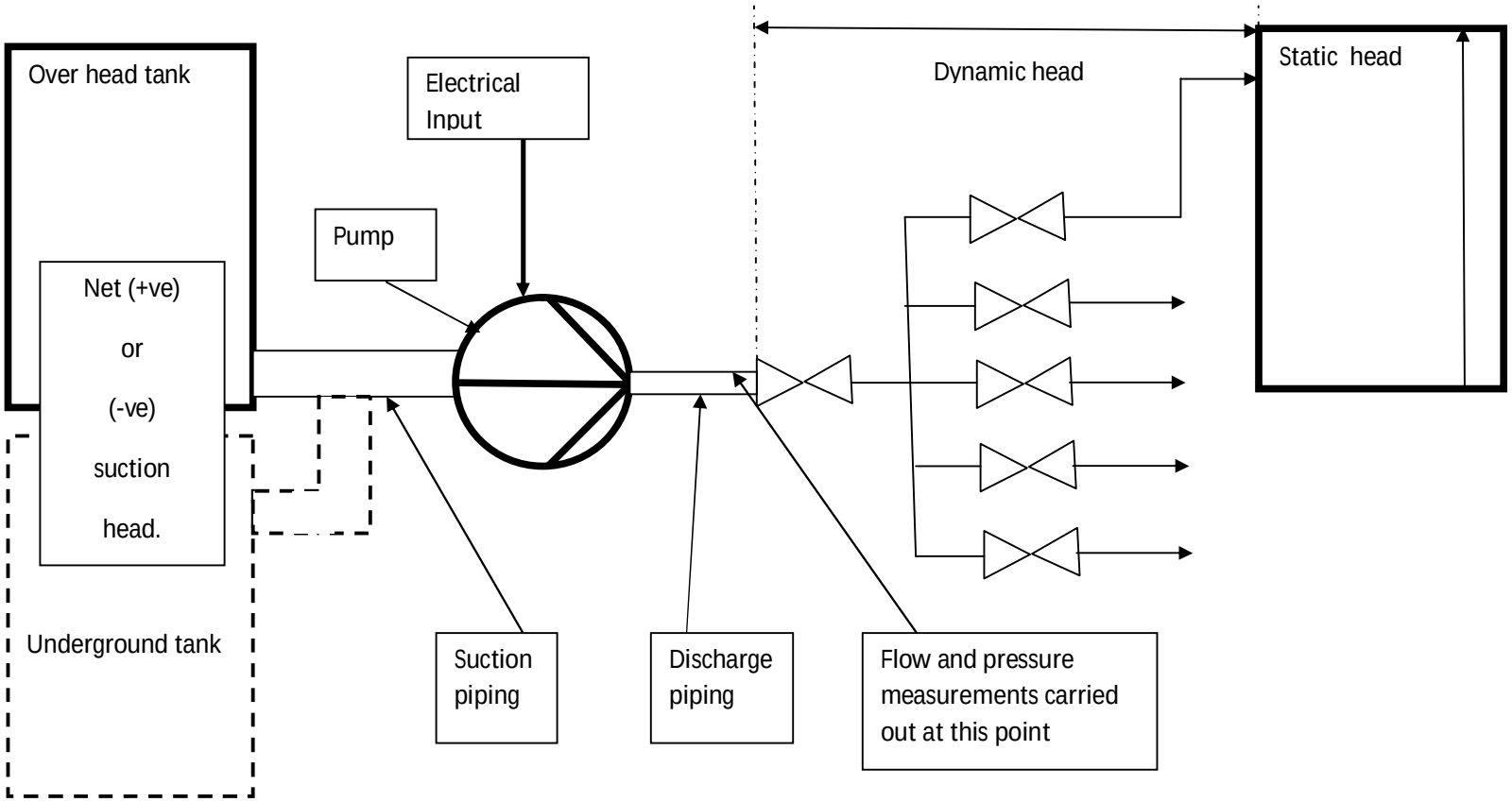
ENERGY AUDIT REPORT
FOR
Various Puming systems
at
A leading chemical Plant
Gujarat

Audit Period

December 2016

INDEX

Typical pumping system



Typical basics about present pumping systems

- All pumps at A CHEMICAL PLANT at present are of "Centrifugal Type" driven by induction motors, where in the impeller keeps rotating at almost constant speed decided by synchronous speed and slip.
- Every pumping system will have suction head comprising of positive or negative suction head or combination of both. All this results into "NET POSTIVE SUCTION HEAD" (NPSH).
- Suction side reservoirs are connected to pump suction through suction piping, which is connected to pump inlet.
- Pump outlet delivers the discharge into discharge piping.
- The fluid pumped is then taken to destination after overcoming "Dynamic head comprising of pipe resistance, joints, elbows, valves and "static head comprising of required lift".
- In case of centrifugal pumps; Suction - Delivery piping design, NPSH , temperature of the fluid handled and speed of the impeller if do not match the requirement; the combination results into poor overall efficiency and CAVITATION in some cases . Impact of cavitations bubbles can result into faster damage of impellers and even involutes in some cases. These effects get aggravated in case of pumps handling slurries with uneven suspended solids and slurries which are abrasive. (Abrasive slurries are handled at A CHEMICAL PLANT).
- In case of process pumps which are used for pressurising the discharge side, the **pump has to deliver against variable discharge pressure**. This is typically characterised by large flow and less pressure to start with and small flow and large pressure to end with. (This is true with filter press filling and washing pumps).

- **Hydraulic power delivered** by pump can be calculated using measured flow and pressure, while electrical input power can be measured simultaneously. For pumps delivering constant flow and pressure, these figures will give average efficiency and the same can be analysed using "Pump Characteristics and recommended duty point".
- Above method will give instantaneous efficiency for pumps handling variable discharge and pressure. Here the process requirement study coupled with observation of operation during one cycle can suggest best suited pump type for better efficiency.

- In this case, at present all **pumps used are of "Centrifugal type."**

  Pumping system efficiency is essentially multiplication of electrical motor efficiency and pump efficiency. As it is not possible to calculate / measure motor efficiency at site, we take it as standard. We confirm this by getting answers to few questions from site
  a) how many times the motor is rewound /burnt while working with Pump?
  b) What is % motor loading against it's rated capacity?
  c) Is motor handling harmonic currents?.

Considering these factors we will assume motor efficiency at a chemical plant around 90%. (Kindly note that much lower motor efficiencies are not possible in case of electrical motors as difference between 100% and actual efficiency has to be dissipated from motor windings and core as heat, and if motor temperatures are within acceptable limits, there are reasons to believe that motor efficiency is also within acceptable limits of above 90%.

Thus for good pumping systems for water,
if we assume pump efficiency to be 80%, then overall efficiency from electrical input to hydraulic output would be 90% x 80% = 72%.
So efficiency between 65% to 75% should be acceptable and achieved for a pumping system.
For slurry pumping the efficiency can be assumed to be between 60 to 65%.

Both these efficiencies are achievable by

a) Selecting Proper type and specifications for pump considering actual application.
b) Selecting single pump or pumping systems like hydro pneumatic pumping based on application.
c) Matching pump characteristics and nature of required H/Q characteristics and as far as possible, operating pumps at BEP.
d) Minimising dynamic head by optimizing all artificial resistances in path of flow.

During energy audit, we also follow same sequence as above,

a) Determine pumping efficiencies by actual measurements.
b) Analyse reasons for exceptionally low efficiencies if any.
c) Recommend system and pump modifications / replacements with budgetary investments and paybacks.

