HydrauCalc

2020b Release

www.hydraucalc.com

APPLICATION DESCRIPTION

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HydrauCalc is a software application that allows accurate modeling and calculating of stabilized flows in piping elements as straight pipes, bends, changes of cross-section, tees, valves, orifices and more.

HydrauCalc is particularly suitable for pre-projects because it allows to estimate quickly the pressure losses of the components of a hydraulic installation, and thus to specify the characteristics of the pumps.

Friction Loss is calculated using the Darcy-Weisbach method, which provides accurate results for non-compressible fluids (liquids). This method also provides satisfactory results of reasonable accuracy for compressible fluids (gases) when the flow velocity is not very high.

HydrauCalc is mainly based on well-known and respected references in the field of fluid flow and pressure drop calculation.

THE REFERENCES

MAINLY REFERENCES

[1] Handbook of Hydraulic Resistance, I.E. Idelchik

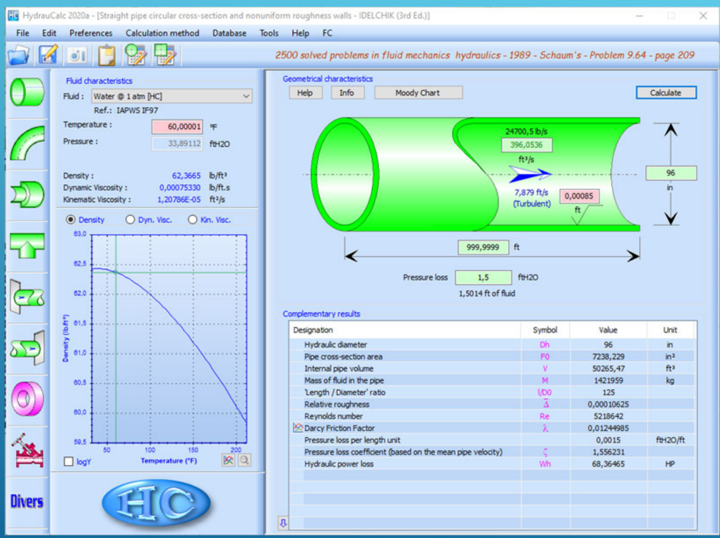
[2] Internal Flow System, D.S. Miller

[3] CRANE - Flow of Fluids Through Valves, Fitting and Pipe - Technical Paper No. 410

[4] Pipe Flow - A Practical and Comprehensive Guide, D. C. Rennels, H. M. Hudson

THE GRAPHICAL USER INTERFACE

GRAPHICAL USER INTERFACE

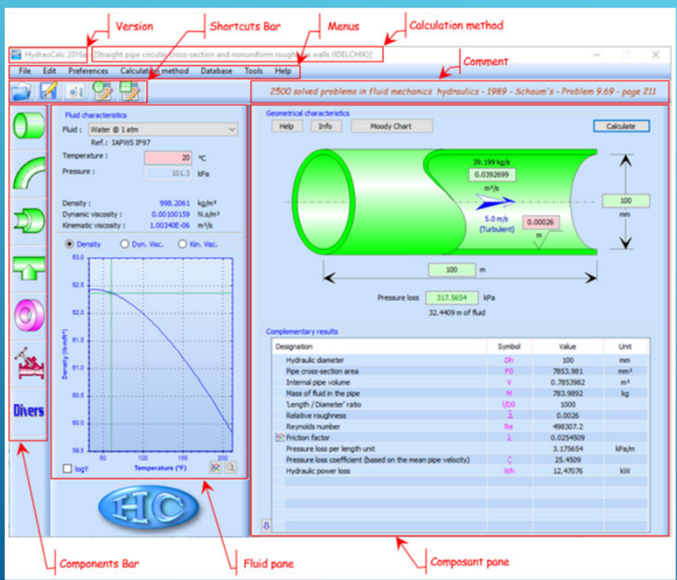


The graphical user interface is available in English, French or Spanish.

From this interface, the user selects the type of component he wants to calculate and the fluid carried in this component. It also provides the necessary input data (fluid and flow characteristics and component geometry).

This interface is intuitive and very easy-to-use.

GRAPHICAL INTERFACE STRUCTURE



The graphical interface is structured in four main parts:

- The components bar
- The fluid pane
- The component pane
- The upper part which includes:
  - The information about release and calculation method chosen
  - Menus and shortcuts bar
  - The display area for a possible comment

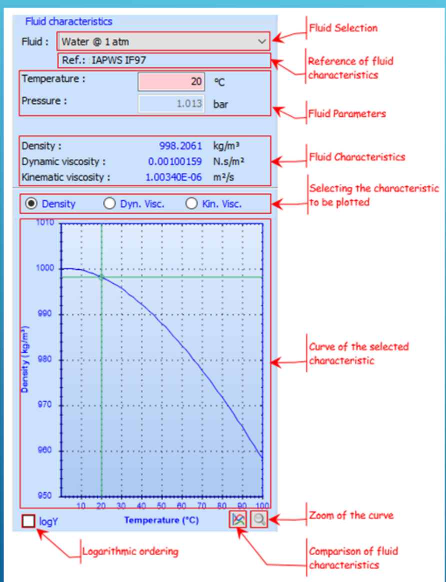
COMPONENTS BAR

The vertical components bar makes it possible to select a family of components (straight pipes, bends, changes of cross-section, tees, pipeline entrances and discharges, restriction and measurement orifices, valves, ...)

Selecting a family displays the available components for that family in one or more horizontal bars.

The shaded components are under development and will be available in a future release.

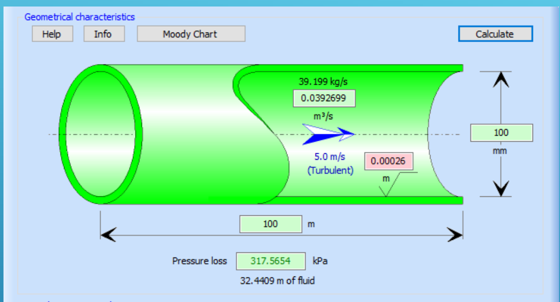
FLUID PANE



The fluid pane mainly allows:

- Select the fluid
- Set the fluid according to the selected fluid type (temperature, pressure, salinity, quality, humidity, ...)
- Visualize the characteristics of the fluid (density, dynamic and kinematic viscosity)
- Visualize the evolution of the characteristics according to the temperature or the pressure (according to the type of selected fluid)

