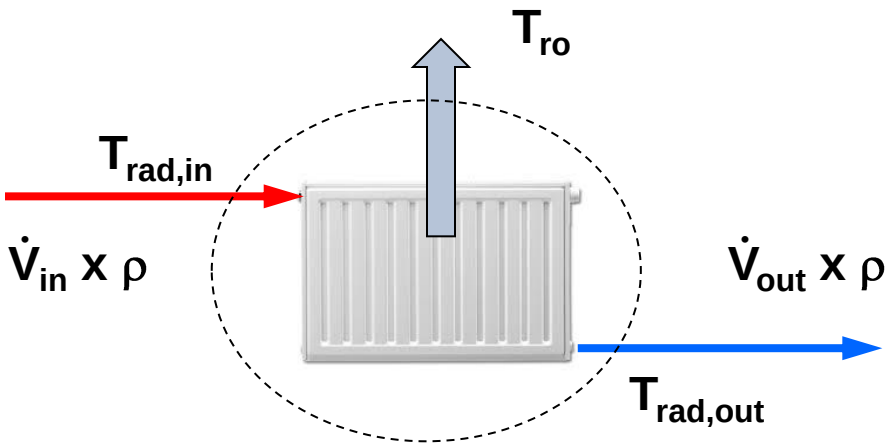
Basisprincipes uit de hydronica

ing. Eddy Janssen

1. Vermogenregeling

$$P_{in} = \dot{V} \cdot \rho \cdot c \cdot (T_{rad,in} - T_{rad,out}) = P_{out} = P_N \cdot \left(\frac{\Delta T_{log}}{\Delta T_{log,N}} \right)^n$$



$$\Delta T_{log} = \frac{T_{rad,in} - T_{rad,out}}{\ln \frac{T_{rad,in} - T_{room}}{T_{rad,out} - T_{room}}}$$

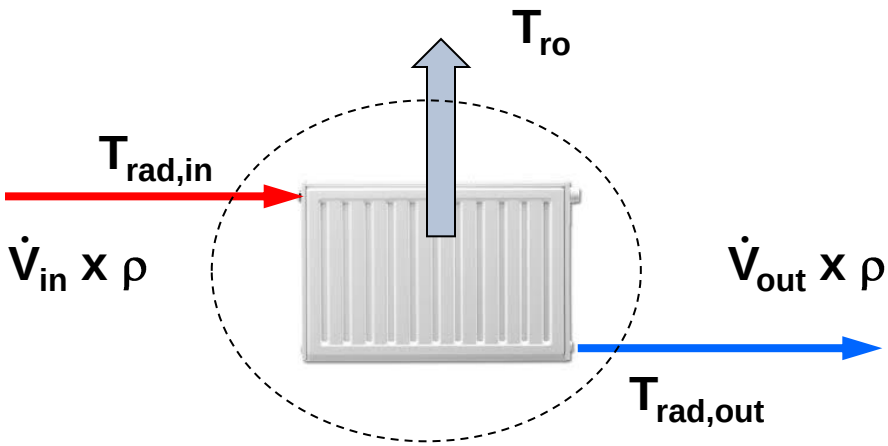
$$\Delta T_{gem} = \frac{T_{rad,in} + T_{rad,out}}{2} - T_{room}$$

