10 REASONS

TO REPLACE FLOWMASTER WITH HYDROSYSTEM

Vincent Soumoy

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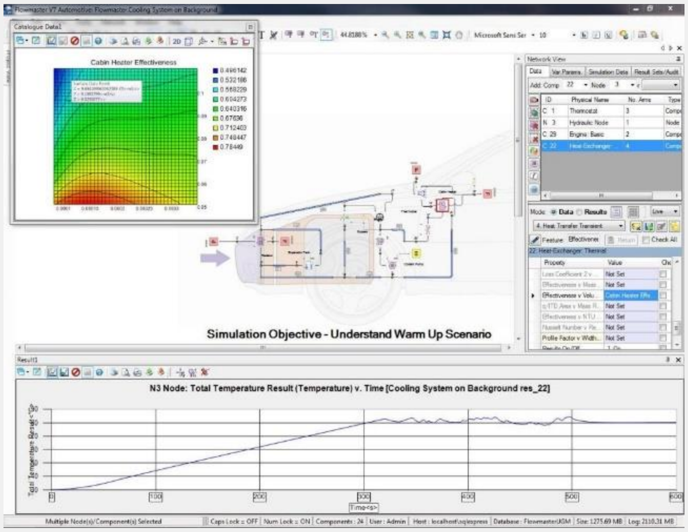
500 Place d'Armes – Suite 1500 – Montreal – QC – H2Y 2W2 – Canada
www.fluidsandco.com

REASON 1
MULTI-VARIANT GRAPHICAL USER INTERFACE

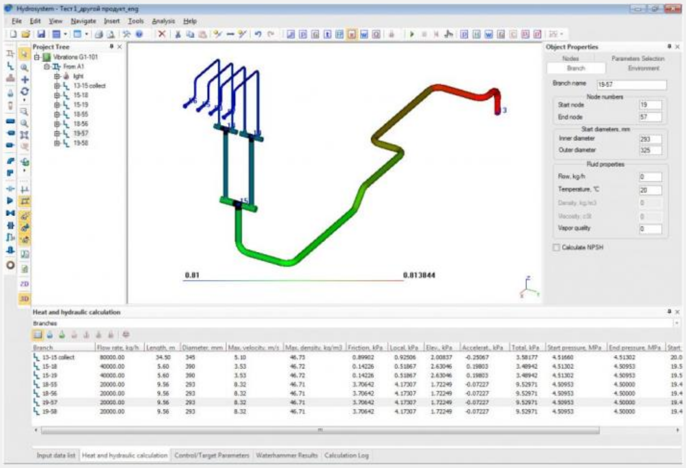
Flowmaster is mainly considering schematic representation of the network.



Flowmaster GUI

Hydrosystem can work with a large spectrum of pipeline types on different stages of design and offers unique multi-variant graphical representations of the model.

The program can switch between different modes and levels of detail (PFD/P&ID – like unscaled scheme with regulated level of detailing, 2D scaled distributed networks on background map, and single line or solid 3D scaled, or unscaled representation for process piping) depending on what is suitable for a specific design phase and pipeline type.



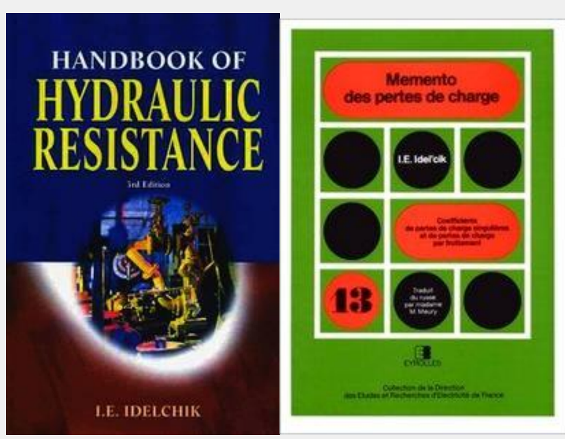
Hydrosystem GUI

REASON 2
BASED ON SEVERAL REFERENCE BOOKS

Flowmaster is based on the world-recognized technical book *“Internal Flow Systems”* by D.S. Miller (Technical Director of British Hydromechanics Research Association).

Blessed with world-known piping hydraulic guru I.E Idelchik (*“Handbook of Hydraulic Resistance”*), **Hydrosystem** has since evolved into one of most powerful piping flow analysis tools.

But losses correlations from D.S. Miller and Ito are also included.



