HydrauCalc

2019b 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

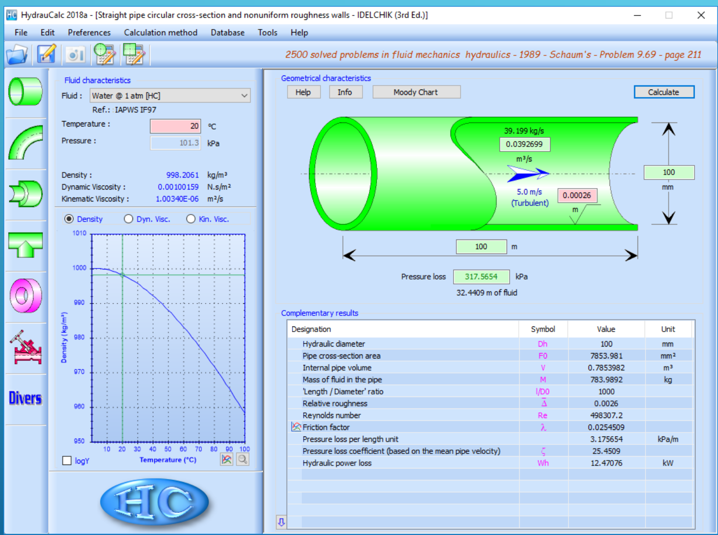
[2] Internal Flow System, D.S. Miller

[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

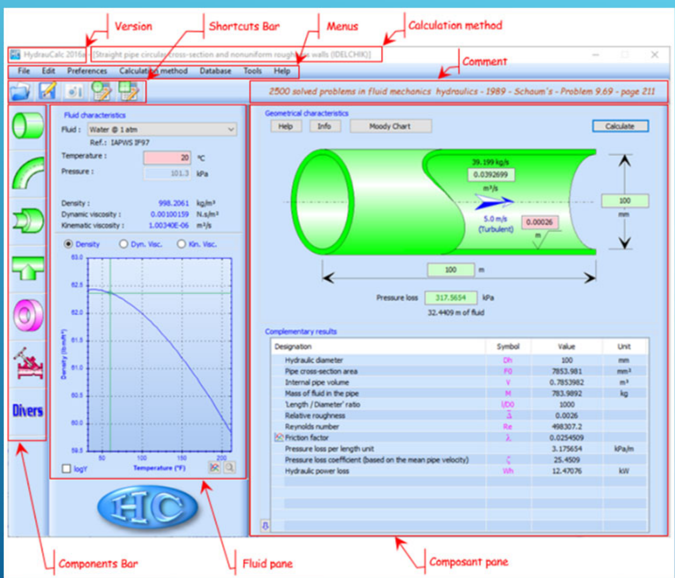


The graphical user interface is available in English or in French.

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

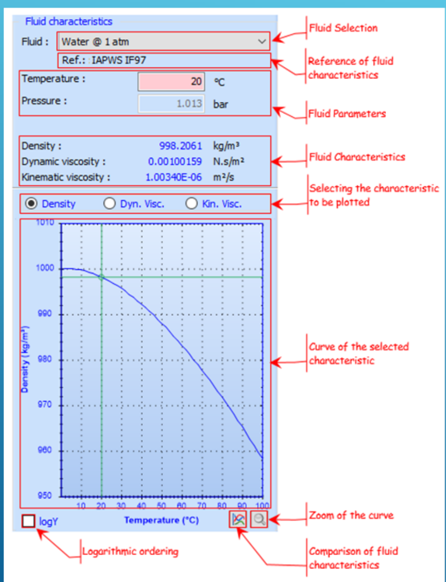
COMPONENTS BAR

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.