- Pumps at a chemical plant can be broadly divided into following catagories.

a) **Water transferring pump** – (e.g. Tag 2302)

These pumps transfer water from one storage to another for further use.
These are normal pumps which mostly transfer the water at relatively constant head, which largely comprises of static head. If these pumps are selected with characteristics matching to actual requirement, one can expect overall efficiency between 65 to 75%. The total power / energy required may be more if dynamic head involved includes excessive pipe resistance, partially open valves etc. Typically these pumping systems are designed to deliver to

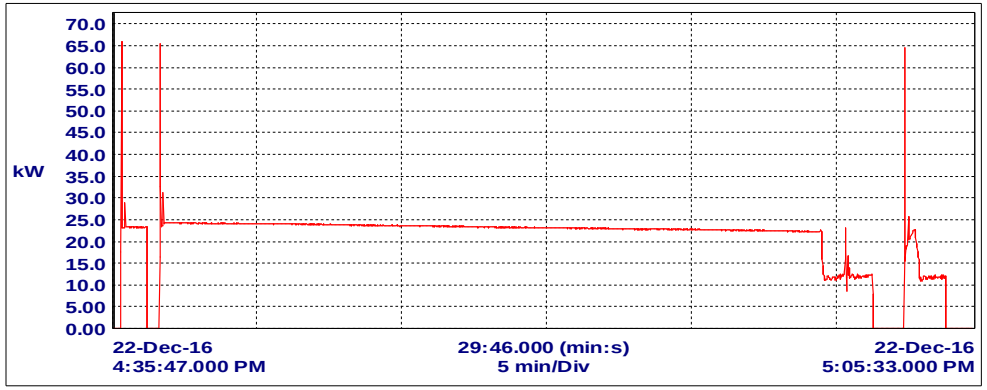
a single sump. In summary data collection of the same, we have noted down dynamic head in terms of bends, valves, tapings etc along with visible static head, where ever possible to understand the impact on efficiency. As regards efficiency of electrical motors, the same may be less by 1 or 2% at present

as they The electrical motors coupled to these pumps receive distorted input voltage and carry current with substantial distortion resulting into increased losses. Further these motors are delivering variable load, which in most of the cases, substantially less than their rated capacity.

b) **Water filling / wash pump** – (e.g Tag 2705).

These pumps lift process water from a single storage and the discharge system is designed to deliver the water to number of filter presses through valves. It is observed that these pumps are required to fulfil pressure requirements of filters, while filling. **So during filling the head and flow requirements vary inversely and the total requirement also varies as number of filters to be filled at any time also varies.** It is very difficult to install a single pump which will deliver overall efficiency between 65% and 75% for such an application.
The ideal energy efficient solution for such application would be a **hydro – pneumatic system with multiple pumps**, operating on pressure feedback or individual pump for each filter press.

c) **Slurry transfer pumps.** (E.G. 2937A) – Reactor to holding tank.

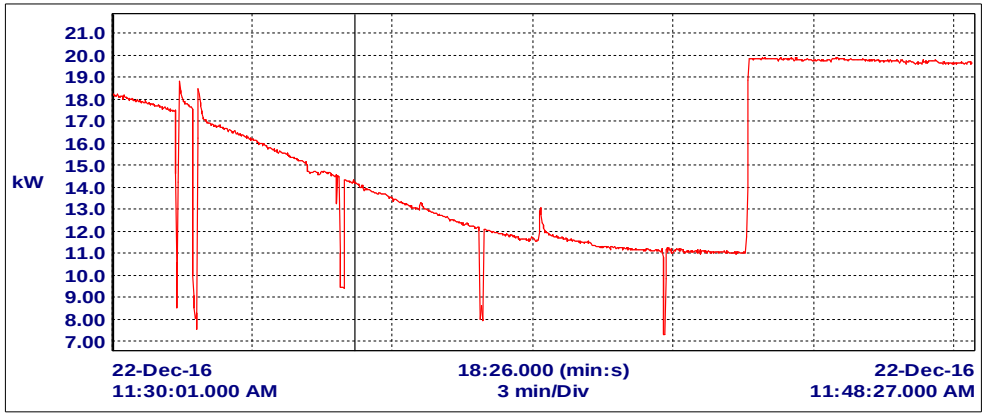


These pumps get exposed to suspended solids and the fluid handled may prove to be abrasive as the same is sand based. Measured flow and head requirements may not match DUTY POINT of pump always resulting into low efficiency. The best suited pumps for this application **are "Positive Displacement Pumps"** which will have to be selected for the system considering overall system requirements. These pumps will deliver 55 to 60% overall efficiency irrespective of variable duty demands of the fluid as against sub 25% efficiencies at present.

d) **Slurry filling pumps**. (E.G. Tag 2849) – Holding tank to Filter presses.

At A CHEMICAL PLANT , these pumps also get exposed to suspended solids, the fluids handled are abrasive and are at elevated temperatures. Following electrical power recording shows a typical filling cycle. The flow and pressure vary inversely during filling so ideally hydraulic power should have remained more or

less constant, but in practice this does not happen, as centrifugal pump efficiency does not remain constant for these “Varying” head and flow requirements during the filling cycle. This is evident from recorded power trend and Flow / pressure readings tabulated bellow from actual cycle.



Sr No	Flow measured m3/hr	Pressure bar	Sr No	Flow measured m3/hr	Pressure bar
1	62.7	2.3	11	20.2	4.3
2	53.4	2.8	12	18.2	4.3
3	51.4	3	13	16.4	4.3
4	48.9	3.1	14	14.6	4.4
5	39.2	3.5	15	13.4	4.3
6	37.8	3.5	16	13.3	4.4
7	30.5	3.9	17	9.8	4.5
8	28.6	4	18	9	4.6
9	26.9	4	19	8.6	4.6
10	23.6	4.1			

Further at A CHEMICAL PLANT the pumping systems are designed to feed number of filter presses simultaneously or single as required. This further demands variable flow and pressure to be delivered by pump. From inlet side NPSH also changes during this demand as Feed tanks are emptied duri process. The best suited pumps for this application **are “ Individual Positive Displacement Pumps”** which will have to be selected for the system considering overall system requirements. These pumps will deliver 55 to 60% overall efficiency irrespective of variable duty demands of the fluid as sub 25% efficiencies at present.

Positive displacement pumps by design deliver more or less constant flow regardless of pressure at which they are required to deliver the same. Fur changes in delivery pressure have very little impact on efficiency of positive displacement pumps.