COMPONENT PANE

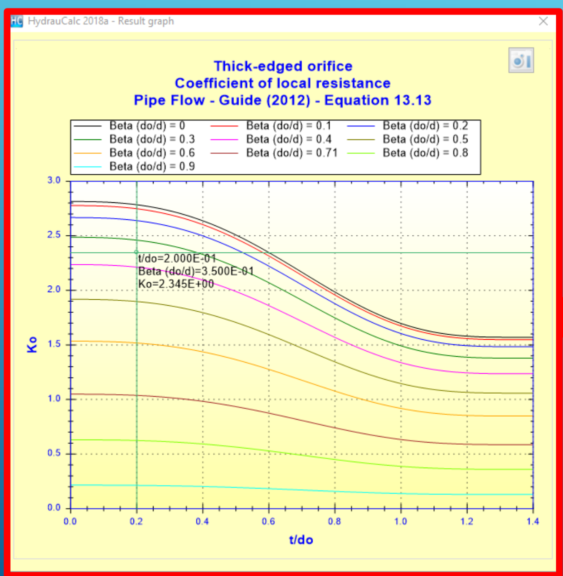


Designation	Symbol	Value	Unit
Hydraulic diameter	Dh	100	mm
Pipe cross-section area	F0	7853.981	mm²
Internal pipe volume	V	0.7853982	m³
Mass of fluid in the pipe	M	783.9892	kg
'Length / Diameter' ratio	l/D0	1000	
Relative roughness	Δ	0.0026	
Reynolds number	Re	498307.2	
Friction factor	λ	0.0254509	
Pressure loss per length unit		3.175654	kPa/m
Pressure loss coefficient (based on the mean pipe velocity)	ζ	25.4509	
Hydraulic power loss	Wh	12.47076	kW

The component pane allows you to:

- Define the geometry of the component according to the selected component type (inside diameter, length, roughness, …)
- Define flow (volume flow rate)
- Execute the calculation of the component
- Visualize the results
- Display the Moody diagram corresponding to the calculation with the calculated point (case of friction loss)
- Access information about the component:
  - Help (technical documentation of the component)
  - Info (information on the use of the component)
  - Other eventually

COMPLEMENTARY RESULTS

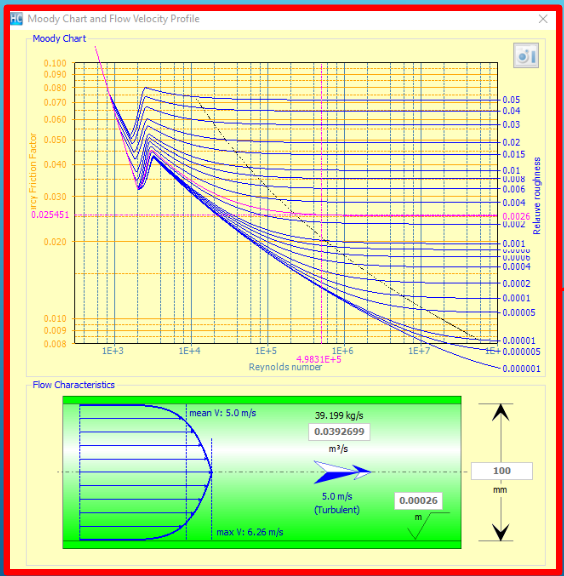


When, in the complementary results, the variable is preceded by the symbol, a simple click on this variable shows the evolution graph of the variable with the calculated point.

Example :

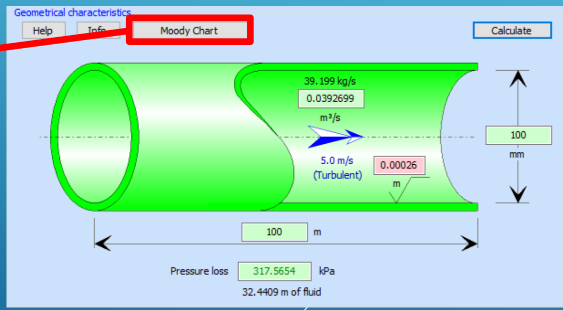
Designation	Symbol	Value	Unit
Pipe cross-section area	A	7853.981	mm²
Orifice cross-section area	Ao	962.1127	mm²
Diameters ratio (Do/d)	β	0.35	
Cross-sections area ratio	Ao/A	0.1225	
Thickness to orifice diameter ratio	t/Do	0.2	
Pipe Reynolds number	NRe	498307.2	
Orifice Reynolds number	NReo	1423735	
Velocity in vena contracta	Vc	65.43075	m/s
Jet velocity ratio (Equation 13.4)	λ	1.603054	
Coefficient Cth (Equation 13.14)	Cth	0.9763061	
Coefficient of local resistance (Equation 13.13)	Ko	2.34488	
Pressure loss coefficient (based on the mean pipe velocity)	K	156.2602	
Hydraulic power loss	Wh	76.56641	kW

MOODY DIAGRAM

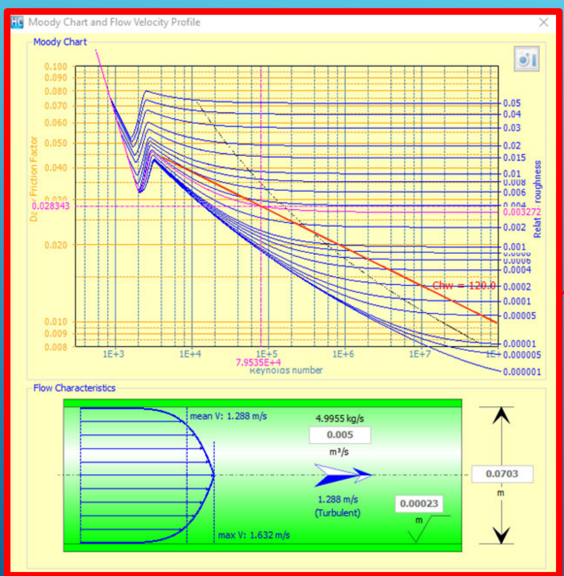


When the component is subjected to friction, the Moody diagram can be consulted to observe the operating point (as well as the flow velocity profile).

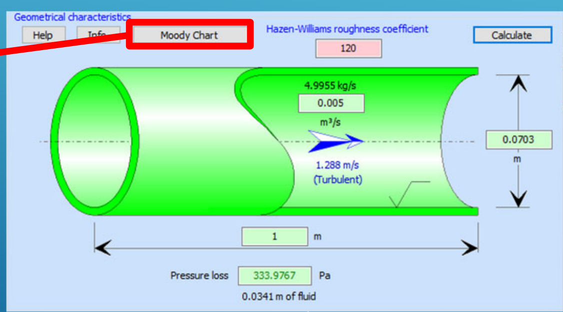
Example of a straight pipe:



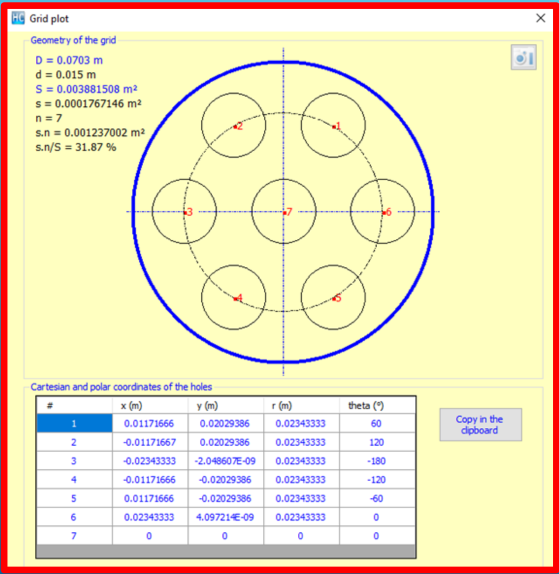
MOODY DIAGRAM AND HAZEN-WILLIAMS FORMULA



For the "Hazen-Williams" calculation method for circular cross-section straight pipes, the Moody diagram shows the relationship between the roughness coefficient of the Hazen-Williams formula and the friction coefficient of Darcy. The diagram also shows the limits of applicability of the Hazen-Williams formula.



