SERVICE SECRET OF SUCCESS

Pumps at its Best

ABIRAMI PUMPS

POWER MANAGEMENT

in

PAPER INDUSTRY

on

PULP STOCK PUMPS

&

PROCESS PUMPS

Submitted by :

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ABSTRACT:

Owing to compete with tough competition for marketing the paper & allied products, need arises to manage the selling price of goods at this juncture of "Customer driven market". Introspection calls for cost reduction. In this regard Industries pracitce tools like TPM, TQM etc.,

Rather than attempting to minimise the fixed expenses energy conservation is identified as high potential area.

Energy conservation is achieved by Power management. Power management Is effected by reduction of Mechanical, Hydraulic & Thermal lossses etc., by incorporating high efficiency pumps, Metallurgy optimisation, and selection of suitable pump and systems.

Cited 2 case studies for reference.

Case study I narrates the selection of "suitable pumps & systems" and

Case study II narrates the "Pumping problems with solution and power management, compares Digital age pump with old age pumps.

As an implied truth, power management as paymaster, propose more than Rs.18,00,000/- cost reduction by conserving 4,32,000 KWhr/Annum for 30 Tons paper mill.

INTRODUCTION

ENERGY CONSERVATION ON PUMPS

This is the breaking issue now being discussed in almost all Industries. Present trend in paper industries doesnot allow the selling price of paper by any means. Globalisation affects to major extent the selling price because of tight competition. Since the selling price is decided by the market, it is most essential to trunk the expenses of manufacturing. Raw materials, wages and other fixed expenses cannot be reduced substantially. The possible price reduction is effected only by updating the technology and using energy efficient equipment.Pump is one of the most scope full equipment in paper industry for power management in turn achieving substantial price reduction.

Pumps are most important rotating equipment for transfer of water, pulp, chemicals, effluent, etc., in paper industries.

In yester decades, customers forced to have very few options, because of manufacturing limited model of pumps. Because of lesser options, Paper industry was forced to buy ready made pumps irrespective of sacrificing their operational requirements. Now Indian pump industry's development is at its best. Consistent R & D on Hydraulics and Improved mechanical reliability, developments in Metallurgy, results with high hydraulic efficiency and increased life of pump performance.

HOW PUMP EFFICENCY IMPROVED ?

HYDRAULIC EFFICIENCY : Hydraulic efficiency is the ratio of effective head to the internal head

$$\eta_h = \frac{He}{Hi} = \frac{Hi - \Delta hp}{He + \Delta hp} = \frac{He}{Hth}$$

Now because of closest range in pumps the ratio of the effective head to internal head is improved.
VOLUMETRIC EFFICIENCY:- The Impeller Discharge is highly capitalized because of reduced re-circulation in the casing

$$\eta_v = \frac{Qr}{Qi} = \frac{Qr}{Qr + Ql}$$

INTERNAL EFFICIENCY:

The internal efficiency of a pump is defined by the expression

$$\eta_l = \frac{Pe}{Pi} = \eta_v \eta_h$$

As the hydraulic efficiency and volumetric efficiency of the pump is improved , simultaneously internal efficiency also increased.

INTERNAL DISCHARGE: The internal Discharge is rate of the flow through the impeller. Hence it is sum of the real discharge Qr and the internal leakage Flow Q1 Through the unavoidable clearance gaps between the impeller and pump casing.

$$Q1 = Qr + Q1$$

The clearance between impeller, casing, casing cover are reduced as much as possible and the leakage flow also reduced.

THE INTERNAL POWER: The internal power is a total power imparted on to the liquid by the impeller at the rated flow.

$$Pi = rl\ Qi\ Hi + Phf = rl\ (Qr + Ql)\ (He + \Delta hp) + Phf$$

Where Phf denotes the power consumed in overcoming hydraulic frictional resistance of the rotating impeller transfered to the liquid in the form of thermal energy.

