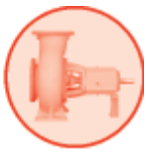
SERVICE SECRET OF SUCCESS

Pumps at its Best

ABIRAMI PUMPS



SMART TECHNIQUES FOR EFFICIENT, EFFECTIVE & ECONOMICAL OPERATION OF CENTRIFUGAL PROCESS PUMPS IN PAPER INDUSTRY

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By

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SMART TECHNIQUES FOR EFFICIENT, EFFECTIVE, & ECONOMICAL OPERATION OF CENTRIFUGAL PROCESS PUMPS IN PAPER INDUSTRY

Abstract:

Pumps are vital hydraulic Machine for Pulp & Paper Process. Pump parameters directly related with process parameter – one of the major power consuming equipment. Smart selection of pumps are systems, perfect installation, proper maintenance ensures Efficient, Effective & Economical operation of Centrifugal pump in Pulp & Paper Industry.

Selection of Suitable pumps & System:

Impeller selection:

Specific Speed Of Impellers:

The performance of a centrifugal pump is expressed in terms of pump speed, total head, and required flow.

This information is available from the pump manufacturer's performance curves.

Specific speed is calculated from the following formula,

using data from these curves at the pump's best efficiency point (BEP.):

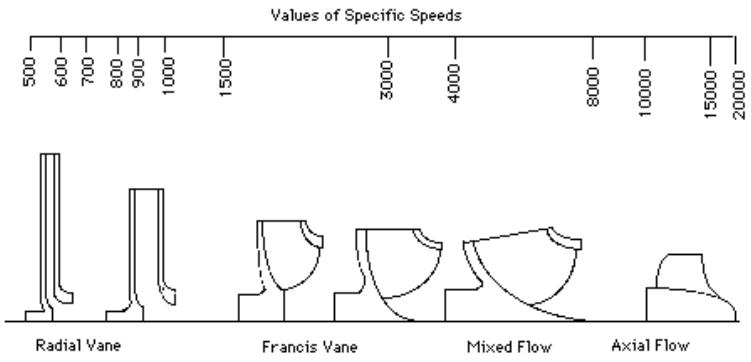
$$\text{Specific Speed } (N_3) = \frac{N\sqrt{Q}}{H^3 14}$$

N = The speed of the pump in revolutions per minute (rpm.)

Q = The flow rate in liters per second (for either single or double suction impellers)

H = The total dynamic head in meters

Please refer to the following chart:

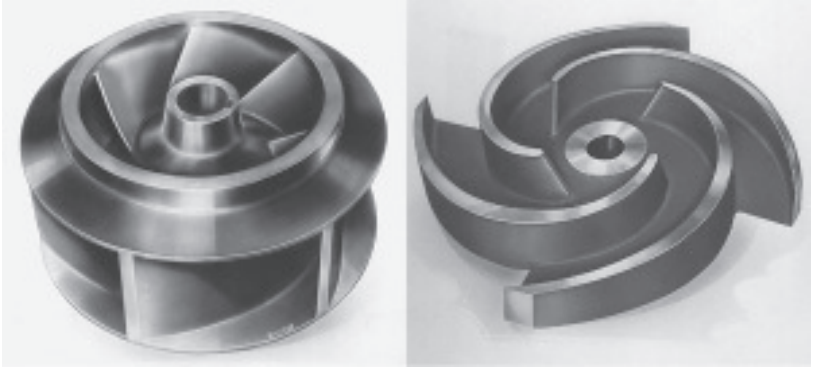


Pumps are traditionally divided into three types:

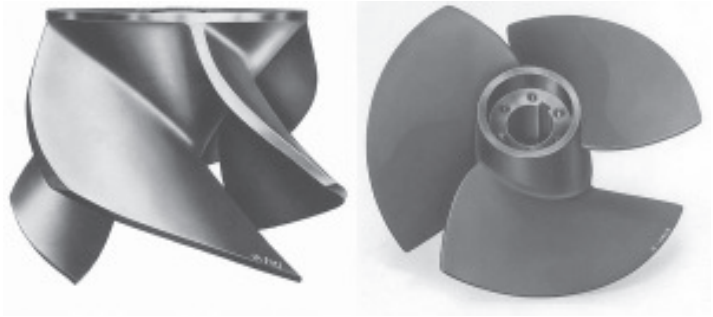
1) Radial Flow 2. Mixed flow, 3. Axial flow.

We can see there is a gradual change from the radial flow impeller, which develops pressure principally by the action of centrifugal force, to the axial flow impeller, which develops most of its head by the propelling or lifting action of the vanes on the liquid.

CLOSED IMPELLER **OPEN IMPELLER**



MIXED FLOW IMPELLER **AXIAL FLOW IMPELLER**



Procedure to select a suitable Centrifugal pumps for process:

1. Liquid details need to be understood perfectly
2. According to consistency, quality of liquid a suitable & perfect impeller type to be selected
3. The capacity of the pump is normally the basic and fixed requirement. However while selecting the head the following factors to be clearly studied and clarified
4. Pump flow and head are directly related with the pump input power.