Data recorded on sample pumping systems at a chemical plant -

Sr. No.	Plant - Area	Description	Tag no.	Flow, m3/hr		Head, m		Head m		Density, kg/m3	Hydraulic Power, kW	Efficiency	No. of Valves	No. of Elbows	No. of Tappings	VFD Freq. (HZ)	Power (KW)			No of Pumps	Avg working Hrs / day	kWh per day	Temperature of fluid handled, ˚C	No. of Filter Presses Fed
				Measured	Rated	Measured	Rated	Process req	Static								Rated, HP	Avg	Max					
1	Old tank farm Area	Initial Water transfer pump to reactor SD plant	2302	60.59	100	30	30			1000	4.95	51.60%					20	9.6		1	8	76.8	80 - 85	
2	New ETP	Filter press supply pump	2705	33.99	150	40	60			1044	3.87	8.16%	10	5	5		100	47.4		2	20	1896		
3	Old ETP	Filter press supply pump	1901	101.5	150	22	60			1044	6.35	29.41%					100	21.6		3	18	1166.4		
4	Old SD Plant	Fresh water filter washing pump	2405	14.76	60	50	60	65	6.3	1000	2.01	21.62%	7	8	3		30	9.3		2	7	130.2	28 - 30	3
5		Filter washing pump with Low TDS water	2406	37.19	100	55	75	65	6.3	1000	5.57	37.66%	7	9	2	41.4	30	14.8		2	6	177.6	50 - 60	5
6		Slurry Transfer pump from holding tank to filer press	2401	7.56	60	26.75	60	55	6.3	1040	0.57	2.29%	8	8	2	47 to 50	30	25	30	2	10	500	80 - 85	
7		Reactor vessel to holding tank slurry transfer pump	2313	238.42	200	13	20		9	1060	8.95	20.35%					60	44	51	2	3	264	80 - 95	
8	Old FD Plant	Slurry Transfer pump from reactor vessel to holding tank	1324	176.45	200	21	20			1037	10.47	26.18%	5	9	1		75	40	60	4	14	2240	72	
9		Slurry Transfer pump from holding tank to filer press	1334	114.92	60	25.8	60			1037	8.38	32.99%				50	50	25.4	30	2	13	660.4	65	1
10	New FD Plant	Slurry Transfer pump from holding tank to filter press	2849	36.43	60	36	60	55		1020	3.65	22.78%	6	22	5	48	30	16	19.8	2	15	480	65	
11		Fresh Water filter press washing pump	3020	21.25	100	70	75	65	6.3	1000	4.05	16.21%	17	19	5	50	50	25		2	13	650	40 -45	1
12		Low TDS wash pump for filter press	3024	32.13	100	72	75	65	6.3	1000	6.30	25.02%	15	13	5	50	50	25.2		2	13	655.2	50	2
13		Slurry transfer pump from reactor vessel to holding tank	2937A	123.12	280	9	30		8.1	1211	3.66	15.63%	7	12	1		75	23.4	66	8	18	3369.6	72	
14	New SD Plant	Fresh water filter washing pump	3829A	62.2	100	50	75			1000	8.47	38.17%				45.8	50	22.2		3	8	532.8	28 - 30	2
15		Low TDS wash pump for filter press	3927A	23	100	55	75			1000	3.45	27.36%				41.2	50	12.6		3	11	415.8	50 -60	
16		Slurry transfer pump from Reactor vessel to holding tank	3722	187.05	200	18	30			1044	9.58	36.15%					50	26.5	28.1	4	3	318	80 - 95	
17		Slurry transfer from holding tank to filter press	3902	96	250	18.5	60			1044	5.05	17.85%				41.2	75	28.3	31.8	2	11	622.6	80 - 85	1
18		Slurry Transfer pump from holding tank to spray drying chamber	FP101	7.745	14	38	NA			1020	0.82	48.12%				37.3	10	1.7	1.8	6	24	244.8	40 -45	

Observations from above:

1) Based on the data collected on process pumps and working hours for these pumps, all pumps put together consume around 14000Kwh per day or approximately electrical energy costing Rs. 100000 per day.
2) The overall efficiency appears to be around 25 to 30% at present. This indicates that on conservative side improvement of at least 25% should be possible by selectively adopting the improvement majors. This indicates annual saving of about Rs.75 Lacs.
3) We recommend following should be way ahead for achieving this.
   a) A detail application study may be conducted with the help of an experienced design engineer having chemical engineering background having experience in slurry handling and batch processing.
   b) Outcome of above study should be in the form a DESIGN QUALIFICATION document for each pumping application – jointly signed by A CHEMICAL PLANT for acceptance of output parameters.
   c) Above document should suggest type, specifications and configuration of pumps to ensure required process parameters at overall pumping efficiency not less than 55 to 65% in both the cases along with 80:20 analysis shows priorities of pumps to be replaced / altered.
   d) Pumping system recommendations should also include modifications required if any in Dynamic head comprising of piping and valves and also automation required if any to improve functional efficiency during dynamic operating conditions.

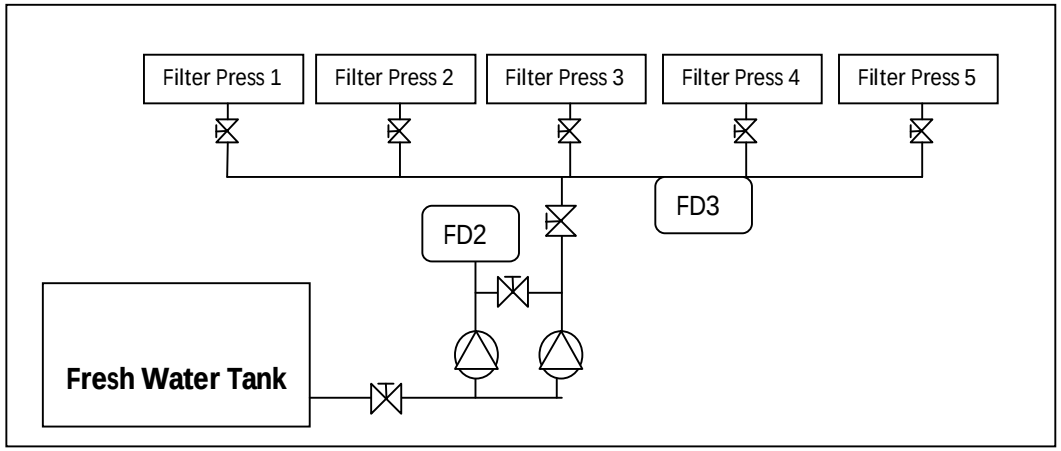
Sample Systems –

The layouts of the following pump systems are indicative of the actual systems. The exact no. of valves and elbows in the actual system are listed in the operating parameters table.

Plant – New FD Plant

Pump – Fresh Water Filter Washing Pump for FD-3

System Diagram

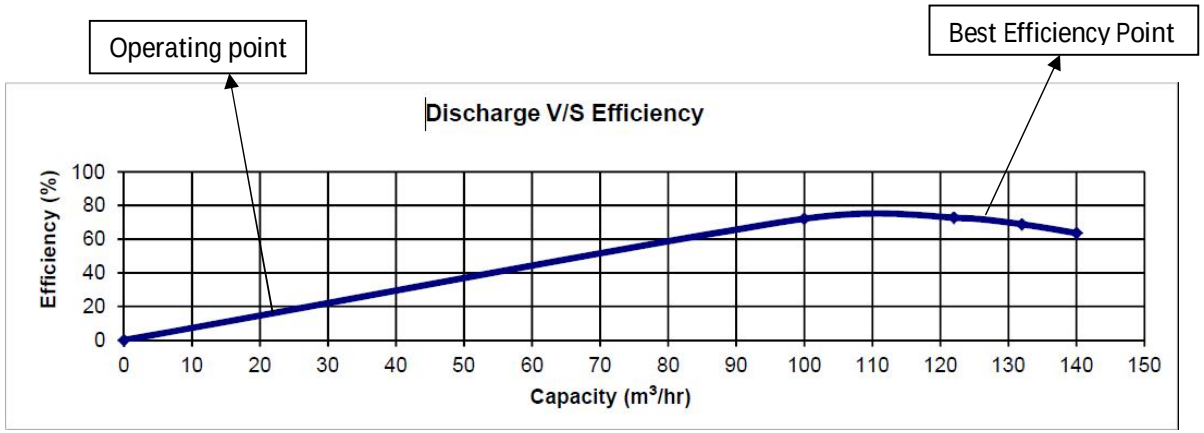


Operating Parameters -

Pump - Fresh Water Filter Washing Pump		
Tag No. - 3020	**Observed**	**Rated**
Observed Flow, m^3/hr	21.25	100
Observed Head, m	70	75
Density of fluid, kg/m^3	1000	
Hydraulic Power, kW	4.05	
Measured Electrical Power @ 50 Hz, kW	25	37.5
Efficiency, %	16.21%	68.7% - 72.7%
Avg working Hrs in a day	13	
Total No. of Pumps	1	
kWh per day	325	
Total No. of valves in the system	17 for FD3 Plant	
Total No. of elbows in the system	19 for FD3 Plant	
Pipe Size, mm (Suction x Discharge)	100 x 65	

