

HydrauCalcXL

Version 2023b

www.hydraucalc.com

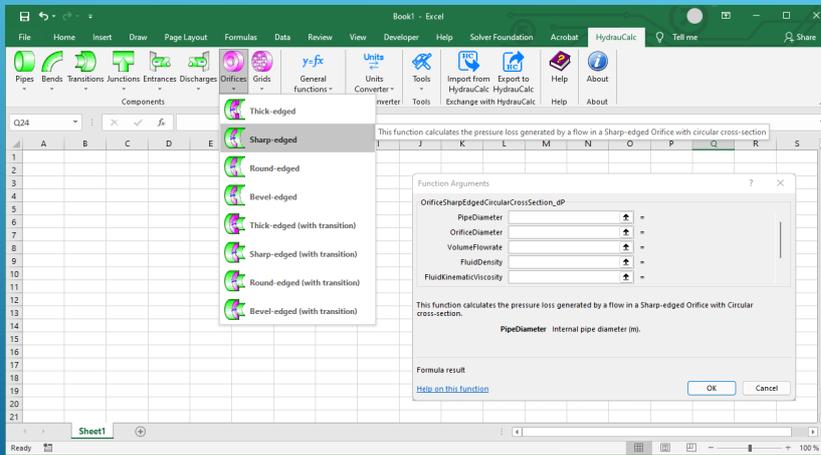
Qu'est-ce que HydrauCalcXL Add-in?

Qu'est-ce que HydrauCalcXL Add-in?

- ▶ HydrauCalcXL Add-in est une bibliothèque de fonctions qui a été développée pour calculer les pertes de pression de composants hydrauliques dans Microsoft Excel®. Cette bibliothèque permet l'appel direct de fonctions relatives au calcul de pertes de pression. Elle est issue de l'application HydrauCalc qui est basée principalement sur des références reconnues et respectées dans le domaine du calcul de débits et de pertes de pression.
- ▶ Les fonctions HydrauCalcXL peuvent être utilisées via l'interface utilisateur d'Excel®, tout comme les propres fonctions intégrées d'Excel®.
- ▶ L'utilisation conjointe de cette bibliothèque et du solveur intégré à Excel® (solveur de systèmes d'équations non-linéaires) permet de résoudre des problèmes d'écoulement itératifs et d'effectuer des analyses d'optimisation multi-variables de systèmes fluides.

L'interface graphique Excel

Interface graphique Excel



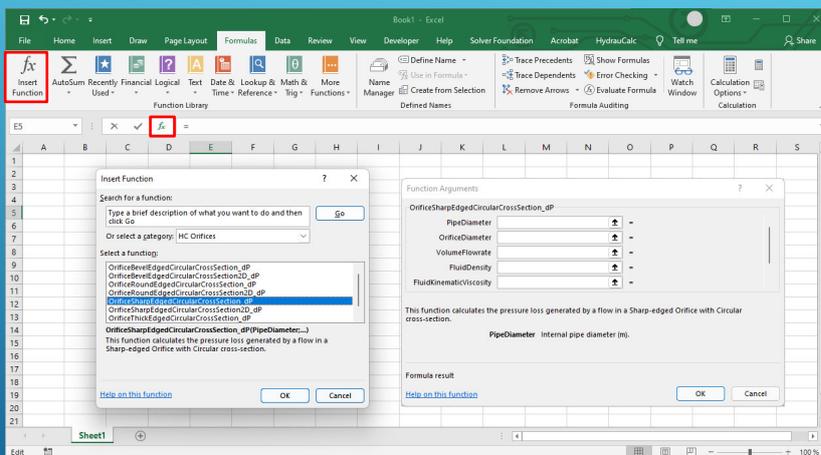
► L'onglet HydraulCalc comporte un ruban qui permet d'appeler les différentes fonctions de la librairie.

► A partir de cette interface, l'utilisateur insère les fonctions des composants qu'il souhaite évaluer.

► Cette interface est intuitive et très facile à utiliser.

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Interface graphique Excel

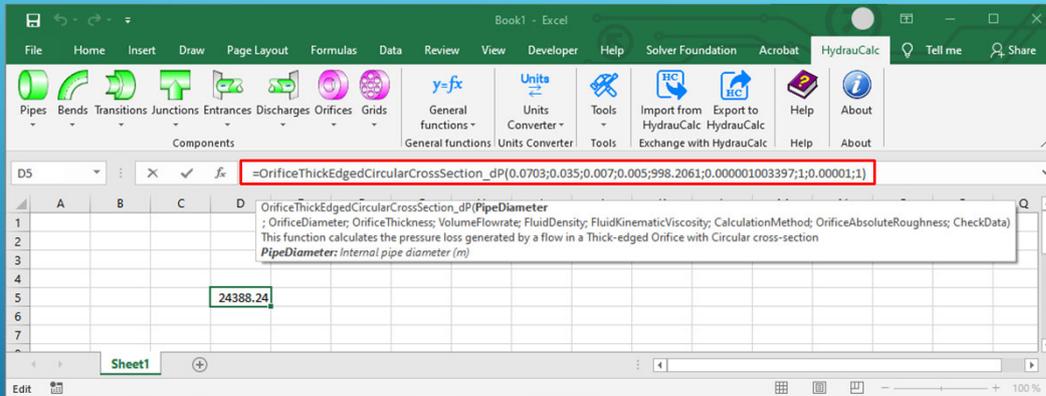


► Les fonctions de la librairie peuvent également être sélectionnées à partir des boutons "Insert Function" de l'onglet "Formulas" ou de la barre des fonctions.

► Cette interface est moins conviviale et moins facile à utiliser que la précédente.

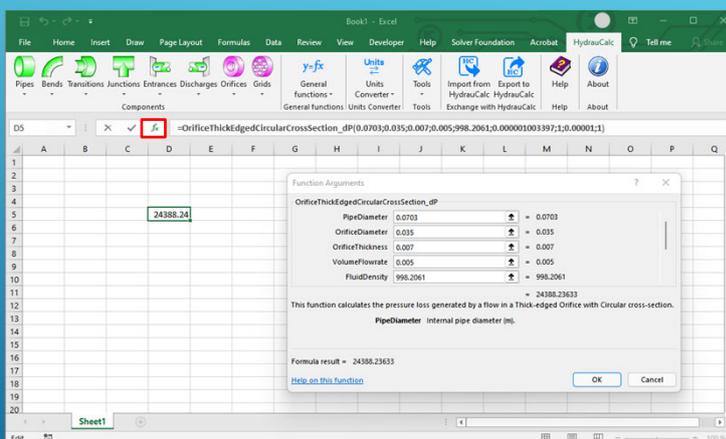
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Interface graphique Excel



Lorsque qu'une fonction est incréée dans une cellule du tableur, il est possible, par la suite, de modifier les paramètres de la fonction en l'affichant dans la barre des formules.

Interface graphique Excel



▶ Les paramètres des fonctions peuvent aussi être modifiés en sélectionnant le bouton "Insert Function" de la barre des fonctions.

Les fonctions de la bibliothèque HydrauCalcXL

Les fonctions de la bibliothèque HydrauCalcXL

Les fonctions de la bibliothèque sont accessibles via le ruban de l'onglet HydrauCalc.

