SIZING OF HYDRAULIC AND DOMESTIC WATER SYSTEMS

Mixing valves and pressure reducing valves

CALEFFI Hydronic Solutions

DESIGN FLOW RATE CALCULATION CRITERIA

The main purpose of sizing a water mains is to ensure the correct delivery of hot or cold water at each point of use. In other words, each appliance must be able to provide the related nominal flow rates provided in any operating condition required by the users.
It is therefore necessary to adopt the calculation criteria for the estimate of the design flow rates.

Regulations for the distribution of domestic water

Both the European and the Italian regulations associate a nominal water flow rate value with each device with the aim of sizing the pipes of the water mains.
Furthermore they introduce a ***simultaneity factor,*** as the simultaneous delivery to all points of use is an unlikely situation. The design flow rate can not be considered as a simple sum of the nominal flow rates of the individual appliances but will have to be corrected with an appropriate simultaneity factor so as to avoid the provision of pipes with excessive diameters.

Sizing of components for hydraulic and domestic water systems

There are no specific standards or simultaneity criteria for ***sizing components for hydraulic and domestic water systems***, such as, in particular, pressure reducing valves and mixing valves. It is, however, recommended to consider a simultaneity factor, even for such devices in order to avoid over-sizing and to ensure operation in the best working range.
The choice of simultaneity factor, depends on various factors such as in particular the type of user, the number and the type of delivery points. Since the simultaneity criteria are founded on a probabilistic basis it is clear that there may be differences between the various methods and that these may be more or less accurate or more or less conservative, depending on the specific case.
The adoption of the simultaneity criterion thus remains a choice of the designer.

Design flow rate calculation

The total flow rate is obtained depending on the type of appliance and the unitary flow rate (with reference to EN 806).

$$G_{TOTAL} = n \cdot G_{SINK} + n \cdot G_{WASHBASIN} + \ldots$$

where n is the number of appliances for each type.

TYPE OF APPLIANCE	UNIT FLOW RATE
kitchen sink	12 l/min
washbasin	6 l/min
bidet	6 l/min
shower	12 l/min
bath	24 l/min
WC with cistern	6 l/min
washing machine	12 l/min
dishwasher	12 l/min

Knowing the value of the total flow rate, the design flow rate is obtained from the graphs or tables referred to in the regulation. The relationship between the design flow rate and the total flow rate defines the simultaneity factor, whose value generally depends on the total flow rate and the type of user.

$$G_{DESIGN} / G_{TOTAL} = F_{SIMULTANEITY}$$

PRESSURE REDUCING VALVE

Pressure reducing valves are devices which, when installed on a private plumbing system, reduce and stabilise the inlet pressure from the water mains. This inlet pressure, in general, is too high and variable for domestic systems to operate correctly.

SIZING

Design flow rate calculation

The first step for sizing a pressure reducing valve is the calculation of the design flow rate according to the steps previously expressed.

Velocity calculation

In order to avoid noise phenomena and rapid wear of the delivery appliances it is advisable that the flow rate velocity in the pipes does not exceed the limit value of 2 m/s. As known, the flow rate velocity value depends on the pass-through flow rate and on the pipe cross section according to the relation:

$$v = \frac{10^3 \cdot 4}{60 \cdot \pi} \cdot \frac{G_{DESIGN}}{DN^2}$$

where:

v	=	flow velocity	[m/s]
G_{DESIGN}	=	fluid flow rate	[l/min]
DN	=	nominal diameter	[mm]

A recommended flow rate velocity range, except for more or less restrictive product specifications, can be:

$$1\ m/s < v < 2\ m/s$$

Consequently the size of the pressure reducing valve will be selected so as to obtain a flow rate within the specified range.

