TI-GCM-08
CM Issue 2

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Saturated Steam Sizing Chart

Let: $\dot{m}$ = Mass flow in kg/h

P_1 = Upstream pressure in bar a

P_2 = Downstream pressure in bar a

K_v = Valve flow coefficient.

χ = Pressure drop ratio = $\dfrac{P_1 - P_2}{P_1}$

Note: To convert gauge pressure to absolute pressure, add 1, i.e. 10 bar g = 11 bar a.

The chart overleaf shows that with a given upstream pressure P_1 and with a pressure drop across the valve more than is needed to give critical flow conditions, or $\chi > 0.42$, the steam flowrate is directly proportional to the K_v of the valve. Conversely, with a given K_v, the flowrate is directly proportional to the upstream pressure P_1.
So for critical flow, we have:-

$\dot{m} = C \times K_v P_1$ and in the units shown, C = 12 (Constant).

Thus: $\dot{m} = 12 K_v P_1$

With a smaller pressure drop, the flow is reduced until it becomes zero, at zero pressure drop. Many formulas are in current use to predict the relationship between flowrate and the pressure drop ratio χ under these conditions. One empirical formula which gives results very close indeed to the British Standard method, but simplifies the calculation, is:-

$$\dot{m} = 12 K_v P_1 \sqrt{1 - 5.67 (0.42 - \chi)^2}$$

If this formula is used when P_2 is below the value which gives critical flow, then the term within the bracket $(0.42 - \chi)$ becomes less than zero. It is then taken as zero, and the function within the square root sign becomes 1.

How to use the chart

How to use the chart

Example 1: How to find K_v value for a critical flow application.

Steam demand of heat exchanger	= 800 kg/h
Steam pressure upstream of valve	= 8 bar g = 9 bar a
Steam pressure required in exchanger	= 3 bar g = 4 bar a

Using the selection chart:

