

Auxiliary Calculator



Click **Auxiliary Calculator** from the **InfoSurge** toolbar to choose an option from the following options in the drop-down menu.

Wave Speed - This option will help you determine the propagation speed for pressure waves in your pipes. Note that the stiffer the material used and the more the pipe is restrained it causes the wave propagation speeds to be higher. Using the correct speeds is essential for accurate calculation of the magnitude of pressure surges in the system.

InfoSurge Calculator - Wave Speed

Calculator

Wave Speed | Resistance | Pump Inertia/Pump File | Edit User Pump File | Pump File Characteristics | Valve Stroking | Valve Modulating | Air Slam Pressure

Liquid
Water | Bulk Modulus (Glb/ft²): 0.046 | Mass Density (slug/ft³): 1.936

Pipe Material
Cast Iron | Young's Modulus (Glb/ft²): 2.611 | Poisson's Ratio: 0.250

Pipe Properties
Pipe Internal Diameter (in): | Pipe Wall Thickness (in):

Pipe Restraint

Wave Speed
 m/s | ft/s

Hide Air vs Wave Propagation <<

Unit: English SI

Compute Close

Graph Data:

Proportion of air by volume (%)	10 bar (km/s)	20 bar (km/s)	50 bar (km/s)
0	1.25	1.25	1.25
0.2	0.75	0.95	1.15
0.4	0.55	0.75	0.95
0.6	0.45	0.65	0.85
0.8	0.38	0.55	0.75
1.0	0.32	0.45	0.65

The presence of even small quantities of air can significantly reduce the wave propagation speeds of water in pipes and tunnels. The above graph is for water in a steel pipe having a Diameter/Thickness ratio of 20. (Ref: Thorley)

Liquid

- **Liquid** - Select the fluid being analyzed and the Bulk Modulus and Mass Density will be automatically updated. If Other is selected, then the Bulk Modulus and Mass Density for the liquid can be entered manually.
- **Bulk Modulus** - The elastic modulus of the liquid.
- **Mass Density** - Density of fluid being analyzed.

Pipe Material

- **Pipe Material** - Select the pipe material being analyzed and the Young's Modulus and Poisson's Ratio will be automatically updated. If Other is selected, then the Young's Modulus and Poisson's Ratio for the pipe material can be entered manually.
- **Young's Modulus** - This is a term that indicates how much the pipe material will stretch under force.
- **Poisson's Ratio** - Ratio of change of diameter per unit diameter to change of length per unit length in elastic stretching or compression of cylindrical specimen.

Pipe Properties

- **Pipe Internal Diameter** - The internal diameter of the pipe.
- **Pipe Wall Thickness** - The wall thickness of the pipe.

Pipe Restraint

- **Pipe Restraint** - This is a factor to indicate how well the pipe is prevented from moving axially.