The internal power is equal to the shaft power less the power Rr used to over come the mechanical frictional resistance of the pump.(Bearings, glands) The Internal power consumption/power loss is reduced by the design of smoother root of impellers and increased surface finish of the internal portion of impellers.

MECHANICAL EFFICIENCY: The mechanical efficiency hm is the ratio of internal power to the power input at the pump shaft.

$$\eta_m = \frac{Pi}{Psh} = \frac{Psh - Pmf}{Psh}$$

The transmission losses are minimised by using low friction Bearing (axial, radial), reduced over hang distance and minimised gland packing friction with the sleeves, reduced shaft deflection at impeller end. (i.e Not to exceed 0.05mm).

OVER ALL EFFICIENCY: As hydraulic efficiency, volumetric efficiency, internal efficiency, mechanical efficiency are improved, over all efficiency also improved.

The over all efficiency of the pump is the "liquid horse power" to the "power input" at the pump shaft.

HIGH EFFIEICNCY MOTORS: Now most of the manufacturers are manufacturing energy efficient motors, this motor efficiency is achieved by reducing core losses (Rr losses) Bearing losses (anti friction Bearings)

The motor efficiency is improved by 5 to 8% compared with old version motors. These motors also designed to take care of mechanical reliability.

By installing variable speed drives for existing energy efficient motors, the power can be reduced by 5%.

Increased pump velocity, reduced hydraulic losses, closest ranges makes paper industry extremely interested in pumps for the purpose of conserving energy by using efficient pumps.

OTHER POINTS FOR EFFICIENCY IMPROVEMENT:

Pump sizes compressed which enable to reduce the hydraulic losses and increases the pump efficiency. High pump velocity also reduces the return flow through pipe during operation.

Improvement in metallurgy of pump construction reduces wear and tear due to corrosion and errosion, which also enables to maintain the impeller clearance to achieve the designed parameter. Duplex stainless steel material type CD4MCU, SS 2324, CB7CU1 are good corrosion/abrassion resistance materials.

Increased surface finish in casing/impeller reduces the frictional loss inside the pump by which the pump efficiency can be increased by 3%.

By reducing the shaft deflection on stuffing box leakage can be controlled and friction can be reduced. Which reduces the transmission losses.

HYDRAULIC SEALING : Stuffing box leakage is one of the hydraulic/ mechanical loss which affects the over all efficiency. Continiuous leakage also affects the environment badly. Hydraulic sealing supersedes the conventional gland packing.

DESIGN OF HYDRAULICS SEALING:

"Back to back impeller and expeller arrangements" arrests liquid entry through stuffing box.

$$Pst = Ps + 20\%\ Pd$$

Stuffing box pressure is calculated as above. The expeller pressure is designed to over come the pressure of stuffing box. By this sealing arrangement transmission loss can be reduced by 10 to 15%.

SELECTION OF SUITABLE PUMPS IN PAPER INDUSTRY :

Pumps are selected normally based on the following factors :

1. SUITABILITY:

Impeller type selection should be based on liquid, Consistency, Fibre length, etc., Wrong selection of impellers (though it is efficient) will lead to continuous maintenance problems like Jamming, or non performing.

2. ENERGY EFFICIENT : Once impeller model is decided, then comes the selection of best efficiency pump as it is directly related with the power. Kindly refer the performance curve furnished.

