Introduction to the program

Welcome to use Vexve valve sizing & selection program! This program is made to help selection of Vexve balancing valves and control valves in liquid flow. The Program calculates all suitable Vexve valve sizes, openings, noise values and cavitation risks for each designed situation, so that the best valve of each situation can be selected.

The program installation

The program can be used directly from Vexve CD-ROM or it can be copied to the hard-drive of PC. If the program is wanted to run from the hard-drive, all necessary files must be copied to the hard-drive. No installation program or rebooting is needed. It is recommendable to make own directory, for example *C:\Vexve*, for the program.

Start the program

The program is started by double clicking the *Vexve.exe* icon. Pressing any button or waiting for a few seconds closes the beginning frame.

Basics of the program

Main menu consists of **File**, **Edit**, **View** and **Help** menus. To activate one of these menus, click the desired menu or press simultaneously the Alt-key and the underlined letter in the menu item, for example “Alt+F“ for the File menu.

Functions of the **File** menu work in a similar way as in other windows applications.

In the **Edit** menu there are **Add new valve** and **Remove valve** functions. Actual valve selection is made by function **Add new valve**. Selected valve can be removed by **Remove valve** function.

View menu functions **Toolbar** and **Status Bar** hide the bars and make the bars visible.

The **Help** menu contains information of Vexve Oy and this help.

Valve selection

Select **Add new valve** function from **Edit** menu and *Add new valve* dialog opens. By giving flow and pressure drop of valve, the program calculates all suitable valves by pressing **Calculate valve** button. Desired valve is selected by activating *valve size* by mouse and pressing **Add valve** button. You can select several valves to the project.
The dialog is closed by pressing the **Close** button.

Use the point (“.”) to the decimal place character!

The valve can be selected also when only the flow coefficient of the valve is known. The common used coefficient of capacity is the Kv value. Check *Use flow coefficient* and enter the Kv value. Flow coefficient can be calculated with following equation.

$$K_V = \frac{Q}{\sqrt{\Delta p}}$$

where K_V = flow coefficient
Q = volumetric flow rate [m^3/h]
Δp = pressure drop in valve [bar]

If the program doesn’t show any valves after calculation, pressure and temperature values are not in allowed range or even the biggest valve is too small for the purpose. Flow coefficient (Kv) of the biggest Vexve

balancing valve is 1840 at full opening. If you need a bigger valve you can connect several valves in parallel. The combined flow coefficient is now given with the following equation.

$Kv_C = Kv_1 + Kv_2...$

where Kv_C = combined flow coefficient of valves
Kv_1 = flow coefficient of valve 1
Kv_2 = flow coefficient of valve 2

Sometimes coefficient of the capacity is given by Cv value. In that case Kv value can be calculated with the following equation.

Kv = 0,865 • Cv

If noise and cavitation values need to be calculated *Noise/Cavitation* must be checked and *absolute input pressure* and *temperature* fields filled.

A normal pressure meter measure reference pressure of the pipe system.

Absolute pressure = Reference pressure + Air pressure of environment (about 1 bar)

Noise calculations are based on standard VDMA24422. Noise and cavitation tests are performed according to standards IEC534.

The smaller the cavitation value, the smaller the risk that the valve cavitates. It is very difficult to predict exactly when and how hard a valve cavitates because cavitation depends on many matters. Due to tests, probability of cavitation can be calculated. This probability is given by cavitation value.

Meaning of cavitation value:

0…0,99	No cavitation (No material damages. Low noise.)
1…1,4	Starting cavitation (A minor risk to material damages. Check noise value!)
1,4…2	Cavitation (There is a risk to material damages especially near 2. Valve is loud.)
2	Heavy cavitation (Material damages. Don't select this valve!)

When all valves of the project are selected, close *Add new valve* dialog by pressing **Close** button. All selected valves are added to the list.

Removing valves from the list

Activate desired valve of the list by clicking the valve. Select **Remove valve** from the **Edit** menu.

Notes in the list

A note is added in a certain valve line by double-clicking the desired valve. The note can be written to the text field in the opening dialog.

Save and print

Save and print functions are found from **File** menu and they work in a similar way as in other Windows programs. Saved project files are named **.vex*.

Correction factors

The values that the program has calculated are exact when
- density of fluid is near 999kg/m^3
- flow is turbulent
- valve has the same size as the pipeline

If these conditions are not fullfilled, correction factors must be used in the calculations. The program does not calculate the correction factor, but the user of the program can calculate them. The correction factors can be calculated by the following formula.

