The accurate flow at the accurate time and at the accurate place

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SUMMARY

In the study and dimensioning of installations there are no short cuts or secrets. Every case requires a total optimizing where all components in the system are evaluated.

Such a total optimizing of a system is based on process knowledge, a knowledge of all components in ths system and on common sense.

The careful use of energy is today of greatest importance for both individual companies and for the economy of the society in large. It is therefore important that energy is considered from the beginning both regarding new installations as well as rebuildings.

By giving a few simple examples, we would like to show the philosophy around the dimensioning in relation to energy consumption.

Example A :

Example A :

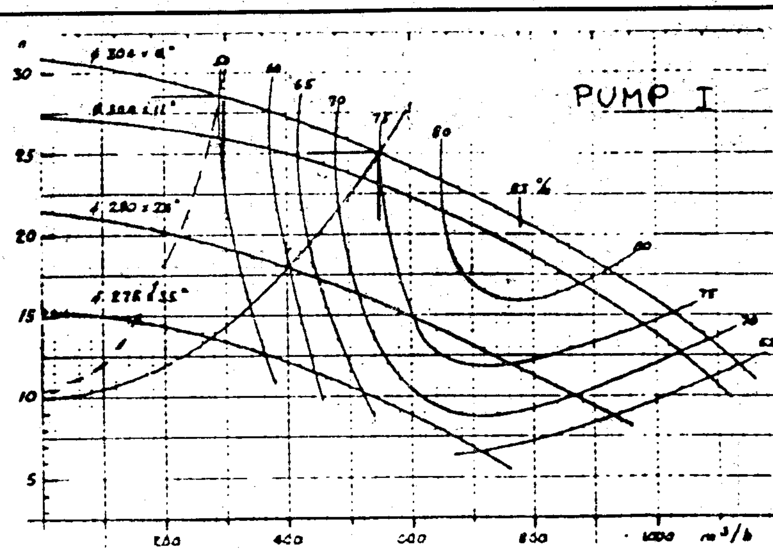
How the selection of the flow, that will dimension the installation and the duration will influence on the selection of a pump and on the power consumption.

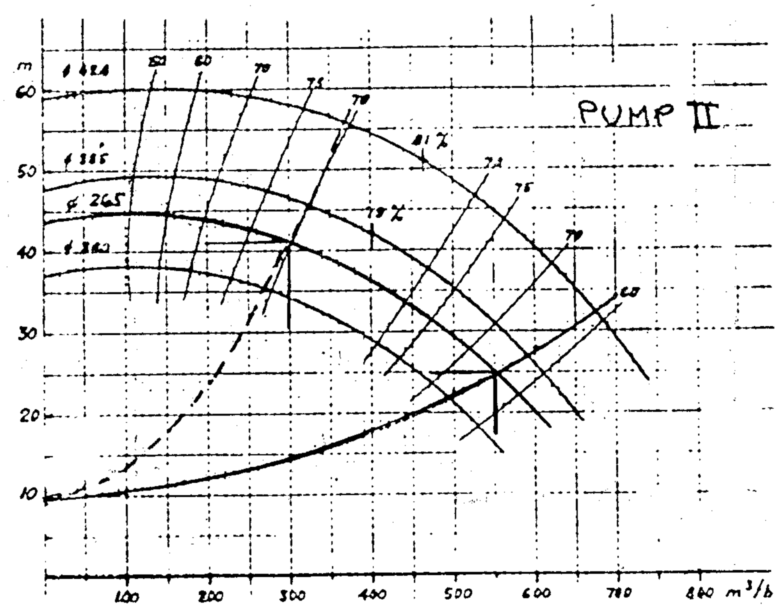
Max. Capacity :	550 m³/h 10% of the year
Total dev. head :	25 m at 550 m³/h
Normal flow :	300 m³/h 90% of the year

Suppose 8400 hours of operation per year and motor efficiency of 90%.