   Since the capacity is a fixed and the ultimate requirement we cannot change the requirement. However by selecting a suitable pumping system we can reduce the friction head which results in "ENERGY SAVING"

   Based on the capacity requirement suitable system must be selected. Pipeline system selection is the most vital for the efficient operation of the pump

   a) Static head – Fixed vertical height
   b) Friction head – Total Pipe length + Bend Losses + Fitting losses
   c) Pressure requirement for the connected equipment

PIPING SYSTEMS FOR PULP & PROCESS LIQUIDS:

Recommended pipe velocity:

1. For clear liquid – Velocity range 1.8-2.2 m/Sec
2. For pulp up to 1% consistency – Velocity range 1.8-2.2m/sec
3. For Pulp consistency 1 to 3% - Velocity – 1.5 to 1.8%
4. For pulp above 3% velocity 1.2 to 1.5 m/Sec.

Suction velocity:

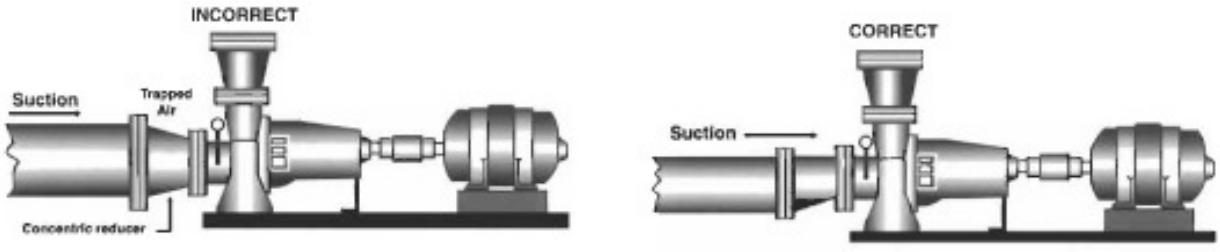
Suction velocity should be always less than 1.2 m/sec for pulp above 3%

For pulp below 3% suction velocity may be within 1.5m/sec.

Pipes selected as per above recommended velocity range will offer an energy conservation of 10 to 20% compared with high velocity piping system i.e lesser dia piping system.

Suction pipe:

Suction pipe should be free from any air trapping and suction pipes to be connected with ECCENTRIC TYPE REDUCER ONLY. Concentric reducers are not suitable in suction piping as there is more chance for air trapping.



Once the Total head requirement is arrived, 5 to 10% Margin can be kept for operational flexibility. The margin should not be more than 10%.

If the pump head is selected with more than 10% margin the pump may not operate at the designed operating condition.

Lesser system head against the designed head, results in high discharge at wrong low efficiency duty point.

Pump should be selected at the Best Efficiency Point and near to BEP.

Due to higher margin on head the larger size pump should be selected resulting with lesser efficient as the duty point will fall at the smaller impeller size of the larger pump. The efficiency of the pump will be lesser in larger pumps

It is not recommended to select pump with less then 60% of BEP or 120% of BEP.

If pump is selected below 60% of BEP large amount of pumping liquids will be re circulated in the casing. The excess energy converted in to heat energy and the same will be transferred to all rotating parts of pump including shaft bearings.

Due to rise in temperature, frequently damages the oil seal, bearing life reduces, reduces gland packing life and above all cavitation may be happened inside the casing due to vapor pressure.

If the pump is selected above 120% of BEP due to high suction velocity the NPSH requirement will raise. If the NPSH (A) is lesser than required, then the pump starts getting cavitation.

Precise pump selection reduces the power cost, maintenance cost and ensures trouble free operation

Though the initial investment cost for the higher piping systems will be higher, through the power saving strategy extra investment can be paid back within 1 year.

If more than 1 type impellers are suitable, the best efficient impeller pump design to be selected

5. The selected pump should have high Mechanical reliability.
6. *Based on liquid details proper metallurgy must be selected.*
   a) For clear liquid with less abrasion – MOC like CF 8, CF 8M, CF 3M etc. can be selected based on the PH and corrosion factor.
   b) For only abrasion – High hardened materials are suitable
   c) For Corrosion combined with abrasion Duplex Stainless steel MOC is most suitable.

Centrifugal process Pump is a simple and the most easy to maintain pumps.

If the pumps and piping systems are selected and synchronized perfectly then the pumping operation will be Efficient, Economical, & Effective.

