



Hydraulic Calculation of Fire Sprinkler Systems Inside of Revit® MEP

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MP6446

This class shows how an extension to Revit software can calculate a fire sprinkler system inside of Revit MEP software. You will learn what additional parameters, such as minimum pressure and water density, you must set at the sprinkler to enable the performance of calculations. The structure of the network has no limits (gridded and looped), and we will show how to define the active area. You will learn how to optimize the network through changing diameters and changing a tree-typed network to a looped one. The calculation is done with the Hazen-Williams formula (or the Darcy-Weisbach formula) according to the rules of the National Fire Protection Association, FM Global, VdS, and others. The result is the minimum pressure and water flow at the pump. You will see how you can show the pressure loss, the water flow, and other elements in a graphic, colored form in Revit software. You can also print the result in a table form.

Learning Objectives

At the end of this class, you will be able to:

- Learn how to design a sprinkler network in Revit software
- Learn how to define necessary parameters for the hydraulic calculation
- Learn how to perform the hydraulic calculation of sprinkler networks
- Learn how to optimize the sprinkler network

About the Speaker

Reinhard is from Austria and studied computer science at the Technical University Vienna. He has been the general manager for the company IDAT (www.idat.de) since 1990. His technical know-how is in the precast industry.

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1. Introduction

What are the IDAT Sprinkler Tools for Revit?

The IDAT Sprinkler Tools are Extensions for Revit MEP to support the hydraulic calculation of sprinkler networks. With the tools the defined sprinkler network from Revit can be calculated. Tree and loop typed systems are supported. Despite the high accuracy of calculation the results are determined very fast due to the optimized calculation method. The calculation is governmentally accepted and according to NFPA FM, VdS and LPC.

The pressure loss is calculated according the Hazen-Williams-Formula. Optionally it can be calculated with the Darcy-Weisbach-Formula (e.g. for foam systems or High-Pressure-Water-Mist-Systems).

The results can be printed in tabular form and are also set to the pipes and sprinklers inside of Revit. With this it is possible to present and analyze the results graphically in Revit. For example the pressure loss or the water flow can be shown with different colors.

These tools are developed by the company IDAT (www.idat.de).

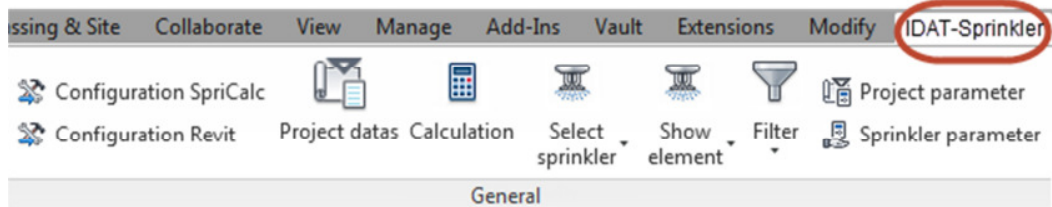
Who is IDAT?

IDAT is a German based company developing software for the Building Industry since 1981.

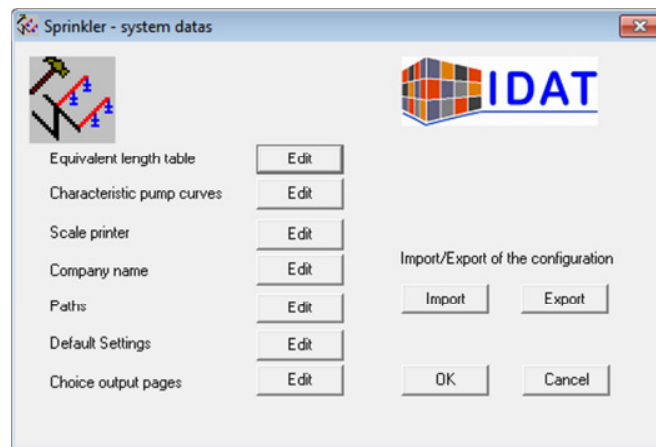
One of the products is a full developed software solution for the hydraulic calculation of sprinkler networks.

2. Configuration

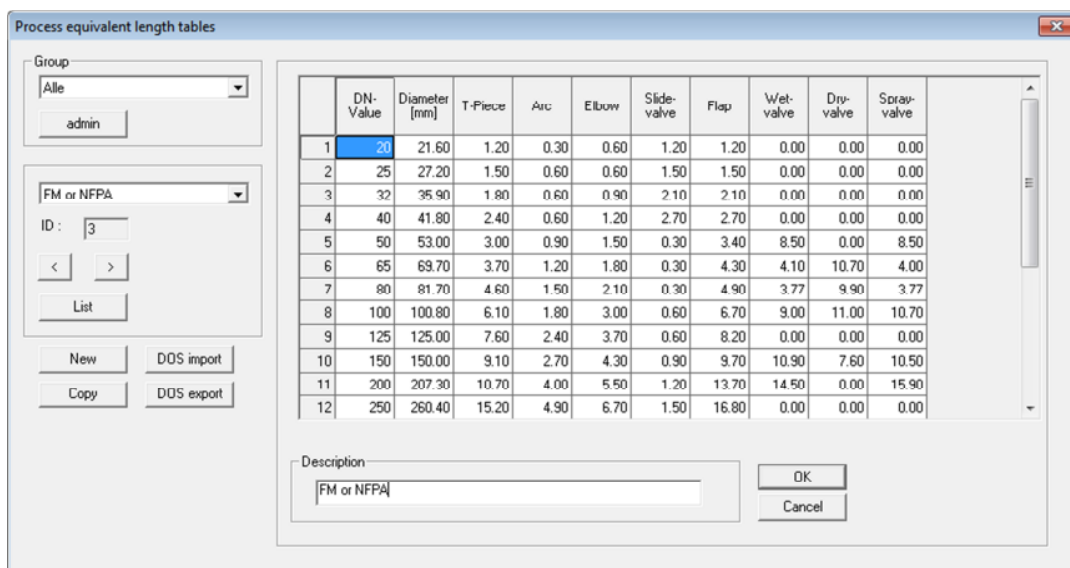
After the installation of the program you will get in Revit MEP the new tab “IDAT-Sprinkler”.



