

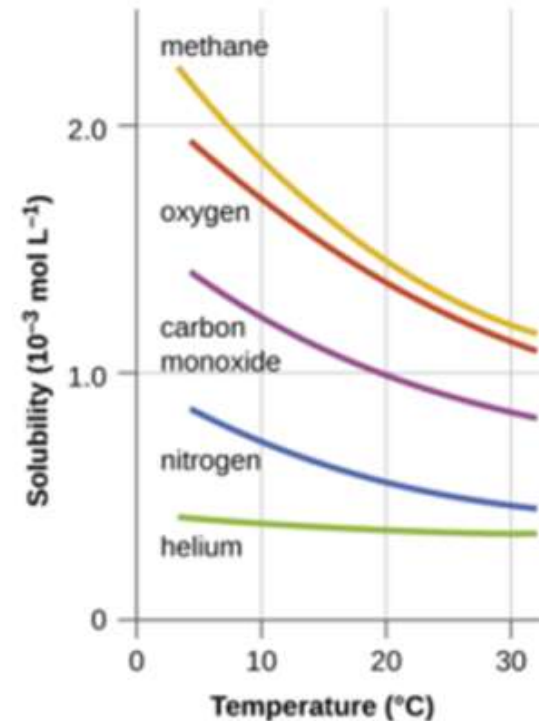
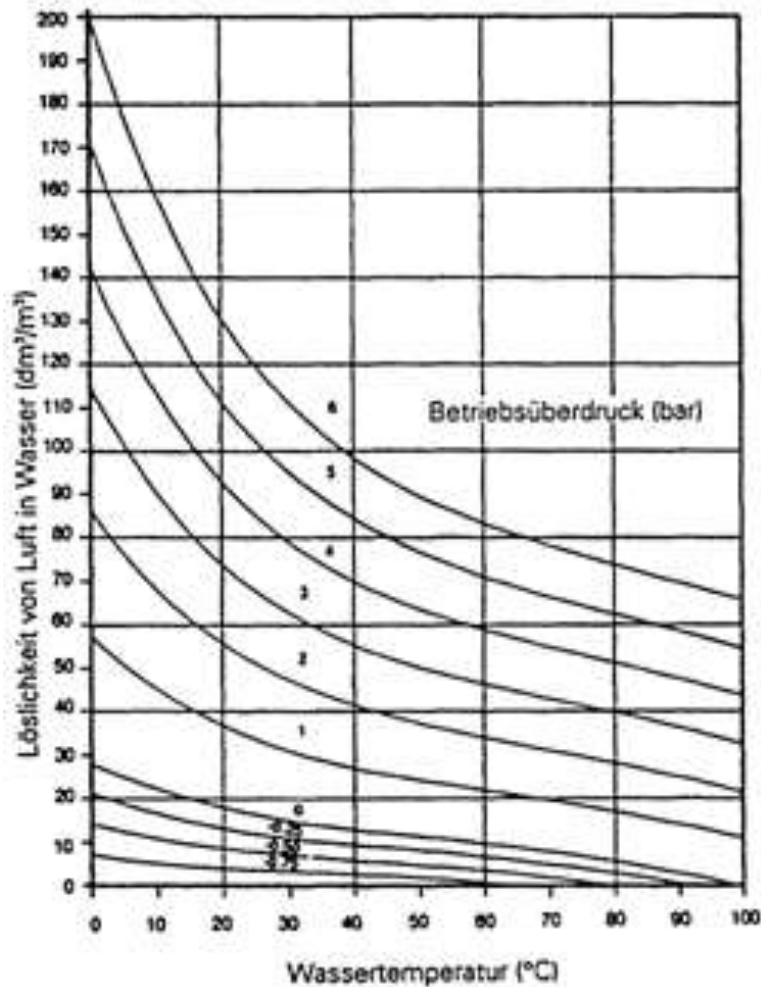


Mechanisms of oxygen entry in heating systems



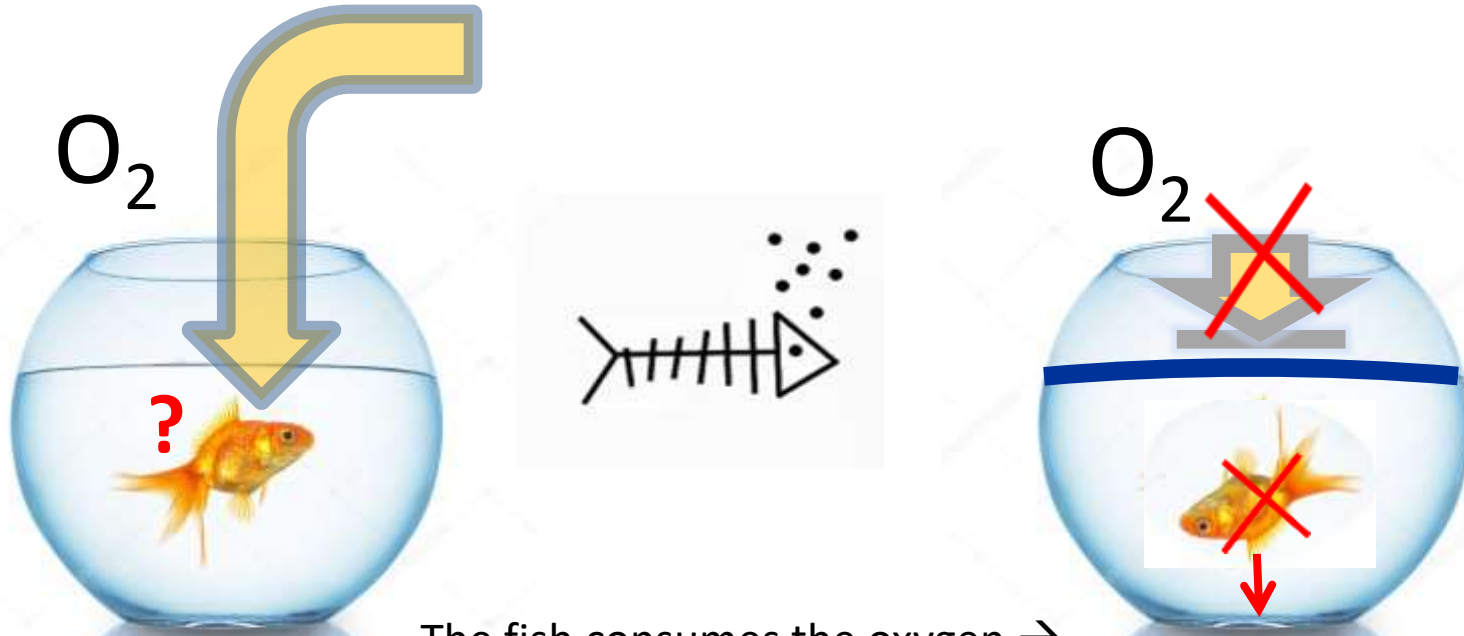
Heating systems want to absorb oxygen to restore a natural balance:

(Henry's Law / inbalance in partial pressure)





Corrosion prevention = eliminate oxygen ingress

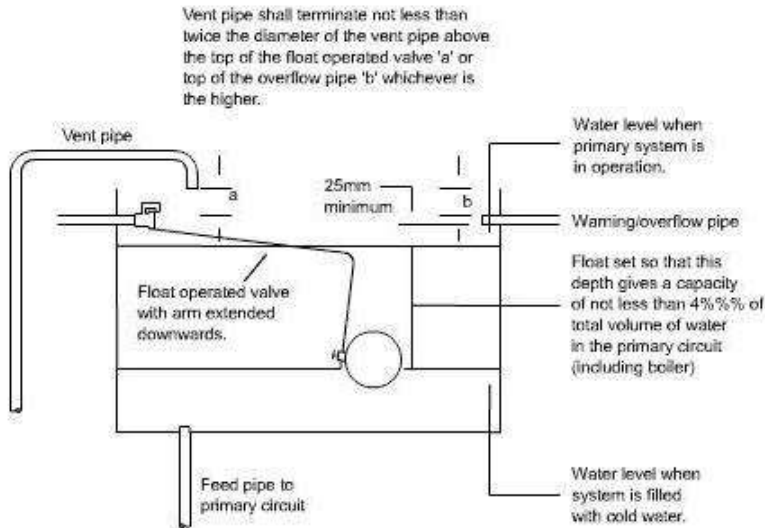


The fish consumes the oxygen →
partial pressure becomes lower than normal →
absorption process of fresh oxygen from the atmosphere →

The more the oxygen gets consumed →
increase of difference in partial pressure →
the more fresh oxygen goes in →



open expansion tank = permanent oxygen entry

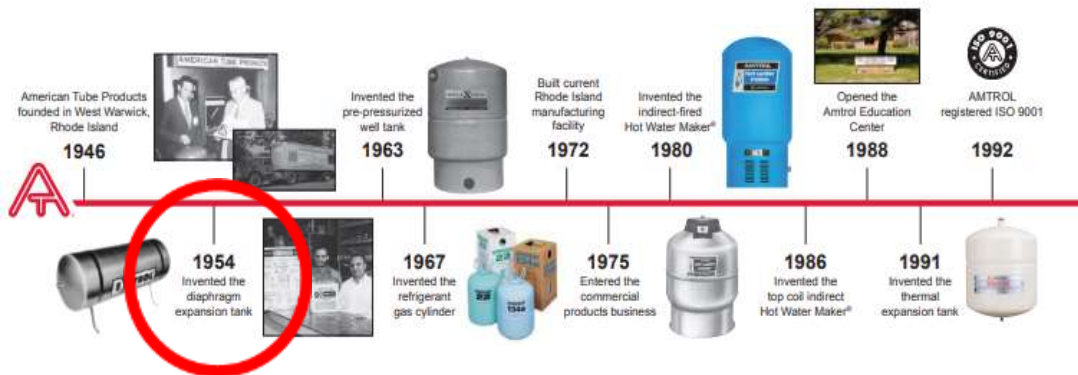


- PRO:
 - Simple, cheap, easy to install
 - Lowest possible, constant pressure, no pressure increase
 - Automatic degassing when hot
- CONTRA:
 - Evaporation when hot, energy loss
 - Oxygen absorption when not hot > corrosion sludge > **PROBLEMS**
 - Reduced longevity, blockages because of sludge generator





That's why Chester H. Kirk in the U.S. invented the sealed expansion tank in 1954 and filed patent in 1959



3,035,614
EXPANSION TANK
Chester H. Kirk, Jr., 14 Glen Ave., Cranston, R.I.
Filed Nov. 4, 1959, Ser. No. 850,872
6 Claims. (Cl. 138—30)



1. An **expansion tank** comprising a hollow body member having a side and end walls, a flexible diaphragm in and spanning said body member between said end walls and having a peripheral portion in peripheral engagement with said side, a continuous ring having a groove in its outer periphery engaging and receiving said peripheral portion and an inwardly extending peripheral rib in said side engaging said peripheral portion of said diaphragm and compressing it into said groove to secure said ring and diaphragm against movement and seal said diaphragm to said side.

Thermal expansion is absorbed by a permanent (compressible) gas cushion, separated from the water by a rubber membrane

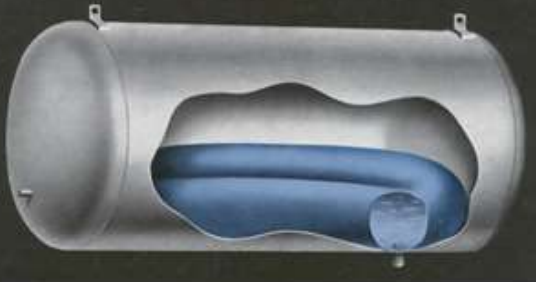


Maybe the first one was Swiss Carl Stücklin in 1958, using the air chamber (PNEU) of a truck tyre, creating the first PNEUMATEX?

Schweizer Konzeption,
Schweizer Qualität,
für Schweizerische
Sicherheitsanforderungen!
Patentsprüche in 9 Staaten

PNEUMATEX
das Sicherheits-Expansionsgefäß

jetzt mit
Spezial-
Hydrometer
mit der
grünen
Zone



Die Praxis hat bestätigt, was Forschung
und Erfahrung schufen: **PNEUMATEX**
ist heute zum Standard geworden!

Wirkungsweise des Pneumatex-Sicherheits-Expansionsgefäßes:

Das durch die Erwärmung der Zentralheizung entstehende Mehr-Volumen an Wasser tritt in das Innere der Butyl-Kautschuk-Blase im Pneumatex-Gefäß ein. Wasser und Luft sind also vollständig getrennt. Das der Anlagegröße entsprechende Gefäß erhält in der Fabrik eine Luftfüllung. Diese Luftfüllung wirkt als weiches Kissen auf das Äußere der Blase und erzeugt auf das ins Blaseninnere eingetretene Wasser einen abgemessenen Gegenruck.