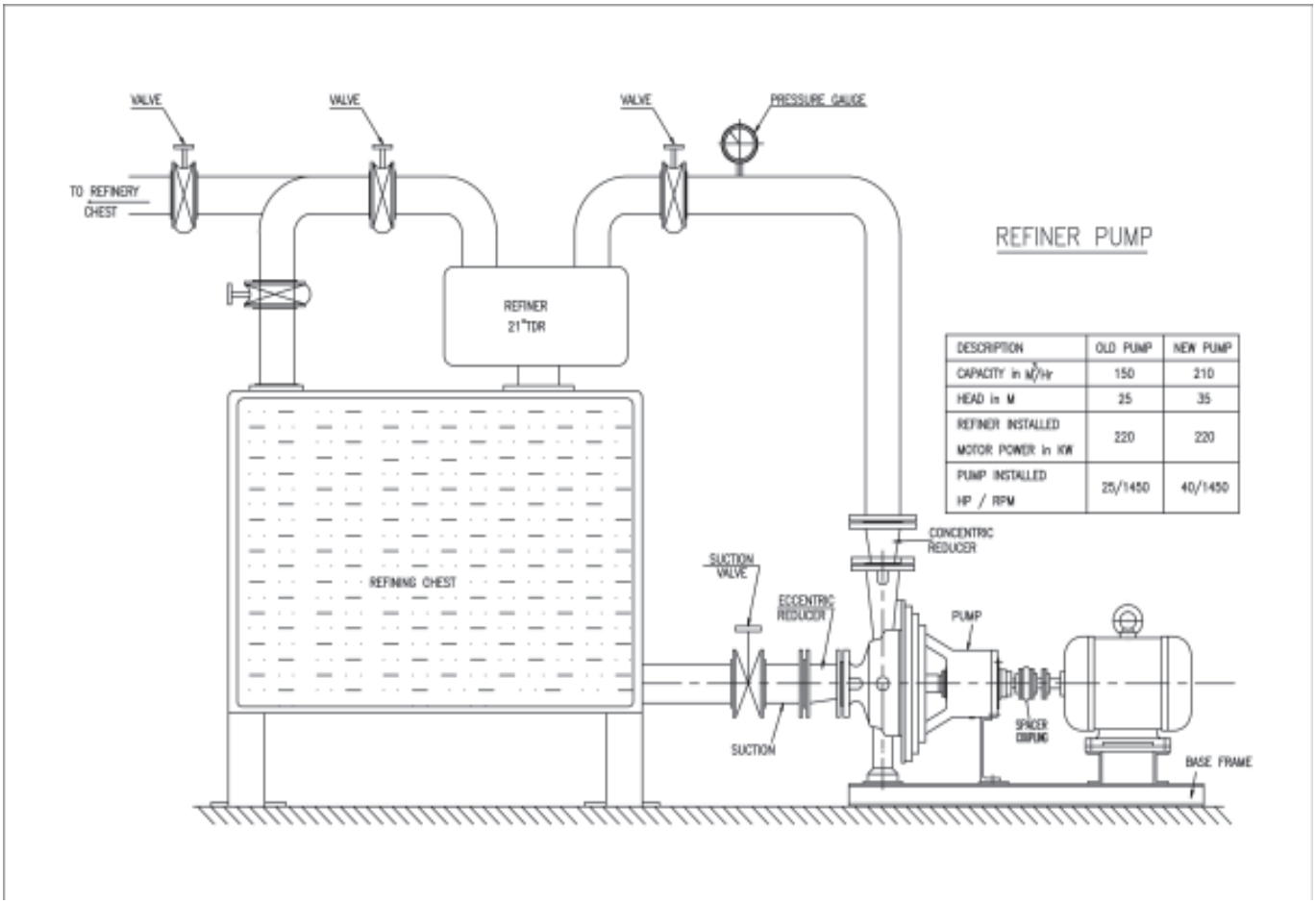
Unmatched pumps for the system leads to heavy power consumption. The below case study clarifies the same.

CASE STUDIES:

CASE STUDY NO.1:

Refiner pump operation:

REFINER PUMP LAYOUT DIAGRAM



DESCRIPTION	OLD PUMP	NEW PUMP
CAPACITY in M³/Hr	150	210
HEAD in M	35	35
REFINER INSTALLED MOTOR POWER in KW	220	220
PUMP INSTALLED HP / RPM	25/1450	40/1450

This case study has been carried out by us in one of the craft mill in India and the details are as below:

Reason for energy audit to reduce the power consumption in refiner operation

The refiner was continuously running for almost 24 hours.

Which incurred heavy power cost as the Refiner consumes almost 300 Amps load every hour

Causes for Extra Power Consumption:

Insufficient inflow to the refiner which caused heavy power consumption without required results neither quantity nor meeting the Quality parameter

Refiner mounted on the Top of chest with vertical height of 8 Mts. & horizontal around 8 Mts. Old pump was designed for 25 MWC.

At the inlet of refiner around 1 to 1.2 Kg/cm2 pressure only found.