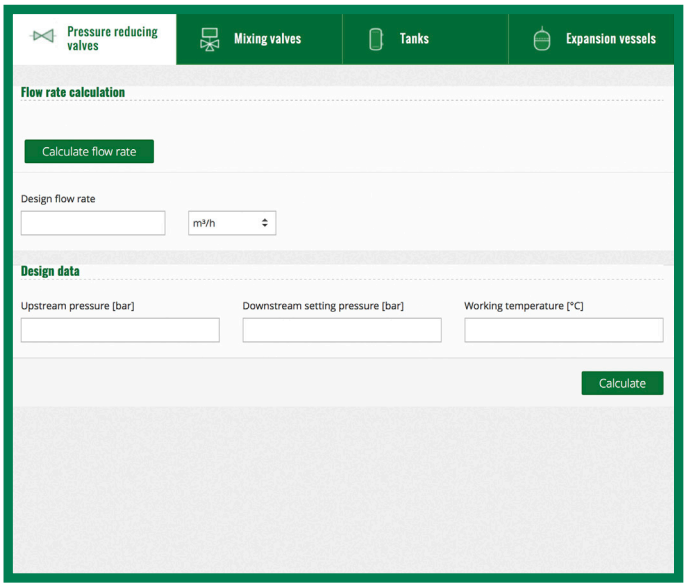
SIZING WITH SOFTWARE

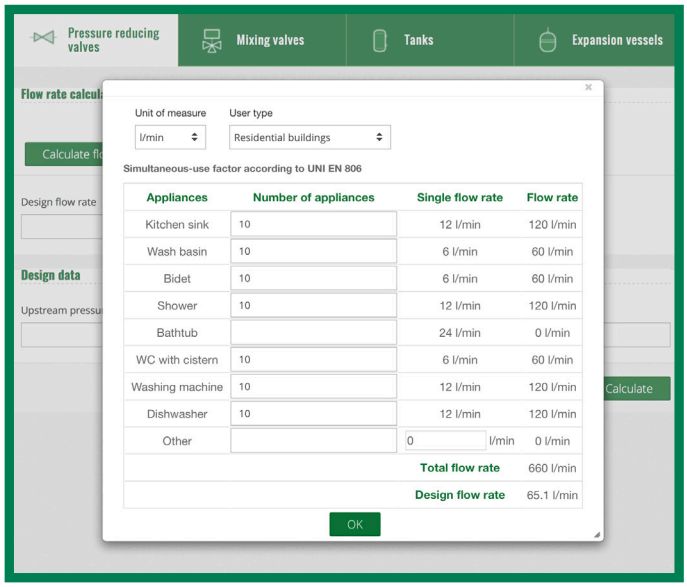
Sizing a pressure reducing valve for a building having 10 flats with single bathroom.

$P_{AVAILABLE}$ = 6 bar Pressure available from the mains

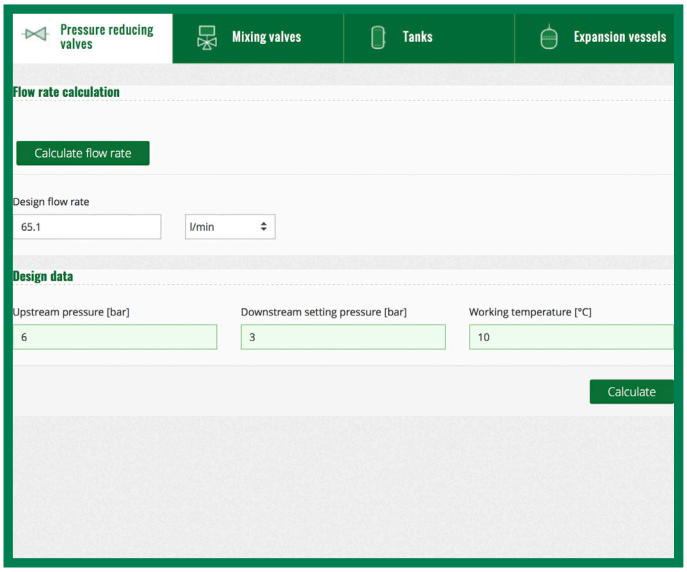
$P_{SETTING}$ = 3 bar Reducing valve setting pressure