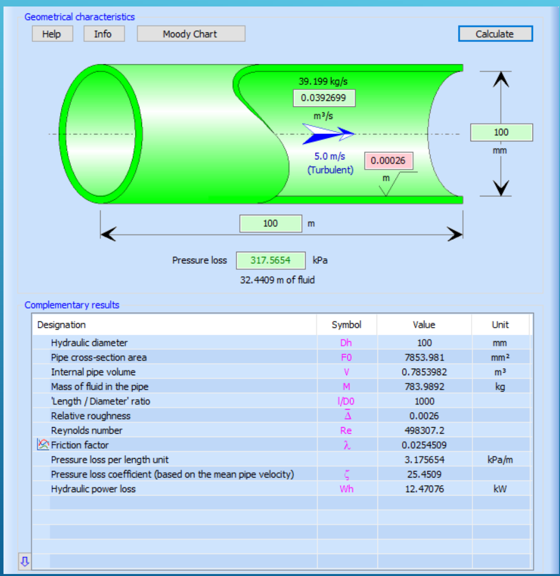
FLUID PANE



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

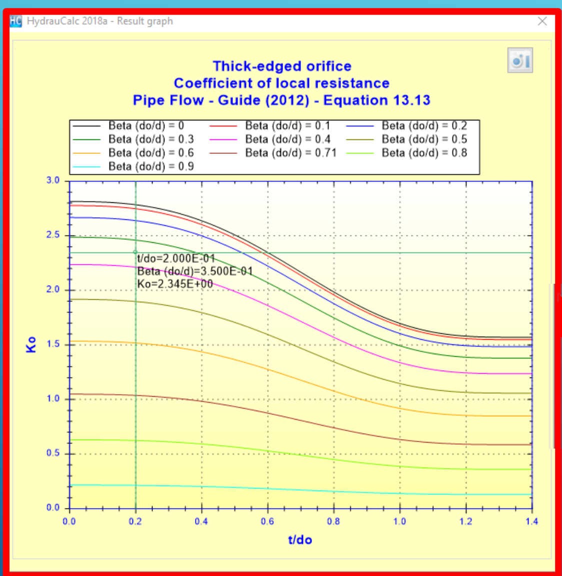


Designation	Symbol	Value	Unit
Hydraulic diameter	Dh	100	mm
Pipe cross-section area	F0	7853.981	mm²
Internal pipe volume	V	0.7853982	m³
Mass of fluid in the pipe	M	783.9892	kg
'Length / Diameter' ratio	l/D0	1000	
Relative roughness	Δ	0.0026	
Reynolds number	Re	498307.2	
Friction factor	λ	0.0254509	
Pressure 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:

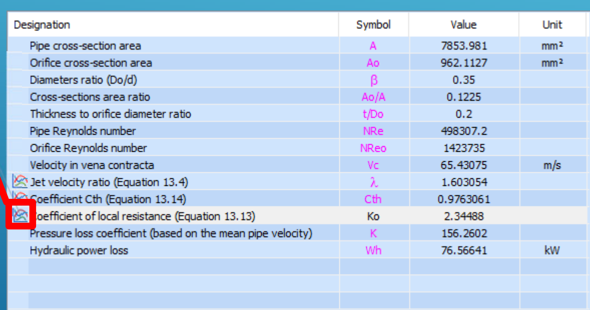
- Define the geometry of the component according to the selected component type (inside diameter, length, roughness, ...)
- Define flow (volume flow rate)
- To execute the calculation of the component
- To visualize the results
- To display the Moody diagram corresponding to the calculation with the 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



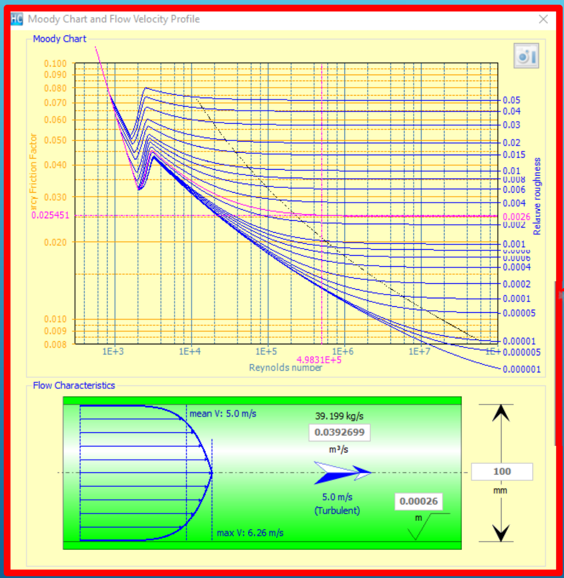
When, in the complementary results, the variable is preceded by the symbol, a simple click on this variable shows the evolution graph of the variable with the calculated point.

Example :



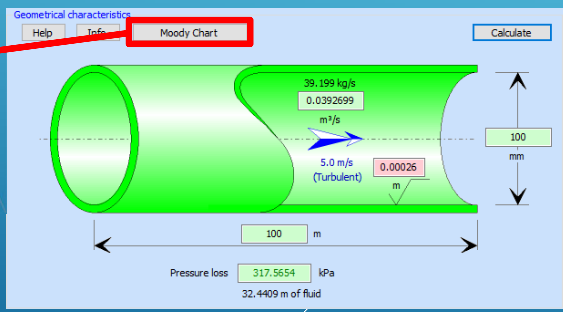
Designation	Symbol	Value	Unit
Pipe cross-section area	A	7853.981	mm²
Orifice cross-section area	Ao	962.1127	mm²
Diameters ratio (Do/d)	β	0.35	
Cross-sections area ratio	Ao/A	0.1225	
Thickness to orifice diameter ratio	t/Do	0.2	
Pipe Reynolds number	NRe	498307.2	
Orifice Reynolds number	NReo	1423735	
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

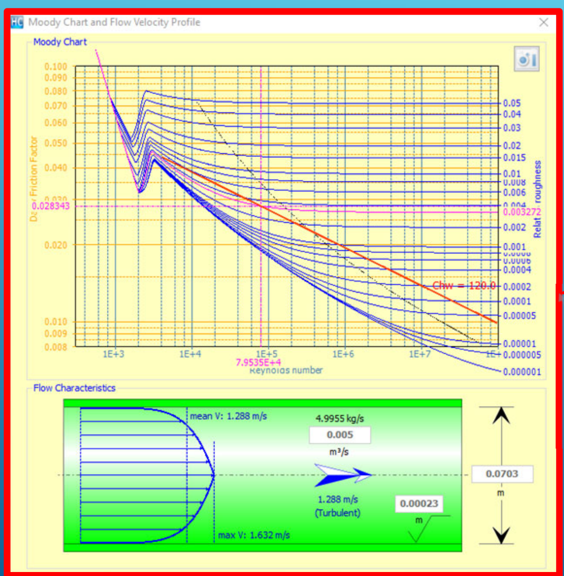


When the component is subjected to friction, the Moody diagram can be consulted to observe the operating point (as well as the flow velocity profile).