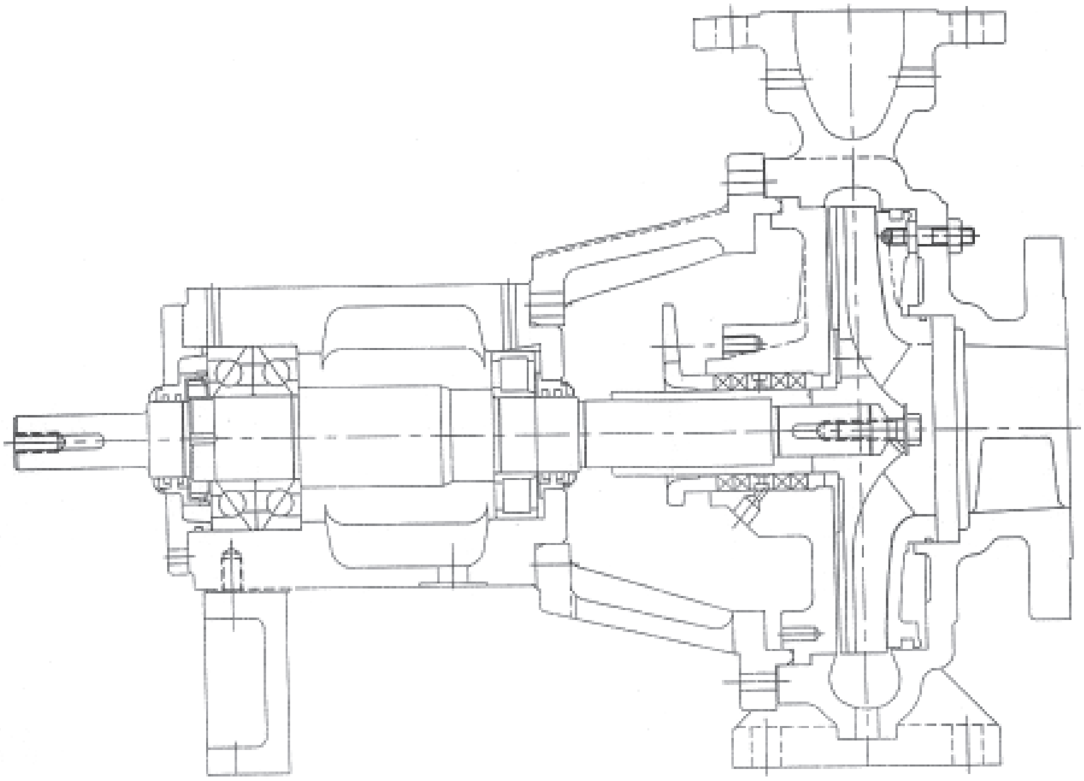
a) Pump should be selected always nearest to the "best efficiency point".

The capacity range of pump should be 60 to 120% of the best efficiency point.

b) Selecting pump in the full diameter of the impeller reduces the option of increasing the capacity and head further. Hence it is desired to select the pump 5% below the maximum Impeller diameter.

C) Selecting pump in minimum impeller diameter increases the hydraulic losses which results the low efficiency.

3. MECHANICAL RELIABILITY : Prime factor of pump selection for the trouble free operation. A model constructional view of a good mechanical reliable pump is furnished here with.



4. COST EFFECTIVE: Cost of the pump based on the above factors, also varies according to the manufacturer.

5. AFTER SALES SERVICE : After sales service also very important factor for pump manufacturer's reputation with the user for the trouble free operation.

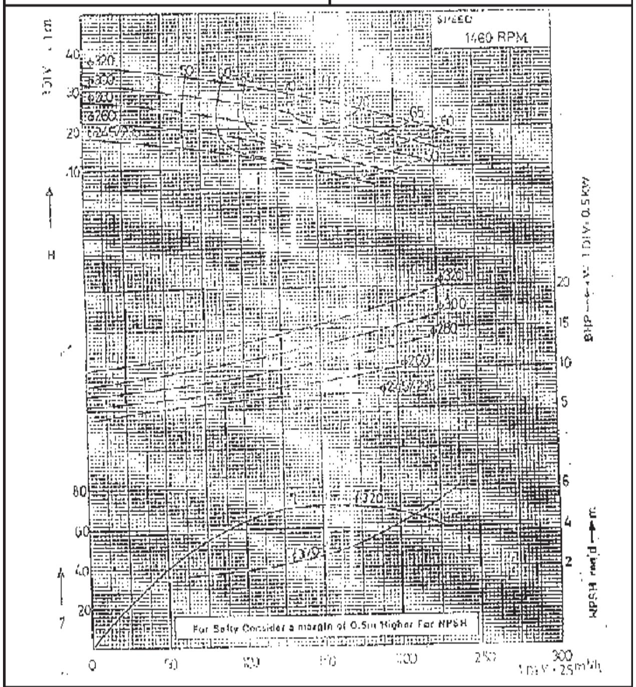
SELECTION OF SUITABLE PUMPS AND SYSTEMS :

