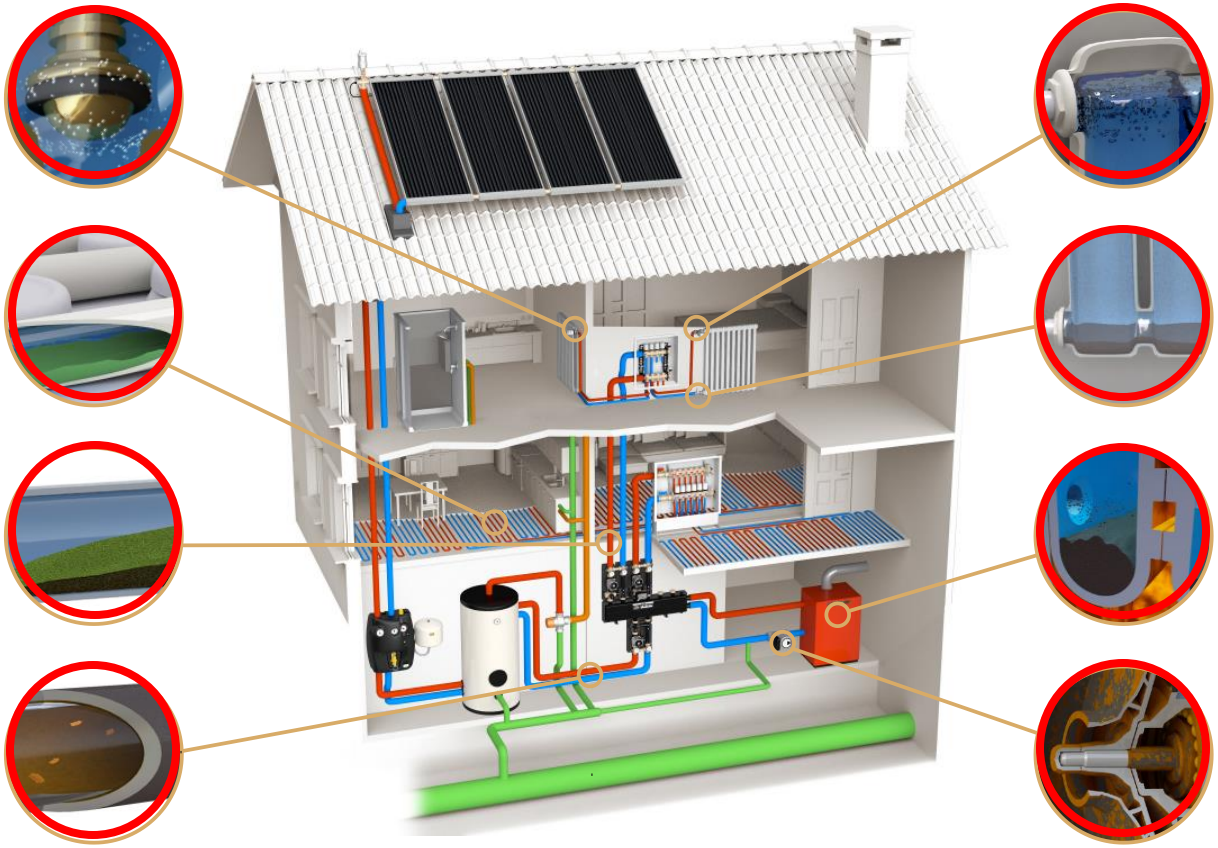
CALEFFI
Hydronic Solutions

Water treatment

AIR AND DIRT RELATED PROBLEMS



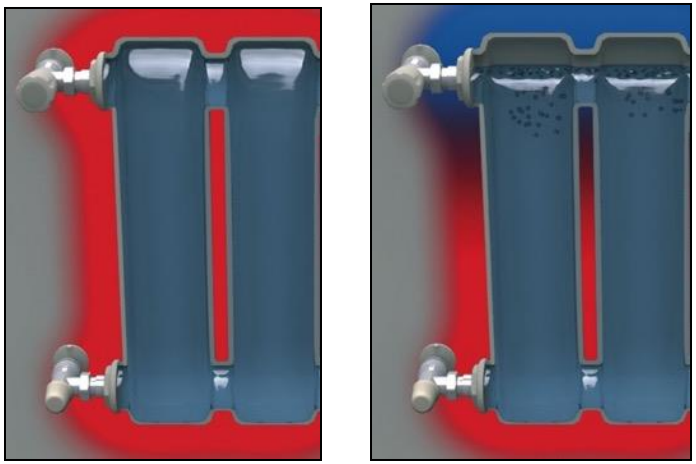
PRESENCE OF AIR

PRESENCE OF DIRT AND SLUDGE

CORROSION AND FOULING

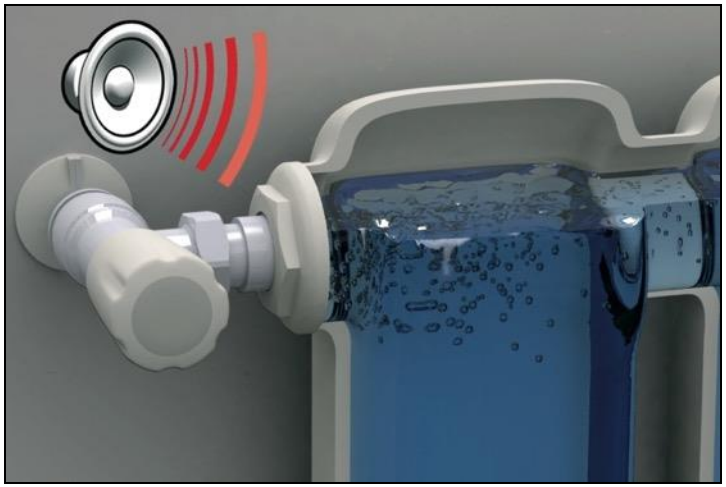
PRESENCE OF AIR
PROBLEMS

POOR HEAT TRANSFER FROM EMITTERS



CORROSION

NOISES IN THE EMITTERS AND PIPES

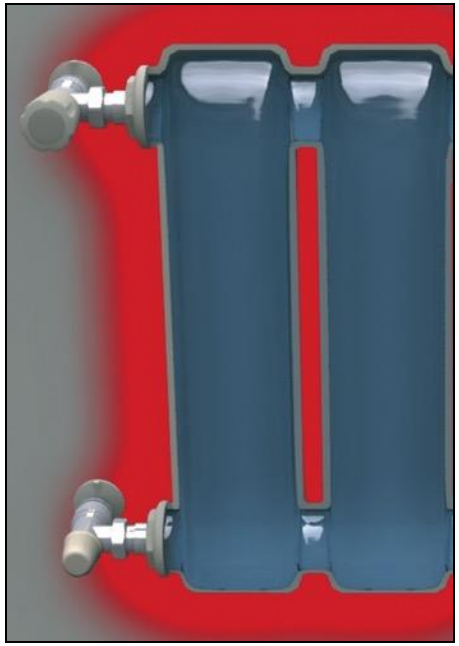


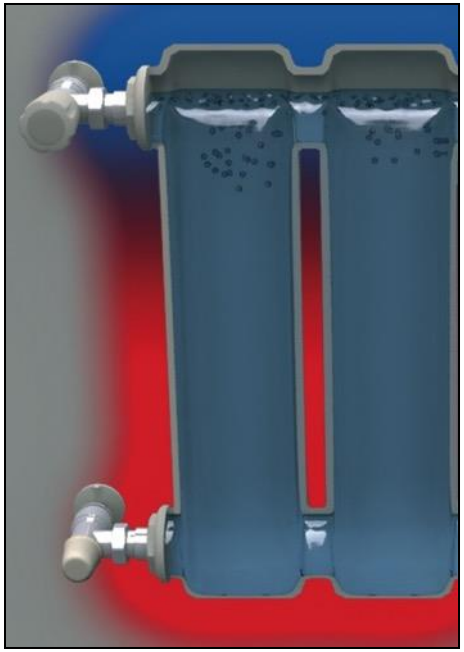
CAVITATION

PRESENCE OF AIR

Poor heat transfer by heat emitters

MUCH LOWER CONVECTIVE HEAT TRANSFER PROPERTIES





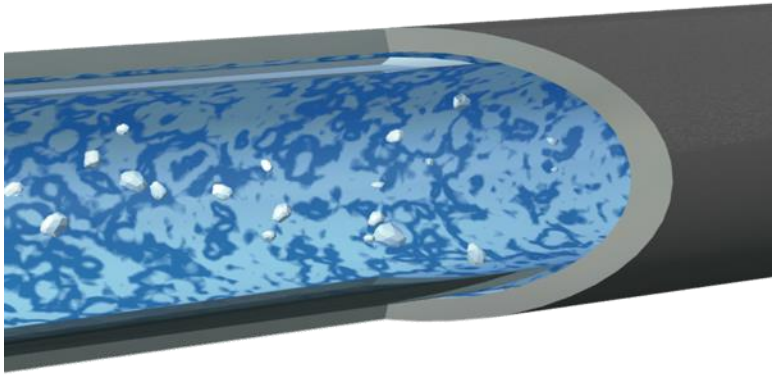
- SIGNIFICANT REDUCTION OF HEAT TRANSFER
- LOWER COMFORT LEVEL
- HIGHER OPERATING COSTS

PRESENCE OF AIR

Noises in piping and heat emitters

NOISE DUE TO AIR FLOW

- DURING NIGHT
- SYSTEM START-UP



NOISE IN SYSTEM COMPONENTS

- DUE TO MICRO-BUBBLE IN WATER FLOW
- RESULT: CAVITATION

PRESENCE OF AIR

Accelerated corrosion

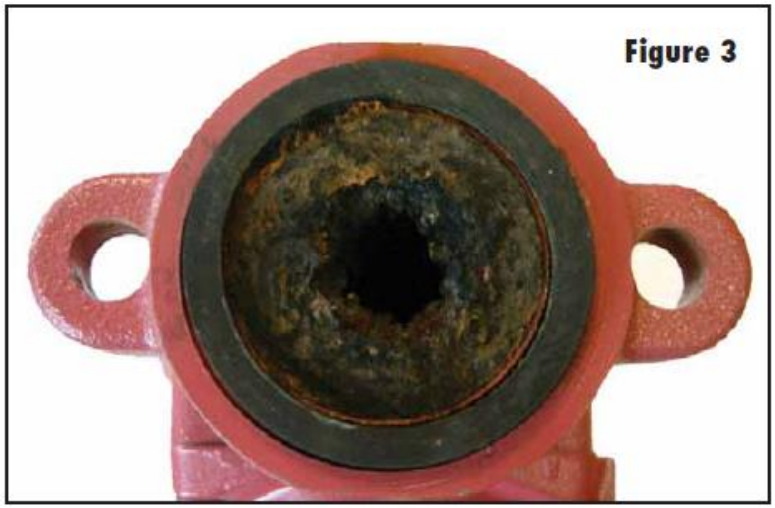
Air contains oxygen → Oxygen + Ferrous metals → **Corrosion**

$$O_2 + 2Fe + 2H_20 \rightarrow 2Fe(OH)_2$$

Iron Hydroxide $Fe(OH)_2$

$$3Fe(OH)_2 \rightarrow Fe_3O_4 + H_2 + 2H_20$$

The compound Fe_3O_4 is called **magnetite**, and appears as a dark gray sludge within the system.



