

HydrauCalcXL

2023a Release

www.hydraucalc.com

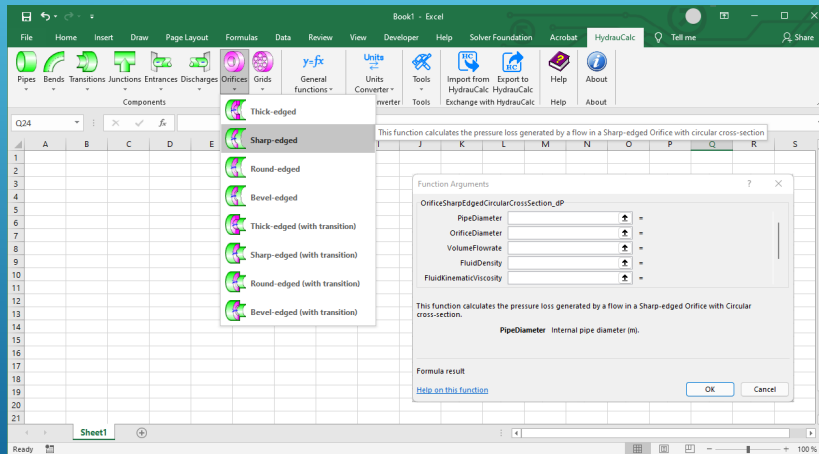
What is HydrauCalcXL Add-in?

What is HydrauCalcXL Add-in?

- ▶ HydrauCalcXL Add-in is a library of functions that has been developed to calculate the pressure losses of hydraulic components in Microsoft Excel®. This library allows the direct call of functions relating to the calculation of pressure losses. It comes from the HydrauCalc application which is based mainly on recognized and respected references in the field of flow and pressure losses calculation.
- ▶ The HydrauCalcXL functions can be used via the user interface of Excel, like the own integrated functions of Excel.
- ▶ The joint use of this library and the solver integrated in Excel® (solver of nonlinear systems of equations) makes it possible to solve iterative flow problems and to perform multi-variables optimization analyzes of fluid systems.

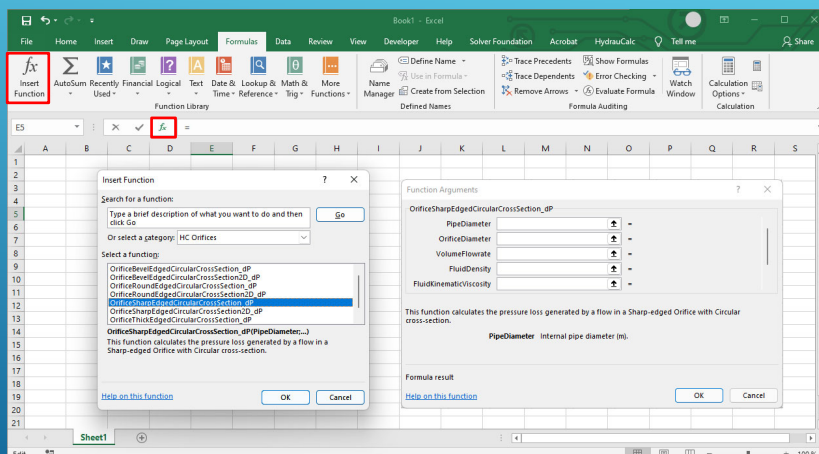
The Graphical Excel Interface

Graphical Excel Interface



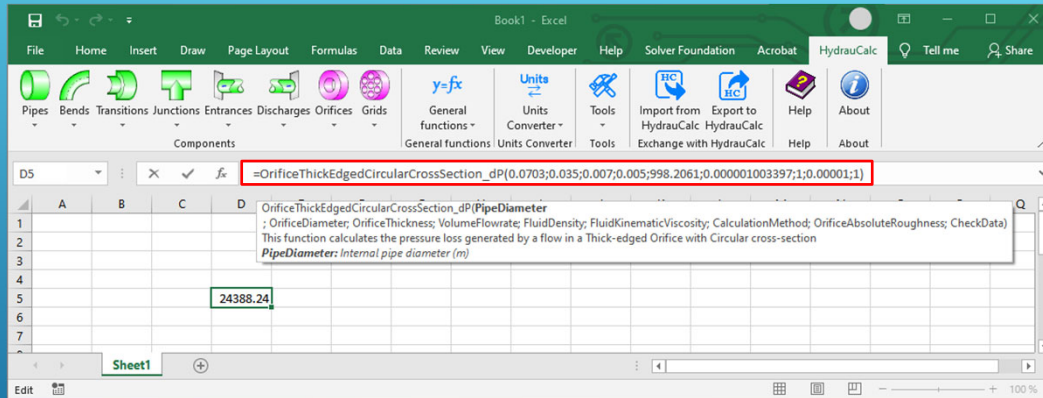
- ▶ The HydraulCalc tab includes a ribbon that allows you to call up the different functions of the library.
- ▶ From this interface, the user inserts the functions of the components that he wishes to evaluate.
- ▶ This interface is intuitive and very easy-to-use.