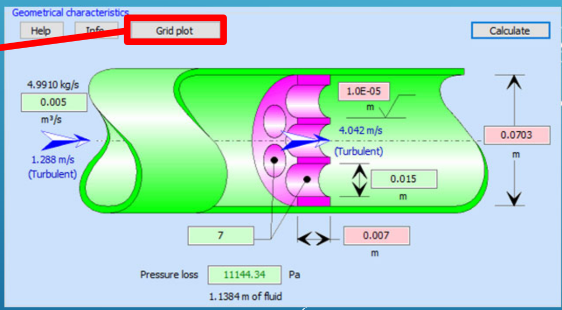
GRID PLOT



#	x (m)	y (m)	r (m)	theta (°)
1	0.01171666	0.02029386	0.02343333	60
2	-0.01171667	0.02029386	0.02343333	120
3	-0.02343333	-2.048607E-09	0.02343333	-180
4	-0.01171666	-0.02029386	0.02343333	-120
5	0.01171666	-0.02029386	0.02343333	-60
6	0.02343333	4.097214E-09	0.02343333	0
7	0	0	0	0

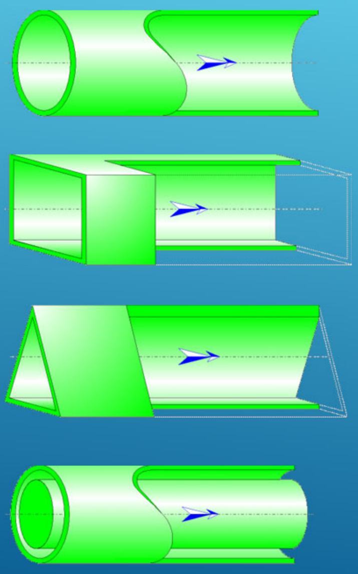
For "Grid" components (perforated plate), the application provides a grid plot with the coordinates of each hole.

Example of a perforated plate plot:



THE COMPONENTS

STRAIGHT PIPES



Circular cross-section

Rectangular cross-section

Triangular cross-section

Annular cross-section

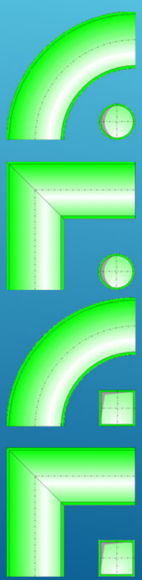
The proposed calculation methods:

- IDELCHIK
  - Uniform roughness walls (Nikuradze equation)
  - Nonuniform roughness walls (Colebrook-White equation)
  - Smooth roughness walls (Filonenko and Althsul equation)
  - Explicit Darcy friction factor
- MILLER
  - Roughness walls (Swamee-Jain equation)
  - Explicit Darcy friction factor
- HAZEN-WILLIAMS (only circular cross-section)
  - Roughness walls (Hazen-Williams equation)

The proposed calculations:

- Pressure loss
- Volume flow rate
- Length of pipe
- Inside diameter (circular cross-section)
- Height or width (rectangular cross-section)
- Height or base (triangular cross-section)

BENDS



Smooth bend with circular cross-section

Miter bend with circular cross-section

Smooth bend with rectangular cross-section

Miter bend with rectangular cross-section

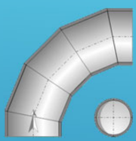
The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

The proposed calculations:

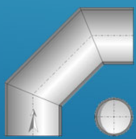
- Pressure loss
- Volume flow rate

BENDS

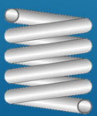


Composite bend 90° with circular cross-section (4 x 22.5°)

Composite bend 90° with circular cross-section (3 x 30°)



Composite bend 90° with circular cross-section (2 x 45°)



Helical tube

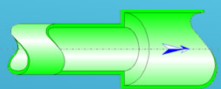
The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

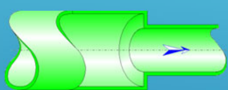
The proposed calculations:

- Pressure loss
- Volume flow rate

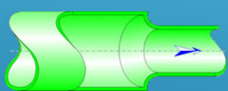
CHANGES OF CROSS-SECTION



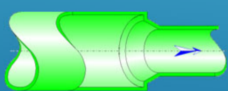
Sudden expansion



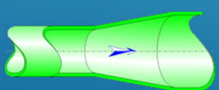
Sudden contraction sharp



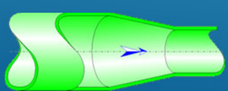
Sudden contraction rounded



Sudden contraction bevelled



Gradual expansion



Gradual contraction

The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

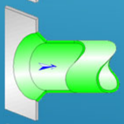
The proposed calculations:

- Pressure loss
- Volume flow rate

ENTRANCE OF PIPELINE

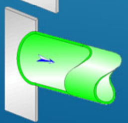
Flush-mounted sharp-edged entrance

Flush-mounted rounded entrance



Flush-mounted bevelled entrance

Sharp-edged entrance mounted at a distance



Sharp-edged entrance mounted at an angle

The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

The proposed calculations:

- Pressure loss
- Volume flow rate

DISCHARGE OF PIPELINE

Flush-mounted sharp-edged discharge

Flush-mounted rounded discharge

Sharp-edged discharge mounted at a distance

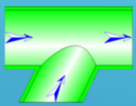
The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

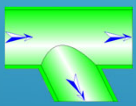
The proposed calculations:

- Pressure loss
- Volume flow rate

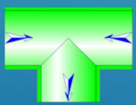
JUNCTIONS



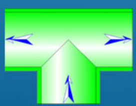
Combining sharp-edged junction



Dividing sharp-edged junction



Symmetric combining sharp-edged T-junction



Symmetric dividing sharp-edged T-junction

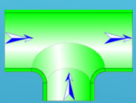
The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE

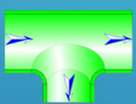
The proposed calculations:

- Pressure loss in each branch

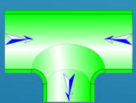
JUNCTIONS (FOLLOWING)



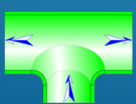
Combining radiused-edged T-junction



Dividing radiused-edged T-junction



Symmetric combining radiused-edged T-junction



Symmetric dividing radiused-edged T-junction

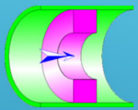
The proposed calculation methods:

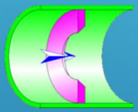
- MILLER
- Pipe Flow Guide

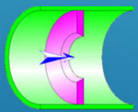
The proposed calculations:

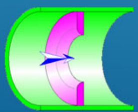
- Pressure loss in each branch

RESTRICTION ORIFICES


Thick-edged orifice


Sharp-edged orifice


Bevelled-edged orifice


Radiused-edged orifice

The proposed calculation methods:

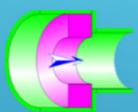
- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

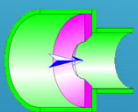
The proposed calculations:

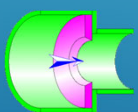
- Pressure loss
- Volume flow rate
- Orifice diameter

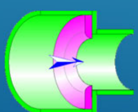
RESTRICTION ORIFICES (FOLLOWING)

New R2020b


Thick-edged orifice
(in transition section)


