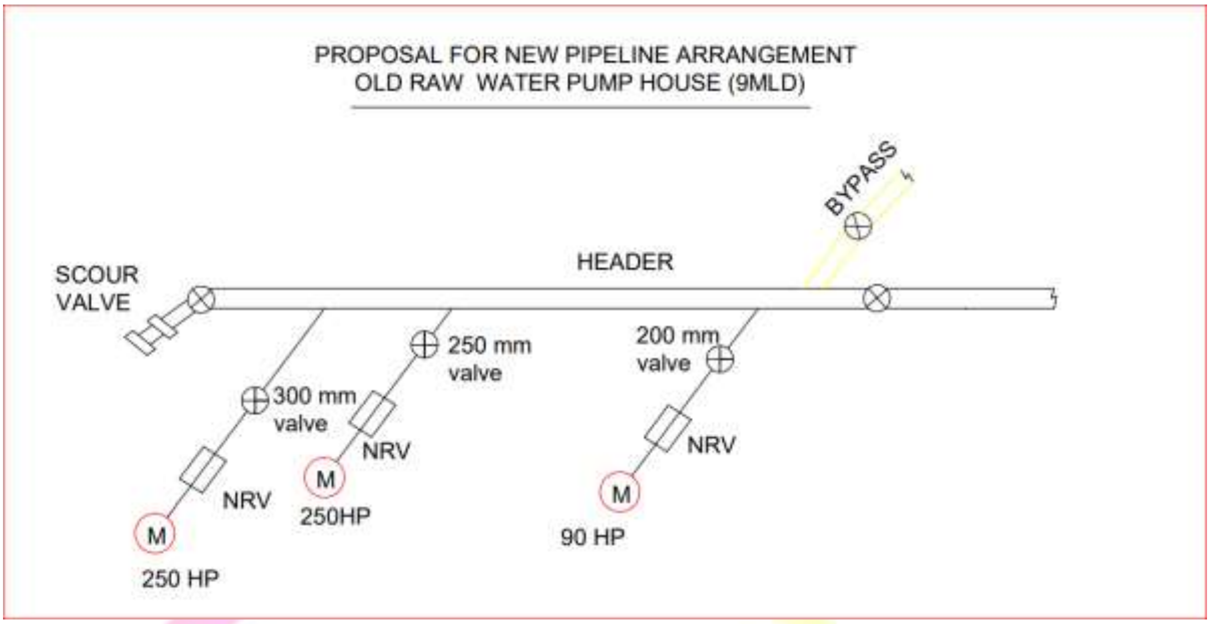
Installing PFC equipment allows conductor cross-section to be reduced, as less current is absorbed by the compensated installation for the same active power.

Reduced voltage drops

Installing capacitors allows voltage drops to be reduced upstream of the point where the PFC device is connected, therefore preventing overloading of the network and reducing harmonics.

4) **Mechanical work to smoothen pumping main inside the ORWPH**

The pipeline arrangements inside the ORWPH are seen as more complicated with U turns of water flow which attracts head losses and inconvenience to operate the valves. It was recommended to smoothen the pumping main with appropriate mechanical work with the provision of a scour valve.



5) General recommendations for the maintenance of 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. Inspecting 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. 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 voltage and current of every hour are documented so that to avail the same for future references.

6) Proposed operating procedure for pump sets.

It is recommended to operate the pumps only for the required rated discharge of 25 mld. At present, it is sufficient to run two 250 hp motor pumps, one from each pump house at a time, provided only the excess discharge from ORWPH can be guided to 16 MLD plant by operating bypass valve, till the proposed VFD is in operation.

7) Procurement of efficient motors

There are two more 250 hp motor pump sets available at each pump house on standby mode, but not in operation as both were under repair. It is recommended that the efficiency tests have to be carried out for these motors once the repair works are over. It could be better to decide to replace the less efficient motor pump sets with the new one, only on evaluation of the actual performance of existing motor pump sets if it is necessary.

8) Providing required ventilation at starter room

It has been observed that there was no sufficient ventilation in the starter room, where a cooling fan is under operation continuously. It is recommended to make ventilation for that room to promote natural draught and which can help to arrest the operation of the fan

9) Substitution by solar energy

The possibility for renewable energy (solar) to meet demand for light load @ 3 KVA can also be exploded, depending on the availability of required intensity of sun rays throughout the day/year.