Pump I :

$$E_I = \frac{550 \times 25}{367 \times 0{,}75 \times 0{,}9} \times 0{,}1 \times 8400 + \frac{300 \times 28{,}5}{367 \times 0{,}51 \times 0{,}9} \times 0{,}9 \times 8400 = 430.340 \text{ KWH/year}$$





Pump II :

$$E_{II} = \frac{550 \times 25}{367 \times 0{,}65 \times 0{,}9} + 0{,}1 \times 8400 + \frac{300 \times 41}{367 \times 0{,}78 \times 0{,}9} \times 0{,}9 \times 8400 = 414.728$$

KWH/year
=414.728 kWh/year

Accordingly a reduction of the operational costs with $E_I - E_{II} = 15.612$ kWh/year

This will give in money saving, supposing 0,15 SEK/kWh of SEK 2.342.-/year

ADVANTAGES BY SELECTION "PUMP II"

- -Lower operational costs
- -Lower cost of investment
- -Possibility of "growing"
- -Cheaper valves

Example B

How the selection of the dimensioning flow, duration, pump and drive influences on the absorbed power.

-LIQUID PROCESS WATER-

Max. flow	150 m³/h
Normal flow	50 ,,
Total dev. head at max. flow	35 m
Total operational time per year	8400 h/year
Total operational time at max. flow 1%	84 ,,
Total operational time at normal flow 99%	8316 ,,
Energy price	0.15 SEK/KWH

I. Direct drive—at constont speed

Operational costs per year :

$$\frac{(84.27 + 8316.1{,}45)\ 0{,}15}{0{,}90}$$

≈20.500 SEK/year

Investment cost :

Pump I	13.850 SEK
Motor 30 KW, M200L)	9.950 SEK

II. Two-speed motor

Operational cost per year :

$$\frac{(84 \cdot 22 + 8316.2{,}2)\ 0{,}15}{0{,}90}$$

≈3.400 SEK/year

Investment cost :

Pump II	8.080 SEK
Motor (2 4/4,5 KW M200LA)	9.900 SEK

Savings :

Saving in pump-investment	5.770 SEK
Saving in motor-investment	50 SEK
	5.820 SEK

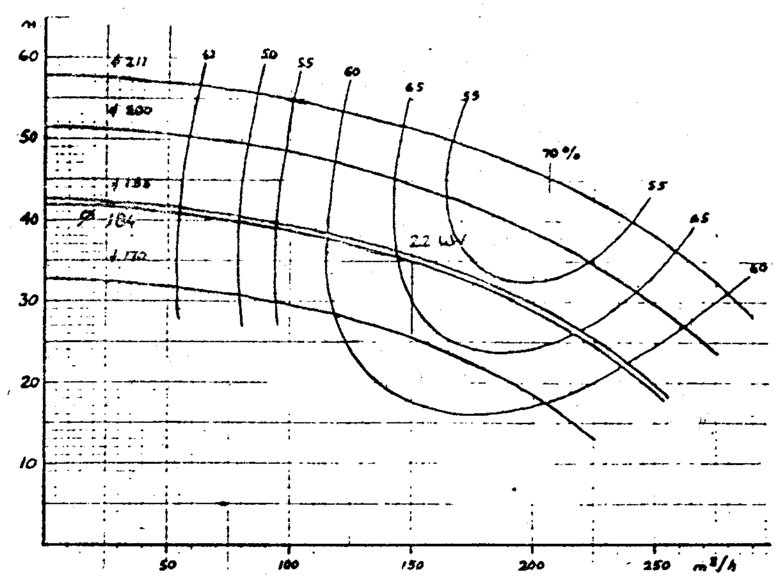


Fig. 4 Two-speed motor 2900 rpm

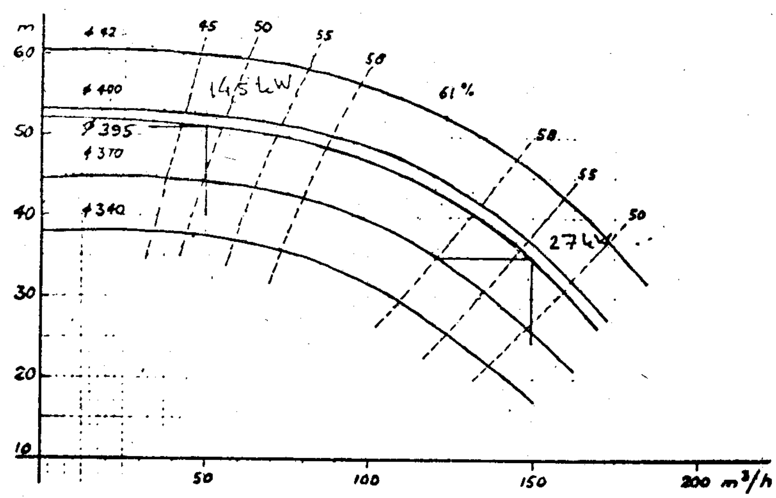


Fig. 3 Constant speed drive 1450 rpm

Yearly operational costs	17.100 SEK

Both investment cost and operational cost is drastically decreased in this case with the two-speed motor drive.