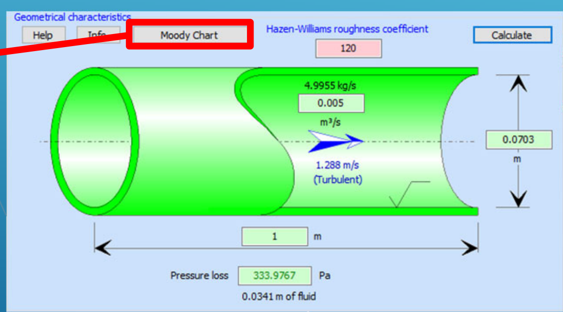
Example of a straight pipe:



MOODY DIAGRAM AND HAZEN-WILLIAMS FORMULA

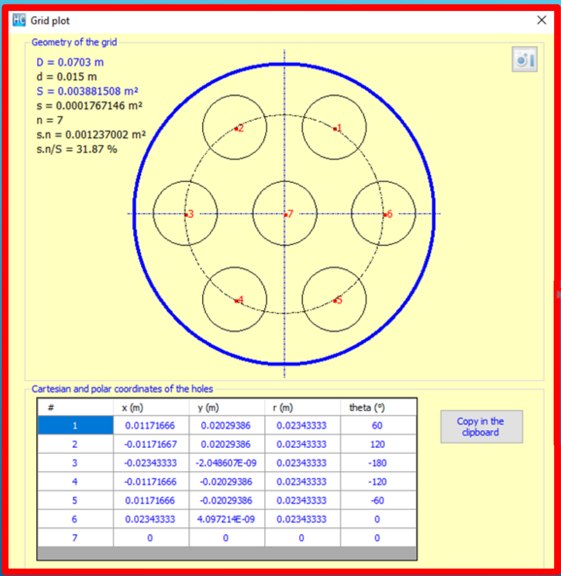


For the "Hazen-Williams" calculation method for circular cross-section straight pipes, the Moody diagram shows the relationship between the roughness coefficient of the Hazen-Williams formula and the friction coefficient of Darcy. The diagram also shows the limits of applicability of the Hazen-Williams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



New R2019b

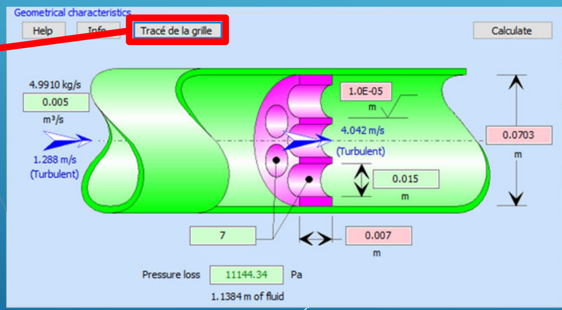
GRID PLOT



#	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

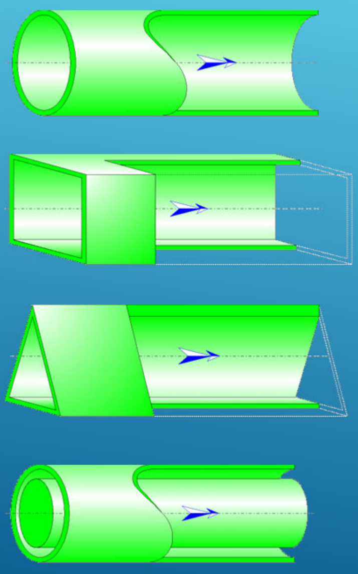
For "Grid" components (perforated plate), the application provides a grid plot with the coordinates of each hole.

Example of a perforated plate plot:



THE COMPONENTS

STRAIGHT PIPES



Circular cross-section

Rectangular cross-section

Triangular cross-section
New R2019b

Annular cross-section
New R2019b

The proposed calculation methods:

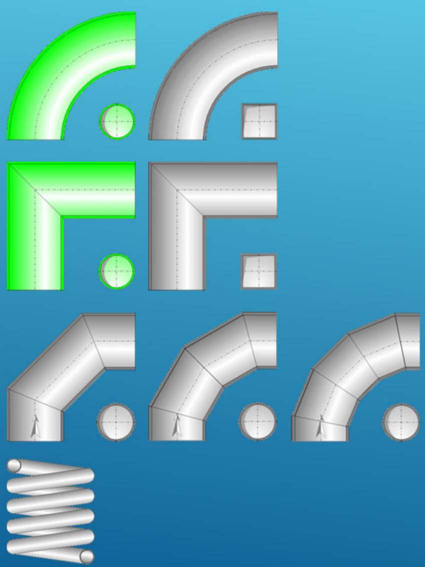
- IDELCHIK
  - Uniform roughness walls (Nikuradze equation)
  - Nonuniform roughness walls (Colebrook-White equation)
  - Smooth roughness walls (Filonenko and Althsul equation)
  - Explicit Darcy friction factor
- MILLER
  - Roughness walls (Swamee-Jain equation)
  - Explicit Darcy friction factor
-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