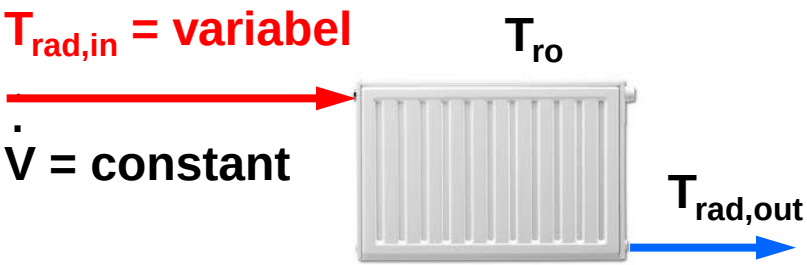
Afbakenen → behoud van massa: in = out

→ behoud van energie: in = out

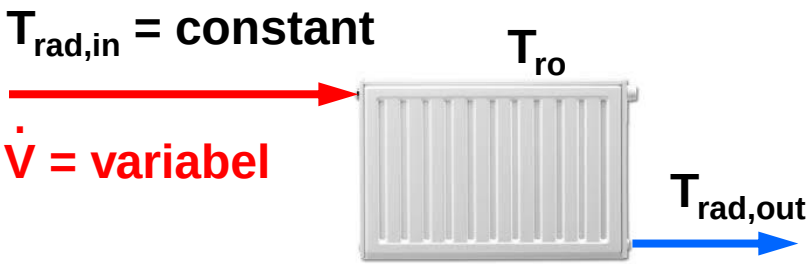
1. Vermogenregeling

$$P_{in} = \dot{V} \cdot \rho \cdot c \cdot (T_{rad,in} - T_{rad,out}) = P_{out} = P_N \cdot \left(\frac{\Delta T_{log}}{\Delta T_{log,N}} \right)^n$$