Whereas 2 to 2.5 Kg inlet pressure at inlet of refiner provides best refining for pulp

ABIRAMI'S SUGGESTION AND IMPLEMENTATION BY MILL:

Description	Previous system details	ABIRAMI'S PROPOSAL
Refiner type	21" TDR	21" TDR
capacity Cum/hr.	150	210
Head	25	35
Refiner inlet pressure	1 to 1.2 Kg/cm^2	2.5 Kg/cm^2
Pipe sizes suc x dis	8" x 6"	10"x 8"
Refiner motor rating	220 KW	220 KW
Pump Motor rating Refiner running time	25 HP/1450 rpm 23 to 24 hours	40 HP/1450 rpm 12 to 13 hours
Power consumption/ day on refiner	3750 Units/day	2150 Units/day
Power cost per year considering 300 days running @ Rs. 6/unit	INR 67.5 Lacks	INR 38.7 Lacks

Over all saving of power in this system: INR. 29 Lacks

By Changing the pump as per above parameter and after modification of piping system the best result is delivered.

Energy Saving on Refiner as a of proper sizing of pump per day – 1600 Units/day i.e around 66 units per hour.

As far as pump is concerned there is no change of power consumption. Though the Installed power is increased to 40 HP instead of 25 HP. The running time of pump is reduced to 13 hours instead of 24 hours

While selecting the pump the following factors must be carefully studied if the pump feeds the pumping media to other equipment.

1. Inlet pressure requirement of the connected equipment
2. Head loss from the pump discharge point to the connecting equipment inlet.
3. To make sure that the piping system is perfect
4. To make sure the Recommended Motor rating is installed

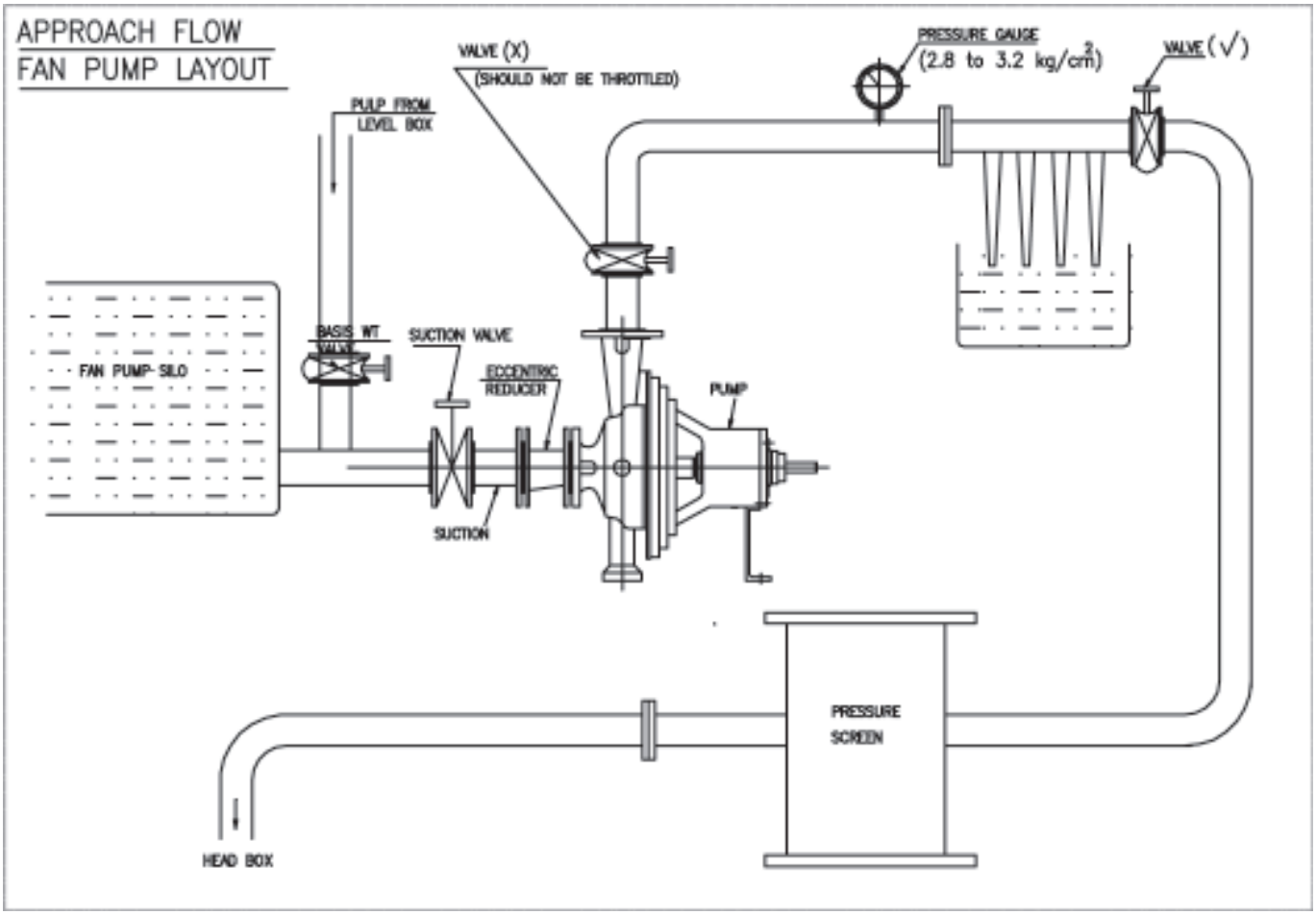
CASE STUDY NO.2:

FAN PUMP OPERATIONS:

Fan pump operation is a heart of approach flow operation, having a direct impact on paper quality.