Graphical Excel Interface



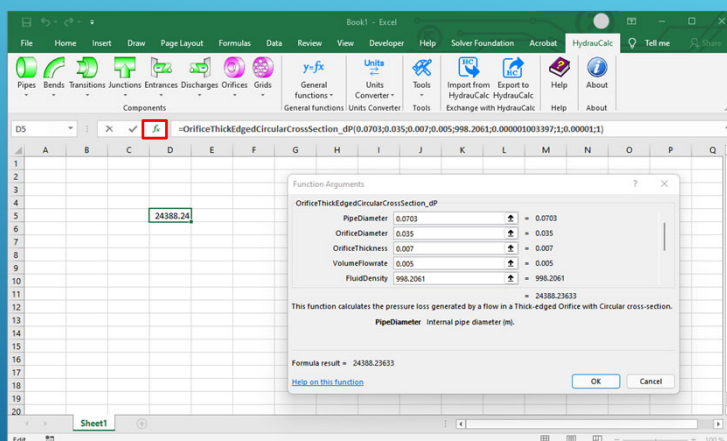
- ▶ The functions of the library can also be selected from the "Insert Function" buttons of the "Formulas" tab or from the function bar.
- ▶ This interface is less friendly and less easy to use than the previous one.

Graphical Excel Interface



When a function is inserted in a cell of the spreadsheet, it is possible, subsequently, to modify the parameters of the function by displaying it in the formula bar.

Graphical Excel Interface



- Function parameters can also be changed by selecting the "Insert Function" button on the function bar.

The Functions of the HydrauCalcXL Library

The functions of the HydrauCalcXL library

The functions of the library are accessible via the ribbon of the HydrauCalcXL tab.

The library includes four types of functions:

- ❑ Functions for calculating pressure losses of piping components such as straight pipes, bends, transitions, junctions, pipeline entrances, pipeline discharges, orifices, grids (68 functions).
- ❑ Functions for calculation between the different variables entering into the general pressure loss formulas (pressure loss, pressure loss coefficient, flow coefficient, volume flow, mass flow, Reynolds number, flow velocity , ...) (103 functions).
- ❑ Functions to convert units of measure to each other (17 functions).
- ❑ Various functions (2 functions).

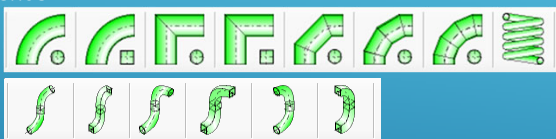
Piping Components

The available piping components

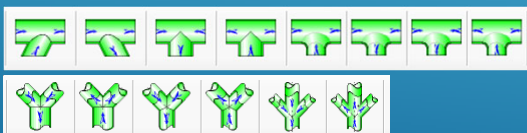
Straight pipes:



Bends:



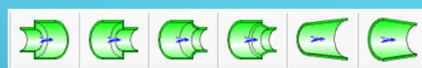
Junctions:



Restriction orifices:



Transitions:



Pipeline entrances:



Pipeline discharges:



Grids:



Component Function Arguments

The arguments of the component pressure drop calculation functions are:

- ❑ The geometry of the component (length, internal diameter, angle and radius of curvature, absolute roughness of the walls, etc.).
- ❑ The characteristic of the flow (volume flowrate).
- ❑ The properties of the conveyed fluid (density and kinematic viscosity).

Example of Using a Component Function

The screenshot displays the HydrauCalcXL software interface. The main window shows a spreadsheet with the following data:

Property	Value	Unit
Density	998.1	kg/m³
Kinematic Viscosity	9.800E-07	m²/s
Volume flowrate	0.005	m³/s
Diameter	0.0525	m
Length	6	m
Absolute roughness	5.0E-06	m

The spreadsheet also shows the following formulas and results:

- Flow velocity:** $\text{FlowVelocity_Qv_DIE}(C12)$ = 2.310 m/s
- Reynolds number:** $\text{ReynoldsNumber_V_D_Mu}(C12,C8)$ = 123796
- Pressure loss coefficient:** $\text{PressureLossCoefficient_dp_Qv_D_Re}(C12,C8)$ = 1.968
- Pipe pressure loss:** $\text{PipeStraightCircularCrossSection_dp}(C12,C13,C14,C15,C16,C17,C18,C19)$ = 5239 Pa

A red arrow points from the formula bar to the function arguments window, which shows the following arguments:

- InternalDiameter: 0.0525
- PipeLength: 6
- VolumeFlowrate: 0.005
- FluidDensity: 998.1
- FluidKinematicViscosity: 9.800000E-07

The function arguments window also displays the formula result: 5239. The help window for the **PipeStraightCircularCrossSection_dp** function is open, showing the following description:

This function calculates the pressure loss generated by a flow in a Straight pipe with Circular cross-section.

