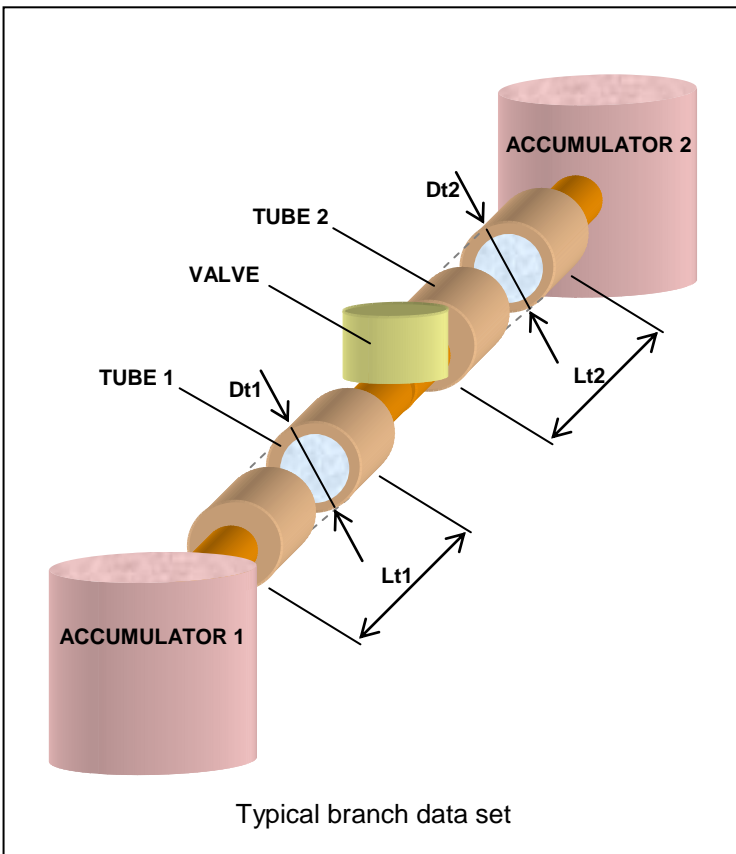
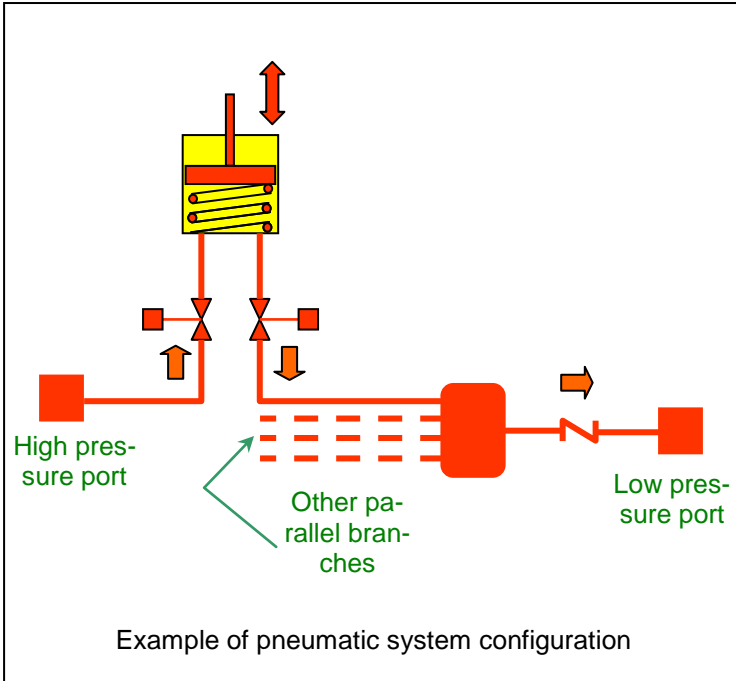


PNEUMA

A PROGRAM FOR THE SIMULATION OF COMPRESSIBLE GAS DYNAMICS IN PIPING AND ACTUATION SYSTEMS



OVERVIEW

PNEUMA is an application software developed with MATLAB/Simulink®, that simulates high compressibility gas flow inside a piping network with valves, accumulators, and variable volume elements.

The program can simulate the dynamic behaviour of a vast family of industrial gas systems, such as pneumatic systems, flares, pressure relief systems of boilers or gas separators for the hydrocarbons and chemical industry.

PNEUMA is particularly suited for the analysis of choked pipe systems, where sonic conditions occur at one or more locations, and for the analysis of pneumatic actuators dynamics and control under operational conditions.