New R2019b

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 and rectangular cross-section

Miter bend with circular and rectangular cross-section

Composite bend with circular cross-section

Helical tube

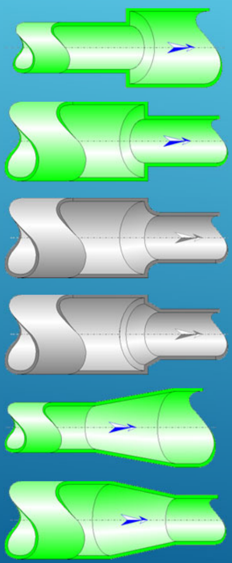
The proposed calculation methods:

- 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

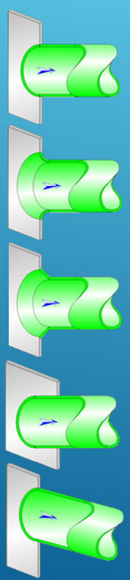
The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

The proposed calculations:

- Pressure loss
- Volume flow rate

ENTRANCE OF PIPELINE



Flush-mounted sharp-edged entrance
New R2019b

Flush-mounted rounded entrance
New R2019b

Flush-mounted bevelled entrance
New R2019b

Sharp-edged entrance mounted at a distance New R2019b

Sharp-edged entrance mounted at an angle New R2019b

The proposed calculation methods:

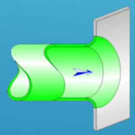
- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

The proposed calculations:

- Pressure loss
- Volume flow rate

DISCHARGE OF PIPELINE

Flush-mounted sharp-edged discharge
New R2019b



Flush-mounted rounded discharge
New R2019b

Sharp-edged discharge mounted at a distance
New R2019b

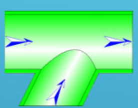
The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

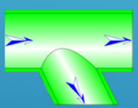
The proposed calculations:

- Pressure loss
- Volume flow rate

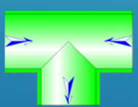
JUNCTIONS



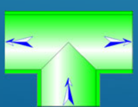
Combining sharp-edged junction



Dividing sharp-edged junction



Symmetric combining sharp-edged T-junction



Symmetric dividing sharp-edged T-junction

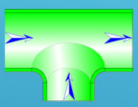
The proposed calculation methods:

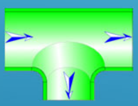
- IDELCHIK
- MILLER
- CRANE

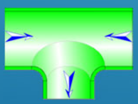
The proposed calculations:

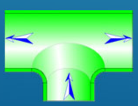
- Pressure loss in each branch

JUNCTIONS (FOLLOWING)


Combining radiused-edged T-junction
New R2019b


Dividing radiused-edged T-junction
New R2019b


Symmetric combining radiused-edged T-junction
New R2019b


Symmetric dividing radiused-edged T-junction
New R2019b

The proposed calculation methods:

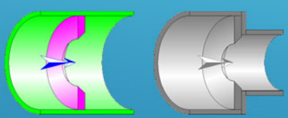
- Pipe Flow Guide

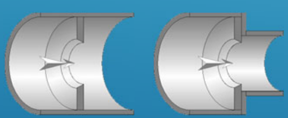
The proposed calculations:

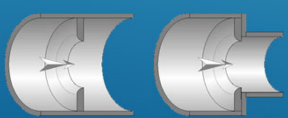
- Pressure loss in each branch

RESTRICTION ORIFICES


Thick-edged orifice (with or without change of pipe diameter)


Sharp-edged orifice (with or without change of pipe diameter)


Bevelled-edged orifice (with or without change of pipe diameter)


Radiused-edged orifice (with or without change of pipe diameter)

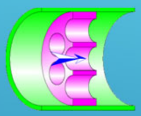
The proposed calculation methods:

- IDELCHIK
- MILLER
- CRANE
- Pipe Flow Guide

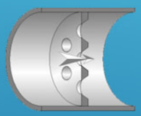
The proposed calculations:

- Pressure loss
- Volume flow rate
- Orifice diameter

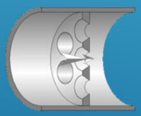
GRIDS



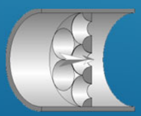
Thick-edged grid



Sharp-edged grid



Bevelled-edged grid



Radiused-edged grid

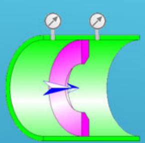
The proposed calculation methods:

- IDELCHIK
- MILLER
- Pipe Flow Guide

The proposed calculations:

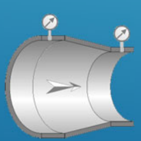
- Pressure loss
- Volume flow rate
- Holes diameter
- Holes number

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

VALVES

Y valve

Ball valve

Butterfly valve

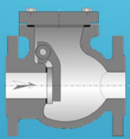
The proposed calculation methods:

- IDELCHIK
- Manufacturers

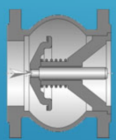
The proposed calculations:

- Pressure loss

CHECK VALVES



Swing check valve



Lift check valve

The proposed calculation methods:

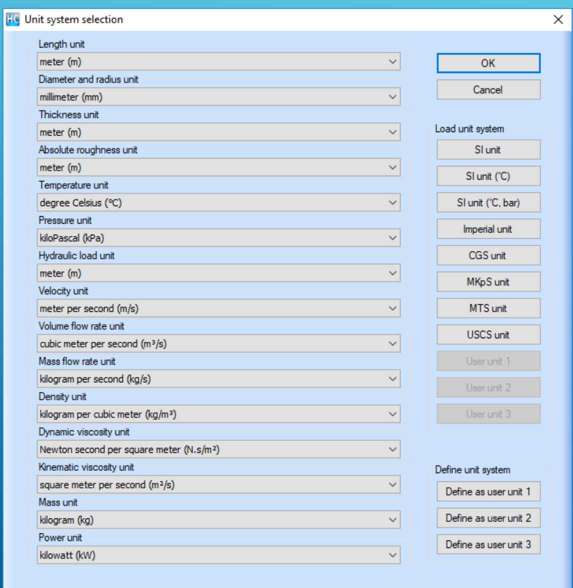
- IDELCHIK
- Manufacturers

The proposed calculations:

- Pressure loss

THE MEASURE UNITS

UNIT SYSTEM SELECTION

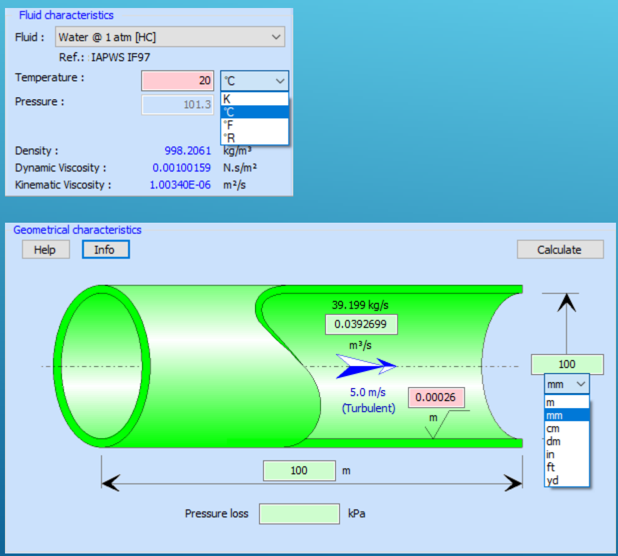


Units can be selected:

- 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.

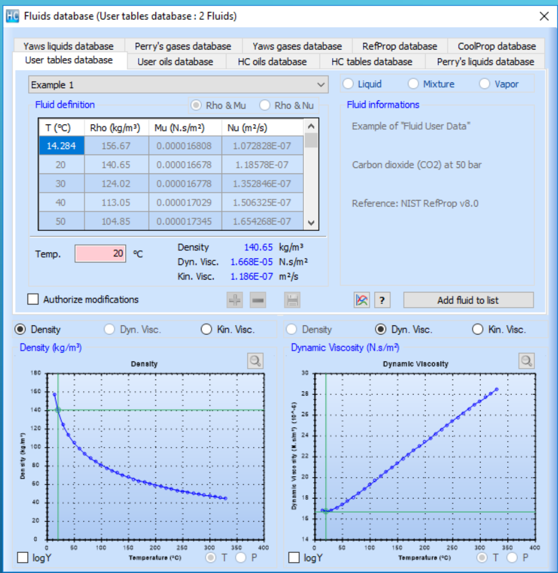
The units displayed in the Fluid Pane and Component Data Panes can be changed by simply clicking on the unit displayed.

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

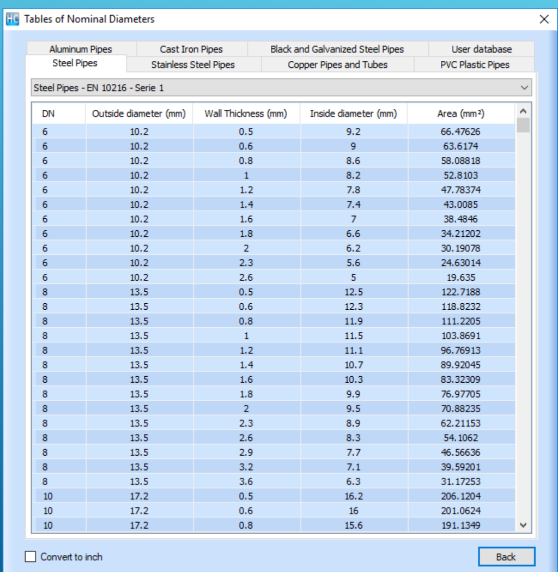


HydrauCalc has a fluid characteristics database consisting of several hundred fluids based on recognized references:

- 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


Tables of Nominal Diameters

Aluminum Pipes | Cast Iron Pipes | Black and Galvanized Steel Pipes | User database
Steel Pipes | Stainless Steel Pipes | Copper Pipes and Tubes | PVC Plastic Pipes