Syntax

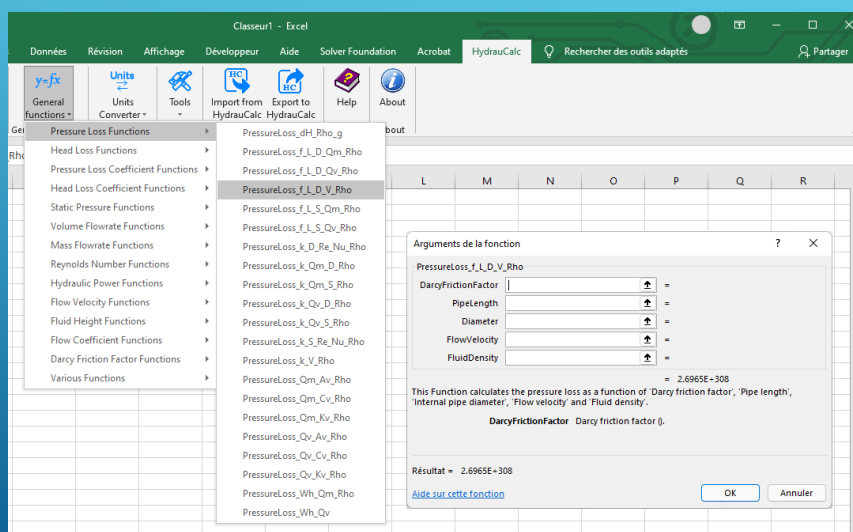
`PipeStraightCircularCrossSection_dp(InternalDiameter, PipeLength, VolumeFlowrate, FluidDensity, FluidKinematicViscosity, CalculationMethod, AbsoluteRoughness, DarcyFrictionFactor, HazenWilliamsRoughnessCoefficient, CheckData)`

PipeStraightCircularCrossSection_dp function syntax has the following arguments:

- InternalDiameter** Double: Internal pipe diameter (m)
- PipeLength** Double: Pipe length (m)
- VolumeFlowrate** Double: Volume flowrate (m³/s)
- FluidDensity** Double: Fluid density (kg/m³)
- FluidKinematicViscosity** Double: Fluid kinematic viscosity (m²/s)
- CalculationMethod** Integer: CalculationMethod (1-7) (optional - default value = 2):
 - 1: DELCHK Uniform Roughness Walls = 1
 - 2: DELCHK Nonuniform Roughness Walls = 2
 - 3: DELCHK Fixed Darcy Friction Factor = 4
 - 4: MILLER Roughness Walls = 5
 - 5: MILLER Fixed Darcy Friction Factor = 6
 - 6: HAZEN-WILLIAMS Roughness Walls = 7
 - 7: DELCHK Nonuniform Roughness Walls = 7
- DarcyFrictionFactor** Double: Darcy friction factor (optional - used only if CalculationMethod = 4 or 5)
- HazenWilliamsRoughnessCoefficient** Double: Hazen-Williams roughness coefficient (optional - used only if CalculationMethod = 7)
- CheckData** Integer: Check input data and results (0/1) (optional - default value = 0)

General formula functions

General formula functions



Example of using general formula functions

The screenshot displays the HydraulCalcXL interface. The spreadsheet contains the following data:

Row	Column	Value	Unit
4	Density	998.1	kg/m³
5	Kinematic Viscosity	9.80E-07	m²/s
7	Volume flowrate	0.005	m³/s
9	Diameter	0.0525	m
10	Length	6	m
11	Absolute roughness	5.0E-06	m
13	Darcy friction factor	0.02	-

Formulas in the spreadsheet include:

- Pressure loss (Pa):** `=PressureLoss_f_L_D_Qv_Rho(C3,C4,C7,C8,D4)`
- Flow velocity (m/s):** `=FlowVelocity_Qv_D(C7,C8)`
- Pressure loss coefficient:** `=PressureLossCoefficient_dP_Qv_D_Rho(C4,C7,C8,D4)`

A "Function arguments call" window is open, showing the arguments for the `PressureLossCoefficient_dP_Qv_D_Rho` function:

- PressureLoss (Pa): 6085.38926
- VolumeFlowrate (m³/s): 0.005
- Diameter (m): 0.0525
- FluidDensity (kg/m³): 998.1

The formula result is 2.286. A red arrow points to the "Help on this function" button, with the text "Calling help for function description." below it.

The "PressureLossCoefficient_dP_Qv_D_Rho function" help window is also open, showing the description, syntax, and formula:

Description: This function calculates the pressure loss coefficient as a function of 'Pressure loss', 'Volume flowrate', 'Internal pipe diameter' and 'Fluid density'.