Process Description –

This pump is used for filter washing succeeding the low TDS filter wash in all the systems. The pump serves five filter presses though a common header. For washing of the filter presses, required pressure of the wash water is 6.5 to 7 kg/cm^2. A flow of water from common header to the filter press is permitted though a manually operated butterfly valve for each filter press. During the audit period, the pump was feeding the water to 1 filter press. Though the required pressure for washing of the pumps is attained by the pump, observed flow is very less compared to rated flow.

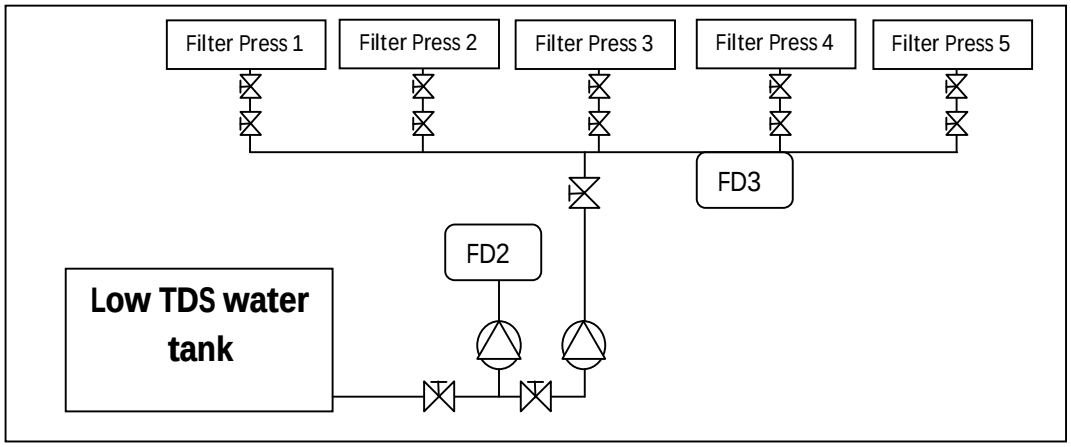


From the characteristic curve shown, it can be seen that the best efficiency point of the pump is between 122 to 132 m^3/hr flow. The observed flow is 21.25 m^3/hr which indicates the operating point is far away from the best efficiency point.

Plant – New FD Plant

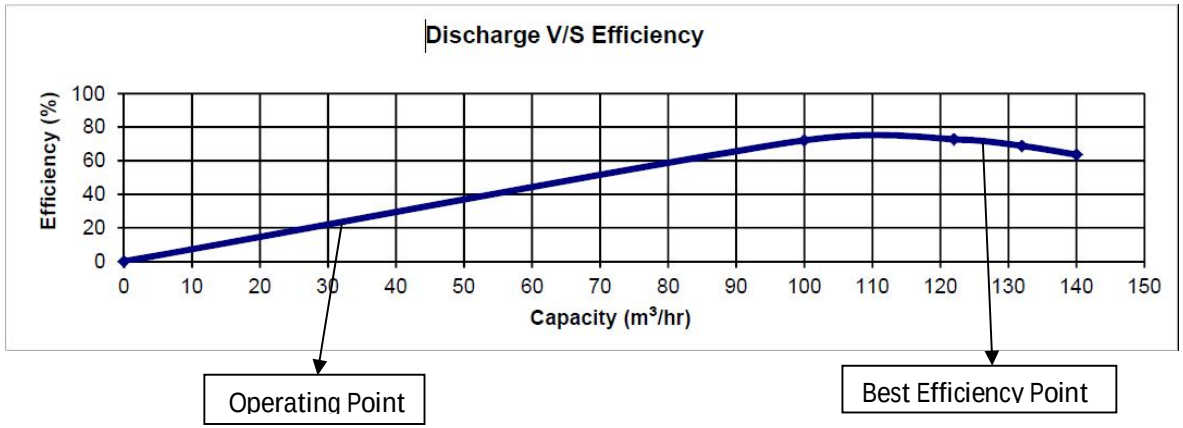
Pump – Low TDS wash pump for Filter Presses

System Diagram –



Operating Parameters -

Pump – Low TDS wash pump		
Tag No. - 3024	**Observed**	**Rated**
Observed Flow, m^3/hr	32.13	100
Observed Head, m	72	75
Density of fluid, kg/m^3	1000	
Hydraulic Power, kW	6.30	
Measured Electrical Power @ 50 Hz, kW	25.2	37.5
Efficiency, %	25.02%	68.7 – 72.7
Avg working Hrs in a day	13	
Total No. of Pumps	2	
kWh per day	655.2	
Total No. of valves in the system	15 for FD3 Plant	
Total No. of elbows in the system	13 for FD3 Plant	
Pipe Size, mm (Suction x Discharge)	100 x 65	



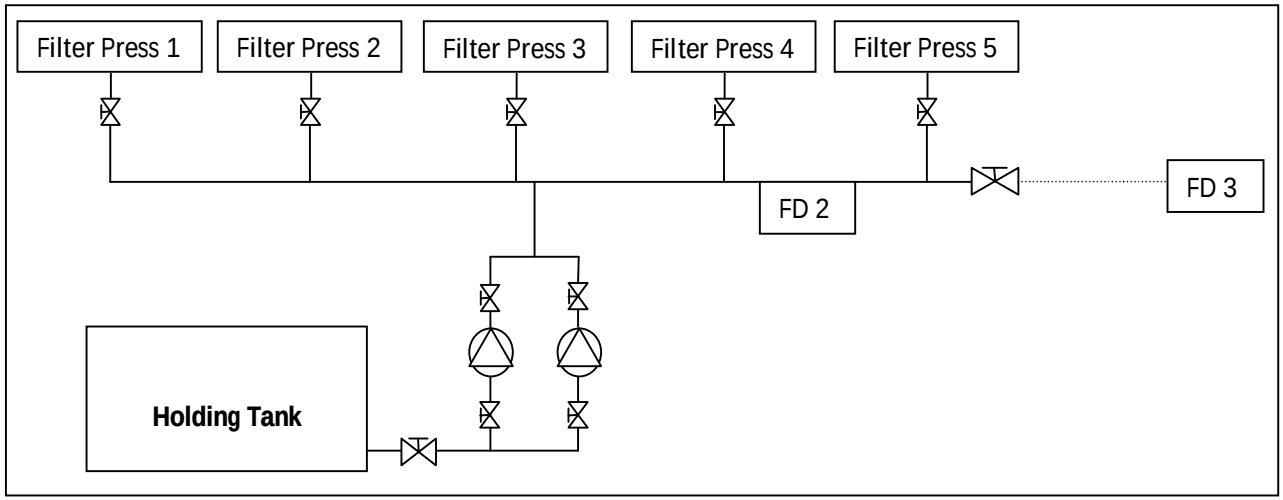
Process Description –

Low TDS wash pump is used for filter press cleaning after removal of the cake from it for all the systems. This pump serves for cleaning of five filter presses. Low TDS wash water is passed from common header to filter press through a couple of manually operated butterfly valves. During audit period, the pump was serving Low TDS water to 2 Filter Presses. Required washing pressure for the filter press is 6.5 – 7 kg/cm^2.

