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HEAT ENGINEERING – TECHNICAL INFORMATION

INTRODUCTION:

Thermal centres play an important role within heat engineering. The following factors are the reasons for this:

- Automation of a thermal centre makes settlements between the supplier and consumer of heat possible, based on the heat actually consumed; at the same time it allows to regulate the heat receiver in accordance with the supplier's requirements (limiting flow through the centre and parameters of water returning to the network) and enable the consumer to limit the amount of heat received at their own will,
- Automation of the thermal centre accounts for the greatest percentage share in power saving out of the total saving that may be achieved through automation of the whole heating system and internal installations of a building,
- Without automation of the thermal centre, automation of internal installations of a building is impossible,
- Automation of a thermal centre makes heat supply to a building independent of fluctuations from the network parameters caused by changes in consumption from neighbouring thermal centres,
- A high number of thermal centres and the demand for automatic control equipment resulting from it, justifies the design and manufacture of specialized assortments of so called heat engineering equipment, including self-operating regulators.

GENERAL CHARACTERISTICS OF REGULATORS:

Zakłady Automatyki "POLNA" S.A. in Przemyśl produces two series of types of self operating regulators:

- Type ZSN, with a flanged body ranging from DN15 to 100,
- Type ZSG, with a thread body end ranging from DN15 to 32.

The regulators are designed for fixed set-point pressure regulation, regulation of pressure differences and/or flow differences in technological installations connected with the regulator's valve in series or parallel.

Depending on the purpose, regulators are divided into the following types:

- ZSN1; ZSG1 – for regulation of pressure after the valve (reducer),
- ZSN2 – for regulation of pressure after the valve (reducer) with an intensifier,
- ZSN3; ZSG3 – for regulation of pressure before the valve (bleed regulator),
- ZSN5; ZSG5 – for regulation of pressure differences with flow limitation on the installation connected with the regulator's valve in series,
- ZSN6; ZSG6 – for regulation of pressure differences with flow limitation on the installation connected with the regulator's valve in series (installation on the return),
- ZSN7; ZSG7 – for regulation of pressure differences on the installation connected with the regulator's valve in parallel,
- ZSN8; ZSG8 – for flow regulation
- ZSN91; ZSG9.1 – for regulation of pressure differences and flow regulation on the installation connected with the regulator's valve in series (installation on the supply),
- ZSN92; ZSG9.2 – for regulation of pressure differences and flow regulation on the installation connected with the regulator's valve in series (installation on the return),
- ZSN10 – for regulation of pressure differences on the installation connected with the regulator's valve in series, with electromagnetic control.

PRINCIPLES OF SELECTING REGULATORS:

A. SELECTION OF REGULATOR'S VALVE

Selection of a regulator's valve means determination of flow coefficient Kv, and then the maximum flow of the medium through the valve or the minimum pressure drop on it.

Installation on the supply Installation on the run-off

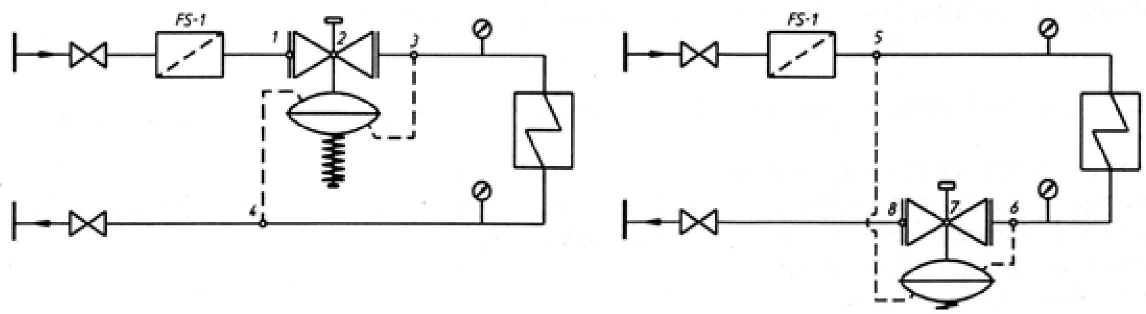

Figure 1

Input data:

Q - flow value [m^3/h],
Kvs - catalogue flow coefficient,
p_z - supply pressure [kPa], pressure in point 1 or 5,
Δp_r - regulated pressure difference [kPa], which means pressure drop on a technological installation connected in series with the valve of the regulator which needs to be stabilized. Pressure difference between points 3 and 4 or 5 and 6.
Δp_d - disposition pressure difference [kPa], which means pressure drop between the points with the highest and the lowest pressure in the centre. Pressure difference between points 1 and 4 or 5 and 8.
p_1 - pressure on valve's inlet (closing component) [kPa] (for steam and gases this should be regarded as the absolute pressure),
p_2 - pressure on valve's outlet [kPa] (for steam and gases this should be regarded as the absolute pressure),
Δp - pressure drop on the valve's closing component [kPa]; ($\Delta p=p_1-p_2$),
Δp_p - pressure difference on the flow limiter: (20 kPa lub 50 kPa),

In regulators without flow limitation, installed on the supply or on the return, and in regulators ZSN6 and ZSG6 (installed on the return), pressure drop on the valve should be assumed for the calculation of flow coefficient:

$$\Delta p = p_1-p_2 = \Delta p_d-\Delta p_r$$

For other regulators, installed on the supply or on the return:

$$\Delta p = p_1-p_2 = \Delta p_d-\Delta p_r-\Delta p_p$$

1. Selection procedure for water.

Pressure drop Δp [kPa] on the regulator's valve is:

$$\Delta p = p_1-p_2$$

The calculated flow coefficient of regulator's valve [m^3/h] is:

$$Kv = \frac{10 \cdot Q}{\sqrt{\Delta p}}$$

After calculating the minimum flow coefficient Kv that way, you should choose from the data board of the regulator, according to catalogue sheets, the nearest flow coefficient Kvs, so that:

$$Kv \leq 0,85 \cdot Kvs$$

The minimum pressure drop on a fully open valve of the regulator should be:

and

$$\Delta p_{min.} = \frac{100 \cdot Q^2}{Kvs^2}$$ - for regulators with a flow limiter

$$\Delta p_{min.} = \frac{100 \cdot Q^2}{Kvs^2} + \Delta p_p$$ - for regulators with a flow limiter

The maximum flow through the valve is:

$$Q_{max.} = 0{,}1 \cdot Kvs \cdot \sqrt{\Delta p}$$

2. Selection procedure for use on steam and gases.
Selection for those applications should be done by the manufacturer of the product.

B. NOISE.

Noise is generated by a valve results from cavitation (when concerning liquids) and excessive flow speed on the valve outlet (when concerning gases).

In regulators ZSN and ZSG no special construction means are designed to lower the potential noise. Therefore, below we just mention situations when excessive noise may occur, which need to be checked after selection of the regulator's valve.

If the boundary condition is exceeded, and the excessive noise is unacceptable (e.g. because of faster wearing out of the valve's closing component due to cavitation), systemic solutions should be applied to avoid such noise.

Such solution are as follows:

- By lowering the temperature on the valve's inlet (e.g. by moving the valve from the supply to the run-off),
- By lowering the pressure on the valve's inlet (e.g. by installing diaphragms before the valve or an additional reduction level)
- By increasing the pressure on the valve's inlet (e.g. by installing diaphragms after the valve or using choking elements in the form of multi-hole plates on the valve's outlet).

The reduction of noise has some conditions by not exceeding the boundary flow speed v = 3 [m/s] in water installations. This condition limits the maximum flow to the following value:

$$Q_{1\ max.}\ [m^3/h] = 8{,}5 \cdot 10^{-3} \cdot DN^2$$

At the flow speed of up to 5 [m/s], higher noise and a possibility of partial cavitation have to be taken into consideration and that value should not be exceeded:

$$Q_{2\ max.}\ [m^3/h] = 14 \cdot 10^{-3} \cdot DN^2$$

for DN50 - $Q_{1\ max.} = 21\ [m^3/h]$ i $Q_{2\ max.} = 35\ [m^3/h]$

C. SELECTION OF SETTING RANGE

The setting range of a regulator should be selected so that the value of regulated pressure would be in the lower half of the setting range. This ensures work with a lower spring tension and results in better parameters of work characteristics (proportionality, insensitivity and hysteresis ranges).