Detailed analysis carried out and two case studies on "system selection" and "pump selection" presented for reference.

CASE STUDY NO.: 1

A new pump selection for a 50 TONS Paper mill for handling pulp stock.
Liquid: Pulp @ 4% consistency;

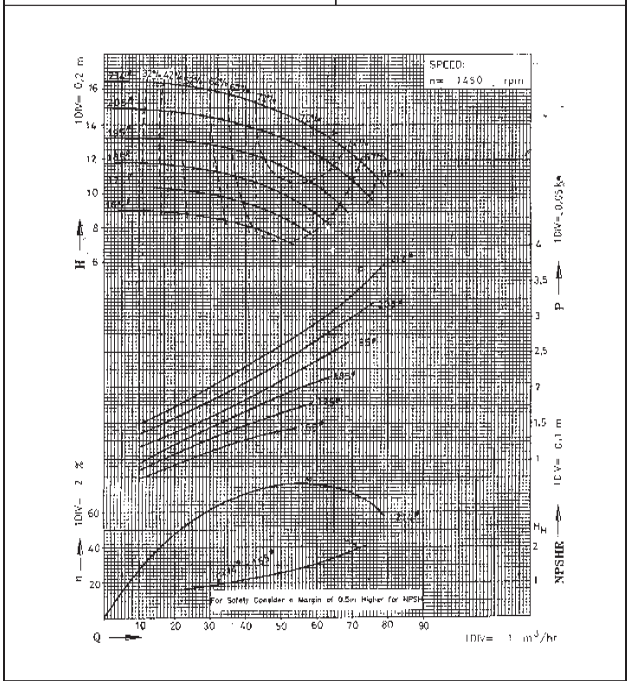
PUMP TYPE : APO 100/320	IMPELLER TYPE : 3V -O
SIZE IN mm : 150 X 100	IMPELLER NO. : 320100/3-0



Performance tested are based on water of viscosity 1 cst., Specific gravity 1

CAPACITY	M³/hr	MOTOR RATING	HP
HEAD	Meter	MOTOR SPEED	1470 RPM
EFFICIENCY	%	CURVE NO.	L 100-005 (M)

PUMP TYPE : AEC - C - 65/20	IMPELLER TYPE : CLOSED
SIZE IN mm : 100 X 65	IMPELLER NO. : C 20065 /M



Performance tested are based on water of viscosity 1 cst., Specific gravity 1.

CAPACITY	M³ / hr.	MOTOR RATING	HP
HEAD	Meter	MOTOR SPEED	1450 RPM
EFFICIENCY	%	CURVE NO.	A 65 - 3(M)

Capacity: 150 cum/hr.

Head : Static head - 11 meters, Horizontal Length- 20 meters

No. of bends: 4 nos. ; Valves: 2 nos.

Frictional loss study based on Hydraulic Institute Pulp friction table:

1cum/hr.: 4.4 GPM ; 150 cum/hr = 660 GPM

STEP-1

Total Friction head: (Horizontal friction loss + Fitting loss)

STEP-2

Valve & fitting loss : K x V^2 /2g

Where K is the friction factor, V^2 /2g is the velocity of the travelling media.

FITTING LOSS: K: 0.18, V^2 /2g: 0.81= 0.14per bend; (4x0.14=0.56 meters) A1

STEP-3

Flanged gate valve: K:0.1; V^2 /2g:0.81= 0.081 per valve(2 x 0.081= 0.16 meters)A2 Total Fitting Loss: A1 + A2 i.e. = 0.72 meters.