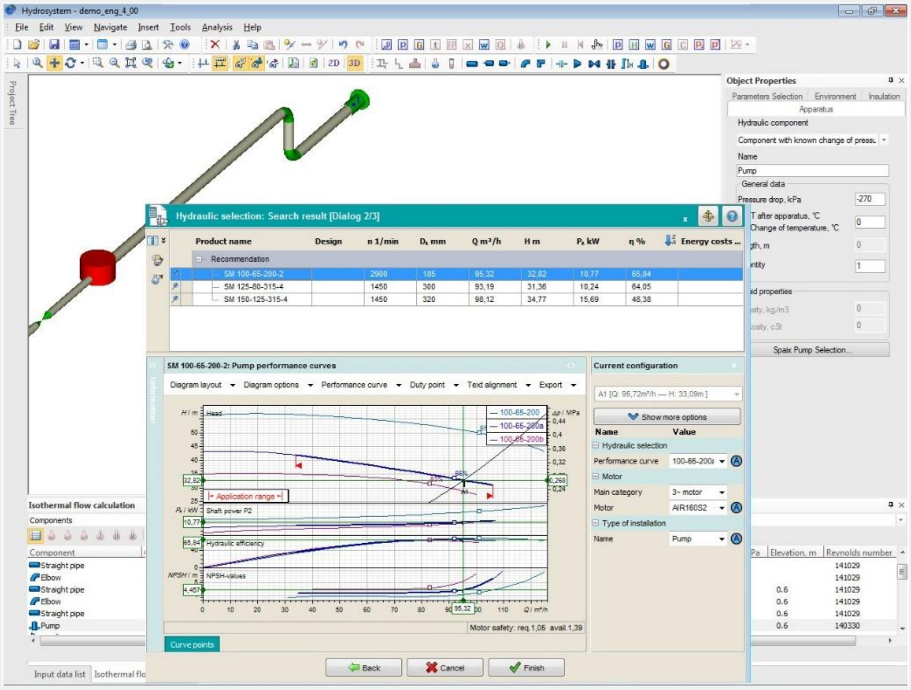
REASON 3
LINK WITH SPAIX FOR PUMP SELECTION

Hydrosystem delivers a unique opportunity for customers who need to select pumps for their piping systems. The seamless integration with famous Spaix software allows forwarding of all necessary data (duty point data, fluid properties, restriction on NPSH) to Spaix with the push of a button. The user then selects the optimal pump (with all optimization features – impeller trimming, changing the rotation speed, changing blade angle of propeller pumps etc.) and forwards all of the selected pump's performance curves back to Hydrosystem for final calculation.

Hydrosystem allows the use of Spaix application for pump selection. To use this option, one should input the pump in Hydrosystem as component with known change of pressure equal to the required head of pump and run the pipeline analysis (isothermal or thermohydraulic).

After that "Spaix Pump Selection..." button appears in the parameters window for that component. Pressing that button will call for "Spaix Pumps" application (if it is installed on that PC) for pump selection.

All the necessary data for pump selection (required head of pump, flowrate, fluid properties etc.) are exported into Spaix and users only need to select the pump from the list of pumps compatible with exported data. After pump is selected, all the pump data (head and NPSH curves, pump manufacturer etc.) are imported into Hydrosystem for further analysis and the component with known change of pressure is transformed into pump piping component.



