Valve33

In[153]:=
```
<< C:\\Hopsan\Compgen\CompgenNG.mx
```

In[154]:=
```
path = ToFileName[{"H:", "PettersDropbox", "Dropbox",
    "HopsanComponents", "PneumaticDevelop", "PneumaticComponents"}]
```

Out[154]=
```
H:\PettersDropbox\Dropbox\HopsanComponents\PneumaticDevelop\PneumaticComponents\
```

In[155]:=
```
path = ToFileName[{"C:", "Users", "petkr14", "Dropbox",
    "HopsanComponents", "PneumaticDevelop", "PneumaticComponents"}]
```

Out[155]=
```
C:\Users\petkr14\Dropbox\HopsanComponents\PneumaticDevelop\PneumaticComponents\
```

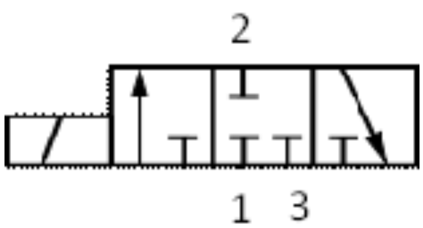
In[156]:=
```
domain = "Pneumatic";
displayName = "Valve33";
brief = "Pneumatic 33-valve";
componentType = "ComponentQ";
author = "Petter Krus <petter.krus@liu.se>";
affiliation = "Division of Fluid and Mechatronic Systems, Linköping University";
SetFilenames[path, domain, displayName];
ResetComponentVariables[];
Date[]
```

Out[164]=
```
{2020, 7, 29, 14, 2, 38.0080433}
```

In[165]:=
```
eps =.; R =.;
```

Component description

This is a simple pneumatic valve with three ports and three positions. It is closes all flow paths when the input signal is zero and opens between pressure port (1) and load port (2) when it is one. The opening is proportional to the input signal. At negative signals it opens the load port (2) to the return port (3). There is no valve dynamics.



In[166]:=
```
inputParameters = {
    {Cd, 0.65, double, "", "Discharge coefficient"},
    {R, 287., double, "J/Kg K", "Gas constant"},
    {cv, 718, double, "J/Kg K", "heatcoeff"},
    {eps, 0.02, double, "", "Linearisation coeff"},
    {x0, 0.1, double, "", "Relative overlap"},
    {A1max, 1. * 10^-5, double, "m2", "Max opening area"},
    {A3max, 1. * 10^-5, double, "m2", "Max opening area"}
  };
```

In[167]:=
```
inputVariables = {
    {xin, 1, double, "", "Input signal -1<xin<1"}
  };
```

In[168]:=
```
outputVariables = {
    {qm12Pos, 0., double, "kg/s", "Internal variable"},
    {qm12Neg, 0., double, "kg/s", "Internal variable"},
    {qm32Pos, 0., double, "kg/s", "Internal variable"},
    {qm32Neg, 0., double, "kg/s", "Internal variable"},
    {Ng32e, 0., double, "", "Internal variable"},
    {Ng12e, 0., double, "", "Internal variable"}
  };

nodeConnections = {
    PneumaticQnode[1, 100000., "fluid port 1"],
    PneumaticQnode[2, 100000., "fluid port 2"],
    PneumaticQnode[3, 100000., "fluid port 3"]
  };
```

In[170]:=
```
0.01 × 2 Pi .001
```

Out[170]=
```
0.0000628319
```

The system of equations

In[171]:=
```
xine = xin;
```

The valve areas are limited between 0 and A1max and A3max respectively .

In[172]:=

$$A12 = A1max\ limit\left[\left(\frac{xine - x0}{1 - x0}\right), 0, 1\right];$$

$$A32 = A3max\ limit\left[\left(\frac{-xine - x0}{1 - x0}\right), 0, 1\right];$$

The flow at inlet and outlet are equal but with opposite sign.