Sharp-edged orifice
(in transition section)


Bevel-edged orifice
(in transition section)

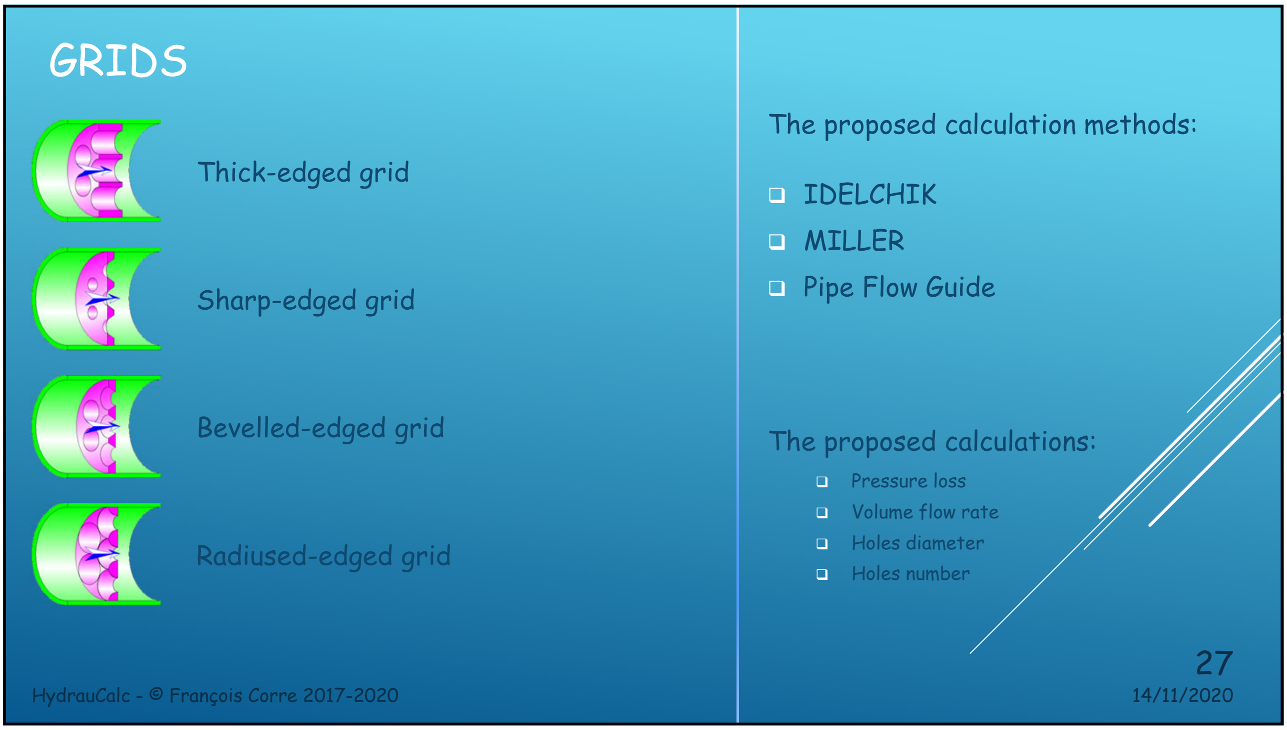

Round-edged orifice
(in transition section)

The proposed calculation methods:

- IDELCHIK
- Pipe Flow Guide

The proposed calculations:

- Pressure loss
- Volume flow rate
- Orifice diameter


GRIDS
Thick-edged grid
Sharp-edged grid
Bevelled-edged grid
Radiused-edged grid
The proposed calculation methods:
IDELCHIK
MILLER
Pipe Flow Guide
The proposed calculations:
Pressure loss
Volume flow rate
Holes diameter
Holes number
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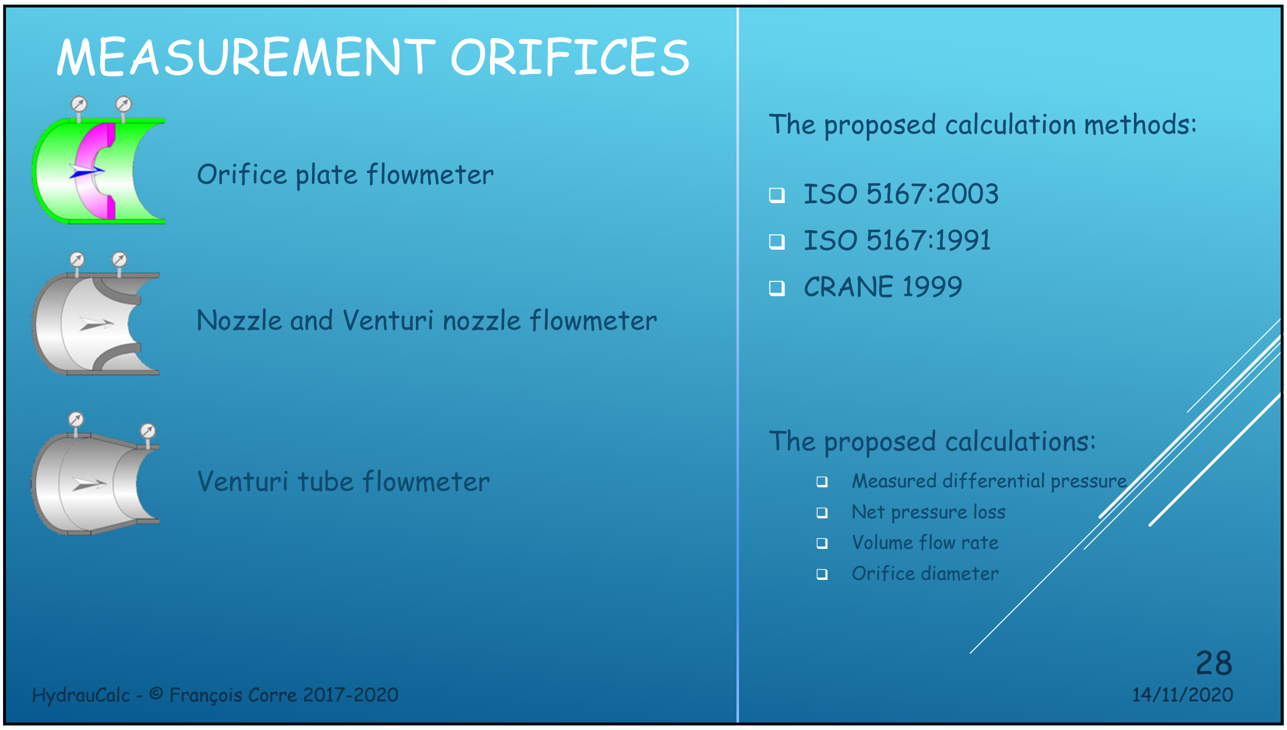
14/11/2020


MEASUREMENT ORIFICES
Orifice plate flowmeter
Nozzle and Venturi nozzle flowmeter
Venturi tube flowmeter
The proposed calculation methods:
ISO 5167:2003
ISO 5167:1991
CRANE 1999
The proposed calculations:
Measured differential pressure
Net pressure loss
Volume flow rate
Orifice diameter
HydrauCalc - © François Corre 2017-2020
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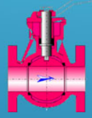
14/11/2020