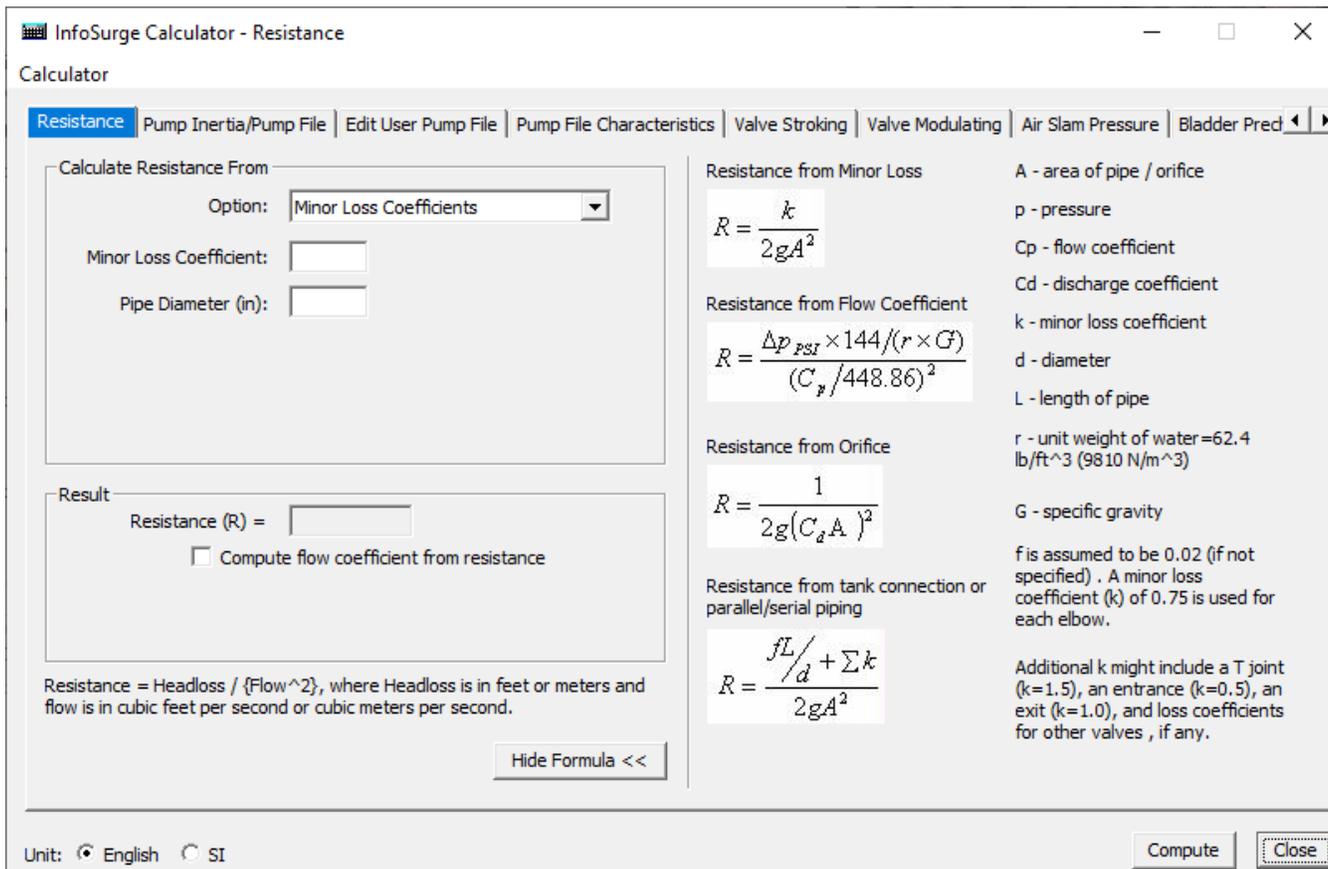
Calculates

- **Wave Speed** in meters per second and feet per second.
- **Hide Air vs Wave Propagation** - This button hides or shows Air vs. Wave Propagation graph.

Unit

- Select either English or SI units:
- **Compute** - This button will compute a value according to the current input data.
- **Close** - This button will close the current dialog box or calculator.

Resistance - This option will help you determine how much the element resists the flow of fluid through the element. The term is defined as head change divided by the flow squared across an element. The Flow Resistance Calculator can be used to calculate the resistance for a variety of situations.