PRESENCE OF AIR

Gaseous cavitation

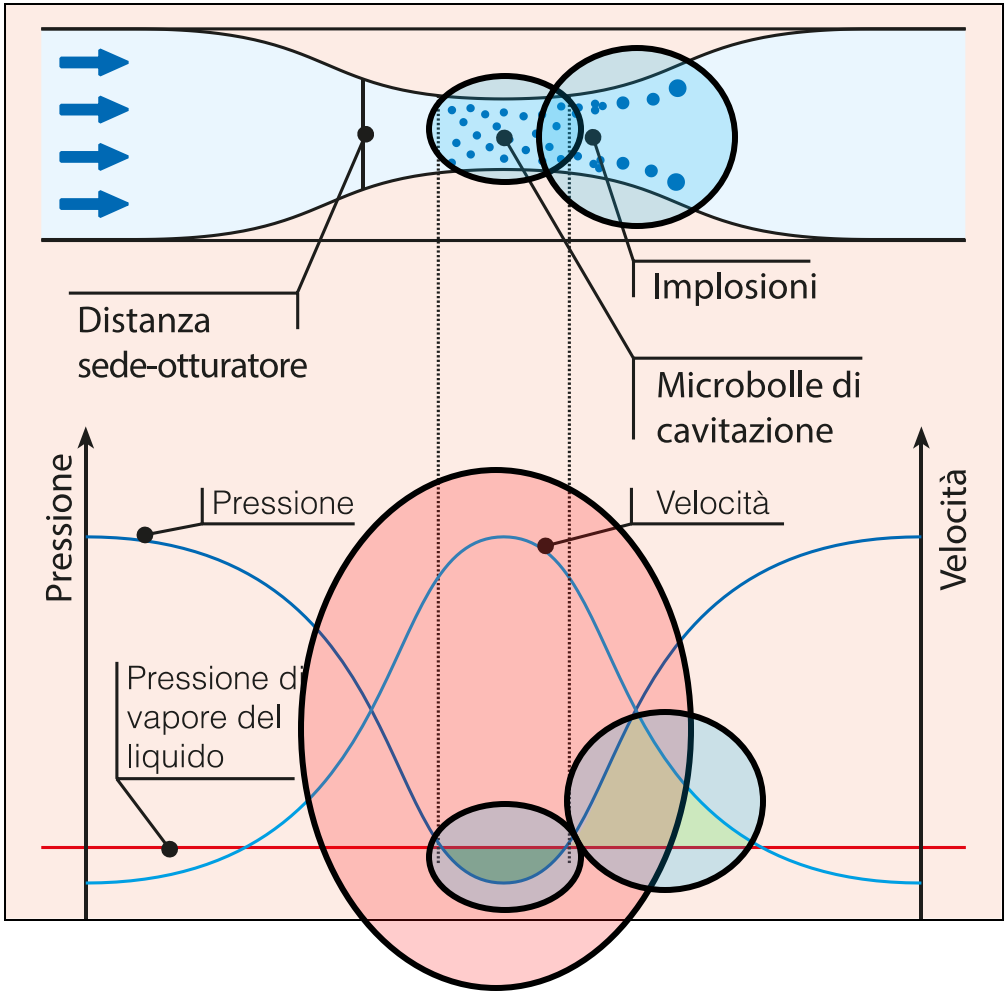
1) RAPID CHANGES OF PRESSURE AND VELOCITY

2) AREA (CAVITY) WITH VERY LOW PRESSURE (HIGH VELOCITY)

3) LIQUID → VAPOUR

4) RAPID INCREASE OF PRESSURE

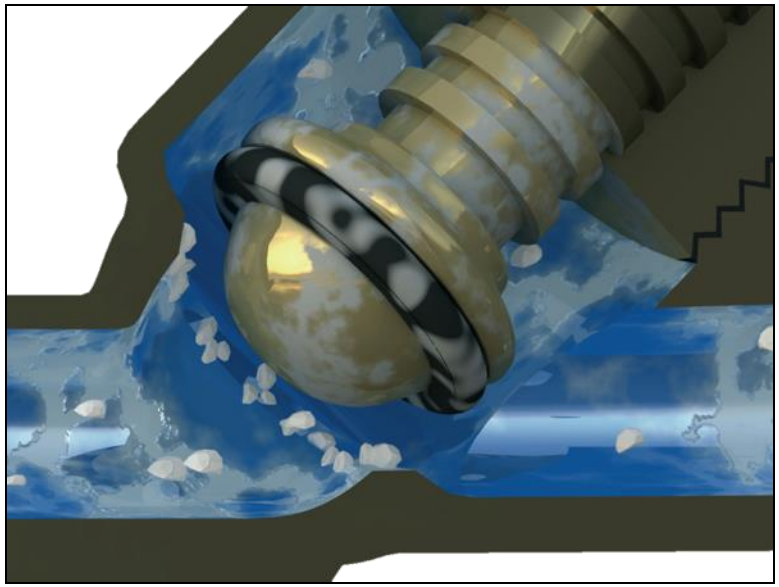
5) **VAPOUR CAVITY IMPLOSION**



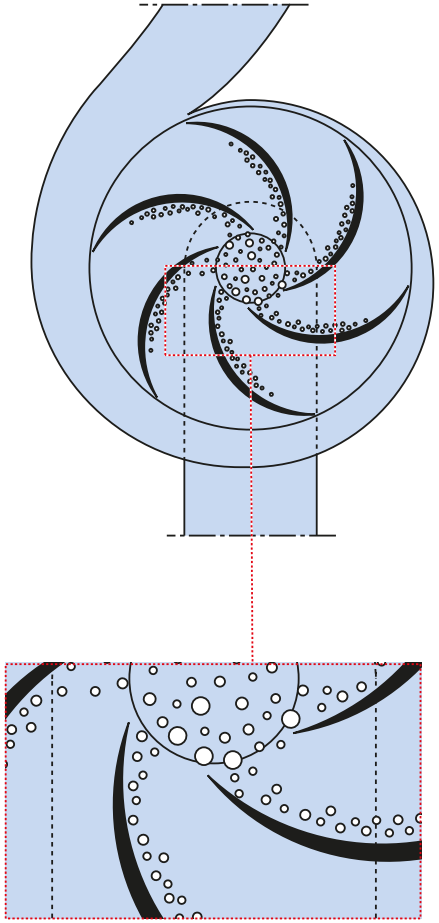
PRESENCE OF AIR

Gaseous cavitation

OBTURATOR



CIRCULATOR



PRESENCE OF AIR

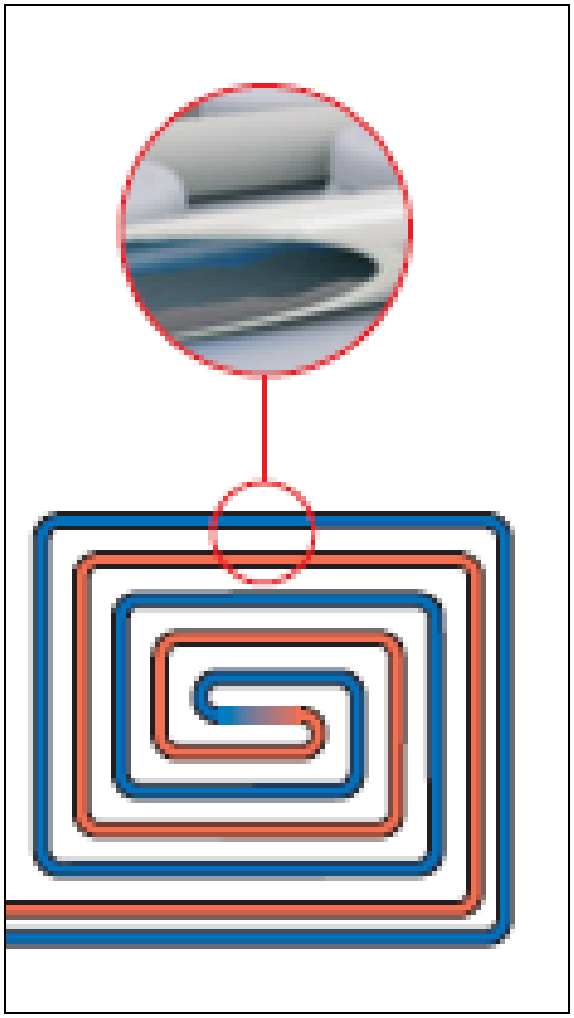
Circulation flow problems

INADEQUATE FLOW

- LOWER FLOW RATE THAN DESIGN ONE (WATER+AIR)
- LOWER ENERGY TRANSFER
- LOW COMFORT CONDITIONS

COMPLETE LOSS OF FLOW

- UNDERFLOOR HEATING SYSTEMS
- DUE TO AIR BUBBLE



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Hydronic Solutions

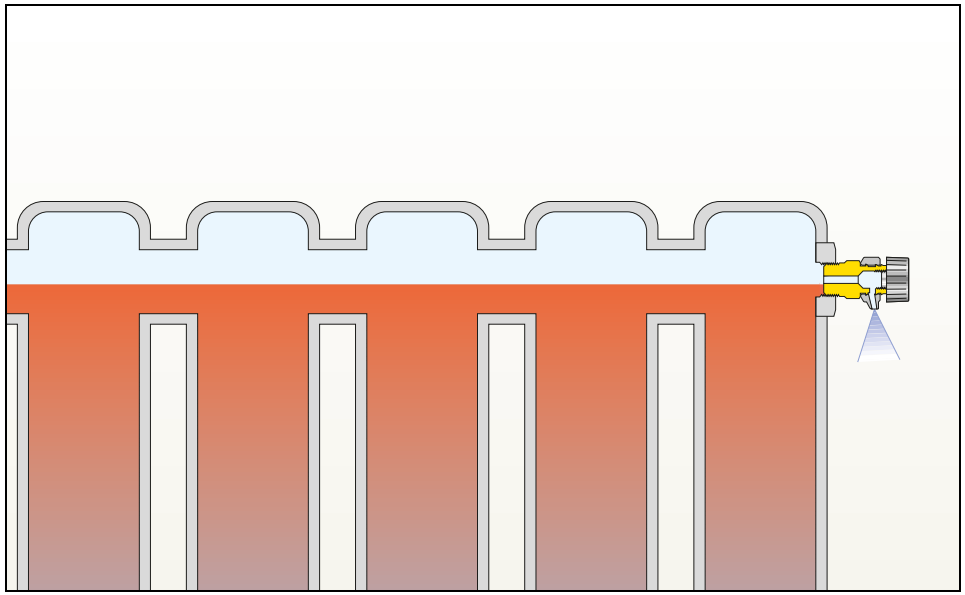
Air separators

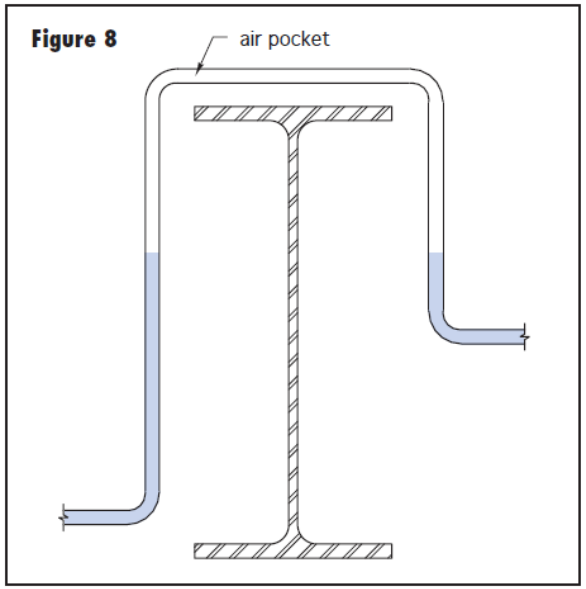
PRESENCE OF AIR

SITUATION 1

AIR NOT EXPELLED DURING SYSTEM FILLING

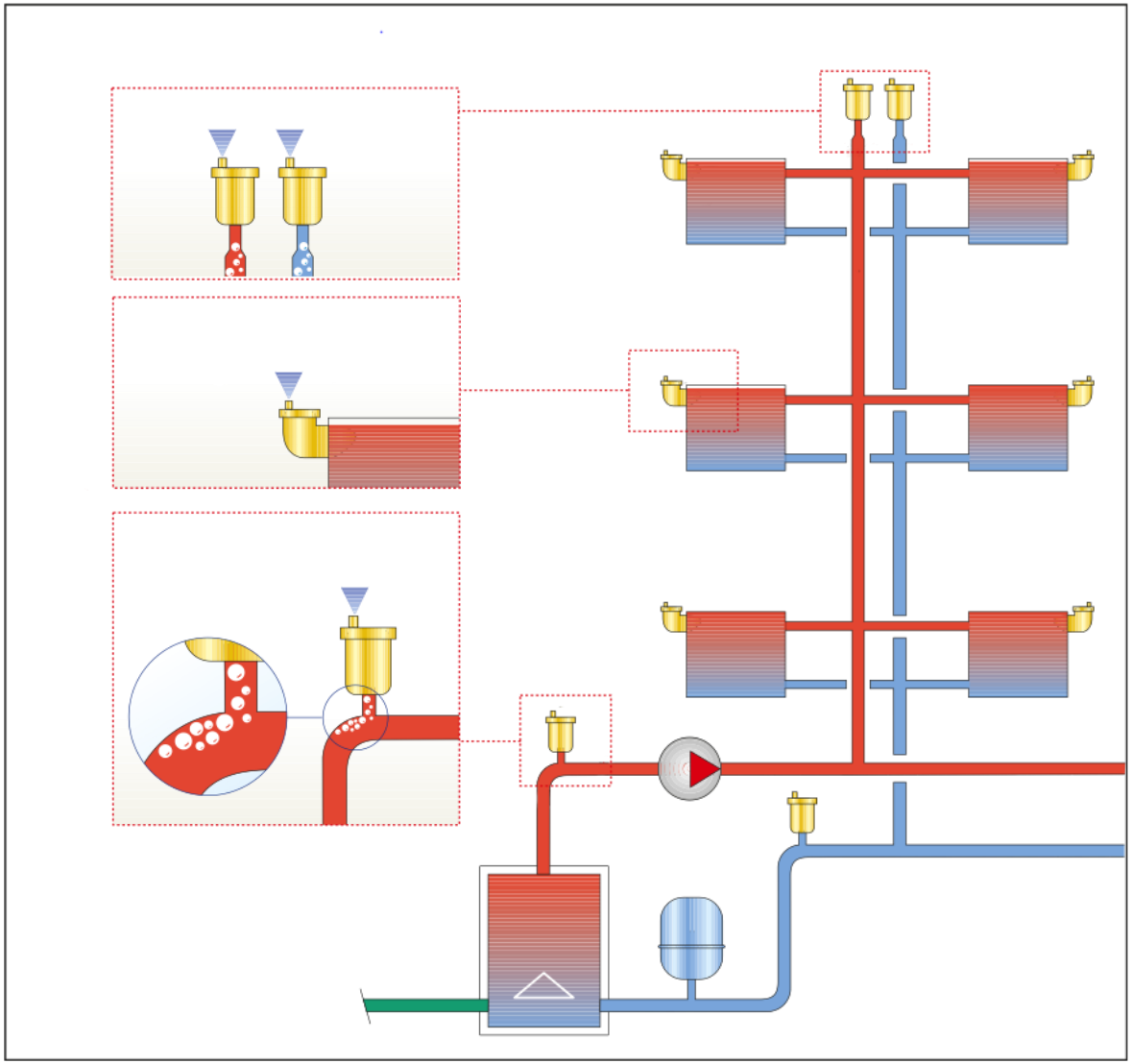
- AT THE UPPER PART OF HEAT EMITTERS
- AT THE TOP OF RISERS
- IN PIPING WITH IN-LINE OBSTACLES