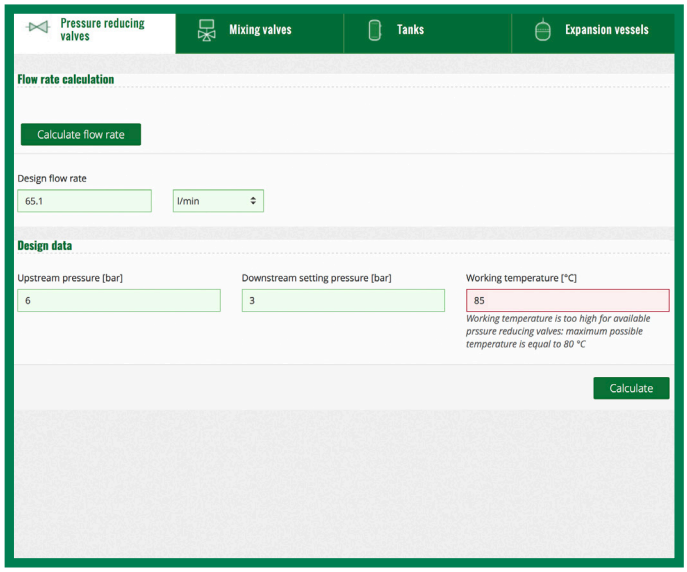
Depending on the type of appliance and the unitary flow rate (with reference to EN 806), through the software support it is possible to quickly obtain the total flow rate (G_{TOTAL}) and the design flow rate (G_{DESIGN}).



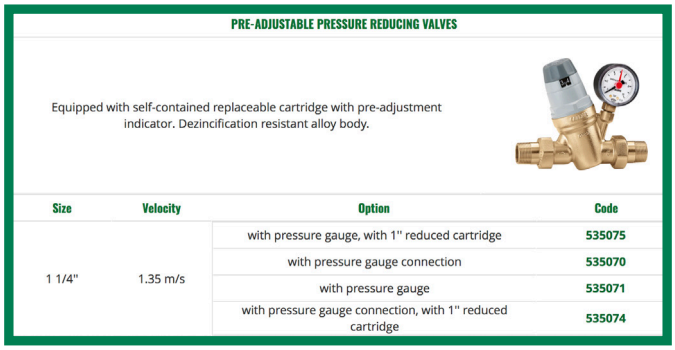


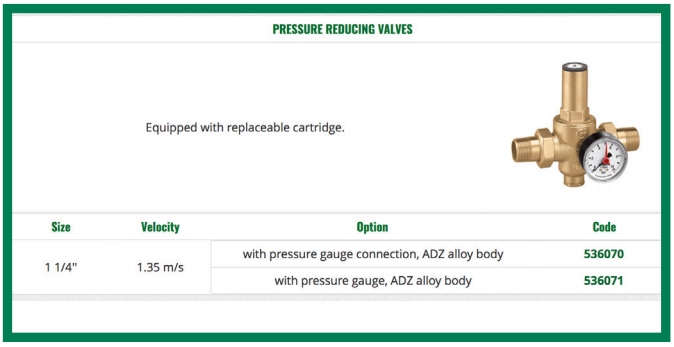
The operating conditions are checked automatically by the program inserting the available upstream pressure, the necessary downstream setting pressure and the design temperature.





The list of products suitable to the design conditions, divided by range, is displayed with a simple click.





MIXING VALVE

The mixing valve (thermostatic or electronic) is used in systems that produce domestic hot water. It is designed to maintain the preset temperature of the mixed water delivered to the user outlet, when there are variations in the temperature and pressure of the hot and cold water at the inlet, or in the drawn-off flow rate.

SIZING

The mixing valves must be sized correctly in order to ensure the accurate supply of mixed water at the required temperature and in safe conditions. In particular it is necessary to know:

- ***the maximum design flow rate*** that the device must ensure during the period of increased use of the system. This flow rate must be evaluated according to a simultaneity criterion according to the type of user and appliances installed.
- the ***head loss generated*** by the design flow rate in the component. This value must not be excessively high depending on the pressure available in the mains, and at the same time can not be too low as this would not allow the correct mixing between hot and cold water.

Design flow rate calculation

It is appropriate to distinguish between small single-family users and medium-sized applications.

For ***single-family users*** practical design flow rate values are proposed and not those derived from national or European standards, for the following reasons:

- the standards generally provide much higher values than those really applicable in small houses;
- the power of boilers for domestic use would not be able to ensure hot water flow rates higher than those indicated.

For ***medium and large-size users*** it is possible to refer to design flow rate values evaluated by the simultaneity criterion expressed in the standards.

