DESIGN, LAYOUT AND INSTALLATION OF PIPELINES FOR LEWA METERING PUMPS

Warning: LEWA metering pumps are reciprocating displacement pumps with pulsating delivery flow. The dimensioning of pipe lines connected to such pumps must therefore be based on criteria different from those applying to rotary pumps. If this is not observed, then there is the danger that serious faults may occur such as metering errors, excesive noise and damage to pump and plant.

Criteria for the design and layout

Due to the pulsation of the metered flow, pressure fluctuations arise which are to be superimposed on to the static pressure level at the suction as well as at the discharge side. Taking into account this pressure profile versus time, the following criteria must be examined:

I. Cavitation

Cavitation symptoms appear when the vapour pressure of the metered fluid is reached anywhere in the system. The consequences of cavitation may be excessive noise, fluctuations in metered flow, valve wear and overload damage. Cavitation-free operation is ensured when the following condition is fulfilled (**fig. 1**):

$$p_{Smin} > p_t \quad \textbf{(1)}$$

II. Overloading

Overloading, which could cause immediate or fatigue fractures, occurs when the highest pressure peaks exceed the maximum permissible operating pressure. The pump will work without overloading if (**fig. 1**):

$$p_{perm} \geqq p_{Dmax} \quad \textbf{(2)}$$

III. Excess delivery

This means that the pump delivers more than its displacement volume. Excess delivery occurs when the pressure at the suction flange is momentarily higher than that at the discharge flange. Consequences of excess delivery can be serious metering errors, severe valve hammering and excessive valve wear. Excess delivery is avoided if at all times (**fig. 1**):

$$p_{Dmin} > p_{Smax} \quad \textbf{(3)}$$

The exact equations for the examination of these layout criteria can be found in LEWA-Information leaflet: Principles D 10 - 012 e (available on request).

As in most practical cases the viscosity of the metered fluid is low ($\eta \geqq 10$ mPas), a simplified computation process can be applied as shown overleaf.

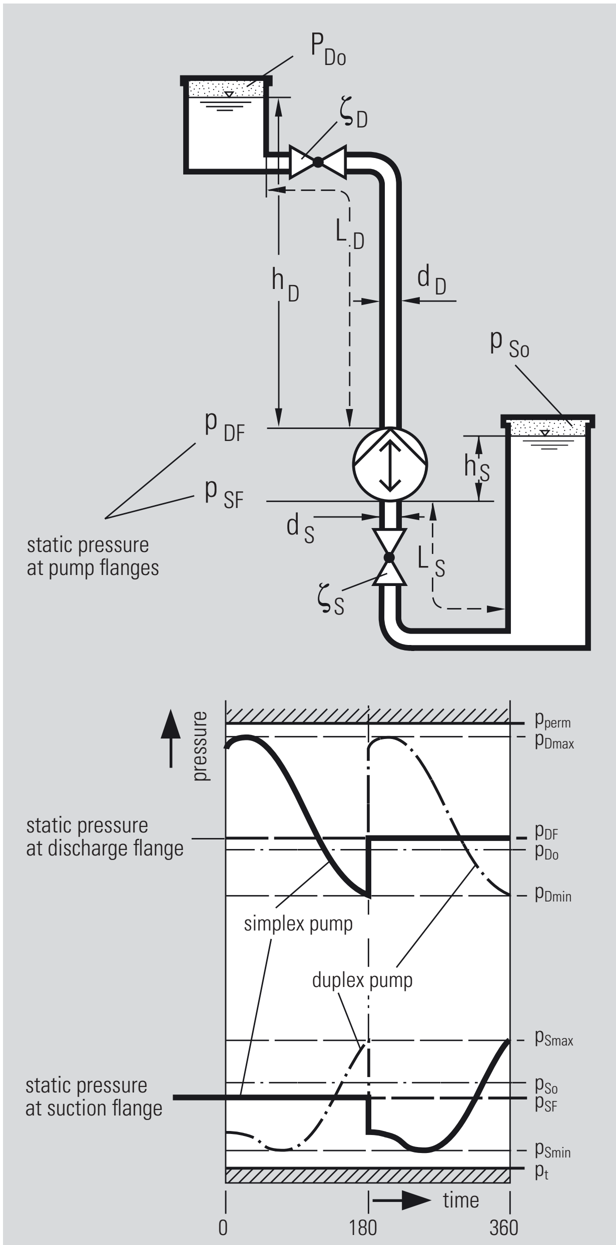

Fig. 1

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Simplified pipe line calculations

Range of validity: low viscosity media ($\eta \geqq 10$ mPas). For trouble-free plant operation the following design criteria must be met:

Criterion I (cavitation on suction side)

$$p_{SF} - \sqrt{\Delta p_E^2 + \left(\frac{\rho \cdot L_S \cdot n \cdot Q_{ges}}{650\ d_S^2 \cdot i}\right)^2} - pt + 1 > 0 \qquad (4)$$