PROGRAM DESCRIPTION

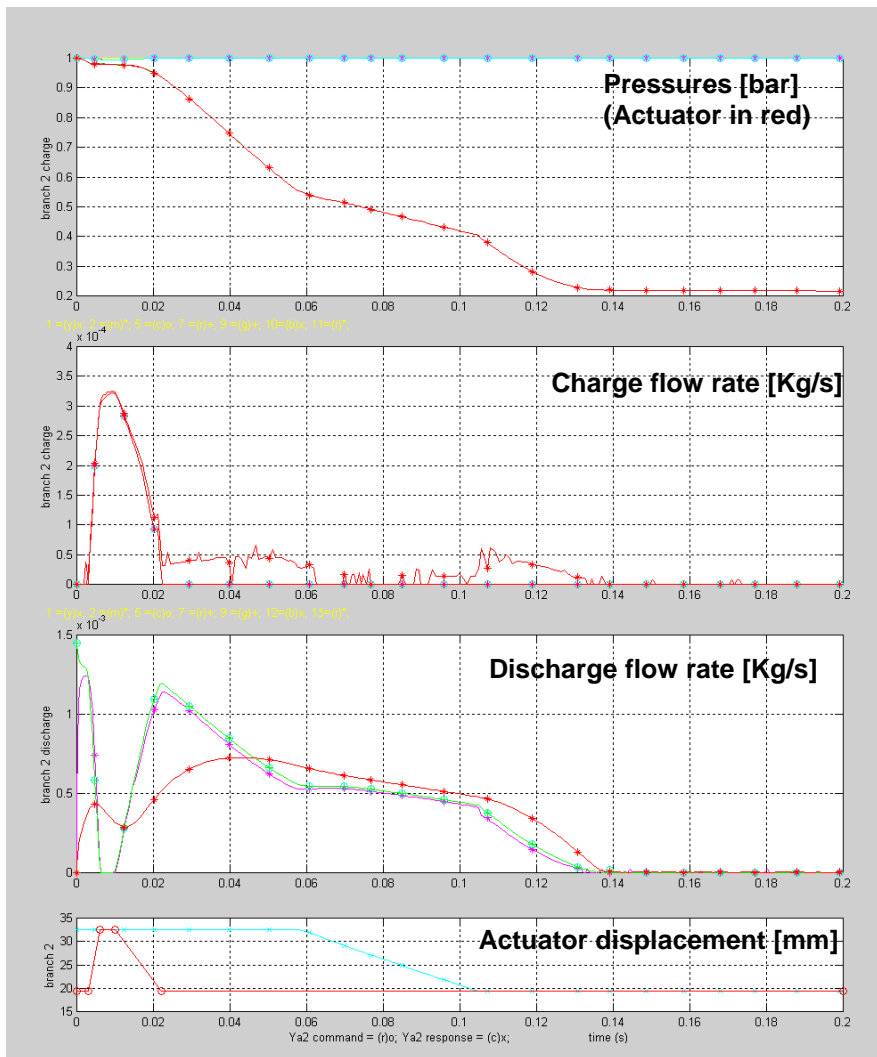
PNEUMA runs under The Mathworks' MATLAB/SIMULINK® environment, a very powerful, qualified mathematical solver and systems simulation tool. The program is endowed with a user-friendly graphic interface based on buttons and menu driven commands, which only require knowledge of basic pc use.

PNEUMA is an advanced engineering tool helpful to design new industrial gas systems and to modify existing ones.

The aim of the dynamic simulations performed by the program is to allow the response of the system to be evaluated, so that the dimensioning of the pipes, fittings and control of the system can be verified.

PNEUMA simulates the system by quasi-steady elements interconnected in series and/or in parallel with lumped volumes accounting for pipes capacity that are bounded in structurally rigid or variable volume enclosures such as pipes, pressure vessels, and accumulators.

The program solves a set of differential equations and non linear algebraic equations in the time domain by describing the mass and energy balance of any enthalpy accumulator of the system and identifying possible choked flow sections as a function of the pressures assigned at the



boundaries of the system and as function of the valves opening sequences.

PNEUMA allows early identification of poorly dimensioned plants components and of choking conditions sometimes unexpected at first glance and can point out problems that can not be identified by a trial and error experimental approach due to the many variables involved.

PROCEDURES OUTLINE

The user selects the configuration to be analysed from a customised library of plants' configurations, each representing a variety of practical solutions, that can also be displayed by opening a MS Word® file. The user then defines the parameters of the simulation in easily editable and pre-formatted texts as MS Excel® files. Data include relevant dimensions, valves flow coefficients, initial conditions of the thermodynamic functions and inertial and elastic parameters of actuators. Results are displayed in a variety of output plots that can be printed or exported to other environments.

Numerical results can also be written in files compatible and already formatted for an easy handling by spreadsheets such as MS Excel®.

SIMULATION SERVICES

PNEUMA is also used as a tool for engineering services that S.A.T.E. provides customers not wishing to enter the functions and details of the program. In this case the results of the simulations are produced as reports, together with comments and guidelines for system modifications.

SOFTWARE LICENCE

PNEUMA can be licensed on a non-exclusive basis together with the library of configurations. Special confidentiality agreements can be set up for clients' proprietary configurations, leaving however S.A.T.E. the sole proprietary of the software tools.

S.A.T.E. - Systems and Advanced Technologies Engineering S.r.l.

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