In[174]:=
```
Ng1 = 1;
```

In[175]:=

$$Ng12pos = \left(signedSquareL\left[\frac{\left(\frac{p2}{p1}\right)^{2/kappa} - \left(\frac{p2}{p1}\right)^{(kappa+1)/kappa}}{Ndenom}, eps\right]\right);$$

In[176]:=

$$Ng12neg = \left(signedSquareL\left[\frac{\left(\frac{p1}{p2}\right)^{2/kappa} - \left(\frac{p1}{p2}\right)^{(kappa+1)/kappa}}{Ndenom}, eps\right]\right);$$

In[177]:=

$$Ng12 := onPositive[p1 - p2]\left(onPositive\left[\frac{p2}{p1} - crit\right] Ng12pos + onNegative\left[\frac{p2}{p1} - crit\right] Ng1\right) + onNegative[p1 - p2]\left(onPositive\left[\frac{p1}{p2} - crit\right] Ng12neg + onNegative\left[\frac{p1}{p2} - crit\right] Ng1\right);$$

In[178]:=

$$Ng32pos = \left(signedSquareL\left[\frac{\left(\frac{p2}{p3}\right)^{2/kappa} - \left(\frac{p2}{p3}\right)^{(kappa+1)/kappa}}{Ndenom}, eps\right]\right);$$

In[179]:=
$$\text{Ng32neg} = \left(\text{signedSquareL}\left[\frac{\left(\frac{p3}{p2}\right)^{2/\text{kappa}} - \left(\frac{p3}{p2}\right)^{(\text{kappa}+1)/\text{kappa}}}{\text{Ndenom}}, \text{eps}\right]\right);$$

In[180]:=
$$\text{Ng32} := \text{onPositive}[p3 - p2] \left(\text{onPositive}\left[\frac{p2}{p3} - \text{crit}\right] \text{Ng32pos} + \text{onNegative}\left[\frac{p2}{p3} - \text{crit}\right] \text{Ng1}\right) + \text{onNegative}[p3 - p2] \left(\text{onPositive}\left[\frac{p3}{p2} - \text{crit}\right] \text{Ng32neg} + \text{onNegative}\left[\frac{p3}{p2} - \text{crit}\right] \text{Ng1}\right);$$

Equations

In[181]:=
$$\text{localExpressions} = \{$$
$$\text{kappa} == 1 + \frac{R}{cv},$$
$$\text{Kg} == \sqrt{\frac{2^{\frac{\text{kappa}+1}{\text{kappa}-1}}\,\text{kappa}\left(\frac{1}{\text{kappa}+1}\right)^{\frac{\text{kappa}+1}{\text{kappa}-1}}}{R}},$$
$$\text{Ndenom} == 2^{\frac{\text{kappa}+1}{\text{kappa}-1}-1}\,(\text{kappa} - 1)\left(\frac{1}{\text{kappa} + 1}\right)^{\frac{\text{kappa}+1}{\text{kappa}-1}},$$
$$\text{crit} == 2^{\frac{\text{kappa}}{\text{kappa}-1}}\left(\frac{1}{\text{kappa} + 1}\right)^{\frac{\text{kappa}}{\text{kappa}-1}},$$
$$cp == cv + R$$
$$\};$$

In[182]:=
```
dE12 = qm12 cp (onNegative[qm12] T2 + onPositive[qm12] T1);
dE32 = qm32 cp (onNegative[qm32] T2 + onPositive[qm32] T3);

qm12 = (onPositive[p1 - p2] qm12Pos - onNegative[p1 - p2] qm12Neg);
qm32 = (onPositive[p3 - p2] qm32Pos - onNegative[p3 - p2] qm32Neg);
```

In[186]:=
$$\text{systemEquationsDA} = \text{Simplify}[\{$$
$$\text{qm12Pos} == \frac{p1\ Cd\ A12\ Kg\ Ng12}{\sqrt{T1}},$$
$$\text{qm12Neg} == \frac{p2\ Cd\ A12\ Kg\ Ng12}{\sqrt{T2}},$$
$$\text{qm32Pos} == \frac{p3\ Cd\ A32\ Kg\ Ng32}{\sqrt{T3}},$$
$$\text{qm32Neg} == \frac{p2\ Cd\ A32\ Kg\ Ng32}{\sqrt{T2}},$$
$$dE2 == dE12 + dE32,$$
$$dE1 == -dE12,$$
$$dE3 == -dE32$$
$$\}];$$

Boundaries

In[187]:=
```
systemBoundaryEquations = {
    p2 == (c2 + Zc2 dE2 ),
    p1 == (c1 + Zc1 dE1 ),
    p3 == (c3 + Zc3 dE3)
   };
```

Independent Variables

In[188]:=
```
systemVariables = {qm12Pos, qm12Neg, qm32Pos, qm32Neg, dE2, dE1, dE3, p2, p1, p3};
```

Expressions

The inlet flow is calculated as the outlet flow with reversed sign.

In[189]:=
```
expressions = {
    qm2 == qm12 + qm32,
    qm1 == - qm12,
    qm3 == - qm32,
    Ng32e == Ng32,
    Ng12e == Ng12
   };
```

In[190]:=
```
Compgen[file]
```