Syntax: `PressureLossCoefficient_dP_Qv_D_Rho(PressureLoss, VolumeFlowrate, Diameter, FluidDensity)`

Arguments:

- PressureLoss (dP):** Double Pressure loss (Pa)
- VolumeFlowrate (Qv):** Double Volume flowrate (m³/s)
- Diameter (D):** Double Diameter (m)
- FluidDensity (p):** Double Fluid density (kg/m³)

Formula:

$$k = \frac{dP}{0.5 \cdot \rho \cdot \frac{Q_v^2}{(\tau \cdot D^5)}}$$

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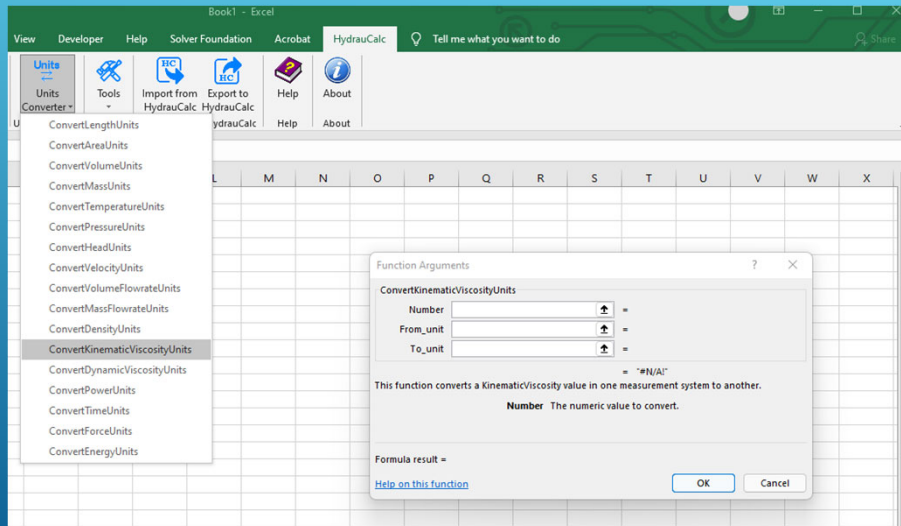
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Functions for converting units of measurement

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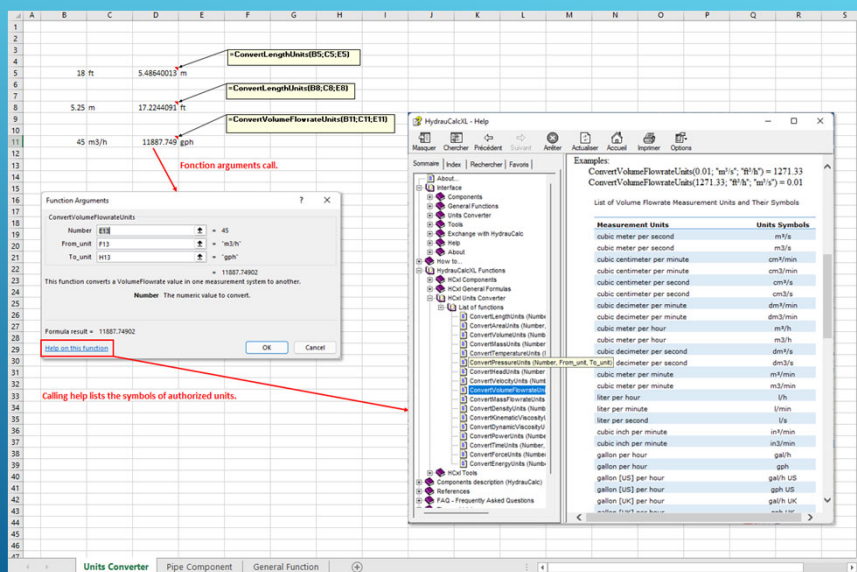
Functions for converting units of measurement



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Example of using measurement unit conversion functions

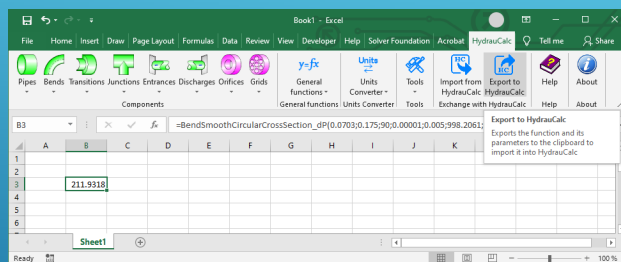


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Data exchange with the HydrauCalc application

