



PNCH012 - variable volume pneumatic chamber with heat exchange (preferred)

Description

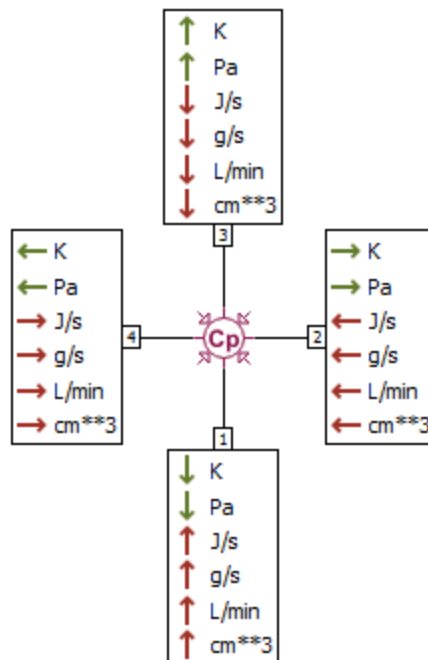
PNCH012 represents a pneumatic chamber with a variable volume and pressure dynamics.

Each port receives a mass flow rate in [g/s] and an enthalpy flow rate in [J/s] as input and gives the pressure in [Pa] and the temperature in [K] of the chamber as output. Each port also receives the volume in [cm³] and volume variation in [L/min] as input. The total volume is calculated by summing the four volume inputs and a dead volume which is a parameter of [PNCH011](#).

The model takes into account heat exchange. It expresses the variation of internal energy U using the first law of thermodynamics applied to an open system.

The total volume of the chamber is limited to a lower value equal to the dead volume divided by 100.

Icon with external variables



Usage

Use this submodel to simulate a pneumatic chamber in a jack, spool valve or any pneumatic chamber in which the volume can vary.

This submodel should be preferred to the simple polytropic chamber [PNCH011](#).

This submodel can be directly connected to any pneumatic PCD component or standard pneumatic component.

One or more [PNGD00](#) submodel should be included in your circuit to define the characteristics of the gas.

Parameter settings

The dead volume is the volume of the pneumatic fluid when all the input volumes are zero. It is essential that this volume is greater than zero.

The '*gas type index*' parameter refers to a gas type defined by an icon put on the sketch. If no gas type icon is used, the gas type index parameter must be set to 0.

Physics and equations

The atmospheric pressure is set using the utility function [pn2getatp](#).

The temperature and pressure derivatives are computed using the utility function [pn2vol](#).

Refer to the documentation of [pn2vol](#) for full details of the calculations.

The additional heat exchange between the chamber and its environment is computed using the following relation:

$$\dot{Q} = k_{th} \cdot S_{th} \cdot (T_{ext} - T_w)$$

where k_{th} is the thermal exchange coefficient [J/m²/K/s], S_{th} the thermal exchange area [m²], T_{ext} the external temperature [K] (these three parameters are defined above in the real parameters settings) and T_w the temperature of the gas inside the chamber [K].

Detailed submodel view

External variables

Title	Variable name	Unit	Type	In/Out	Default value
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Port 1						
1	temperature	temp	K	explicit state	output	293.15
2	pressure	press	Pa	explicit state	output	0
3	enthalpy flow rate at port 1	dh1	J/s	basic variable	input	-
4	mass flow rate at port 1	dm1	g/s	basic variable	input	-
5	derivative of volume at port 1	dvol1	L/min	basic variable	input with default	0
6	volume at port 1	vol1	cm**3	basic variable	input with default	0
Port 2						
1	duplicate of temp	temp2	K	duplicate [hidden]	output	-
2	duplicate of press	press2	Pa	duplicate [hidden]	output	-
3	enthalpy flow rate at port 2	dh2	J/s	basic variable	input	-
4	mass flow rate at port 2	dm2	g/s	basic variable	input	-
5	derivative of volume at port 2	dvol2	L/min	basic variable	input with default	0
6	volume at port 2	vol2	cm**3	basic variable	input with default	0
Port 3						
1	duplicate of temp	temp3	K	duplicate [hidden]	output	-
2	duplicate of press	press3	Pa	duplicate [hidden]	output	-
3	enthalpy flow rate at port 3	dh3	J/s	basic variable	input	-
4	mass flow rate at port 3	dm3	g/s	basic variable	input	-
5	derivative of volume at port 3	dvol3	L/min	basic variable	input with default	0
6	volume at port 3	vol3	cm**3	basic variable	input with default	0
Port 4						
1	duplicate of temp	temp4	K	duplicate [hidden]	output	-
2	duplicate of press	press4	Pa	duplicate [hidden]	output	-
3	enthalpy flow rate at port 4	dh4	J/s	basic variable	input	-
4	mass flow rate at port 4	dm4	g/s	basic variable	input	-
5	derivative of volume at port 4	dvol4	L/min	basic variable	input with default	0
6	volume at port 4	vol4	cm**3	basic variable	input with default	0

Internal variables

	Title	Variable name	Unit	Type	Default value
1	volume of pneumatic chamber	vol	cm**3	basic variable	-
2	mass of gas in chamber	mgas1	g	basic variable	-

Real parameters

	Title	Variable name	Unit	Default value
1	dead volume	cvol0	L	1
2	thermal exchange coefficient	kth	J/m**2/K/s	0
3	thermal exchange area	sth	m**2	0.1
4	external temperature	extemp	K	293.15

Integer parameters

	Title	Variable name	Default value
1	gas type index	gi	1

[Contents of the Pneumatic Component Design library](#)