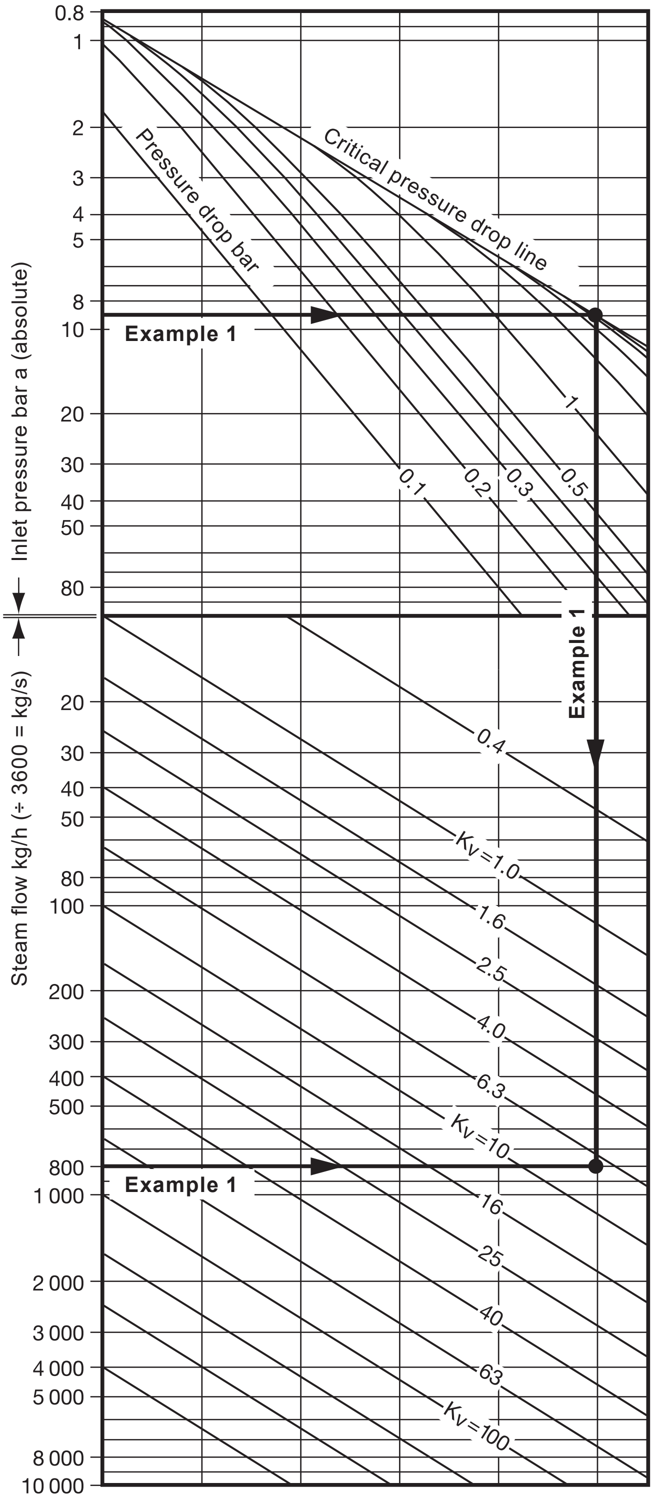
Draw a horizontal line from 800 kg/h

Draw a horizontal line from 9 bar a to the critical pressure drop line, which is reached before a pressure drop line for (9 - 4 = 5 bar) and drop a vertical line from the intersection to meet the 800 kg/h horizontal.

Read the K_v at this crossing point, i.e. K_v = 7.5

Refer to the K_v values given on the appropriate Technical Information Sheet for each valve type.

SA (self-acting), EL (electric/electronic) and PN (pneumatic) valves may be selected using their maximum Kv values.



A complete sizing chart is shown on page 5.

For Water Sizing Chart see TI-GCM-09

How to use the chart

Example 2: How to find the K_v value for a non-critical flow application.

Steam demand of heat exchanger = 230 kg/h.

Steam pressure upstream of valve = 5 bar g = 6 bar a

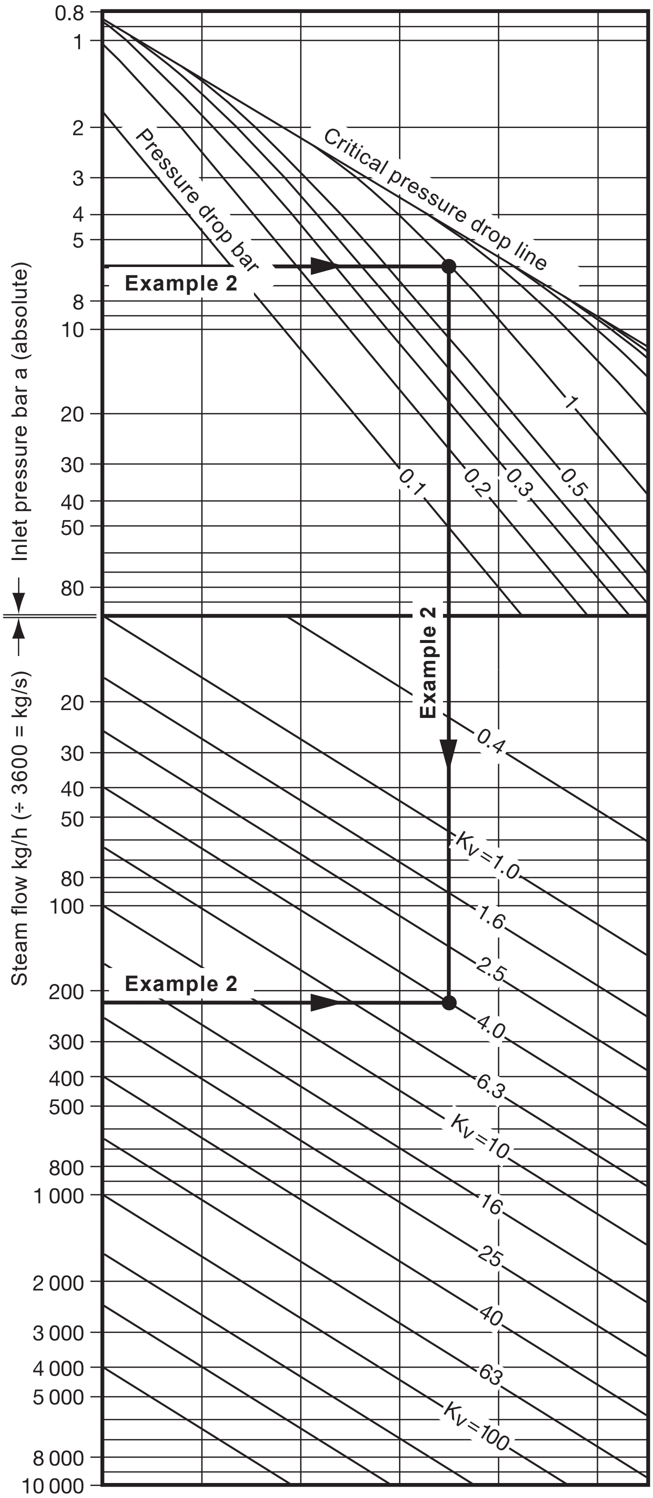
Steam pressure required in exchanger = 4 bar g = 5 bar a

Using the selection chart:

Draw horizontal lines from 230 kg/h, and from 6 bar a to pressure drop of (6 - 5 = 1 bar).