Data exchange with HydrauCalc application

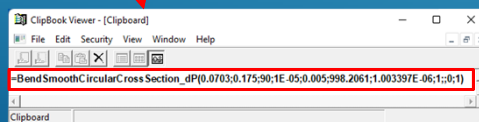
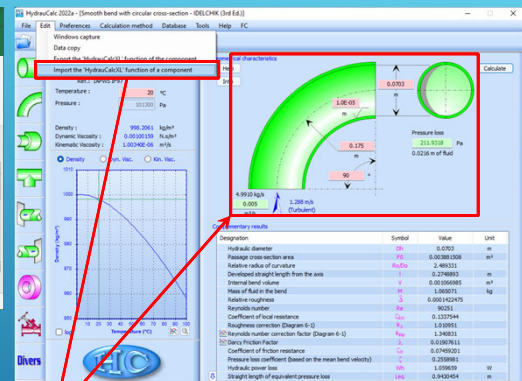
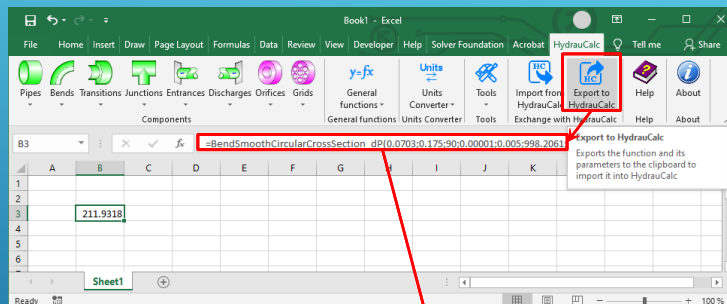


Data can be exchanged between the "HydrauCalcXL" library and the "HydrauCalc" application via the clipboard.

Data export to HydrauCalc

1 - Export function to Clipboard

2 - Import function from Clipboard



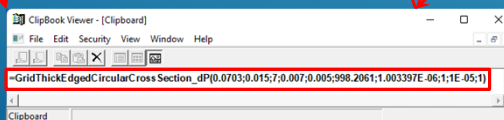
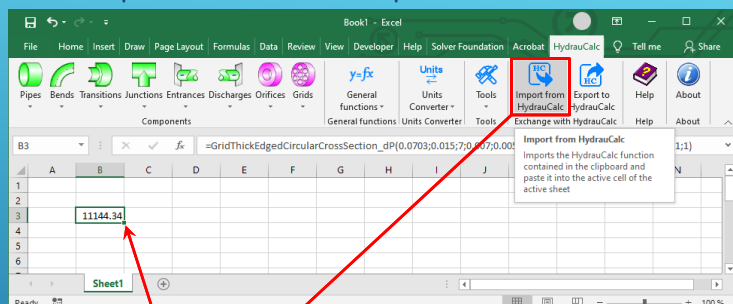
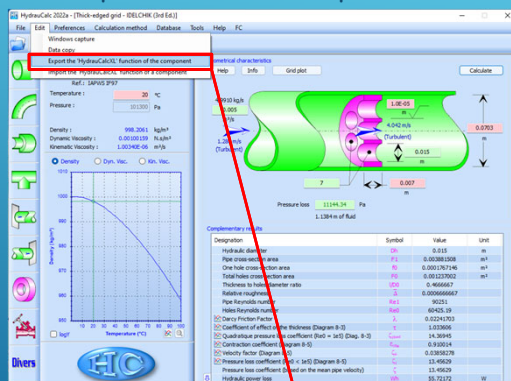
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Data import from HydrauCalc

1 - Export function to Clipboard

2 - Import function from Clipboard



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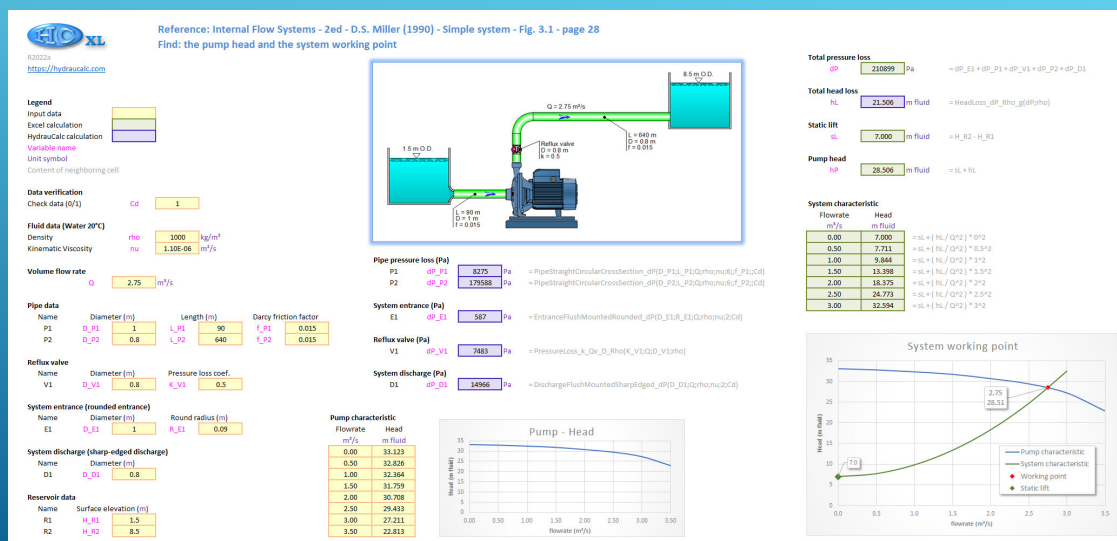
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Examples of systems solved using HydraulCalcXL and Excel solver