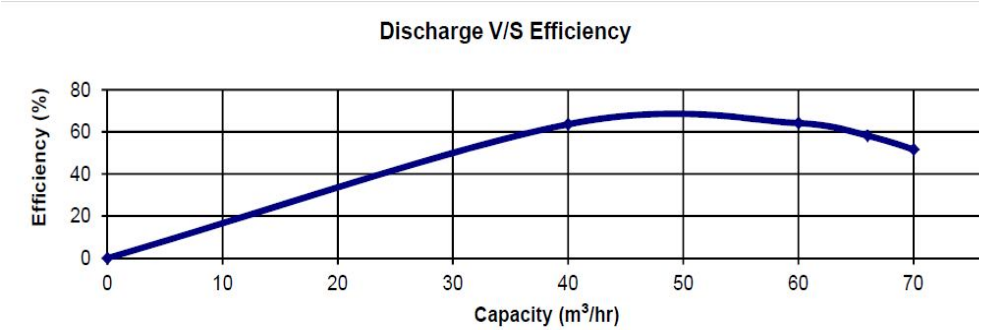
Plant – New FD Plant

Pump – Slurry Transfer Pump from Holding Tank to Filter Press

System Diagram –



Pump – Slurry Transfer Pump from holding tank to filter press		
Tag No. - 2849	**Observed**	**Rated**
Observed Flow, m^3/hr	36.43	60
Observed Head, m	36	60
Density of fluid, kg/m^3	1020	1000
Hydraulic Power, kW	3.64	
Measured Electrical Power, kW @ 48 Hz	16	22.38
Efficiency, %	22.78%	66%
Avg working Hrs in a day	15	
Total No. of Pumps	1	
kWh per Day	240	
Total No. of valves in the system	6	
Total No. of elbows in the system	22	
Pipe Size, mm (Suction x Discharge)	75 x 50	



Process Description –

The pump transfers the slurry held in the holding tank to a filter press. The slurry transfer flow rate varies from the initial condition of empty filter press to final condition of filter press full of slurry. The slurry pressure inside the filter press is gradually increased from 0 kg/cm^2 to 5.5 kg/cm^2. The varying flow rate of the pump is controlled with the help of VFD.

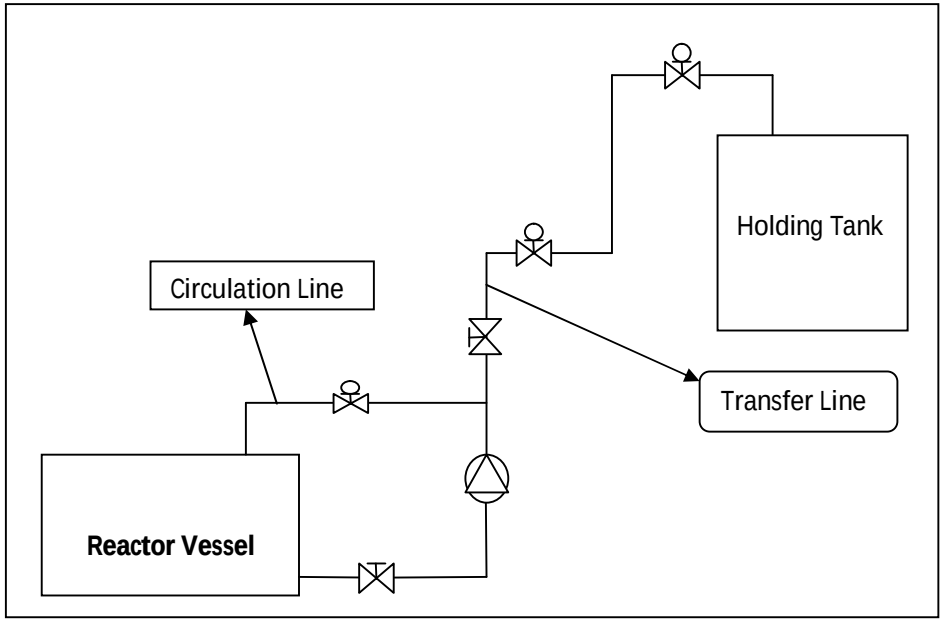
Plant – New FD Plant

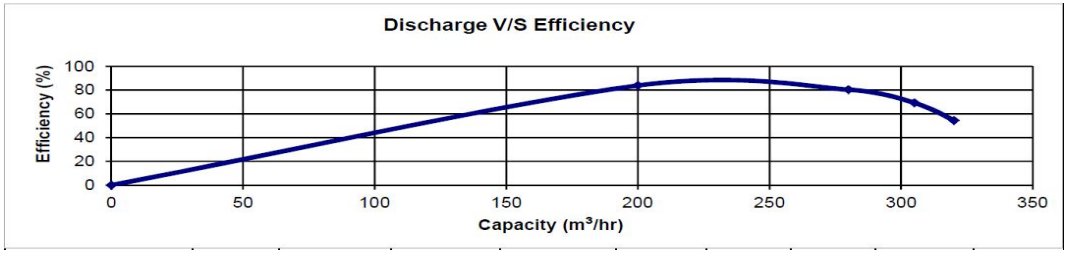
Pump – Slurry Circulation / Transfer Pump from Reactor Vessel to Holding Tank

Process Description –

The pump circulates the slurry in the reaction vessel during the enhancement of the reaction. Once the reaction is complete, the pump transfers the slurry from reaction vessel to holding tank. During the slurry transfer, maximum flow rate is maintained. The static height from the pump to holding is 8.1m.