La bibliothèque comprend quatre types de fonctions :

- ❑ des fonctions de calcul de pertes de pression de composants de tuyauterie tels que tuyaux rectilignes, coudes, changements de section, bifurcations, diaphragmes, grilles, entrées de circuit, sorties de circuit (74 fonctions),
- ❑ des fonctions de calcul entre les différentes variables entrant dans les formules générales de pertes de pression (perte de pression, coefficient de perte de pression, coefficient de débit, débit volumique, débit massique, nombre de Reynolds, vitesse d'écoulement, ...) (103 fonctions),
- ❑ des fonctions de conversion d'unités de mesure entre elles (17 fonctions),
- ❑ des fonctions diverses (2 fonctions).

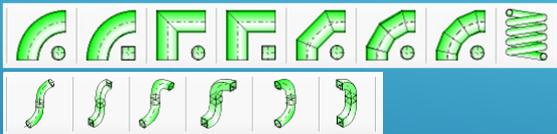
Les composants de tuyauterie

Les composants de tuyauterie disponibles

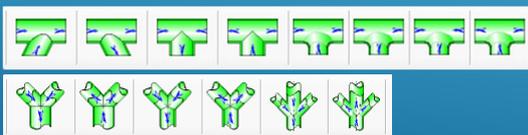
Tuyaux rectilignes :



Coudes :



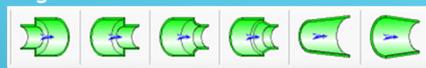
Bifurcations :



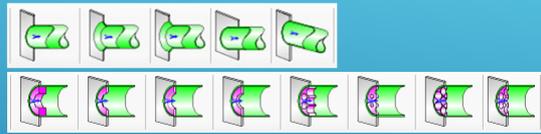
Diaphragmes d'équilibrage :



Changements de sections :



Entrées de circuit :



Sorties de circuit :



Grilles :



Arguments des fonctions de composants

Les arguments des fonctions de calcul de pertes de charge des composants sont :

- La géométrie du composant (longueur, diamètre intérieur, angle et rayon de courbure, rugosité absolue de parois , etc...).
- La caractéristique de l'écoulement (débit volumique).
- Les propriétés du fluide véhiculé (masse volumique et viscosité cinématique).

Exemple d'utilisation d'une fonction de composant

The screenshot illustrates the use of the `PipeStraightCircularCrossSection_dP` function in HydrauCalcXL. The spreadsheet shows the following data and formulas:

Cell	Value / Formula	Unit
B7	Density	998.1 kg/m ³
B8	Kinematic Viscosity	9.800E-07 m ² /s
B9	Volume flowrate	0.005 m ³ /s
B12	Diameter	0.0525 m
B13	Length	6 m
B14	Absolute roughness	5.0E-06 m
B15	Flow velocity (Formula: <code>=FlowVelocity_Qv_DICIRC(C7)</code>)	2.310 m/s
B16	Reynolds number (Formula: <code>=ReynoldsNumber_V_D_Mu(R7,C12,C8)</code>)	123736
B17	Pressure loss coefficient (Formula: <code>=PressureLossCoefficient_dP_Qv_D_Rho(D7,C12,C7)</code>)	1.968
B18	Pipe pressure loss (Formula: <code>=PipeStraightCircularCrossSection_dP(C12,C13,C10,C7,C8,E7,C4)</code>)	5239 Pa

The **Function Arguments** dialog box for `PipeStraightCircularCrossSection_dP` shows the following inputs:

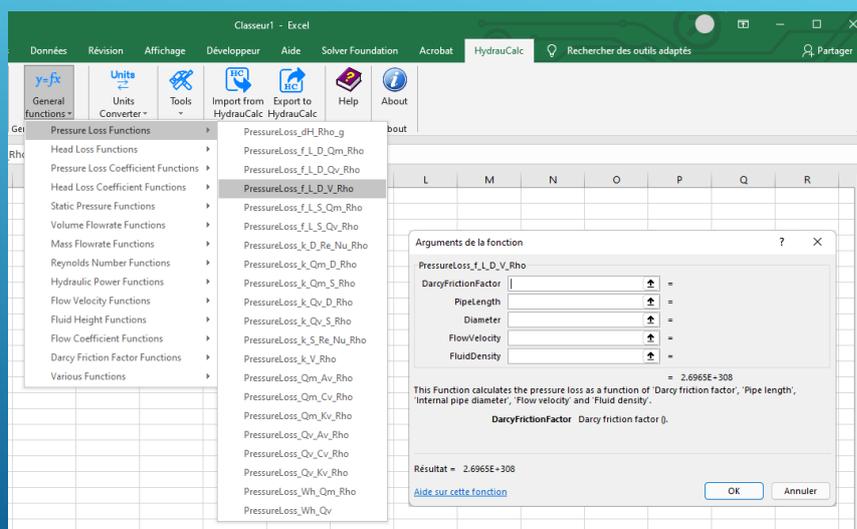
- InternalDiameter: 0.0525
- PipeLength: 6
- VolumeFlowrate: 0.005
- FluidDensity: 998.1
- FluidKinematicViscosity: 9.8000009E-07

The **Help** window for the `PipeStraightCircularCrossSection_dP` function provides the following details:

- 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)`
- 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:** Int: CalculationMethod (1-7) [optional - default value = 2]
 - AbsoluteRoughness:** Double: Absolute roughness (m) [optional - used only if CalculationMethod = 1, 2 or 5]
 - DarcyFrictionFactor:** Double: Darcy friction factor (optional - used only if CalculationMethod = 4 or 6)
 - HazenWilliamsRoughnessCoefficient:** Double: Hazen-Williams roughness coefficient (optional - used only if CalculationMethod = 7)
 - CheckData:** Int: Check input data and results (0/1) [optional - default value = 0]

Les fonctions de formules générales

Les fonctions de formules générales



Exemple d'utilisation de fonctions de formules générales

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

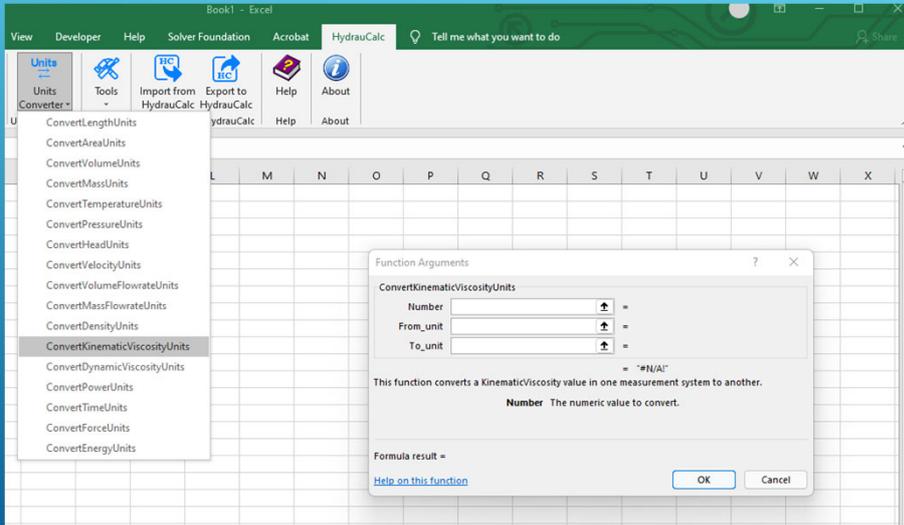
Density	998.1 kg/m³	Pressure loss	6985 Pa
Kinematic Viscosity	9.80E-07 m²/s	Flow velocity	2.332 m/s
Volume flowrate	0.005 m³/s	Pressure loss coefficient	2.286
Diameter	0.0525 m		
Length	6 m		
Absolute roughness	5.0E-06 m		
Darcy friction factor	0.02		

