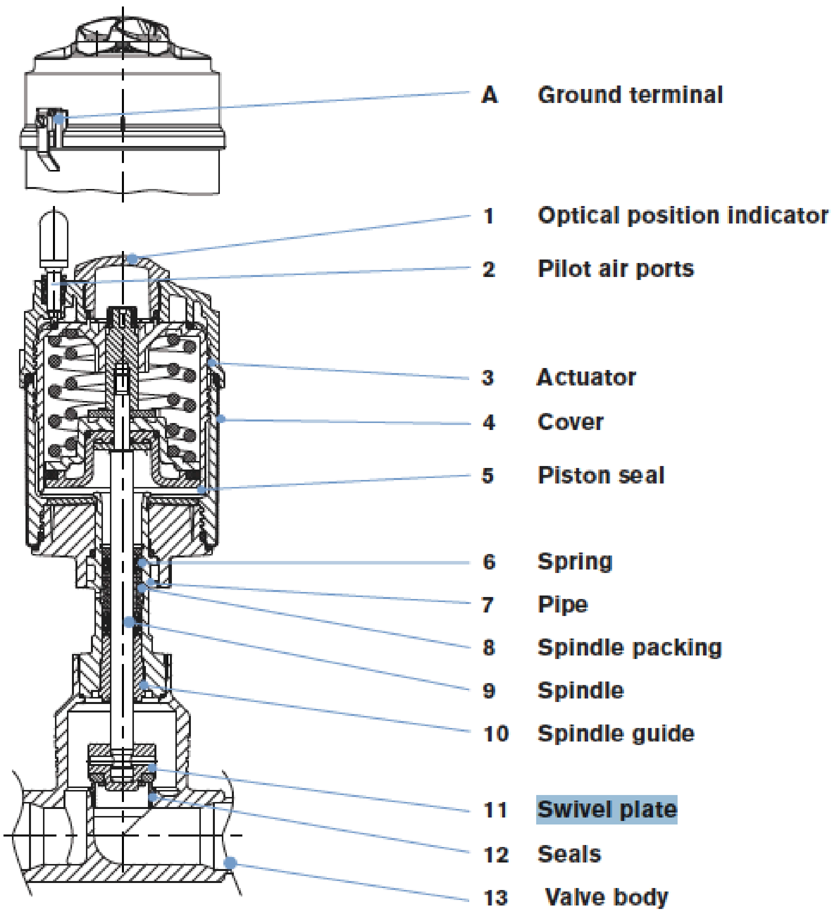
Livescript by M. Fraganza, M. Miccio, M. Rossi - Rev_5.mlx

Consider a **Burkert 2013 globe valve**



with the related Table provided by the manufacturer.

Objectives

- Size the valve with design data that is not unique, but subject to constraints of the type >=
- Calculation and graphical representation of the Intrinsic Characteristic for a globe valve by formulas
- Calculation of the flow coefficient at 70% of the relative stroke.
- The inherent characteristic chosen for the valve automatically determines the authority value.
- Plot of the installed characteristic based on the values of rangeability and authority.

- `Calculations of specific points of the installed characteristic`

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Problem

It is required the sizing of a **globe valve** for the following conditions:

nominal diameter of the line: DN = 65 mm

liquid: olive oil, with a density ϱ = 920 kg/m3

upstream pressure of the valve: P1 = 4.5 atm

downstream pressure of the circuit in which the valve is inserted: P3 = 1.6 atm

downstream pressure of the valve P2 as given from the formula ΔP = (P1 - P2) = 35%(P1 - P3)

nominal flow rate in the range: 4.5 ÷ 6.5 L/s

vapor pressure: Pv= 0.003 atm

liquid critical pressure ratio factor: FF = 0.956

1. Calculate the **flow coefficient Cv** for the above conditions

The manufacturer provides the following Table for a Burkert 2013 valve:

DN (mm)	K_{vn} ($m^3(H_2O)$ / h $bar^{1/2}$)
10	2.7
15	4.0
20	7.1
25	12.0
32	18.0
40	34.0
50	48.0
65	64.0

$C_{vn} = 1.16\ K_{vn}$

which is available with the usual intrinsic characteristics: **linear, equal percentage** and **quadratic**.

The *rangeability* is always r = 30.

2. **Size the valve** for the problem, choosing the one with the most appropriate DN and intrinsic characteristic.