Drop a vertical line from the intersection to meet the 230 kg/h horizontal.

Read the K_v at this crossing point, i.e. K_v = 4.



How to use the chart

Example 3: How to find the pressure drop across a valve with a known K_v.

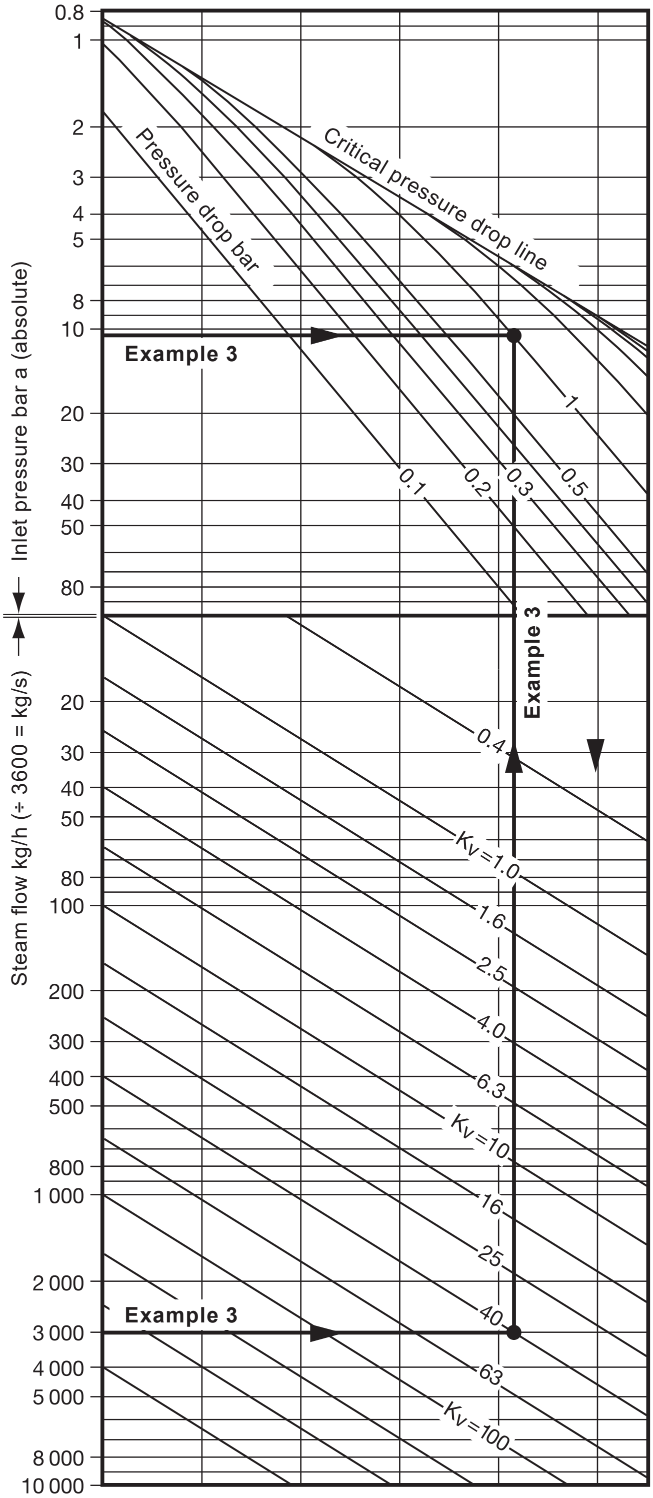
Steam demand of heat exchanger	= 3 000 kg/h
Steam pressure upstream of valve	= 10 bar g = 11 bar a
K_v of valve to be used	= 40

Using the selection chart:

Draw horizontal lines from 11 bar a, and from 3 000 kg/h to meet K_v = 40 line.

Draw a vertical line upwards from the intersection to meet the 11 bar a horizontal.

Read the pressure drop at this crossing point, i.e. ΔP = 1 bar (approximately).



Saturated steam sizing chart

This sizing chart is empirical and should not be used for critical applications