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THE ANALYSIS OF HYDRAULIC CHARACTERISTICS OF REGULATORY VALVE, INFLUENCED FROM VALVE'S AUTHORITY AND CONSTRUCTIVE CHARACTERISTICS

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ABSTRACT
The valve's authority presents report between pressure dropping in valve, and pressure dropping in the entire system. Since the regulatory valves influence the fluid flowing, this corresponds with changing the drop pressure in valve and system, therefore valve's authority changes.
Changing valve's authority, affects with changing the characteristics of regulatory valve.
By changing valve's authority, characteristics of valve with equal percentage might become a valve with linear characteristics, as well as characteristics of parabolic valve might become a valve with linear characteristics. These changes affect, choosing the proper valve.
Key words: Valve authority, valve characteristic

1. INTRODUCTION

The flowing characteristic of valve shows the dependence of fluid flowing Q and the step of opening valve *h*. This dependence is named the valve of static characteristics. The constructive characteristic is identical with static characteristic, but the only difference is that here the dropping pressure in valve is constant. The valve characteristic k_v shows the proportional between k_v and the fluid flowing Q.
The term k_V means the fluid flowing, expressed (m^3/h) in temperature between 5^0C and 30^0C, which flows in valve through pressure dropping from 1 bar.
Often the moving step of plate h (independent variable) and fluid flowing Q (dependent variable) are expressed in percentage of their maximum values. This dependence might be linear or non-linear, depending on the mode of using the valve.

2. THE HYDRAULIC CHARACTERISTICS OF THE REGULATORY VALVE

2.1. The linear characteristic of valve

The valve has a linear characteristic of the fluid flowing, where the difference of flowing is proportional with the difference of plate step of valve:

$$dQ = a \cdot dh \qquad (1)$$

where:

dh - the difference of plate step of valve,

dQ - the difference of flowing,

a - the proportional coefficient,

After the integration and substitution comes

$\bar{Q} = \bar{Q}_{\min} + (1 - Q_{\min}) \cdot \bar{h}$ (2) respectively $\bar{K}_V = \bar{K}_{V\min} + (1 - \bar{K}_{V\min}) \cdot \bar{h}$ (3)

2.2. The valve characteristic with equal percentage

In order to respect the characteristic with equal percentage, fluid flowing is necessary to have minimal value even when the valve is fully closed.

The flowing difference is proportional with: the difference of plate step of valve and the flowing quantity which can be expressed:

$$dQ = a \cdot Q \cdot dh \quad (4)$$

After the integration and substitution comes:

$\bar{Q} = \left(\frac{Q_{\min}}{Q_{\max}}\right) \cdot \left(\frac{Q_{\min}}{Q_{\max}}\right)^{-H} = \left(\frac{Q_{\min}}{Q_{\max}}\right)^{1-H}$ (5) respectively $\overline{K_V} = (\overline{K_{V\min}})^{1-\bar{h}}$ (6)

3. THE VALVE'S AUTHORITY

As it is discussed above the constructive characteristics of valve are defined with condition that the pressure dropping in valve must be constant. When changing the fluid flowing in the system, the pressure dropping is not the same, which means that the valve static characteristic is not always the same with the constructive one.

Valve's authority shows the report between pressure dropping in valve and the pressure dropping in the entire system:

$$s = \frac{dp_{v.\min}}{dp_{s.\max}} \quad (7)$$

$dp_{v.\min}$ - the pressure dropping in valve,

$dp_{s.\max}$ - the pressure dropping in the entire system.

4. THE DEPENDENCE OF STATIC CHARACTERISTIC FROM THE CONSTRUCTIVE CHARACTERISTICS AND VALVE'S AUTHORITY

The pressure dropping in the regulatory valve can be expressed as

$$\Delta p_v = \Delta p_s - \Delta p_c \quad (8)$$

where:

Δp_s – the pressure dropping in the entire system (including valve),

Δp_c – the pressure dropping in the entire system (without valve).