Steel Pipes - EN 10216 - Serie 1

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

Convert to inch

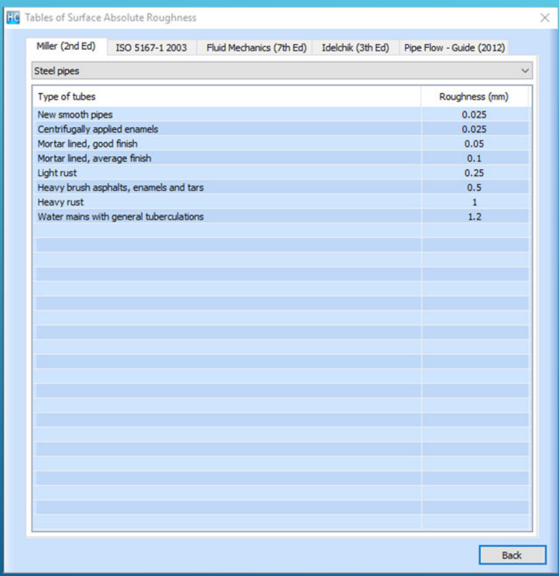
Back

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 ROUGHNESSES


Tables of Surface Absolute Roughness

Miller (2nd Ed) | ISO 5167-1 2003 | Fluid Mechanics (7th Ed) | Idelchik (3th Ed) | Pipe Flow - Guide (2012)

Steel pipes

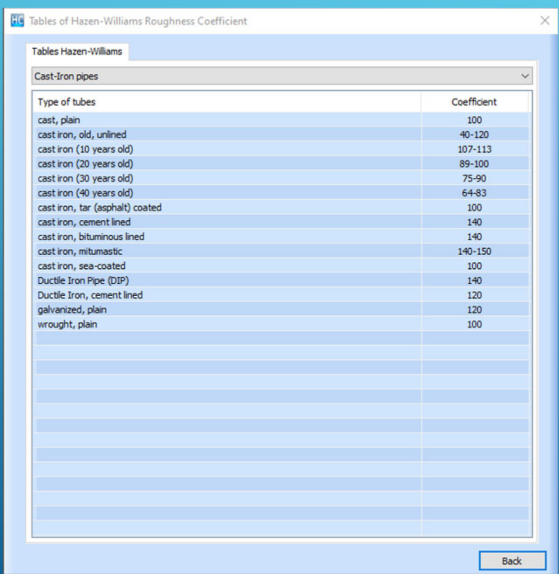
Type of tubes	Roughness (mm)
New smooth pipes	0.025
Centrifugally applied enamels	0.025
Mortar lined, good finish	0.05
Mortar lined, average finish	0.1
Light rust	0.25
Heavy brush asphalts, enamels and tars	0.5
Heavy rust	1
Water mains with general tuberculations	1.2

Back

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


Tables of Hazen-Williams Roughness Coefficient

Tables Hazen-Williams

Cast-Iron pipes

Type of tubes	Coefficient
cast, plain	100
cast iron, old, unlined	40-120
cast iron (10 years old)	107-113
cast iron (20 years old)	89-100
cast iron (30 years old)	75-90
cast iron (40 years old)	64-83
cast iron, tar (asphalt) coated	100
cast iron, cement lined	140
cast iron, bituminous lined	140
cast iron, mitumastic	140-150
cast iron, sea-coated	100
Ductile Iron Pipe (DIP)	140
Ductile Iron, cement lined	120
galvanized, plain	120
wrought, plain	100

Back

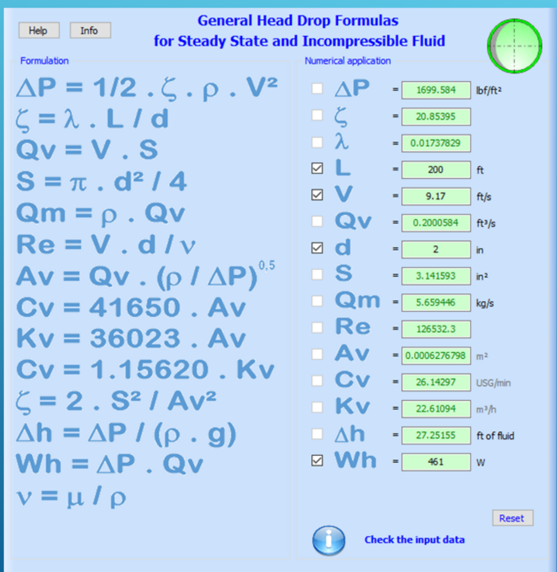
HydrauCalc has a database of values of Hazen-Williams roughness coefficient from:

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

New R2019b

THE TOOLS

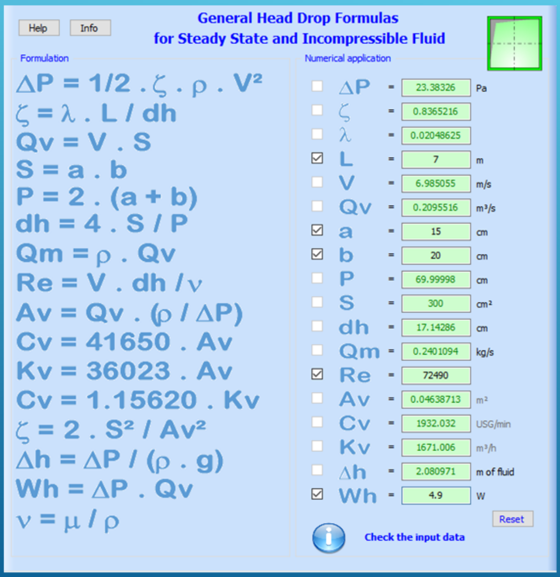
TOOL – CALCULATOR FOR CIRCULAR CROSS-SECTIONS



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.