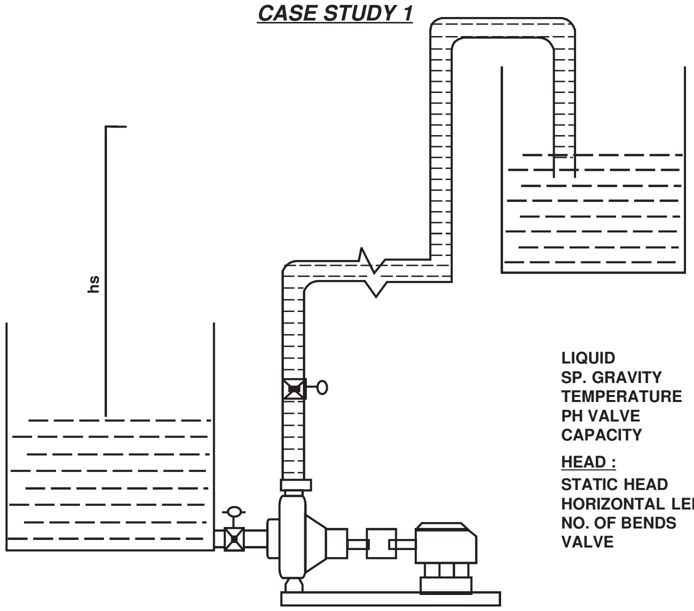
Total Horizontal Length: 20 meter travelling length + Fitting loss

FRICTION LOSS USING 6" M. S. PIPE:

Friction loss for 20 meters at 6" pipe: 35 meters per 100 meters

: 20.72 x 35/100 = 7.2 Meters.

CASE STUDY 1



LIQUID	:	PULP@4% CONSISTENCY
SP. GRAVITY	:	1.05
TEMPERATURE	:	AMBIENT
PH VALVE	:	NEUTRAL
CAPACITY	:	150 m.cu/hr

HEAD :

STATIC HEAD	: 11 Mts
HORIZONTAL LENGTH	: 20 Mts
NO. OF BENDS	: 4 Nos
VALVE	: 2 VALVES

Total Dynamic head: Static head + Friction head; 11 + 7.2 = 18.252 Mts.
Total head rounded of 20 meters.

POWER CALCULATION AND SELECTION OF THE SUITABLE PUMP:

Suitable pump selection curve enclosed, Pump model: APO 100/32
@ 67% Efficiency

$$BKW = \frac{Q.\ H.\ Sg}{367.\ \eta}$$

$$\frac{150 \text{ cum/hr} \times 20 \text{ meters} \times 1.05 \text{(Specific gravity)}}{367 \text{(Constant)} \times 67\% \text{(Efficiency)}}$$

BKW: 12.81 KW; HP = BKW/0.746; BHP: 17.7

Recommended Motor rating: 20 HP

Summary of 6” Pipe : Head- 20 meters; BHP: 17.7

FRICTION LOSS STUDY FOR 8” PIPE for above parameter:

Fitting loss factor for fittings: K:0.15 meters.

Velocity $V^2/2g$: 0.27 meters; Loss per bend: 0.16 meters.

VALVE LOSS: K-0.08 Mts.; Velocity: 0.27 M/s.: Valve loss : 0.02/meter
0.02 x 2= 0.04 Mts.

Horizontal friction loss: 20 + 0.04 + 0.16 = 20.2 meters

Loss per 100 meters in 8” pipe size: 18 meters per 100 meters = 3.7 meters.

Total Dynamic head: Static head + friction head = 11+ 3.7 = 14.7 = 15 meters.