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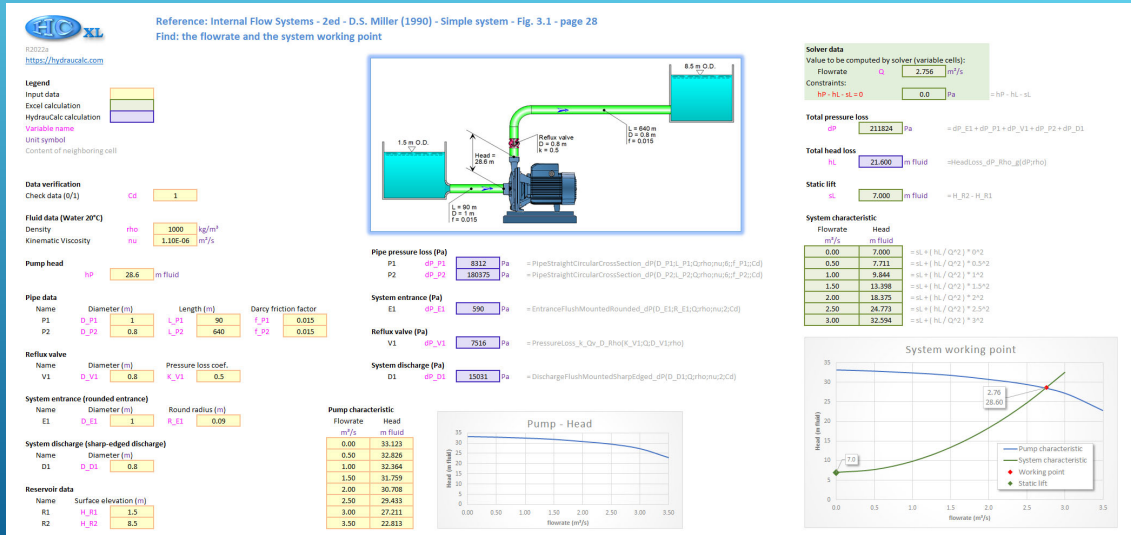
- Find: the pump head and the system working point.
- The pump flowrate is an input data. The functions integrated into HydraulCalcXL allow you to calculate explicitly (direct calculation without iteration) the pressure drop of the components.



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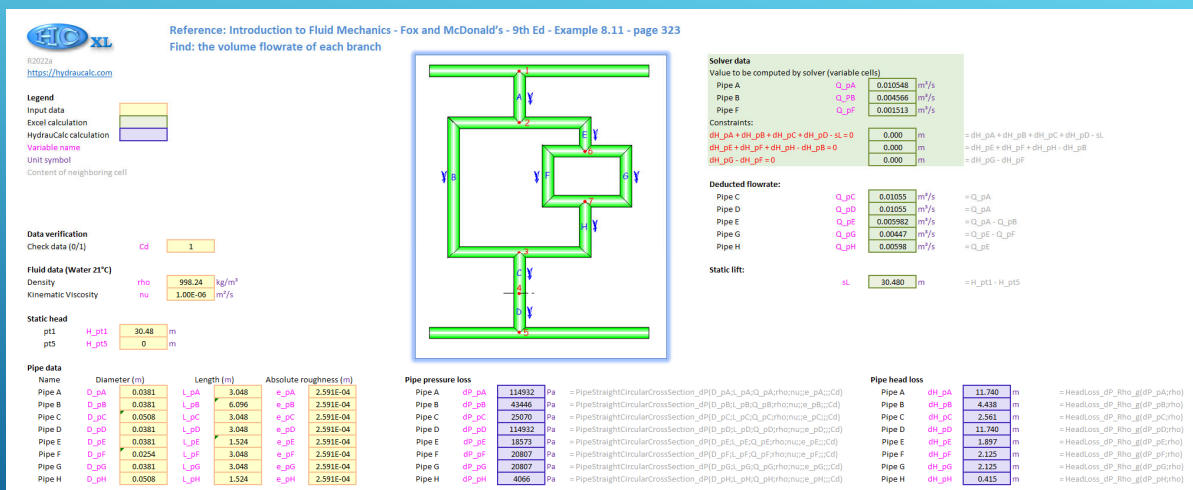
- Find: the flowrate and the system working point.
- The pump head is an input data. The use of the Excel solver is necessary to resolve the system and find the flowrate.



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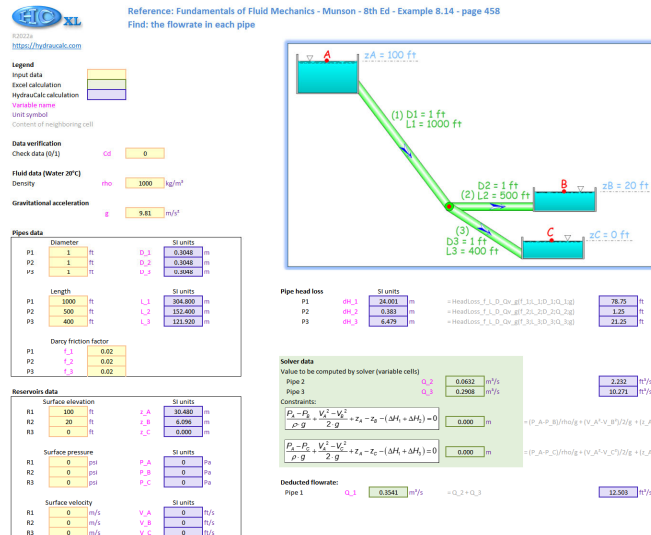
- Find: the volume flowrate of each branch.
- This problem illustrates the use of Excel to solve a set of coupled, nonlinear equations for unknown flowrates.