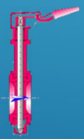
VALVES

New R2020b

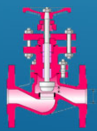
Y globe valve



Ball valve



Butterfly valve



Globe valve

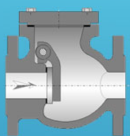
The proposed calculation methods:

- IDELCHIK
- MILLER
- Manufacturers

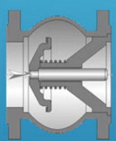
The proposed calculations:

- Pressure loss
- Volume flow rate

CHECK VALVES



Swing check valve



Lift check valve

The proposed calculation methods:

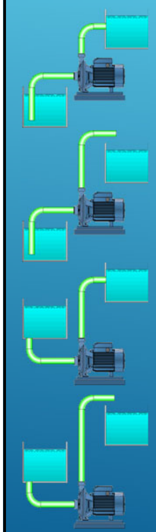
- IDELCHIK
- Manufacturers

The proposed calculations:

- Pressure loss

PUMP QUICK DESIGN

New R2020b



Suction lift operation
Tank with pipe ending below the fluid level

Suction lift operation
Free flow from the pipe ending above the water level

Suction head operation
Tank with pipe ending below the fluid level

Suction head operation
Free flow from the pipe ending above the water level

The proposed calculation method:

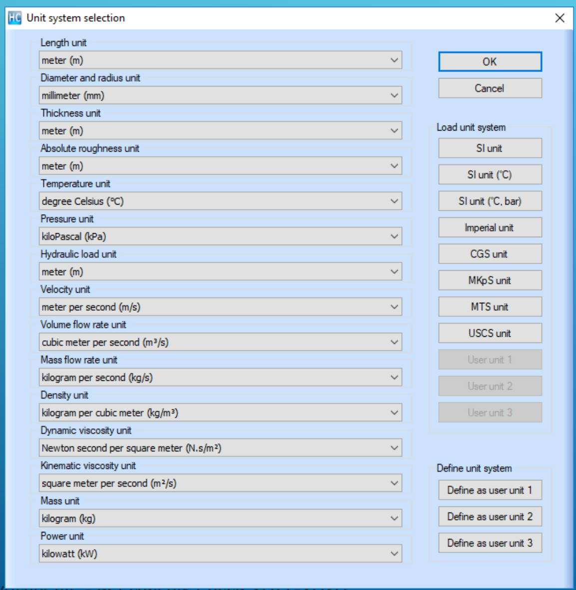
- KSB Manufacturer

The proposed calculations:

- Total Dynamic Head (TDH)
- Net Positive Suction Head available ($NPSH_a$)
- Pressure loss in suction and discharge lines
- Pressures at the pump flanges

THE MEASURE UNITS

UNIT SYSTEM SELECTION

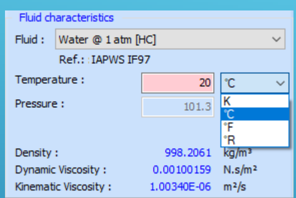


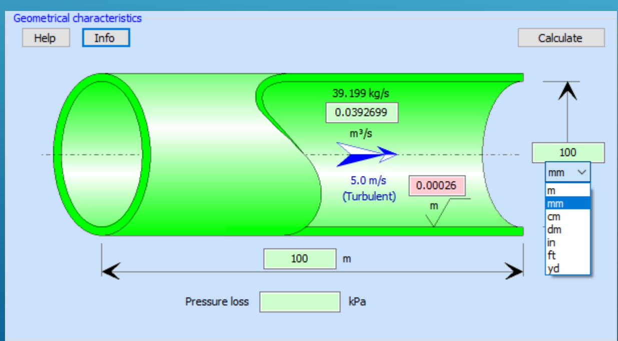
Units can be selected:

- individually
- by unit systems

The user can define his own systems of units (within the limit of three systems)

UNITS MODIFICATION





The application has a dynamic unit conversion engine.

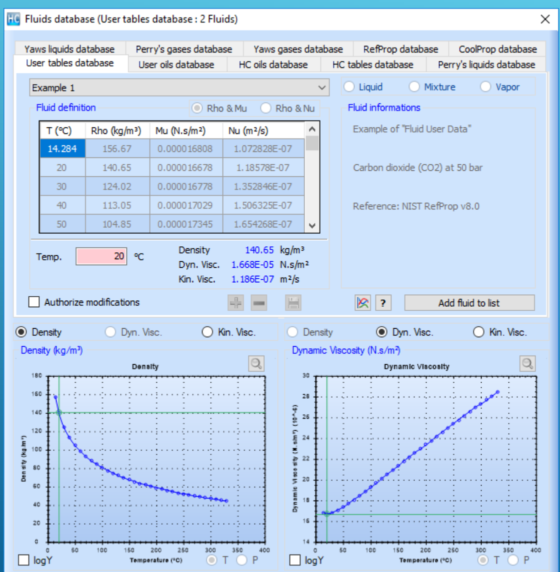
The units displayed in the Fluid Pane and Component Data Panes can be changed by simply clicking on the unit displayed.

After selecting a new unit, the value entered in the input box is automatically converted to the new unit.

The results will be displayed in the current units.

THE DATABASES

DATABASE - FLUIDS

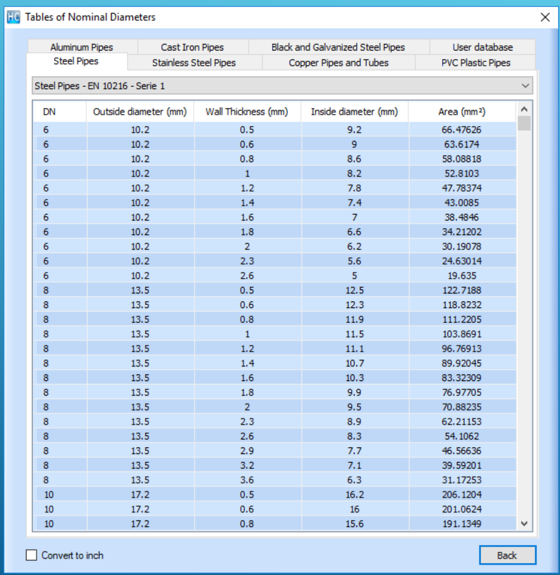


HydrauCalc has a fluid characteristics database consisting of several hundred fluids based on recognized references:

- Perry's Handbook
- Oil products
- Yaws Handbook
- Coolprop
- Refprop (coming soon ...)

The user can also define his own fluids in the form of point tables as a function of temperature.