Two dialog boxes are open:

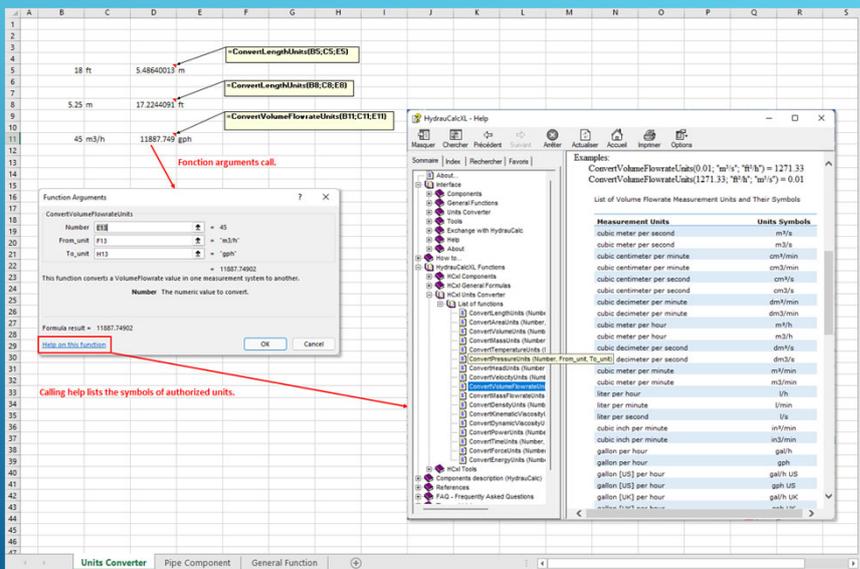
- Function Arguments:** Shows the function `PressureLossCoefficient_dP_Qv_D_Rho` with arguments: PressureLoss (6985), VolumeFlowrate (0.005), Diameter (0.0525), and FluidDensity (998.1). The formula result is 2.286.
- PressureLossCoefficient_dP_Qv_D_Rho function:** Provides a description: "This function calculates the pressure loss coefficient as a function of 'Pressure loss', 'Volume flowrate', 'Internal pipe diameter' and 'Fluid density'." It lists the syntax: `PressureLossCoefficient_dP_Qv_D_Rho(PressureLoss, VolumeFlowrate, Diameter, FluidDensity)` and the arguments: PressureLoss [Pa], VolumeFlowrate [Qv] [Double Volume flowrate (m³/s)], Diameter [D] [Double Diameter (m)], and FluidDensity [ρ] [Double Fluid density (kg/m³)]. It also includes the formula:
$$k = \frac{dP}{0.5 \rho \frac{Qv^2}{(\tau \cdot D^5/4)}}$$

Les fonctions de conversion d'unités de mesure

Les fonctions de conversion d'unités de mesure

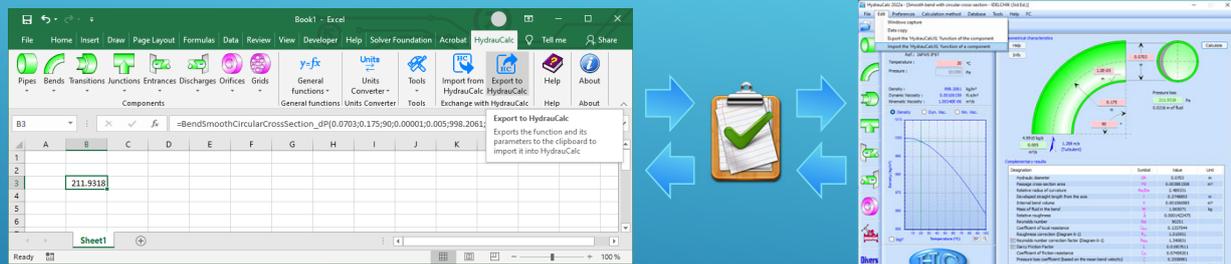


Exemple d'utilisation de fonctions de conversion d'unités de mesure



Echange de données avec l'application HydraulCalc

Echange de données avec l'application HydraulCalc

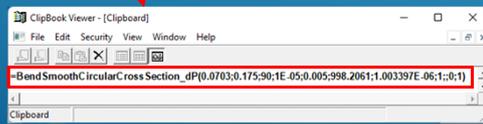
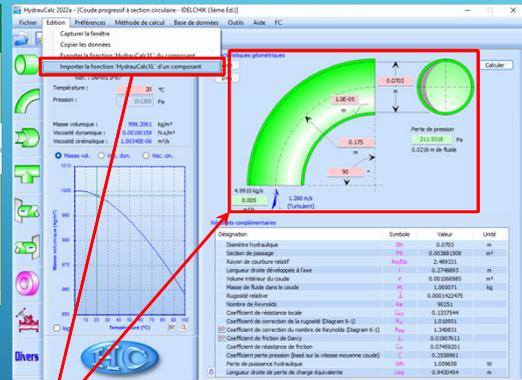
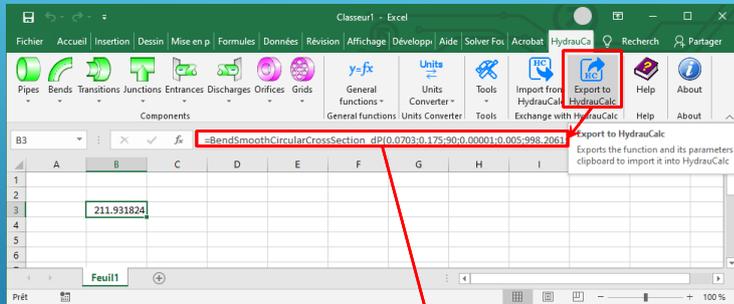


Les données peuvent être échangées entre la bibliothèque "HydraulCalcXL" et l'application "HydraulCalc" via le presse-papier.

Exportation de données vers HydraulCalc

1 - Export de la fonction vers Clipboard

2 - Import de la fonction depuis Clipboard



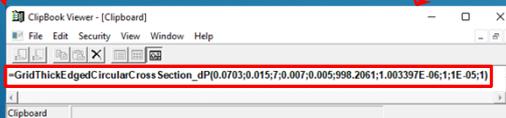
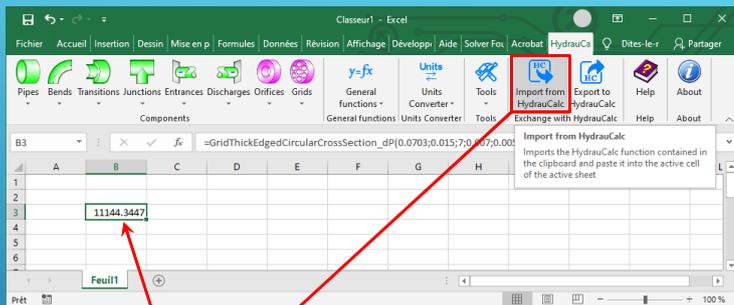
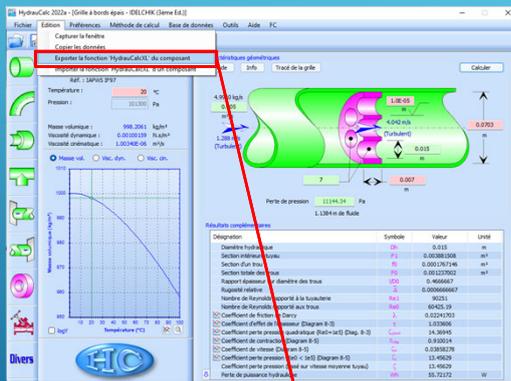
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Importation de données depuis HydraulCalc

1 - Export de la fonction vers Clipboard

2 - Import de la fonction depuis Clipboard



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Exemples de systèmes résolus à l'aide de HydraulCalcXL et du solveur Excel

- ▶ Recherche : la HMT de la pompe et le point de fonctionnement du système.
- ▶ Le débit de la pompe est une donnée d'entrée. Les fonctions intégrées à HydraulCalcXL permettent de calculer explicitement (calcul direct sans itérations) la perte de charge des composants.