The pressure dropping Δp_c is proportional with the square of flowing and can be expressed

$$\frac{\Delta p_c}{\Delta p_{c\max}} = \frac{Q^2}{Q_{\max}^2} = \bar{Q}^2 \quad (9)$$

The dependence of static characteristic from constructive characteristic of valve can be expressed with relation

$$\overline{Q} = \overline{K}_v \sqrt{\frac{\Delta p_v}{\Delta p_{v.\min}}} \quad (10)$$

By substituting equations (8), (9) in equation (10), comes to relation

$$\overline{Q} = \overline{K}_v \sqrt{\frac{\Delta p_s - \Delta p_{c\max} \overline{Q}^2}{\Delta p_{v\min}}} \qquad (11)$$

Thus:

$$\overline{Q} = \sqrt{\frac{\overline{K}_v^2 \Delta p_s}{\Delta p_{v\min} + \overline{K}_v^2 \Delta p_{c\max}}} \qquad (12)$$

Since: $\Delta p_{c\max} = \Delta p_{s\max} - \Delta p_{v\min}$ (13)

and $$n = \frac{\Delta p_s}{\Delta p_{s\max}} \qquad (14)$$

By substituting equations (8), (13) and (14) in equation (12), comes the relation:

$$\overline{Q} = \sqrt{\frac{n}{1 + \left(\frac{1}{\overline{K}_v^2} - 1\right) \cdot s}} \qquad (15)$$

The equation (15) shows the static characteristic ($\overline{Q}$) in function of: constructive characteristic ($\overline{K}_v$), valve's authority (s) and report (n).

In special case when the pressure source is not dependence of flowing in system, then n=1, which means there is no pump but there is a source with a constant pressure, therefore equation (15) takes the form

$$\overline{Q} = \sqrt{\frac{1}{1 + \left(\frac{1}{\overline{K}_v^2} - 1\right) \cdot s}} \qquad (16)$$

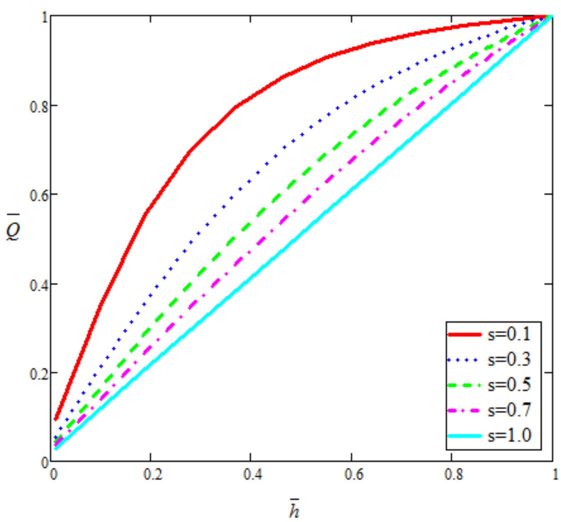

Figure 1.The linear characteristic of valve

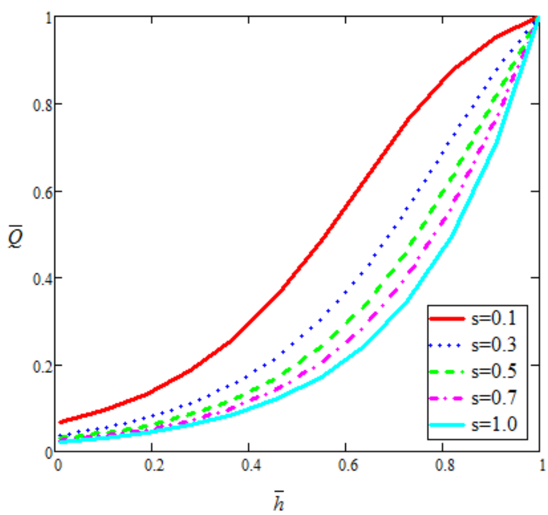

Figure 2. The valve characteristic with equal percentage

5. CONCLUSION

From figure 1 can be concluded:

- If valve's authority is smaller than s<0.3, then the static characteristic changes a lot from the constructive one.
- If valve's authority is bigger than s>0.5, then it can be taken that the linear constructive characteristic is rough with linear static characteristic of the valve.

From figure 2 can be concluded:

- If valve's authority is smaller than s<0.3, then the constructive characteristic is rough with linear static characteristic,
- If valve's authority is bigger than s>0.5 constructive characteristic is rough to static characteristic with equal percentage.

As it is discussed above is can be concluded that valve's authority is preferred to be s≥0.5, which means that static characteristic of the valve responds to constructive characteristic

For the linear regulatory system, constructive characteristic of the regulatory valve must be the same with the static characteristic and vise versa.

6. REFERENCES

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