AIR REMOVAL DEVICES

Automatic air vent – Application diagram



PRESENCE OF AIR
SITUATION 2

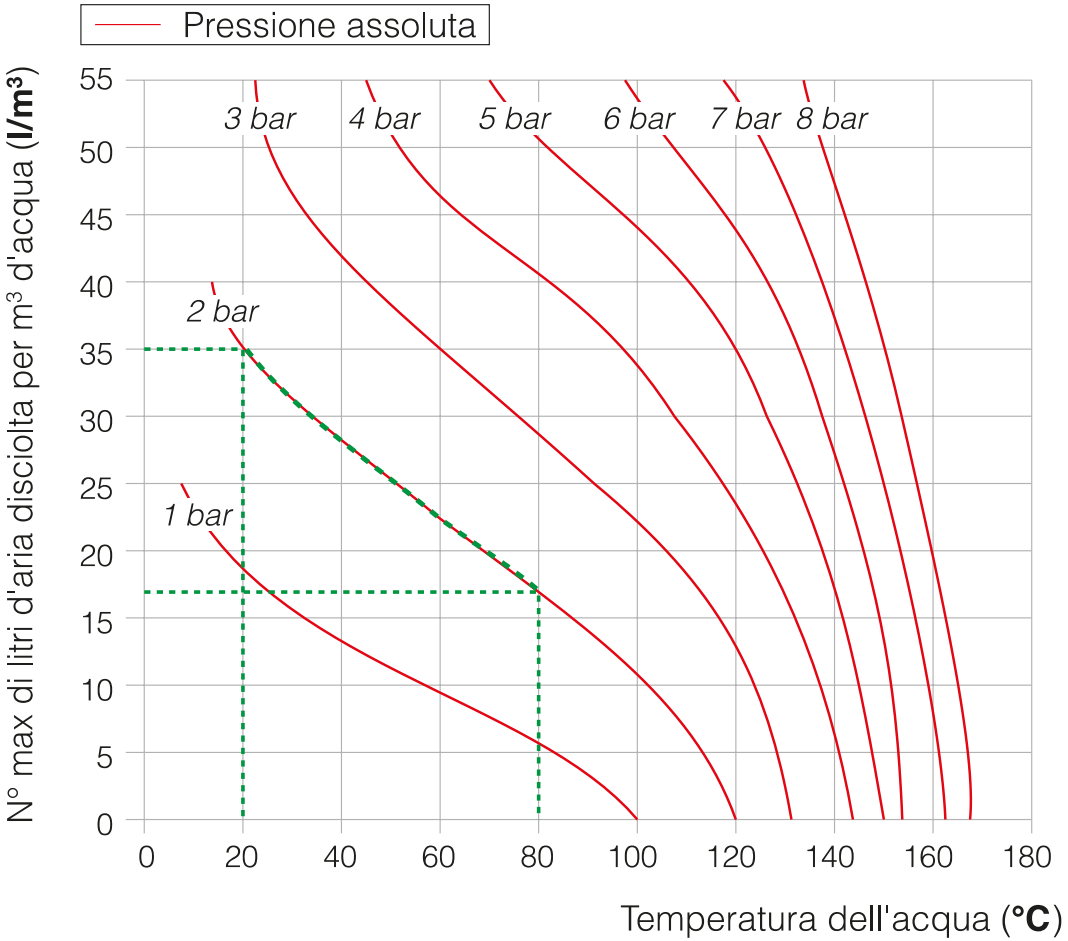
AIR DISSOLVED INSIDE WATER INTRODUCED DURING SYSTEM FILLING

AMOUNT OF DISSOLVED AIR

f(WATER PRESSURE)

f(WATER TEMPERATURE)

HENRY'S LAW



PRESENCE OF AIR
SITUATION 2

AMOUNT OF DISSOLVED AIR

HENRY'S LAW

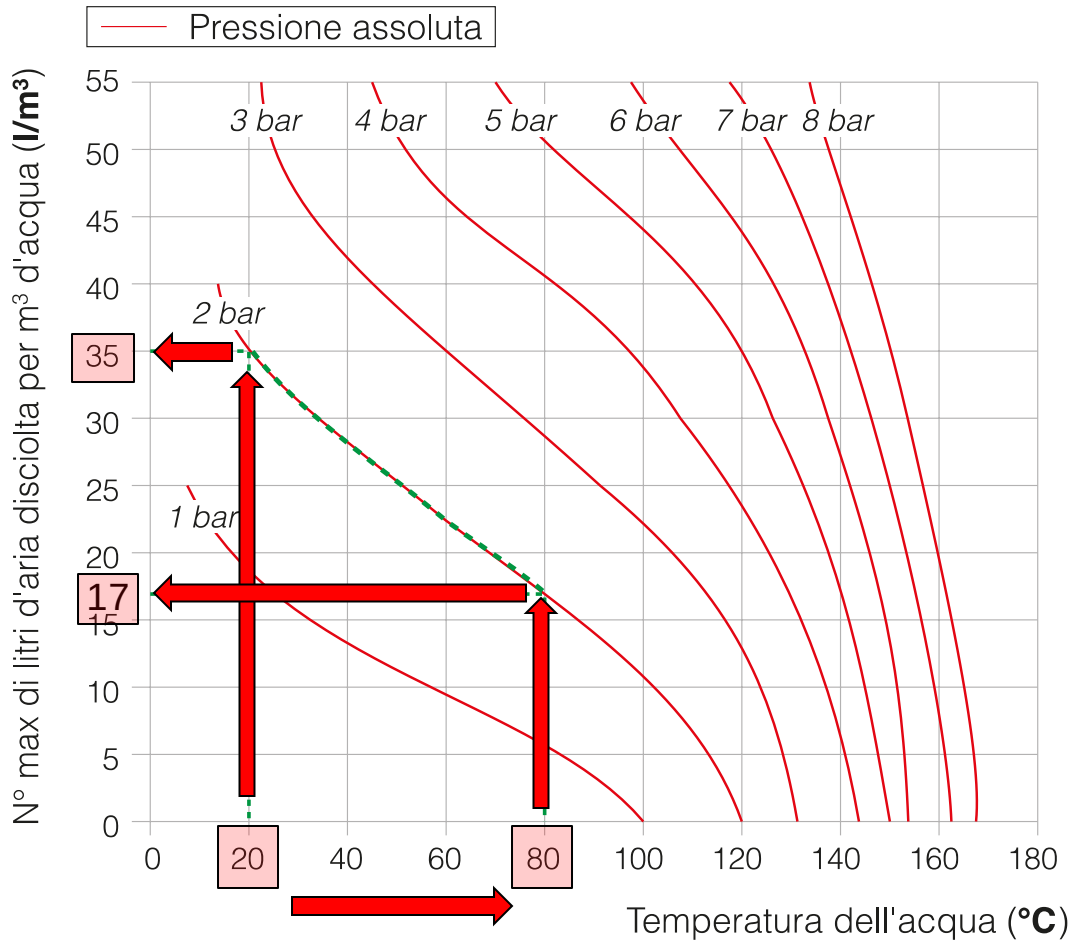
Filling with 1 m³ of water at:
20˚C
2 bar

35 Nl of dissolved air

Heating of water at:
80˚C
2 bar

17 Nl of dissolved air

18 Nl of air released



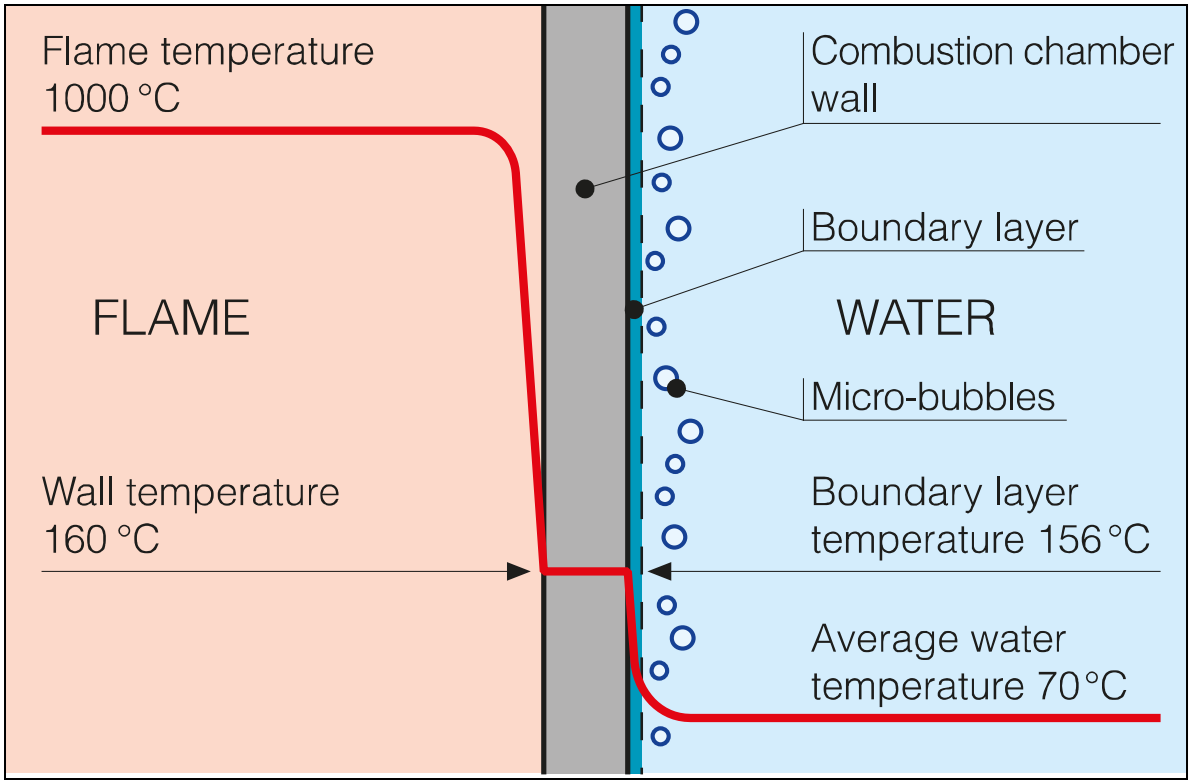
PRESENCE OF AIR

Boiler micro-bubbles

MICRO BUBBLES GENERATION ⇨

HOTTEST PART OF SYSTEMS

SURFACE OF COMBUSTION CHAMBER



DEAERATOR

Operating principle

ENLARGMENT OF SECTION

CREATION OF TURBOLENCE

FLOW VELOCITY REDUCTION

STICKING AGAINST MESH SURFACE

RELEASE OF MICROBUBBLES FROM FLOW

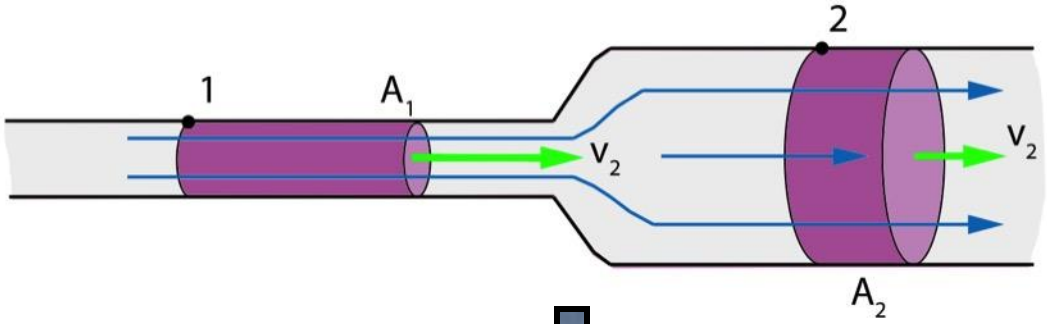
The bubbles fuse with each other. They increase in volume and rise towards the top.