DATABASE - PIPINGS



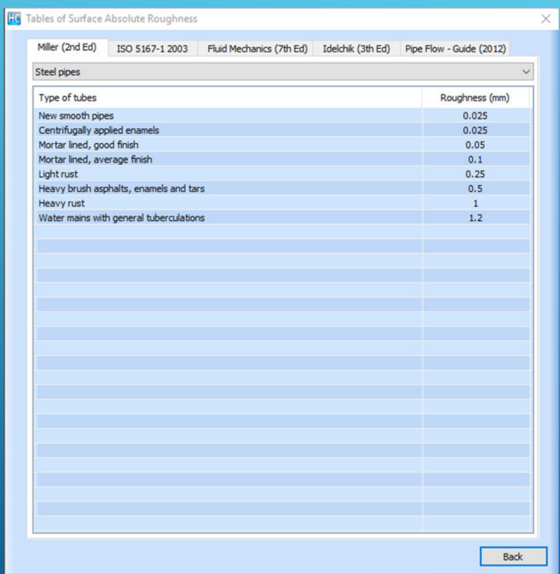
DN	Outside diameter (mm)	Wall Thickness (mm)	Inside diameter (mm)	Area (mm²)
6	10.2	0.5	9.2	66.47626
6	10.2	0.6	9	63.6174
6	10.2	0.8	8.6	58.08818
6	10.2	1	8.2	52.8103
6	10.2	1.2	7.8	47.78374
6	10.2	1.4	7.4	43.0085
6	10.2	1.6	7	38.4846
6	10.2	1.8	6.6	34.21202
6	10.2	2	6.2	30.19078
6	10.2	2.3	5.6	24.63014
6	10.2	2.6	5	19.635
8	13.5	0.5	12.5	122.7188
8	13.5	0.6	12.3	118.8232
8	13.5	0.8	11.9	111.2205
8	13.5	1	11.5	103.8691
8	13.5	1.2	11.1	96.76913
8	13.5	1.4	10.7	89.92045
8	13.5	1.6	10.3	83.32309
8	13.5	1.8	9.9	76.97705
8	13.5	2	9.5	70.88235
8	13.5	2.3	8.9	62.21153
8	13.5	2.6	8.3	54.1062
8	13.5	2.9	7.7	46.56636
8	13.5	3.2	7.1	39.59201
8	13.5	3.6	6.3	31.17253
10	17.2	0.5	16.2	206.1204
10	17.2	0.6	16	201.0624
10	17.2	0.8	15.6	191.1349

HydrauCalc has a database defining the diameters of the main pipe standards.

- Steel piping
- Stainless steel piping
- Copper piping
- PVC piping
- Aluminium piping
- Cast iron piping
- Black and galvanized steel piping

The user can also add his own diameter tables.

DATABASE - WALL ROUGHNESS'S

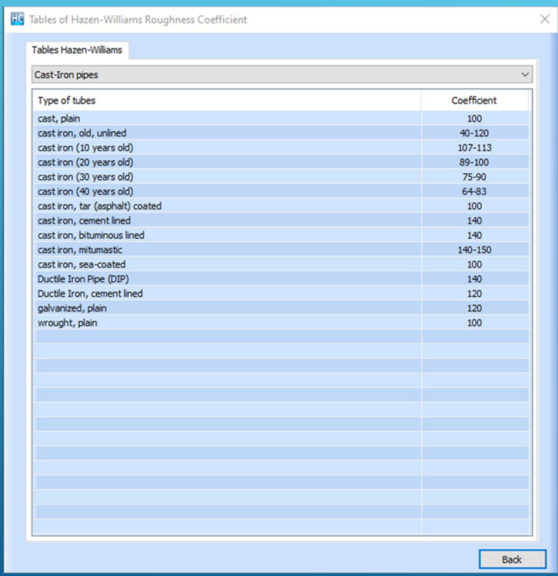


Type of tubes	Roughness (mm)
New smooth pipes	0.025
Centrifugally applied enamels	0.025
Mortar lined, good finish	0.05
Mortar lined, average finish	0.1
Light rust	0.25
Heavy brush asphalts, enamels and tars	0.5
Heavy rust	1
Water mains with general tuberculations	1.2

HydrauCalc has a database of values of absolute roughness of pipe wall from recognized references:

- MILLER
- ISO 5167-1 2003
- Fluid Mechanics – F. White
- IDELCHIK
- Pipe Flow Guide

DATABASE - ROUGHNESS COEFFICIENT

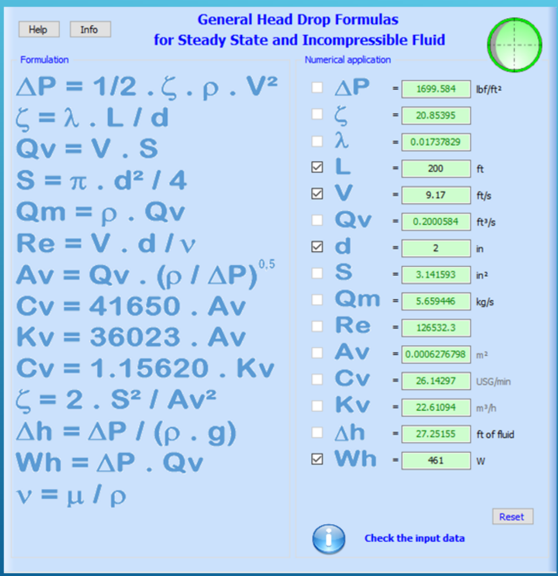


HydrauCalc has a database of values of Hazen-Williams roughness coefficient from:

- Hydraulic Tables by GARDNER S. WILLIAMS and ALLEN HAZEN - 2nd Ed. (1914)

THE TOOLS

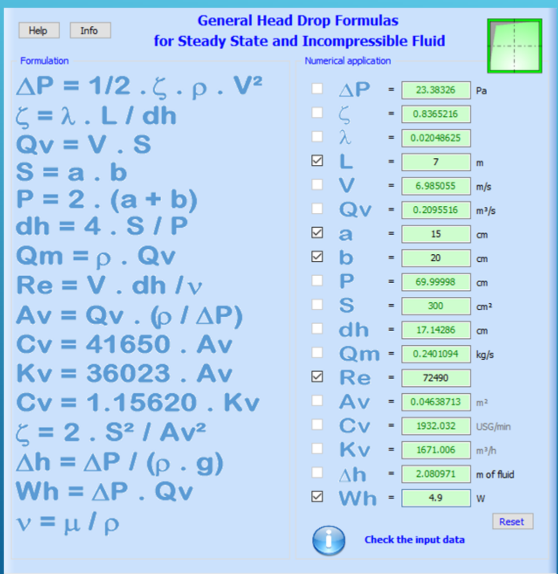
TOOL – CALCULATOR FOR CIRCULAR CROSS-SECTIONS



The application allows, from known input data and for circular cross-sections, to automatically calculate those that can be deduced.

It is thus possible to determine the volume flow rate corresponding, for example, to an imposed mean velocity, so as to inform the input data of the components.

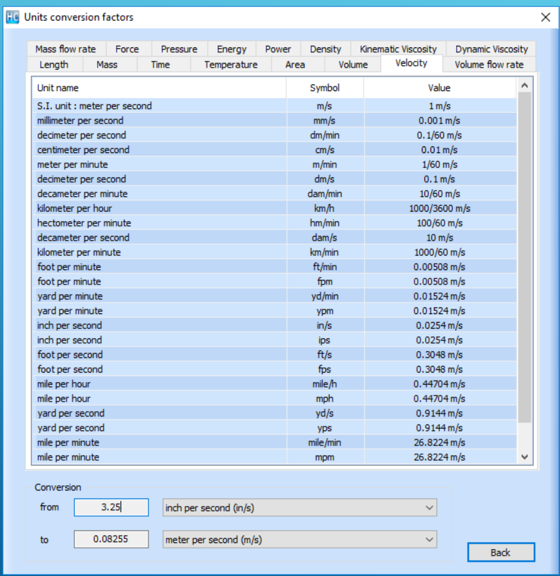
TOOL – CALCULATOR FOR RECTANGULAR CROSS-SECTIONS



The application also makes it possible, from known input data and for rectangular cross-sections, to calculate those that can be deduced from it.