Criterion II (overloading)

$$p_{zul} - p_{DF} - \frac{\rho \cdot L_D \cdot n \cdot Q_{ges}}{650 \cdot d_D^2 \cdot i} \geqq 0 \qquad (5)$$

Criterion III (excess delivery)

$$p_{DF} + p_{DHV} - \frac{\rho \cdot L_D \cdot n \cdot Q_{ges}}{650 \cdot d_D^2 \cdot i} - p_{SF} - \frac{\rho \cdot L_S \cdot n \cdot Q_{ges}}{650 \cdot d_S^2 \cdot i} > 0 \qquad (6)$$

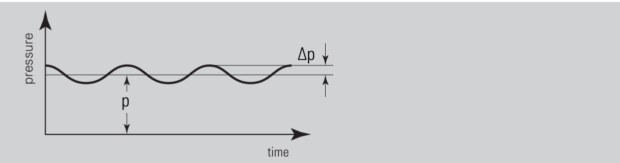
Layout of pulsation dampers

a) Design aim: Damping of pressure pulsation

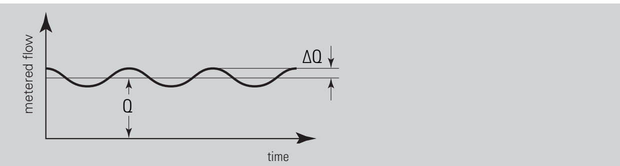
Assumption: $\Delta p/p \leq 5\%$ und $p_L/p = 0{,}7$.

$$V_{PD} \geqq \frac{Q_{ges}}{5 \cdot n \cdot i^2} \qquad (7)$$

If pulsation dampers with gas/liquid contact must be installed, safety considerations (absorption of the gas in the liquid) recommend the choice of a larger damper.



b) Design aim: Damping of metered flow pulsation

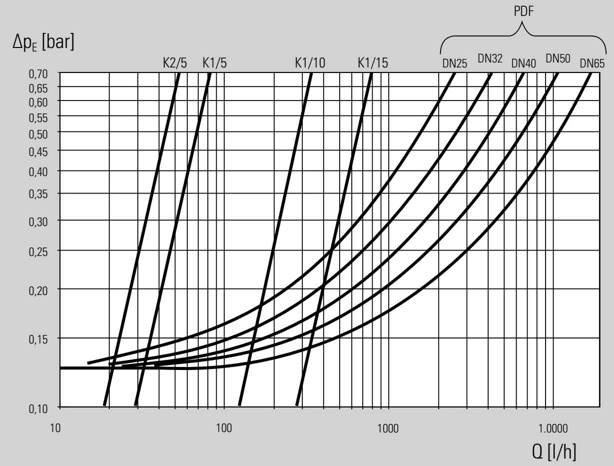


The metered flow becomes smoother, the lower the delivery pressure, the longer the pipe line and the larger the flow resistances in the pipe line are. Satisfactory damping of metered flow pulsation is, as a rule, achieved in the suction pipe if the pulsation damper is chosen in accordance with equation 7, and the pipe line is at least several meters in length. It is absolutely essential to avoid resonance conditions which occur if the natural frequency of the sVstem „liquid mass in the pipe line /gas cushion elasticity in the pulsation damper" is close to or coincides with the excitation frequency generated by the metering pump.

The appropriate design equations for this condition can be found in LEWA-Information leaflets D5-200 e and D10-012 e (available on request).

Suction valve pressure drop Δp_E

Versus metered flow per pump head Q (=Q_{tot}/i) for various types of valves.



K 2/5 = double ball valve DN (nom. dia) 5
K 1/15 = single ball valve DN 15
PDF = plate valve with spring

Symbols

d_D	mm	bore diameter of discharge pipe bore diameter of suction pipe
d_S	mm	number of pump heads with common pipe line
L_D	m	length of discharge pipe
L_S	m	length of suction pipe
n	min^{-1}	stroke frequency of pump
p_{DF}	bar	static pressure head at pump discharge flange
p_{SF}	bar	static pressure head at pump suction flange
p_t	bar	absolute vapour pressure of fluid at operating temperature
p_{perm}	bar	maximum permissible working pressure of pump
p_L/p		ratio of absolute gas charging pressure in pulsation damper to mean absolute pressure in pipe line
Δp_E	bar	suction valve pressure drop in pump head (see diagram)
Δp_{DHV}	bar	lifting pressure of pressure retaining valve (if fitted)
Δ p/p		relative pressure fluctuation in pulsation damper
Q_{tot}	l/h	metered flow of pump (from all pump heads in multi-cylinder pump with common pipe line)
V_{PD}	dm^3	volume of pulsation damper
ρ	kg/dm^3	density of fluid at operating temperature