SELECTION OF PUMP:

Efficiency of pump: 65%; Pump model: APO 100/32

BKW: 150 (cum/hr) x 15 (meters) x 1.05
367 x 65% : 9.9 BKW

BHP: 9.9/0.746= 13.27 Recommended motor power: 15 HP

Summary of 8" Pipe selection:

Head: 15 meters. ; BKW: 9.90 ; BHP : 15 HP

FRICTION LOSS STUDY FOR 10" PIPE for the above parameter:

Fitting loss : K – 0.14; V^2 /2g : (0.1: 0.14 x 0.1) : 0.14 per bend.
Total Bend loss: 4 x 0.14 = 0.56 meters.
Valve loss: K: 0.07; V^2 /2g: 0.10 = 0.07 x 0.1: 0.007 meters

Horizontal Friction Loss: 20 meters + (0.056 meters + 0.007) = 20.063Mts.

= 20.063 x 13/100 = 2.6 meters Horizontal Loss.
Total Dynamic head: 11 + 2.6 = 13.6 meters Rounded off to: 14 meters
SELECTION OF PUMP:

Pump Model: APP 100/32; Efficiency: 63%
BKW= 150 (cum/hr) x 14 (meters) x 1.05 / 367 x 63% = 9.53KW=12.78 HP
Motor HP: 15/1450 RPM
Summary:
TDH for 10" pipe: 14 meters; Required power: 15 HP

CASE STUDY No. 2

One of our customer asked us to find the solution for their pumping problem.
Problem: Customer needs 100 cum/hr. Capacity discharge per hour. From the well water for their process requirements Against Which customer is getting
60 cum/hr. Details below:

Existing detail:	Customer Requirment
Capacity: 60 cum/hr.	100 cum/hr.

Pump head designed: 30 meters
Pump size: 5" x 3" (Old version pump)
Pipe size: 4"
Head: Static head: 15 meters; Horizontal Length: 330 meters.
No. of bends: 4 nos. ; No. of valves: 2 nos.; Foot valve: 1 no.
Existing pump efficiency estimates: 39%
Exsisting motor HP: 20HP/1450 RPM;

HEAD REQUIRED FOR PUMPING 100 cum/hr with Exsisting 4" pipe:

Total Horizontal Length: 330 meters.
Fitting Loss Valve: K- 0.23; V^2 /2g : 1.91; Vl = 0.43 per valve
Total valve loss: 4 x 0.43 = 1.72' = 0.52 meters.
GATE VALVE LOSS: K: 0.16; V^2 /2g : 1.91 ; V2 = 0.3'= 0.9 meters
Foot Valve Loss: K: 0.8; V^2 /2g: 0.667; V3 = 0.53 meters.
V1 + V2 + V3 = 1.86 ; Total Fitting Loss: 1.86 Mts. Rounded off 2.0 mts.
Total Horizontal Length: 330 + 2 = 332

Total friction head: 332 x 10.2mts(Loss per 100 Mts.)=40.5
TOTAL HEAD: Static head + Friction head=15 + 40.5= 50.5Meters

Rounded off: 51 meters.

SUITABLE PUMP FOR 100 M^3/hr and the total Head 51 meter
IF THE PUMP IS OPERATED WITH THE EXSISTING PIPE SYSTEM:
Pump Type: AEC-C-80/20; Size: 125 x 80; Efficiency: 70%
BHP: 26.6; Motor rating: 30 HP/1450 RPM