Reference: Internal Flow Systems - 2ed - D.S. Miller (1990) - Simple system - Fig. 3.1 - page 28
Find: the pump head and the system working point

Legend

- Input data
- Excel calculation
- HydraulCalc calculation
- Variable name
- Unit symbol
- Content of neighboring cell

Data verification
Check data (Q/s)

Fluid data (Water 20°C)

Density	ρ	1000	kg/m ³
Kinematic Viscosity	ν	1.10E-06	m ² /s

Volume flow rate

Q	2.75	m ³ /s
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Pipe data

Name	Diameter (m)	Length (m)	Darcy friction factor
P1	0.8	90	0.015
P2	0.8	640	0.015

Reflux valve

Name	Diameter (m)	Pressure loss coef.
V1	0.8	0.5

System entrance (rounded entrance)

Name	Diameter (m)	Round radius (m)
E1	0.8	0.09

System discharge (sharp-edged discharge)

Name	Diameter (m)
D1	0.8

Reservoir data

Name	Surface elevation (m)
R1	1.5
R2	8.5

Pipe pressure loss (Pa)

P1	8275	Pa
P2	179588	Pa

System entrance (Pa)

E1	587	Pa
----	-----	----

Reflux valve (Pa)

V1	7483	Pa
----	------	----

System discharge (Pa)

D1	14956	Pa
----	-------	----

System characteristic

Flowrate (m ³ /s)	Head (m fluid)
0.00	7.000
0.50	7.711
1.00	8.984
1.50	13.398
2.00	18.375
2.50	24.773
3.00	32.594

Total pressure loss

ΔP	210899	Pa
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Total head loss

HL	21.506	m fluid
----	--------	---------

Static lift

SL	7.000	m fluid
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Pump head

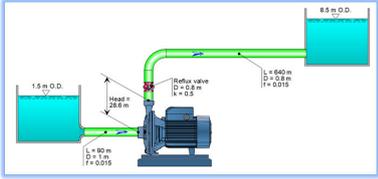
HP	28.506	m fluid
----	--------	---------

System working point

Pump - Head

- Recherche : le débit et le point de fonctionnement du système.
- La HMT de pompe est une donnée d'entrée. L'utilisation du solveur Excel est nécessaire pour résoudre le système et trouver le débit.

Reference: Internal Flow Systems - 2ed - D.S. Miller (1990) - Simple system - Fig. 3.1 - page 28
Find: the flowrate and the system working point



Legend
Input data
Excel calculation
HydrauCalc calculation
Variable name
Unit symbol
Context of neighboring cell

Data verification
Check data (d/f) Cd = 1

Fluid data (Water 20°C)
Density rho = 1000 kg/m³
Kinematic Viscosity nu = 1.0E-06 m²/s

Pump head
HP = 28.6 m fluid

Pipe data

Name	Diameter (m)	Length (m)	Darcy Friction factor
P1	0.91	90	0.015
P2	0.92	640	0.015

Reflux valve

Name	Diameter (m)	Pressure loss coef.
V1	0.92	0.5

System entrance (rounded entrance)

Name	Diameter (m)	Round radius (m)
E1	0.91	0.09

System discharge (sharp-edged discharge)

Name	Diameter (m)
D1	0.91

Reservoir data

Name	Surface elevation (m)
R1	1.5
R2	8.5

Pump characteristic

Flowrate (m³/s)	Head (m fluid)
0.00	33.123
0.50	32.826
1.00	32.364
1.50	31.759
2.00	30.788
2.50	29.413
3.00	27.211
3.50	22.812

Pipe pressure loss (Pa)

Name	Flowrate (m³/s)	Pressure loss (Pa)
P1	0.91	8312
P2	0.92	180375

System entrance (Pa)

Name	Flowrate (m³/s)	Pressure loss (Pa)
E1	0.91	590

Reflux valve (Pa)

Name	Flowrate (m³/s)	Pressure loss (Pa)
V1	0.92	7516

System discharge (Pa)

Name	Flowrate (m³/s)	Pressure loss (Pa)
D1	0.91	15031

Solver data
Value to be computed by solver (variable cells):
Flowrate Q = 2.256 m³/s
Constraints:
HP - HL - SL = 0 = 0.0 Pa = HP - HL - SL

Total pressure loss
dp = 211824 Pa = dp_E1 + dp_P1 + dp_V1 + dp_P2 + dp_D1

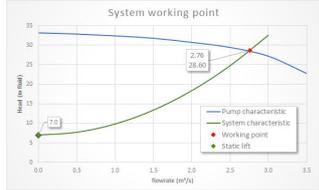
Total head loss
HL = 21.600 m fluid = HeadLoss_dp_Rho_g(dp/ρg)

Static lift
SL = 7.000 m fluid = H_R2 - H_R1

System characteristic

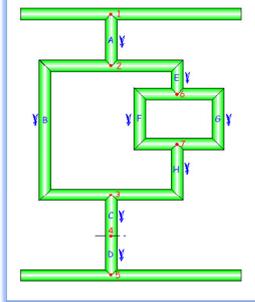
Flowrate (m³/s)	Head (m fluid)
0.00	7.000
0.50	7.711
1.00	5.844
1.50	13.398
2.00	18.375
2.50	24.773
3.00	32.584

System working point



- Recherche : le débit volumique de chaque branche.
- Ce problème illustre l'utilisation d'Excel pour résoudre un ensemble d'équations non linéaires couplées pour des débits inconnus.