Die natürliche Expansion und Kontraktion des Heizungswassers erfolgt stetig und langsam. Selbst für größere Anlagen genügt einfaßlich ein geringer "L"-Anschluß. Wird jedoch eine Anlage aus Versehen überfüllt oder überheizt, dann verhindert die mit dem Kessel verbundenen, mehrfachen Pneumatex-Sicherheitsventile einen unzulässigen Druckanstieg. Butyl ist unter allen synthetischen Kautschuk-Arten die atemungsständigste. Da Licht und Ozon im Gefäß fehlen, kann mit einer Lebensdauer der Blase von 12-15 Jahren gerechnet werden. - Im Falle des Bruchs sind die Kosten und der Zeitaufwand gering.

Die Kombination von PNEUMATEX-Gefäß, Spezial-Hydrometer und Sicherheitsventile ergibt optimale Sicherheit und weist viele echte Fortschritte auf:

1. **Vollständige Sicherheit** durch die Pneumatex-Mehrfach-Membranventile
2. **Einfache Montage** des Gefäßes im Heizraum selbst, ohne Konsolen
3. **Kein Wärmeverlust, keine Gefäß-Isolierung**; Gefäß wird nur handwarm
4. **Gefäß rostfrei**, Trennung von Wasser und Luft schließt Korrosion aus
5. **Wegfall der Kosten** für lange Sicherheitsleitungen und deren Isolation
6. **Projektilierung stark vereinfacht**, besonders bei Mehr-Kessel-Anlagen
7. **Spart Armaturen und Montagekosten** durch Wegfall von Wechsel-Ventilen
8. **Spart Baukosten**, keine Aufbauten bei Flachdecken mit Deckenheizung
9. **Entlüftungproblem beseitigt** durch absolute Trennung von Wasser und Luft
10. **Frontfrei**, da der horizontalste Dachüberlauf nur vollständig entfällt.

Das Pneumatex-System ist in tausenden von Anlagen seit mehr als fünf Jahren im Betrieb und bewährt sich einwandfrei.

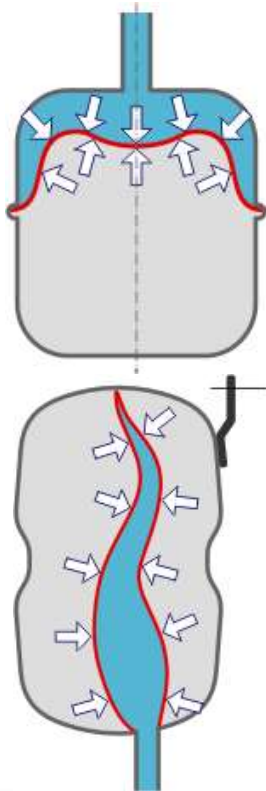


Flamco claims it was their MD, Johan Wormmeester, who had the idea of clenching two cooking pots together with a metal clenching ring and having a rubber "bowl hat" in between the two parts



Sealed system: sealed membrane expansion tanks

Membrane or bladder type



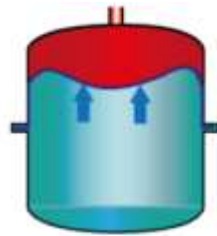
- PRO
 - Near to (or inside) the boiler
 - Lower installation cost (proximity)
- CONTRA
 - Variable pressure
 - Diffusion of the gas cushion through the membrane > **after some time WORSE than open system:**
 - **AIR INGRESS** through AAVents
 - Reduced longevity for the entire system
 - Several other complications (opening pressure, membrane stretch, residual water)



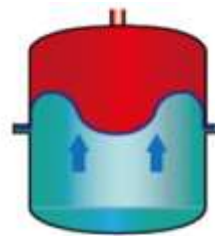
Consequences of variable pressure



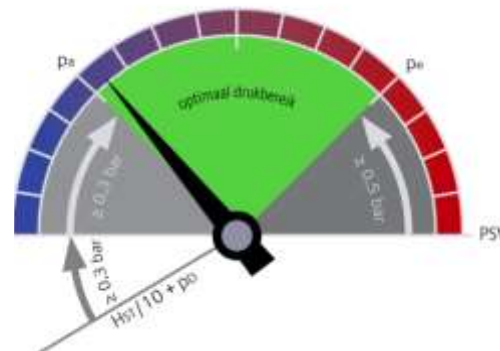
Toestand bij levering
(voordruk)



Installatie gevuld
geen opwarming
(vuldruk)



Maximum druk bij de
hoogste temperatuur
(einddruk)

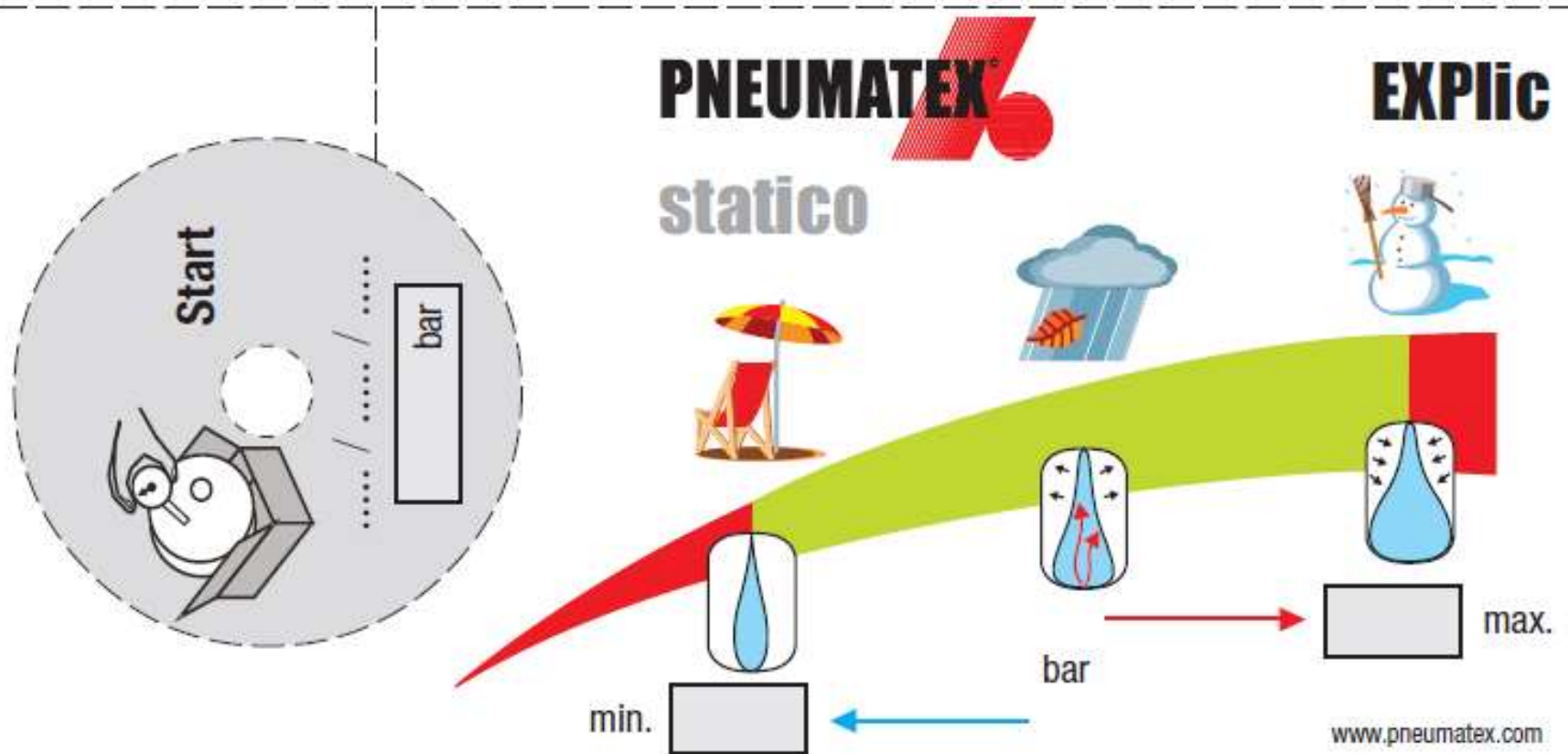


Compression of the gas cushion leads to pressure increase (BOYLE's law)

- Consequently substantial difference between gross volume vs. useful volume
- Users don't relate the pressure increase vs water absorption of the tank: daily practice shows numerous problems
- Problem cost can be extreme: multiple of cost of the tank



Reality however shows that:
systems with closed expansion tanks
(variable pressure) BARELY VARY IN PRESSURE



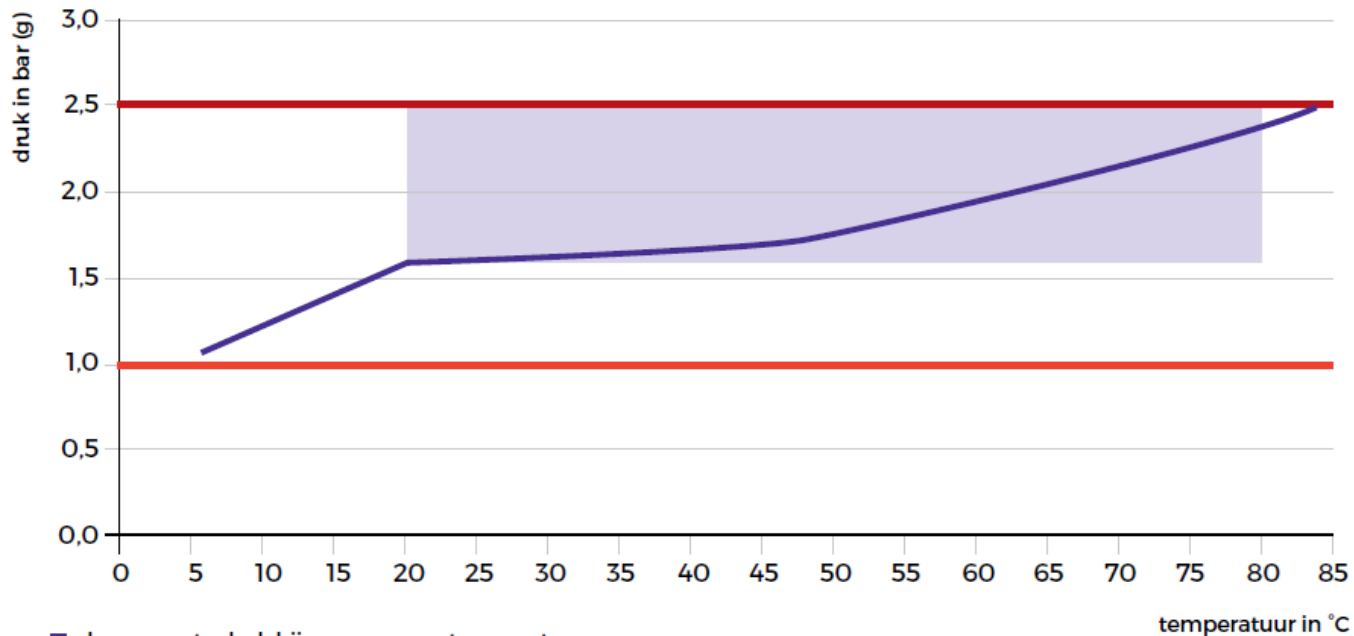
HOW COME? ... and what are the consequences ?



T-P graph in theory

Figuur 2:

T-P GRAFIEK VOOR WARMWATERINSTALLATIES



■ de gewenste druk bij een gegeven temperatuur

■ absoluut minimale druk (= voordruk expansievat)

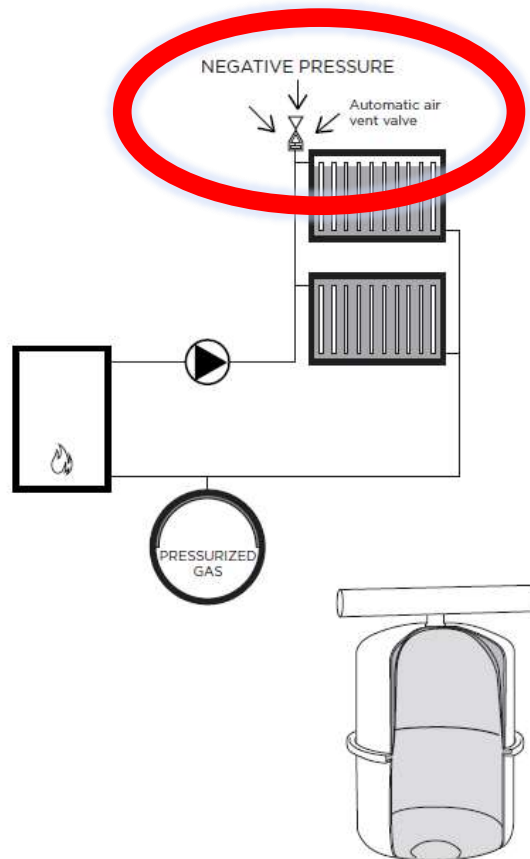
■ absoluut maximale druk (= openingsdruk veiligheidsventiel minus veiligheidsmarge).
De veiligheidsmarge = 0,5 bar bij ventielen tot 3 bar, 10% bij hogere insteldrukken

■ de drukvariatie weer die in warmwatersysteem mag heersen (verticaal druk in bar(g), en horizontaal temperatuur in °C). Het veilige gebied (geen onmiddellijk risico op onderdruk of overdruk) is in feite een band over en onder de blauwe lijn.