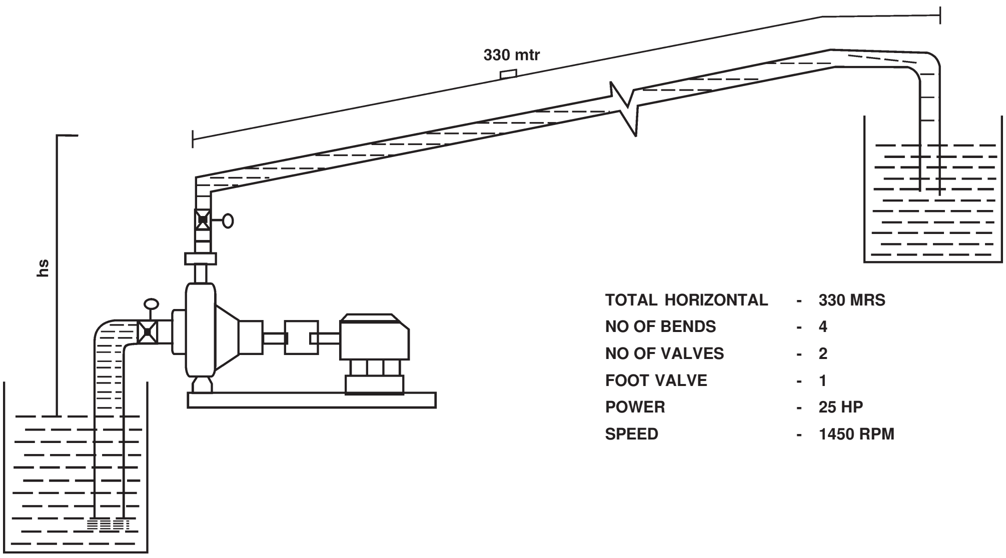
FRICTION LOSS STUDY FOR 6" PIPE for the above parameter:

Fitting Loss: No. of Bends: 4; K: 0.18; V^2 / 2g: 0.371=0.18 x 0.371
=0.06 per bend Total Bend loss: V1: 4 x 0.06= 0.26 Meters.
Valve Loss: K : 0.1; V^2 /2g: 0.371; V2: 2 x 0.037= 0.074 Meters.
Foot Valve: K:0.8; V^2 /2g: 0.0371; V3: 0.29 Meters.
V1 + V2 + V3 = 0.624 Meters.
Horizontal Length: 330 + 0.624 = 330.62
Horizontal Frictional loss for 6" pipe: 1.31 meters/100 meters.
Total Friction head: 331 x 1.31/100 = 4.33Mts.
TDH= Static head + Friction head = 15 + 4.3 = 19.33 Rounded off: **20 Meters**.
SUITABLE PUMP SELECTION:
Pump type: AEC – C- 100/26; Efficiency: 74% ; BHP: 9.87 HP
Recommended Motor: 12.5 HP/1450 RPm

FRICTION LOSS STUDY FOR 8" PIPE for the above parameter:

Fitting Loss: No. of Bends: 4; K: 0.15; V^2 / 2g: 0.129 = 0.15 x 0.129
=0.019 per bend; Total Bend loss: V1: 4 x 0.019= 0.077 Meters.
Valve Loss: K : 0.08 x 0.129; V2 0.010 x 2 = 0.020 Meters.
Foot Valve: K: 0.8 x 0.129 = V3 0.10 Meters
V1 + V2 + V3 = 0.019 Meters.
Horizontal Length: 330 + 0.019 = 330.19

CASE STUDY 2



Horizontal Frictional loss for 8” pipe: 0.34 meters/100 meters.

Total Friction head: 331 x 0.34/100 = 1.12 Mts.

TDH= Static head + Friction head = 15 + 1.12 = 16.12 Rounded off: 17 **Meters**.

CASE STUDY 1

CASE STUDY NO.1	POWER AND INITIAL COST COMPARISION FOR CENTRIFUGAL PUMP AND SYSTEMS									
Sl. No.	Capacity cum/hr.	Pipe size Inches	Total Dynamic Head in Mts.	Pump Type	Brake Kilowatt	Fittings cost in Rs.	Power cost Rupees	Power cost per year	Initial cost	Pay back period compared with
1	150	6”	20	APO100/32	12.81	14,250.00	35,000.00	4,48,350.00	49,250.00	
										1 & 2
2	150	8”	15	APO100/32	9.9	20,350.00	35,000.00	3,46,500.00	55,350.00	21 days
										1 & 3
3	150	10”	14	APO100/32	9.53	33,740.00	35,000.00	3,33,550.00	68,740.00	61 days
										2 & 3
										353 days

HIGHLIGHTS :

Compared with 6” & 8” pipes are saving 2.91KW power & Pay back within 21 days.