Example C :

How dimensioning according to caracteristics at normal operation and duration together with selection of drive influences on absorbed power.

FRESH WATER APPLICATION

Background :

Pump at a fresh water station, pipe 10 km length from the water station to the consumer.

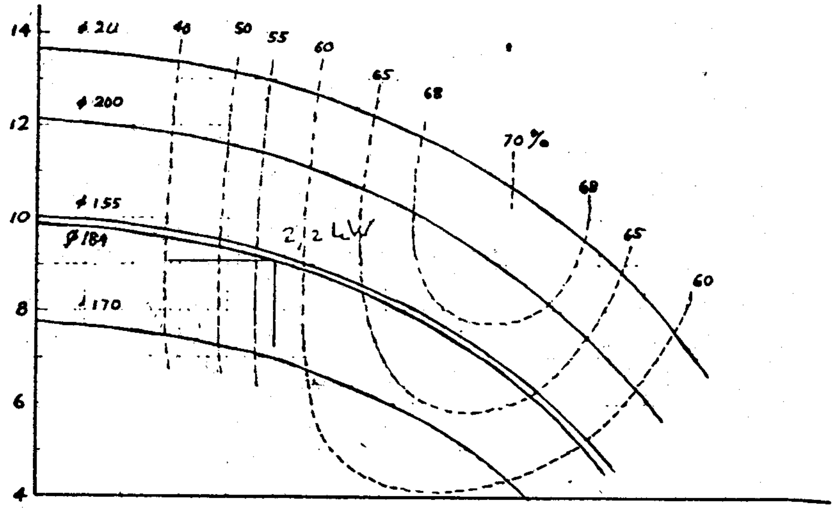


Fig. 5 Two-Speed motor 1450 rpm

Before :

Initially dimensioned for a max. flow that even in the most extreme case very rarely will occur.

Overflow is returned back to the river.

Variations in flow depending on the mill production and on the time of the year. (Water-temperature)

Absorbed power before, with direct drive, 261 KW.

After :

Dimensioning flow as selected after normal need and to the pump was installed a D.C. motor where the speed was controlled against the level in the following cleaning station.

Absorbed power after these modifications, 87 KW.

Savings will accordingly be 174 KW

Example D :

How the System-design influences on pump selection and energy consumption.

APPLICATION PRESSURE INCREASE TO FILTER WASHERS

Case 1 :

One pump, dimensioned to carry both the large flow, that is requirad for the washer liquor and the high pressure to the sprayers at the same time.

Absorbed power—225 KW

Case 2 :

Two pumps were used, one to give the required total flow and the second to increase the pressure to the sprayers.

Absorbed power	
pump 1	60 KW
pump 2	15 KW
Total	75 KW

Saving (225-75) KW=150 KW

Example E

How system design influences on pump selection, drive and absorbed power.