The first command “Configuration SpriCalc” opens an external program:



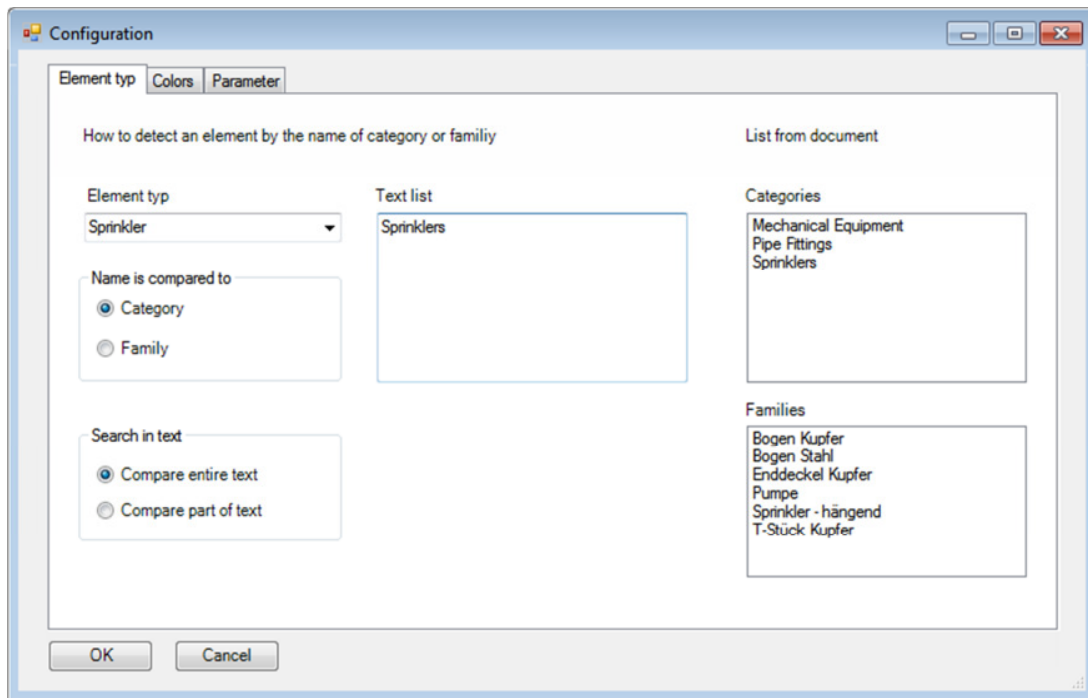
This program is to administrate different settings for the calculation program e.g. the equivalent length table.



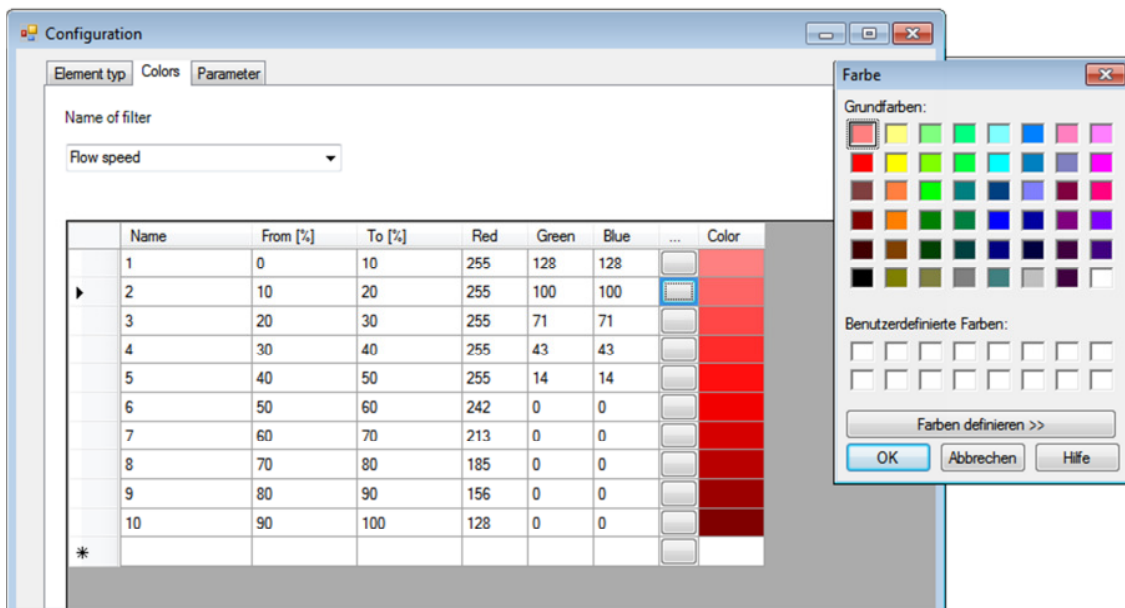
Hydraulic Calculation of Fire Sprinkler Systems Inside of Revit® MEP

The second command is for settings of the Revit part of the program.

On the first tab you can define how to detect elements. A sprinkler has the Category **Sprinklers**. So we are looking for the name of the category to detect a sprinkler.