Viscosity (non-turbulent flow)

Non-turbulent flow occurs usually with high viscosity fluids, for example oils, and with small valve sizes and low flow velocities. Non-turbulent flow reduces volumetric flow rate. If flow is non-turbulent we have to use correction factor $F_{R,}$ which takes into consideration the reduction of the flow. Intensity of turbulence can be calculated by attached equations.

$$\mathrm{Re}_{Ve} = \frac{\sqrt{Q \cdot \sqrt{\Delta p}}}{\nu}$$

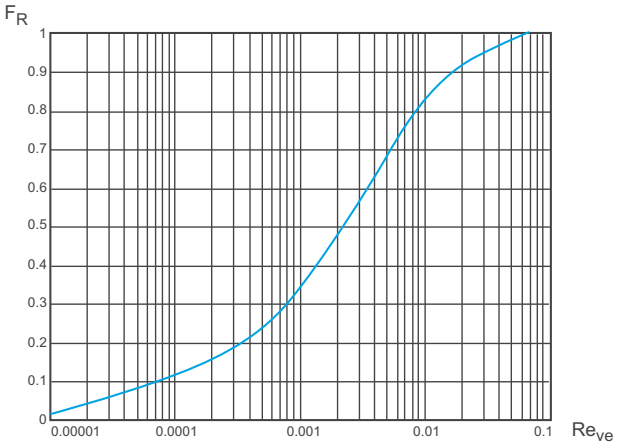
where Re_{Ve} = intensity of turbulence
Q = volumetric flow rate [m^3/h]
Δp = pressure drop in valve [bar]
ν = kinematic viscosity [cSt (centistoke = 10^{-6}m^2/s)]

If dynamic viscosity is known, kinematic viscosity can be calculated with the following equations.

$$\nu = \eta / \rho$$

where η = dynamic viscosity [Ns/m^2]
ρ = fluid density [kg/m^3]

The correction factor F_R can be estimated from the following picture.



When **F_R < 1**, the correct valve can be calculated by entering value $Q_E = Q/F_R$ to the *Flow* field of the *Add new valve* dialog (Q_E = volumetric flow rate, witch was entered to the flow field of the program).

For example:

Fluid is motor oil (47 ºC), **Q = 20 m^3/h and Δp = 10 kPa = 0,1 bar.** Kinematic viscosity of oil is 161 cSt.
Re_{Ve} = $(Q^{1/2} \cdot \Delta p^{1/4})/ = (20^{1/2} \cdot 10^{1/4})/161 = 0{,}0156$. Correct factor ($F_R$) is estimated from the picture, **F_R = 0,89**.
The flow entered to the program, is **$Q_E = Q/F_R = 20/0{,}89$ m^3/h = <u>22,5 m^3/h</u>**.

Normally when fluid media is water or liquid with almost same viscosity, there is no need to calculate correction factor of viscosity. Flow is almost always turbulent in these cases.

Fluid density

When density of liquid increases, volumetric flow through the valve decreases. If density differs from 999kg/m^3 a lot, you must use the correct factor of density. The correct factor can be calculated by the following equation.

$$F_\rho = \sqrt{\frac{\rho_0}{\rho}}$$

where
F_ρ = correct factor of density
ρ_0 = density of water at 15,6 ºC (999kg/m^3)
ρ = density of liquid [kg/m^3]

When **$F_\rho \neq 1$**, correct valve can be calculated by entering value $Q_E = Q/F_\rho$ to the *Flow* field of the *Add new valve* dialog.

For example:

Fluid is water (200 ºC) and **Q = 10 m^3/h**. Water density at 200 ºC is **863 kg/m^3**, **F_ρ = (999/863)$^{1/2}$ = 1,076**,
The flow entered to the program, is **$Q_E = Q/F_\rho$ = 10/1,076 m^3/h = 9,3 m^3/h**.

Piping geometry

If the valve is smaller dimension than the pipeline fittings inlet and outlet of the valve have to be used. The fittings create flow resistance. This resistance is taken into consideration by using the piping geometry factor. For the standard concentric reducers the piping geometry factor can be approximated with the following equation.

$$F_P = \frac{1}{\sqrt{1 + \frac{0{,}5 \cdot \left[1 - \left(\frac{d}{D_1}\right)^2\right]^2 + \left[1 - \left(\frac{d}{D_2}\right)^2\right]^2 - \left(\frac{d}{D_1}\right)^4 + \left(\frac{d}{D_2}\right)^4}{0{,}00160} \cdot \left(\frac{K_V}{d^2}\right)^2}}$$

where
F_P = piping geometry factor
d = extension pipe of valve diameter [mm]
D_1 = pipe inlet diameter [mm]
D_2 = pipe outlet diameter [mm]
K_V = valve flow coefficient

When **$F_P < 1$**, correct valve can be calculated by entering value $Q_E = Q/F_P$ to the *Flow* field of the *Add new valve* dialog.

For example:

Valve flow coefficient (Kv) is **30** and flow **10 m^3/h**. Pipelines are **DN80**, and you select by the program valve size **DN50**. You substitute following values to the above equation.
D = 50mm, D1 = 80 mm, D2 = 80 mm, K_V = 30

=> **F_P = 0,976**

The flow entered to the program, is **$Q_E = Q/F_P$ = 10/0,976 m^3/h = 10,25 m^3/h**.

As you see, effect of the fittings are normally very small, F_p factor is normally 0,9…1. If the valve is one size smaller than the pipeline there is no need to calculate the piping geometry factor.

In the case of several correction factors, the flow value to be entered, is calculated: **$Q_E = Q/(F_R \bullet F_\rho \bullet F_P)$**