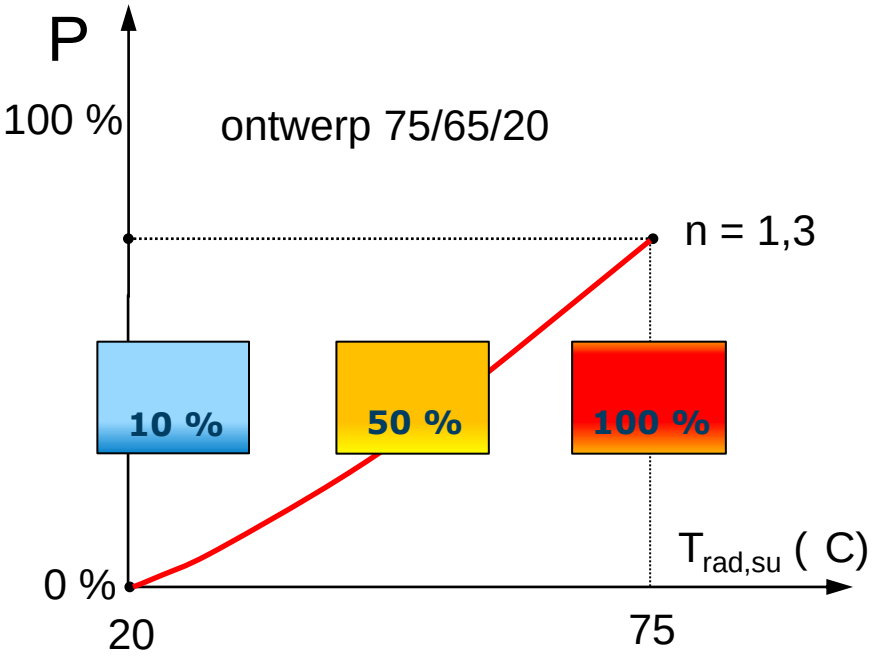


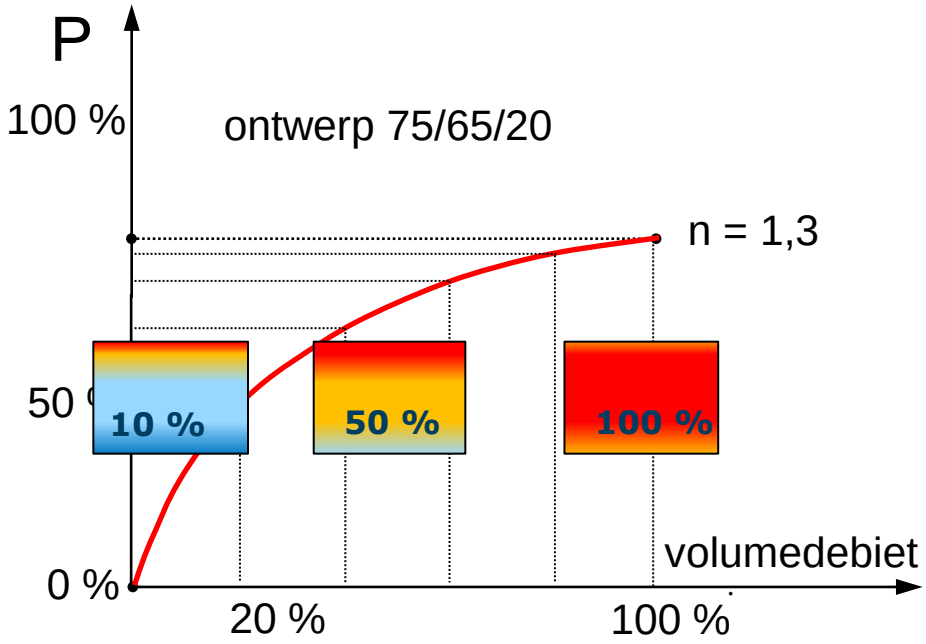
watertemperatuurregeling



waterdebietregeling

1. Vermogenregeling





$T_{rad,in}$ = variabel

T_{ro}

$\dot{V}$ = constant

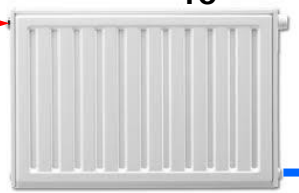
$T_{rad,out}$

watertemperatuurregeling

$T_{rad,in}$ = constant

T_{ro}

$\dot{V}$ = variabel

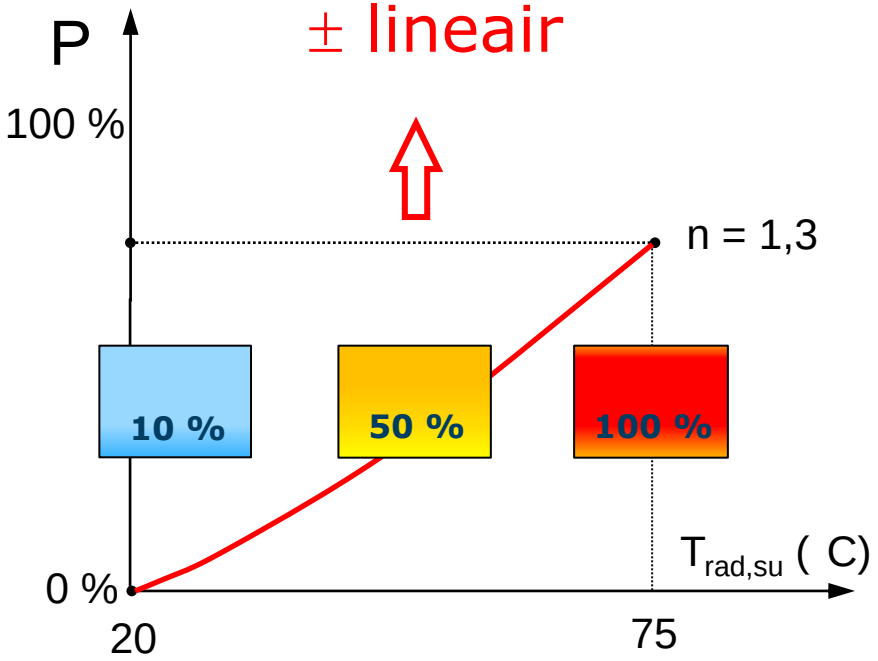


$T_{rad,out}$

waterdebietregeling

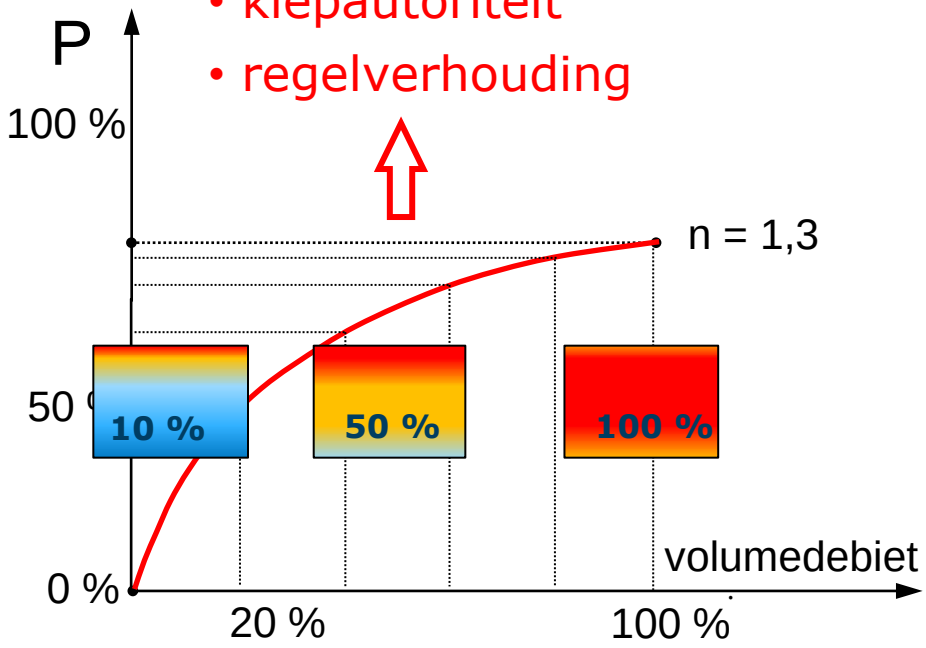
1. Vermogenregeling

± lineair



NIET lineair

- klepkarakteristiek
