FIRE PUMP FOR FPSO UNIT

PUMPSENSE FLUID ENGINEERING PVT. LTD.

TEMPERATURE RISE IN A CENTRIFUGAL PUMP

COOLING APPLICATION FOR GUANGZHOU UNIVERSITY

1. Preparing temperature rise curve of a pump from its performance curve

There are two pumps having performances as shown in the following figures. One is a 8 stage boiler feed pump (6”x4”- 8”) & the other is a single stage split case pump (12”x10”-26”). We have to prepare temp rise curves for both & compare their nature. Assume that the pumped liquid is water at 15^0 C.

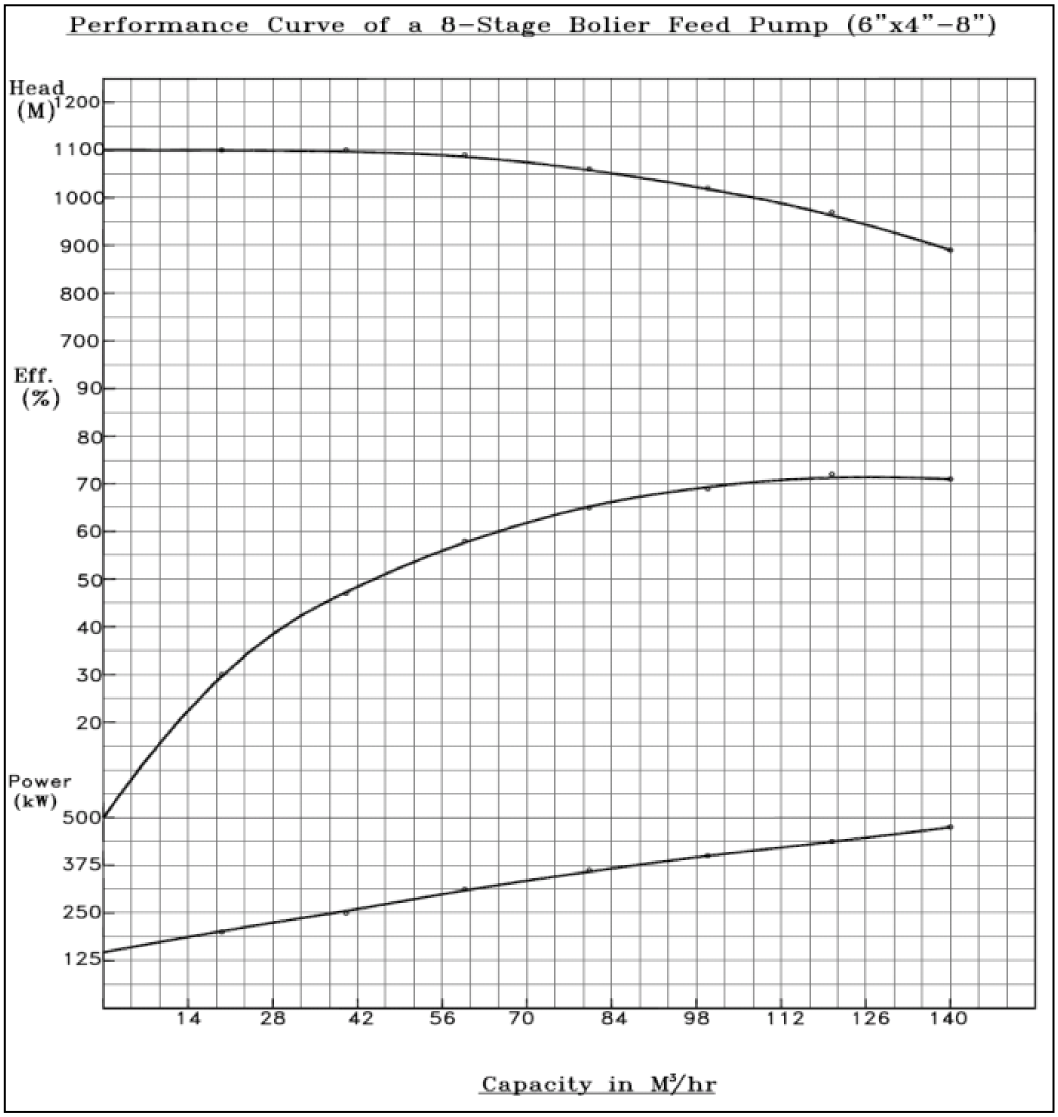

Fig. 1: Performance curve of a 8 stage boiler feed pump 1

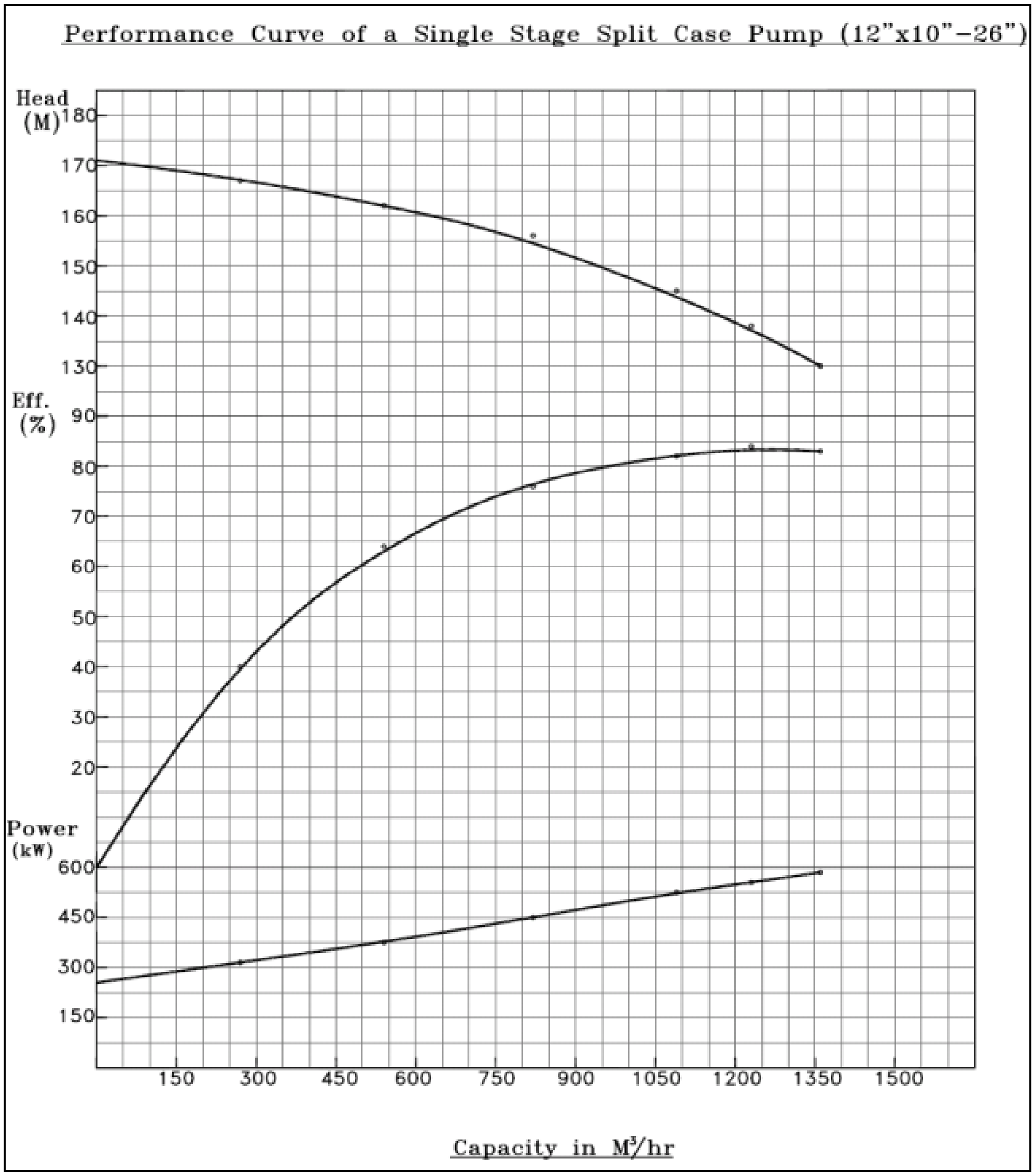

Fig. 2: Performance curve of a single stage split case pump 2

Description

Using the curves we can tabulate the head & efficiency (%) values at various flow rates for the two pumps. Temperature rise can be calculated using the following formula:

$$\boldsymbol{T}\ (°\mathrm{C}) = \frac{\boldsymbol{H}}{\mathbf{104} \times \boldsymbol{C_p}} \times \left(\frac{\mathbf{1}}{\boldsymbol{\eta}} - \mathbf{1}\right)$$

Here, ***T*** = *temp rise through the pump,* ^{0}C

H = *total developed head at the flow being considered, m*

η = *efficiency in decimals*

$\boldsymbol{C_p}$ = *sp. heat of the liquid at pumping temp. = 4.18*

Using the Fig. 1 & 2, we can tabulate head & efficiency (%) values at various flow rates and temperature rise. **The values obtained are tabulated below:**

Flow (M^3/hr)	Head (M)	Eff. (%)	Temp. Rise (ºC)
0	1112	0	0
20	1104	30	5.97
40	1096	47	2.86
60	1088	58	1.83
80	1064	65	1.33
100	1024	69	1.07
120	968	72	0.87
140	888	71	0.84

Fig. 3: Temp rise values for pump 1

Flow (M^3/hr)	Head (M)	Eff. (%)	Temp. Rise (ºC)
272	167	40	0.58
545	162	64	0.21
817	156	76	0.11
1090	145	82	0.07
1226	138	84	0.06
1362	130	83	0.06