Reference: Introduction to Fluid Mechanics - Fox and McDonald's - 9th Ed - Example 8.11 - page 323
Find: the volume flowrate of each branch



Legend
Input data
Excel calculation
HydrauCalc calculation
Variable name
Unit symbol
Context of neighboring cell

Data verification
Check data (d/f) Cd = 1

Fluid data (Water 23°C)
Density rho = 998.24 kg/m³
Kinematic Viscosity nu = 1.00E-06 m²/s

Static head

Name	Surface elevation (m)
p1	30.48
p5	0

Pipe data

Name	Diameter (m)	Length (m)	Absolute roughness (m)
Pipe A	0.0381	L_PA	3.048
Pipe B	0.0381	L_PB	6.096
Pipe C	0.0508	L_PC	3.048
Pipe D	0.0381	L_PD	3.048
Pipe E	0.0381	L_PE	3.524
Pipe F	0.0254	L_PF	3.048
Pipe G	0.0381	L_PG	3.048
Pipe H	0.0508	L_PH	1.524

Pipe pressure loss

Name	Flowrate (m³/s)	Pressure loss (Pa)
Pipe A	dp_PA	114932
Pipe B	dp_PB	43446
Pipe C	dp_PC	25070
Pipe D	dp_PD	114932
Pipe E	dp_PE	18373
Pipe F	dp_PF	20807
Pipe G	dp_PG	20807
Pipe H	dp_PH	4066

Solver data
Value to be computed by solver (variable cells):
Pipe A Q_PA = 0.010548 m³/s
Pipe B Q_PB = 0.004566 m³/s
Pipe F Q_PF = 0.001513 m³/s
Constraints:
dH_PA + dH_PB + dH_PC + dH_PD - SL = 0 = 0.000 m = dH_PA + dH_PB + dH_PC + dH_PD - SL
dH_PE + dH_PF + dH_PH - dH_PB = 0 = 0.000 m = dH_PE + dH_PF + dH_PH - dH_PB
dH_PG - dH_PF = 0 = 0.000 m = dH_PG - dH_PF

Deducted flowrate:

Name	Flowrate (m³/s)
Pipe C	0.01055
Pipe D	0.01055
Pipe E	0.005982
Pipe G	0.00447
Pipe H	0.00598

Static lift:

Name	Static lift (m)
SL	30.480

Pipe head loss

Name	Head loss (m)	
Pipe A	dH_PA	11.740
Pipe B	dH_PB	4.438
Pipe C	dH_PC	2.561
Pipe D	dH_PD	11.740
Pipe E	dH_PE	1.897
Pipe F	dH_PF	2.125
Pipe G	dH_PG	2.125
Pipe H	dH_PH	0.415

- Recherche : le débit dans chaque tuyau.
- Ce problème illustre l'utilisation d'Excel pour résoudre un ensemble d'équations non linéaires couplées pour des débits inconnus.
- Cet exemple montre également l'utilisation des fonctions de conversion d'unités.

Reference: Fundamentals of Fluid Mechanics - Munson - 8th Ed - Example 8.14 - page 458
Find: the flowrate in each pipe

Pipe head loss

Pipe	Head loss (m)	Head loss (ft)
P1	0.493	1.62
P2	0.383	1.26
P3	0.479	1.57

Solver data

Value to be computed by solver (variable cells)

Pipe	Flow rate (m³/s)	Flow rate (ft³/s)
Pipe 1	0.544	19.2
Pipe 2	0.662	23.5
Pipe 3	0.298	10.7

Deducted flowrate: Pipe 1 = 0.544 m³/s

- Recherche : le coefficient de perte de charge des deux vannes de régulation pour permettre le débit souhaité dans chaque échangeur de chaleur et le point de fonctionnement de la pompe.
- Cet exemple montre un équilibrage de réseau simple.

Reference: AFT Fathom 10 - Examples - Pump Sizing and Selection with Flow Control Valves
Find: the pressure loss coefficient of the two control valves to allow a flowrate of 25 m³/s (0.006944 m³/s) in each heat exchanger

Volume flow rate

Flow rate (m³/s)	Flow rate (ft³/s)
0.006944	0.246

Head data

Head (m)	Head (ft)
10.000	32.808
0.000	0.000
0.000	0.000

Head loss

Pipe	Head loss (m)	Head loss (ft)
P2	0.000	0.000
P3	0.000	0.000
P4	0.000	0.000
P5	0.000	0.000
P6	0.000	0.000
P7	0.000	0.000
P8	0.000	0.000
P9	0.000	0.000
P10	0.000	0.000
P11	0.000	0.000
P12	0.000	0.000

Pump data

Flow rate (m³/s)	Head (m)
0.000	10.000
0.006944	10.000
0.013888	10.000
0.020832	10.000
0.027776	10.000
0.034720	10.000
0.041664	10.000
0.048608	10.000
0.055552	10.000
0.062496	10.000
0.069440	10.000
0.076384	10.000
0.083328	10.000
0.090272	10.000
0.097216	10.000
0.104160	10.000
0.111104	10.000
0.118048	10.000
0.124992	10.000
0.131936	10.000
0.138880	10.000
0.145824	10.000
0.152768	10.000
0.159712	10.000
0.166656	10.000
0.173600	10.000
0.180544	10.000
0.187488	10.000
0.194432	10.000
0.201376	10.000
0.208320	10.000
0.215264	10.000
0.222208	10.000
0.229152	10.000
0.236096	10.000
0.243040	10.000
0.250000	10.000

Results

Flow rate (m³/s)	Head (m)
0.006944	10.000
0.013888	10.000
0.020832	10.000
0.027776	10.000
0.034720	10.000
0.041664	10.000
0.048608	10.000
0.055552	10.000
0.062496	10.000
0.069440	10.000
0.076384	10.000
0.083328	10.000
0.090272	10.000
0.097216	10.000
0.104160	10.000
0.111104	10.000
0.118048	10.000
0.124992	10.000
0.131936	10.000
0.138880	10.000
0.145824	10.000
0.152768	10.000
0.159712	10.000
0.166656	10.000
0.173600	10.000
0.180544	10.000
0.187488	10.000
0.194432	10.000
0.201376	10.000
0.208320	10.000
0.215264	10.000
0.222208	10.000
0.229152	10.000
0.236096	10.000
0.243040	10.000
0.250000	10.000

- Recherche : le débit volumique dans la boucle.
- Ce problème illustre l'utilisation du solveur d'Excel pour déterminer le débit dans la boucle.

HydrauCalcXL Reference: AFT Fathom 10 - Examples - Heat Exchanger System
Find: the volume flowrate in the loop

Legend
Input data
Excel calculation
HydrauCalc calculation
HydrauCalc model
Unit symbol
Constant of neighboring cell
Check data (OK)

Fluid data
Water 21 °C 1.018
Density 999.1086 kg/m³
Dynamic Viscosity 0.00100272 N/m²
Kinematic Viscosity 0.00100327 m²/s

Pipe data

Name	Diameter (m)	Length (m)	Absolute roughness (m)
P1	0.1033	L93	0.00015
P2	0.1033	L93	0.00015
P3	0.1033	L93	0.00015
P4	0.1033	L93	0.00015
P5	0.1033	L93	0.00015
P6	0.1033	L93	0.00015
P7	0.1033	L93	0.00015

Bend data

Name	Diameter (m)	Curvature radius (m)	Angle (°)	Absolute roughness (m)
J2	0.1033	0.00184	90	0.00015
J3	0.1033	0.00184	90	0.00015
J4	0.1033	0.00184	90	0.00015
J5	0.1033	0.00184	90	0.00015
J6	0.1033	0.00184	90	0.00015
J7	0.1033	0.00184	90	0.00015

Head Exchanger loss

Flowrate (m ³ /s)	Press. loss (Pa)
0.0000	0
0.0020	2903
0.0040	11612
0.0060	26127
0.0080	44441
0.0100	67276

Pump J5

Flowrate (m ³ /s)	Press. loss (Pa)
0.0000	6.000
0.0020	5.900
0.0040	5.790
0.0060	5.590
0.0080	4.800

