Valve52

In[1]:=
```
<< C:\\Hopsan\Compgen\CompgenNG.mx
```

This path is pointing to where the file should be generated

In[2]:=
```
path = ToFileName[{"C:", "Users", "petkr14", "Dropbox",
     "HopsanComponents", "PneumaticDevelop", "PneumaticComponents"}];
```

In[3]:=
```
path = ToFileName[{"H:", "PettersDropbox", "Dropbox",
     "HopsanComponents", "PneumaticDevelop", "PneumaticComponents"}];

domain = "Pneumatic";
displayName = "Valve52";
brief = "Pneumatic 52-valve";
componentType = "ComponentQ";
author = "Petter Krus*<petter.krus@liu.se>,
     Victor Juliano De Negri** <victor.de.negri@ufsc.br>";
affiliation = "*IEI/Flumes, Linköping University, **Universidade
     Federal de Santa Catarina";
SetFilenames[path, domain, displayName];
ResetComponentVariables[];
Date[]
```

Component description

This is a simple pneumatic valve with three ports and three positions. The opening is proportional to the input signal and limited between 0 and 1. At 1 input signal it opens between pressure port (1) and load port (4) and between the load port (2) and return (3). When the input signal it is one. At zero input signal it opens the load port (2) to the pressure port (1) and between the load port (4) and return port (5). The opening is proportional to the input signal. There is no valve dynamics

In[14]:=
```
inputParameters = {
    {Bf, .528, double, "", "B, ISO critical pressure ratio"},
    {Cf, 1. × 10^-13, double, "", "C, ISO flow coefficient"},
    {x0, 0.1, double, "", "Relative overlap"},
    {p0, 100000., double, "Pa", "Nominal pressure"},
    {T0, 297., double, "K", "Nominal temperature"},
    {R, 287., double, "J/Kg K", "Gas constant"},
    {cv, 718, double, "J/Kg K", "heatcoeff"},
    {eps, 0.02, double, "", "Linearisation coeff"}
   };
```

In[15]:=
```
inputVariables = {
    {xin, 1, double, "", "Input signal 0<xin<1"}
   };
```

In[16]:=
```
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"},
    {qm14Pos, 0., double, "kg/s", "Internal variable"},
    {qm14Neg, 0., double, "kg/s", "Internal variable"},
    {qm54Pos, 0., double, "kg/s", "Internal variable"},
    {qm54Neg, 0., double, "kg/s", "Internal variable"},
    {Ng32e, 0., double, "", "Internal variable"},
    {Ng12e, 0., double, "", "Internal variable"},
    {Ng54e, 0., double, "", "Internal variable"},
    {Ng14e, 0., double, "", "Internal variable"},
    {Bfe, 0., double, "", "Internal variable"}
   };
```

In[17]:=
```
nodeConnections = {
    PneumaticQnode[1, 100000., "fluid port 1 (P)"],
    PneumaticQnode[2, 100000., "fluid port 2 (A)"],
    PneumaticQnode[3, 100000., "fluid port 3 (R)"],
    PneumaticQnode[4, 100000., "fluid port 4 (B)"],
    PneumaticQnode[5, 100000., "fluid port 5 (S)"]
   };
```

The system of equations

The spool position is recalculated.

In[18]:=
```
xine = 1 - 2 xin;
```

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

In[19]:=
```
Cf12 = Cf limit[((xine - x0)/(1 - x0)), 0, 1];
Cf32 = Cf limit[((-xine - x0)/(1 - x0)), 0, 1];
Cf14 = Cf limit[((-xine - x0)/(1 - x0)), 0, 1];
Cf54 = Cf limit[((xine - x0)/(1 - x0)), 0, 1];
```

In[23]:=
```
Bf12 = Bf;
Bf32 = Bf;
Bf14 = Bf;
Bf54 = Bf;
```

Calculation of the Ng functions for flow calculations.

In[27]:=
```
Ng1 = 1;
```

In[28]:=
```
Ng12Pos := (signedSquareL[1 - ((p2/p1 - Bf12)^2/(1 - Bf12)^2), eps])
```

In[29]:=
```
Ng12Neg := (signedSquareL[1 - ((p1/p2 - Bf12)^2/(1 - Bf12)^2), eps])
```

In[30]:=
$$Ng12 := onPositive[p1 - p2]\left(onPositive\left[\frac{p2}{p1} - Bf12\right] Ng12Pos + onNegative\left[\frac{p2}{p1} - Bf12\right] Ng1\right) + onNegative[p1 - p2]\left(onPositive\left[\frac{p1}{p2} - Bf12\right] Ng12Neg + onNegative\left[\frac{p1}{p2} - Bf12\right] Ng1\right);$$

In[31]:=
$$Ng32Pos := \left(signedSquareL\left[1 - \frac{\left(\frac{p2}{p3} - Bf32\right)^2}{(1 - Bf32)^2}, eps\right]\right)$$

In[32]:=
$$Ng32Neg := \left(signedSquareL\left[1 - \frac{\left(\frac{p3}{p2} - Bf32\right)^2}{(1 - Bf32)^2}, eps\right]\right)$$

In[33]:=
$$Ng32 := onPositive[p3 - p2]\left(onPositive\left[\frac{p2}{p3} - Bf32\right] Ng32Pos + onNegative\left[\frac{p2}{p3} - Bf32\right] Ng1\right) + onNegative[p3 - p2]\left(onPositive\left[\frac{p3}{p2} - Bf\right] Ng32Neg + onNegative\left[\frac{p3}{p2} - Bf32\right] Ng1\right);$$