COMBINED ACTION OF DIFFERENT PHYSICAL PRINCIPLES

DEAERATOR

Sizing Criteria

OPTIMAL WATER SPEED AT THE DEVICE CONNECTION (A1) **≈ 1,2 m/s**



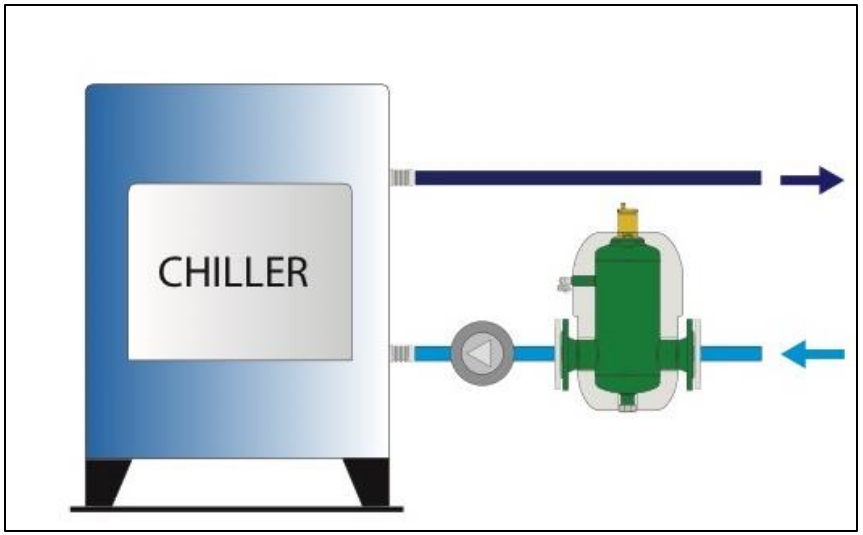
OPTIMAL DESIGN WATER FLOW-RATE

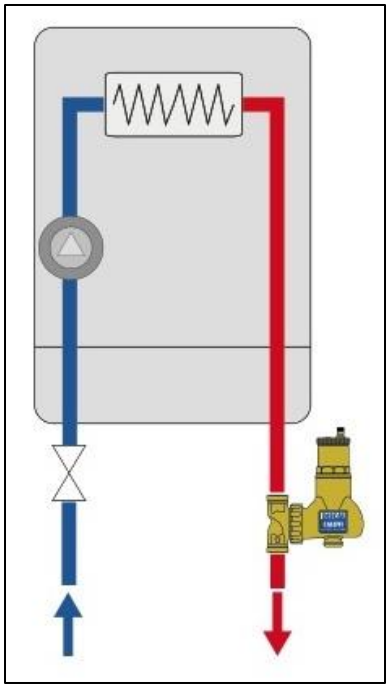
DN	Ø 22 - 3/4" - 1"	3/4"	1"	1 1/4"	1 1/2"	2"
l/min	22,7	22,7	35,18	57,85	90,33	136,6
m³/h	1,36	1,36	2,11	3,47	5,42	8,20

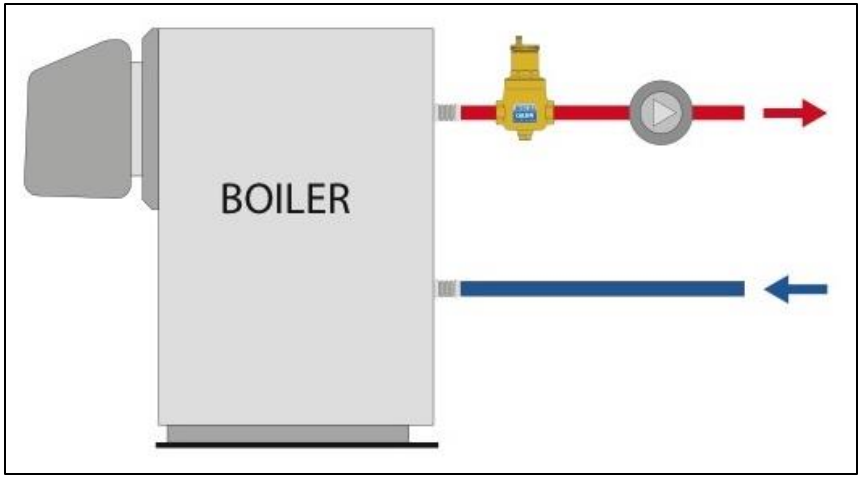
MAXIMUM WATER SPEED AT THE DEVICE CONNECTION (A1) **≈ 1,5 m/s**

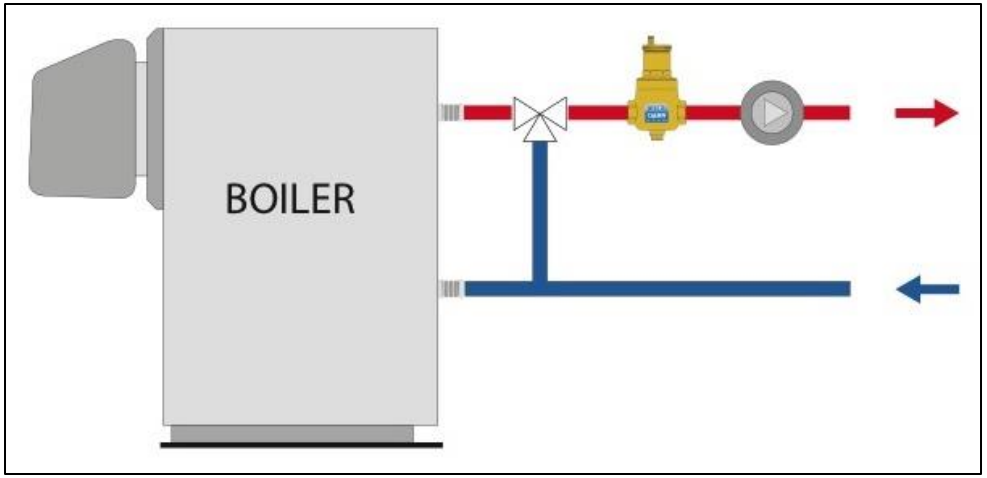
DEAERATOR

Installation









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Impurities inside systems

PRESENCE OF DIRT

Reduced heat transfer in heat exchangers

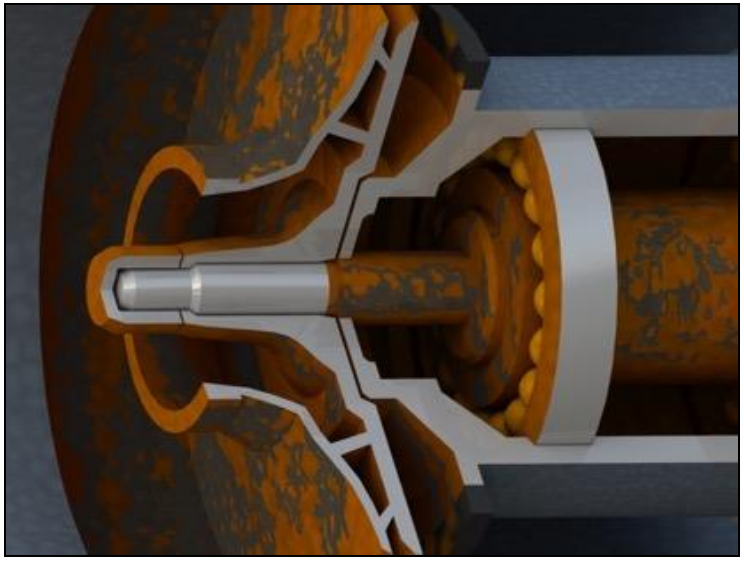
INSIDE BOILERS

- SIGNIFICANT REDUCTION OF HEAT TRANSFER
- HEAT EXCHANGER BREAKING POSSIBILITY
- HIGHER OPERATING COSTS AND ENERGYMCOSUNPTION

