

EcosimPro

Modelling and Simulation Software



FLUIDAPRO LIBRARY

The FLUIDAPRO library is designed to dynamically simulate fluid systems. Complex fluid systems where heat transfer is coupled with control could be easily evaluated with this library.

EcosimPro

EcosimPro is a powerful **modelling** and **simulation** tool with a simple interface that makes the design of **multi-disciplinary** dynamic systems easy and intuitive using graphic diagrams.

For users with specific needs, EcosimPro provides an object-oriented non-causal approach towards creating reusable component libraries and is based on very powerful symbolic and numerical methods capable of processing **complex systems** represented by differential-algebraic equations (DAE) or ordinary-differential equations (ODE) and discrete events. However, low-level problems such as programming calls with numerical solvers, equation handling, etc, are solved automatically or using simple wizards.

Features

FLUIDAPRO is a professional EcosimPro library which provides typical fluid components. The following are the most important features of the library:

- Gas, liquid and two-phase flow regimes for ideal or real fluids
- Reverse flow, inertia and high speed phenomena are considered in pipes, volumes and junctions
- Calculation of concentrated (valves) and distributed (pipes) pressure losses
- Heat transfer between walls (pipes and tanks) and the fluid
- Single tank models are available with the option of liquid level calculation
- Pneumatic/hydraulic actuators, check valves, 3- and 4-way controlled valves and pressure regulators
- Other special components such as heat exchangers and liquid pumps

Another phenomenon modelled in pipes, pumps or other components is bubble formation due to the cavitation phenomena in a liquid. Besides, FLUIDAPRO facilitates the analysis of transient aspects due to inertia (pressure waves and water-hammer) and bubble collapse.

Using **drag & drop** methodology, the user can quickly create the fluid diagram to be analysed, the representation of which is very similar to the physical system. The FLUIDAPRO library provides a large palette of components to be inserted (click and drag) in a model. Other components that a user may possibly require can be easily built by means of inheritance and aggregation.

Thanks to EcosimPro's features, libraries can be built that are easy to **configure** and **extend**, adding any components and characteristics as needed. This can be done graphically through a simple, user friendly interface, or through EcosimPro's **object-oriented language** which makes it possible to re-use existing codes.

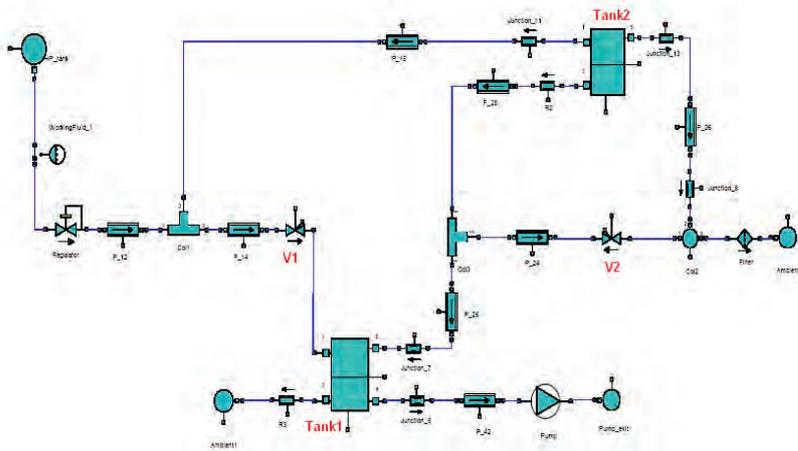
One of the library's biggest advantages is the possibility of its use in the multidisciplinary facet of EcosimPro. This means that we can jointly study, for example, dynamic fluid systems together with heat transfer processes and control diagrams.

The components

From a computational point of view, components are divided into two classes:

- **Capacitive elements (C)**, integrating the mass and the energy conservation equations





- **Momentum elements (M)**, calculating explicitly the mass flows between capacitive elements

The FLUIDAPRO library has the following **component** types:

- Volumes, heat exchangers and tanks
- Pumps, pipes and tubes
- Junctions, valves, filters, vacuum pump
- Other topological components such as the tee component, electro-valves and actuators

Finally, the use of **thermodynamic functions** is another basic technique when using FLUIDAPRO components. Four categories of fluids are presented:

- Perfect gases
- Simplified liquids (energy and transport properties not depending on pressure)
- Van der Waals fluids
- Real fluids that consider all possible zones of operation (liquid, superheated, supercritical and two-phase flow)

Example

The following example shows some of FLUIDAPRO's capabilities modelling a **vacuum network**. The model represents a system that deals with the extraction of polluted air from several places where high cleaning conditions are required.

It contains two single tanks, a pressure regulator, a vacuum pump, pneumatic valves, tees and calibrated orifices. The aim of the simulation is to control the pressure level in Tank1 and Tank2 by switching valves V1 and V2.

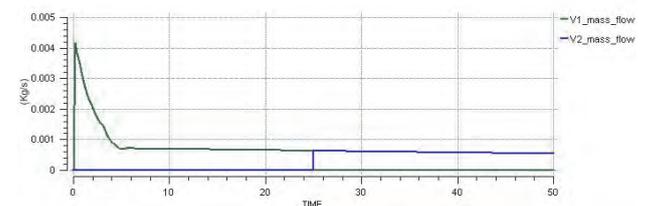
At the beginning of the simulation, valve V1 is opened and valve V2 is closed, permitting a direct air flow from the external atmosphere to Tank1.

In this first stage, the air in the low pressure area is pumped out reaching the desired pressure conditions in Tank1 in less than 5 s. The pressure drops until the pressure difference in the regulator is enough to open it.

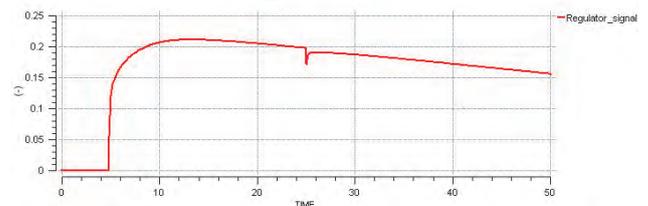
After this, the pump maintains the pressure level in the tanks by pumping out the incoming air flow from the regulator and filter branches and the tank leaks. The valves are kept in their initial status until 25 s, when V1 is closed and V2 is opened. Then the air coming from the pressure regulator reaches Tank1 after passing through Tank2. The change of valve status can be clearly seen in the mass flow plots. The pressure level of the tanks is kept in the same way as in the previous stage. Finally, the simulation is stopped at 50 s.

In this example we have studied the dynamic behaviour of a fluid system in the light of variations in the opening of the different valves.

Plot 1



Plot 2



Plot 3