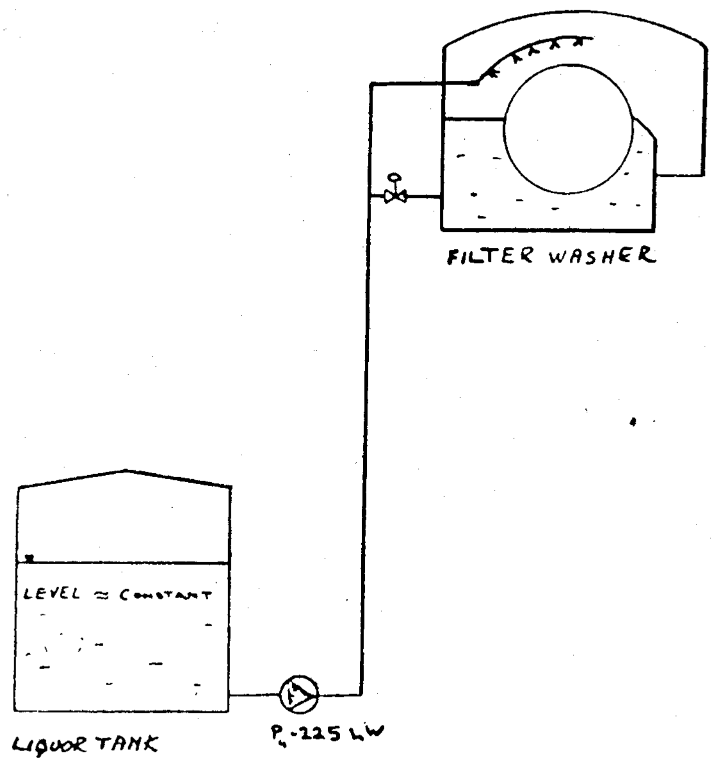


Fig. 6. Case 1

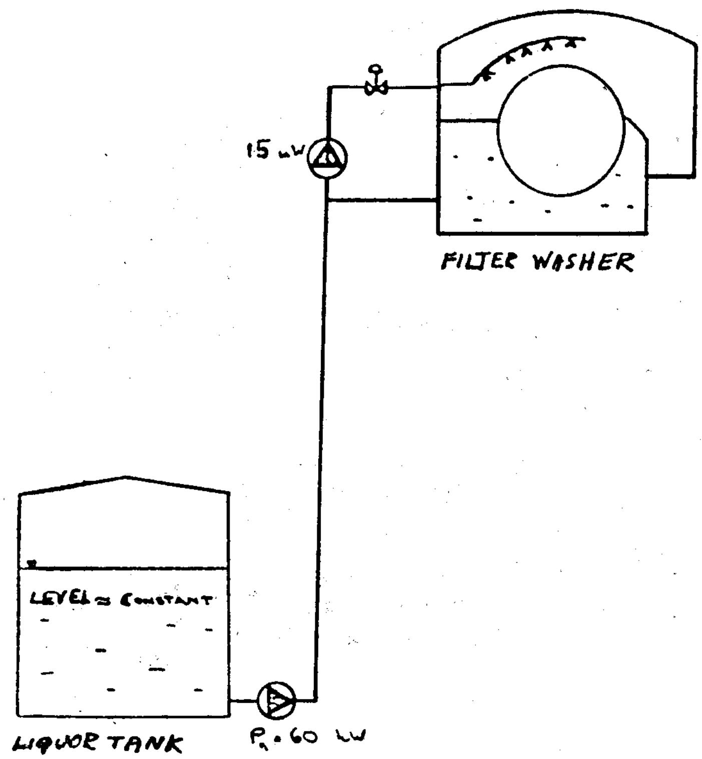


Fig. 7. Case 2

APPLICATION BACK WATER TANK

Case 1 :

Both pumps are direct driven with constant speed electrical motors and are regulated by throttling on discharge side.

Dimensioning flow is 300 m^3/h.

Pump 1 has the outlet for the discharge pipe in the upper part of the back water tank and must be dimensioned for 25 m static head.

Pump 2 is dimensioned for the lowest available suction head and occuring additional suction heads are are throttled away.

Case 2 :

Valves for throttling control are eliminated and replaced with variable speed drive.

Pump 1 : By entering the pump discharge pipe in the bottom of the tower, we can dimension the head for the average level in the tank which is 12,5 m. Average saving in head would therefore be 12,5 m.

Pump 2 : The component of the suction head that earlier was throttled away, can now be used as the throttling valves are taken away and the regulation is made by controlling the speed. Therefore, the saving also for this pump will be 12.5 m.

Total Savings :

By eliminating the throttling valves, the friction losses in each pipe will be reduced with another 5 m.