Head Exchanger pressure loss

J1	Flowrate (m ³ /s)
J1	0.0194

Head Exchanger pressure loss

J2	Flowrate (m ³ /s)
J2	0.0194
J3	0.0194
J4	0.0194
J5	0.0194
J6	0.0194
J7	0.0194

Head Exchanger pressure loss

J8	Flowrate (m ³ /s)
J8	0.0194
J9	0.0194
J10	0.0194
J11	0.0194
J12	0.0194
J13	0.0194
J14	0.0194

Head Exchanger pressure loss

J15	Flowrate (m ³ /s)
J15	0.0194
J16	0.0194
J17	0.0194

Head Exchanger pressure loss

J18	Flowrate (m ³ /s)
J18	0.0194
J19	0.0194
J20	0.0194
J21	0.0194
J22	0.0194
J23	0.0194
J24	0.0194
J25	0.0194
J26	0.0194
J27	0.0194
J28	0.0194
J29	0.0194
J30	0.0194
J31	0.0194
J32	0.0194
J33	0.0194
J34	0.0194
J35	0.0194
J36	0.0194
J37	0.0194
J38	0.0194
J39	0.0194
J40	0.0194
J41	0.0194
J42	0.0194
J43	0.0194
J44	0.0194
J45	0.0194
J46	0.0194
J47	0.0194
J48	0.0194
J49	0.0194
J50	0.0194
J51	0.0194
J52	0.0194
J53	0.0194
J54	0.0194
J55	0.0194
J56	0.0194
J57	0.0194
J58	0.0194
J59	0.0194
J60	0.0194
J61	0.0194
J62	0.0194
J63	0.0194
J64	0.0194
J65	0.0194
J66	0.0194
J67	0.0194
J68	0.0194
J69	0.0194
J70	0.0194
J71	0.0194
J72	0.0194
J73	0.0194
J74	0.0194
J75	0.0194
J76	0.0194
J77	0.0194
J78	0.0194
J79	0.0194
J80	0.0194
J81	0.0194
J82	0.0194
J83	0.0194
J84	0.0194
J85	0.0194
J86	0.0194
J87	0.0194
J88	0.0194
J89	0.0194
J90	0.0194
J91	0.0194
J92	0.0194
J93	0.0194
J94	0.0194
J95	0.0194
J96	0.0194
J97	0.0194
J98	0.0194
J99	0.0194
J100	0.0194

Head Exchanger pressure loss

J101	Flowrate (m ³ /s)
J101	0.0194
J102	0.0194
J103	0.0194
J104	0.0194
J105	0.0194
J106	0.0194
J107	0.0194
J108	0.0194
J109	0.0194
J110	0.0194
J111	0.0194
J112	0.0194
J113	0.0194
J114	0.0194
J115	0.0194
J116	0.0194
J117	0.0194
J118	0.0194
J119	0.0194
J120	0.0194
J121	0.0194
J122	0.0194
J123	0.0194
J124	0.0194
J125	0.0194
J126	0.0194
J127	0.0194
J128	0.0194
J129	0.0194
J130	0.0194
J131	0.0194
J132	0.0194
J133	0.0194
J134	0.0194
J135	0.0194
J136	0.0194
J137	0.0194
J138	0.0194
J139	0.0194
J140	0.0194
J141	0.0194
J142	0.0194
J143	0.0194
J144	0.0194
J145	0.0194
J146	0.0194
J147	0.0194
J148	0.0194
J149	0.0194
J150	0.0194
J151	0.0194
J152	0.0194
J153	0.0194
J154	0.0194
J155	0.0194
J156	0.0194
J157	0.0194
J158	0.0194
J159	0.0194
J160	0.0194
J161	0.0194
J162	0.0194
J163	0.0194
J164	0.0194
J165	0.0194
J166	0.0194
J167	0.0194
J168	0.0194
J169	0.0194
J170	0.0194
J171	0.0194
J172	0.0194
J173	0.0194
J174	0.0194
J175	0.0194
J176	0.0194
J177	0.0194
J178	0.0194
J179	0.0194
J180	0.0194
J181	0.0194
J182	0.0194
J183	0.0194
J184	0.0194
J185	0.0194
J186	0.0194
J187	0.0194
J188	0.0194
J189	0.0194
J190	0.0194
J191	0.0194
J192	0.0194
J193	0.0194
J194	0.0194
J195	0.0194
J196	0.0194
J197	0.0194
J198	0.0194
J199	0.0194
J200	0.0194

Head Exchanger pressure loss

J201	Flowrate (m ³ /s)
J201	0.0194
J202	0.0194
J203	0.0194
J204	0.0194
J205	0.0194
J206	0.0194
J207	0.0194
J208	0.0194
J209	0.0194
J210	0.0194
J211	0.0194
J212	0.0194
J213	0.0194
J214	0.0194
J215	0.0194
J216	0.0194
J217	0.0194
J218	0.0194
J219	0.0194
J220	0.0194
J221	0.0194
J222	0.0194
J223	0.0194
J224	0.0194
J225	0.0194
J226	0.0194
J227	0.0194
J228	0.0194
J229	0.0194
J230	0.0194
J231	0.0194
J232	0.0194
J233	0.0194
J234	0.0194
J235	0.0194
J236	0.0194
J237	0.0194
J238	0.0194
J239	0.0194
J240	0.0194
J241	0.0194
J242	0.0194
J243	0.0194
J244	0.0194
J245	0.0194
J246	0.0194
J247	0.0194
J248	0.0194
J249	0.0194
J250	0.0194
J251	0.0194
J252	0.0194
J253	0.0194
J254	0.0194
J255	0.0194
J256	0.0194
J257	0.0194
J258	0.0194
J259	0.0194
J260	0.0194
J261	0.0194
J262	0.0194
J263	0.0194
J264	0.0194
J265	0.0194
J266	0.0194
J267	0.0194
J268	0.0194
J269	0.0194
J270	0.0194
J271	0.0194
J272	0.0194
J273	0.0194
J274	0.0194
J275	0.0194
J276	0.0194
J277	0.0194
J278	0.0194
J279	0.0194
J280	0.0194
J281	0.0194
J282	0.0194
J283	0.0194
J284	0.0194
J285	0.0194
J286	0.0194
J287	0.0194
J288	0.0194
J289	0.0194
J290	0.0194
J291	0.0194
J292	0.0194
J293	0.0194
J294	0.0194
J295	0.0194
J296	0.0194
J297	0.0194
J298	0.0194
J299	0.0194
J300	0.0194

Head Exchanger pressure loss

J301	Flowrate (m ³ /s)
J301	0.0194
J302	0.0194
J303	0.0194
J304	0.0194
J305	0.0194
J306	0.0194
J307	0.0194
J308	0.0194
J309	0.0194
J310	0.0194
J311	0.0194
J312	0.0194
J313	0.0194
J314	0.0194
J315	0.0194
J316	0.0194
J317	0.0194
J318	0.0194
J319	0.0194
J320	0.0194
J321	0.0194
J322	0.0194
J323	0.0194
J324	0.0194
J325	0.0194
J326	0.0194
J327	0.0194
J328	0.0194
J329	0.0194
J330	0.0194
J331	0.0194
J332	0.0194
J333	0.0194
J334	0.0194
J335	0.0194
J336	0.0194
J337	0.0194
J338	0.0194
J339	0.0194
J340	0.0194
J341	0.0194
J342	0.0194
J343	0.0194
J344	0.0194
J345	0.0194
J346	0.0194
J347	0.0194
J348	0.0194
J349	0.0194
J350	0.0194
J351	0.0194
J352	0.0194
J353	0.0194
J354	0.0194
J355	0.0194
J356	0.0194
J357	0.0194
J358	0.0194
J359	0.0194
J360	0.0194
J361	0.0194
J362	0.0194
J363	0.0194
J364	0.0194
J365	0.0194
J366	0.0194
J367	0.0194
J368	0.0194
J369	0.0194
J370	0.0194
J371	0.0194
J372	0.0194
J373	0.0194
J374	0.0194
J375	0.0194
J376	0.0194
J377	0.0194
J378	0.0194
J379	0.0194
J380	0.0194
J381	0.0194
J382	0.0194
J383	0.0194
J384	0.0194
J385	0.0194
J386	0.0194
J387	0.0194
J388	0.0194
J389	0.0194
J390	0.0194
J391	0.0194
J392	0.0194
J393	0.0194
J394	0.0194
J395	0.0194
J396	0.0194
J397	0.0194
J398	0.0194
J399	0.0194
J400	0.0194