CHAPTER 13

CONCLUSION

The objective of the study was to delineate the issues in energy consumption pumping stations, 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 realised that each power utility centre has a unique optimisation need. It is also realised that the present specific energy consumption of raw-water pumping is 454.4 kWh per MLD and 6.6 kWh per MLD in the filter house. The kWh per MLD consumption is comparatively low in the filter house as there is no heavy pumping mechanism except backwash pumps and blower. No successful pumpset combination has been identified in operation to get the required 25 MLD of clear water as all the possible combinations of pump sets at both pumping stations do not match the required discharge. The cost of chemicals are comparatively low when compared to the overall expenditure, however, there is no data available to optimise the chemical quantity requirements. Benchmarking for energy use has been proposed and it can be achieved by introducing the proposed operating procedure and proper valve arrangements till the proposed VFD for flow control is established.

On evaluating, it is understood that the motor pump is less efficient not only to the inherent inability of the motor pump sets but due to the lack of optimisation and hence, it is not recommended to replace at this juncture, as some of them are not even required for the proposed pumping mechanism.

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

ANNEXURE 1

PAYBACK CALCULATIONS

A 1.1 **Supply and fixing of VFD with 250 HP motor at ORWPH**

Supply and fixing of VFD with 250 HP motor at ORWPH			
Particulars	**Unit**	**Quantity**	**Amount**
Investment required in Rs.	Rs.	1	850000
Energy required to pump one mld water	kwh	454.4	
Quantity of water through over flow per day	MLD	4	
Total quantity of energy can be saved per year	Kwh	654336	
KSEB rate for KWH	Rs.		5.75
Amount that can be saved per year	Rs.		3762432
Payback period in year	Year		0.2259177

6) **A1.2 Interconnection of the circular GLSR with rectangular GLSR to isolate latter.**

Interconnecting the circular GLSR with rectangular GLSR to isolate latter			
Particulars	**Unit**	**Quantity**	**Amount in Rs.**
Expenses expected to carry out the work as per No.2021/24914	Rs.	1	650000
Energy in KWH per MLD of water	KWH/MLD	454.4	
Leakage water	MLD per day	2.281	
Leakage water	MLD per year	821.16	
Total KWH that can be saved	KWH per year	373135.104	
KSEB rate for KWH	Rs.	5.75	
Total amount that can be saved per year	Rs.		2145526.848
Payback period in year	Year		0.303

A1.3 Supply and fixing of PF Capacitors to improve PF

Supply and fixing of PF Capacitors to improve PF			
Particulars	Unit	Quantity	Amount
Average power charge per month with 0.95 PF	Rs.		2185910
Incentive / penalty	Rs.		0
Expected pf by increasing Capacitors	PF	1	
Required capacitors rating @ 5 kvar	2		
Expected incremental increase of PF @ 0.01		3	
Expected savings by increasing PF per month @ 0.05%	Rs.		3278.865
Expected savings as incentive by increasing PF per year	Rs.		39346.38
Cost for Capacitors @ Rs.500 per kvar For 10 kvar	Rs.		5000
Payback period in year	year		0.127077

A1.4 Mechanical work to smoothen pumping main inside the orwph

Mechanical work to smoothen pumping main inside the orwph			
Particulars	**Unit**	**Quantity**	**Amount in Rs.**
Expenses expected to carry out the work.	Rs.		50000
Savings of head loss	m	0.2	
Quantity of water pumped.	MLD	9	821.16
Rate of discharge equivalent to 9 MLD	m^3/s	0.10417	
Energy required to pump 9 mld water to 0.2 m head/day	Kwh		4.90515696
Energy required to pump 9 mld water to 0.2 m head/year	Kwh		1765.856506
Cost for raw water pumping per kwh	Rs.		5.75
Amount required for additional pumping of 0.2 m head per year	Rs.		10153.67491
Payback period in year	Year		4.924325474

ANNEXURE 2

CALCULATION FOR PROPOSED BENCHMARK

Calculation for proposed benchmark								
Total MLD required (including backwash produced per day) : 25								
Location of Motors	**Proposed hp for operation**	**Rated voltage**	**Rated current**	**PF**	**KW**	**No. of hours in operation per day**	**KWH**	**KWH/MLD**
ORWPH	250	415	314.5	0.97	219.2746	24	5262.591	210.5
NRWPH	250	415	316	0.97	220.3204	24	5287.691	211.5
Total								**422**
Filter House								6.6

Total **428.6**

ANNEXURE 3

RECORDINGS OF DATAS

A3.1 Flow measurement

A3.2 ELECTRICAL DATA MEASUREMENTS

A3.3 LEAK OBSERVATION OF GLSR

..\Downloads\WhatsApp Video 2021-10-19 at 3.06.22 PM.mp4

A3.4 INSTRUMENTS USED

1) Clamp meters
2) Multimeters
3) Flow meters
4) Thermo meters
5) Pressure gauges
6) Tapes having different capacities
7) Cameras
8) TOD meter etc..