Total savings in absorbed

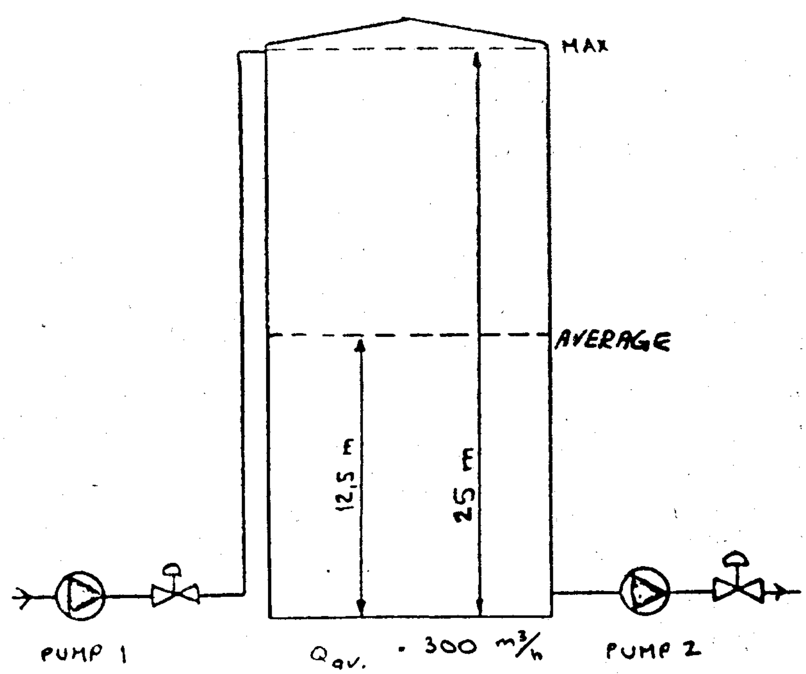


Fig. 8. Case 1

power will therefore be :

$$P_1 = P_2 = \frac{300 \cdot (12,5+5)}{367 \cdot 0,7} = 20,4 \text{ KW}$$

where 0,7 is the pump efficiency 70%.

Additional gain is less noise and lower maintenance cost.

Example F

In this example we will not only consider the pump and its drive but also other equipment that is found in the pump system.

Application, so called pressure screens with one inlet and two outlets.

Large powers are often throttled away as the regulation of the pressure screen in many cases is done on both outgoing valves. An economic regulation regarding enei gy shauld be based on at least one of the two valves being open. With a well-designed regulation the throttling losses can be rtduced drastically. Both pump and pressure can also work under more favourable conditions.

Comments :

As shown in the above examples, you can easily calculate absorbed power with the following formulas :

$$P_{pump} = \frac{\varrho \cdot g \cdot Q \cdot H}{\eta_{pump}} \text{ or}$$

$$P_{tot} = \frac{P_{pump}}{\eta_{motor}}$$

where

P=Absorbed power	(W)	or	KW
ϱ=Density	(kg/m^3)	–	kg/dm^3
Q=Flow	(m^3/s)		m^3/h
H=Head	(m)		m
η=Efficiency	—		
g=Graviation 9,81	(m/s^2)		m/s^2