A typical fan pump approach flow with centric leaners & Pressure screen system is analysed below

FAN PUMP LAYOUT DIAGRAM



In the above system, Based on the GSM requirements operational parameter varies from 60 to 120% of the pump duty parameter.

To manage the required flow requirement to the head box operator's generally control/throttle the suction or discharge valve or throttling both.

Valve must be controlled in a right location otherwise it affects pumping operation very badly.

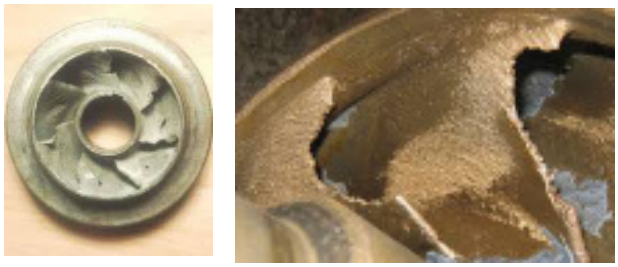
Valve Control - General Guidance:

1. Suction throttling must be avoided, it may lead to a suction cavitation, pump discharge and pressure reduces, abnormal sound inside the volute casing happens, if you allow to run further it could damage the rotating parts and damage the volute casing.
2. Valve to be throttled on the delivery side but not before the Centricleaners,
3. If throttling is done before Centricleaners the required pressure will be dropped below the control valve and large amount of liquid re circulate in the casing, Which creates heavy back pressure on the pump. The required pressure will not be delivered to the system. The Centricleaners cannot be operated effectively.

Heavy particles escape and further carries to pressure screen and head box. This could affect the paper quality and the wear and tear of Machine parts.

Due to heavy back pressure & change in pressure, Cavitation and vapor bubbles bursting may happen inside the casing.

The results of cavitation shown in the picture.



Symptoms for cavitation effect:

1. Through noise, pump sounds differently like shacking & cracking noise.
2. Fluctuation in the discharge volume and pressure
3. Fluctuation/erratic in power consumption
4. Reduction in pump efficiency and out put

Managing cavitation less Pump operation:

1. Proper selection of pump, Pump over sizing in this area will consume excess power and difficult to match the required operating parameters.
2. Suction Must be free flow and air tight
3. Not to throttle suction valve
4. Discharge valve operation only after CC.
5. Pressure gauge must be provided in the inlet of CC to ensure the recommended pressure is maintained, Normally 2.8 to 3.2 Kg/cm2
6. If the Discharge valve to be throttled more than 50%, then the pump designed parameter to be intervened and impeller size to be modified as per the optimum requirements.
7. Variable Frequency Drum is better option which doesn't require valve operation and reduces the throttling as well.

While selecting the Fan pump following notes can be taken care:

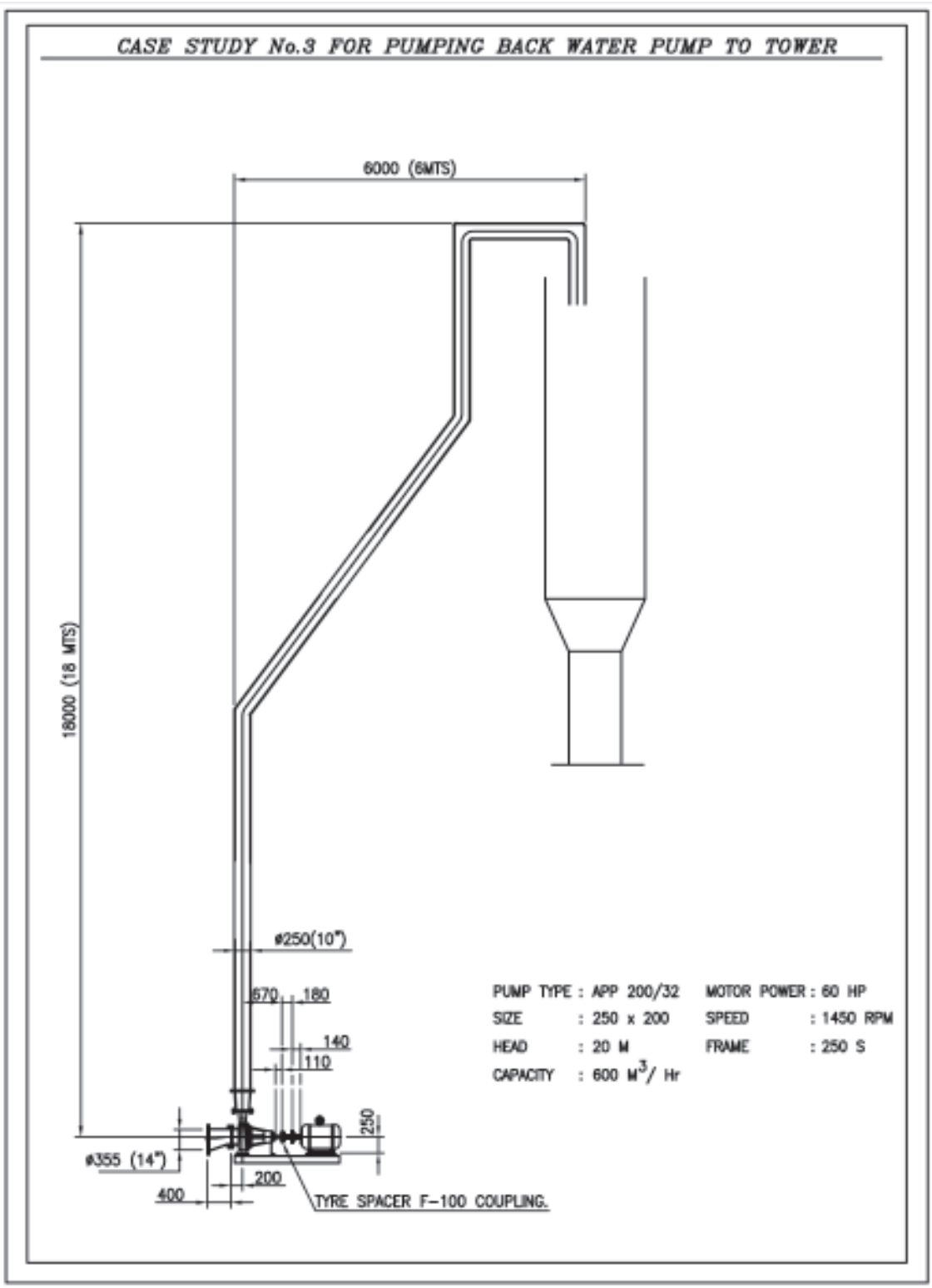
1. Not to opt for wide operating capacity variation in the same pump. Better to select operating range within 70 to 110% of best efficiency point for the efficient and trouble free operation
2. If the pump to be operated less than 70% or more than 110% a different suitable pump can be kept as a standby to meet out special operational requirements.

CASE STUDY No. 3

BACK WATER PUMP OPERATION

Operation description: One of the mill using Back water pumps having trouble in High Energy consumption on Back water pumping system and the shortage of Back water for process. The detailed system study and solutions are as below.

BACK WATER PUMP LAYOUT DIAGRAM



ABIRAMI PROPOSED THE SAVINGS BY CHANGING THE EXISTING PUMP TO ABIRAMI PUMP

Description	Old Installation	Equivalent ABIRAMI MODEL
Pump Type	HM 150	APC150/32
Pump size	200 x 150	200 x 150
Pipe size	200 x 150	200 x 150
Suction velocity		
Discharge velocity		
Capacity	400	400
Head	32	32
Efficiency	65%	86%
Brake Killo watt	61.2	40.6
Input Power	123 Amps	79.0
Motor KW	100 HP	60 HP
Type of Drive	VFD	VFD

Unit Saving Perhour : 20.6 KWH

Power cost per unit considered : Rs. 6/-

for 300 days running per year

Total Saving Per year : Rs. 8,89,220/-

CUSTOMERS NEW REQUIREMENT IN THE SAME SERVICE:

In the same system Customer needed more Volume of water i.e 600 Cum/hr. instead of existing 400 Cum/hr.

We have suggested the customer to modify the system as per the new requirement

Our Revised Proposal for the same as below

Description	Equivalent ABIRAMI MODEL
Pump Type	APC 200/32
Capacity in Cum/hr	600
Head in Mts	22
Pump size in mm	250 x 200
Pipe size in mm	350 x 300
Suction pipe velocity in M/sec	
Discharge pipe velocity in M/sec Efficiency in %	 84%
Brake Killo watt	42.8
Input Power Amps	80.0
Type of Drive	VFD
Investment cost on pipes and fittings in SS	Rs.3,78,000/- lakhs
Cost of pumps & accessories,	Rs. 3,25,000/- lakhs
Total Investment	Rs. 7,03,000/- lakhs

ENERGY SAVING SUMMARY FOR CASE STUDY 3:

1. Just by Changing the old version pump with New ABIRAMI Energy efficient Pump almost Rs. 9 Lakhs saving observed
2. By Changing the Pumps & System to meet out New capacity requirement of 600 Cum/hr. ABIRAMI proposed almost with the same power of ABIRAMI'S APC 150/32 pump.
3. In total ABIRAMI Reduced the Total Power requirement by 50% By suggesting Suitable pumps and system.
4. **Overall 35 Units are saved and the saving power year in INR.15,12,000.00**
5. **PAY BACK PERIOD FOR ABOVE SYSTEM : LESSTHAN 6 MONTHS**