- klepautoriteit
- regelverhouding



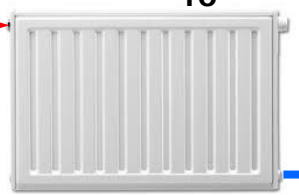
$T_{rad,in}$ = variabel

$\dot{V}$ = constant

watertemperatuurregeling

$T_{rad,in}$ = constant

$\dot{V}$ = variabel

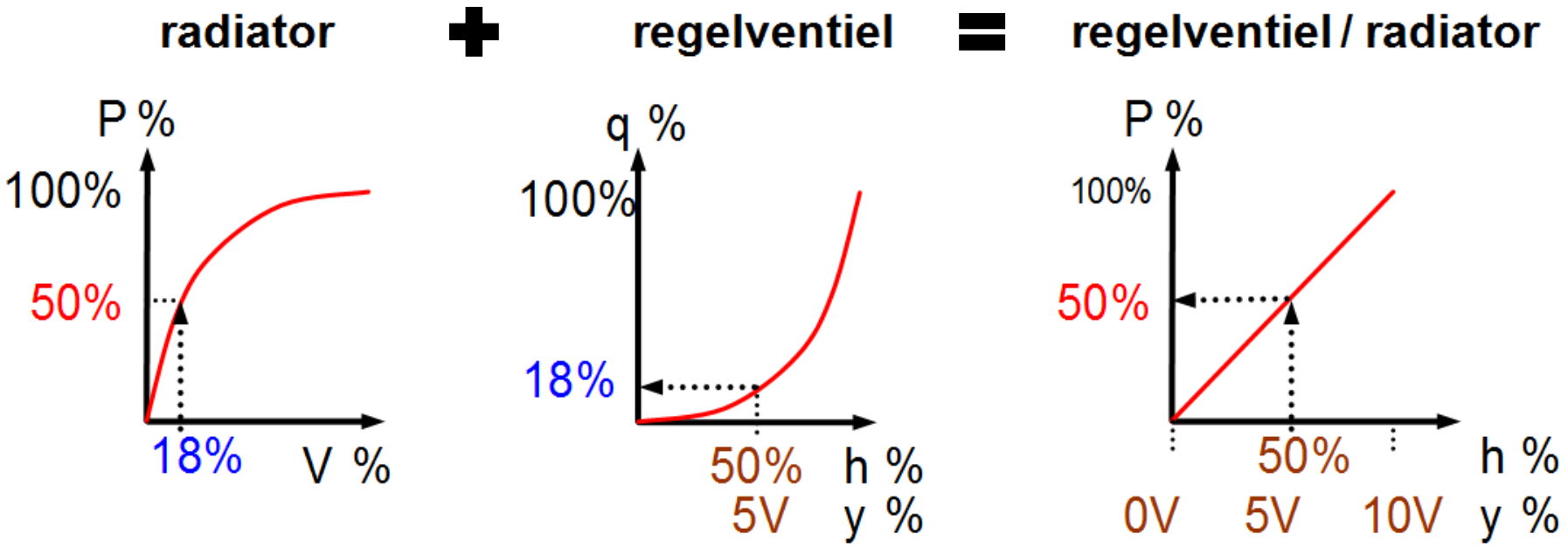


waterdebietregeling

1. Vermogenregeling via waterdebiet

Klepkarakterisitiek

⇨ **lineair gedrag indien Δp_{klep} = constant**

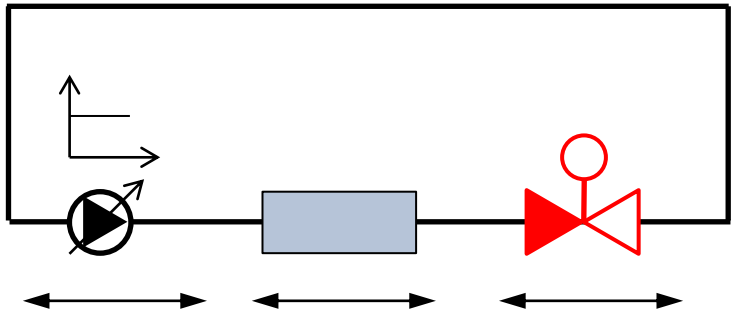


1. Vermogenregeling via waterdebiet

Klepkarakterisitiek

⇒ **lineair gedrag indien Δp_{klep} = constant**