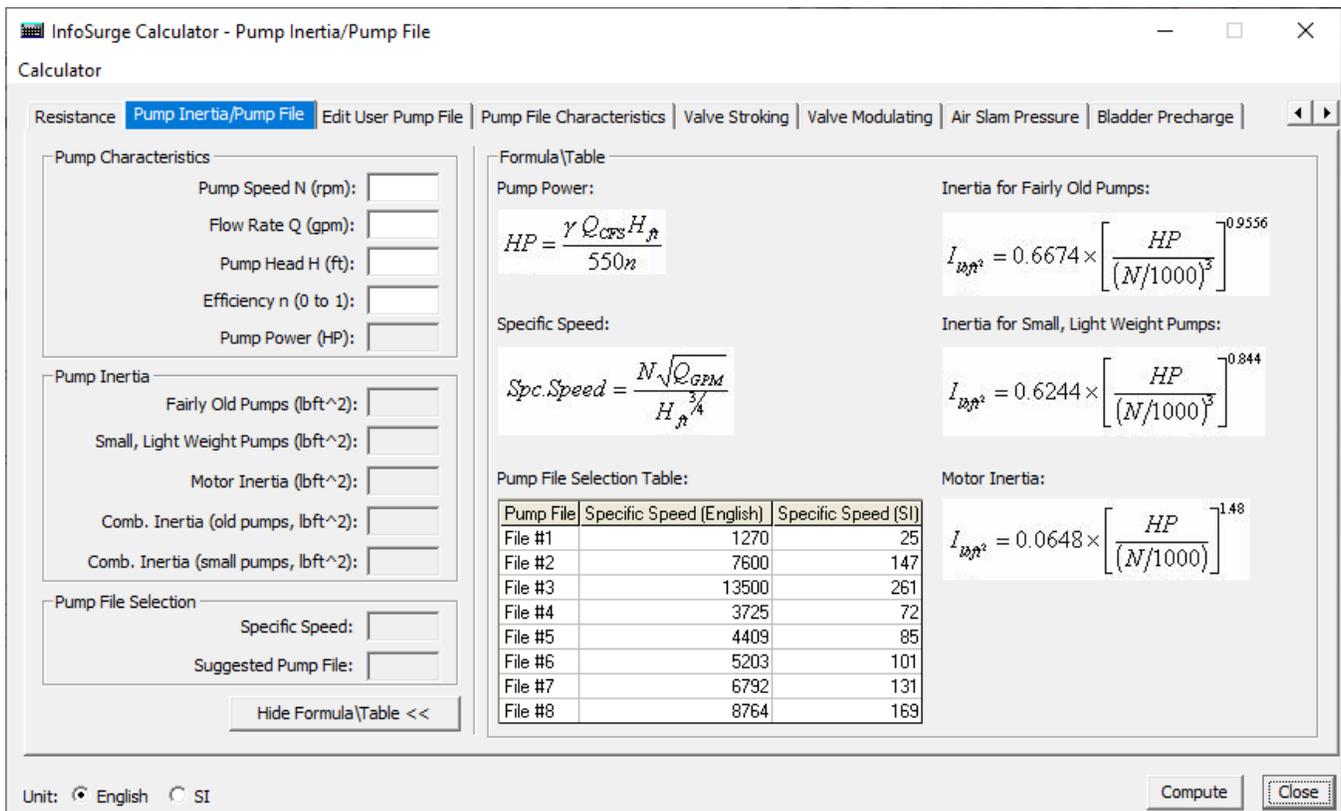
Calculate Resistance from

- **Option** - Select an option from the drop-down menu.
- **Minor Loss Coefficient** - Resistance calculation using minor loss coefficient.
- **Pipe Diameter** - Enter pipe diameter.

Result

- **Resistance (R)** - Resistance of flow through element.
- **Computer flow coefficient from resistance** - When selected the flow coefficient is calculated.
- **Hide Formula** - This button will hide the formula display on the right side of the dialog box.
- **Compute** - This button will compute a value according to the current input data.
- **Close** - This button will close the current dialog box or calculator.

Pump Inertia - This option will help you determine the sum of the pump inertia and the motor inertia. The Pump Inertia Calculator calculates the pump and motor inertia based on the rated conditions using curves fit to a large quantity of data.



Pump Inertia

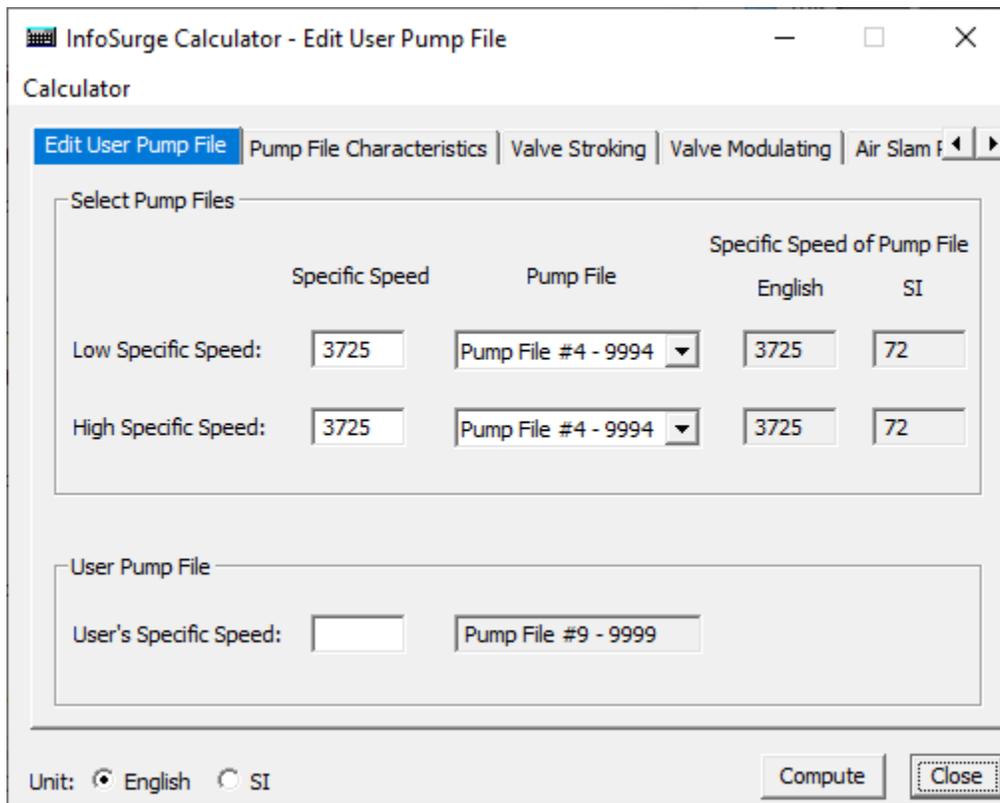
- **Fairly Old Pumps** - Inertia for pumps manufactured before 1970.
- **Small, Light Weight Pumps** - Inertia for small, light weight pumps.
- **Motor Inertia** - The inertia of the moving parts of the motor.
- **Comb. Inertia (Old Pumps)** - Combined inertia for old pumps.
- **Comb. Inertia (Small Pumps)** - Combined Inertia for small pumps.