These values are defined in the tables shown in the following paragraph.

Ideal kv calculation

It is necessary to make an assessment of the objective head loss $\Delta P_{OBJECTIVE}$, i.e. the head loss expendable from the mixing valve when switching to the design flow rate.
Even in this case the ideal value ranges are proposed within which to evaluate the objective head loss. In ***single-family users*** it should be between 3 and 7 m w.g. (however it is recommended to not go below 2 m w.g.); in ***medium and large-sized users*** it is preferable to be between 5 and 10 m w.g. and in any case not go below 2 m w.g..

SINGE-FAMILY USERS

DESIGN FLOW RATE OF 1 FLAT	
with 1 bathroom	12 l/min
with 2 bathrooms	15 l/min
with 3 bathrooms	18 l/min

SIZING HEAD LOSSES	
minimum	2 m w.g.
Objective	5 m w.g.
maximum	7 m w.g.

MEDIUM AND LARGE-SIZED USERS

DESIGN FLOW RATE
Evaluation through simultaneity criterion

SIZING HEAD LOSSES	
minimum	2 m w.g.
Objective	6 m w.g.
maximum	10 m w.g.

Knowing the design flow rate G_{DESIGN} and establishing the objective head loss $\Delta P_{OBJECTIVE}$ it is possible to calculate the Kv flow coefficient value which characterizes the ideal size of the mixing valve:

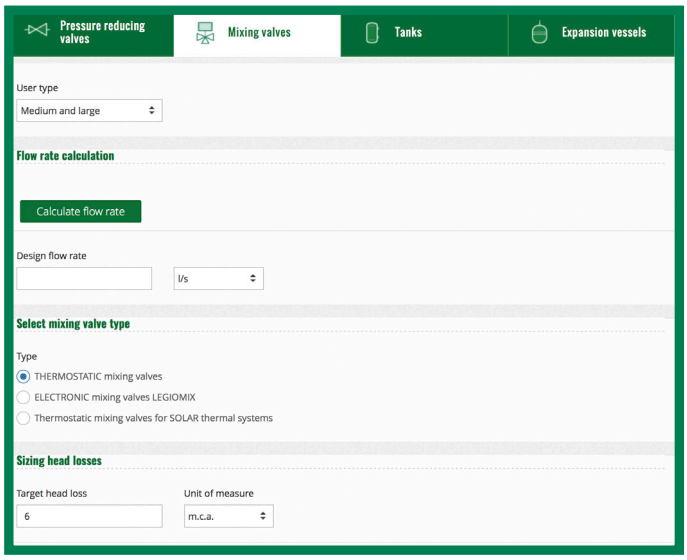
$$Kv_{IDEAL} = \frac{G_{DESIGN}}{\sqrt{DP_{OBJECTIVE}}}$$

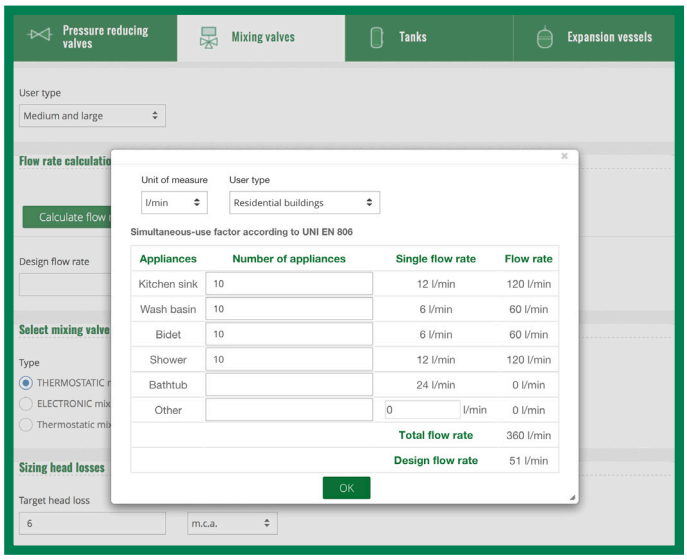
Among the commercially available Kv values, the ones closest to the ideal value calculated are chosen; of these it is verified that the actual head loss does not exceed the minimum or maximum limits indicated.