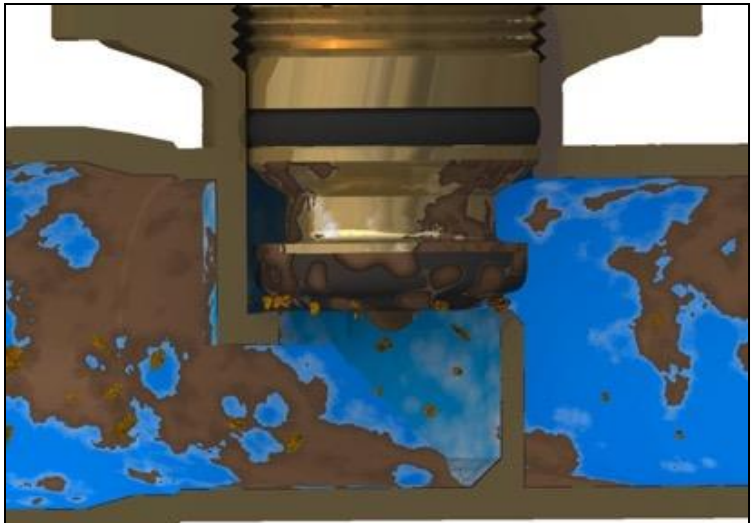
PRESENCE OF DIRT

Problems related to mechanical components

DAMAGES TO ROTATING COMPONENTS IN CIRCULATORS

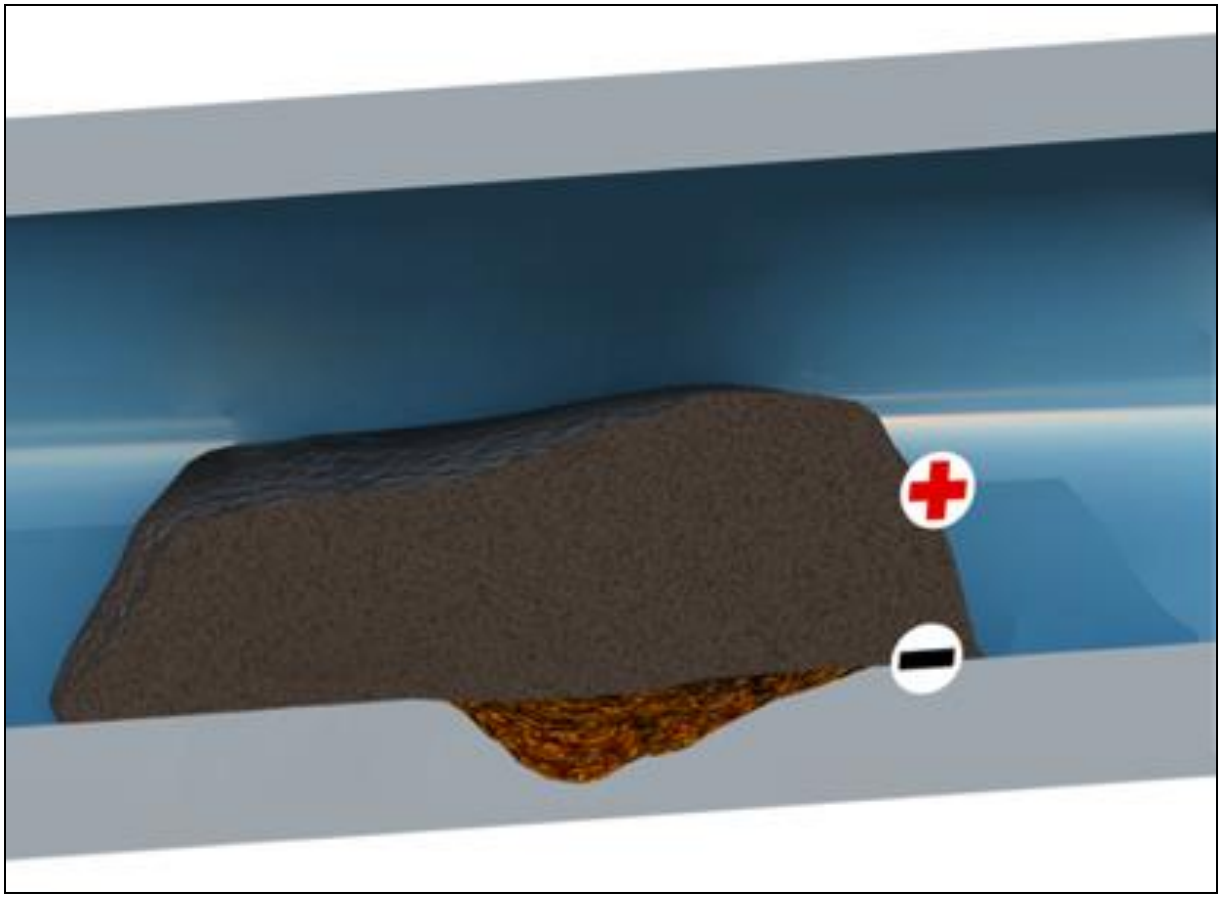


VALVES IRREGULAR WORKING



PRESENCE OF DIRT AND SLUDGE

Corrosion

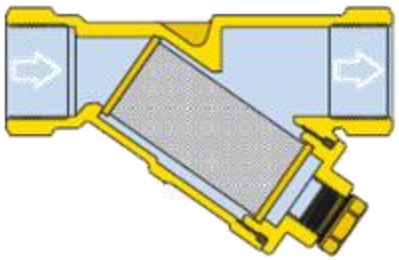


BASIC MATERIAL (STEEL) + DIRT + OXYGEN ⇒ **CORROSION**

DIRT REMOVAL DEVICES

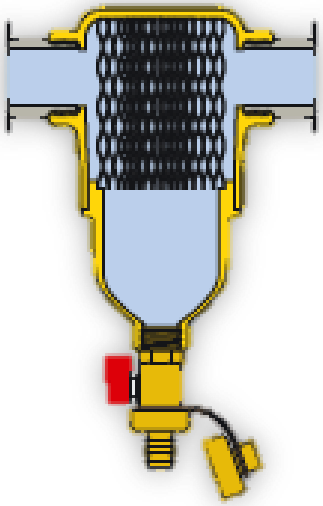
Strainers vs Dirt Separators

STRAINER



BASED ON MESH SIZE

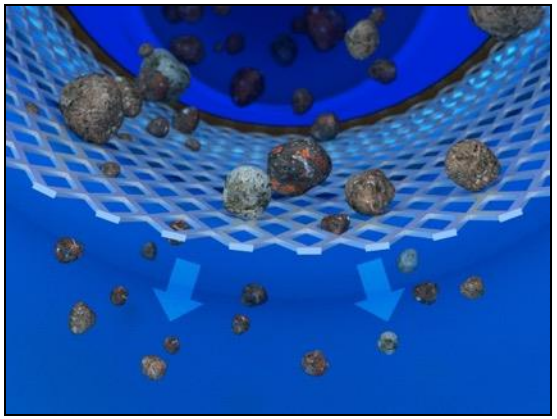
DIRT SEPARATOR



BASED ON DROPPING BY GRAVITY

DIRT REMOVAL DEVICES

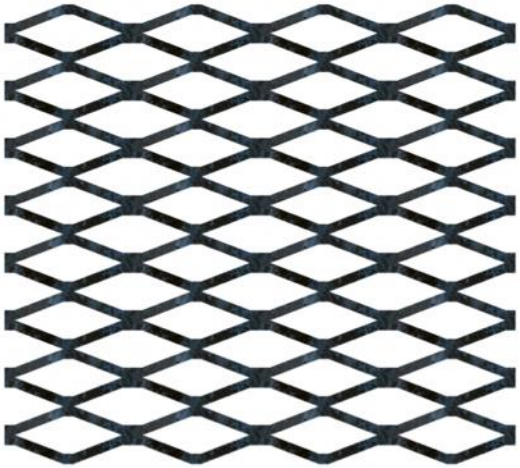
Filtration



MESH SIZE

MINIMUM IMPURITY DIAMETER TRAPPED [µm]

Size	½”	¾”	1”	1 ¼”	1 ½”	2”
Mesh size [µm]	400	400	400	470	470	530



Kvs

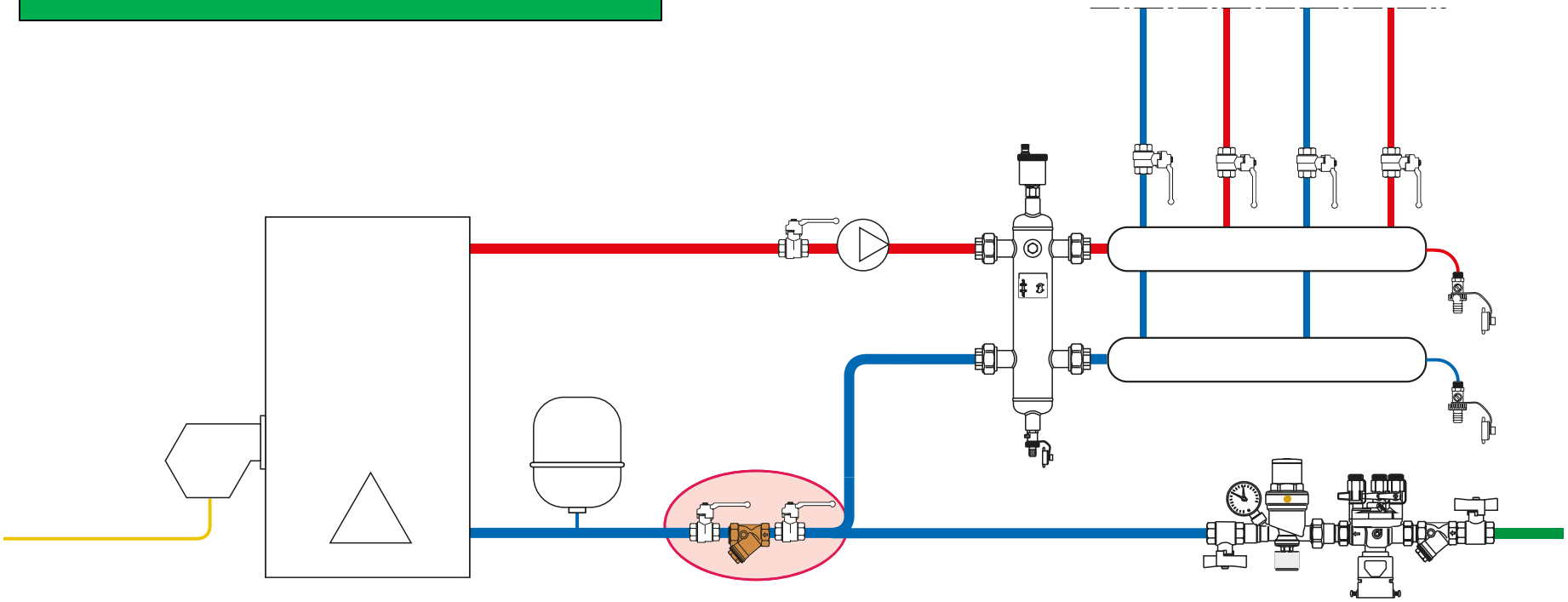
THE Kvs VALUE IS CALCULATED WITH CLEAN MESH

Size	½”	¾”	1”	1 ¼”	1 ½”	2”
Kvs	4,1	7,3	11,0	17,4	25,0	37,0

DIRT REMOVAL DEVICES

Filtration

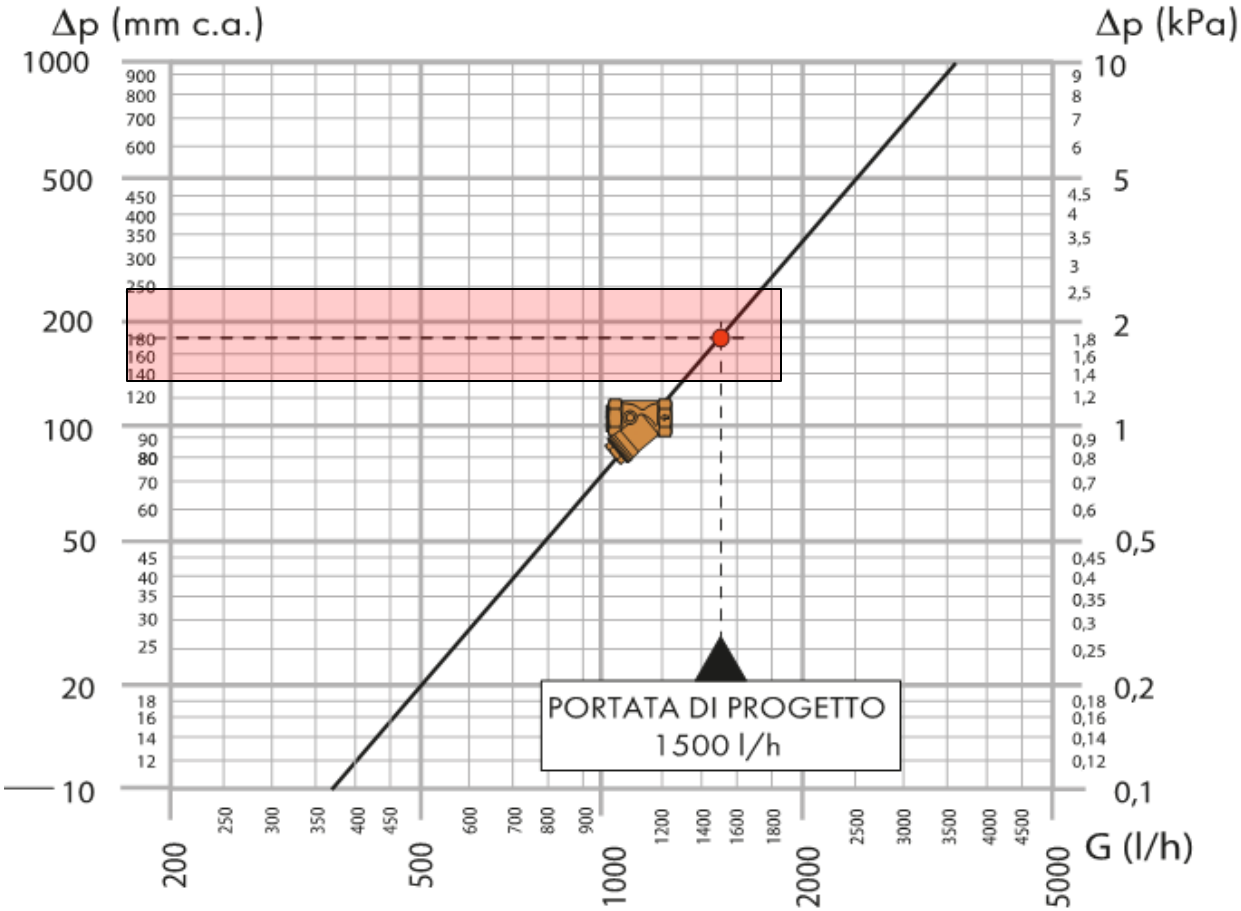
STRAINER INSTALLATION



DIRT REMOVAL DEVICES

Filtration: example

Y-STRAINER: 1” size (mesh 0,4 mm)



DESIGN FLOW
1500 l/h

ΔP STRAINER = 180 mm w.c. (1.8 kPa)

(no obstruction)

DIRT REMOVAL DEVICES

Filtration: example

INSUFFICIENT FILTER MAINTENANCE

↓

70% OBSTRUCTION

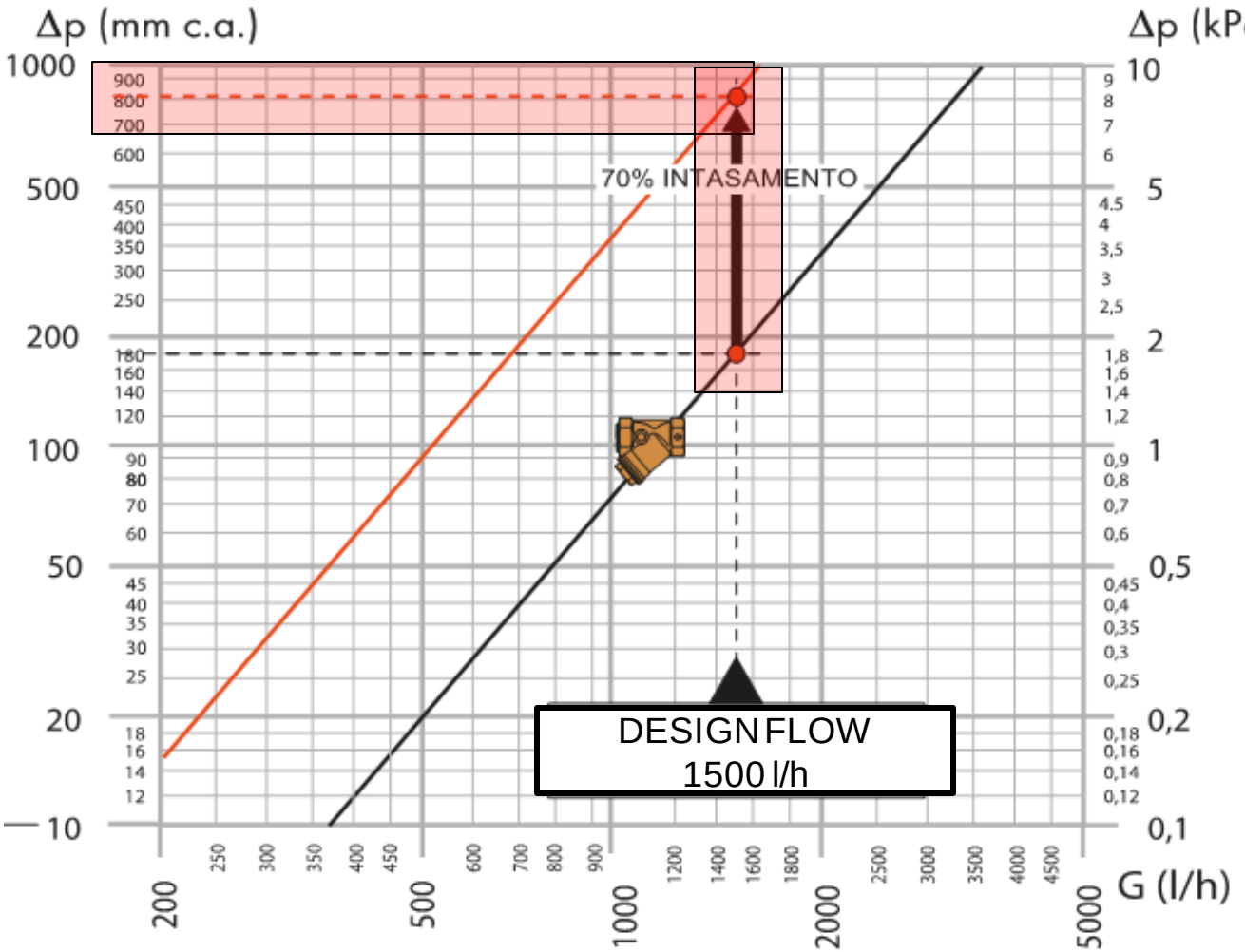
↓

STRAINER PRESSURE LOSS INCREASED BY 4.5 TIMES (experimental data)