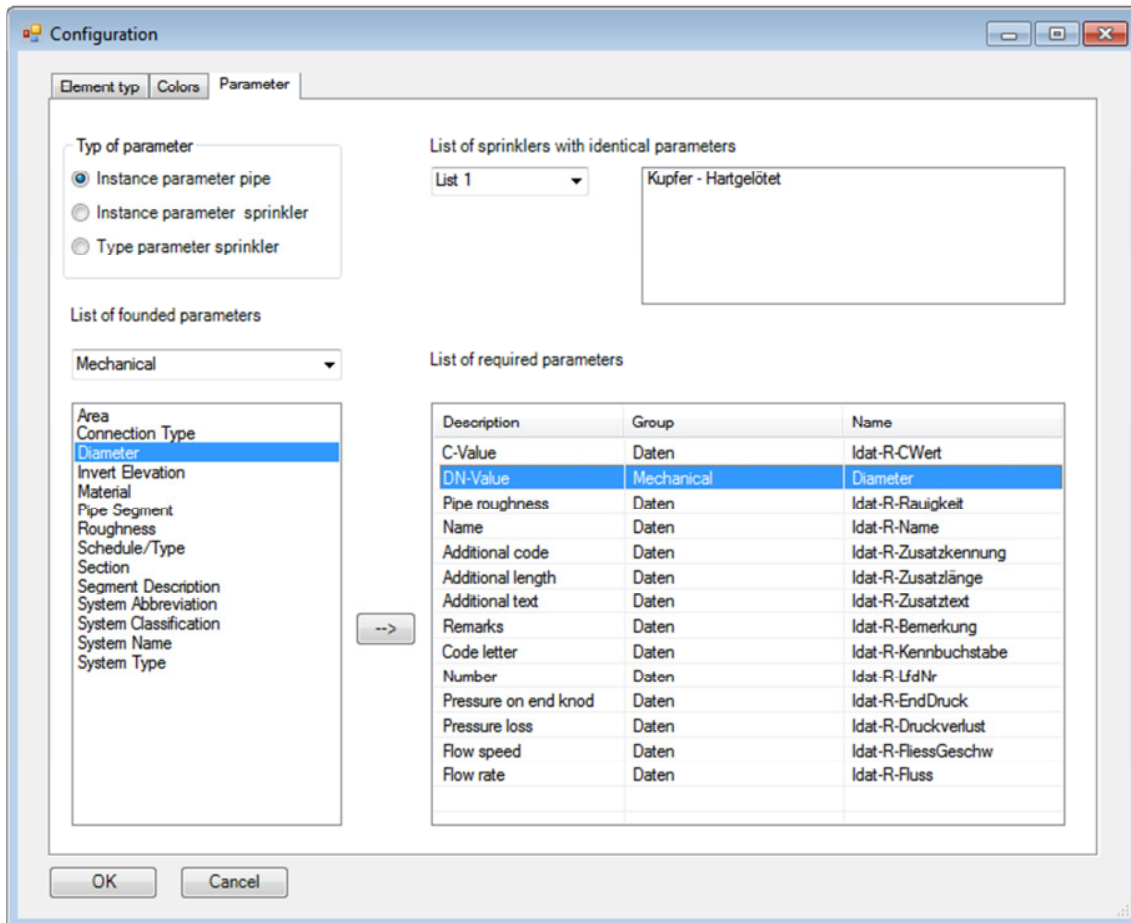


On the second tab we can set the colors for some filters. You here can e.g. define the colors for different flow speed in the pipe.



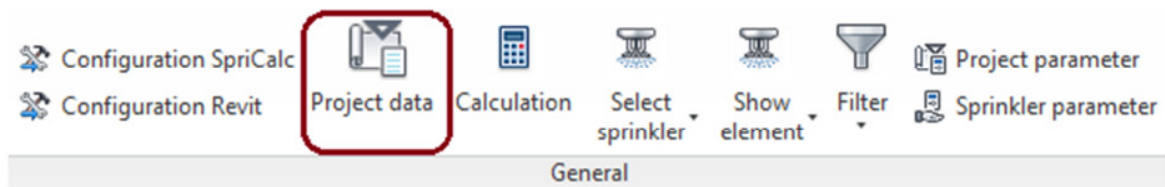
Hydraulic Calculation of Fire Sprinkler Systems Inside of Revit® MEP

On the third tab you see the used shared parameters of the IDAT system.



It is possible to define which parameter has to be used in the program. For example, the pipes need the Shared Parameter Idat-DN-Value. But instead of using this parameter you can link the **Diameter** from the group **Mechanical** to it.

3. Project data



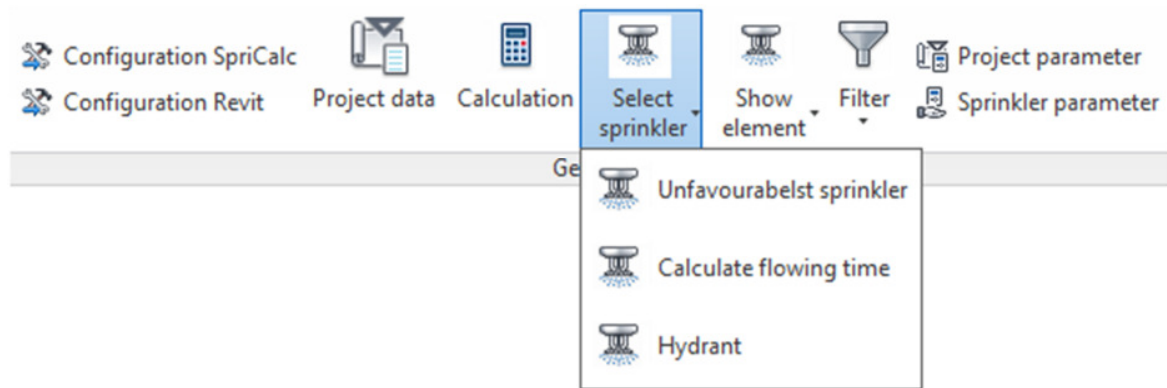
Here we describe the project in a dialog on three tabs. The most important tab is the third tab. We set here the kind of calculation and the active area.