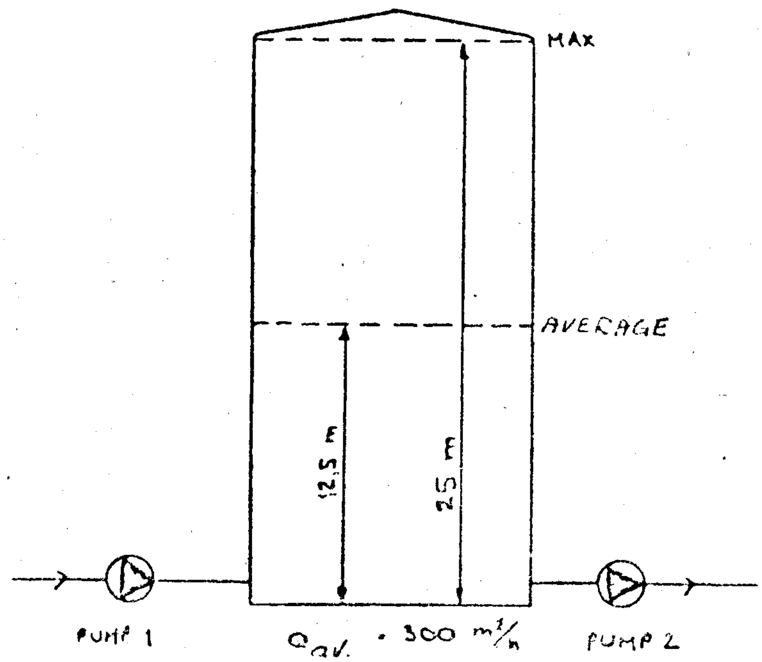


Fig. 9. Case 2

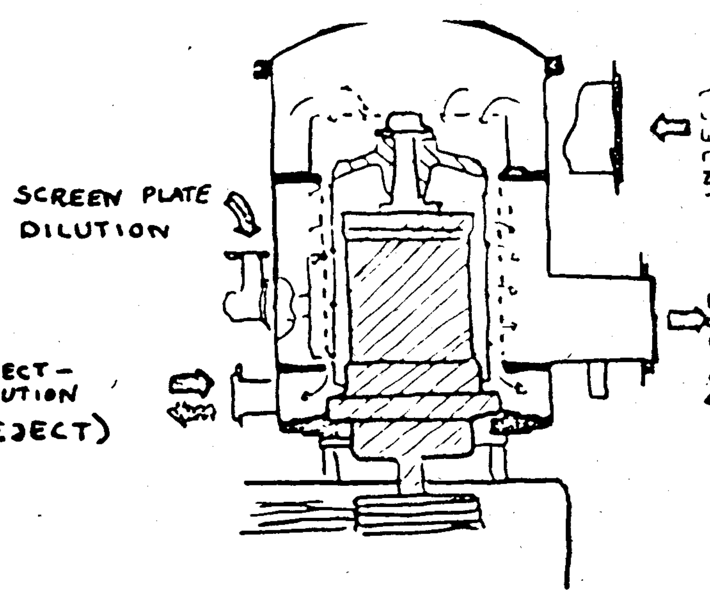


Fig. 10

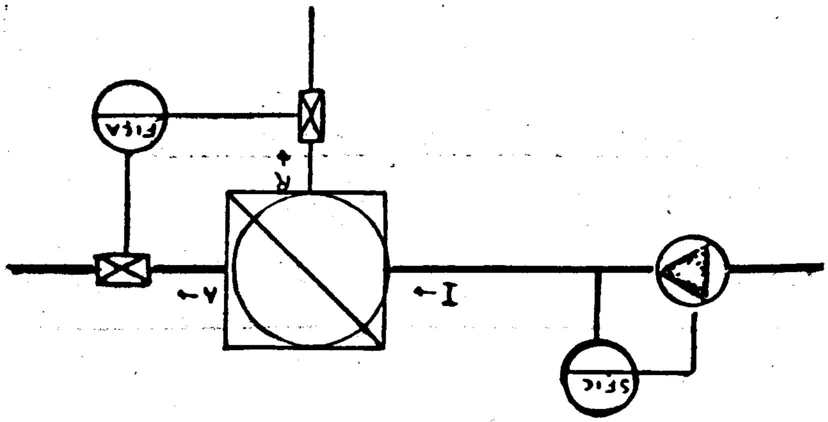


Fig. 11

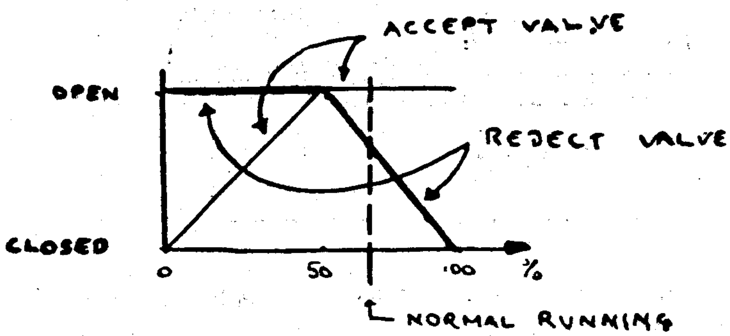


Fig. 12. Examples on suitable regulation

if the later dimensions are used, the above formulas can be written as

$$P_{tot} = \frac{Q \cdot H \cdot \varrho}{367 \cdot \eta_{pump} \cdot \eta_{motor}}$$

For making rough calculations, you can with a sufficient accuracy use

$$\eta_{motor} = 0{,}9$$
$$\eta_{pump} = 0{,}7$$

Simple rough calculations of the above described type will give indications on where and on what in the system savings can be done. In many cases it will be sufficient as a base for direct action, or if this is found necessary, can lead to a more detailed study. As a basic rule it is of course the large power consumers that can be influenced in the first place.