DIRT REMOVAL DEVICES

Filtration: example

Y-STRAINER: 1” size (mesh 0,4 mm)



DESIGN FLOW
1500 l/h

NO MAINTENANCE

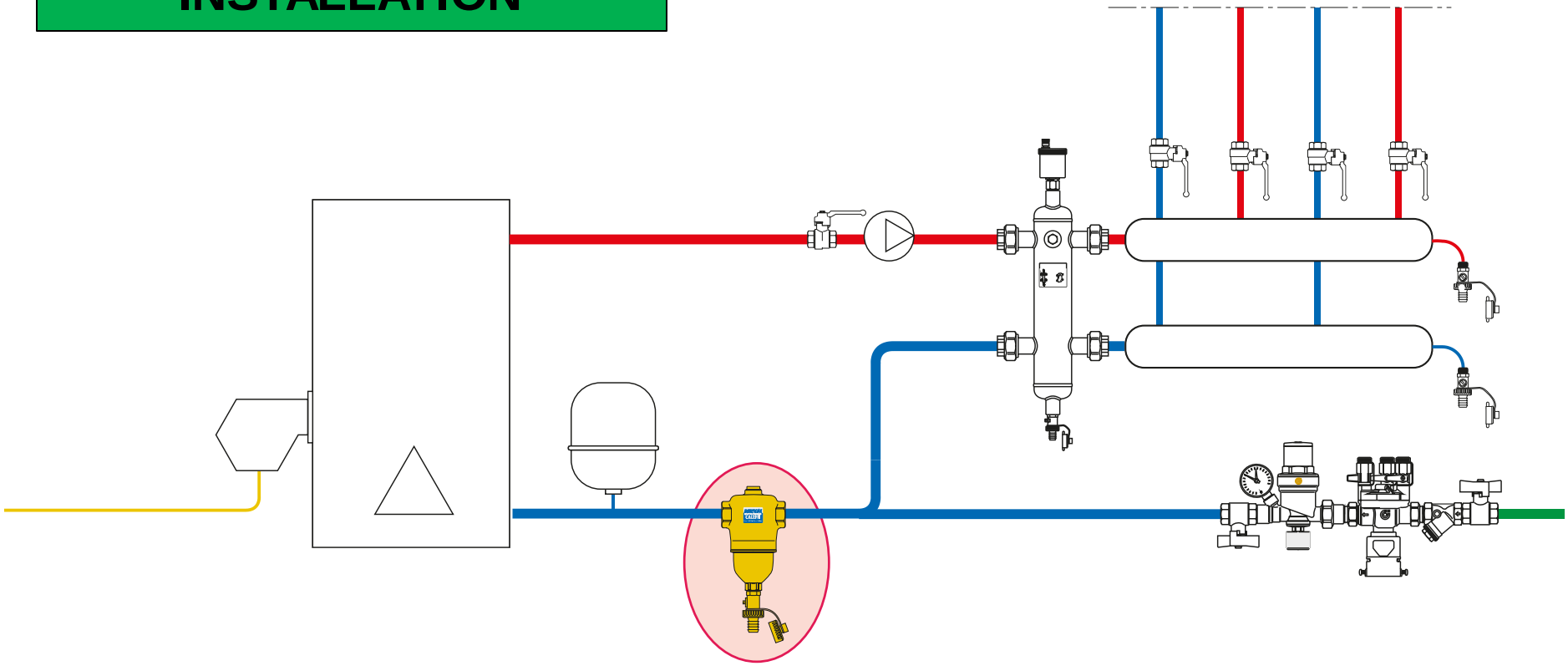
ΔP STRAINER = 780 mm w.g. (7,8 kPa)

(70% obstruction)

DIRT REMOVAL DEVICES

Dirt separator: example

DIRT SEPARATOR INSTALLATION



DIRT REMOVAL DEVICES

Operating principle

ENLARGMENT OF SECTION

IMPURITIES COLLISION AGAINST MESH

FLOW VELOCITY REDUCTION

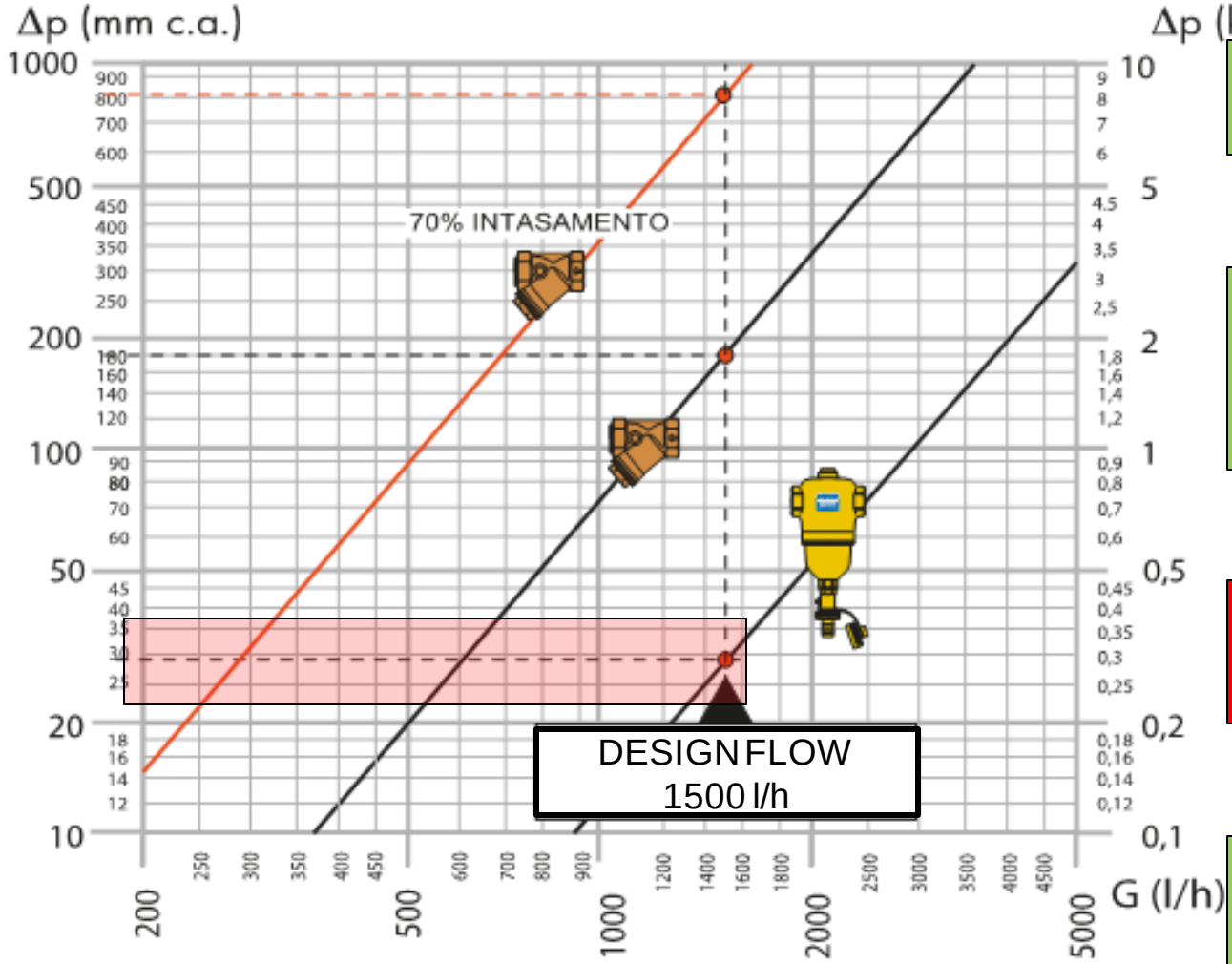
DIRT SEPARATION

DROPPING BY GRAVITY

COMBINED ACTION OF DIFFERENT PHYSICAL PRINCIPLES

DIRT REMOVAL DEVICES

Dirt separator: example



DESIGN FLOW
1500 l/h

ΔP DIRT SEPARATOR
28 mm w.g.
(0,28 kPa)

NO MAINTENANCE

ΔP DIRT SEPARATOR
28 mm w.g.
(0,28 kPa)