REASON 4
LIST AND LABEL REPORT GENERATOR

Pipeline name: Tech.water
Hydraulic calculation

№	Component	Qty	Length, m	Elev, m	D., mm	V, m/s	Density, kg/m3	Viscosity, cSt	Pressure losses, kPa: Friction	Local	Elev.	P, MPa	NPSH, m	Temp., °C	Heat losses, kW
Tech.water, Branch 5-7															
0					200							2.723			
1	Tee (main leg)	1			200	6.50	918.28	0.20				2.723		150.0	
2	Straight pipe	1	2.00		200	6.50	918.28	0.20	4.304			2.719		150.0	
3	Tee (main leg)	1			200							2.719		150.0	
Tech.water, Branch 8-9 by															
0					100							2.724			
1	Tee (side leg)	1			100	9.42	918.28	0.20		43.66		2.680		150.0	
2	Straight pipe	1	1.00		100	9.42	918.27	0.20	12.387			2.668		150.0	
3	Elbow	1	0.24		100	9.42	918.26	0.20	2.918	14.06		2.651		150.0	
4	Straight pipe	1	1.00		100	9.42	918.26	0.20	12.387			2.639		150.0	
5	Knife gate valve	1			100	9.42	918.26	0.20				2.639		150.0	
6	Straight pipe	1	1.00		100	9.42	918.25	0.20	12.387			2.626		150.0	
7	Elbow	1	0.24		100	9.42	918.24	0.20	2.918	14.06		2.609		150.0	
8	Straight pipe	1	1.00		100	9.42	918.23	0.20	12.387			2.597		150.0	
9	Tee (main leg)	1			100					27.85		2.569		150.0	
Tech.water, Branch 8-9															
0					200							2.724			
1	Tee (main leg)	1			200	2.46	918.28	0.20		0.891		2.723		150.0	
2	Straight pipe	1	0.50		200	2.46	918.28	0.20	0.177			2.723		150.0	
3	Component with known change of pressure and/or temperature	1			200	2.34	966.48	0.33		70.00		2.653		90.00	
4	Straight pipe	1	0.80		200	2.34	966.48	0.33	0.269			2.653		90.00	
5	Orifice	1			200	2.34	966.44	0.33		78.38		2.574		90.00	
6	Straight pipe	1	1.00		200	2.34	966.44	0.33	0.326			2.574		90.00	
7	Tee (side leg)	1			200					4.978		2.569		90.00	
Tech.water, Branch 7-11															
0					200							2.719			
1	Tee (side leg)	1			200	1.69	918.28	0.20		17.24		2.702		150.0	
2	Straight pipe	1	2.00		200	1.69	918.28	0.20	0.291			2.701		150.0	
3	Tee (main leg)	1			200					7.932		2.693		150.0	
Tech.water, Branch 17-11															
0					200							2.693			
1	Tee (main leg)	1			200	4.81	918.26	0.20				2.693		150.0	
2	Straight pipe	1	2.00		200	4.81	918.26	0.20	2.358			2.691		150.0	
3	Elbow	1	0.47		200	4.81	918.26	0.20	0.639	3.674		2.687		150.0	
4	Straight pipe	1	2.00		200	4.81	918.26	0.20	2.358			2.684		150.0	
5	Tee (main leg)	1			200							2.684		150.0	
Tech.water, Branch 11-12															
0					200							2.684			
1	Tee (side leg)	1			200	2.30	918.26	0.20		9.014		2.675		150.0	
2	Straight pipe	1	0.50		200	2.30	918.26	0.20	0.154			2.675		150.0	

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detailed results | Page 3

Hydrosystem includes a List & Label report generator by Combit for printing input and output data.

The software allows you to print, preview and save documents (as a List & Label file with an LL extension). The saved files can be viewed and printed using Combit List & Label Viewer, installed with Hydrosystem.

Reports can also be saved in other formats for inclusion in various documents (for example, pdf files for Adobe Acrobat).

The document template can also be changed (for example, editing of the title block format, adding of the company logo, etc.) using the included form editor, List & Label Designer.

Pipeline name: Tech.water
Hydraulic calculation

NN	Branch	Fluid	Flowrate kg/h	Length, m	Inner D, mm	Maximum: Velocity m/s	Maximum: Density kg/m3	Pressure losses, kPa: Friction (major)	Local (minor)	Elevation change	Pressure, MPa: Start	End	Temperature, °C: Start	End	NPSH m
1	inlet 1-2	water	444458.4	7.2	100	17.12	966.73	269.749	196.800		3.20000	2.73345	90.00	150.00	
2	inlet 4-3	water	379779.6	10.2	100	14.78	966.73	269.894	106.252		3.20000	2.82385	90.00	160.00	
3	inlet 6-5	water	351293.9	13.2	100	13.82	966.73	300.829	175.626		3.20000	2.72354	90.00	170.00	
4	inlet 18-17	water	324468.1	18.2	100	12.92	966.73	346.133	160.075		3.20000	2.69379	90.00	180.00	
5	outlet 15-16	water	500000.0	1.0	200	4.81	918.17	1.314			2.53612	2.53481	150.00	150.00	
6	outlet 12-13	water	500000.0	1.0	200	4.81	918.17	1.314			2.52934	2.52802	150.00	150.00	
7	outlet 9-10	water	500000.0	1.0	200	4.81	918.19	1.314			2.56941	2.56809	150.00	150.00	
8	2-8	water	500000.0	4.5	200	4.81	918.28	5.355	3.674		2.73345	2.72443	150.00	150.00	
9	3-2	water	55541.6	2.0	200	0.53	918.34	0.029	90.084		2.82385	2.73345	150.00	150.00	
10	3-5	water	324238.0	2.0	200	3.12	918.34	0.991	99.374		2.82385	2.72354	150.00	150.00	
11	5-7	water	675531.9	2.0	200	6.50	918.28	4.304			2.72354	2.71924	150.00	150.00	
12	8-9 by	water	244536.1	4.5	100	9.42	918.28	55.384	99.633		2.72443	2.56941	150.00	150.00	
13	8-9	water	255463.9	2.3	200	2.46	966.51	0.772	154.245		2.72443	2.56941	150.00	90.00	
14	7-11	water	175531.9	2.0	200	1.69	918.28	0.291	25.168		2.71924	2.69379	150.00	150.00	
15	17-11	water	500000.0	4.5	200	4.81	918.26	5.355	3.674		2.69379	2.68476	150.00	150.00	
16	11-12	water	238468.8	2.3	200	2.30	955.92	0.679	154.747		2.68476	2.52934	150.00	105.00	
17	11-12 by	water	261531.2	4.5	100	10.07	918.26	63.352	92.074		2.68476	2.52934	150.00	150.00	
18	7-14	water	500000.0	4.5	200	4.81	918.28	5.625	18.802		2.71924	2.69481	150.00	150.00	