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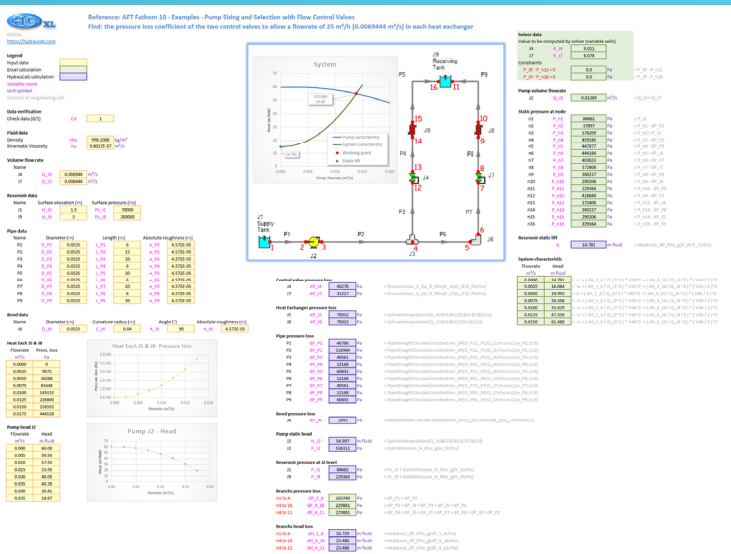
- Find: the flowrate in each pipe.
- This problem illustrates use of Excel to solve a set of coupled, nonlinear equations for unknown flowrates.
- This example demonstrates also the use of unit conversion functions.



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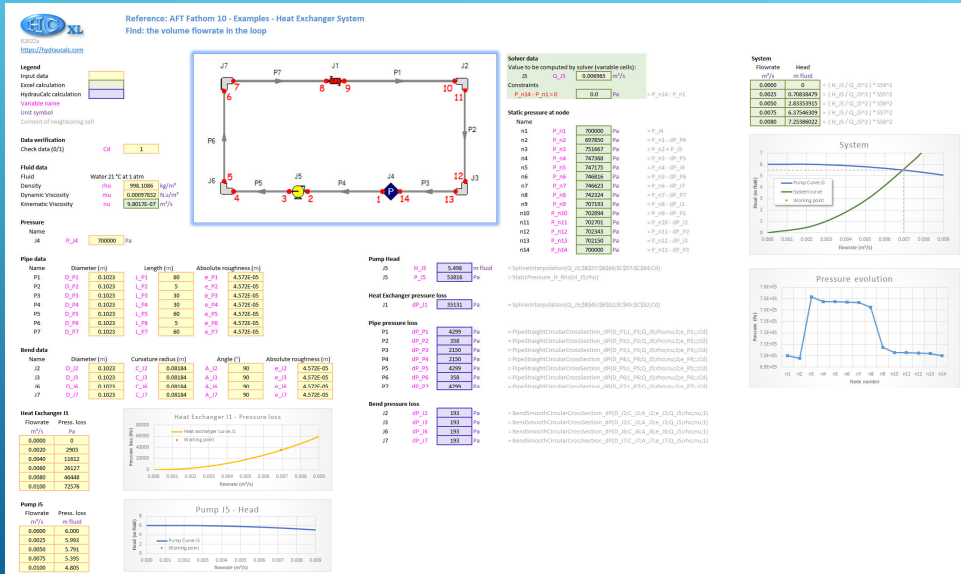
- Find: the pressure loss coefficient of the two control valves to allow the desired flowrate in each heat exchanger and the working point of the pump.
- This example shows simple system flow balancing.