The 'Project-specific data' dialog box is shown with the 'Project data' tab selected. The dialog contains several sections for configuring the project:

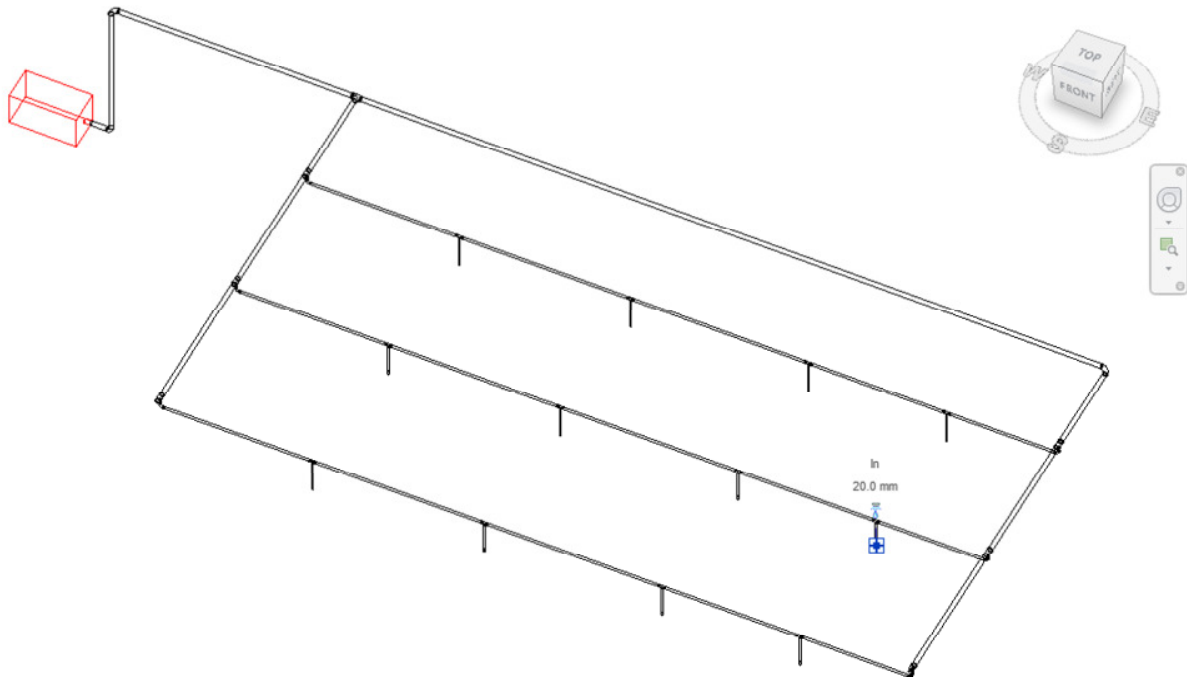
- Pipe diameter and equivalent lengths:** A dropdown menu is set to 'FM or NFPA'.
- Plant type:** Radio buttons for 'Wet system' (selected), 'Drying system', 'Quick drying system', 'Pilot-operated drying system', 'Tandem system', and 'Deluge system'.
- Mode of operation:** Radio buttons for 'Pressure reading at feed-in point' (with a pressure input of 10 bar), 'Specification of the least favourable sprinkler' (with a mark of 1604), and 'Calculation of least favourable sprinkler' (selected).
- Flowing time calculation:** A checked checkbox for 'Calculation' and a 'Mark of sprinkler' input field set to 1594.
- Darcy-Weisbach:** A checkbox for 'Calculation acc. to Darcy-Weisbach' (unchecked), and input fields for 'Density of fluid [kg/m³]' and 'Viscosity [mm²/s]' both set to 0.
- Active area:** Radio buttons for 'most favourable' (selected) and 'least favourable'. An 'Active area' input field is set to 2. A note below states '0 = Total pipe net'.

At the bottom of the dialog are 'OK' and 'Abbrechen' buttons.

4. Select sprinklers



In the dialog of the previous chapter we can see the most unfavorable sprinkler at the mark 1604 and on the right side the sprinkler for flowing time calculation with the mark 1594. To set these mark numbers we can select sprinkler in Revit and then call the commands above.



Now we can start the calculation.

5. Calculation

The calculation can be done according the Hazen-Williams or the Darcy-Weisbach-Formula. You can choose this in the project data.

Conditions for the Hazen-Williams-Formula:

Only water with max. 3 % foam

The max. pressure is less than 20 bar

$$\Delta p = 6,05 * 105 * Q^{1,85} * C^{-1,85} * d^{-4,85} * l$$

Δp = pressure loss in bar

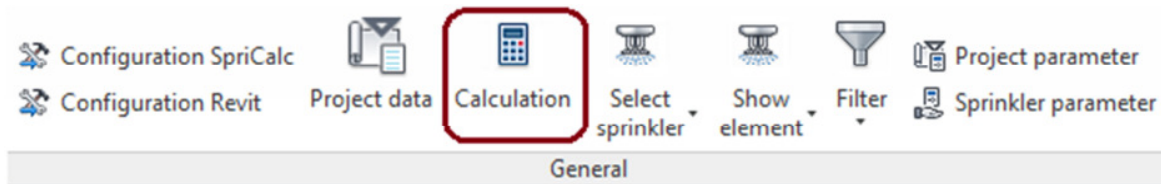
Q = water flow in l/min

C = C-Value

d = inner diameter of the pipe in mm

l = length of the pipe in m

If the mentioned conditions are not fulfilled, the pressure loss must be calculated by the **Darcy-Weisbach-Formula**.