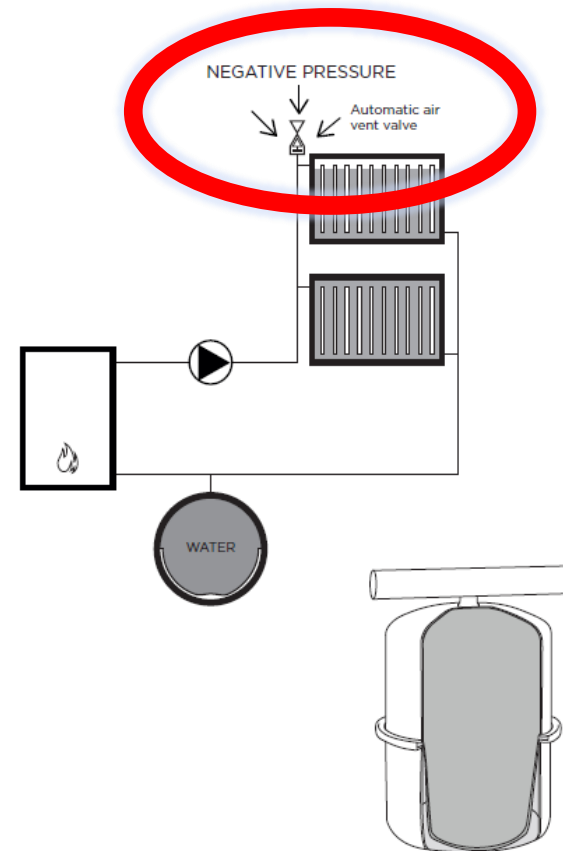


If pressure at the highest point is not guaranteed
AT ALL TIME,
there is an even more **serious problem**

Excessively high inflation pressure,
therefore, too little water in the
expansion vessel



Inflation pressure too low (potentially due to loss
of inflation pressure?), therefore too much water
in the expansion vessel





Known mechanisms of oxygen entry:

Magnetite formation [g] in a 1000l water system:

Cause of oxygen entry	Once (startup)	Yearly	Ranking
Residual (trapped) AIR 10%	91		6
Initial FILL water	36		7
Topping up (replenishment)		3,6	8
Negative pressure		3.658	3
Permeation through plastics with EVOH layer		135	4
Permeation plastics no oxygen barrier		235.686	1
Permeation rubber hoses		5.971	2
Oxygen from expansion tank 150/1,5	375		5



Conclusion: proper system design

- Do not use oxygen diffuse synthetics
 - “old” (non-barrier type) polyethylene, polybutene, polypropylene, PVC, ...
 - Rubber
- Take care of proper pressurization
- Minimize other risks
- Protect by means of corrosion monitoring



Minimize other risks: Domestic hot water preparation

Safety valves that (often) leak ALWAYS reveal an underlying problem

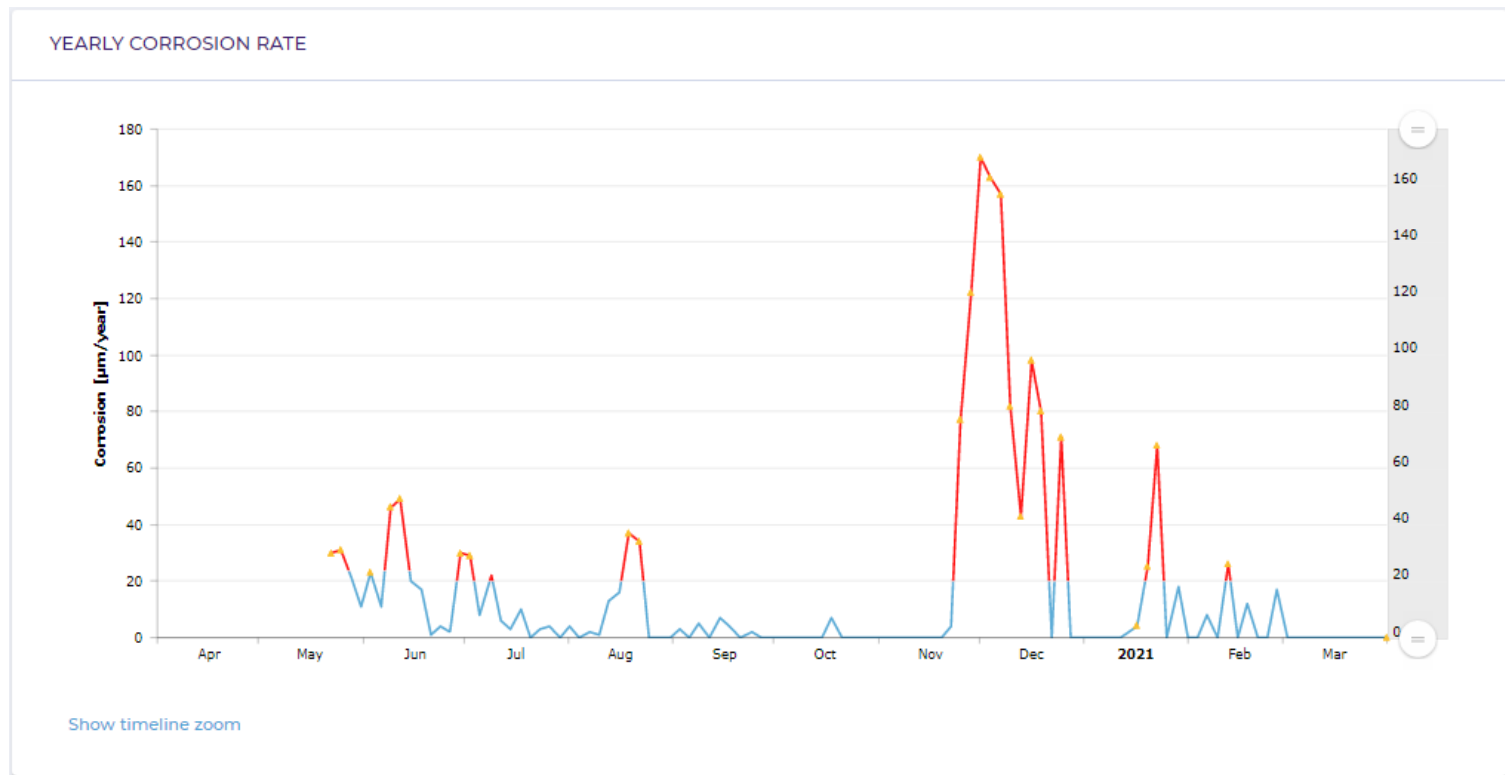




Other risks:

Domestic hot water preparation

- Safety valves that (often) leak ALWAYS reveal an underlying problem: case PIVA

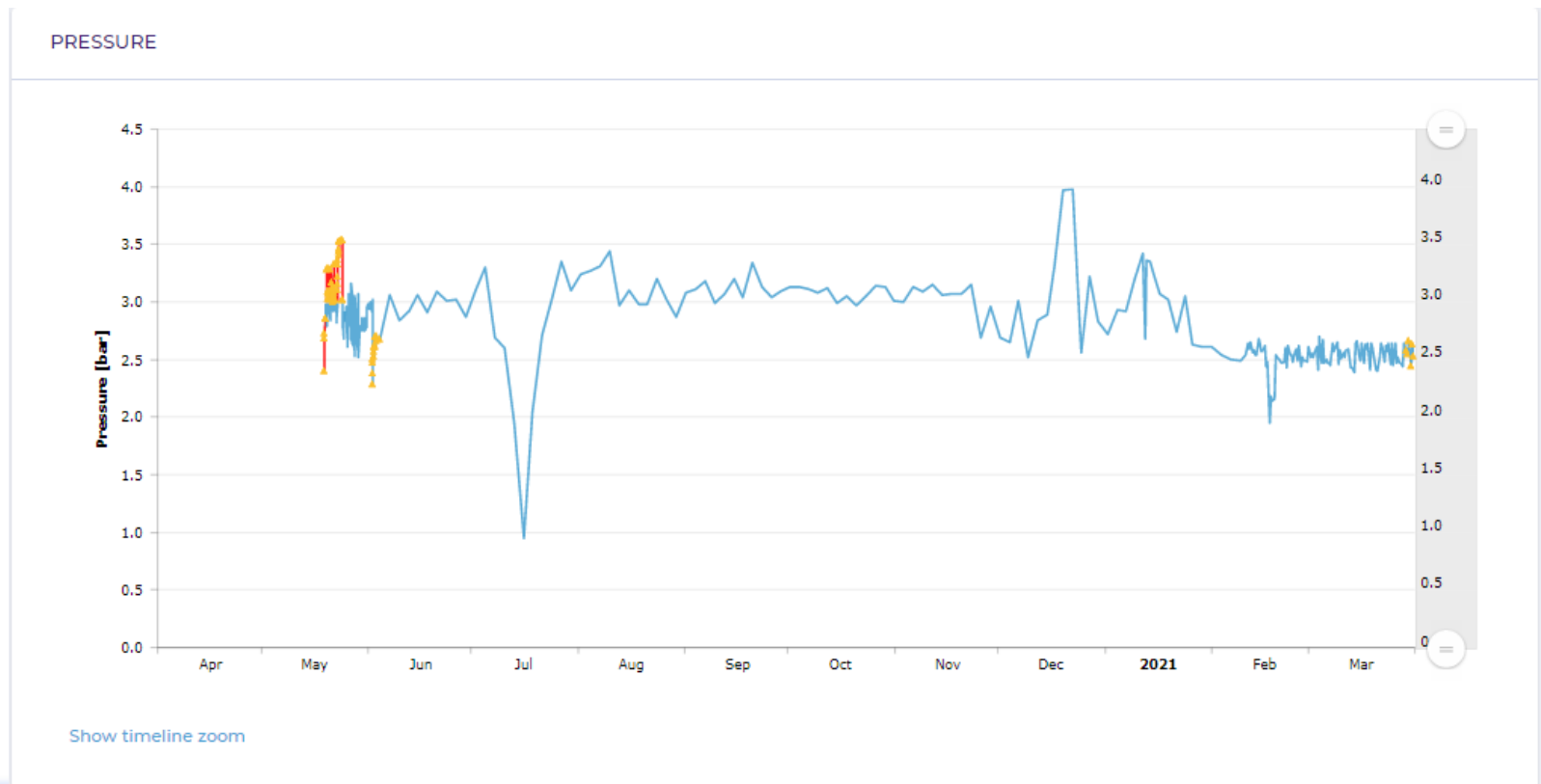




Other risks:

Domestic hot water preparation

Safety valves that (often) leak ALWAYS reveal an underlying problem: case PIVA

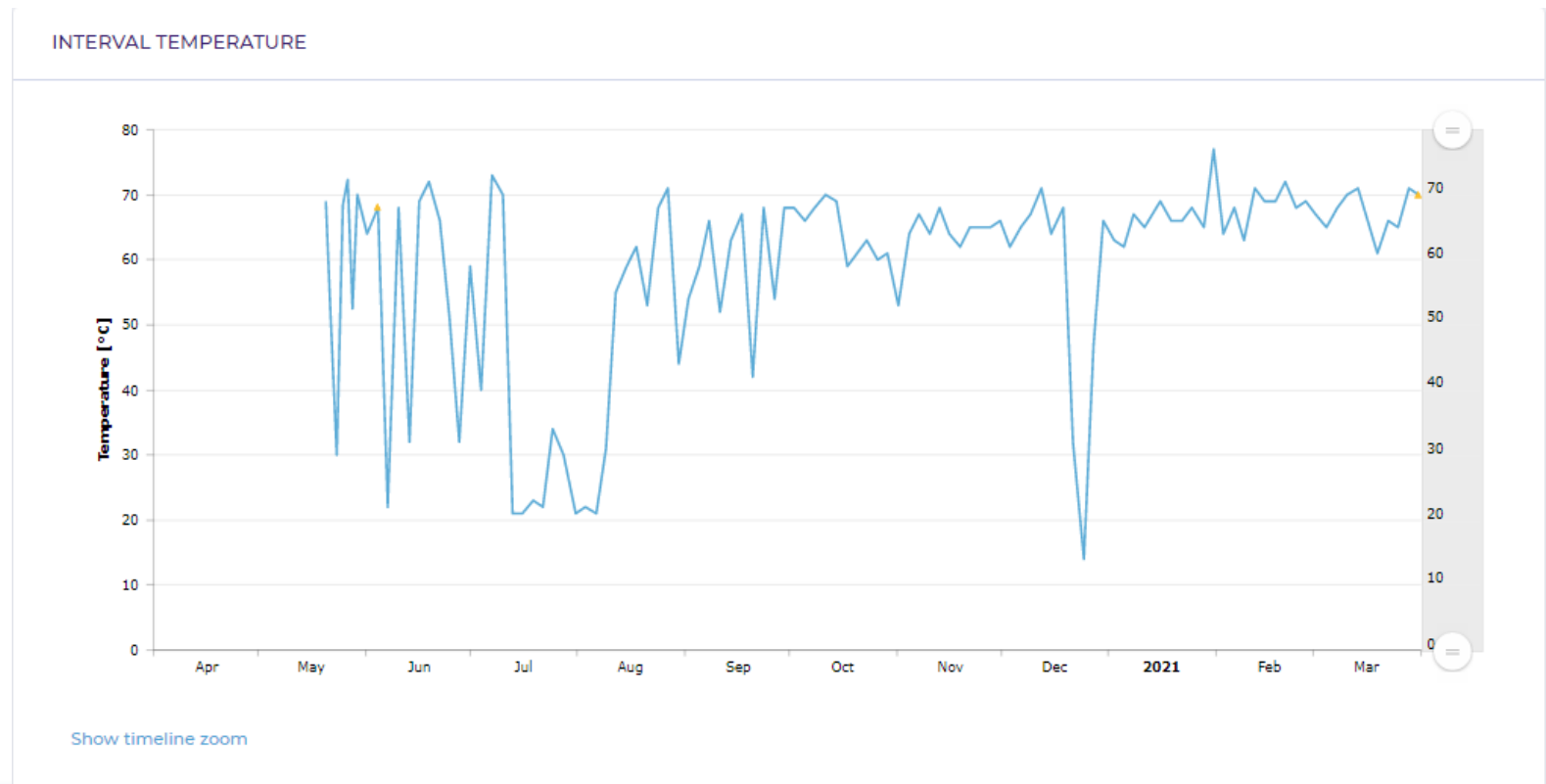




Other risks:

Domestic hot water preparation

Safety valves that (often) leak ALWAYS reveal an underlying problem: case PIVA

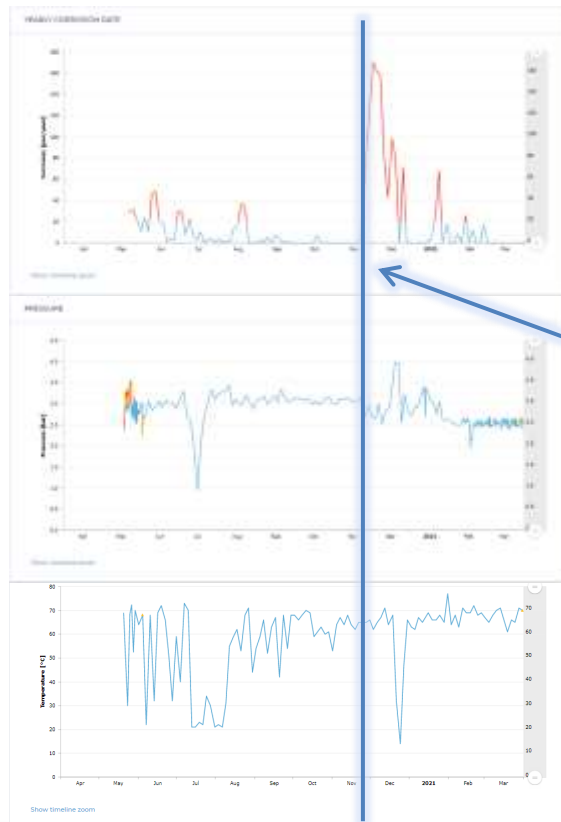




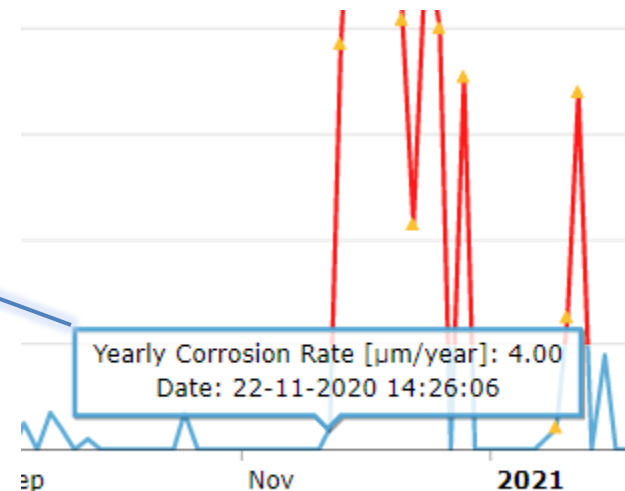
Other risks:

Domestic hot water preparation

Safety valves that (often) leak ALWAYS reveal an underlying problem: case PIVA



Start of a heavy increase in corrosion rate

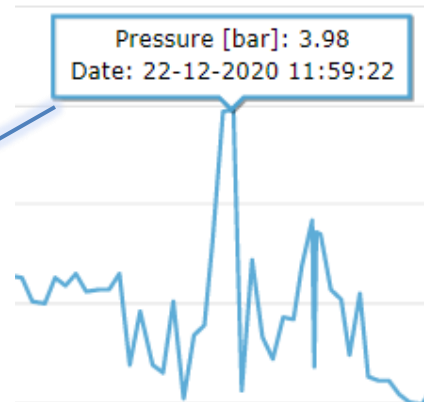
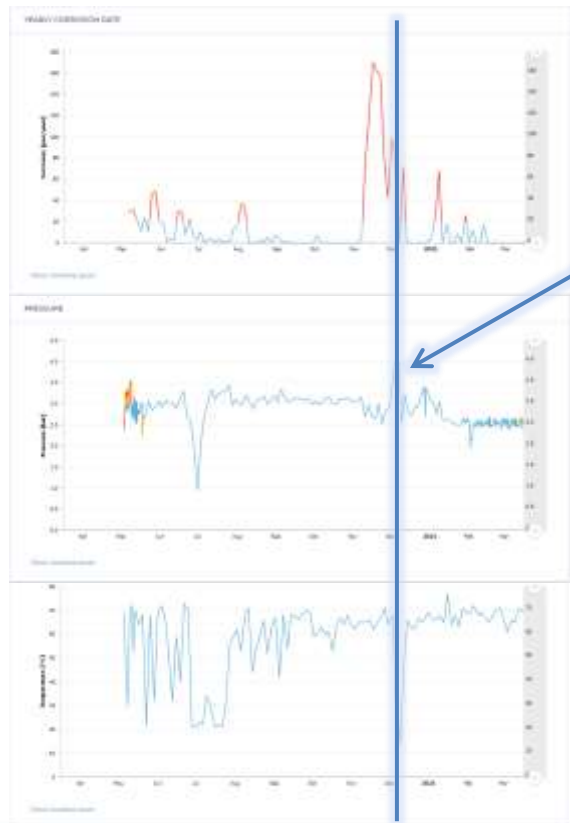




Other risks:

Domestic hot water preparation

Safety valves that (often) leak ALWAYS reveal an underlying problem: case PIVA



First opening of safety valves at 4 bar



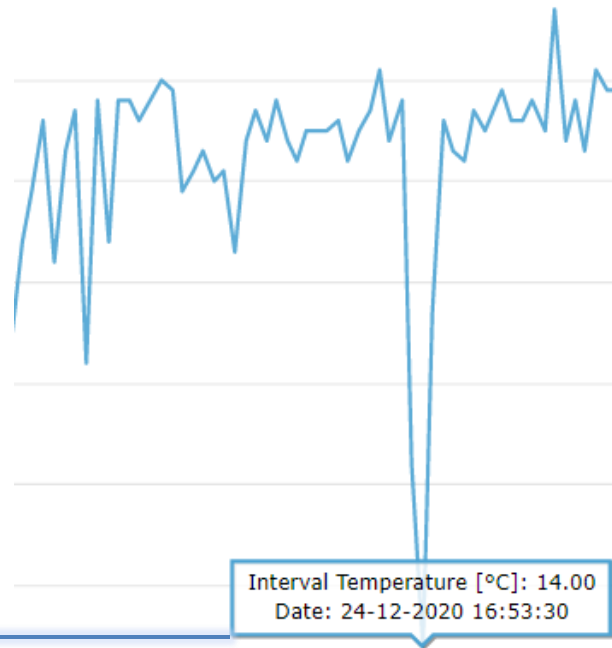
Other risks:

Domestic hot water preparation

Safety valves that (often) leak ALWAYS reveal an underlying problem: case PIVA



System breaks down, temperatures drop to lowest level





We encounter one such system at least once a month...

- Cause can be a leaking boiler or plate heat exchanger
- Or a combination with other causes, which is the reason that the true underlying cause is masked by other symptoms (see further)
- The user very seldom sees the problem
 - His heating system works fine most of the time
 - Leaking safety valves are often connected to drain pipes
 - The awareness of the long-term consequences is just not there



Just a few examples





VERY OFTEN
leaking safety valves
may also reveal
a defunct expansion /
pressurization

- Loss of inflating pressure
- Wrongly situated zero-point
- Malfunctioning content indicator
- Pressurization tank (system) undersized or wrongly calibrated





Minimize other risks: pressure step degasser (vacuum degasser)

[Home](#)[Over de cluster](#)[Innovatie](#)[Inspiratie](#)[Nieuws & ager](#)

Case study's smart buildings

Om de sector te inspireren met welke smart toepassingen er zijn, willen we u motiveren om de weg naar smart buildings te verkennen en ook te helpen de eerste drempels te overwinnen. We doen dit door u kennis te laten maken met de cases en de voorbeelden van smart building toepassingen beschreven.

Ben je als clusterlid geïnteresseerd om in de kijker te zetten, klik dan hier.

AZ Zeno kiest voor gebouwbeheersysteem met unieke topologie

[Version française](#)

Slimme corrosiedetectie in CV-installaties

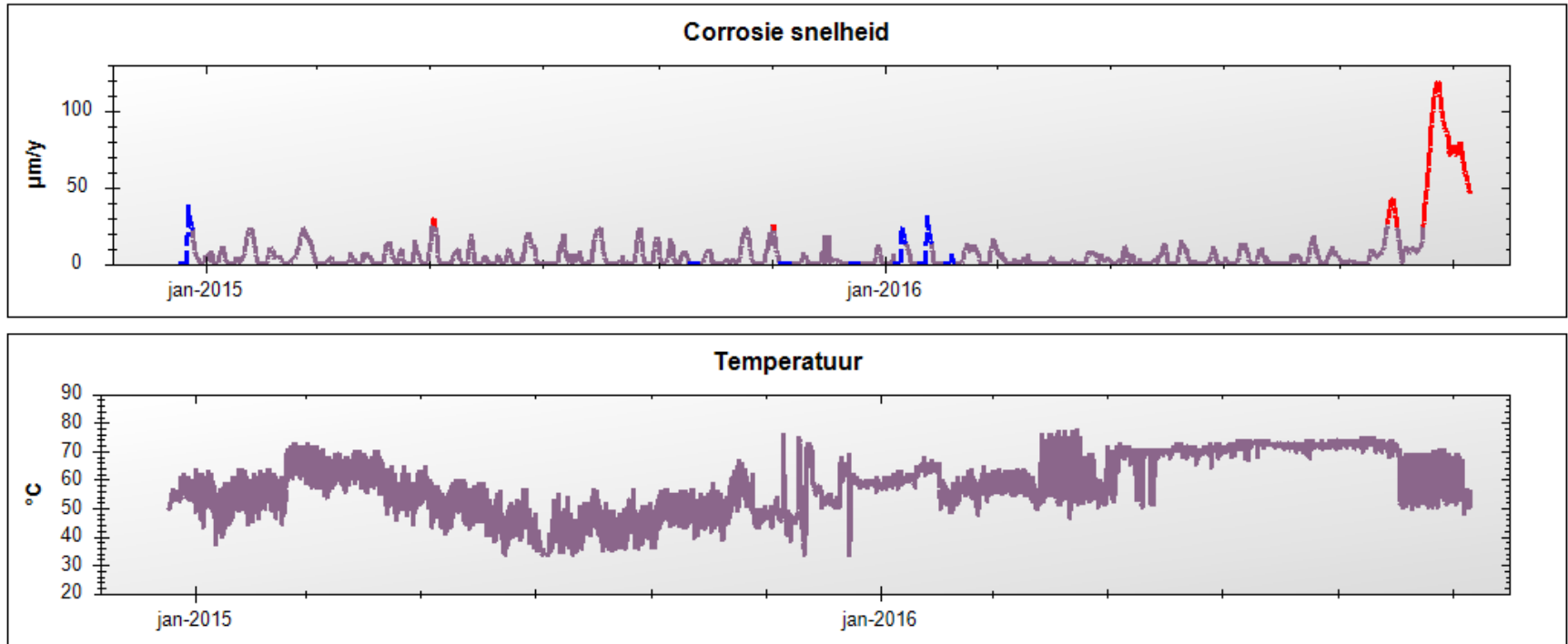
[Version française](#)