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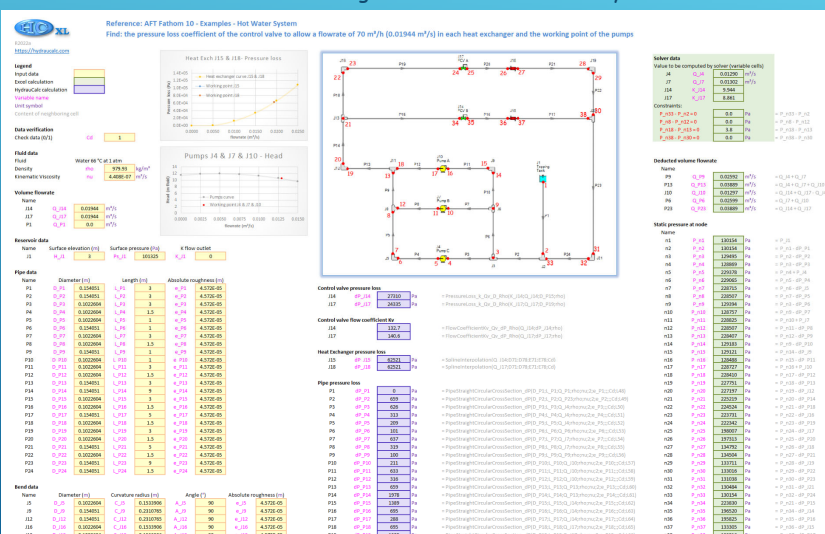
- Find: the volume flowrate in the loop.
- This problem illustrates the use of Excel solver to find the flowrate in a simple closed loop system.



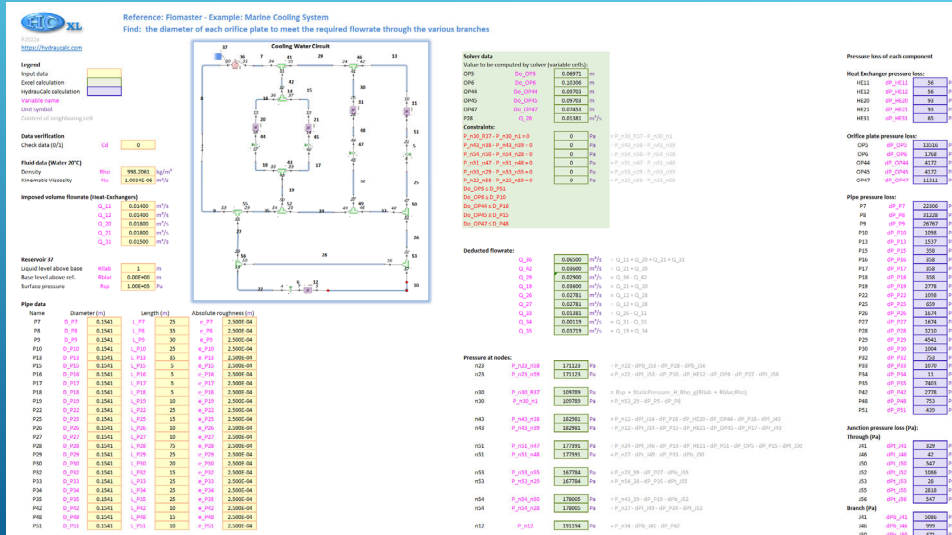
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- Find: the pressure loss coefficient of the two control valves to allow the desired flowrate in each heat exchanger and the working point of the pumps.
- This problem illustrates the use of Excel to solve a closed loop system with multiple pumps. In addition, the flows in the branches of the two exchangers are to be balanced by control valves.



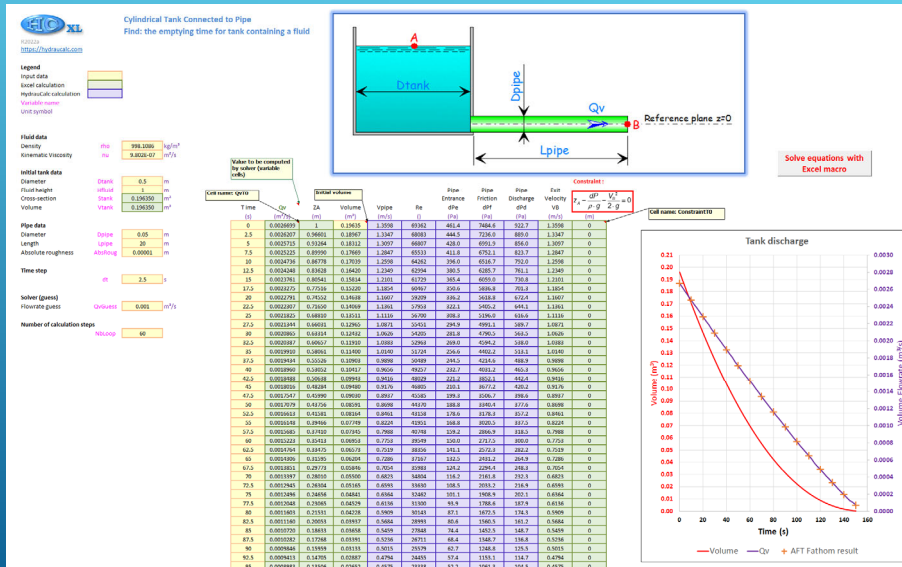
- Find: the diameter of each orifice plate to meet the required flowrate through the each heat exchanger.
- This problem illustrates the use of Excel solver to solve a complex closed loop system. In addition, the flows in the branches of the five exchangers are to be balanced by restriction orifices.



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- Find: the emptying time for tank containing a fluid.
- This problem illustrates the use of the Excel Solver to perform a transient analysis of a system.



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