White Paper for the design of Tailored of Plunger Valves.

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15 February, 2022

Abstract

The scope of this With paper is to provide guidelines for designing the Inherent Control Valve Flow Characteristics in such a way as to allow linear Installed Flow Characteristics.

Contents

1 Scope

The inherent and installed flow characteristic, the relationship between flow coefficient and valve stroke, has been a subject of misunderstandings and endless debate with water transport and distribution systems operators.

The control valves must be analyzed from the perspective of their *inherent characteristics* and their system behavior (*Installed characteristics*). The *"inherent flow characteristic"* is the relationship between the flow rate through a valve and the travel of the closure member as the closure member is moved from the closed position to-rated travel with a constant pressure drop across the valve. *The Inherent flow characteristics* are determined under laboratory conditions. But, what interests hydraulic design engineers, control engineers, and automation engineers are *the installed flow characteristics. "The Installed flow characteristics"* include both the valve and pipeline effects. In other words, One crucial requirement in selecting the proper control valve is ensuring that the valve has the properly *installed flow characteristic. The installed flow characteristic* usually differs from the inherent due to changes in pressure drop: as flow increases, there is less pressure drop available across the valve. It's generally desirable to have a linear installed characteristic.

2 Basic definitions

Basic terminology used herein is based on definitions stated in "Control Valve Terminology" [2] or applicable IEC standards.

- **Flow coefficient:** Flow coefficient is a constant (K_v) related to the geometry of a valve plus cylinder (obturator) for a given valve opening that can be used to predict flow rate; see ANSI/ISA-75.01.01 (IEC 60534-2-1 Mod)-2007, "Flow Equations for Sizing Control Valves," [1] and ANSI/ISA-75.02.01-2008, "Control Valve Capacity Test Procedures" [3].
- **Inherent flow characteristic:** The Inherent flow characteristic is the relationship between the flow rate through a valve and the travel of the closure member as the closure member is moved from the

closed position to-rated travel with a constant pressure drop across the valve [4]. The Inherent flow characteristics are determined under laboratory conditions by testing the valve flow versus valve position or travel using a constant differential pressure drop across the valve through the test. Manufacturers publish the inherent flow characteristics for each control valve plus the cylinder. The Inherent flow characteristics are standardized for a fixed pressure drop as defined using the valve flow coefficient value K_v.

- **Inherent flow characteristic curves:** Control valves can be mounted with different cylinders in such a way as to present different performance curves for the percentage of rated $K_{v_{max}}$ versus the percent of rated travel of the cylinder. There are three basic characteristics: Quick opening; Linear and Equal percentage.
- **Relative flow coefficient (ϕ):** The relative flow coefficient is the flow coefficient ($K_{v_{max}}$) ratio at a stated full open to the flow coefficient (K_v) at rated travel [4].

3 Example A

It is a simple water transport system between two reservoirs, which are 500 *meters* apart, and the elevation of the deposits is 100 and 5 *meters*, respectively. Before the entrance to the second tank, a control valve has been installed (see Flow Schematic).

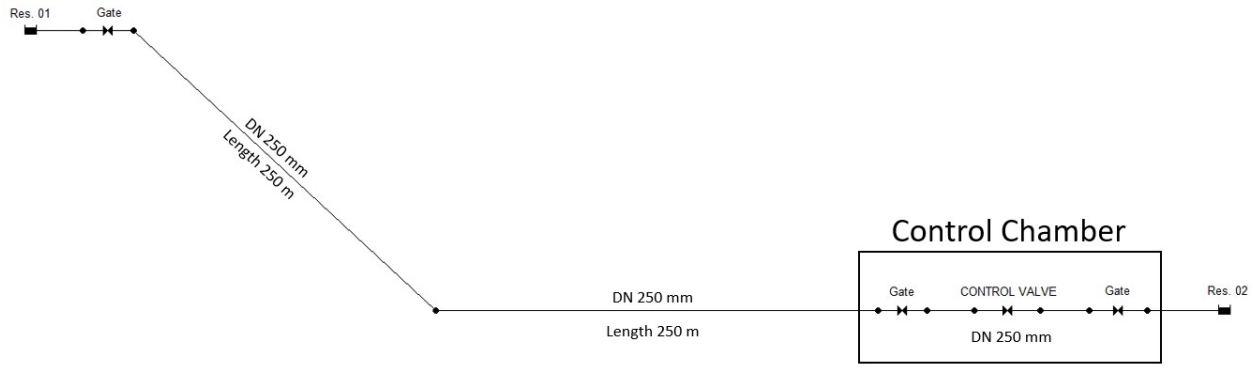

Figure 1: Flow Schematic

The maximum flow possible the line gives, considering the losses due to fittings and pipe, is 370.53 l/s.

Kv and Zeta Value
depending on valve position

Valve Position	Kv (l/s)	Zv (-)
10%	1.4	257,537.8
15%	4.5	23,330.4
20%	10.6	4,307.8
25%	20.2	1,184.6
30%	33.8	422.4
35%	51.5	181.5
40%	73.2	89.9
45%	98.2	49.9
50%	125.8	30.4
55%	155.0	20.0
60%	184.9	14.1
65%	214.5	10.5
70%	243.2	8.1

75%	270.4	6.6
80%	295.8	5.5
85%	319.1	4.7
90%	340.4	4.2
95%	359.6	3.7
100%	376.8	3.4

Reference

[1] American National Standards Institute ; International Society of Automation: ANSI/ISA-75.01.01-2007, Flow equations for sizing control valves.

[2] American National Standards Institute ; ISA–The Instrumentation, Systems, and Automation Society ; Instrument Society of America: ANSI/ISA-75.05.01-2000 (R2005), Control Valve Terminology.

[3] International Society of Automation ; American National Standards Institute: ANSI/ISA-75.02.01-2008, Control valve capacity test procedures.

[4] International Society of Automation ; American National Standards Institute: ISA-75.11-2013 (2013), Inherent flow characteristic and rangeability of control valves.

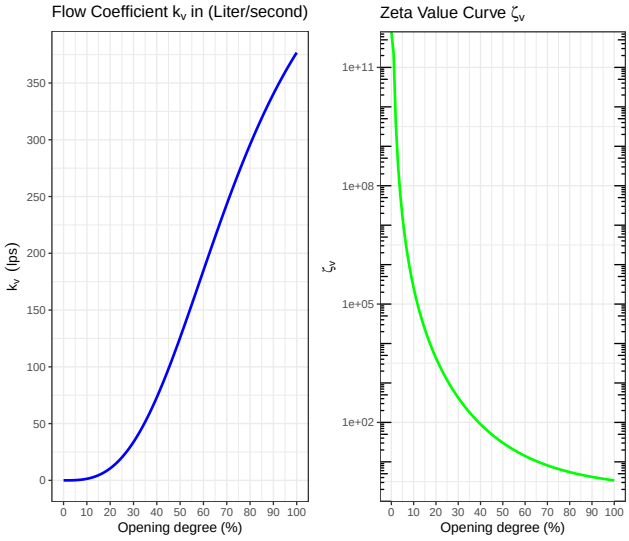

Figure 2: Flow Coeficient and Zeta Value