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Summary results

Stage	Page	Pages
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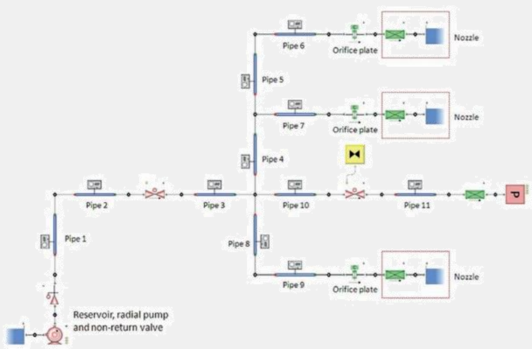
Pipeline calculation
by Hydrosystem 3.85
Summary results

REASON 5
EASY SIZING OPTIONS



To size a piping with **Flowmaster**, is not easy.

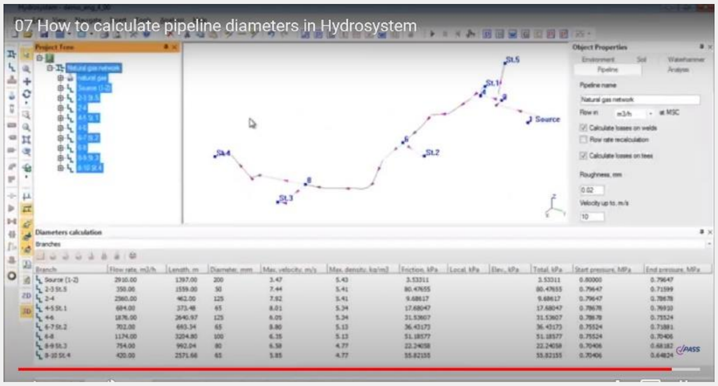
The first option, called Flowbalancing, will compute the flow rate in the full system branches.

Flowbalancing performs incompressible pressure loss calculations for individual components but allows flow rates for components to be specified as an input parameter. The analysis calculates the pressure conditions for those components, referred to as balancing components, and reports results which allow the user to optimise components or set component data to achieve the desired flows.

In the Fire Protection System above, water is pumped from a constant head reservoir through a control valve and into a branched network of sprinkler nozzles. The required analysis calculates the orifice plate diameters that will achieve a specified flow rate through each sprinkler nozzle.

Volumetric flow rate can be specified in most components, but it is most appropriate to components that can be set up to give the desired flow rate at the pressure conditions prevailing in the network. The best-suited components to the use of balancing flows are control valves, orifices, pipes, pumps, reservoirs, and accumulators.

The second option, that allows a single branch to be sized is using PID controller that would regulate the position of a valve, for example.



To size a piping system into **Hydrosystem**, is very easy as shown in this less than two-minute video https://youtu.be/AaXWvY1yeyE

You just need to set the pressure at all inlet and outlets points, and the flow rates in all branches, letting the diameters blanc, then run diameters calculation to determine nominal sizes of pipelines branches.

You may decide to select the diameter to provide the required fluids velocity limit, just setting this value as input data (only in the appropriated branch).