maar $\Delta p_{klep} \neq$ constant ⇒ klepautoriteit β



$$\Delta p_{pomp} = \Delta p_{rest} + \Delta p_{klep}$$

Stel: klep ↘ dus $\dot{V}$ ↘ $\quad c^{te} \quad$ ↘ ↗

1. Vermogenregeling via waterdebiet

Klepkarakterisitiek

⟹ **lineair gedrag indien Δp_{klep} = constant**

maar $\Delta p_{klep} \neq$ constant ⟹ **klepautoriteit** β

$$\beta = \frac{\Delta p_{klep}}{\Delta p_{klep} + \Delta p_{rest}} = \frac{\Delta p_{klep}}{\Delta p_{pomp}}$$

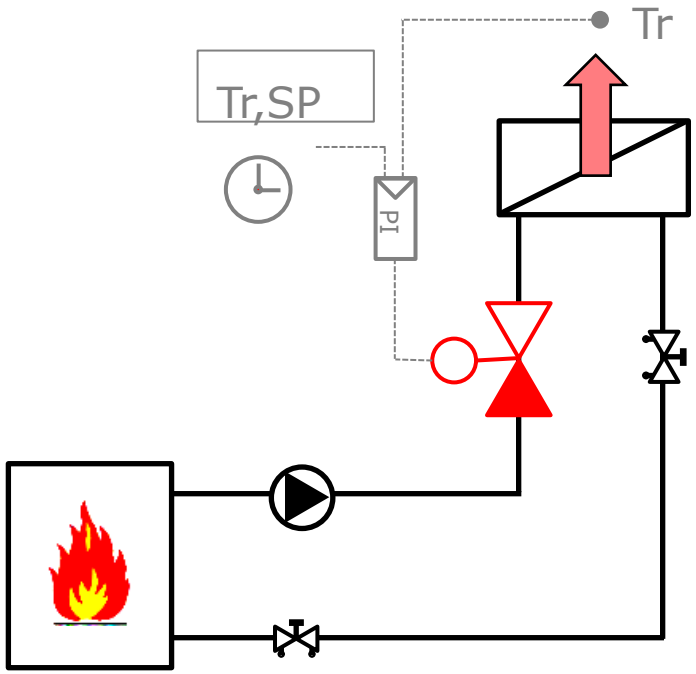
β = mate waarin het debiet luistert naar klep