It is thus possible to determine the volume flow rate corresponding, for example, to an imposed Reynolds number, so as to inform the input data of the components.

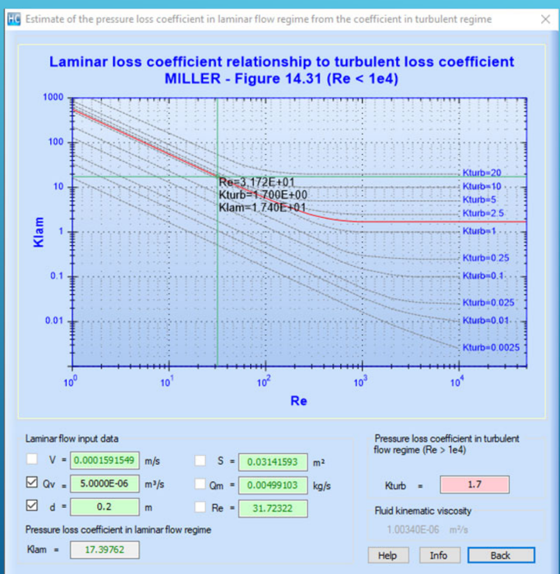
TOOL – UNITS CONVERSION



The application has a tool allowing:

- to view the conversion factors of the measurement units integrated in the application,
- to convert together units of measurement of the same physical size.

TOOL - ESTIMATE PRESSURE LOSS COEFFICIENT IN LAMINAR FLOW

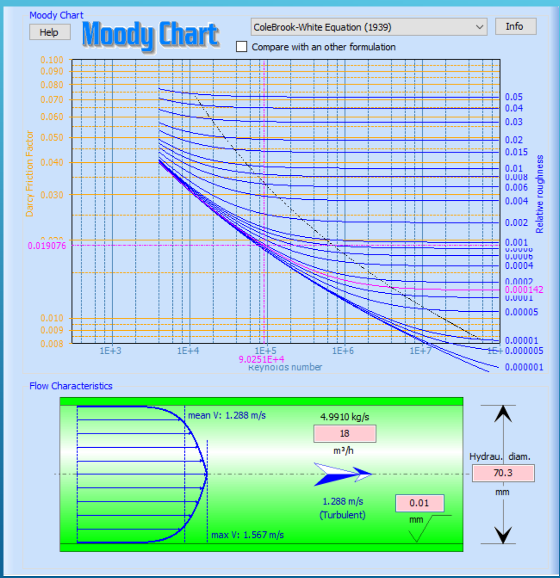


The application has a tool making it possible to obtain an estimate of the coefficient of pressure loss in the laminar flow regime, if the coefficient of pressure loss in the turbulent flow regime is known.

This method only applies to minor pressure losses (pipe fittings, valves, etc.) and is based on the following reference book:

- Internal Flow System, D.S. Miller

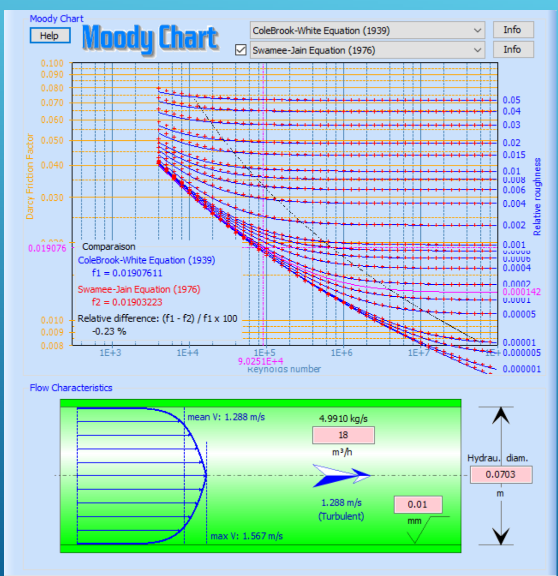
TOOL – MOODY DIAGRAM



The application has a tool to calculate the coefficient of friction from more than 40 other formulations published by recognized scientists. The curves of iso-values of relative roughness are plotted in a Moody diagram and the calculated point is presented.

The velocity profile of the flow corresponding to the calculation point is also plotted in a pipe of same hydraulic diameter as that of the component.

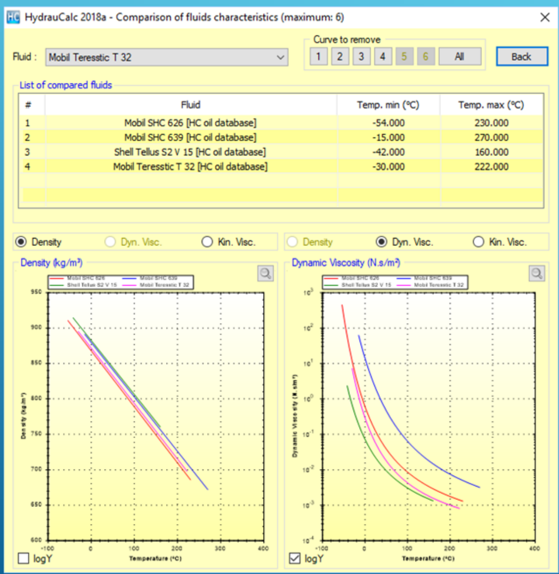
TOOL – MOODY DIAGRAM (FOLLOWING)



This tool also makes it possible to compare two different formulations for determining the Darcy friction coefficient.

The relative difference found at the calculation point is calculated and displayed on the diagram.

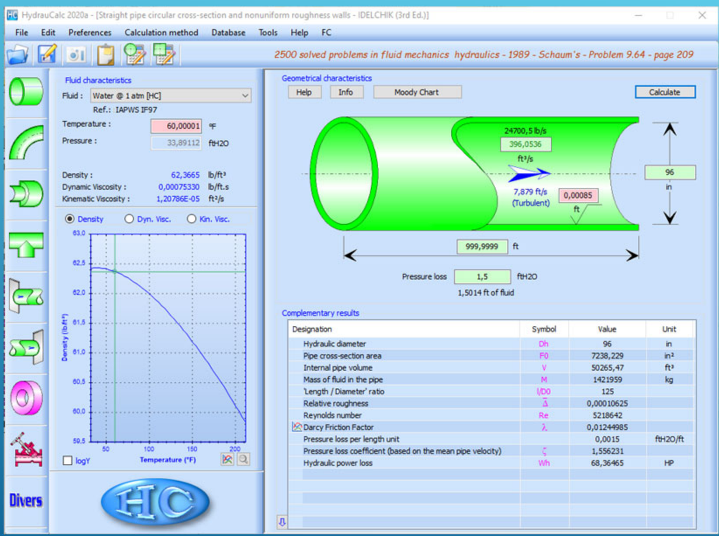
TOOL – FLUID COMPARATOR



The application has a tool to compare the characteristics of the fluids integrated in the application or defined by the user (density, dynamic viscosity and kinematic viscosity).