Pump File Selection - This option will help you determine the head and torque as a function of flow and speed. The Pump File Selector is a utility to assist you in selecting the appropriate Pump File for your simulation (see above screenshot).

Pump File Selection

- **Specific Speed** - Computes and displays the Specific Speed of the pump. Specific Speed is the number to characterize a pump. It is defined by $N_s = N_R Q_R^{1/2} / H_R^{3/4}$ where the Reference Flow Q_R is in gpm (m³/s) and the Reference Head H_R is in ft (m).
- **Suggested Pump File** - Suggests the pump file that most closely relates to the computed pump.

Edit User Pump File - This option will help you customize an intermediate pump file based on the pump's specific speed. The date in the intermediate pump file is interpolated from the two pump files chosen by you.



Select Pump Files

- **Low Specific Speed** - The specific speed of the pump file chosen by you, which is the lower bound of the specific speed range for interpolation.
- **High Specific Speed** - The specific speed of the pump file chosen by by you, which is the upper bound of the specific speed range for interpolation.

User Pump File

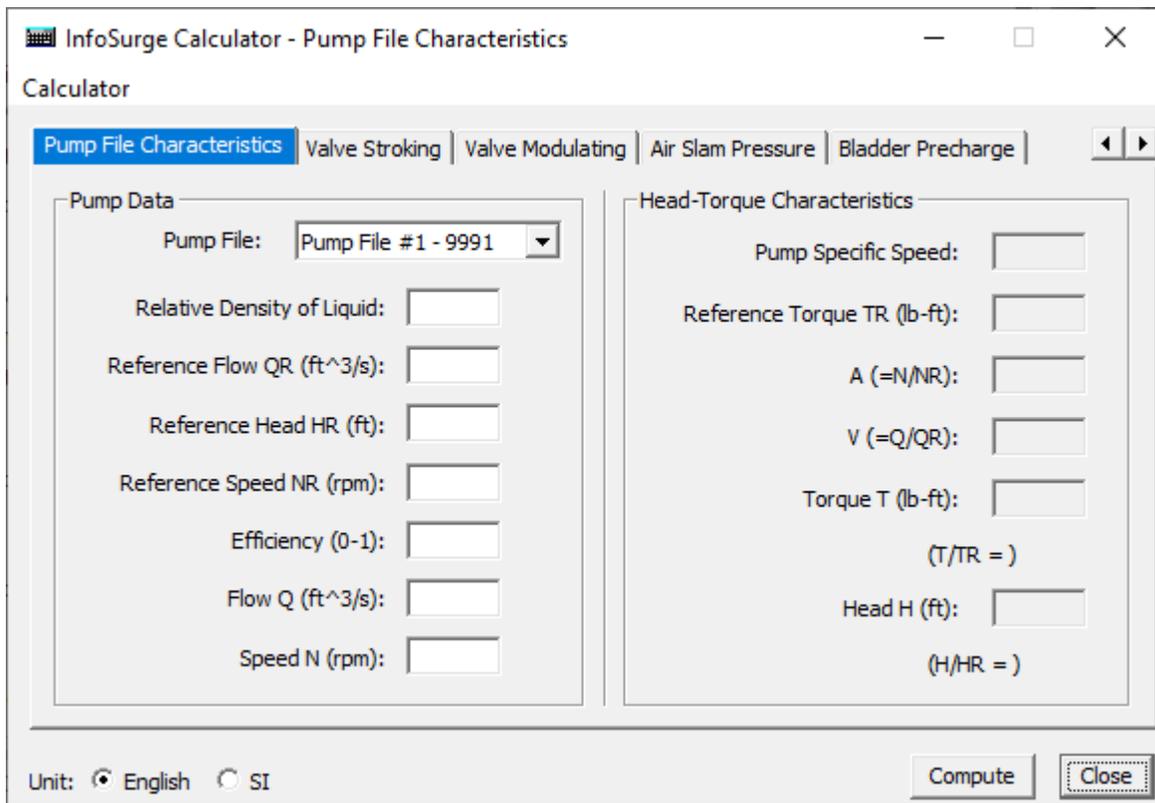
- **User's Specific Speed** - The specific speed of a pump specified by you.