If we start the calculation we get some result forms we can print. The head form shows the project data and the main results.

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SPRINK.DAT - SprCalc

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Butler: DAT - GmbH Phorstraße 10 D-64293 Darmstadt Operator:		Mode of operation: <input checked="" type="checkbox"/> wet system <input type="checkbox"/> dry system <input type="checkbox"/> fast dry system <input type="checkbox"/> prior driven dry system <input type="checkbox"/> tandem system Roughness of pipe (C-value) 120		BG: Effective area: <input checked="" type="checkbox"/> favourable <input type="checkbox"/> least favourable Demand: <input checked="" type="checkbox"/> pressure at sprinkler <input type="checkbox"/> pump pressure Use of pipes according to DIN	
Project-No.: 0815 / abc	Operating company:	Supply of hydrants with water:		Item at node No. Strangrohr-No. : 0 ; Sprinkler-No. : 0	
Person in charge:		Height of storage (m)	Ceiling protec.	Rack protec.	
Date:		min. water admission (m³/min)			
Object:		real effective area (ea) (m²)			
		max. protection area/sprinkler in ea (m²)			
		No. of sprinklers / effective area			
		No. of additional sprinkler / effective area			
		hydraulic considered no. of sprinkler			
		no. of protected decks			
		biggest distance of sprinkler (m)			

Demand press required / Supply press available / cushion	[bar]	1.829	9.495	7.666	according Hazen-Williams
Water rate at point to feed in / Pump	[l/min]	741.56	1989.73		
hydraulic unfavourable/sprinkler in the effective area					
Sprinkler No.		1602 - S2			
minimum pressure / Required density	[bar]	0.563	60,000		
geodetic difference in height sprinkler - point to feed	[m]	2.51			
geodetic difference in height lowest sprinkler - point to feed	[m]	2.51			
max. pressure of sprinkler in the effective area	[bar]	0.651			
min. pressure of sprinkler in the effective area	[bar]	0.563			
max. water speed in the effective area	[m/s]	5.60			
No. of sprinklers in the effective area		12			

NUM

Some other forms show the results for pipes and sprinklers according to NFPA or VdS.

SPRINK.DAT - SprCalc

Print Options View ?

Calculation of pressure loss Name of project : 0815 / abc No. of protection area : 2 Date : Page : 1

Pipe No.	Begin	Flow	K-Factor	Fitting Type	Length	C-Factor	Pressure
	End	[l/min]	Diameter		FTG	FR-Loss	[bar]
49	43	q =	K =		L = 0.51	C = 120.00	Pt = 0.809
		Q =	F =		F =	Pe = -0.25	Pf = -0.2462
221	41	Vel = 0.00	D = 25	TL = 0.51		Δp = -0.0000	Pt = 0.563
48	42	q =	K =		L = 0.51	C = 120.00	Pt = 0.826
		Q =	F =		F =	Pe = -0.25	Pf = -0.2462
234	37	Vel = 0.00	D = 25	TL = 0.51		Δp = -0.0000	Pt = 0.580
47	41	q =	K =		L = 2.65	C = 120.00	Pt = 0.563
		Q = 72.3	F =		F =	Pe =	Pf = 0.0168
235	37	Vel = 1.19	D = 32	TL = 2.65		Δp = 0.0063	Pt = 0.580
46	47	q = 60.0	K = 80.00		L =	C = 120.00	Pt = 0.563
		Q = 60.0	F =		F =	Pe =	Pf =
1602 - S2	41	Vel =	D = 20	TL =		Δp =	Pt = 0.563
45	41	q =	K =		L = 2.06	C = 120.00	Pt = 0.563
		Q = -12.3	F =		F =	Pe =	Pf = -0.0005
222	34	Vel = 0.20	D = 32	TL = 2.06		Δp = -0.0002	Pt = 0.563
44	40	q =	K =		L = 0.51	C = 120.00	Pt = 0.809
		Q =	F =		F =	Pe = -0.25	Pf = -0.2462
228	34	Vel = 0.00	D = 25	TL = 0.51		Δp = -0.0000	Pt = 0.563
43	39	q =	K =		L = 0.51	C = 120.00	Pt = 0.815
		Q =	F =		F =	Pe = -0.25	Pf = -0.2462
201	31	Vel = 0.00	D = 25	TL = 0.51		Δp = -0.0000	Pt = 0.568

NUM

The results are also written to the pipes and sprinkler in the Revit model. They will be set in the shared parameters of pipes and sprinklers.

6. Shared parameters

For pipes there are only Instance parameters.