If the diameters of part of the pipeline branches are know, you may specify them as input data. In this case, the program will determine the diameters only for the rest of the branches.

REASON 6
REAL MULTIPHASE FLOWS

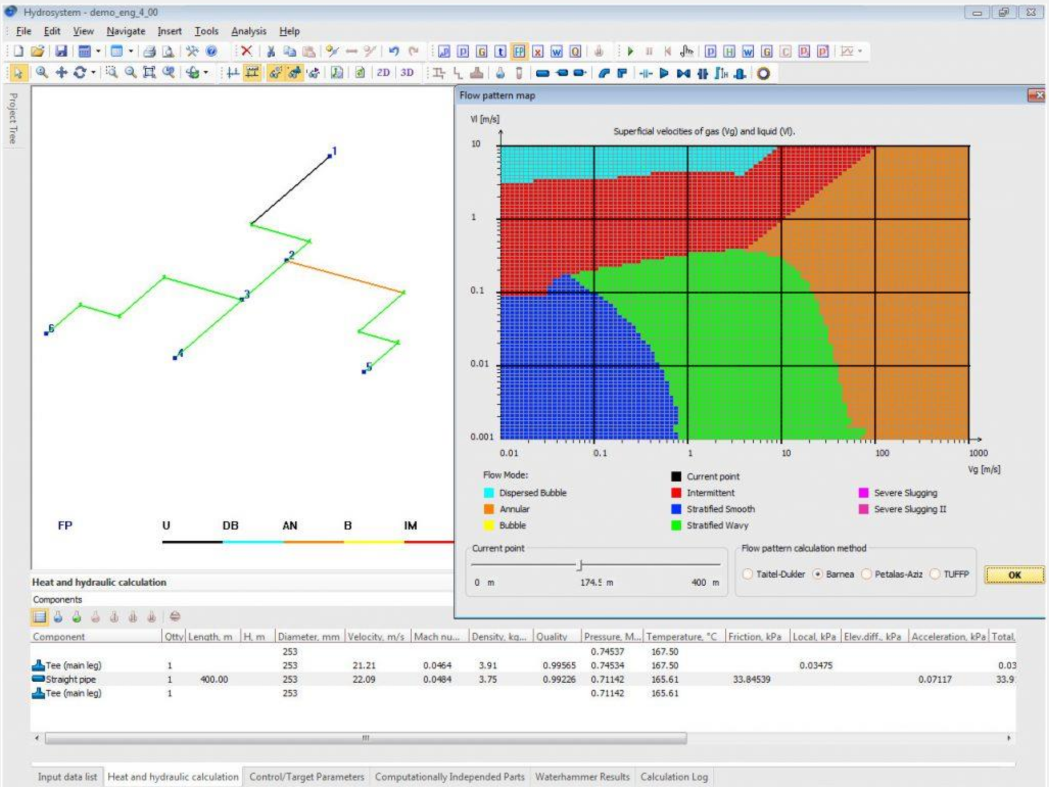
At the very beginning, a multiphase model was included into Flowmaster, not anymore present in 1994. Around 2000 Flowmaster moved to target the automotive market and created a HVAC module.

In 2012, Mentor announced the Flowmaster Power and Energy version for system level thermo-fluid simulation. This new product provided a two-phase solution modeling the phase change from liquid to vapor for steam generation or from vapor to liquid when steam is consumed. This new capability was ideal for the power generation markets, accurately describing industry-specific components that must be developed to meet industry modeling requirements with faster and more accurate analysis.

But with Flowmaster multiphase is for steam and water only.

Hydrosystem provides a calculation engine for all necessary fluid properties and phase equilibrium on the base of fluid composition, for a wide spectrum of fluids and applications, namely with the proprietary Properties and STARS, GERG 2008 and WaterSteamPro libraries.

For more advanced fluid properties and phase equilibrium calculations the program can use the **Simulis Thermodynamics** library by **ProSim**.



Two-phase gas-liquid flow can be analyzed ignoring mass transfer between phases (so-called “frozen” flow) or considering vaporization and condensation. Frozen flow analysis can be performed both for isothermal flow and as a heat and hydraulic calculation.

Gas-liquid flow is steady, and phases are in the state of thermodynamic equilibrium and having the same temperature and pressure. “Slippage” of liquid and gas phases can be considered, i.e., their movement at different flow velocity.