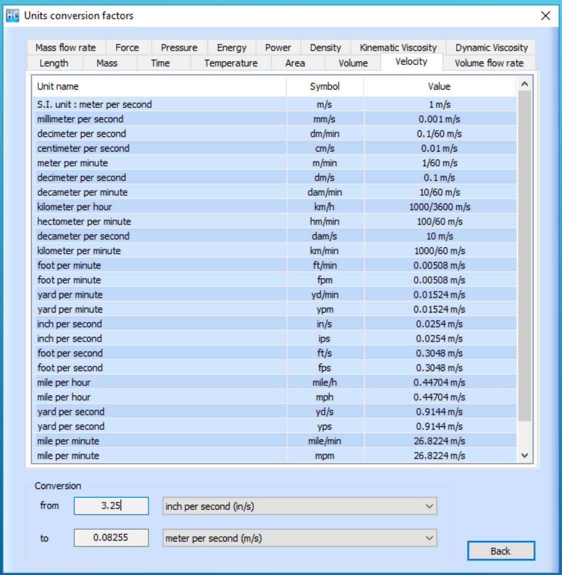
TOOL – CALCULATOR FOR RECTANGULAR CROSS-SECTIONS



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

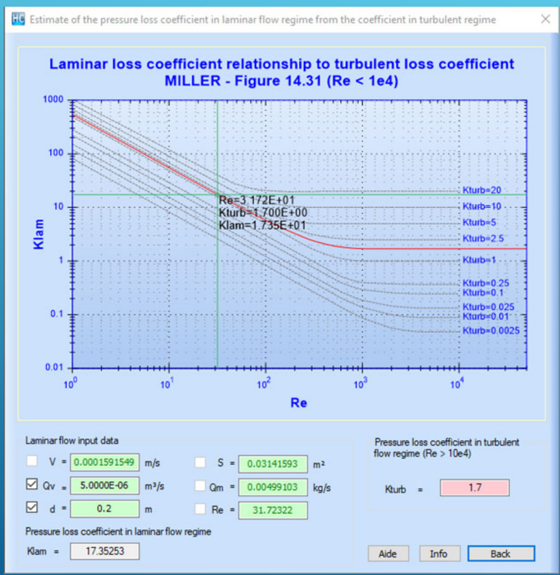


Unit name	Symbol	Value
S.I. unit : meter per second	m/s	1 m/s
millimeter per second	mm/s	0.001 m/s
decimeter per second	dm/min	0.1/60 m/s
centimeter per second	cm/s	0.01 m/s
meter per minute	m/min	1/60 m/s
decimeter per second	dm/s	0.1 m/s
decameter per minute	dam/min	10/60 m/s
kilometer per hour	km/h	1000/3600 m/s
hectometer per minute	hm/min	100/60 m/s
decameter per second	dam/s	10 m/s
kilometer per minute	km/min	1000/60 m/s
foot per minute	ft/min	0.00508 m/s
foot per minute	fpm	0.00508 m/s
yard per minute	yd/min	0.01524 m/s
yard per minute	ypm	0.01524 m/s
inch per second	in/s	0.0254 m/s
inch per second	ips	0.0254 m/s
foot per second	ft/s	0.3048 m/s
foot per second	fps	0.3048 m/s
mile per hour	mile/h	0.44704 m/s
mile per hour	mph	0.44704 m/s
yard per second	yd/s	0.9144 m/s
yard per second	yps	0.9144 m/s
mile per minute	mile/min	26.8224 m/s
mile per minute	mpm	26.8224 m/s

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



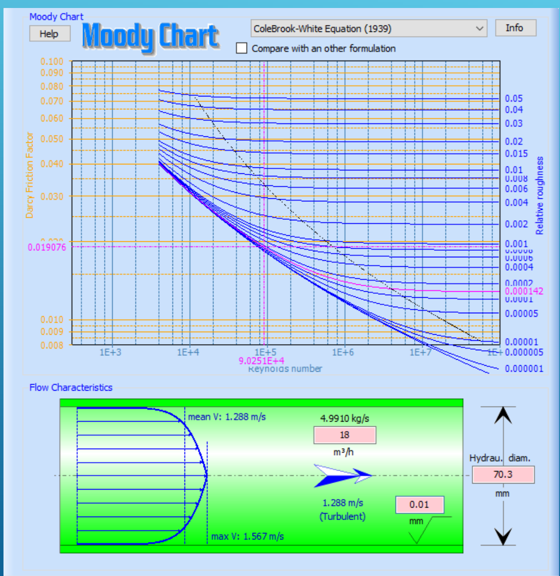
The application has a tool making it possible to obtain an estimate of the coefficient of pressure loss in the laminar flow regime, if the coefficient of pressure loss in the turbulent flow regime is known.