Head Exchanger pressure loss

J401	Flowrate (m ³ /s)
J401	0.0194
J402	0.0194
J403	0.0194
J404	0.0194
J405	0.0194
J406	0.0194
J407	0.0194
J408	0.0194
J409	0.0194
J410	0.0194
J411	0.0194
J412	0.0194
J413	0.0194
J414	0.0194
J415	0.0194
J416	0.0194
J417	0.0194
J418	0.0194
J419	0.0194
J420	0.0194
J421	0.0194
J422	0.0194
J423	0.0194
J424	0.0194
J425	0.0194
J426	0.0194
J427	0.0194
J428	0.0194
J429	

- Recherche : le diamètre de chaque diaphragme pour répondre au débit requis à travers chaque échangeur de chaleur.
- Ce problème illustre l'utilisation du solveur d'Excel pour résoudre un système complexe en boucle fermée. De plus, les débits dans les branches des cinq échangeurs doivent être équilibrés par des diaphragmes d'équilibrage.

Reference: Fiomaster - Example: Marine Cooling System
Find: the diameter of each orifice plate to meet the required flowrate through the various branches

Legend
Fluid data
Head calculation
HydraulCalc calculation
Simulation input
Units symbol

Fluid data
Density: 980.265 kg/m³
Kinematic viscosity: 0.000102 m²/s

Head calculation
Check data (m): 0

Head data (Water 15°C)
Density: 980.265 kg/m³
Kinematic viscosity: 0.000102 m²/s

Imposed volume flowrate (Heat Exchangers)

HE01	0.0100	m ³ /s
HE02	0.0100	m ³ /s
HE03	0.0100	m ³ /s
HE04	0.0100	m ³ /s
HE05	0.0100	m ³ /s

Reservoir H₀
Liquid level above base: 1 m
Base level above ref.: 0.0000 m
Surface pressure: 1.0000E+05 Pa

Pipe data

Name	Diameter (m)	Length (m)	Absolute roughness (m)
P1	0.1541	10	0.000004
P2	0.1541	1.50	0.000004
P3	0.1541	1.50	0.000004
P4	0.1541	1.50	0.000004
P5	0.1541	1.50	0.000004
P6	0.1541	1.50	0.000004
P7	0.1541	1.50	0.000004
P8	0.1541	1.50	0.000004
P9	0.1541	1.50	0.000004
P10	0.1541	1.50	0.000004
P11	0.1541	1.50	0.000004
P12	0.1541	1.50	0.000004
P13	0.1541	1.50	0.000004
P14	0.1541	1.50	0.000004
P15	0.1541	1.50	0.000004
P16	0.1541	1.50	0.000004
P17	0.1541	1.50	0.000004
P18	0.1541	1.50	0.000004
P19	0.1541	1.50	0.000004
P20	0.1541	1.50	0.000004
P21	0.1541	1.50	0.000004
P22	0.1541	1.50	0.000004
P23	0.1541	1.50	0.000004
P24	0.1541	1.50	0.000004
P25	0.1541	1.50	0.000004
P26	0.1541	1.50	0.000004
P27	0.1541	1.50	0.000004
P28	0.1541	1.50	0.000004
P29	0.1541	1.50	0.000004
P30	0.1541	1.50	0.000004
P31	0.1541	1.50	0.000004
P32	0.1541	1.50	0.000004
P33	0.1541	1.50	0.000004
P34	0.1541	1.50	0.000004
P35	0.1541	1.50	0.000004
P36	0.1541	1.50	0.000004
P37	0.1541	1.50	0.000004
P38	0.1541	1.50	0.000004
P39	0.1541	1.50	0.000004
P40	0.1541	1.50	0.000004
P41	0.1541	1.50	0.000004
P42	0.1541	1.50	0.000004
P43	0.1541	1.50	0.000004
P44	0.1541	1.50	0.000004
P45	0.1541	1.50	0.000004
P46	0.1541	1.50	0.000004
P47	0.1541	1.50	0.000004
P48	0.1541	1.50	0.000004
P49	0.1541	1.50	0.000004
P50	0.1541	1.50	0.000004
P51	0.1541	1.50	0.000004
P52	0.1541	1.50	0.000004
P53	0.1541	1.50	0.000004
P54	0.1541	1.50	0.000004
P55	0.1541	1.50	0.000004
P56	0.1541	1.50	0.000004
P57	0.1541	1.50	0.000004
P58	0.1541	1.50	0.000004
P59	0.1541	1.50	0.000004
P60	0.1541	1.50	0.000004
P61	0.1541	1.50	0.000004
P62	0.1541	1.50	0.000004
P63	0.1541	1.50	0.000004
P64	0.1541	1.50	0.000004
P65	0.1541	1.50	0.000004
P66	0.1541	1.50	0.000004
P67	0.1541	1.50	0.000004
P68	0.1541	1.50	0.000004
P69	0.1541	1.50	0.000004
P70	0.1541	1.50	0.000004
P71	0.1541	1.50	0.000004
P72	0.1541	1.50	0.000004
P73	0.1541	1.50	0.000004
P74	0.1541	1.50	0.000004
P75	0.1541	1.50	0.000004
P76	0.1541	1.50	0.000004
P77	0.1541	1.50	0.000004
P78	0.1541	1.50	0.000004
P79	0.1541	1.50	0.000004
P80	0.1541	1.50	0.000004
P81	0.1541	1.50	0.000004
P82	0.1541	1.50	0.000004
P83	0.1541	1.50	0.000004
P84	0.1541	1.50	0.000004
P85	0.1541	1.50	0.000004
P86	0.1541	1.50	0.000004
P87	0.1541	1.50	0.000004
P88	0.1541	1.50	0.000004
P89	0.1541	1.50	0.000004
P90	0.1541	1.50	0.000004
P91	0.1541	1.50	0.000004
P92	0.1541	1.50	0.000004
P93	0.1541	1.50	0.000004
P94	0.1541	1.50	0.000004
P95	0.1541	1.50	0.000004
P96	0.1541	1.50	0.000004
P97	0.1541	1.50	0.000004
P98	0.1541	1.50	0.000004
P99	0.1541	1.50	0.000004
P100	0.1541	1.50	0.000004