Fig. 4: Temp rise values for pump 2

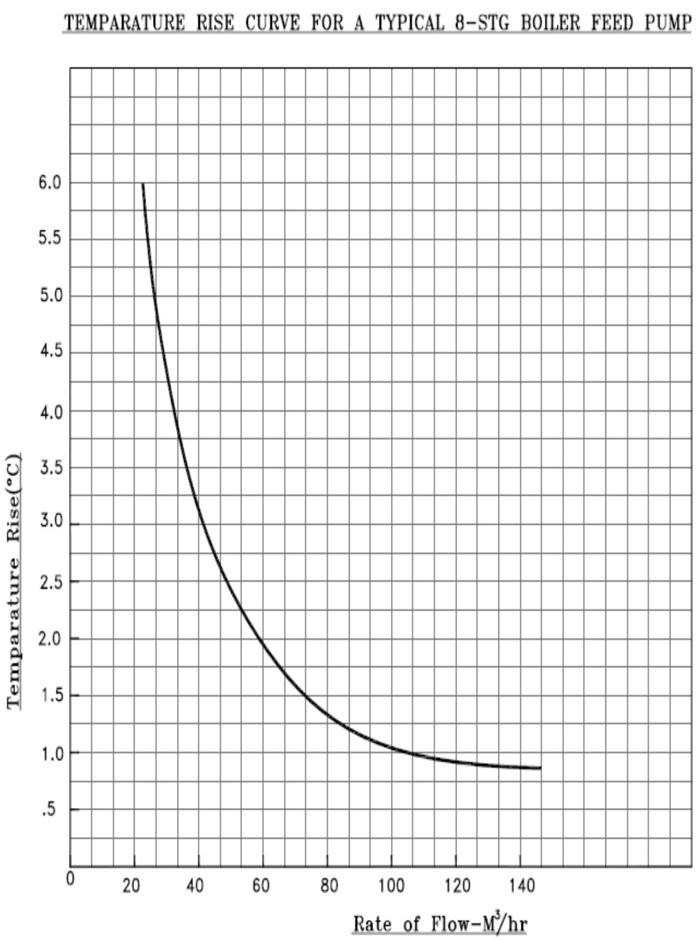

Fig. 5: Temp rise curve of pump 1

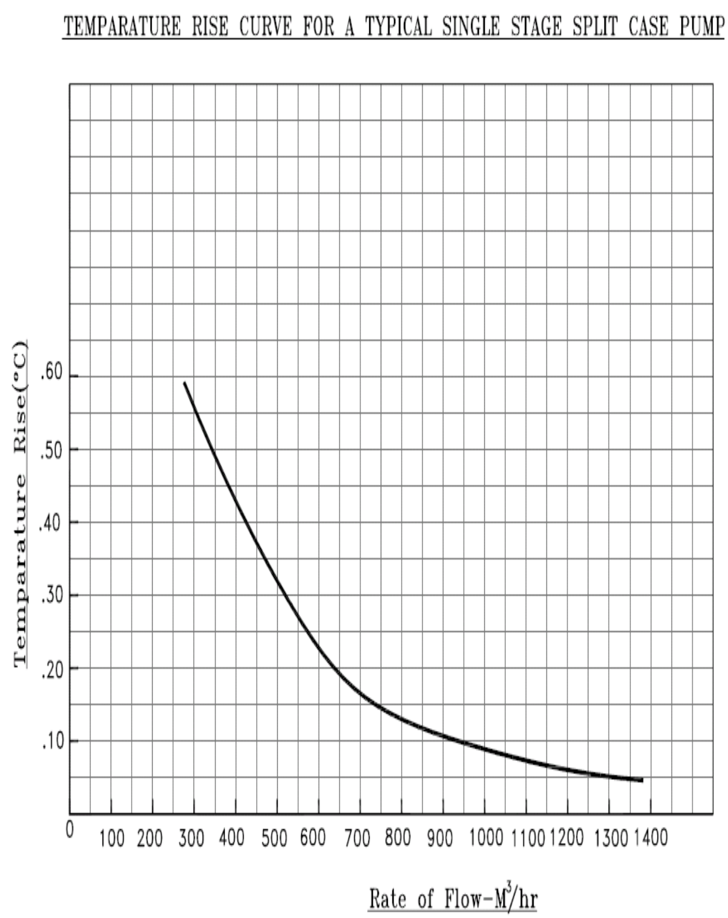

Fig. 6: Temp rise curve of pump 2

2. Determining the fluid's rate of temperature rise at shut off condition

A pump has a casing capacity of 0.0255 m^3 and is pumping water at 15^0C and the power input at shut-off is 19 KW.

We have to determine:

a) The rate of temperature rise

b) The time required to boil the water in the casing

Description

The rate of temperature rise at shut off is given by

$$\boldsymbol{T_{so}(metric) = \frac{60 \times P_{pso}}{V \times C_p \times \rho}}$$

Here,

T_{so} *= rate of temperature rise, $^0C/min$*

P_{pso}*= input power at shut-off for the liquid pumped, kW*

V *= casing internal volume, m^3*

C_p *= Specific heat, KJ/kg^0C*

ρ *= density, kg/m^3*

Power input at shut-off is 19 KW (given).

C_p for water at 15°C is 4.19 KJ/Kg^0C and ρ is 1000 kg/m^3.

a) $T_{so} = \frac{60\times19.0}{0.0255\times4.19\times1000} = 10.7\ °C/min$

b) $Time\ required\ for\ boiling = \frac{100-15}{10.7} = \ 7.95\ min$

3. Minimum flow in a pump – Temperature rise criterion

We have to determine the minimum flow required to prevent the temperature of the pump used in the previous examples from raising more than a commonly accepted maximum value when pumping water at 15°C.

A commonly accepted practice limits the temperature rise through a pump to 8^0C for most common installation. This is adequate and minimum flow may be calculated with equation.

$$\boldsymbol{Q(metric) = \frac{433 \times P_p}{C_p \times \rho}}$$

Here,

Q = *minimum flow rate, m^3/hr.*

P_p = *Input power at the minimum flow, kW*

433 = *constant*

C_p = *Specific heat, kJ/kg^{0}C*

ρ = *density, kg/m^3*

Power input at shut-off is 19 KW.

C_p for water at 15°C is 4.19 and ρ is 1000.

$$Q = \frac{433 \times 19}{4.19 \times 1000} = 1.96\ m^3/hr$$