THE CALCULATION REPORT

CALCULATION REPORT



To include a calculation result in a document, it is possible to copy the window using the button and paste it into the document.

The screenshot contains all the data used for the calculation and the results:

- in the title bar:
  - the release of the application,
  - the type of component calculated and the calculation method used,
- in the fluid pane:
  - the characteristics of the fluid used,
- in the component pane:
  - the input data of the component,
  - the desired main result (value in green colour),
  - the additional results from the calculation.

THE DATA EXPORT

DATA EXPORT

Straight pipe circular cross-section and nonuniform roughness walls - IDELCHIK (3rd Ed.)		
Diameter	0,3333598	m
Pipe cross-section area	0,08728033	m²
Length	609,6	m
Absolute Roughness	4,60E-005	m
Volume flow rate	25,57719	m³/s
Pressure loss	1,00E+009	Pa
Fluid head	102191,5	m of fluid
Pressure loss coefficient	23,33955	
Darcy Friction Factor	0,01276324	
Flow velocity	293,0464	m/s
Reynolds number	1,00E+008	
Hydraulic power loss	2,56E+010	W
Density	997,9705	kg/m³
Dynamic Viscosity	9,75E-004	N.s/m²
Kinematic Viscosity	9,77E-007	m²/s

Feuille1 Feuille2 Feuille3

For each component, the input data and the main results can be copied to the clipboard, using the button , for reuse in another application, for example a spreadsheet.

DATA EXPORT

Référence : Pipe Flow - A Practical and Comprehensive Guide (2012) - Example 7.4 - page 71

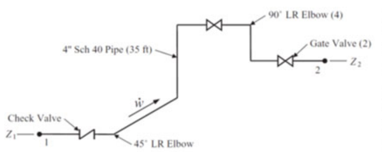


FIGURE 7.1. Four-inch pipe section.

Ktotal = N1.K1 + N2.K2 + N3.K3 + N4.K4 + N5.K5
K 4,394

dPtotal = N1.dP1 + N2.dP2 + N3.dP3 + N4.dP4 + N5.dP5
dP 15,216 psi

HydrauCalc result:
P1 - P2 = dP + dH
P1 - P2 17,380 psi

Reference result:
P1 - P2 17,41 psi

Relative difference:
0,174%

N1	Number	1	
	4" Schedule 40 Pipe (New, Clean Steel)		
	Straight pipe circular cross-section and nonuniform roughness walls -		
	Diameter	0,3355	ft
	Pipe cross-section area	0,0884	ft²
	Length	35	ft
	Absolute Roughness	1,50E-04	ft
	Volume flow rate	0,05681	m³/s
dP1	Pressure loss	6,15249	psi
	Fluid head	14,2205	ft of fluid
K1	Pressure loss coefficient	1,77655	
	Darcy Friction Factor	0,01703	
	Flow velocity	22,6954	ft/s
	Reynolds number	724116	
	Hydraulic power loss	3,27677	HP
rho	Density	62,3013	lb/ft³
	Dynamic Viscosity	2,04E-05	lbf.s/ft²
	Kinematic Viscosity	1,05E-05	ft²/s

N2	Number	1	
	45 ° LR Elbow		
	Smooth bend with circular cross-section - Pipe Flow - Guide (2012)		
	Diameter	0,3355	ft
	Passage cross-section area	0,0884	ft²
	Bend angle	45	°
	Radius of curvature	0,50325	ft
	Absolute Roughness	0,00015	ft
	Volume flow rate	0,05681	m³/s
dP1	Pressure loss	0,51601	psi
	Fluid head	1,19267	ft of fluid
K2	Pressure loss coefficient	0,149	
	Flow velocity	22,6954	ft/s
	Reynolds number	724116	
	Hydraulic power loss	0,27482	HP
	Density	62,3013	lb/ft³
	Dynamic Viscosity	2,04E-05	lbf.s/ft²
	Kinematic Viscosity	1,05E-05	ft²/s

N3	Number	4	
	90 ° LR Elbow		
	Smooth bend with circular cross-section - Pipe Flow - Guide (2012)		
	Diameter	0,3355	ft
	Passage cross-section area	0,0884	ft²
	Bend angle	90	°
	Radius of curvature	0,50325	ft
	Absolute Roughness	0,00015	ft
	Volume flow rate	0,05681	m³/s
dP1	Pressure loss	0,75173	psi
	Fluid head	1,7375	ft of fluid
K3	Pressure loss coefficient	0,21706	
	Flow velocity	22,6954	ft/s
	Reynolds number	724116	
	Hydraulic power loss	0,40036	HP
	Density	62,3013	lb/ft³
	Dynamic Viscosity	2,04E-05	lbf.s/ft²
	Kinematic Viscosity	1,05E-05	ft²/s

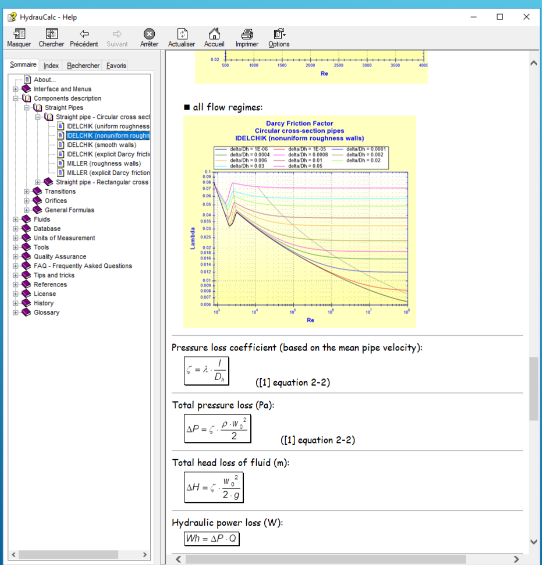
Feuil1

Exporting the main data and results to a spreadsheet allows you to perform additional calculations such as:

- Calculation of the total pressure loss of the circuit by summing the pressure losses of each component.
- Search for the flow circulating in the circuit from the sum of the pressure loss coefficients and using the solver integrated into the spreadsheet.

THE ASSURANCE QUALITY

TECHNICAL DOCUMENTATION



In general, each component has several calculation methods that come from different reference works. For all components, each calculation method is detailed in a technical document including:

- A description of the method used
- The mathematical formulation of the model
- The nomenclature used for the equations
- The range of the formulation
- An example of an application
- The bibliographic reference (s) used for modelling

COMPONENTS MODEL VALIDATION

HydrauCalc comes with a document that provides a comparison of software results with a series of examples published in well-known and respected references. Examples of hydraulic analysis include calculations of flow, pressure drop and pipe sizing for compressible and incompressible fluids.

The results obtained by the HydrauCalc application are very close to the published results.

At each new software release, a series of tests is performed to check the non-regression of the software features.

THE ROAD MAP

ROAD MAP

Next release (2021a release):

- Add new components.
- Creation of an Excel add-in for performing pressure loss calculations in an Excel spreadsheet.
- Development of a .NET class library (API) which can be used with different programming languages, including Managed C ++, C #, F #, Visual Basic ...

Following releases:

- Gradual addition of new components.

HydrauCalc

2020b Release

www.hydraucalc.com