During hydraulic analysis of a two-phase gas-liquid flow, the pattern of two-phase flow at different points along the pipeline is found, and for all components the following values are calculated: two-phase flow pattern, void fraction and true phase velocities, as well as hydrostatic losses in components due to elevation change, pressure loss due to friction, pressure loss due to local resistance, pressure loss due to acceleration of flow and Mach number.

Hydrosystem utilizes several methodologies for different calculations, from which the user can select the most appropriate methods for any given task. There is also a high degree of flexibility in which methodologies should be used for various types of components in different situations, which can be set using special rules of method selection for two-phase analysis. User defined rules may be used as well as one of the predefined rules included in the software.

Analysis of two-phase flow considering mass transfer (boiling/condensation) may be performed for pipelines of various structures without recycles. Individual branches are analyzed using direct calculation method, long pipes are subdivided into parts with slight change of calculated parameters, if necessary.

Change of flow temperature and phase composition for this type of flow is calculated using full energy balance equation. First change of fluid enthalpy is determined, then phase equilibrium based on enthalpy and pressure is calculated and finally fluid temperature and phase composition are obtained.

To analyze flow with mass transfer in unbranched pipeline one may enter pressure in the end node of a branch. In this case the fluid temperature is also interpreted as being entered in the end node. The “upstream” calculation is then performed to obtain initial flow parameters (quality, temperature, pressure).

The analysis determines where in the pipeline the fluid state changes to one phase (liquid or gas). In these points the automatic switch to one-phase methods is performed. Similarly, the reverse transition is recognized (the beginning of boiling up or condensation) with switching to two-phase methods.

For two-phase flow in unbranched pipelines Hydrosystem determines where the choked flow occurs in the pipeline (at the end of straight pipes, at the exit, in reducers and abrupt expansions).

Hydrosystem can also do severe slugging prediction and can calculate settling slurry flow (i.e. liquid + solid particles) including flow pattern prediction.

REASON 7
DIRECT INTEGRATION WITH CAD AND BIM

Cad to **Flowmaster** (CAD2FM) is a fully automated function to convert MCAD piping geometry into an equivalent Flowmaster sub-system, bypassing data re-entry errors and compressing the time required for such a conversion from hours to minutes compared to manual 'measure and re-enter' approaches. This entails the use of FloEFD to prepare the geometry for export, perform the conversion using a simple 'coarse/fine' slider bar to control the level of abstraction, then export of a .cad2fm file containing the Flowmaster sub-system. The cad2fm file is then imported into FloMaster and saved to the sub-system catalogue for subsequent reuse.

Hydrosystem has numerous interfaces with design and analysis software (see below table).

Software	Import into PASS/HYDROSYSTEM	Export from PASS/HYDROSYSTEM
PASS/START-PROF	✓	✓
Unigraphics	✓	
Tricad MS	✓	
AVEVA PDMS/E3D/MARINE	✓	✓
OpenPlant	✓	
autoPLANT	✓	
Solidworks	✓	
CADWorx	✓	
Cadison	✓	
SmartPlant 3D	✓	
Inventor	✓	
Neutral Format	✓	✓
PLANT 4D	✓	
AutoCAD		✓
Autodesk REVIT	✓	

Moreover, the Revit-PASS integration system allows you to accurately transfer the geometry of the pipeline and attributive information from the BIM design system to the system for calculating the strength and rigidity of pipelines.

Data exchange is implemented through an open format, which makes it possible to divide the roles of users in the project and optimize the organization's budget by using only the necessary products.

Using the Revit-PASS integration system will allow design organizations to effectively organize the design of industrial facilities due to a significant reduction in the time required for re-entering data. In addition, the use of the integration system when Autodesk Revit and PASS are used together excludes the possibility of errors associated with manual data entry into the calculation model.