1. Vermogenregeling via waterdebiet

Klepkarakterisitiek

➡ **lineair gedrag indien Δp_{klep} = constant**

maar $\Delta p_{klep} \neq$ constant ➡ klepautoriteit β



	Δp_{rest}	Δp_{klep}	Δp_{pomp}	β
a	10			
b	10			
c	10			

⬇

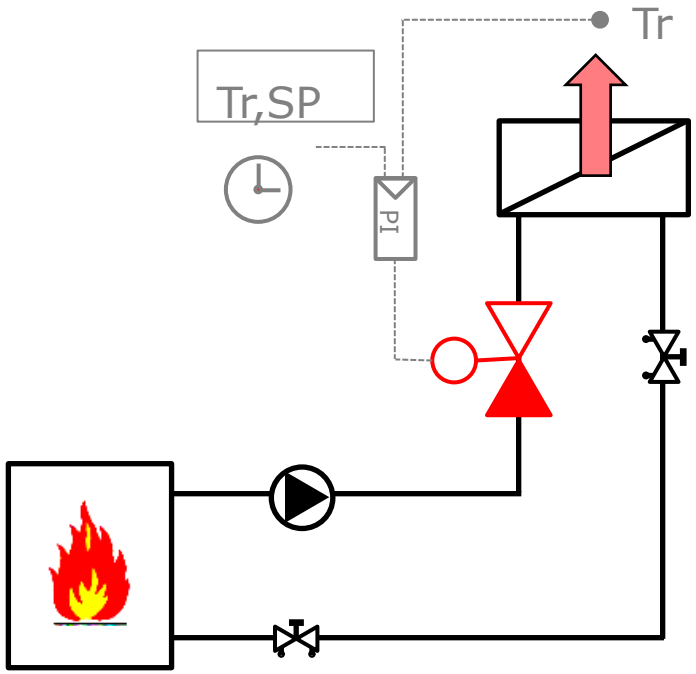
installatieontwerp

1. Vermogenregeling via waterdebiet

Klepkarakterisitiek

➡ lineair gedrag indien Δp_{klep} = constant

maar $\Delta p_{klep} \neq$ constant ➡ klepautoriteit β



	Δp_{rest}	Δp_{klep}	Δp_{pomp}	β
a	10	1		
b	10	10		
c	10	100		

⬇

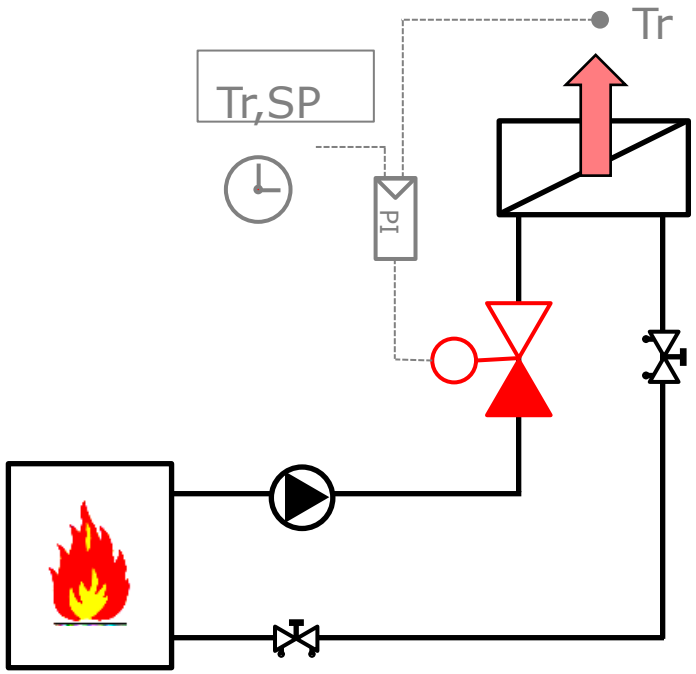
klepkeuze

1. Vermogenregeling via waterdebiet

Klepkarakterisitiek

➡ **lineair gedrag indien Δp_{klep} = constant**

maar $\Delta p_{klep} \neq$ constant ➡ klepautoriteit β



	Δp_{rest}	Δp_{klep}	Δp_{pomp}	β
a	10	1	11	
b	10	10	20	
c	10	100	110	

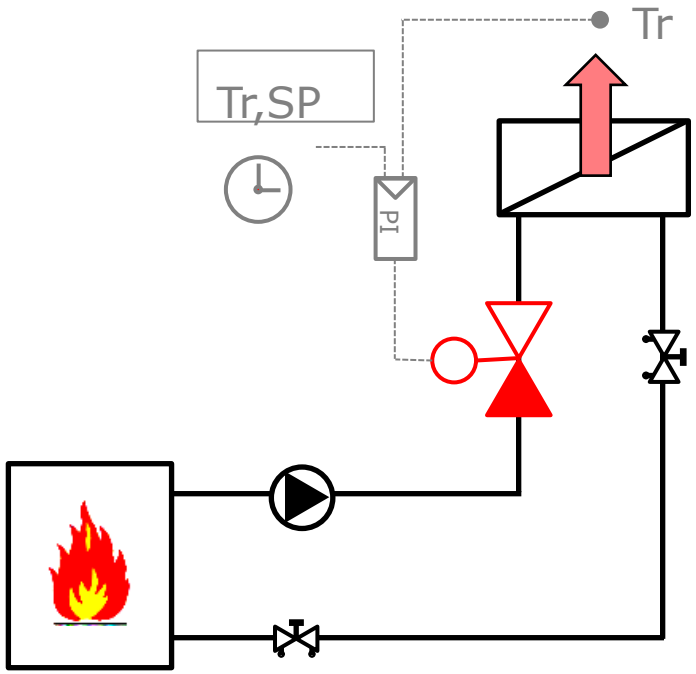
$$\Delta p_{rest} + \Delta p_{klep} = \Delta p_{pomp}$$

