
# PIPENET -- TRANSIENT MODULE

The PIPENET Transient Module provides a speedy and cost-effective means of in-house rigorous transient analysis. The Transient Module can be used for predicting pressure surges, calculating hydraulic transient forces or even modelling control systems in flow networks. The salient features of the Transient module are summarised below.

## Built-in Element Models

The following range of element models is available at present

- **Pipes**
- **Pumps**: Simple pump, Turbo pump
- **Valves**: Operating valve, non-return valve, check valve, fluid damped check valve, liquid surge relief valve, regulator valve, inertial check valve.
- **Tanks**: Accumulator tank, simple tank, surge tank
- **Vacuum breaker / Air release valve**
- **Caissons**
- **Control systems**: Pressure or Flow sensor, PID controller, Transfer function

New models can be developed if required.

## Fittings

Multiple fittings can be inserted on a pipe and it is not necessary to treat them as separate entities. They are simply defined as attributes of a pipe. This is a powerful feature of PIPENET. PIPENET can also calculate the k-factors of the built-in fittings.

## Time Operation of Valves

The operating valve model can be used to represent a manual valve or a control valve. In the case of a manual valve, its operation would be directly specified by a user-defined boundary condition. In the case of a control valve, the operation would be defined by a signal from the control loop.

## Operation of Pumps (Simple or Turbo)

The pressure increase provided by a simple pump depends on its speed and performance curve. The performance curve can be entered and saved as a library. The pump speed is specified directly or by a signal from the control loop.
The turbo pump can additionally handle the ‘spin down’ due to pump failure.

## Control Systems

Control systems allow components such as pumps or valves to react to changes in pressure or flowrate in some part of the network.
A sensor measures an instantaneous reading for pressure or flowrate, which is converted to a signal for the controlled device by means of a PID controller. Transfer functions can also be included in the control loop to model the dynamics of the sensor and the controlled device.

**Hydraulic Transient Forces**
Pipework can experience significant stresses and movements, or even sustain damage, due to fluid transient phenomena such as water hammer. PIPENET can calculate hydraulic transient forces and these can be read by pipe stress or structural analysis programs for further processing.

**Initial Conditions**
PIPENET can automatically generate the initial steady state solution. For cases where the starting point is not steady state, the user can supply own starting condition.

**Stationary Initial Condition**
Often a pipe network system would start from a stationary condition where the flow is zero throughout the system. It is possible to do this automatically.

**Vapour Cavitation Modelling**
Under transient flow conditions pipework can locally experience very low pressures. Generally these would be cyclic in nature. Constant formation and collapse of vapour cavities would accompany this phenomenon in cycles. PIPENET can model this.

**Automatic Calculation of Wave Speed and Time Step**
Under transient flow conditions, the effect of a disturbance makes itself felt throughout the system in the form of waves. The wave speed depends on parameters such as the modulus of elasticity of the pipe material, diameter, wall thickness, the Poisson's ratio and the compressibility of the fluid. The wave speed is of fundamental importance, and PIPENET can calculate it automatically. The program can also determine the time step for calculation automatically. The user can optionally specify both the wave speed and the time step.

**Tabular Output**
Typically, a large amount of calculated results would be produced by transient analysis. For this reason, the Transient module allows the user to define which variables are to be output and in what format.

**Graphical Output**
While tabular output is useful for a thorough analysis, graphical output can be used to get a quick overview. The Transient module allows the user to output selected variables graphically. The graphs can also be viewed as movies in real time.

**Forces Output**
The force-time history can be output in the form of a forces file. This file is specifically intended for further processing by pipe stress or structural analysis programs.

**Functions available for Boundary Conditions**
The following functions may be used for specifying the boundary conditions.
(These are time dependent.)

- Constant
- Sine Wave
- Damped Sine Wave
- Profile - linear, step or cubic
- Power Ramp
- Exponential
- Asymmetric Pulse