Pressure loss of each component

Heat Exchanger pressure loss

HE01	0.0000	Pa
HE02	0.0000	Pa
HE03	0.0000	Pa
HE04	0.0000	Pa
HE05	0.0000	Pa

Orifice plate pressure loss

OP1	0.0000	Pa
OP2	0.0000	Pa
OP3	0.0000	Pa
OP4	0.0000	Pa
OP5	0.0000	Pa
OP6	0.0000	Pa
OP7	0.0000	Pa
OP8	0.0000	Pa
OP9	0.0000	Pa
OP10	0.0000	Pa
OP11	0.0000	Pa
OP12	0.0000	Pa
OP13	0.0000	Pa
OP14	0.0000	Pa
OP15	0.0000	Pa
OP16	0.0000	Pa
OP17	0.0000	Pa
OP18	0.0000	Pa
OP19	0.0000	Pa
OP20	0.0000	Pa
OP21	0.0000	Pa
OP22	0.0000	Pa
OP23	0.0000	Pa
OP24	0.0000	Pa
OP25	0.0000	Pa
OP26	0.0000	Pa
OP27	0.0000	Pa
OP28	0.0000	Pa
OP29	0.0000	Pa
OP30	0.0000	Pa
OP31	0.0000	Pa
OP32	0.0000	Pa
OP33	0.0000	Pa
OP34	0.0000	Pa
OP35	0.0000	Pa
OP36	0.0000	Pa
OP37	0.0000	Pa
OP38	0.0000	Pa
OP39	0.0000	Pa
OP40	0.0000	Pa
OP41	0.0000	Pa
OP42	0.0000	Pa
OP43	0.0000	Pa
OP44	0.0000	Pa
OP45	0.0000	Pa
OP46	0.0000	Pa
OP47	0.0000	Pa
OP48	0.0000	Pa
OP49	0.0000	Pa
OP50	0.0000	Pa

Pipe pressure loss

P1	0.0000	Pa
P2	0.0000	Pa
P3	0.0000	Pa
P4	0.0000	Pa
P5	0.0000	Pa
P6	0.0000	Pa
P7	0.0000	Pa
P8	0.0000	Pa
P9	0.0000	Pa
P10	0.0000	Pa
P11	0.0000	Pa
P12	0.0000	Pa
P13	0.0000	Pa
P14	0.0000	Pa
P15	0.0000	Pa
P16	0.0000	Pa
P17	0.0000	Pa
P18	0.0000	Pa
P19	0.0000	Pa
P20	0.0000	Pa
P21	0.0000	Pa
P22	0.0000	Pa
P23	0.0000	Pa
P24	0.0000	Pa
P25	0.0000	Pa
P26	0.0000	Pa
P27	0.0000	Pa
P28	0.0000	Pa
P29	0.0000	Pa
P30	0.0000	Pa
P31	0.0000	Pa
P32	0.0000	Pa
P33	0.0000	Pa
P34	0.0000	Pa
P35	0.0000	Pa
P36	0.0000	Pa
P37	0.0000	Pa
P38	0.0000	Pa
P39	0.0000	Pa
P40	0.0000	Pa
P41	0.0000	Pa
P42	0.0000	Pa
P43	0.0000	Pa
P44	0.0000	Pa
P45	0.0000	Pa
P46	0.0000	Pa
P47	0.0000	Pa
P48	0.0000	Pa
P49	0.0000	Pa
P50	0.0000	Pa
P51	0.0000	Pa
P52	0.0000	Pa
P53	0.0000	Pa
P54	0.0000	Pa
P55	0.0000	Pa
P56	0.0000	Pa
P57	0.0000	Pa
P58	0.0000	Pa
P59	0.0000	Pa
P60	0.0000	Pa
P61	0.0000	Pa
P62	0.0000	Pa
P63	0.0000	Pa
P64	0.0000	Pa
P65	0.0000	Pa
P66	0.0000	Pa
P67	0.0000	Pa
P68	0.0000	Pa
P69	0.0000	Pa
P70	0.0000	Pa
P71	0.0000	Pa
P72	0.0000	Pa
P73	0.0000	Pa
P74	0.0000	Pa
P75	0.0000	Pa
P76	0.0000	Pa
P77	0.0000	Pa
P78	0.0000	Pa
P79	0.0000	Pa
P80	0.0000	Pa
P81	0.0000	Pa
P82	0.0000	Pa
P83	0.0000	Pa
P84	0.0000	Pa
P85	0.0000	Pa
P86	0.0000	Pa
P87	0.0000	Pa
P88	0.0000	Pa
P89	0.0000	Pa
P90	0.0000	Pa
P91	0.0000	Pa
P92	0.0000	Pa
P93	0.0000	Pa
P94	0.0000	Pa
P95	0.0000	Pa
P96	0.0000	Pa
P97	0.0000	Pa
P98	0.0000	Pa
P99	0.0000	Pa
P100	0.0000	Pa

Through (m³/s)

OP1	0.0000	m ³ /s
OP2	0.0000	m ³ /s
OP3	0.0000	m ³ /s
OP4	0.0000	m ³ /s
OP5	0.0000	m ³ /s
OP6	0.0000	m ³ /s
OP7	0.0000	m ³ /s
OP8	0.0000	m ³ /s
OP9	0.0000	m ³ /s
OP10	0.0000	m ³ /s
OP11	0.0000	m ³ /s
OP12	0.0000	m ³ /s
OP13	0.0000	m ³ /s
OP14	0.0000	m ³ /s
OP15	0.0000	m ³ /s
OP16	0.0000	m ³ /s
OP17	0.0000	m ³ /s
OP18	0.0000	m ³ /s
OP19	0.0000	m ³ /s
OP20	0.0000	m ³ /s
OP21	0.0000	m ³ /s
OP22	0.0000	m ³ /s
OP23	0.0000	m ³ /s
OP24	0.0000	m ³ /s
OP25	0.0000	m ³ /s
OP26	0.0000	m ³ /s
OP27	0.0000	m ³ /s
OP28	0.0000	m ³ /s
OP29	0.0000	m ³ /s
OP30	0.0000	m ³ /s
OP31	0.0000	m ³ /s
OP32	0.0000	m ³ /s
OP33	0.0000	m ³ /s
OP34	0.0000	m ³ /s
OP35	0.0000	m ³ /s
OP36	0.0000	m ³ /s
OP37	0.0000	m ³ /s
OP38	0.0000	m ³ /s
OP39	0.0000	m ³ /s
OP40	0.0000	m ³ /s
OP41	0.0000	m ³ /s
OP42	0.0000	m ³ /s
OP43	0.0000	m ³ /s
OP44	0.0000	m ³ /s
OP45	0.0000	m ³ /s
OP46	0.0000	m ³ /s
OP47	0.0000	m ³ /s
OP48	0.0000	m ³ /s
OP49	0.0000	m ³ /s
OP50	0.0000	m ³ /s

Function pressure loss (Pa)

J01	0.0000	Pa
J02	0.0000	Pa
J03	0.0000	Pa
J04	0.0000	Pa
J05	0.0000	Pa
J06	0.0000	Pa
J07	0.0000	Pa
J08	0.0000	Pa
J09	0.0000	Pa
J10	0.0000	Pa
J11	0.0000	Pa
J12	0.0000	Pa
J13	0.0000	Pa
J14	0.0000	Pa
J15	0.0000	Pa
J16	0.0000	Pa
J17	0.0000	Pa
J18	0.0000	Pa
J19	0.0000	Pa
J20	0.0000	Pa
J21	0.0000	Pa

HydraCalcXL

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