SIZING WITH SOFTWARE

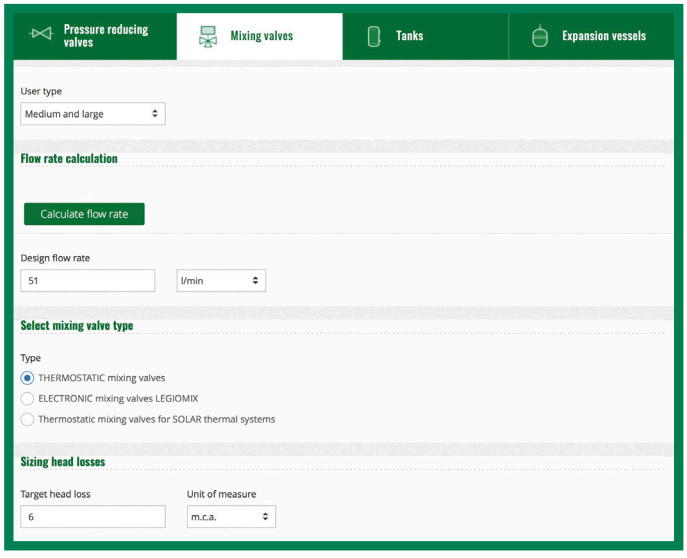
Sizing a thermostatic mixing valve for a centralized system serving 10 flats with single bathroom.

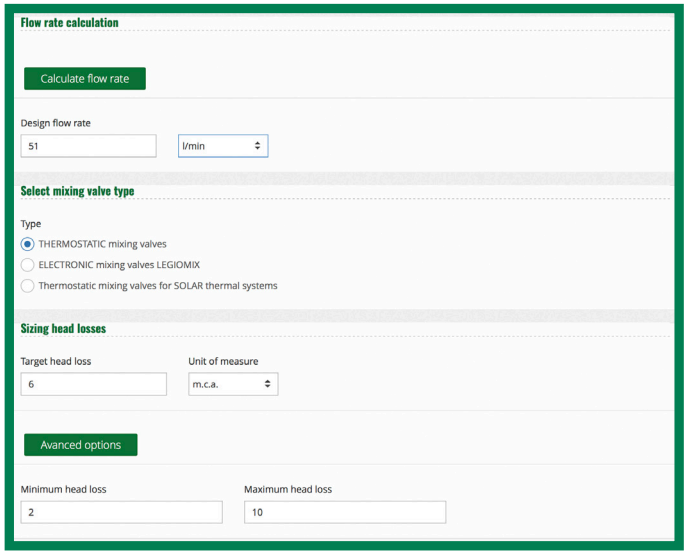
Depending on the type of appliance and the unitary flow rate (with reference to EN 806), through the software support it is possible to quickly obtain the total flow rate (G_{TOTAL}) and the design flow rate (G_{DESIGN}).





Furthermore adding the information regarding the type of mixing valve and the objective head loss of the mixing valve completes the data necessary for the sizing.
For a more specific choice it is also possible to enter in the advanced options the of minimum and maximum head loss that the mixing valve can have.





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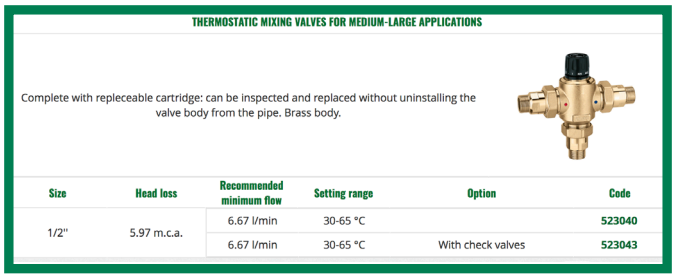

THERMOSTATIC MIXING VALVES FOR MEDIUM-LARGE APPLICATIONS

Complete with repleceable cartridge: can be inspected and replaced without uninstalling the valve body from the pipe. Brass body.

Size	Head loss	Recommended minimum flow	Setting range	Option	Code
1/2"	5.97 m.c.a.	6.67 l/min	30-65 °C		523040
		6.67 l/min	30-65 °C	With check valves	523043

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