Slim techniek beheren in winkelketens

[Version française](#)



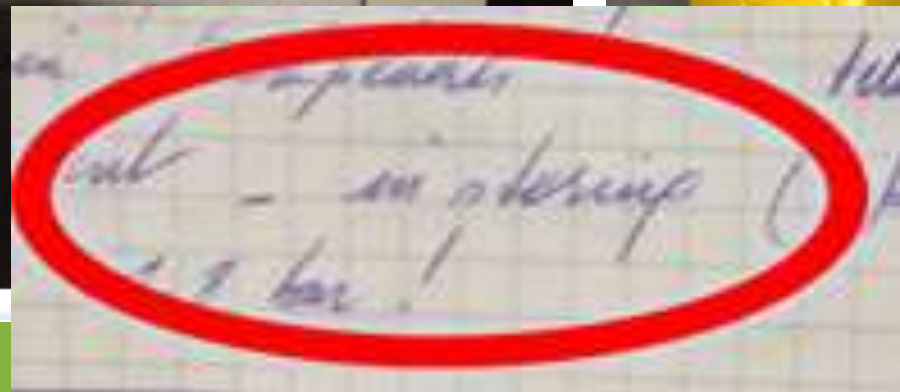
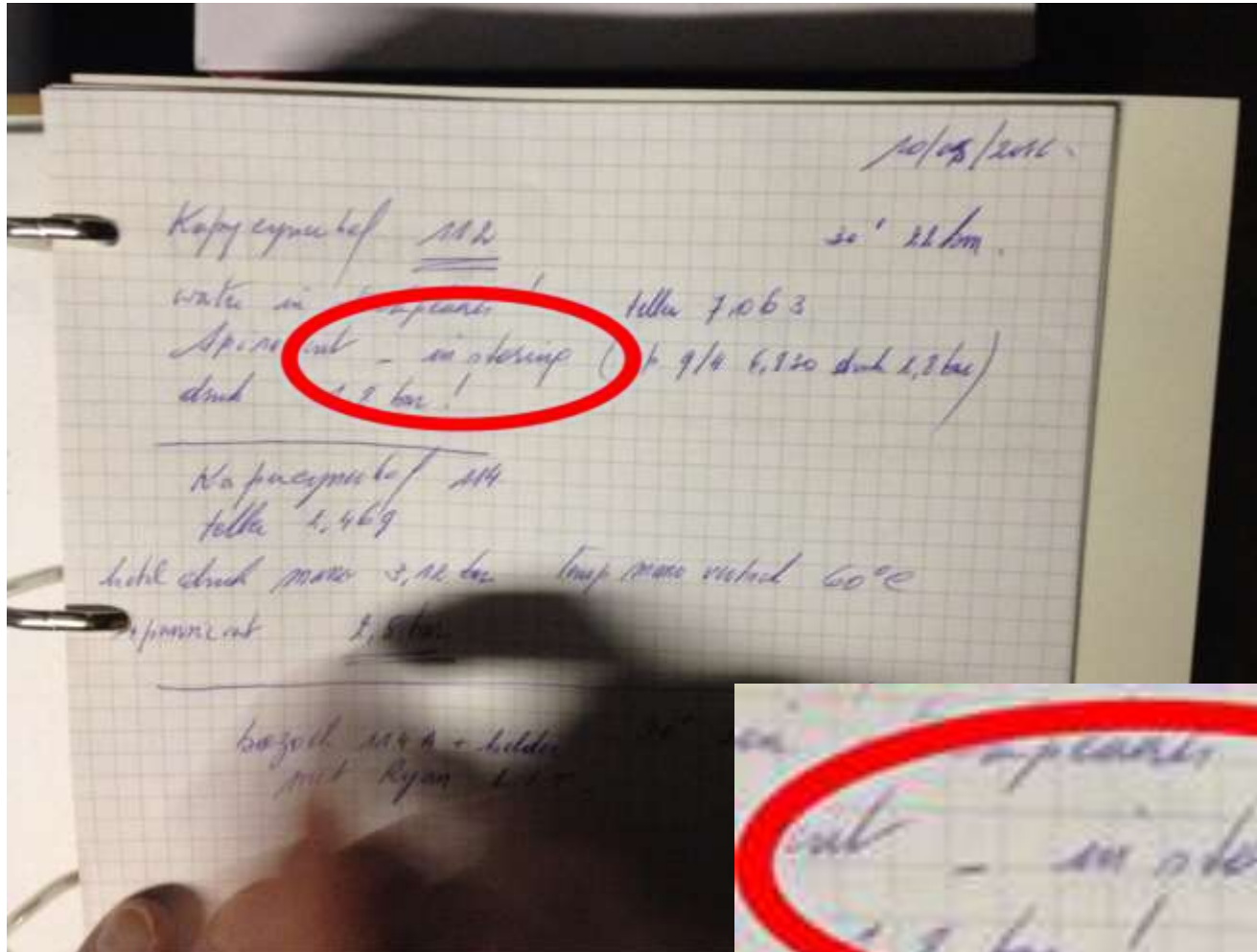
2 years of trouble-free operation, suddenly a huge peak in corrosion



After a little investigation, the vacuumdegasser reveals to have a problem...

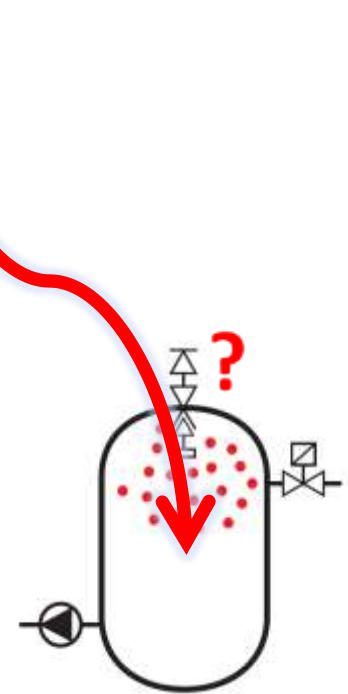
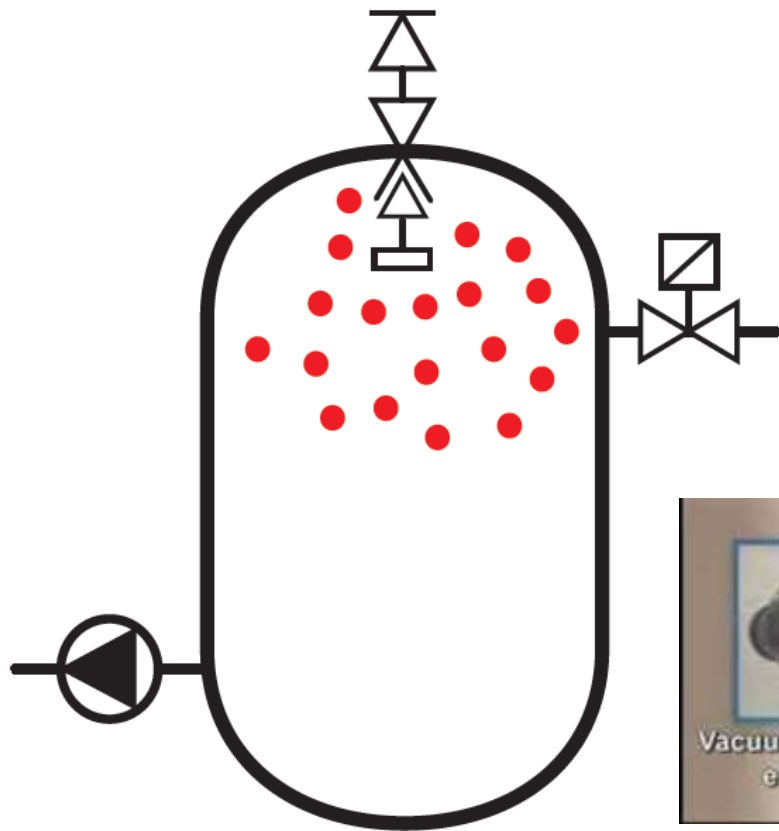


Logbook mentions a problem with the degasser, inspection shows ...



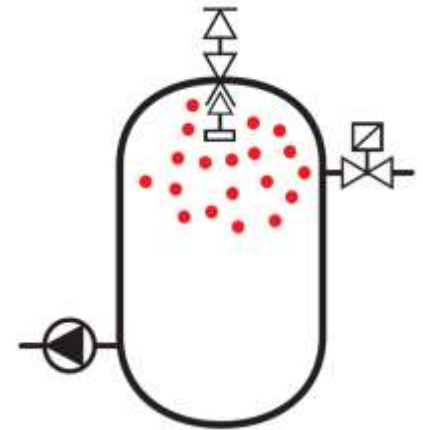
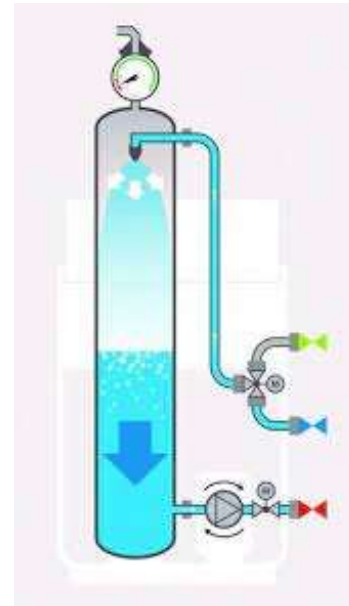
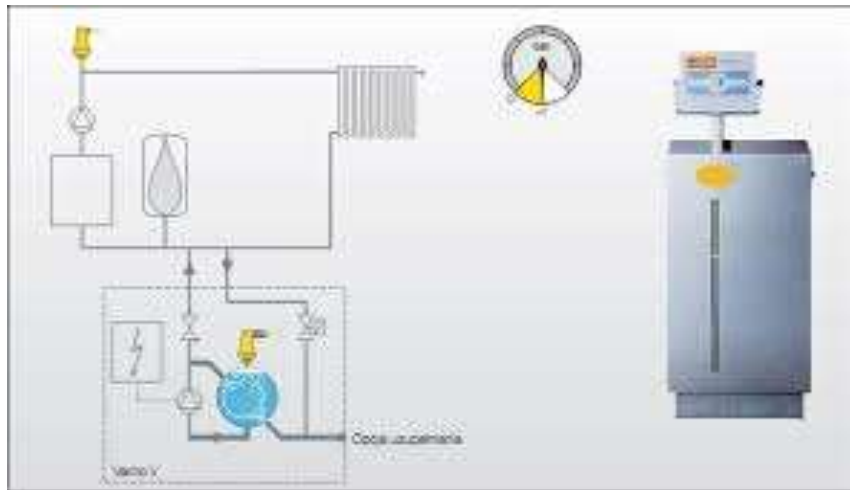
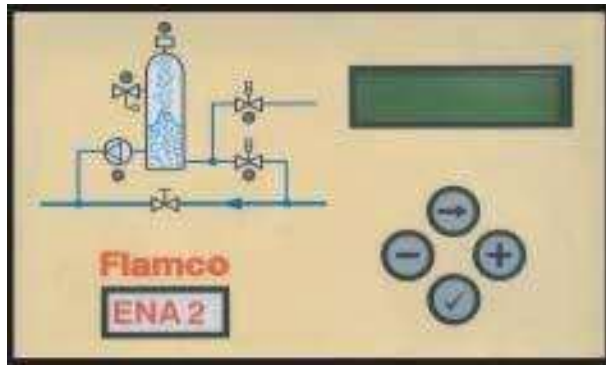