Unit

Select between English and SI units:

- **Compute** - This button will compute a value according to the current input data.
- **Close** - This button will close the current dialog box or calculator.

Pump File Characteristics - This option will help you to determine operating conditions for pumps described by a pump file based on the rated conditions and the Flow and Speed at which the pump is operating.



Pump Data

- **Pump File** - Allows the you to determine operating conditions for pumps based on the rated conditions and the flow and speed at which the pump is operating. Select the Pump File to use as determined by the Pump File Selector.
- **Relative Density of Liquid** - Enter the Relative Density of the liquid. Use 1 for water.
- **Reference Flow QR** - Flow rate of the pump that defines the Pump File Characteristics.
- **Reference Head HR** - Head gain that defines the Pump File Characteristics.
- **Reference Speed NR** - Speed of the pump that defines the Pump File Characteristics.
- **Efficiency (0-1)** - The pump efficiency is the pump hydraulic power divided by the electrical power.
- **Flow (Q)** - Unit of flow being used during operation.
- **Speed (N)** - Operating Speed of the pump, rpm.

Head-Torque Characteristics

- **Pump Specific Speed** - Specific speed of the pump.
- **Reference Torque (TR)** - Reference torque of the pump.
- **A(N/NR)** - Dimensionless pump speed.
- **V(Q/QR)** - Dimensionless flow.
- **Torque (T)** - Operating torque of the pump.
- **Head (H)** - Head gain during the operation.

Unit

Select between English and SI units:

- **Compute** - This button will compute a value according to the current input data.
- **Close** - This button will close the current dialog box or calculator.

Valve Stroking - This option will allow you to determine the optimum 2-stage closure for a valve in a single pipeline. Based on the properties of the pipeline and initial conditions, it calculates the optimal set of closing time and area ratio for the first stage and the corresponding velocity and head. Note that the valve stroking calculator is valid for single uniform pipeline only but it also provides a general operational rule for a valve operation to minimize the surge problem.

Input Data

- **Use Velocity or Flowrate** - Select Velocity or Flowrate.
- **Pipe Length (L)** - Enter the length of pipe in feet.
- **Diameter (D)** - Enter the valve diameter in inches.
- **Wave Speed (C)** - Enter the speed of the pressure wave propagation in a pipe filled with fluid.
- **Steady State Velocity (Vo) or Flowrate (Qo)** - Enter the velocity or flowrate during steady state simulation.
- **Steady State Head (Ho)** - Enter the Pressure Head in the steady state simulation.
- **Total Time for Closure (Tc)** - Enter the total time to close the valve.
- **Specific Gravity (G)** - Enter the specific gravity of the fluid.

Value Strokng Details

- **Initial Flow Coefficient (Cv)** - Flow coefficient during the steady state simulation.
- **Stage-1 Closure Time (2L/C)** - Time for a pressure wave to return.
- **Cv Ratio for Stage-1 Closure** - Flow coefficient ratio at the stage-1 closure time.
- **Cv for Stage-1 Closure** - Flow coefficient at the stage-1 closure time.
- **Velocity after Stage-1 Closure** - Velocity at the stage-1 closure time.
- **Flow after Stage-1 Closure** - Flow at the stage-1 closure time.
- **Head after Stage-1 Closure** - Head at the stage-1 closure time.

Unit

Select either English or SI units:

- **Compute** - This button will compute a value according to the current input data.
- **Close** - This button will close the current dialog box or calculator.

Value Modulating - This option will allow you to calculate the data needed to use an Active Valve as a Modulating Regulating Valve. For normal applications, static active valves are assumed to maintain their initial settings during the transient analysis. To obtain modulating performance, you need to run the steady-state for both the initial and final conditions. With these hydraulic results, you can enter the head and flow values for both initial and final conditions into this calculator. The tool will then provide the corresponding initial and final valve settings, from which you can derive an appropriate operation change curve for the selected active valve over the specified time.