REASON 8
DIRECT LINK TO STRESS ANALYSIS TOOLS

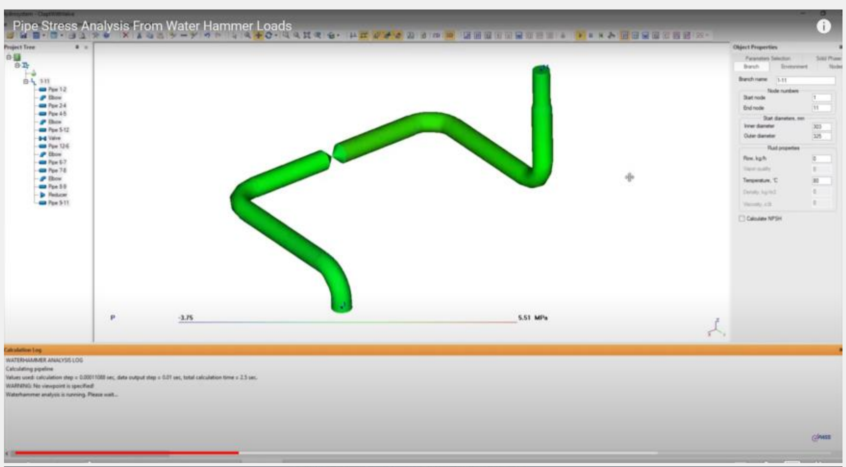
Flowmaster, long considered one of the most accurate tools for water hammer analysis has introduced the ability to automatically calculate and easily export this data as a time history plot to the industry leading pipe stress analysis tools.

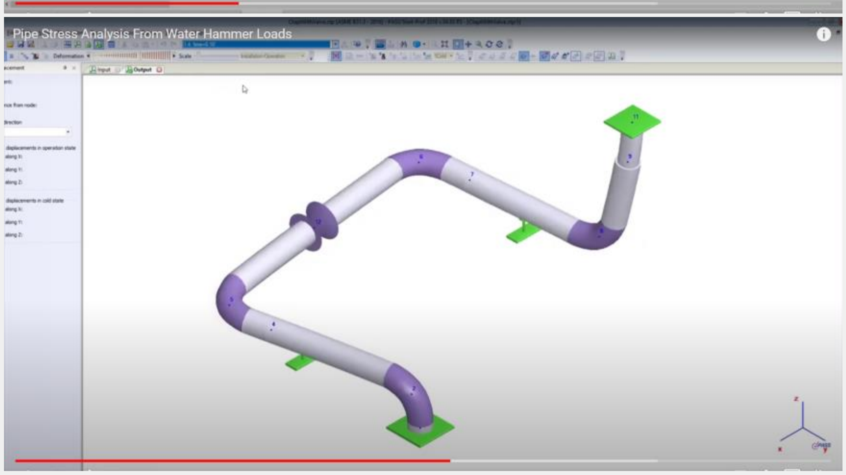
You may now export a hydrodynamic force time history plot for use in Intergraph CAESAR II.

Hydrosystem is of course linked to Intergraph CAESAR II but also the other main software from the PASS suite: Start-prof.

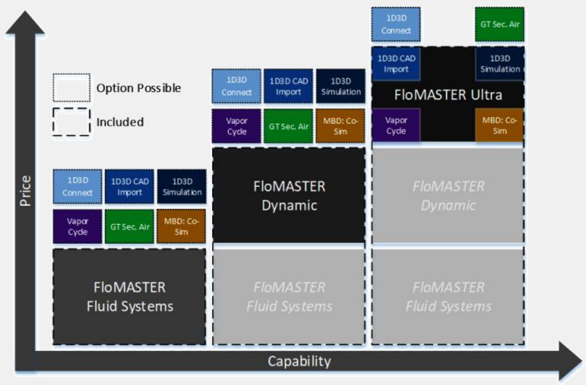
Start-Prof provides comprehensive pipe stress, flexibility, stability, and fatigue strength analysis with related sizing calculations according to international and national codes and standards. First introduced in 1965, it combines a highly efficient solver, powerful analysis features, a user-friendly GUI, an intuitive 3D graphical pre/post-processor, and a detailed help system with embedded intelligence from generations of piping design experts.

It can be used to simulate stress behaviour from Hydrosystem results like in the waterhammer example below (available at https://youtu.be/-ycRP_KEr8c)





REASON 9
LARGE DIFFERENCE IN PRICING



Flowmaster offers three base applications: **Flowmaster**

High accuracy **fluid system** tool with low cost of ownership, combining high usability with a professionally maintained codebase. Allows users to analyse complex fluid systems (liquids and gases) in order to size components, model pressure drops, simulate heat transfer within and to/from the fluid and carry out parametric studies on different design variables. Script based models are also supported to allow users to easily create components based on proprietary IP.

Dynamic. Builds on the Fluid System module with an industry proven and respected rapid transient solver. The tool of choice for applications ranging from aircraft fuel system mission profiles to power station cooling network shutdowns and component failures.

Ultra. High value 'bundle' which enhances the Fluid Systems Dynamic application with our powerful Vapor Cycle and model-based-design (1D3D CAD Import, 1D3D Simulation and Co-Simulation) options.