System Diagram –





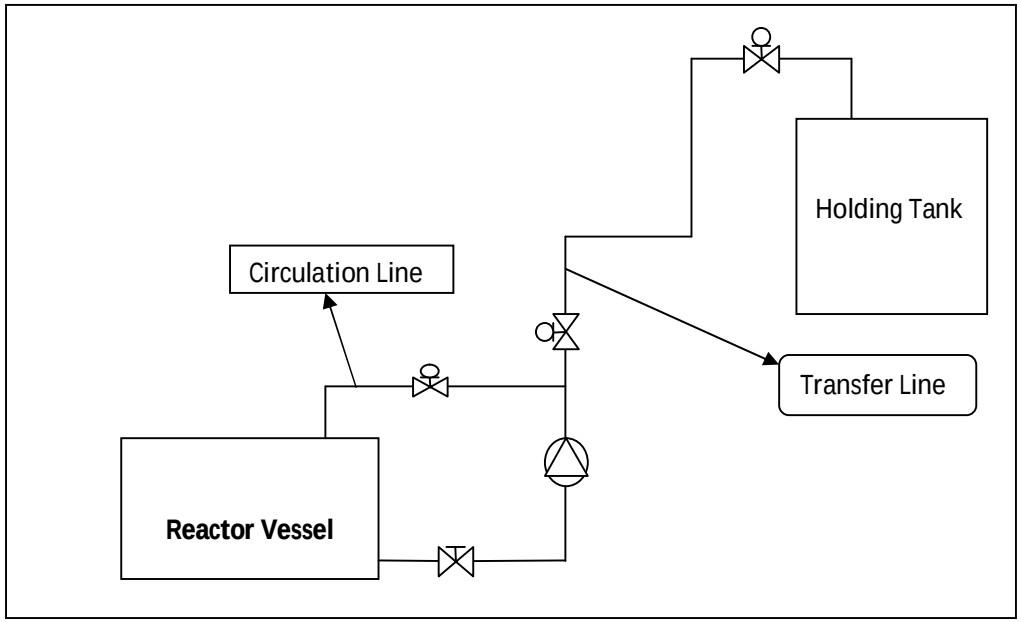
Operating Parameters -

Pump - Slurry Circulation / Transfer Pump from Reactor Vessel to Holding Tank		
Tag No. - 2937A	Observed	Rated
Observed Flow, m^3/hr	123.12	280
Observed Head, m	9	30
Density of fluid, kg/m^3	1211	1000
Hydraulic Power, kW	3.656636	
Measured Electrical Power, kW	23.4	55.9
Efficiency, %	15.63%	
Avg working Hrs in a day	18	
Total No. of Pumps	8	
kWh per Day	3369.6	
Total no. of valves in the system	7	
Total no. of elbows in the system	12	
Pipe Size, mm (Suction x Discharge)	125 x 100	

Plant – Old FD Plant

Pump – Slurry Transfer Pump from Reactor Vessel to Holding Tank

System Diagram –



Pump - Slurry Circulation / Transfer Pump from Reactor Vessel to Holding Tank		
Tag No. - 1324	Observed	Rated
Observed Flow, m^3/hr	176.45	200
Observed Head, m	21	20
Density of fluid, kg/m^3	1037	
Hydraulic Power, kW	10.47	
Measured Electrical Power, kW	44	55.95
Efficiency, %	23.80%	
Avg working Hrs in a day	14	
Total No. of Pumps	4	
kWh per Day	2464	
Total No. of Valves	5	
Total No. of Elbows	9	
Pipe Size, mm (Suction x Discharge)	125 x 100	

Process Description –

The pump circulates the slurry in the reaction vessel during the enhancement of the reaction and transfers the slurry from reaction vessel to holding tank after completion of reaction. During the slurry transfer, maximum flow rate is maintained. The static height from the pump to holding tank is 7 m.

Plant – Old SD Plant

Pump – Fresh Water Filter Washing Pump

Observed Parameters –

Pump - Fresh water filter washing pump		
Tag No. - 2405	**Observed**	**Rated**
Observed Flow, m^3/hr	14.76	60
Observed Head, m	50	60
Density of fluid, kg/m^3	1000	
Hydraulic Power, kW	2.01	
Measured Electrical Power, kW	9.3	22.38
Efficiency, %	21.62%	
Avg working Hrs in a day	7	
Total No. of Pumps	2	
kWh per Day	223.2	
Filter Presses Fed	3	
Pipe Size, mm (Suction x Discharge)	75 x 50	