InfoSurge Calculator - Valve Modulating

Calculator

Pump File Characteristics | Valve Stroking | **Valve Modulating** | Air Slam Pressure | Bladder Precharge

Settings

State Variable: Flowrate:

Wide Open Resistance Specific Gravity:

Flow Coefficient

Resistance = Headloss / {Flow^2}, where Headloss is in feet or meters and Flow is in cubic feet per second or cubic meters per second.

Flow Coefficient = Flow (in gpm or m^3/hr) that develops a pressure drop of 1 psi or 1 bar across the valve.

Initial Steady State Condition

Upstream Head (ft):

Downstream Head (ft):

Flowrate (ft^3/s):

Final Steady State Condition

Upstream Head (ft):

Downstream Head (ft):

Flowrate (ft^3/s):

Valve Modulation

Wide Open Resistance:

Initial Ratio:

Final Ratio:

Unit: English SI

Compute Close

Settings

- **State Variable** - Select to use Head or Pressure units for the calculator.
- **Flow Rate** - Select the flow units for the calculator.
- **Resistance or Flow coefficient** - Select Resistance or Flow coefficient.
 - *Wide Open Resistance* is how much the element resists the flow of fluid through it. The term is defined as head change divided by the flow squared across an element.
 - *Flow Coefficient (Cv)* is used by valve manufacturers to describe the flow resistance of the element. It is defined as the flow (gpm) where there is a 1 psi pressure drop across the element. Thus if the manufacturer says his 12 inch butterfly valve has a flow coefficient of 6500, this means that it will flow 6500 gpm with a pressure drop of 1 psi. The formula is $\text{flow(gpm)} = C_v * (\text{pressure drop (psi)})^{0.5}$.
- **Specific Gravity** - The specific gravity is the ratio of the specific weight of a given fluid to the specific weight of water at a standard temperature and pressure. This is dimensionless term. Often, the reference specific weight of water is 9810 N/m^3 , which corresponds to its weight at 4°C under standard atmospheric pressure.

Initial Steady State Conditions

- **Upstream Head** - Pressure head on the upstream side of the valve.
- **Downstream Head** - Pressure head on the downstream side of the valve.
- **Flowrate** - Enter the rate of flow for the initial conditions.

Final Steady State Conditions

- **Upstream Head** - Pressure head on the upstream side of the valve.
- **Downstream Head** - Pressure head on the downstream side of the valve.
- **Flow Rate** - Enter the rate of flow for the final conditions.

Value Modulation

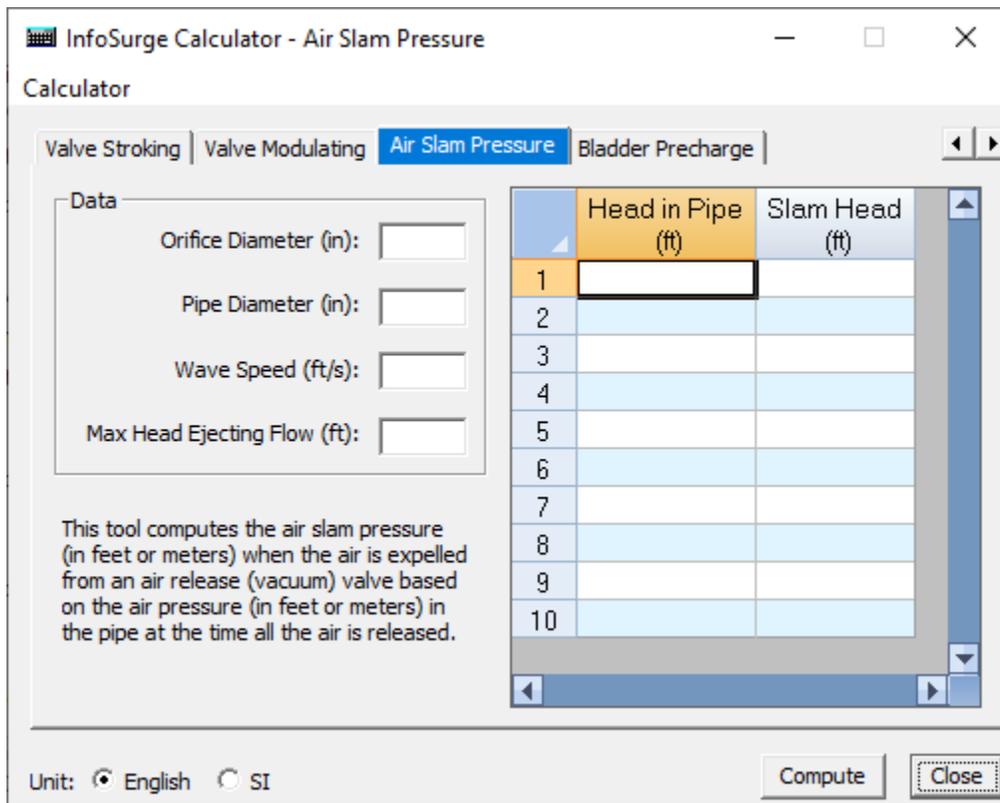
- **Wide Open Resistance** - Calculates and displays the resistance when valve is fully open.
- **Initial Ratio** - Calculates and displays the initial valve ratio setting.
- **Final Ratio** - Calculates and displays the final valve ratio setting.