Data		⌆
Idat-R-DNValue	50	
Idat-R-CValue	120	
Idat-R-Roughness		
Idat-R-Name		
Idat-R-IDLetter		
Idat-R-No		
Idat-R-Add Length		
Idat-R-Add Text		
Idat-R-Add code		
Idat-R-Remark		
Idat-R-EndPress	74070.00 Pa	
Idat-R-Loss of pressure	7530.00 Pa	
Idat-R-Flow speed	3.08 m/s	
Idat-R-Flow	730.10 L/s	

For sprinklers the are Instance parameters

Data		⌆
Idat-S-MinPressure	50000.00 Pa	
Idat-S-Area	6.000 m ²	
Idat-S-Flow rate	0.00 L/s	
Idat-S-Water admission	10.000000	
Idat-S-Remark		
Idat-S-ActiveArea	1	
Idat-S-Add Text		
Idat-S-Add Length		

Sprinklers have also type parameters

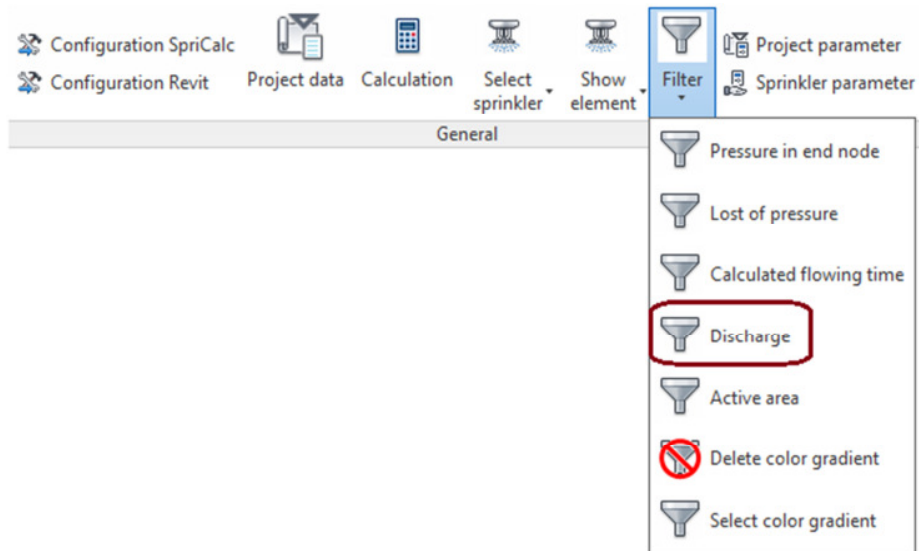
The screenshot shows the 'Type Properties' dialog box for a 'Sprinkler - Pendant' family. The 'Type' is set to '15 mm Pendant'. Below the dropdowns are buttons for 'Load...', 'Duplicate...', and 'Rename...'. The 'Type Parameters' section contains a table with the following parameters and values:

Parameter	Value
Assembly Description	
Type Mark	
Cost	
OmniClass Number	23.65.70.17.11.24
OmniClass Title	Fire Fighting Sprinkler Heads
Fire Protection	
Data	
Idat-S-Name	S1
Idat-S-Lechler nozzle	<input type="checkbox"/>
Idat-S-DNValue	20.0 mm
Idat-S-KFactor	80.000000

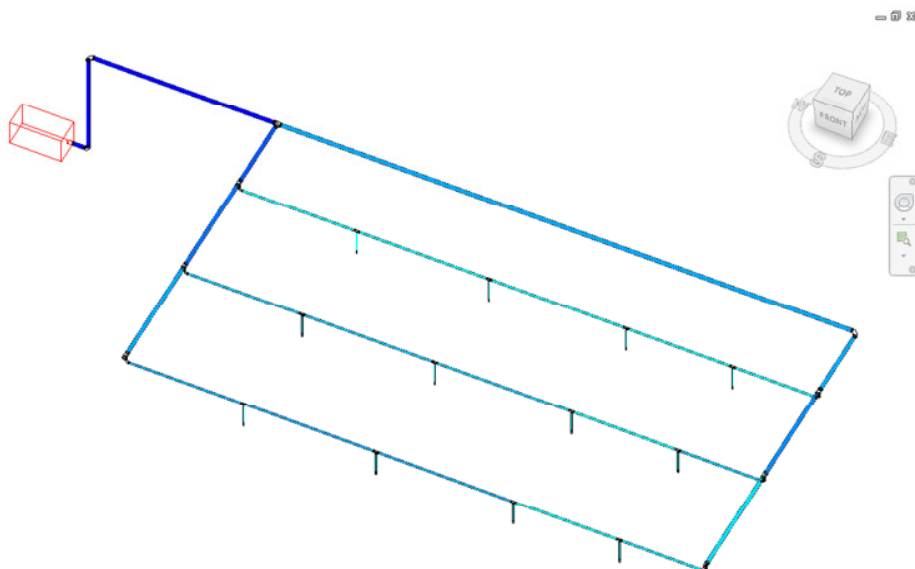
At the bottom of the dialog are buttons for '<< Preview', 'OK', 'Cancel', and 'Apply'.

The data for the last four parameters of the pipes are set by the calculation program.