CASE STUDY No. 4

FOR PUMPING MEDIUM PRESSURE BOOSTER PUMP FOR MOULD SIEVE CLEANING

Problem Studied:

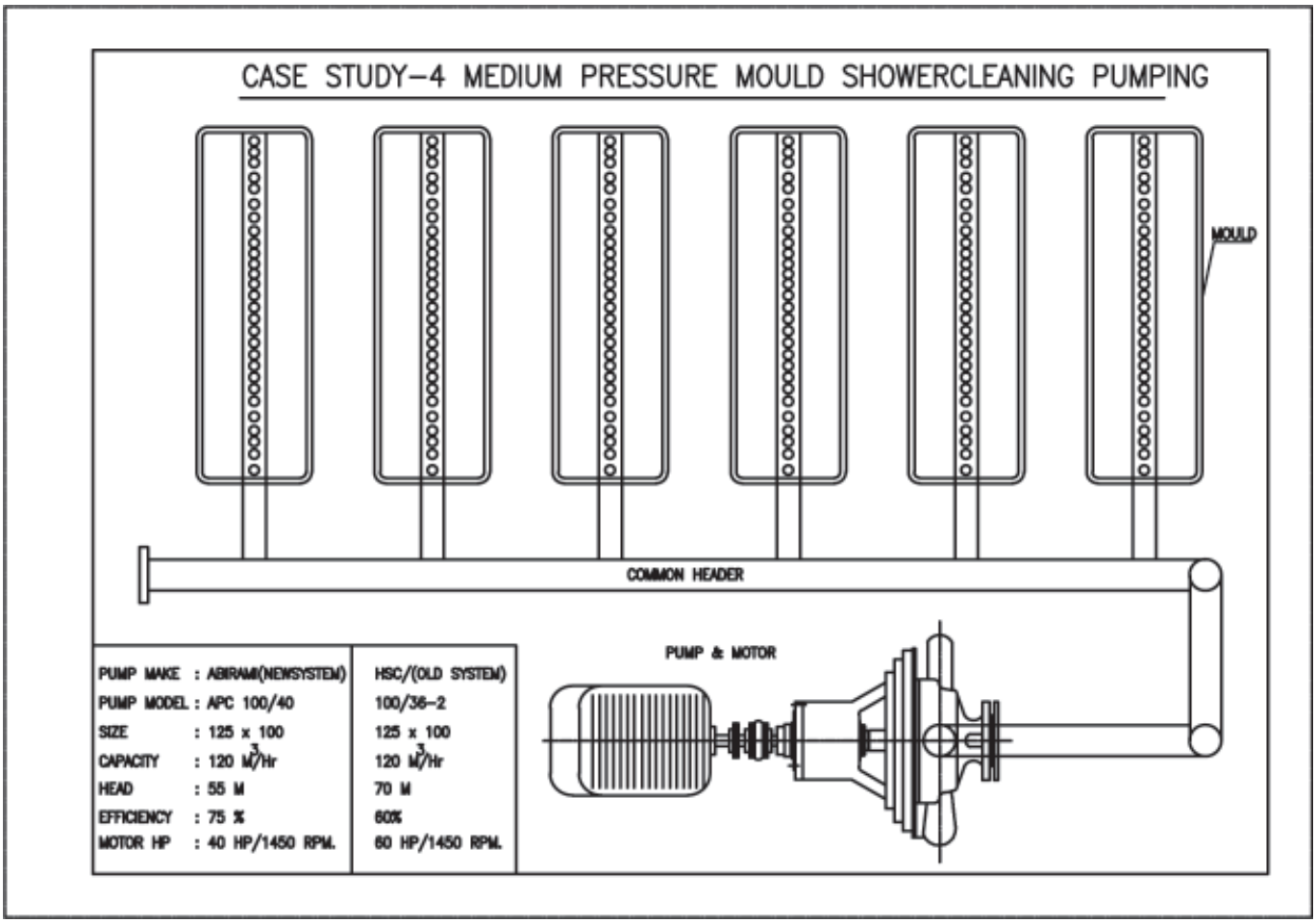
1 No. HSC pump installed for Sieve cleaning application as per below operating data:

Nature of Problem:

Sieve cleaning is not proper which affects the quality of product

Required pressure for Sieve cleaning 60 to 80 Psi, Where as the system showed a pressure of 15 to 20 Psi only also unable to open the valve duty Motor over load. We have studied and observed the following details from the previous system

Description	**Old Operating Details**
Pump type	HSM 100/36-2
Capacity	120 Cum/hr
Head	70 Mts.
Pump size in mm	125 x 100
Motor Load	80 to 85 Amps (full load)
System pressure observed	15 to 20Psi
Pump Efficiency	60%
Motor KW/Speed	45/2900



Plant requirements:

60 to 80 psi pressure in the all shower pipes

Against their requirement only 20 to 25 Psi only observed in the system. Then we have analysed the system as under. Pump discharge flows through 6 shower pipes for sieve cleaning and 2 nos. for trimming as per diagram.