Unit

Select either English or SI units:

- **Compute** - This button will compute a value according to the current input data.
- **Close** - This button will close the current dialog box or calculator.

Air Slam Pressure - This option will allow you to estimate the surge pressure potential due to air expulsion from an air release/vacuum release valve. It calculates the pressure surge generated by the water column impact following the expulsion of air from an air release/vacuum release valve. You can provide the required data displayed on the screen and an upper limit for the air pressure just prior to the slam and the tool computes surge pressures for a range of air pressures up to the maximum.



Data

- **Orifice Diameter** - The orifice diameter in the air valve.
- **Pipe Diameter** - The diameter in the pipe.
- **Wave Speed** - This is the speed of the pressure wave propagation in a pipe filled with fluid.
- **Max. Head Ejecting Flow** - The maximum pressure head in the pipe.

Calculate

- **Head in Pipe** - The head in the pipe.
- **Slam Head** - The surge pressure potential due to air expulsion from an air release/vacuum valve.

Unit

- **English** - Select for English units (feet).
- **SI** - Select for metric units (meters).
- **Compute** - This button will compute a value according to the current input data.
- **Close** - This button will close the current dialog box or calculator.

Bladder Precharge - This option will allow you to use the results obtained for a Closed Surge Tank to size a Bladder Tank and determine the required precharge pressure. This Bladder Tank will provide the same results as the Closed Surge Tank. The Initial Volume is input for the closed surge tank and the Maximum Volume is determined by the Volume plot for the surge tank. (Make sure the initial maximum volume has been reached.) The initial air pressure is computed by the initial steady state analysis.

Settings

- **Volume** - Select between Gallons or Cubic Feet for English units and Liters or Cubic Meters for SI units.
- **Pressure** - Select between Pounds per Square Inch (PSI) or Feet for English Units and Kilo Pascal (kPa) or Meters for SI units.

Input Data

- **Maximum Air Volume** - Maximum allowable air volume in the bladder tank.
- **Initial Air Pressure** - The air pressure when initially installed (connected) to the pipeline system.
- **Initial Air Volume** - The air volume when initially installed (connected) to the pipeline system.