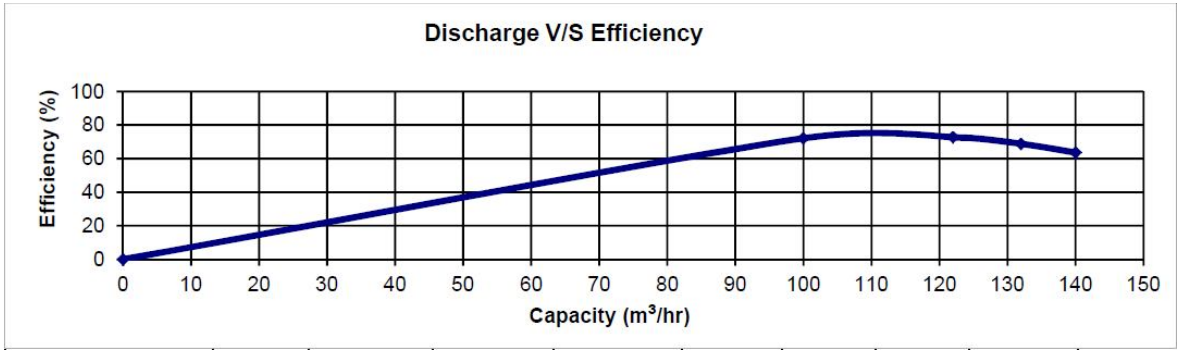
Plant – Old SD Plant

Pump – Low TDS wash pump for filter press

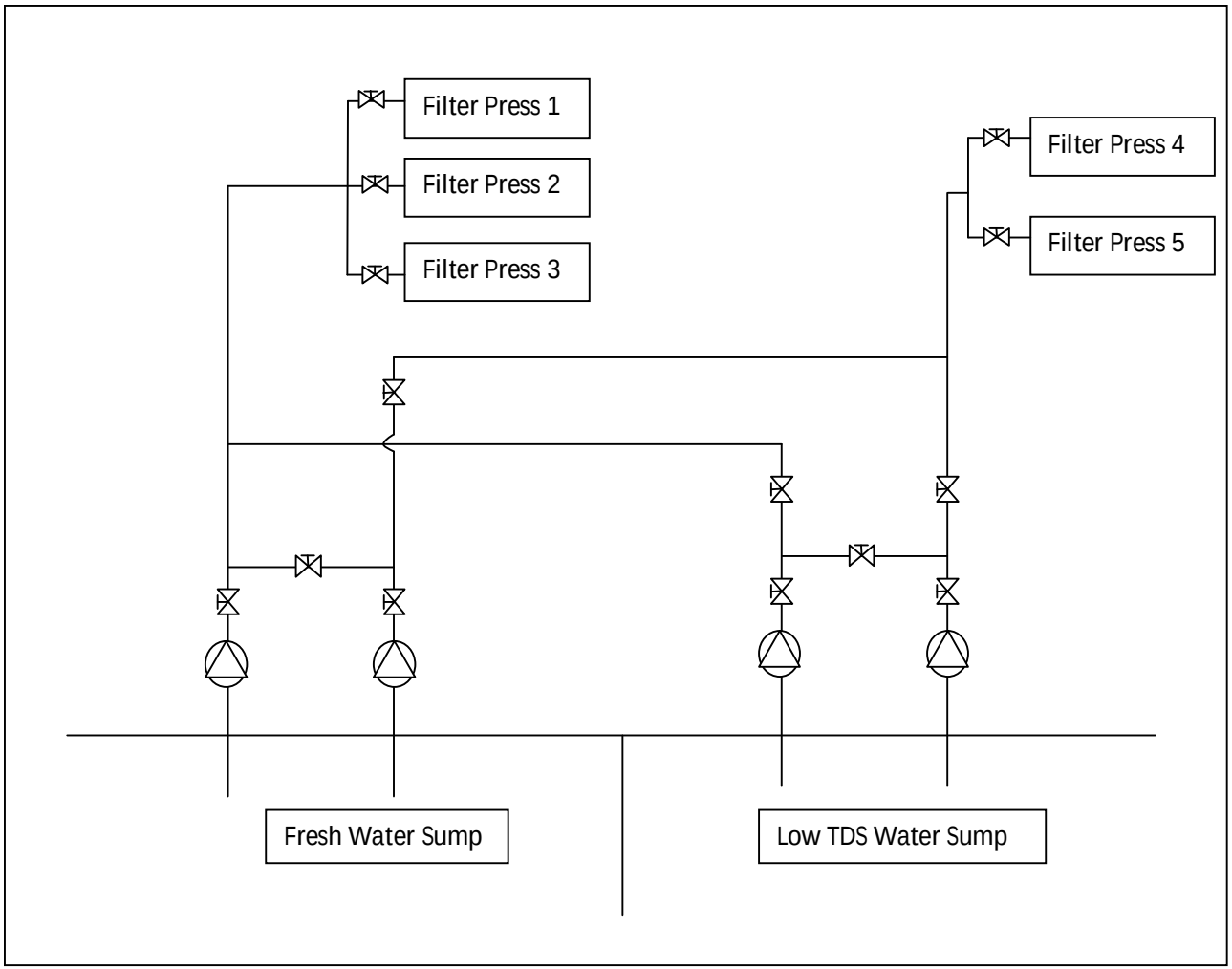
Observed Parameters –

Pump – Low TDS Wash pump for filter press		
Tag No. - 2405	**Observed**	**Rated**
Observed Flow, m^3/hr	37.19	100
Observed Head, m	55	75
Density of fluid, kg/m^3	1000	
Hydraulic Power, kW	5.57	
Measured Electrical Power, kW @ 41.4 Hz	14.8	22.38
Efficiency, %	37.66%	
Avg working Hrs in a day	6	
Total No. of Pumps	2	
kWh per Day	177.6	
Filter Presses Fed	5	
Pipe Size, mm (Suction x Discharge)	100 x 65	

Characteristics curve for Low TDS Pump -



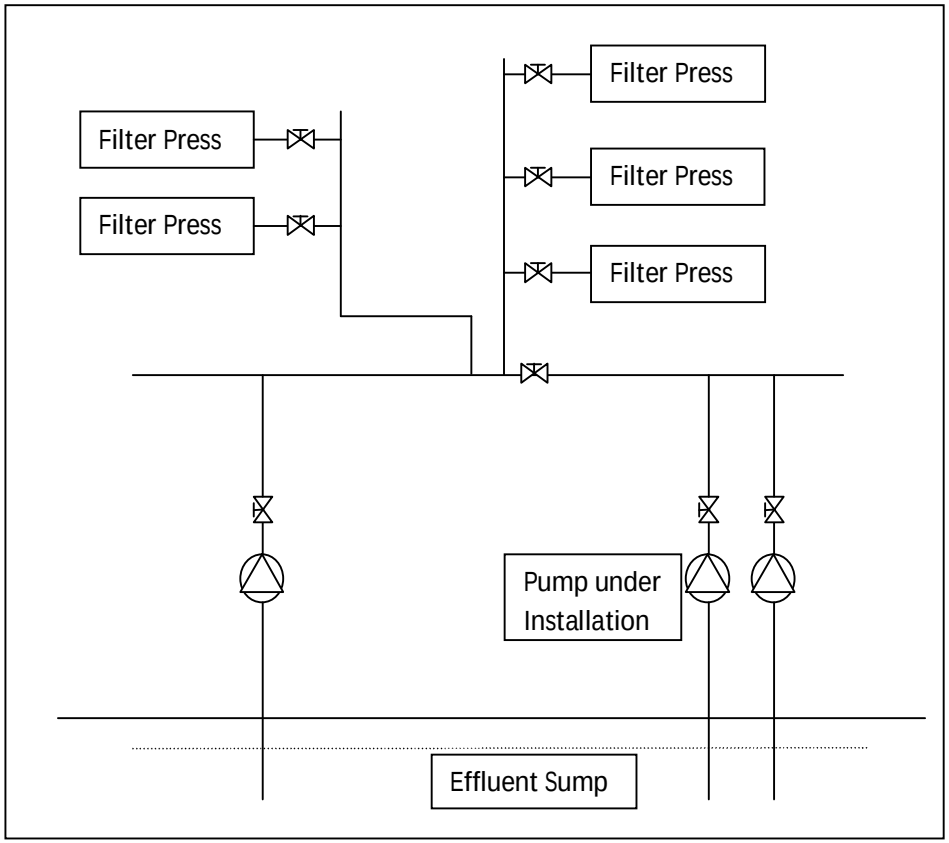
Fresh Water and Low TDS Water System for old SD Plant -



Plant – New ETP

Pump – Filter Press Supply Pump

System Diagram -



Pump – Filter Press Supply Pump		
Tag No. - 2705	**Observed**	**Rated**
Observed Flow, m^3/hr	33.99	150
Observed Head, m	40	60
Density of fluid, kg/m^3	1044	
Hydraulic Power, kW	3.87	
Measured Electrical Power, kW	47.4	75
Efficiency, %	8.16	
Avg working Hrs in a day	20	
Total No. of Pumps	2	
kWh per Day	1896	
Pipe Size, mm (Suction x Discharge)	150 x 100	

Plant – Old FD Plant

Pump – Slurry Transfer Pump from Holding Tank to Filter Press

Operating Parameters –

Pump - Fresh water filter washing pump		
Tag No. - 3829A	**Observed**	**Rated**
Observed Flow, m^3/hr	62.2	100
Observed Head, m	50	75
Density of fluid, kg/m^3	1000	
Hydraulic Power, kW	8.47	
Measured Electrical Power, kW @ 45.8 Hz	22.2	37.5
Efficiency, %	38.17%	
Avg working Hrs in a day	8	
Total No. of Pumps	3	
kWh per Day	532.8	
Pipe Size, mm (Suction x Discharge)	100 x 65	

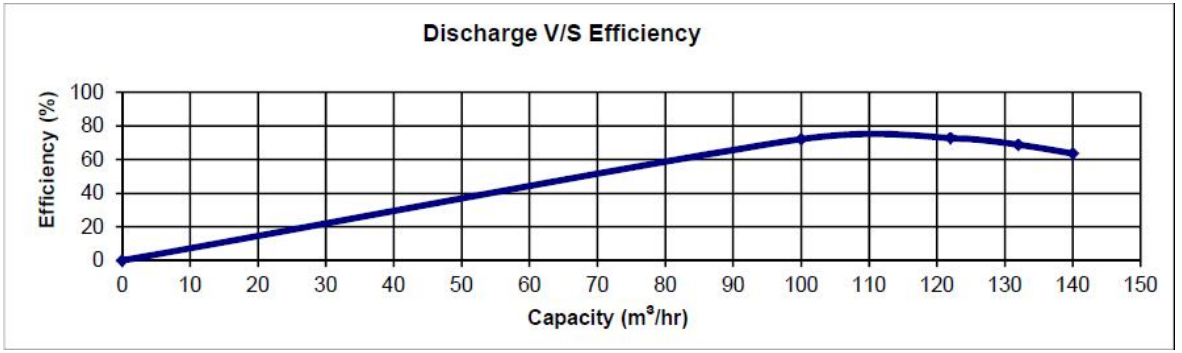
Plant – New SD Plant

Pump – Fresh water filter washing pump

Operating Parameters -

Pump – Slurry Transfer Pump from Holding Tank to Filter Press		
Tag No. – 1334	Observed	Rated
Observed Flow, m^3/hr	114.92	60
Observed Head, m	25.8	60
Density of fluid, kg/m^3	1037	
Hydraulic Power, kW	8.38	
Measured Electrical Power, kW @ 50 Hz	25.40	22.38
Efficiency, %	32.99%	
Avg working Hrs in a day	13	
Total No. of Pumps	2	
kWh per Day	660.4	
Filter Presses Fed	1	
Pipe Size, mm (Suction x Discharge)	100 x 80	