Some vacuum degassers on the market continue pumping, even if they have a malfunction



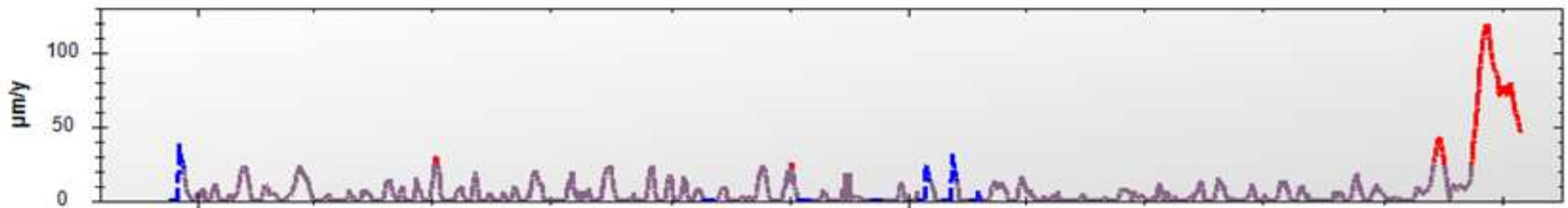
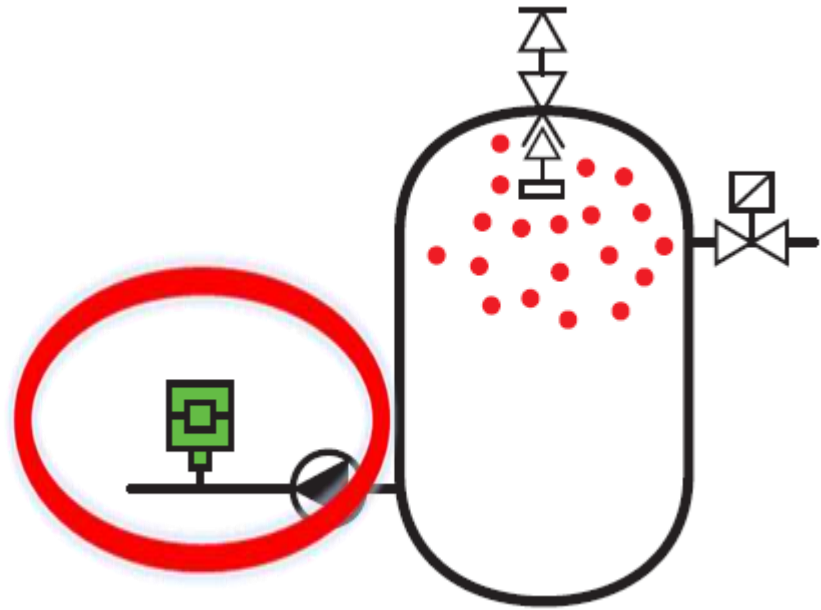


Well known brands: Flamco, Reflex, Pneumatex, Spirotech





Conclusion: vacuum degassers must be corrosion-monitored





Combisystems: often a very well hidden menace





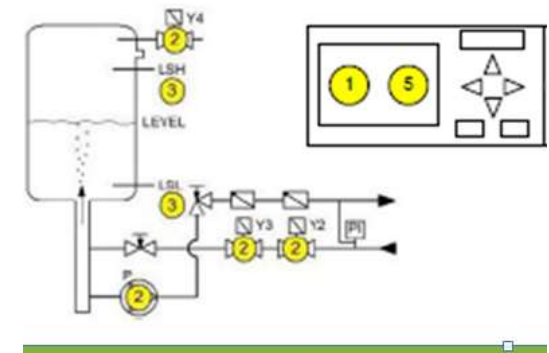
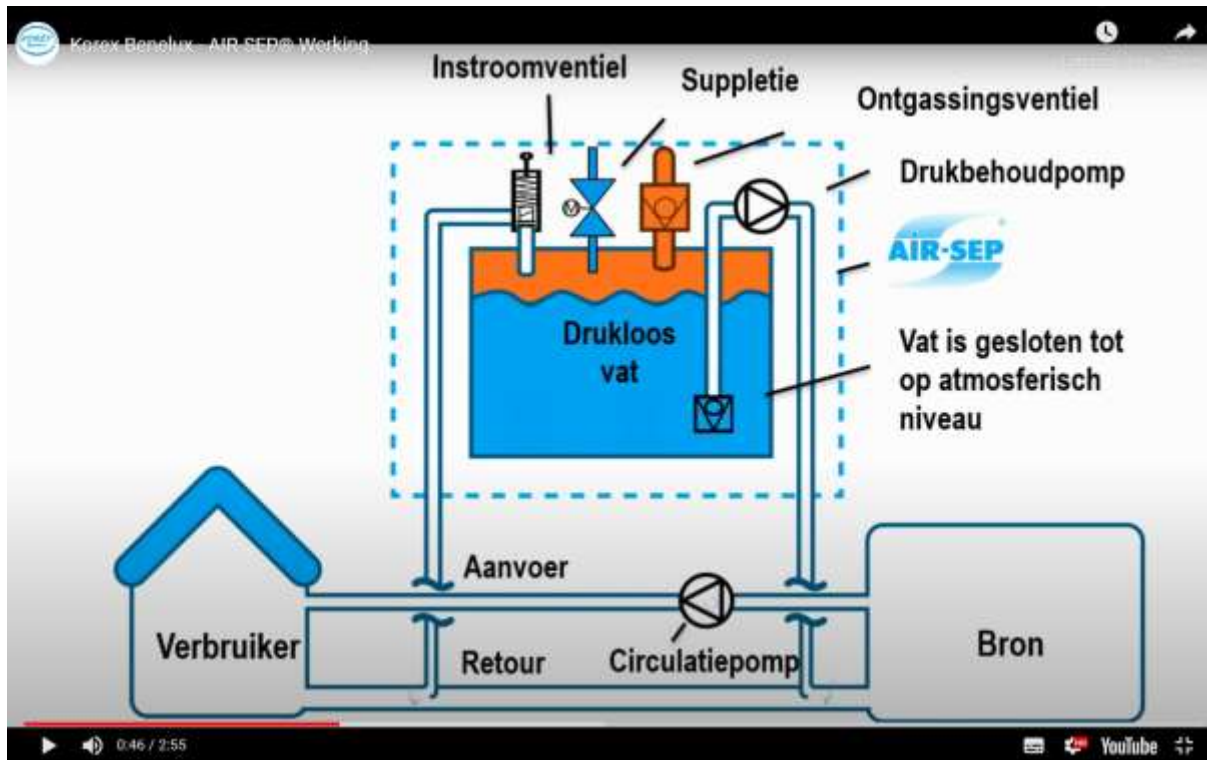
combi expansion and degassing



and oxygenating !

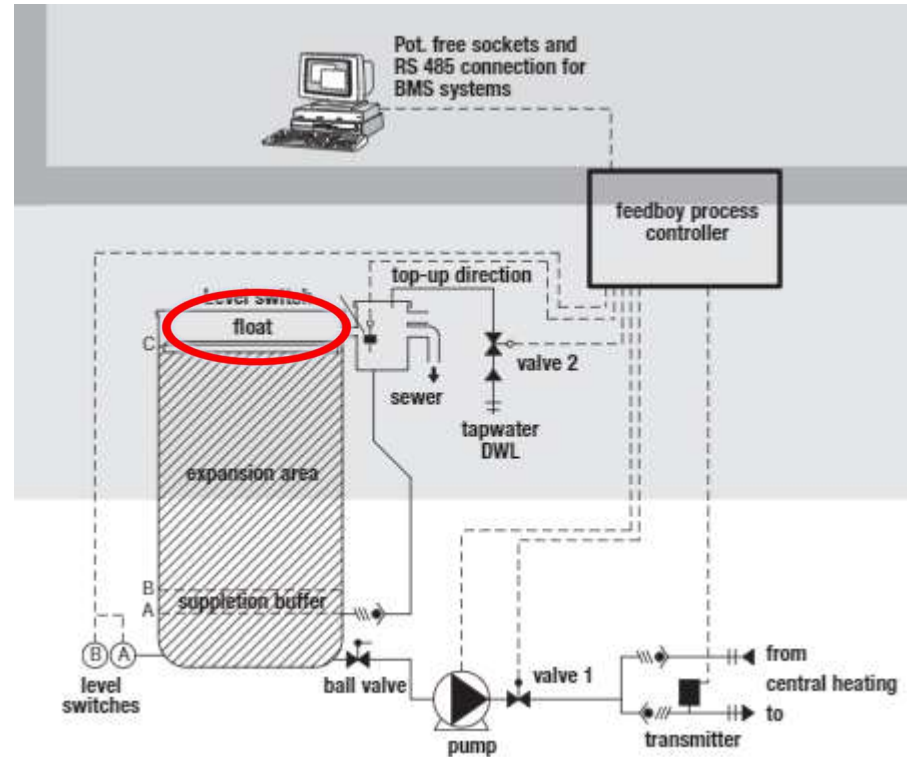


Korex and Olymp have an open degassing vessel that looks closed





Flexcon Feedboy (not available anymore) has a PU float





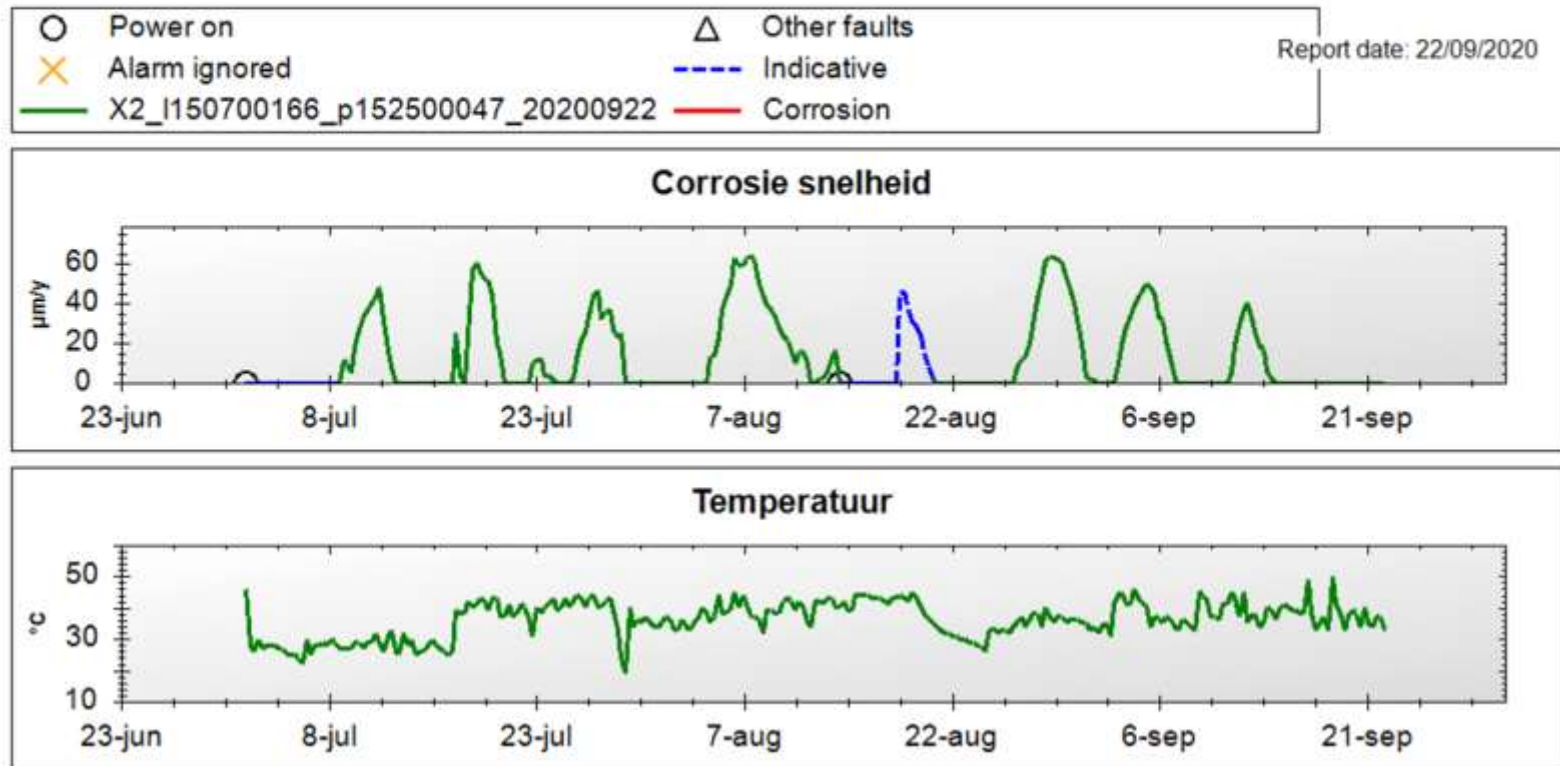
The interior speaks for itself



And this tank is
made of
STAINLESS
STEEL !!!