Next, you are prompted to enter the sized valve in a circuit, taking DPn equal to the original value (P1 - P2) and considering an user's equipment pressure drop:

DP0= 2.9 atm

3. How much is the V **authority**?

4. Discuss if the calculated value for the authority V is consistent or not with the inherent characteristic previously chosen under the point 2)

5. Calculate V_punto_n

6. How much is the **flow rate** V_punto1(h) which passes the valve for **h1 = 0.4**?

7. How much is the actual **pressure drop** across the valve DPv1 for **h1 = 0.4**?

8. What is the **relative stroke** h2 that allows a flow rate V_punto2 = 155 gal/min passing trough the circuit

9. Check **cavitation** according to IEC norm

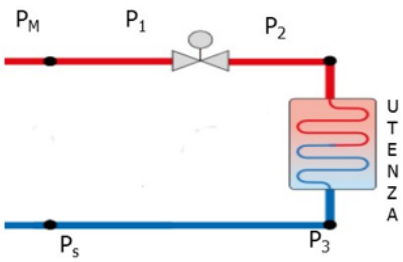
Solution

Insert Data

d =

$920\ \frac{kg}{m^3}$

G_f = 0.92



The pressure values must be entered in *psi*

P1 = 66 psi

P3 = 23.38 psi

In this case the pressure P2 must be calculated from the problem data,

with the simple formula: $P_2 = P_1 - \frac{35}{100}(P_1 - P_3)$

P2 = 51.08 psi

$\Delta P = P_1 - P_2$ # this is the "deltaP_design"

deltaP_design = 14.92 psi

The value of the flow rate must be entered in *gal(US)/min*

V_punto =

$103\ \frac{gal}{min}$

Flow Coefficient

$$C_v = \frac{\dot{V}}{\sqrt{\frac{\Delta P}{G_f}}} \qquad \frac{gal}{min \cdot psi^{0.5}}$$

C_v =

$$25.58\ \frac{\mathrm{gal}\ \frac{1}{\sqrt{\mathrm{psi}}}}{\mathrm{min}}$$

Sizing the valve

The **Manufacturer's Table** is :

DN (mm)	C_{vn} (gal/min psi$^{1/2}$)
10	3.12
15	4.64
20	8.236
25	13.92
32	20.88
40	39.44
50	55.68
65	74.24

DN = $(10\ \mathrm{mm}\quad 15\ \mathrm{mm}\quad 20\ \mathrm{mm}\quad 25\ \mathrm{mm}\quad 3\ \mathrm{mm}\quad 40\ \mathrm{mm}\quad 50\ \mathrm{mm}\quad 65\ \mathrm{mm})$

C_vn =

$$\left(3.12\,\sigma_1\quad 4.64\,\sigma_1\quad 8.24\,\sigma_1\quad 13.9\,\sigma_1\quad 20.9\,\sigma_1\quad 39.4\,\sigma_1\quad 55.7\,\sigma_1\quad 74.2\,\sigma_1\right)$$

