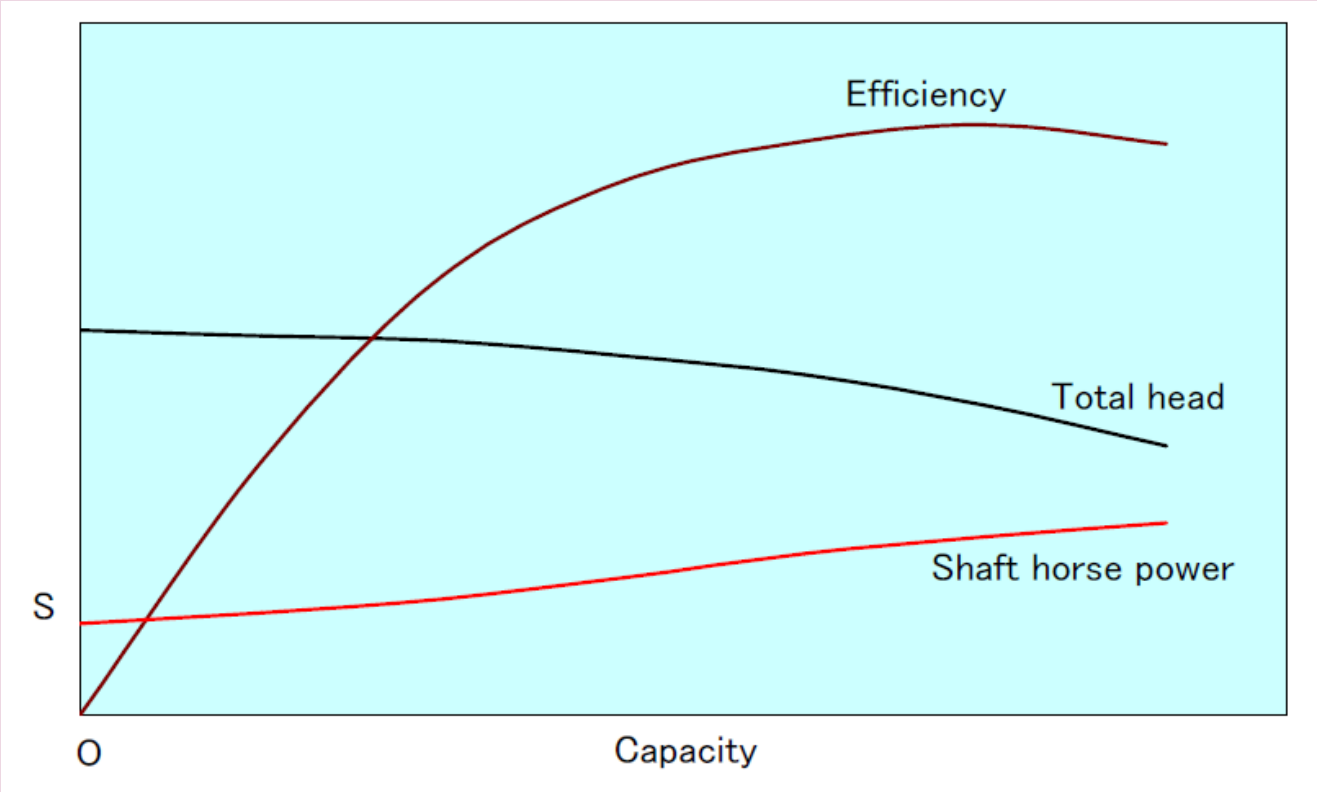
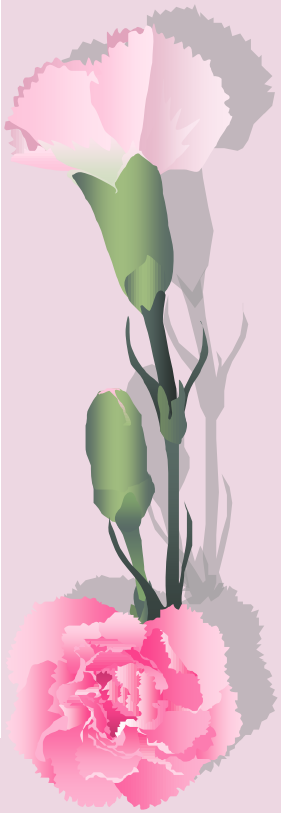
Pump shutoff operation