In[34]:=
$$Ng14Pos := \left(signedSquareL\left[1 - \frac{\left(\frac{p4}{p1} - Bf14\right)^2}{(1 - Bf14)^2}, eps\right]\right)$$

In[35]:=
$$Ng14Neg := \left(signedSquareL\left[1 - \frac{\left(\frac{p1}{p4} - Bf14\right)^2}{(1 - Bf14)^2}, eps\right]\right)$$

In[36]:=
$$Ng14 := onPositive[p1 - p4]\left(onPositive\left[\frac{p4}{p1} - Bf14\right] Ng14Pos + onNegative\left[\frac{p4}{p1} - Bf14\right] Ng1\right) + onNegative[p1 - p4]\left(onPositive\left[\frac{p1}{p4} - Bf14\right] Ng14Neg + onNegative\left[\frac{p1}{p4} - Bf14\right] Ng1\right);$$

In[37]:=
$$Ng54Pos := \left(signedSquareL\left[1 - \frac{\left(\frac{p4}{p5} - Bf54\right)^2}{(1 - Bf54)^2}, eps\right]\right)$$

In[38]:=
$$Ng54Neg := \left(signedSquareL\left[1 - \frac{\left(\frac{p5}{p4} - Bf54\right)^2}{(1 - Bf54)^2}, eps\right]\right)$$

In[39]:=
$$Ng54 := onPositive[p5 - p4]\left(onPositive\left[\frac{p4}{p5} - Bf54\right] Ng54Pos + onNegative\left[\frac{p4}{p5} - Bf54\right] Ng1\right) + onNegative[p5 - p4]\left(onPositive\left[\frac{p5}{p4} - Bf54\right] Ng54Neg + onNegative\left[\frac{p5}{p4} - Bf54\right] Ng1\right);$$

The system of equations

The spool position is recalculated.

In[40]:=
```
xine = 2 xin - 1;
```

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

In[41]:=
```
A12 = A1max limit[(xine - x0)/(1 - x0), 0, 1];
A32 = A3max limit[(-xine - x0)/(1 - x0), 0, 1];
A14 = A1max limit[(-xine - x0)/(1 - x0), 0, 1];
A54 = A3max limit[(xine - x0)/(1 - x0), 0, 1];
```

Calculation of the Ng functions for flow calculations.

In[45]:=
```
Ng1 = 1;
```

Equations

In[46]:=
```
localExpressions = {
    cp == cv + R
  };
```

Expressions for enthalpy flows and mass flows.

In[47]:=
```
dE12 = qm12 cp (onNegative[qm12] T2 + onPositive[qm12] T1);
dE32 = qm32 cp (onNegative[qm32] T2 + onPositive[qm32] T3);
dE14 = qm14 cp (onNegative[qm14] T4 + onPositive[qm14] T1);
dE54 = qm54 cp (onNegative[qm54] T4 + onPositive[qm54] T3);

qm12 = (onPositive[p1 - p2] qm12Pos - onNegative[p1 - p2] qm12Neg);
qm32 = (onPositive[p3 - p2] qm32Pos - onNegative[p3 - p2] qm32Neg);
qm14 = (onPositive[p1 - p4] qm14Pos - onNegative[p1 - p4] qm14Neg);
qm54 = (onPositive[p5 - p4] qm54Pos - onNegative[p5 - p4] qm54Neg);
```

The system equations to be solved in each time step

In[55]:=
```
systemEquationsDA = Simplify[{
    qm12Pos == Cf12 p1 p0 Sqrt[T0/T1] Ng12,
    qm12Neg == Cf12 p2 p0 Sqrt[T0/T2] Ng12,
    qm32Pos == Cf32 p3 p0 Sqrt[T0/T3] Ng32,
    qm32Neg == Cf32 p2 p0 Sqrt[T0/T2] Ng32,
    qm14Pos == Cf14 p1 p0 Sqrt[T0/T1] Ng14,
    qm14Neg == Cf14 p4 p0 Sqrt[T0/T4] Ng14,
    qm54Pos == Cf54 p5 p0 Sqrt[T0/T5] Ng54,
    qm54Neg == Cf54 p4 p0 Sqrt[T0/T4] Ng54,
    dE1 == -dE12 - dE14,
    dE2 == dE12 + dE32,
    dE3 == -dE32,
    dE4 == dE14 + dE54,
    dE5 == -dE54
    }];
```

Boundaries

The boundary equations for transmission line ports

In[56]:=
```
systemBoundaryEquations = {
   p1 == (c1 + Zc1 dE1),
   p2 == (c2 + Zc2 dE2),
   p3 == (c3 + Zc3 dE3),
   p4 == (c4 + Zc4 dE4),
   p5 == (c5 + Zc5 dE5)
  };
```

Independent Variables

In[57]:=
```
systemVariables = {qm12Pos, qm12Neg, qm32Pos, qm32Neg, qm14Pos,
    qm14Neg, qm54Pos, qm54Neg, dE1, dE2, dE3, dE4, dE5, p1, p2, p3, p4, p5};
```

Expressions

Variables are calculated that are not directly involved in the system equations. The inlet flow is calculated as the outlet flow with reversed sign.

In[58]:=
```
expressions = {
    qm1 == -qm12 - qm14,
    qm2 == qm12 + qm32,
    qm3 == -qm32 ,
    qm4 == qm14 + qm54 ,
    qm5 == -qm54,
    Ng32e == Ng32,
    Ng12e == Ng12,
    Ng54e == Ng54,
    Ng14e == Ng14,
    Bfe == Bf
  };
```

In[59]:=
```
Compgen[file]
```