Apart from setting ranges recommended in our catalogue sheets, there are also special ranges that are possible.

D. CALCULATION EXAMPLES.

Example 1.

Regulator of pressure differences, installation on the supply, for water.

Technical data:

- Disposition pressure difference - $\Delta p_d = 450$ kPa,

- Regulated pressure difference - Δp_r = 60 kPa,
- Maximum flow - Q = 12 m^3/h

Calculations: $\Delta p = p_1 - p_2 = \Delta p_d - \Delta p_r = 450 - 60 = 390$ kPa

$$Kv = \frac{10 \cdot Q}{\sqrt{\Delta p}} = \frac{10 \cdot 12}{\sqrt{390}} = 6{,}0$$

In such a case, we choose a ZSN5 regulator, Kvs 8, setting range 40…160 kPa.

The nominal diameter of the regulator will be selected after an analysis of the flow speeds:

$$Q_{1\ max.}\ [m^3/h] = 8{,}5 \cdot 10^{-3} \cdot DN^2 \quad (\nu_{max.} = 3\ m/s),$$

$$Q_{2\ max.}\ [m^3/h] = 14 \cdot 10^{-3} \cdot DN^2 \quad (\nu_{max.} = 5\ m/s),$$

- for DN25 $Q_{1\ max.}$= 5,3 m^3/h ; $Q_{2\ max.}$= 8,75 m^3/h,
- for DN32 $Q_{1\ max.}$= 8,7 m^3/h ; $Q_{2\ max.}$= 14,3 m^3/h,
- for DN40 $Q_{1\ max.}$= 13,6 m^3/h ; $Q_{2\ max.}$= 22,4 m^3/h,

By choosing a DN25 regulator, we have to take into account a significant level of noise. Regulator DN32 in a special Kvs8 product is more beneficial. Regulator DN40 guarantees the greatest comfort as for the loudness of work.

Example 2.

A dual-function regulator of pressure differences and flow, for an installation on the return, for water.

Technical data:
- Disposition pressure difference - Δp_d = 400 kPa,
- Regulated pressure difference - Δp_r = 180 kPa,
- Maximum flow - Q = 32 m^3/h
- Choke setting assumed - Δp_p = 50 kPa,

Calculations: $\Delta p = p_1 - p_2 = \Delta p_d - \Delta p_r - \Delta p_p = 400 - 180 - 50 = 170$ kPa

$$Kv = \frac{10 \cdot Q}{\sqrt{\Delta p}} = \frac{10 \cdot 32}{\sqrt{170}} = 24{,}5$$

$$Kvs \cong \frac{Kv}{0{,}85} \cong 29 \qquad \text{assume Kvs 32}$$

In such a case we would choose a ZSN92; DN50; Kvs32; with pressure differences setting range 80…320 kPa, choke setting 50 kPa.

Depending on the flow speed, the flow is:

$$Q_{1\ max.} = 21\ m^3/h\ ;\ Q_{2\ max.} = 35\ m^3/h,$$

The regulator will work with an increased noise level.
The following condition is fulfilled:

$$\Delta p_d = 400 > 2 \cdot \Delta p_r = 2 \cdot 180 = 360$$

With a fully open choke, the valve works as a pressure differences regulator. The maximum flow is dependent on the acceptable flow speed. The range of flow regulation depends on the position of the choke and setting Δp_p.

$$Q = (0{,}1 \ldots 1{,}0) \cdot 10^{-1} \cdot Kvs \cdot \sqrt{\Delta p_p}$$

$$Q_{min.} = 0{,}1 \cdot 10^{-1} \cdot 32 \cdot \sqrt{50} = 2{,}3\ m^3/h$$

$$Q_{max.} = 1 \cdot 10^{-1} \cdot 32 \cdot \sqrt{50} = 23\ m^3/h$$

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