The rust deposit
originates from
the pipes of the
system !!!

Combi expansion system (expansion + degassing combined): DEFUNCT VACUUM RETAINER VALVE



One small Risycor in a very remote part of a system over 100m3 detects a recurring corrosion pattern

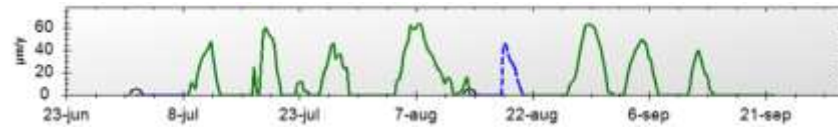


In the main boiler room,
I discover an interesting detail





Automatic air vents WITH non return valve



That were NOT screwed airtight, but mounted loose !!!



These tanks become open tanks that breathe !!!



Flamcomat and Reflex Variomat have the same functional principle

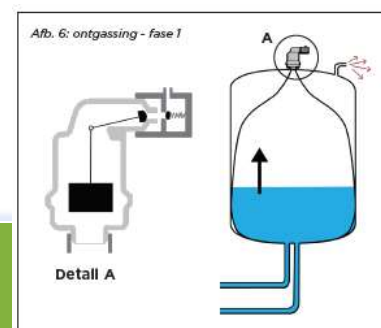
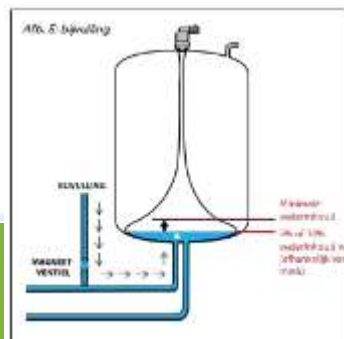
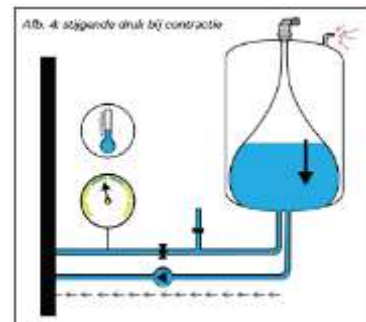
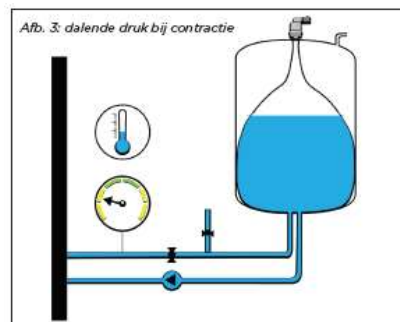
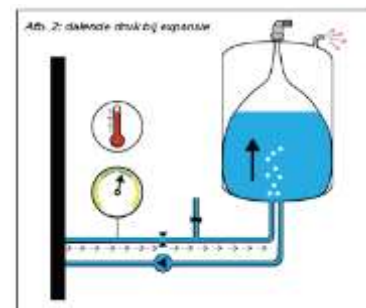
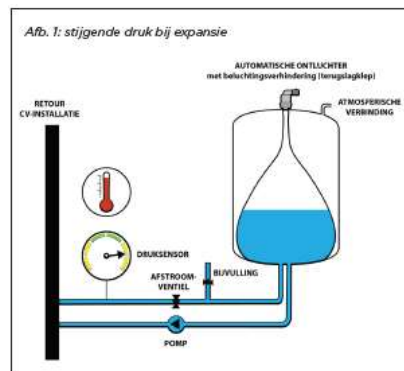




Most sadly there is also a “Rubbergate”

VERTROUWELIJK EN ANONIEM ONDERZOEK
NAAR EEN MOGELIJK BELANGRIJKE
CORROSIEVEROORZAKER

April 2020





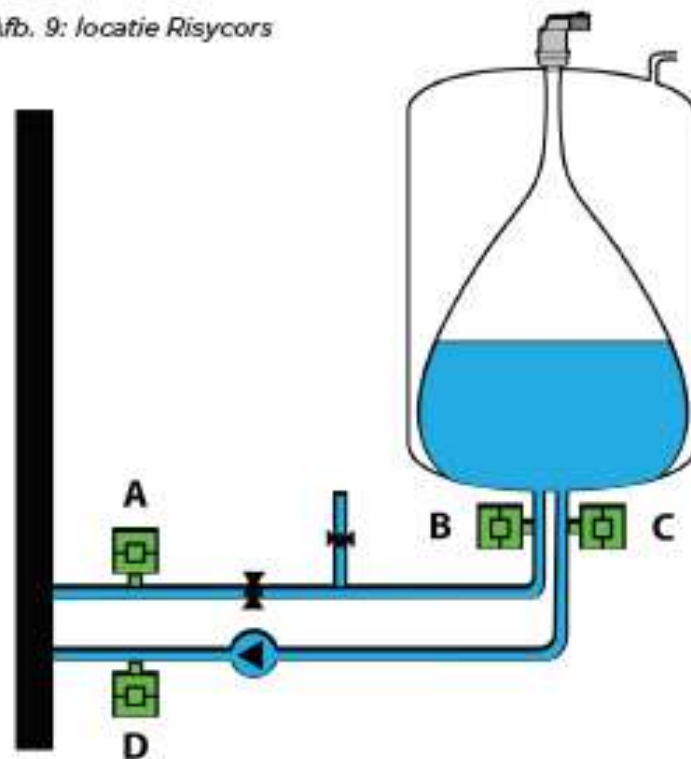
Afb. 8: EPDM balg in een Reflex Variomat



Permeability coefficient
($\text{cm}^3\text{-cm} \times 10^{-8}/\text{cm}^2\text{-s-atm}$)

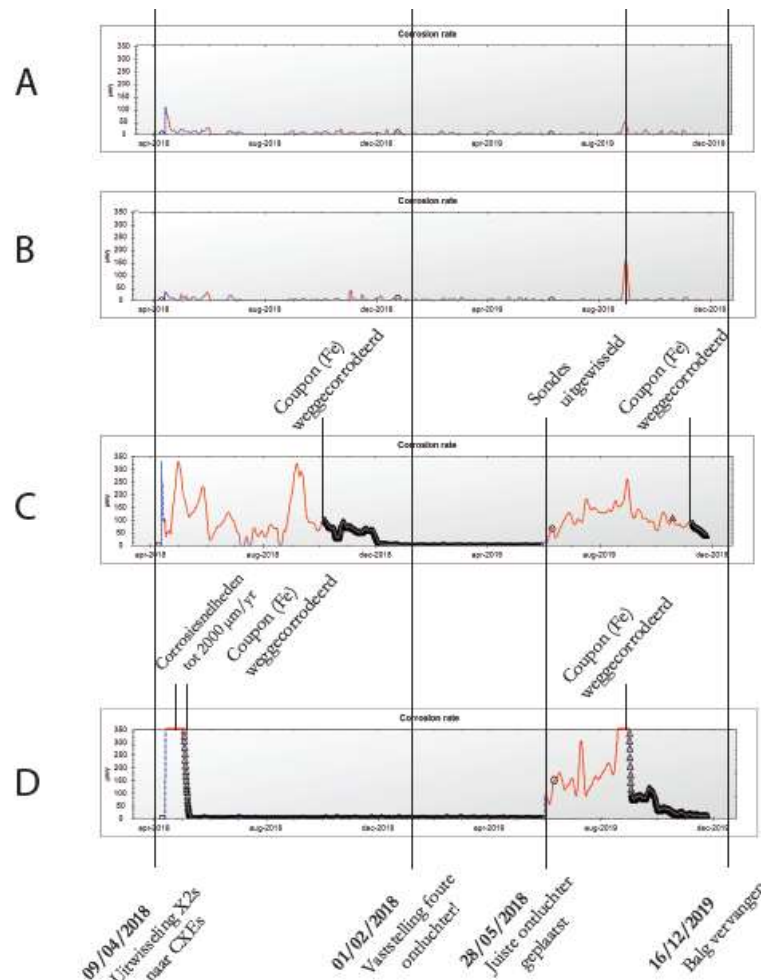
Gas	IIR	EPDM
Lucht	.6	7.9
CO2	3.92-5.18	85
H2	5.5	29-111
He2	6.4	19.7
Stikstof	.24	6.4
Zuurstof	.99	16-18