Description	Old Operating System details
Pump type	HSM 100/36-2
No. of Showers	6
No. of holes in each	54 per pipe x 6 = 324
Hole size	3mm
Edge cutter nozzle size	6mm x 2 nos
Required pressure	75 to 80 Psi (5 to 5.5 Kg/cme)
Flow for 3mm holes @ 80 psi	13.7 lpm per hole
Total flow requirement for 324 holes	266 Cum/hr.
Trimming nozzle flow 55lpm per nozzle	6.6
Total Flow requirement	Around 275 Cum/hr

Whereas the pump is designed for 120 Cum/hr @ 70 Mts. which could not meet out the requirement. We have suggested two option to the customer.

Option 1

Suitable pump to suit as per your system requirement.

Description	Proposed pump details
Pump type	APC 150/40
Pump size suc x dis	200 x 150
Pipe size suggested	10" x 8"(common header)
Holed pipe size suggested	3"
Flow in Cum/hr	275
Head	55 Mts.
Efficiency	77%
BKW	53.5
Motor KW/speed	75/1450

Option 2:

If the shower pipe holes could be drilled to 1.8mm the results are as below

Description	ABIRAMI PUMP
Pump type	APC 100/40
Pump size in mm	125 x 100
Pipe size proposed	8" x 6"
Holed pipe size	2"
No. of Showers	6
No. of holes in each	54 per pipe x 6 = 324

Hole size	3 mm
Edge cutter nozzle size	6 mm x 2 nos
Required pressure	75 to 80 Psi (5 to 5.5 Kg/cme)
Flow for 3mm holes @ 80 psi	5 lpm(0.3 Cum/hr) per hole
Total flow requirement for 324 holes	97.2 Cum/hr.
Trim nozzle flow 55.l pm per nozzle	6.6 Cum/hr
Total Flow requirement	103.8
With Operating Margin 10%	115 Cum/hr
Head in Mts.	55 Mts.
Efficiency	70%
Break kilo watt	24.62
Motor HP/Speed	40/1450

FINAL SUMMAY OF CASE STUDY 4

Description	**OPTION 1** Shower pipe with 3mm hole	**OPTION 2** Shower pipe with 1.8mm hole
Operating pressure	60 to 80 Psi	60 to 80 Psi
Shower pipe hole size	3 mm	1.8 mm
Flow in Cum/hr.	275	120
Pipe size suc x dis	10" x 8"	8" x 6"
Shower pipe size	3"	2"
Brake Killowatt	53.5	24.62
Cost of Pump, Accessories & Motor	Rs. 5,50,000.00	Rs. 3,25,000.00
Cost of Pipes, Valves bends etc	Rs. 2,80,000.00	Rs. 65,000.00
Power cost per year for 300 days continuous run	Rs. 23,11,200.00	Rs. 10,63,600.00

Over all Advantages in Option 2

Cost benefit in Option 2 on Power - Rs.12,47,600/-

Investment on Pumps, Accessories and Motor Less by Rs. 5,70,000/-

Pay back period on Pump & Motor – less than 4 months

However plant operator should monitor the pressure gauge reading continuously, to ensure the pressure dose in drops below 4 Kg/Cm2. If the pressure drops further the hole size of shower pipes need to be inspected and the hole size is to be enlarged more than 2mm.

Customer had Chosen the option 2 obviously thus the system started and running Efficiently.

Conclusion:

Selection of suitable Impeller pumps,

Proper piping systems selection and evaluating the perfect in let pressure requirements while pumping to other equipment's like Boiler, HDC, Turbo, Screens etc., makes the **pumping operation Efficient**.

Operating the pump at the designed duty Installing system monitoring gauges like pressure gauges, and flow meters in critical areas with proper foundation for pump and motor, perfect piping supports monitoring the pump operation periodically to ensure noise free, vibration free makes the **pump operation Effectively**

Follwing systematic maintenance schedule for pumps, maintaining the essential and recommended genuine spare parts for pumps, perfect bearings lubrication intervals, ensure there won't be sudden break down in the pump operation. This process makes **pump operation Economical**

Bibliography:

- Impeller pumps ; Stephen lazarkiwicz,
- Hydraulic Institute Engineering Data – Hydraulic institute
- ABIRAMI Technical team

- **Right Pump & system Selection for Bright Paper Industry**
- **Efficient Pumps & system – effective formula for Best Power Conservation**
- **Perfect Piping installation curtails the Power & Maintenance cost**
- **Smart Process operation for enhanced product quality and equipment life**
- **Systematic Maintenance schedule and techniques for Economical operation**