where

$$\sigma_1 = \frac{\mathrm{gal}\ \frac{1}{\sqrt{\mathrm{psi}}}}{\mathrm{min}}$$

scelta_riga = 7

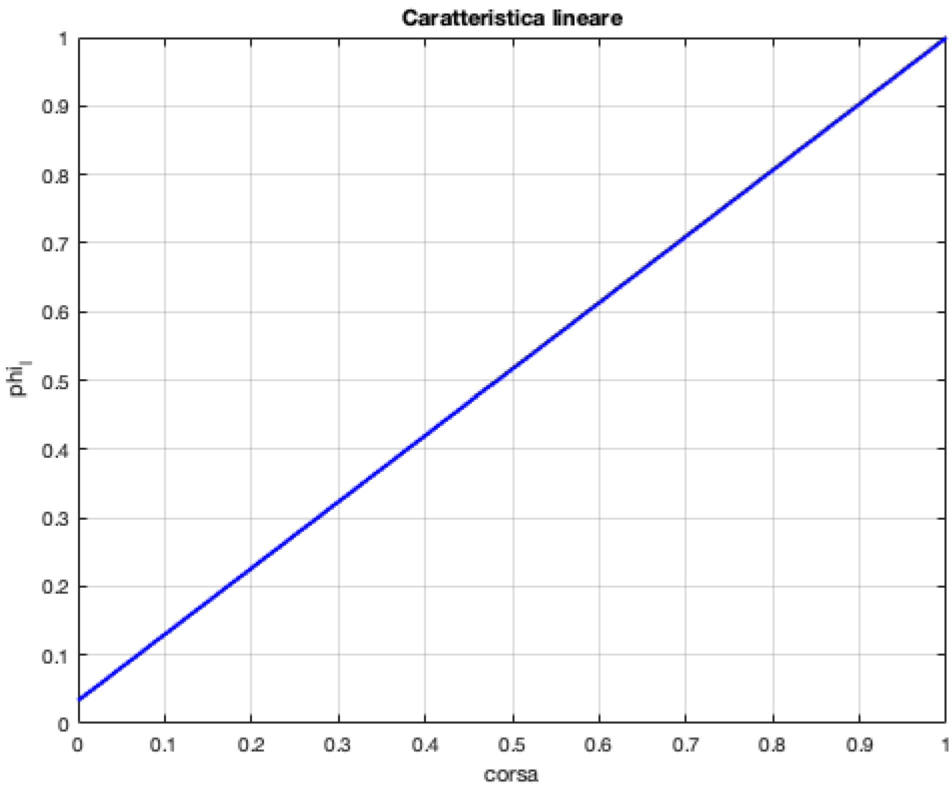
my_DN = $50\ \mathrm{mm}$

my_Cvn =

$$55.68\ \frac{\mathrm{gal}\ \frac{1}{\sqrt{\mathrm{psi}}}}{\mathrm{min}}$$

Linear Characteristic

$$\phi_{\mathrm{lineare}} = h + \frac{(1-h)}{r}$$

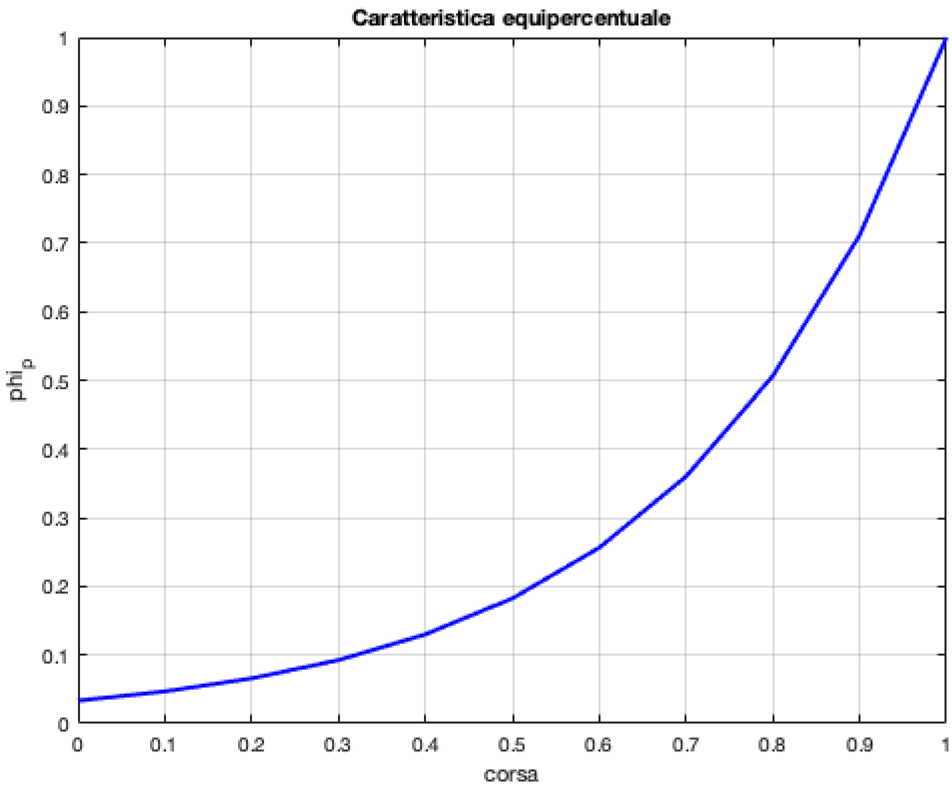



```
Cv_70_lin =
```

$$39.5 \, \frac{\text{gal} \, \frac{1}{\sqrt{\text{psi}}}}{\text{min}}$$

Equipercentage Characteristic

$$\phi_{\text{equipercentuale}} = r^{(h-1)}$$

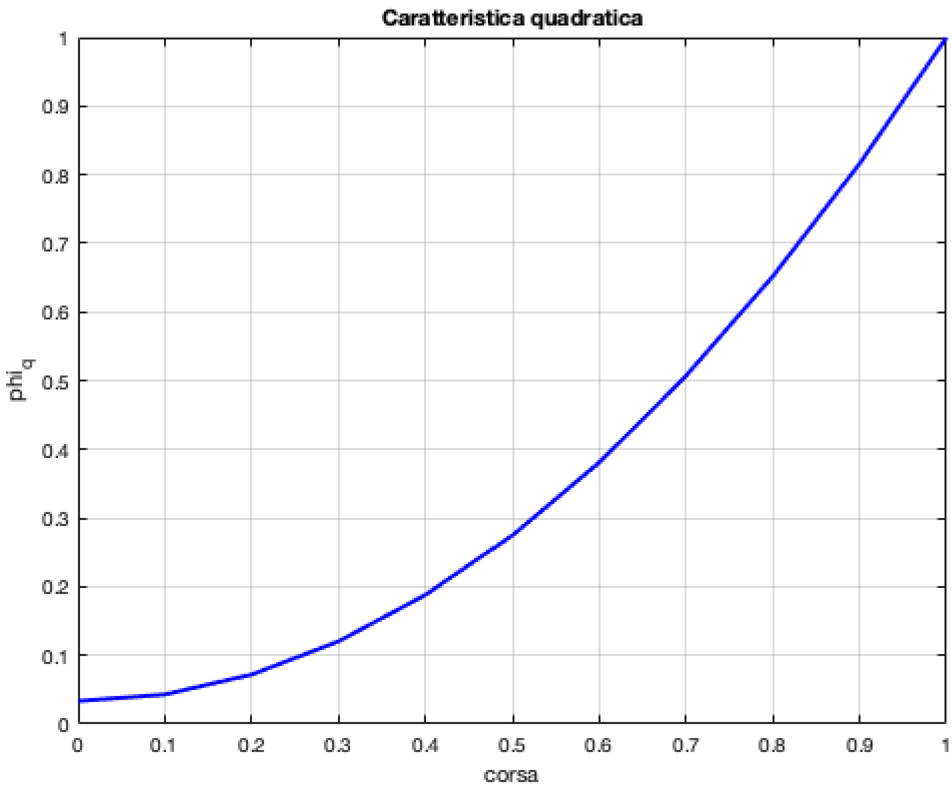



```
Cv_70_exp =
```

$$20.1 \frac{\mathrm{gal}\,\frac{1}{\sqrt{\mathrm{psi}}}}{\mathrm{min}}$$

Parabolic Characteristic

$$\phi_{\mathrm{quadratica}} = h^2 + \frac{(1-h^2)}{r}$$




```
h = 0.7000
Cv_70_par =
```

$$28.2 \frac{\text{gal} \frac{1}{\sqrt{\text{psi}}}}{\text{min}}$$

Choice of the most suitable intrinsic characteristic for the valve with the DN already chosen

```
C_v = 25.5794
Cv_70_lin = 39.5328
Cv_70_exp = 20.0707
Cv_70_par = 28.2298
stringa_1 =
"sizing ok  -:)"
stringa_3 =
"Car_quadratic"
```

Authority

Delta_Pn = 14.92 psi

```
Delta_P0 = 42.62 psi
```

$$\Delta P_u = \Delta P_0 - \Delta P_n$$

```
Delta_Pu = 27.7 psi
```

authority : $V = \dfrac{\Delta P_n}{\Delta P_0}$

```
authority = 0.35
```

```
stringa =
"la caratteristica intrinseca migliore è quadratica"
```