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Magnetic Effect

DIRT REMOVAL DEVICES

Operating principle

ENLARGMENT OF SECTION

↓

FLOW VELOCITY REDUCTION

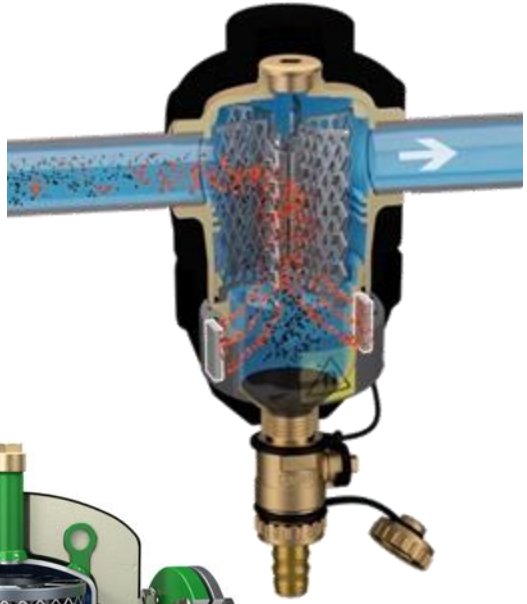
IMPURITIES COLLISION AGAINST MESH

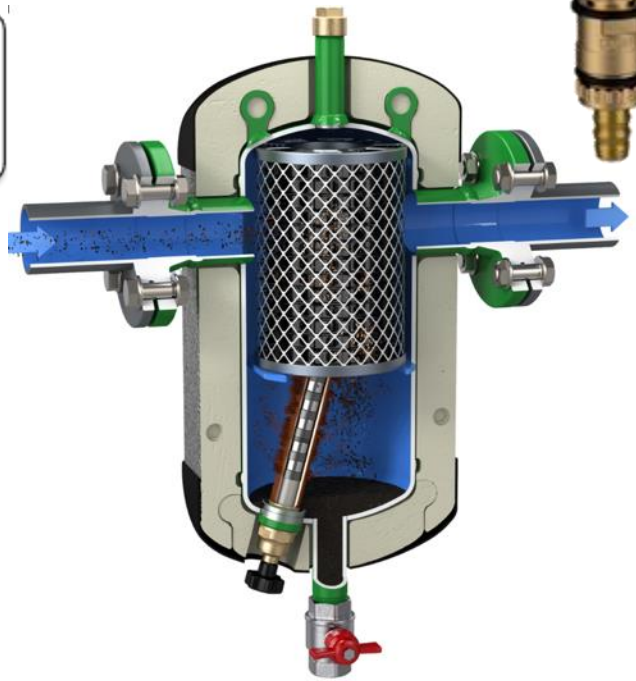
↓

DIRT SEPARATION

↓

DROPPING BY GRAVITY +
MAGNETIC ATTRACTION

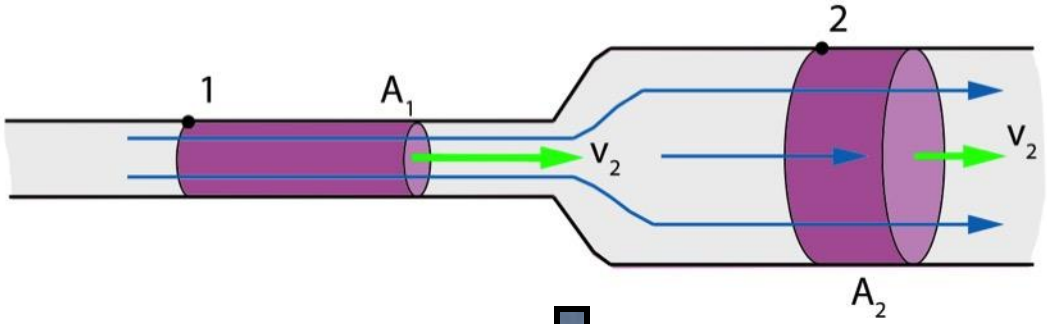




DIRT SEPARATOR

Sizing Criteria

OPTIMAL WATER SPEED AT THE DEVICE CONNECTION (A1) **≈ 1,2 m/s**



OPTIMAL DESIGN WATER FLOW-RATE

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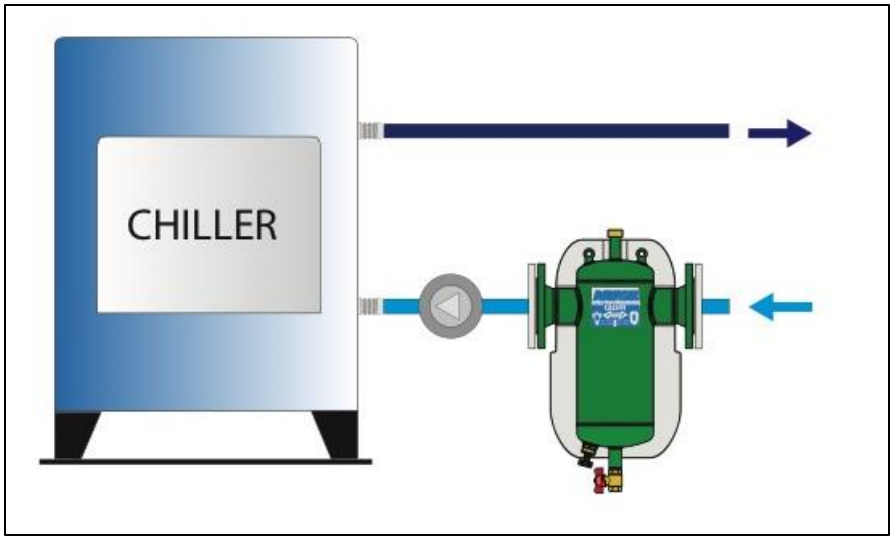
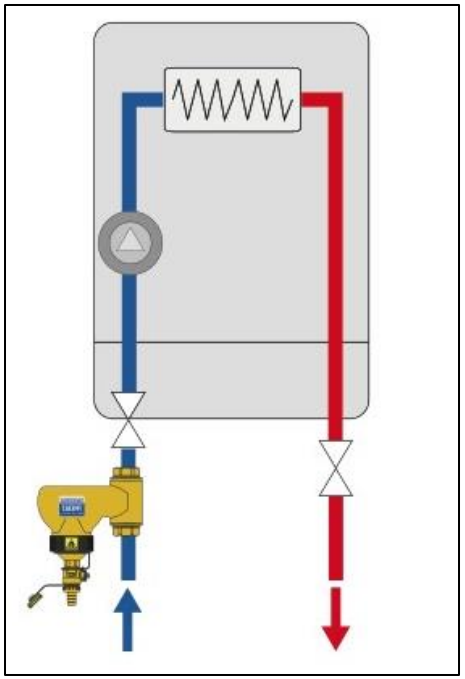
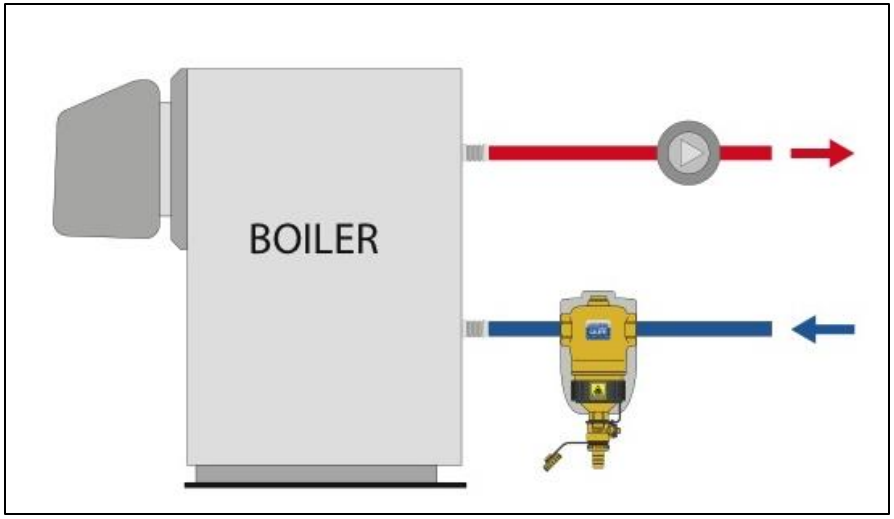
MAXIMUM WATER SPEED AT THE DEVICE CONNECTION (A1) **≈ 1,5 m/s**