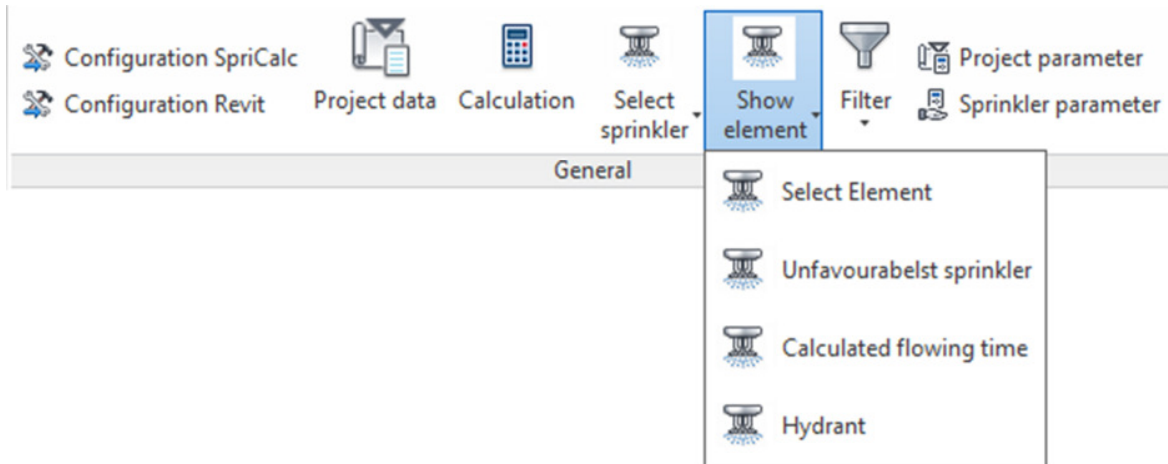
7. Show the results



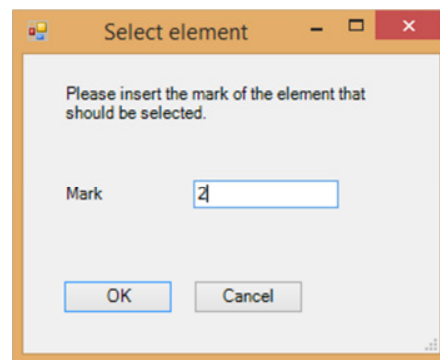
Now we can show different results of the calculation e.g. the discharge. In the configuration we had set colors to different levels of the discharge.



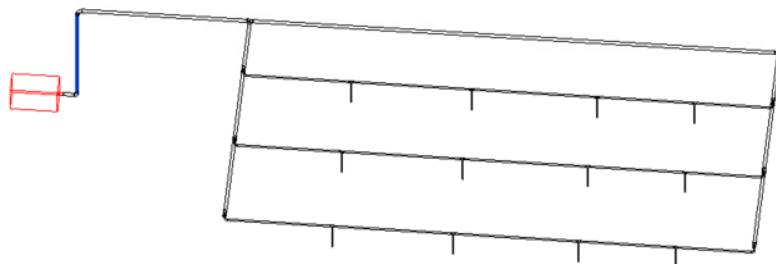
8. Show elements



If we see the results in the calculation program it is easy to find the according element in the Revit model. We just need to enter the mark number and the program selects the pipe or the sprinkler for us.

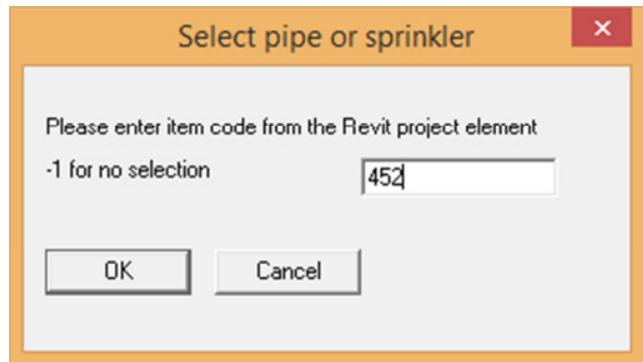
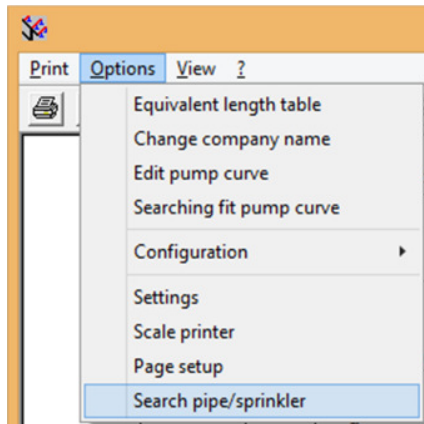


Relative Roughness	11216.535433
Dimensions	
Outside Diameter	63.5 mm
Inside Diameter	60.2 mm
Size	65 mm
Length	2245.3
Identity Data	
Common	
Mark	2
Phasing	
Phase Created	New Construction
Phase Demolished	None
Data	
Idat-R-DNValue	50
Idat-R-CValue	120
Idat-R-Roughness	
Idat-R-Name	
Idat-R-IDLetter	



Hydraulic Calculation of Fire Sprinkler Systems Inside of Revit® MEP

It is also possible to do this in the calculation program.



If we select an element by its mark from the Revit model, it will be selected in the form:

SPRINK.DAT - SprCalc

Print Options View ?

Calculation of pressure loss Name of projekt : 0815 No. of protection area : 0 Date : Page : 1

Pipe No.	Beg End	Flow [l/min]	K-Factor Fitting Type Diameter	Length FTG Total	C-Factor FR-Loss	Pressure [bar]
532	368	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
441	363	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
531	367	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
461	361	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
530	363	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 3,00 F = TL = 3,00	C = 120,00 Pe = Δp =	Pt = 1,013 Pf = Pt = 1,013
442	359	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
529	366	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
450	359	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
528	365	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
470	356	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
527	361	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 3,00 F = TL = 3,00	C = 120,00 Pe = Δp =	Pt = 1,013 Pf = Pt = 1,013
462	356	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
526	364	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
452	353	q = Q = 2117,0 Vel= 15,99	K = F = D = 50	L = 0,50 F = TL = 0,50	C = 120,00 Pe = -0,25 Δp = 0,4905	Pt = 1,013 Pf = Pt = 1,013
525	518	n =	K =	L =	C =	Pt =