Nominal Flow

$$\dot{V}_n = C_{\text{vn}} \sqrt{\frac{\Delta P_n}{G_f}} \qquad \frac{\text{gal}}{\text{min}}$$

```
V_nominale =
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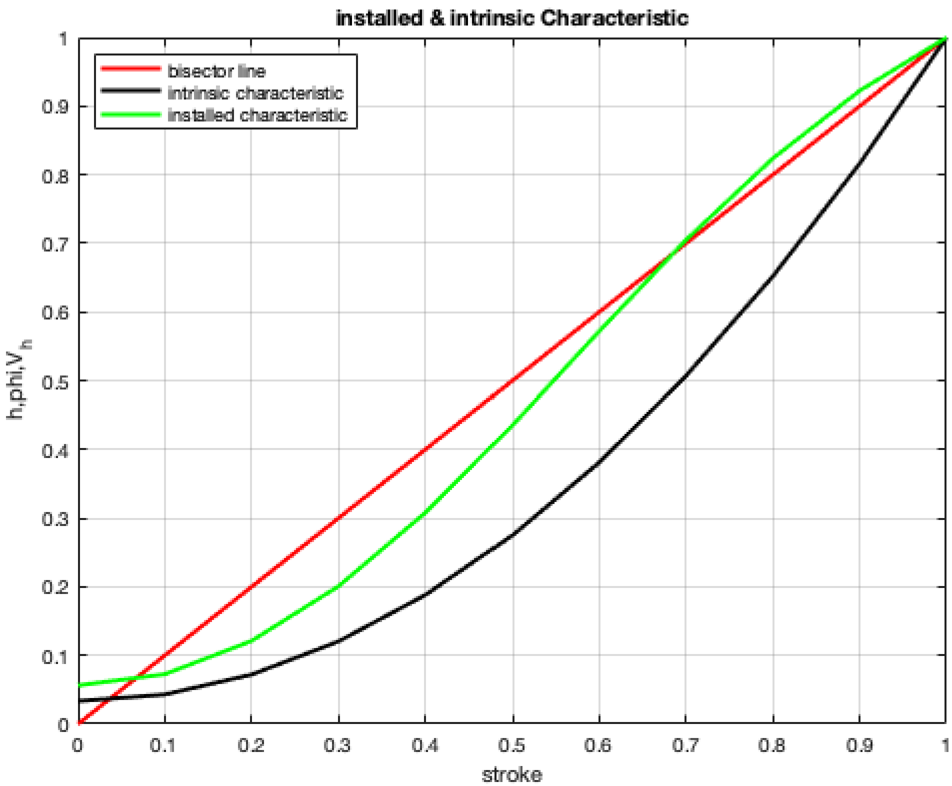
$224.2\ \dfrac{\text{gal}}{\text{min}}$

Installed Characteristic



Flow rate at given h

```
phi = 0.1880
```

$$\dot{V}_1(h) = \frac{V_{\text{nominale}}}{\sqrt{\left(1 - \text{authority} + \frac{\text{authority}}{(\phi(h))^2}\right)}} \qquad \frac{\text{gal}}{\text{min}}$$

```
V_punto1 =
```

$69.0\ \frac{\text{gal}}{\text{min}}$

Pressure drop across the valve at given h

$$\Delta P_{v1} = \left(\frac{\dot{V}_1(h)}{\phi(h) \cdot C_{vn}}\right)^2 \cdot G_f\ \text{psi}$$

Delta_PV = $39.99\ \text{psi}$

Relative stroke at a given flow rate

$$\phi(h_2) = \sqrt{\frac{\text{authority}}{\left(\frac{\dot{V}_n}{\dot{V}(h_2)}\right)^2 - 1 + \text{authority}}}$$

phi_2 = 0.493

Stroke value formula for quadratic case $h_q = \sqrt{\left(\frac{(\phi(h_2) \cdot r - 1)}{(r-1)}\right)}$

Stroke value formula for equalpercentage case $h_{exp} = \frac{\log(\phi_{exp})}{\log(r)} + 1$

Stroke value formula for linear case $h_{lin} = \frac{\phi_{lin} \cdot r - 1}{r - 1}$

h_2 is determined by the expression of the intrinsic characteristic

h_q = 0.6893

Cavitation

Checking cavitation according to the IEC 60534 Norm

Pv = 0.044 psi

F_F = 0.9560

F_L is taken equal to 0.9 for a **globe valve**

F_L = 0.9000

Delta_P = 14.92 psi

$$\Delta P_{max} = F_l^2 \cdot (P_1 - F_f * P_v)$$

Delta_Pmax = 53.4 psi

stringa =
"No cavitation :-)"

Flow Characteristic

K_c = 0.6480

Values are determined with ref. at Cv at 70% of the stroke

Delta_Pc = 42.7 psi

Rad_Delta_Pc = $\sqrt{42.7 \text{ psi}}$

Delta_Pmax = $53.4\ psi$

Rad_Delta_Pmax = $\sqrt{53.4\ psi}$

Delta_Pf = $66.0\ psi$

Rad_Delta_Pf = $\sqrt{66.0\ psi}$

Cv_70_par = 28.2298

V_puntoc =

$192.4\ \frac{gal}{min}$

V_max =

$215.1\ \frac{gal}{min}$

V_efflux = $(0 \quad 192.0 \quad 215.0 \quad 215.0)$

Rad_DeltaP_efflux = $(0 \quad 6.54 \quad 7.31 \quad 8.12)$