Characteristics curve for Fresh Water Filter washing Pump -



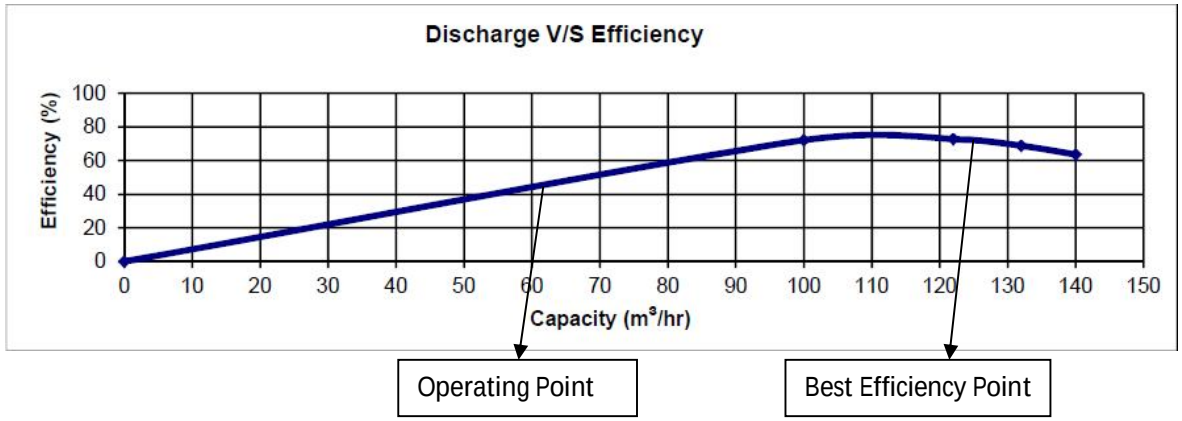
Plant – New SD Plant

Pump – Low TDS wash pump for filter press

Operating Parameters –

Pump - Low TDS wash Pump for Filter Press		
Tag No. - 3927A	Observed	Rated
Observed Flow, m^3/hr	23	100
Observed Head, m	55	75
Density of fluid, kg/m^3	1000	
Hydraulic Power, kW	3.45	
Measured Electrical Power, kW @ 41.2 Hz	12.6	37.5
Efficiency, %	27.36%	
Avg working Hrs in a day	11	
Total No. of Pumps	3	
kWh per Day	415.8	
Filter Presses Fed	2	
Pipe Size, mm (Suction x Discharge)	100 x 65	

Characteristics curve for Low TDS wash Pump -



Plant – New SD Plant

Pump – Slurry Transfer Pump from Reactor Vessel to Holding Tank

Operating Parameters –

Pump - Slurry transfer pump from Reactor Vessel to Holding Tank		
Tag No. - 3722	Observed	Rated
Observed Flow, m^3/hr	187.5	200
Observed Head, m	18	30
Density of fluid, kg/m^3	1044	
Hydraulic Power, kW	9.60	
Measured Electrical Power, kW	26.5	37.5
Efficiency, %	36.23%	
Avg working Hrs in a day	3	
Total No. of Pumps	4	
kWh per Day	318	
Pipe Size, mm (Suction x Discharge)	150 x 125	

Plant – New SD Plant

Pump – Slurry transfer pump from holding tank to filter press

Operating Parameters –

Pump - Slurry transfer pump from Holding Tank to Filter Press		
Tag No. - 3902	Observed	Rated
Observed Flow, m^3/hr	96	250
Observed Head, m	18.5	60
Density of fluid, kg/m^3	1044	
Hydraulic Power, kW	5.05	
Measured Electrical Power, kW @ 41.2 Hz	28.3	55.95
Efficiency, %	17.85%	
Avg working Hrs in a day	11	
Total No. of Pumps	2	
kWh per Day	622.6	
Pipe Size, mm (Suction x Discharge)	150 x 100	

Plant – New SD Plant

Pump – Slurry Transfer pump from holding tank to spray drying chamber

Operating Parameters –

Pump - Slurry Transfer pump from holding tank to spray drying chamber		
Tag No. - 3902	**Observed**	**Rated**
Observed Flow, m^3/hr	7.745	14
Observed Head, m	38	NA
Density of fluid, kg/m^3	1020	
Hydraulic Power, kW	0.82	
Measured Electrical Power, kW @ 37.3 Hz	1.7	7.5
Efficiency, %	48.12%	
Avg working Hrs in a day	11	
Total No. of Pumps	2	
kWh per Day	37.4	
Pipe Size, mm (Suction x Discharge)	75 x 50	

Plant – Old Tank-farm Area

Pump – Initial Water transfer pump to reactor SD plant

Observed Parameters –

Pump - Initial Water transfer pump to reactor SD plant		
Tag No. - 2302	**Observed**	**Rated**
Observed Flow, m^3/hr	60.59	100
Observed Head, m	30	30
Density of fluid, kg/m^3	1000	
Hydraulic Power, kW	4.95	
Measured Electrical Power, kW	9.6	14.92
Efficiency, %	51.60%	
Avg working Hrs in a day	8	
Total No. of Pumps	1	
kWh per Day	76.8	
Pipe Size, mm (Suction x Discharge)	125 x 100	

Plant – Old ETP

Pump – Filter Press Supply Pump

Observed Parameters –

Pump - Filter Press Supply Pump		
Tag No. - 1901	Observed	Rated
Observed Flow, m^3/hr	101.5	150
Observed Head, m	22	60
Density of fluid, kg/m^3	1044	
Hydraulic Power, kW	6.35	
Measured Electrical Power, kW	21.6	21.6
Efficiency, %	29.41%	
Avg working Hrs in a day	14	
Total No. of Pumps	3	
kWh per Day	907.2	
Pipe Size, mm (Suction x Discharge)	150 x 100	

Plant – Old SD Plant

Pump – Slurry transfer pump from holding tank to filter press

Observed Parameters –

Pump - Slurry Transfer pump from holding tank to filter press		
Tag No. - 2401	**Observed**	**Rated**
Observed Flow, m^3/hr	7.56	60
Observed Head, m	26.75	60
Density of fluid, kg/m^3	1000	
Hydraulic Power, kW	0.55	
Measured Electrical Power, kW	25	22.38
Efficiency, %	2.20%	
Avg working Hrs in a day	20	
Total No. of Pumps	2	
kWh per Day	1000	
Total No. of valves in the system	15	
Total No. of elbows in the system	19	
Pipe Size, mm (Suction x Discharge)	150 x 100	

Plant – Old SD Plant

Pump – Slurry transfer pump from Reactor Vessel to Holding Tank

Observed Parameters –

Pump - Slurry Transfer pump from Reactor Vessel to Holding Tank		
Tag No. - 2313	**Observed**	**Rated**
Observed Flow, m^3/hr	238.42	200
Observed Head, m	13	20
Density of fluid, kg/m^3	1060	
Hydraulic Power, kW	8.95	
Measured Electrical Power, kW	44	44.76
Efficiency, %	20.35%	
Avg working Hrs in a day	3	
Total No. of Pumps	2	
kWh per Day	264	
Pipe Size, mm (Suction x Discharge)	125 x 100	