1. Pump condition at shutoff operation

As shown in the figure below, in the performance curve of the pump, shaft horse power S (kW) is loaded in the pump when the capacity is 0, that is, shutoff operation. However, the pump at shutoff operation doesn't work effectively. In a word, a constant electric power keeps being input to the pump by a driver though the pump doesn't do effective work.





Pump shutoff operation

2. To what is shaft horse power *S* consumed?

Shaft horse power *S* is consumed as follows at shutoff operation.

(1) Temperature rise of the liquid inside the pump and its suction and discharge pipings

(2) Pump vibration and noise

(3) Conduction of heat to construction parts such as casing of pump

(4) Thermal radiation from surface of the pump

(5) Flushing to shaft seal

(6) Internal circulation through wearing etc.

Because the suction and discharge piping installation dimensions, the installed location of the pump, the ambient temperature around the pump, the wind velocity, etc. might not be able to be specified, each ratio cannot indiscriminately mean these consumption. Moreover, the liquid temperature rise in the pump is faster than the time of conduction of heat to the casing and thermal radiation from surface of the pump. In general, then it is assumed that it stays on the safe side, and shaft power *S* is consumed only to the temperature rise of the liquid in the pump, when the shutoff operation of pump is discussed.

Pump shutoff operation

3. How many degrees of the temperature rise in the liquid in the pump?

(1) Abbreviation

S : Shaft horse power at shutoff (kW)

Cw : Specific heat of the liquid (kcal/(kg・℃))

Ww : Liquid mass in the pump (kg)

Δt : Temperature rise of liquid in the pump (K(℃))

T : Operating time at shutoff (s)

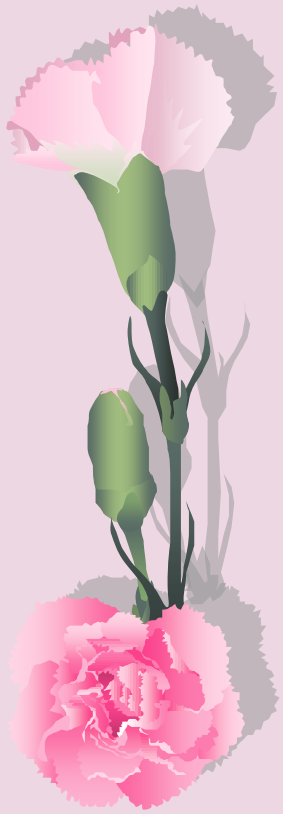
(2) Heat balance equation

By 1 kW=0.2389 kcal/s

$$0.2389 \times S \times T = Cw \times Ww \times \Delta t \quad \cdots\cdots (1)$$

Then, Δt is;

$$\Delta t = (0.2389 \times S \times T) / (Cw \times Ww) \quad \cdots\cdots (2)$$



Pump shutoff operation

4. Danger at shutoff operation

From the equation (2), temperature rise of liquid in the pump Δt ;

①Proportional to operating time at shutoff *T* and shaft horse power at shutoff *S*

②Inverse proportional to specific heat of the liquid *Cw*

Except for pumps that the shaft horse power is high such as high pressure pumps, pump manufacturers operate pumps at shutoff for seconds or ten-odd seconds to measure shutoff total head before delivery. However shutoff operation must be avoided.

Especially, the liquid temperature rises in a short time for pumps with high shaft horse power, and the saturated vapor pressure rises in a short time for pumps handle liquefied gas. Then, it causes a serious accident, such as internal seizure or the pump casing crack results in emitting handling liquid.