Afb. 9: locatie Risycors



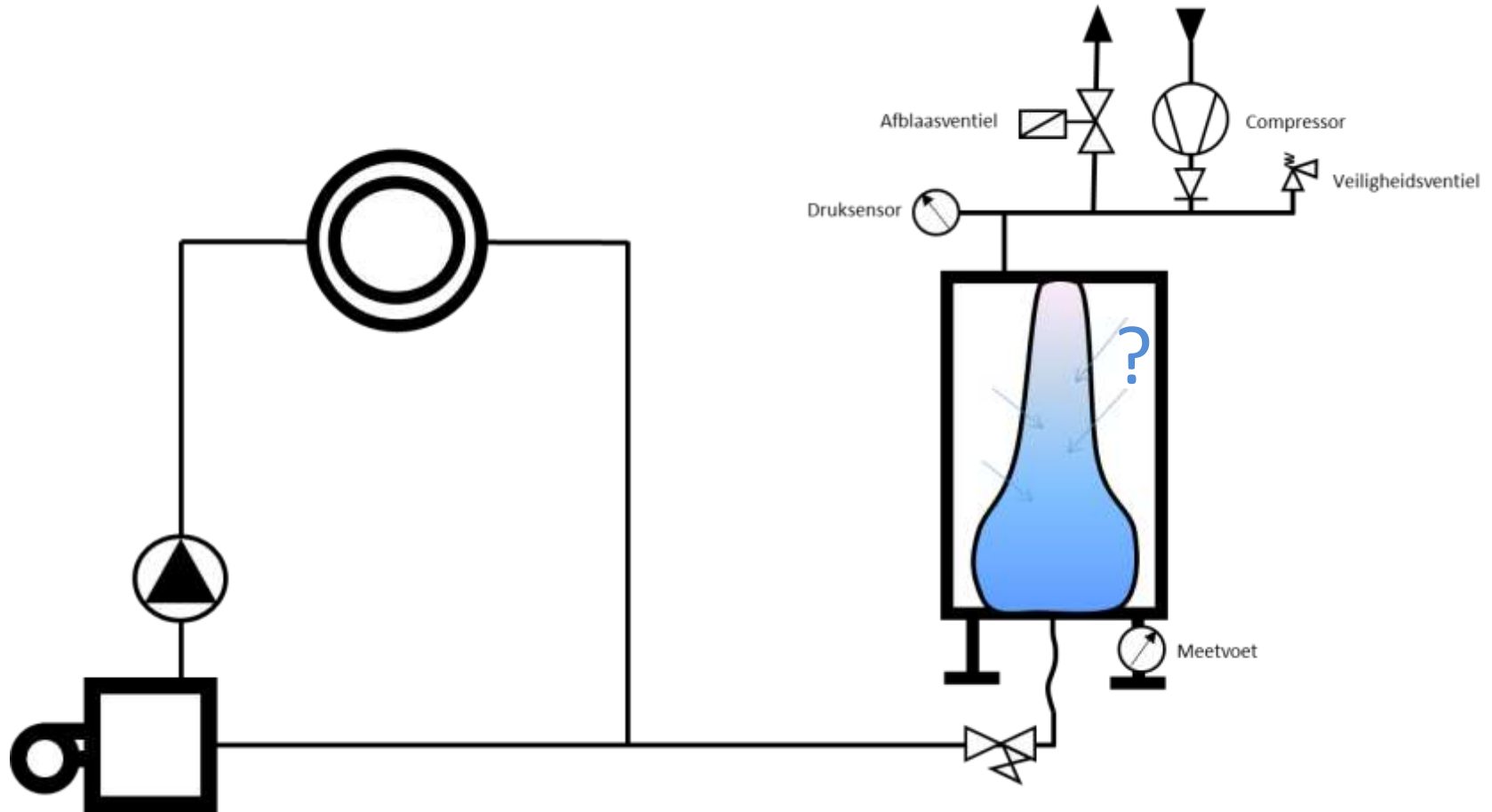


Afb. 12: vier RIsycor CX-en gemonteerd in de installatie



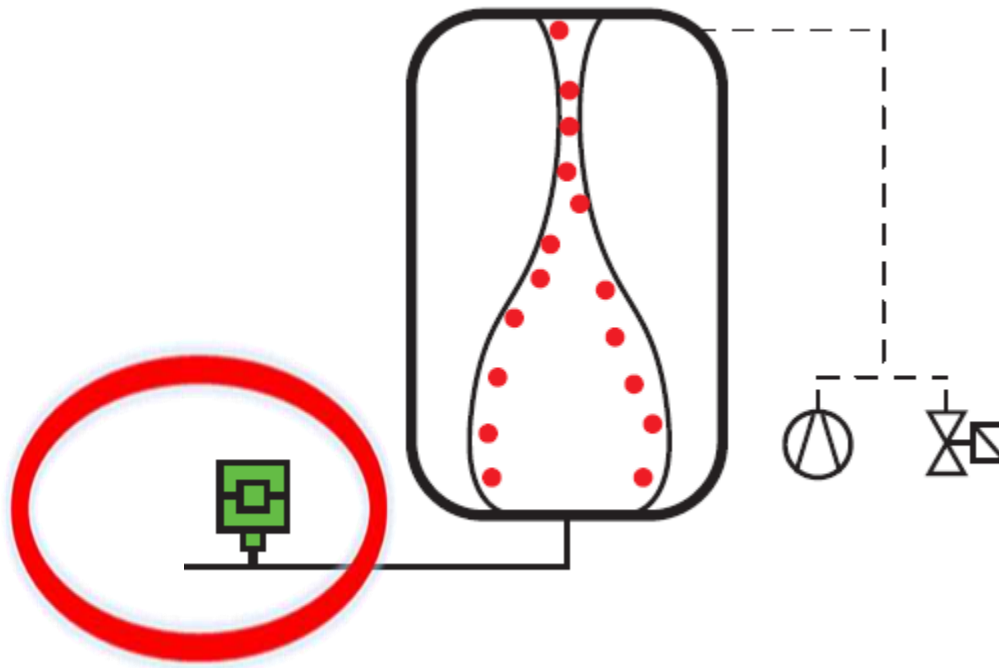


Finally: compressor systems





Conclusion: compressor systems must be corrosion-monitored





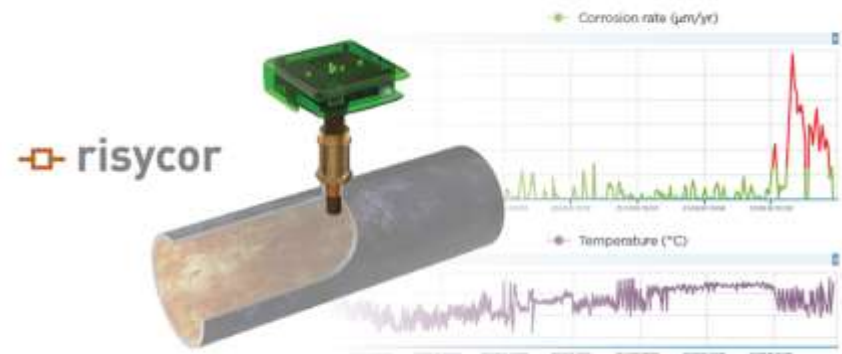
Corrosion monitoring:

- ✓ Desired security level
- ✓ Budget
- ✓ Technical complexity
- ✓ Ease of problem solving

WTCB/CSTC writes:

Aangezien corrosie een sluipend verschijnsel is, wordt aanbevolen om – ook in kleinere installaties – in corrosiemonitoring te voorzien

La corrosion étant un phénomène insidieux, il est recommandé de mettre en place un monitoring, et ce même dans les petites installations



3 possible scenarios

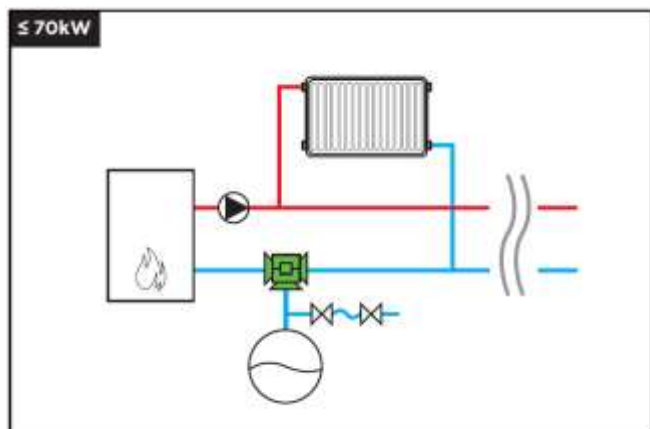
✓ **Minimal** : one Risycor per system

✓ **Optimal** : **minimal** +
✓ one Risycor per RISK CIRCUIT
✓ one Risycor per RISK COMPONENT

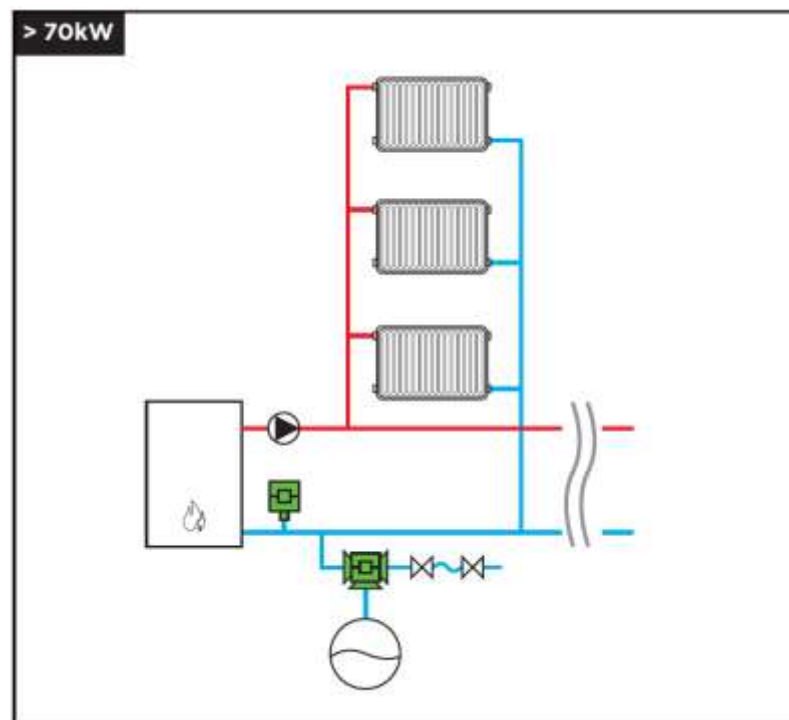
✓ **Ideal** : **optimal** +
✓ one Risycor in return of every riser



Application guideline: Minimal



All in ca. 500€

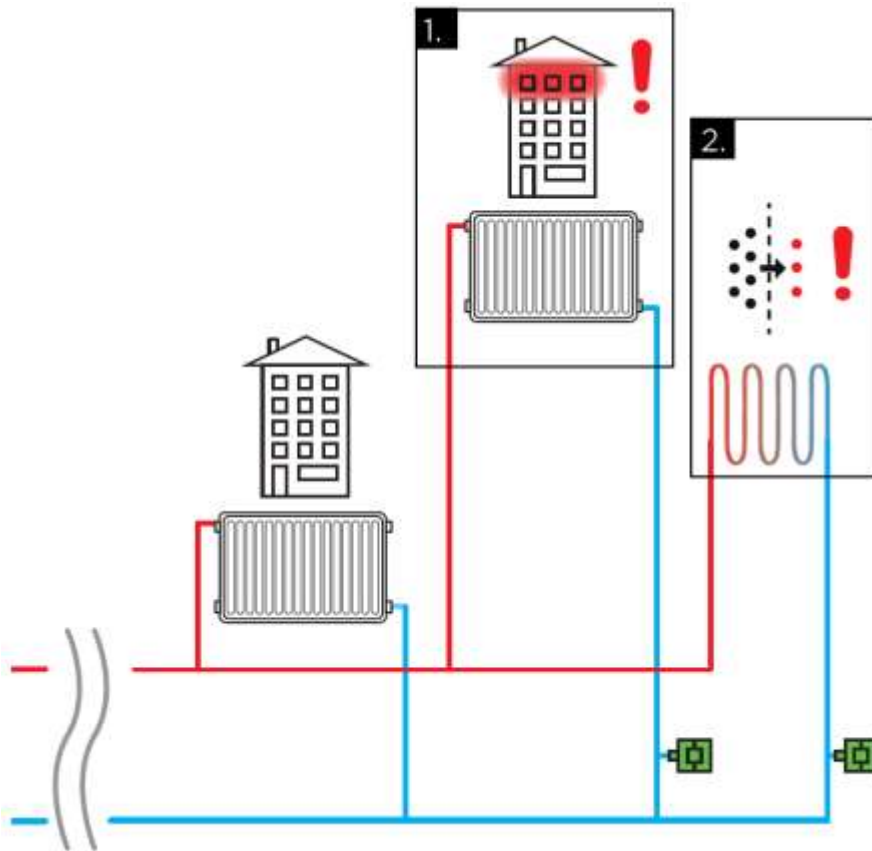


All in ca. 1500€





Application guideline: Optimal



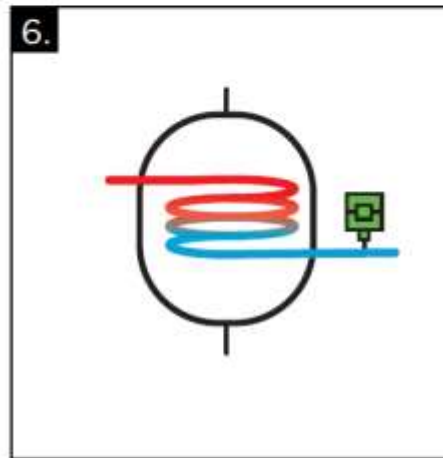
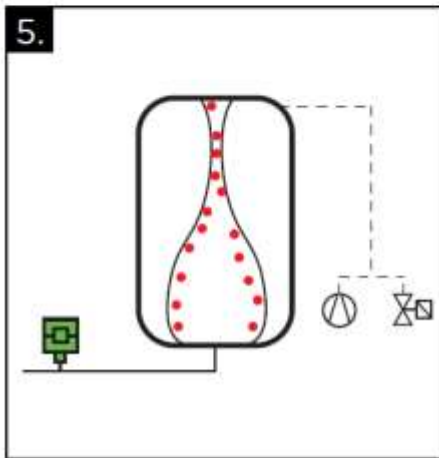
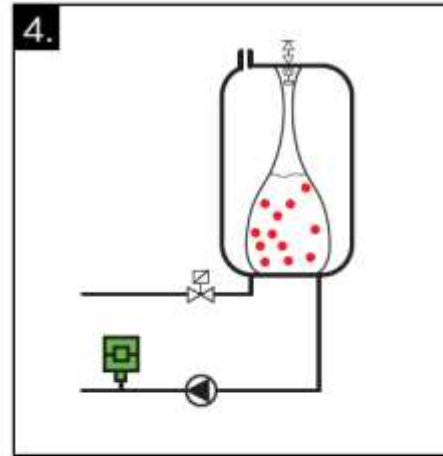
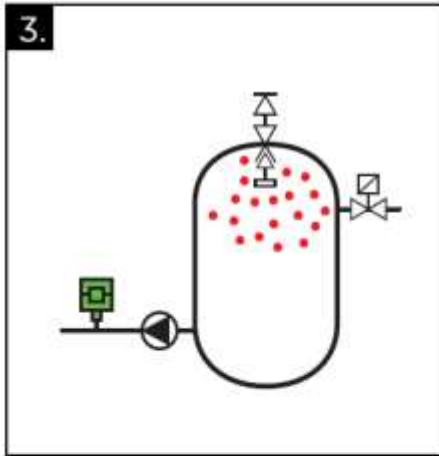
Circuits @RISK
for oxygen entry:

- ✓ Highest point
- ✓ Non-oxygen tight synthetics
- ✓ Rubber hoses





Application guideline: Optimal



Components @RISK for oxygen entry:

- 3. pressure step- (or vacuum) degassers
- 4. combi- pump expansion systems
(degassing within the bladder)
- 5. Compressor expansion systems
- 6. domestic hot water generation





Application guideline: **Ideal**

In the return of every riser



Alternative “Ideal low cost” (TXV)



 **risycor**



Look forward