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

New R2019b

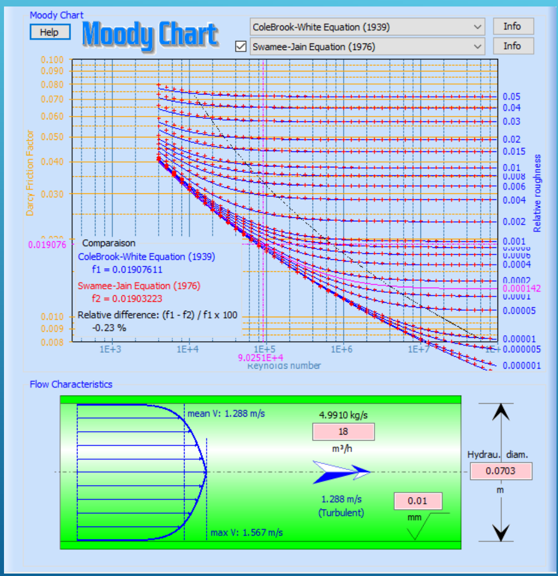
TOOL – MOODY DIAGRAM



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.

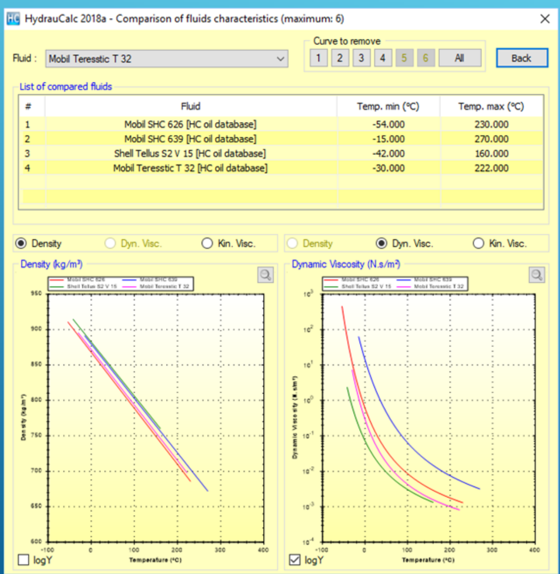
TOOL – MOODY DIAGRAM (FOLLOWING)



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

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

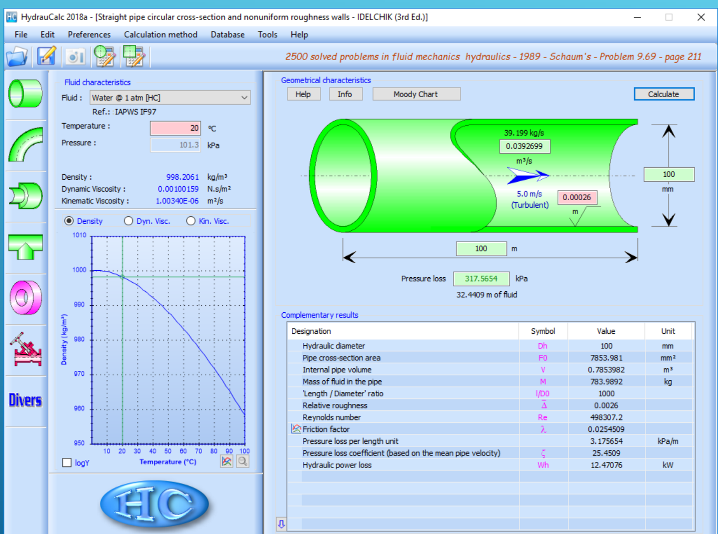
TOOL – FLUID COMPARATOR



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



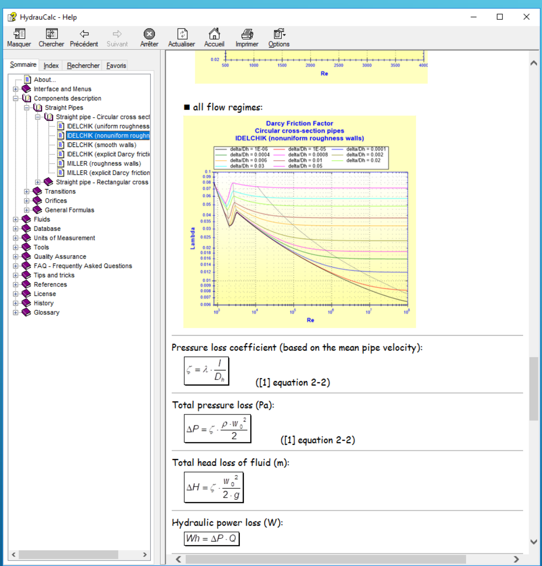
To include a calculation result in a document, it is possible to copy the window using the button and paste it into the document.

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 color),
  - the additional results from the calculation.

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 (2020a release):

- Add new components

Following releases:

- Gradually complete all components

HydrauCalc

2019b Release

www.hydraucalc.com