Output Data

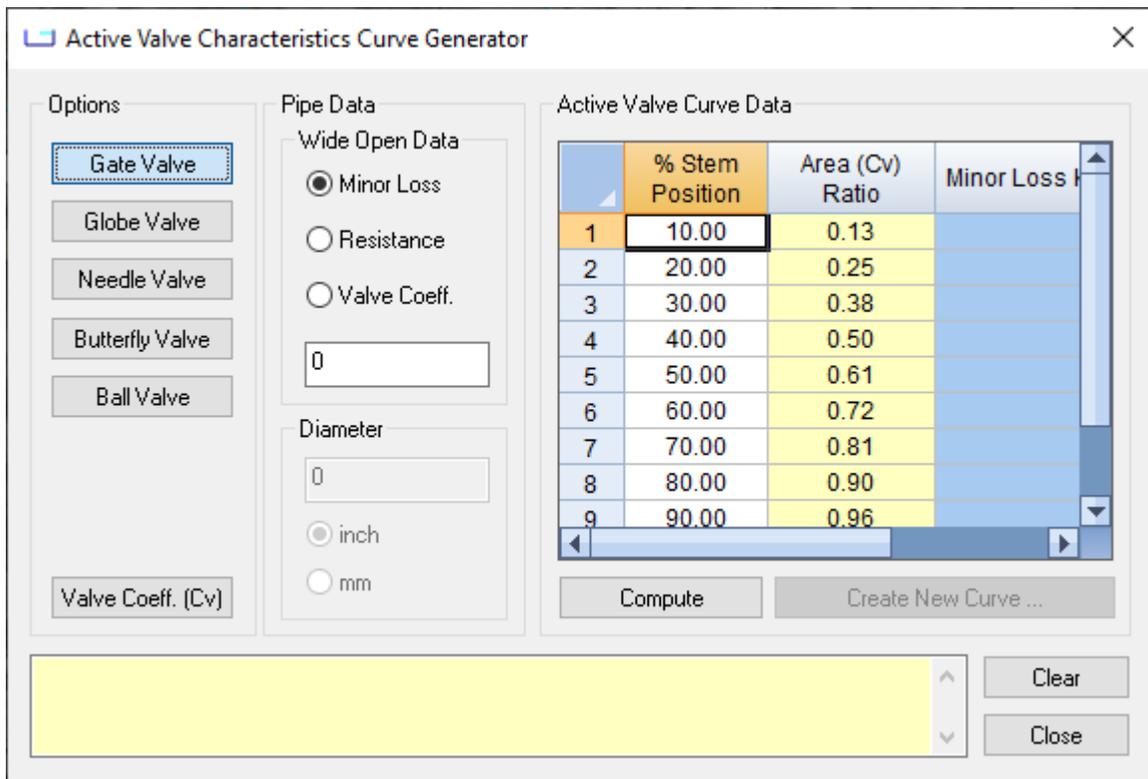
- **Precharge Pressure** - Displays the precharge pressure in the selected pressure units.
- **Bladder Volume** - Displays the bladder volume in the selected volume units.

Unit

Select **English** or **SI** units:

- **Compute** - This button will compute a value according to the current input data.
- **Close** - This button will close the current dialog box or calculator.

AV Characteristics Curve Generator - This option will allow you to calculate the minor loss (k-coefficient) for a valve based on an input curve of the Open Area Ratio versus the Stem Position. The Active Valve Characteristics Curve Generator can be used to create a curve that describes the Minor Loss vs. Percent Open characteristics of a typical valve. This curve is used to describe the throttle control valve characteristics in the Curve data field of the Attribute Browser. The Throttle Control Valve is used to model an Active Valve in a surge model. After the new AV Characteristic Curve is generated the **Create New Curve** button will allow you to automatically move the new curve data into the current model's curve data table.



Options

To generate the Active Valve Characteristics Curve, select the valve type or flow coefficient option:

- **Gate Valve** - Select this option for typical gate valve characteristics.
- **Globe Valve** - Select this option for typical globe valve characteristics.
- **Needle Valve** - Select this option for typical needle valve characteristics.
- **Butterfly Valve** - Select this option for typical butterfly valve characteristics.
- **Ball Valve** - Select this option for typical ball valve characteristics.
- **Valve Coefficient (Cv)** - This option allows you to calculate the minor loss coefficient curve based on the internal diameter of the valve when the percent stem position and the valve coefficient (Cv) are known.

Pipe Data

Wide Open Data

This section of the dialog box allows the user to calculate the Minor Loss coefficient based on a known Minor Loss, Resistance or Valve Coefficient.

- **Minor Loss** - Enter the minor loss (k) of the wide open valve.
- **Resistance** - Enter the Resistance of the wide open valve.
- **Valve Coefficient** - Enter the valve coefficient (Cv) of the wide open valve.
- **Value** - Enter the Minor Loss, Resistance or Valve Coefficient to be used for the curve data calculation.

Diameter

Enter the valve diameter, if required, for the curve data calculation.

- **Value** - Enter the diameter value.
- **Inch** - Select this option for diameter in inches.
- **mm** - Select this option for diameter in millimeters.

Active Valve Curve Data

- **% Stem Position** - This value is defined by the user usually in evenly spaced increments according to available data.
- **Area (Cv) Ratio** - Open area ratio (=open area / full open area)
- **Minor Loss K** - The Minor Loss Coefficient value that corresponds to the valve percent open which is used during the surge analysis.
- **Compute** - This button will compute the headloss coefficient according to assigned loss value.
- **Create new Curve** - This button will export the calculated values to a new curve in the model operation data that can then be assigned to an active valve within the system.
- **Clear** - This button will clear the current input data from the calculator.
- **Close** - This button will close the current dialog box or calculator.