Hence 6” pipe is taken away from the recommendation

Compared with 8” & 10” Pipes 10” pipe are saving only 37KW power & Pay back period is almost 1 year. Hence it is prefered to choose 8”

However it is purely customers choice wheather to choose 8” or 10”

CASE STUDY 2

CASE STUDY 2	POWER / INITIAL COST COMPARISION FOR CENTRIFUGAL PUMP & SYSTEMS										
Sl. No.	Capacity	Pipe size	Total Dynamic	Pump Type	Efficiency	Brake	Fittings cost	Power unit	Power cost	Initial cost	Pay back period
	cum/hr.	Inches	Head in Mts.		in %	Kilo watt	Rupees	Rupees	per year	Rupees	compared with
				Existing							
1	60	4” (existing)	30	5” x 3”	33%	14.92	N/A	N/A	5,22,200		Not suitable
	If New Generation pump is offered for the existing parameter										1 & 2
2	60	4”	30	AEC50/16	74%	6.62	N/A	40,000.00	2,31,700	40,000.00	86 days
	PUMP & SYSTEM SELECTION FOR 100cum/hr.										
3	100	4”	51	AEC65/20	76%	18.28	N/A	26,000.00	6,39,800	26,000.00	N/A
											3 & 4
4	100	6”	20	AEC100/26	74%	7.36	1,30,075	30,000.00	2,57,600	1,60,075.00	100 days
											3 & 5
5	100	8”	17	AEC100/26	73%	6.34	1,86,505	30,000.00	2,21,900	2,16,505.00	140 days
											4 & 5
											230 days
	HIGHLIGHTS :										
	Sl.no 1&2 are the comparision with the old version pump & new version pump. By changing the pump alone 8.32 Kw. can be saved.										
	However the required flow is 100 cum/hr. Hence this option is dropped										
	If the pump is used with the same system (ie) 4” size pipe then the TDH is 51 & BKW 18.28										
	where us customer requirement is to get 100cum/hr. Capacity with out increasing the existing motor capacity or										
	with the reduced power compares with the existing one.										
	6” & 8” are ideally suitable for the required parameter.										
	On Long run basis 8” pipe yeild us maximum benefit. Hence 8” Pipe is recommended										

SUITABLE PUMP SELECTION:

Pump type: AEC – C- 100/26; Efficiency: 73% ; BHP: 8.5 HP

Recommended Motor: 10 HP/1450 RPM

From above case study it is clearly seen that the old version pumps are consuming higher power and the New Version pumps largely saves power and mechanical reliability also comparitively improved.

From the pump aspect it is observed that minimum 30% power can be saved compared with older version pumps. If the pipe line selection is also perfect, then on long run the user can save power cost of 50 to 60% from the present power bill.

CONCLUSION:

1. Selection of pipes, fittings & other pressure losses (pumping liquid passing through Pressure equipment like Boiler, Refiner, Turbo seperator, Digestor) must be calculated while deciding the TDH. Friction head should be reduced as to bare minimum.
2. Selection of HIGH EFFICIENCY PUMPS based on the operating duty is the Critical point for Energy saving. Detailed dialogue by the Pump user with manufacturer, during selection of pump, will yield best result.
3. There is a scope of conserving energy by minimum 40% in the existing system by reducing the friction head and by changing the old age pumps with High efficiency digital age pumps.

3. **From our various analysis, by adopting the above, a 30 TONS paper mill can Save 50 to 60 units/ hour only on pumps. In terms of Value Rs. 18 Lacs.**

   Needless to reiterate, above study on “power management on pumps” which incurrs more revenue in this crunching juncture.

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