*Minimum **Flomaster** annual license is starting at 5 000 US$*

and the complete perpetual license price is around 100 000 US$

Hydrosystem Pressure provides simulation and sizing of any piping network for pressure effects related to single phase steady state flow conditions.

Hydrosystem Pressure&Heat provides simulation and sizing of any piping network for single phase steady state flow and thermal conditions.

The Multiphase module provides analysis of multi-phase flow in piping systems. The Surge module provides analysis of liquid transient flow in piping systems. The Solid Phase module provides analysis of settling slurry flow.

Hydrosystem Complete provides comprehensive hydraulic and thermal analysis and related sizing calculations for piping systems of any complexity.

*Minimum **Hydrosystem** annual license is starting at 1 000 US$*

and the complete perpetual license price is 10 000 US$

So Hydrosystem is between 5x and 10x cheaper than Flowmaster!

REASON 10
WORLDWIDE SUPPORT AND HIGHLY ACTIVE PERMANENT DEVELOPMENT AND IMPROVMENT

Flowmaster, was some time ago the leading general purpose 1D computational fluid dynamics (CFD) solution for the modeling and analysis of fluid mechanics in complex piping systems of any scale.

The development started in the early 1980's and took over 30 man-years of initial development.

Flowmaster grew inside the Flowmaster Group, namely for the automotive and aerospace industry, as main competitor of Amesim, at the beginning of the 20^{th} century.

It was acquired by the Mentor Graphics and more recently by Siemens.

Now Flowmaster is part of a large group: support is depending on the knowledge of the local representative (the former team is not present anymore) and the development is decided by the strategy of the group only.

First introduced in 1977 and blessed with world-known piping hydraulic guru Idelchik, **Hydrosystem** has since evolved into one of most powerful piping flow analysis tools.

Founded in 1992, and currently one of leading Russian IT companies, PSRE (Piping System Research & Engineering) Co. develops now **Hydrosystem** as a part of a complete solution (PASS software) for engineering of Piping Systems and related equipment including engineering consulting.

The program is under highly active permanent development and improvement, with priorities defined by the needs of existing and potential customers.

The worldwide distributors know very well the various capabilities of the software and are listening to customer requests.

THE AUTHOR

Amongst the numerous 1D piping tools present on the market, Vincent Soumoy was involved with 3 of them (some since 1994), in Europe and North America, and wrote the following papers.

He worked with Flowmaster from 1994 to 2008 and from 2015 to 2017, with Flownex from 2017 to 2020 and with Hydrosystem since 2019.

He is considering that for most of the requested uses, Hydrosystem is now offering the best quality/price ratio.

Fluids & C° is at your disposal for any question or dedicated quote.

The right 1D - CFD choice for your digital transformation
Vincent Soumoy (Fluids & Co)
CAE Conference – on line (2020)

Coupling 1D and 3D CFD Myth or Reality
Vincent Soumoy (Fluids & Co)
NAFEMS - World Congress in Quebec (2019)

Coupling 1D and 3D CFD The Challenges and Rewards of Co-Simulation
David Kelsall (Mentor) & Vincent Soumoy (EURO/CFD)
NAFEMS - Benchmark Magazine (2010) & EnginSoft Newsletter (2011)

Where systems simulation meets CFD
The introduction of 1D models in CFD computations
Vincent Soumoy (EURO/CFD)
NAFEMS - Benchmark Magazine (2009)

Validation des modélisations et flexibilité d'intégration :
deux dimensions incontournables pour les logiciels scientifiques.
Vincent Soumoy (Flowmaster)
Journée Nationale : logiciels pour la modélisation et le calcul scientifique – Paris (2006)

Flexibilité d'intégration et facilité de compréhension : deux nouvelles dimensions pour les logiciels scientifiques
Vincent Soumoy (Flowmaster), Gil Jouhanneau (EDF), Karine Huyge (The Mathworks)
Micad, Paris (2003)

Semt Pielstick successfully apply Flowmaster to ship engine internal and external flows
J.R. Magré, J.L. Bertholom (Semt Pielstick), V. Soumoy (Flowmaster)
Simouest Conference– Virtual Shipbuilding, the current state of affairs, Nantes (2002)

A link between CAD system and simulation tools will help shipbuilders to reduce their delay.
R. de Gongora (Sener), V. Soumoy (Flowmaster)
Simouest Conference– Virtual Shipbuilding, the current state of affairs, Nantes (2002)