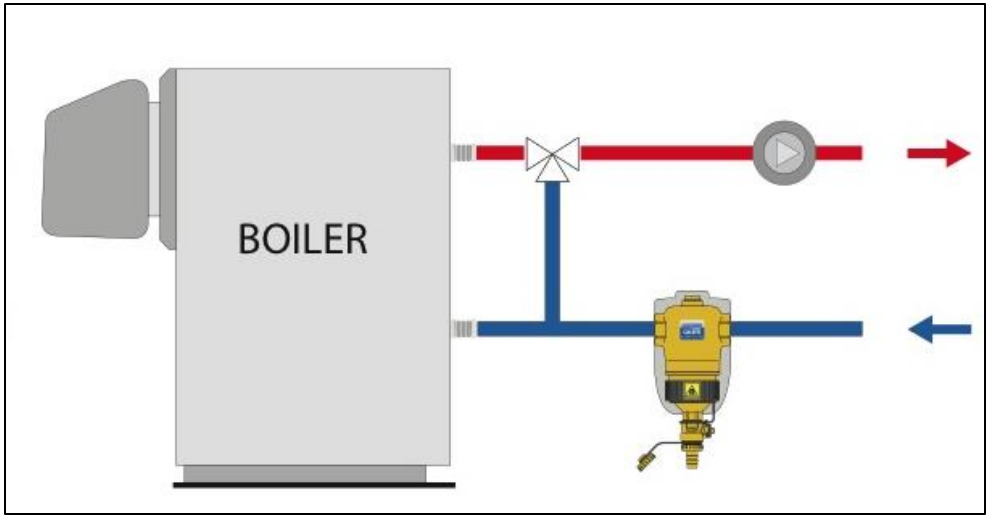
DIRT SEPARATOR

Installation









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Hydronic Solutions

Multifunctional Components

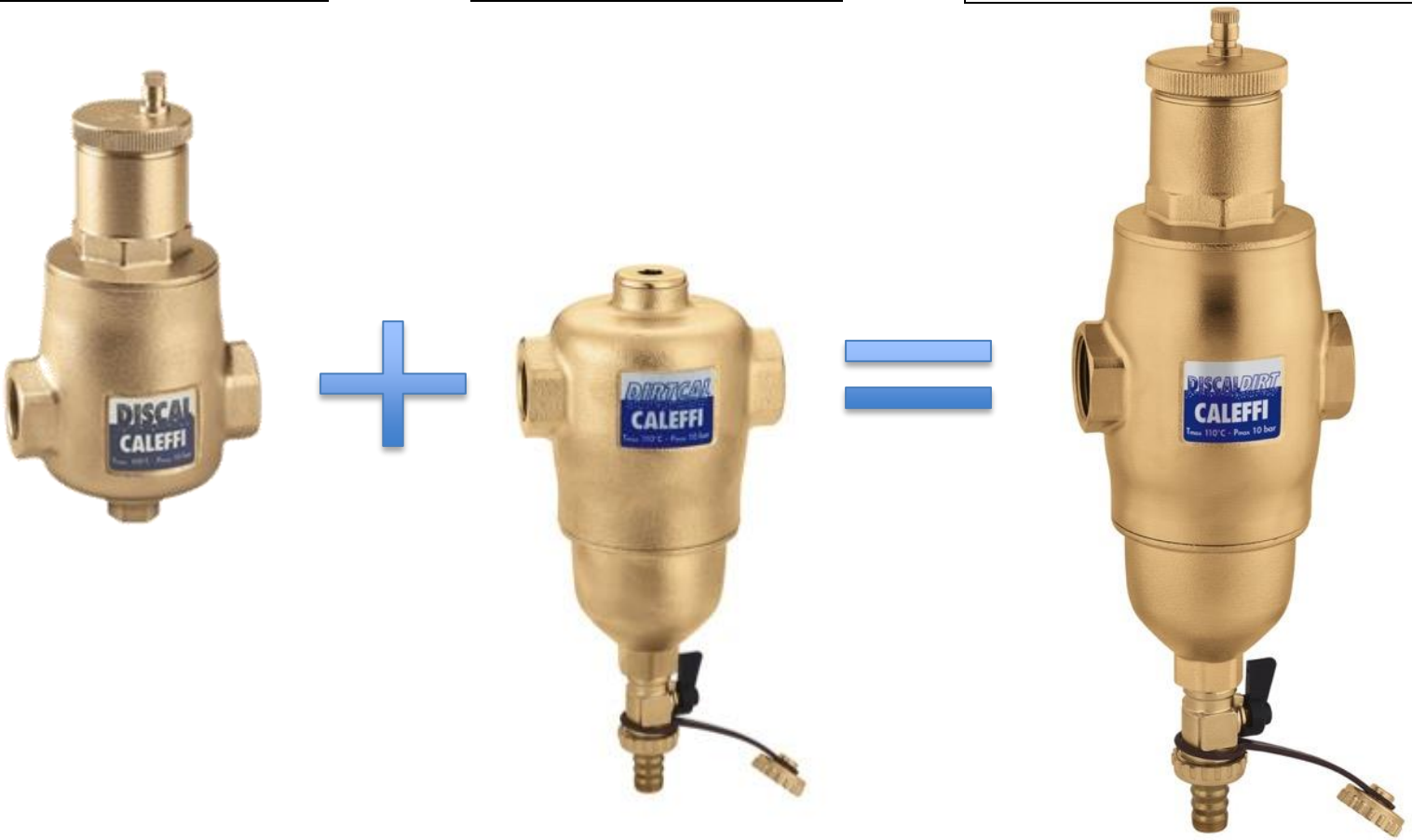
AIR AND DIRT SEPARATOR

Combined Functions

AIR SEPARATOR

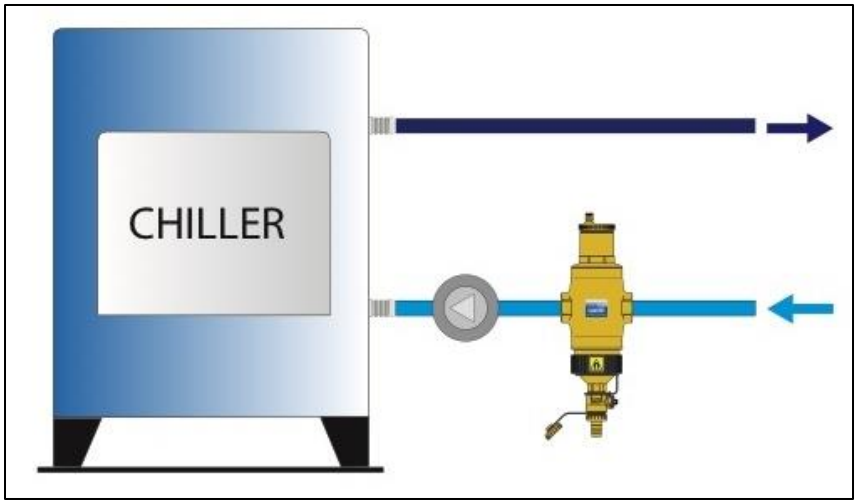
DIRT SEPARATOR

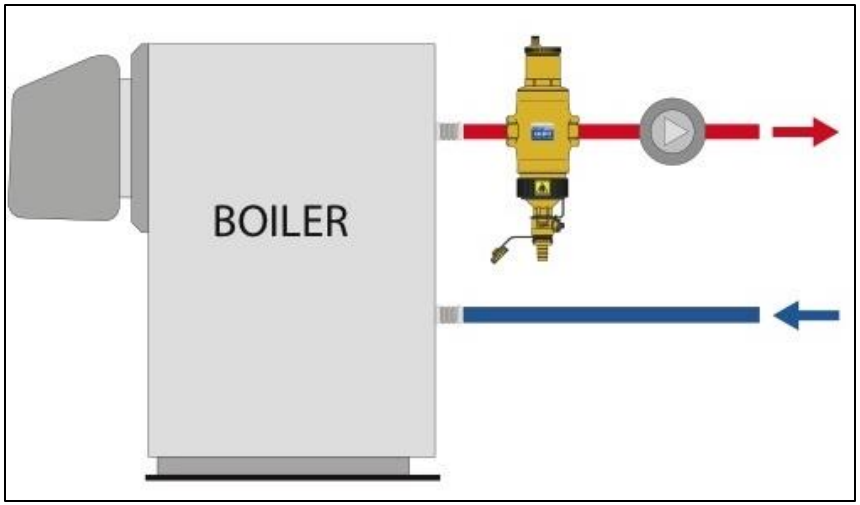
COMBINED COMPONENT

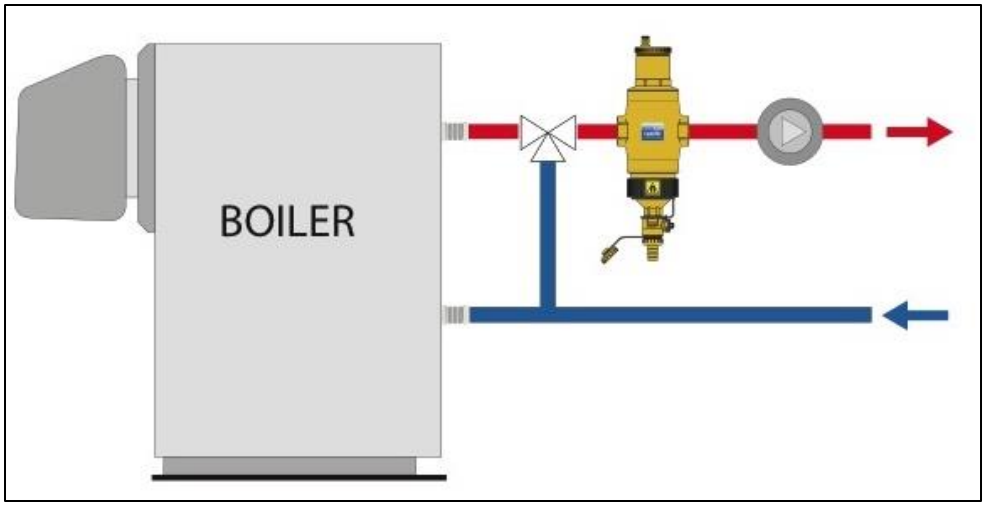


AIR AND DIRT SEPARATOR

Installation







MULTIFUNCTIONAL HYDRAULIC SEPARATOR

Combined Functions

HYDRAULIC SEPARATOR

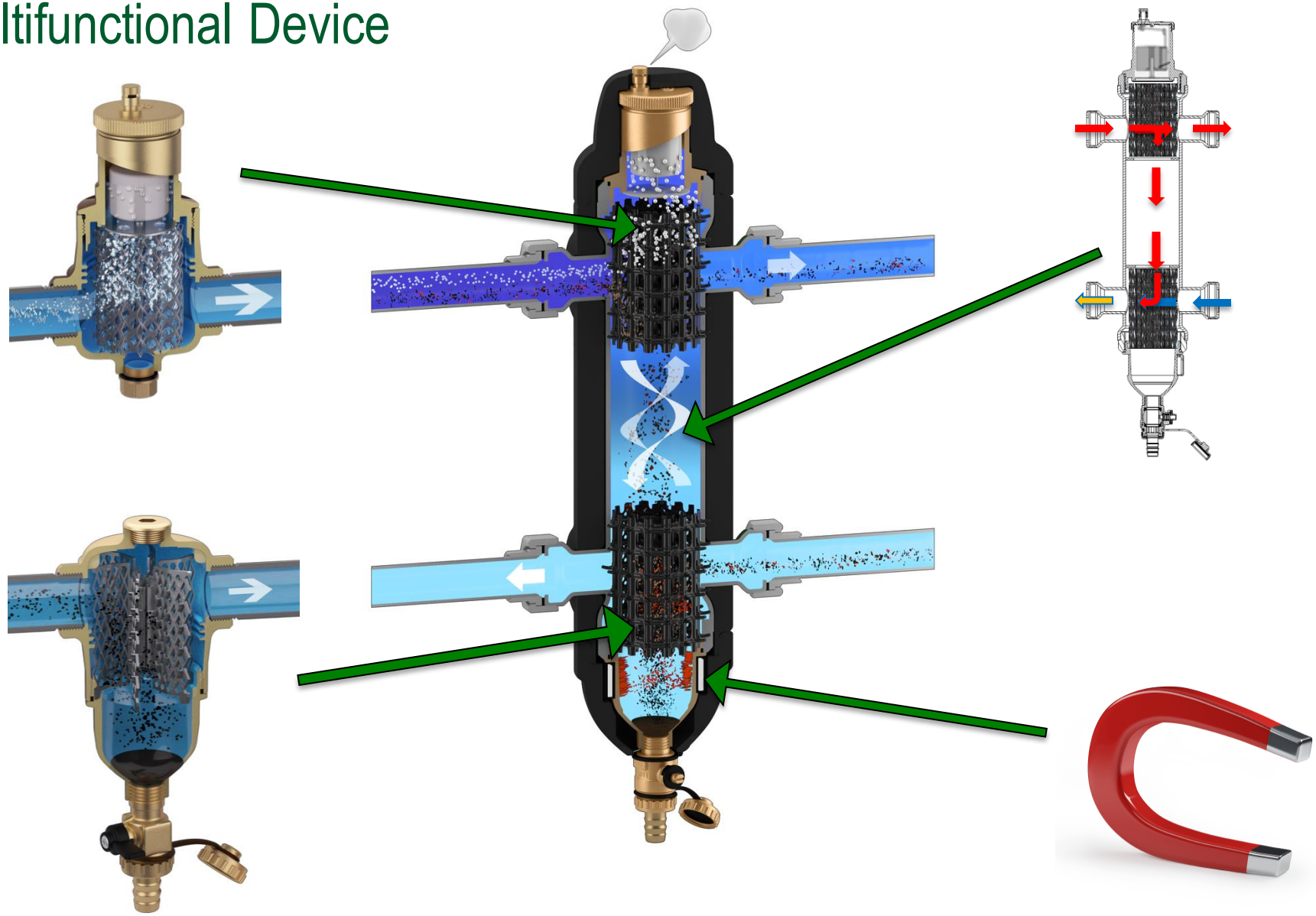
AIR SEPARATOR

DIRT SEPARATOR

MAGNETIC EFFECT

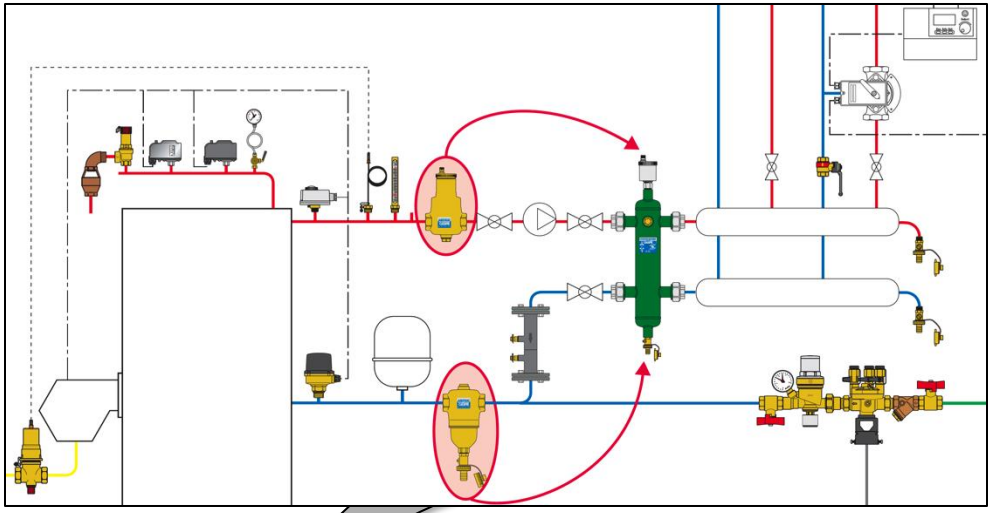
MULTIFUNCTIONAL HYDRAULIC SEPARATOR

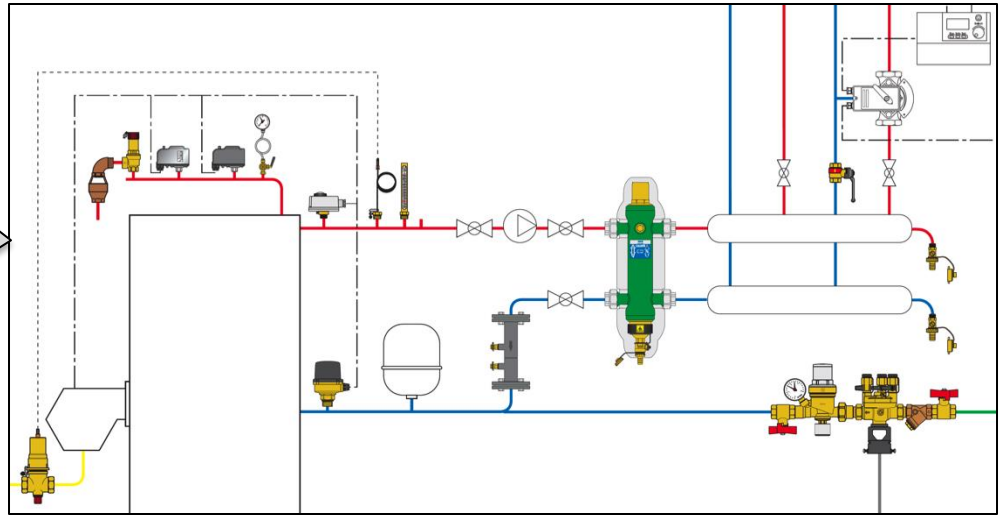
Multifunctional Device



MULTIFUNCTIONAL HYDRAULIC SEPARATOR

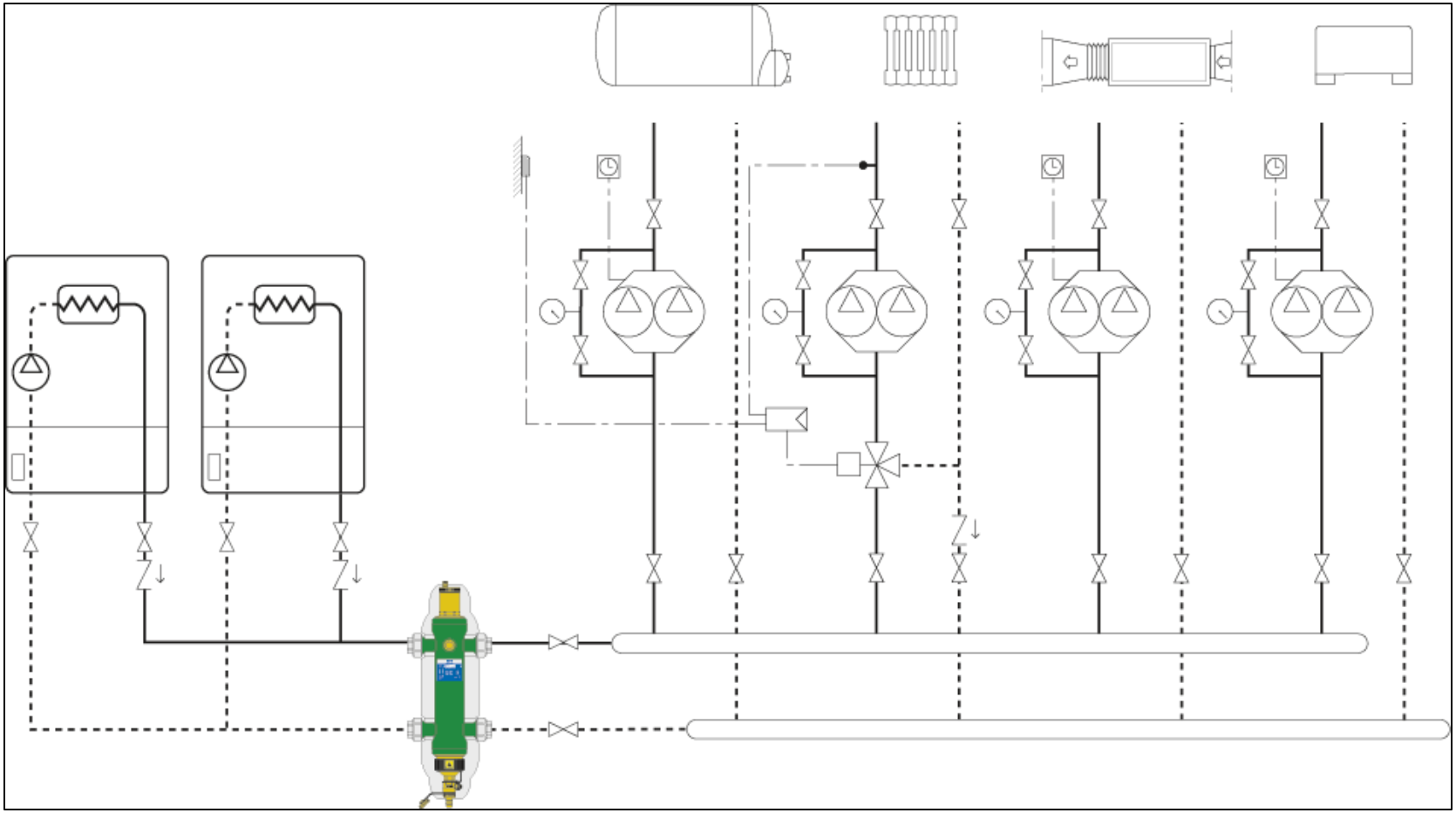
Installation





MULTIFUNCTIONAL HYDRAULIC SEPARATOR

Scheme of application



Thank you.

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Hydronic Solutions