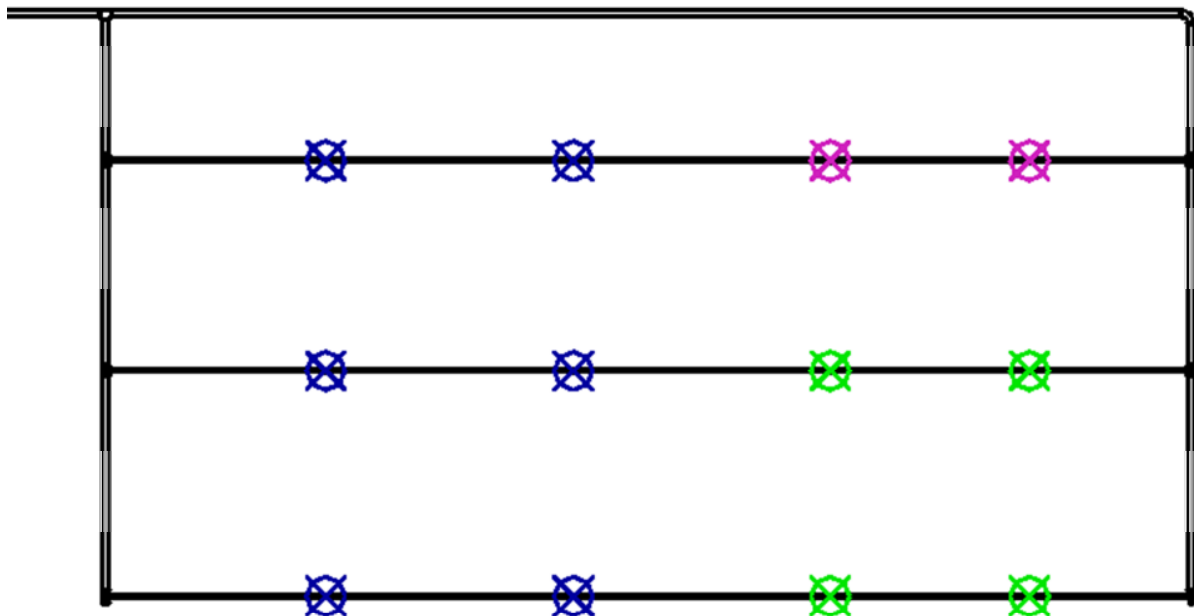
Zeile: 1 NUM

9. The active area

We can set different active (or operation) areas. That means every sprinkler will get an own value for his active area. In this example the active area is 2:

Data	
Idat-S-MinPressure	50000.00 Pa
Idat-S-Area	6.000 m ²
Idat-S-Flow rate	0.00 L/s
Idat-S-Water admission	10.000000
Idat-S-Remark	
Idat-S-ActiveArea	2
Idat-S-Add Text	
Idat-S-Add Length	

The green sprinklers belong to active area 2. So we have only 4 sprinklers in the calculation and not all 12.



Hydraulic Calculation of Fire Sprinkler Systems Inside of Revit® MEP

We have to set this value 2 in the dialog of project data.

Project-specific data

Project data Ceiling / Shelves protection Mode of operation

Pipe diameter and equivalent lengths
VDS nach DIN 2458

Plant type
☒ Wet system
☐ Drying system
 Viscosity [mm²/s]: 0

Active area
 Active area
 2
 0 = Total pipe net
☒ most favourable
☐ least favourable

OK Cancel

If we start now the calculation we can see the results.

SPRINK.DAT - SpriCalc

Print Options View ?

biggest distance of sprinkler (m)

Demand press required / Supply press available / cushion	[bar]	0,900	9,532	0,546
Water rate at point to feed in / Pump	[l/min]	240,63	870,76	
hydraulic unfavourablest sprinkler in the effective area				
Sprinkler-No.		1604 - 32		
minimum pressure / Required density	[bar]	0,563	60,000	
geodetic difference in height sprinkler - point to feed	[m]	2,51		
geodetic difference in height lowest sprinkler - point to feed	[m]	2,51		
max. pressure of sprinkler in the effective area	[bar]	0,568		
min. pressure of sprinkler in the effective area	[bar]	0,563		
max. water speed in the effective area	[m/s]	1,62		
No. of sprinklers in the effective area		4		

NUM

In the table we also find only 4 sprinklers.

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Calculation of pressure loss : Name of project :

Name	Beg.- node	End.- node	P _{beg}	K	Q _s
			[bar]		[l]
221	43	41	0.809		
234	42	37	0.826		
233	41	37	0.563		
1602 - S2	47	41	0.563	80.00	
222	41	34	0.563		
228	40	34	0.809		
201	39	31	0.815		
238	38	29	0.842		
239	37	29	0.580		
214	36	25	0.831		
215	31	25	0.568		
300	35	23	0.823		
1604 - S2	46	34	0.563	80.00	
280	34	33	0.563		
545	33	23	0.815		
208	32	22	0.814		
1592 - S2	45	31	0.568	80.00	
202	31	22	0.568		
181	30	20	0.881		
522	29	28	0.596		
523	28	18	0.860		
369	27	18	0.877		
218	26	17	0.846		
219	25	17	0.584		
195	20	14	0.634		
194	24	14	0.882		
546	23	13	0.560		
1594 - S2	44	22	0.568	80.00	
200	22	21	0.568		
547	21	13	0.821		

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Calculation of pressure loss : Name of project :

Name	Beg.- node	End.- node	P _{beg}	K	Q _s
			[bar]		[l]
182	20	12	0.634		
188	19	12	0.880		
527	18	10	0.614		
525	17	16	0.600		
526	16	10	0.863		
198	15	9	0.884		
199	14	9	0.636		
599	13	7	0.566		
189	12	11	0.633		
598	11	7	0.878		
530	10	5	0.617		
528	9	8	0.637		
529	8	5	0.885		
548	7	6	0.614		
596	6	4	0.893		
481	5	4	0.624		
4	4	3	0.643		
2	3	2	0.944		
3	1	2	0.986		