1. Vermogenregeling via waterdebiet

Klepkarakterisitiek

➡ **lineair gedrag indien Δp_{klep} = constant**

maar $\Delta p_{klep} \neq$ constant ➡ klepautoriteit β



	Δp_{rest}	Δp_{klep}	Δp_{pomp}	β
a	10	1	11	1/11
b	10	10	20	10/20
c	10	100	110	100/110

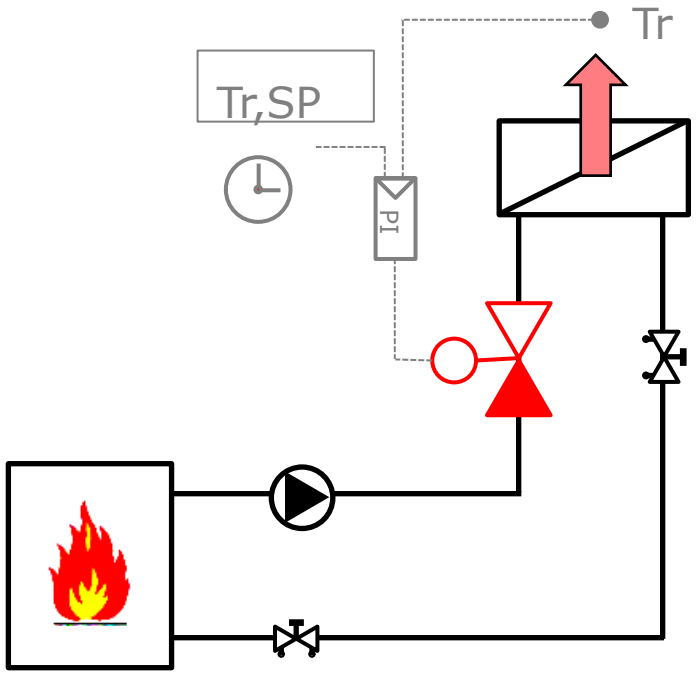
$$\beta = \frac{\Delta p_{klep}}{\Delta p_{klep} + \Delta p_{rest}} = \frac{\Delta p_{klep}}{\Delta p_{pomp}}$$

1. Vermogenregeling via waterdebiet

Klepkarakterisitiek

➡ **lineair gedrag indien Δp_{klep} = constant**

maar $\Delta p_{klep} \neq$ constant ➡ klepautoriteit β



	Δp_{rest}	Δp_{klep}	Δp_{pomp}	β
a	10	1	11	1/11
b	10	10	20	10/20
c	10	100	110	100/110

β ↗ : - regelgedrag ↗

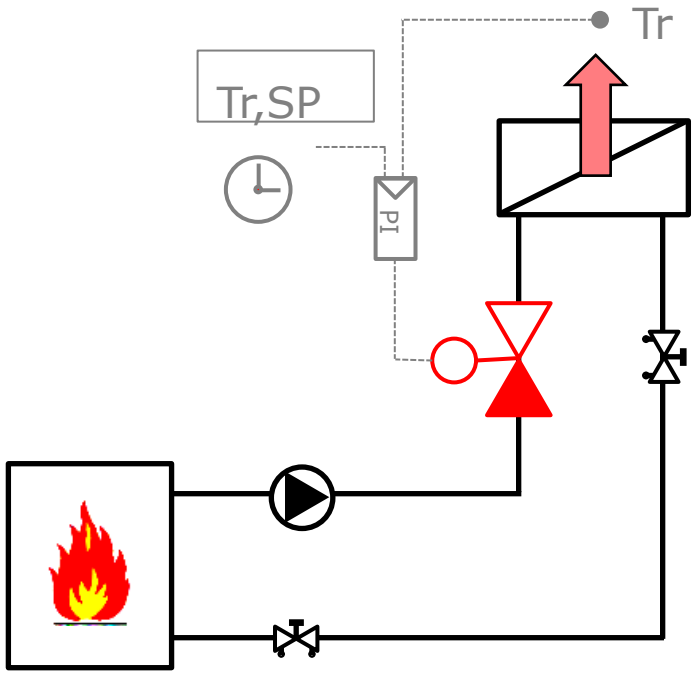
- pompenvermogen ↗

1. Vermogenregeling via waterdebiet

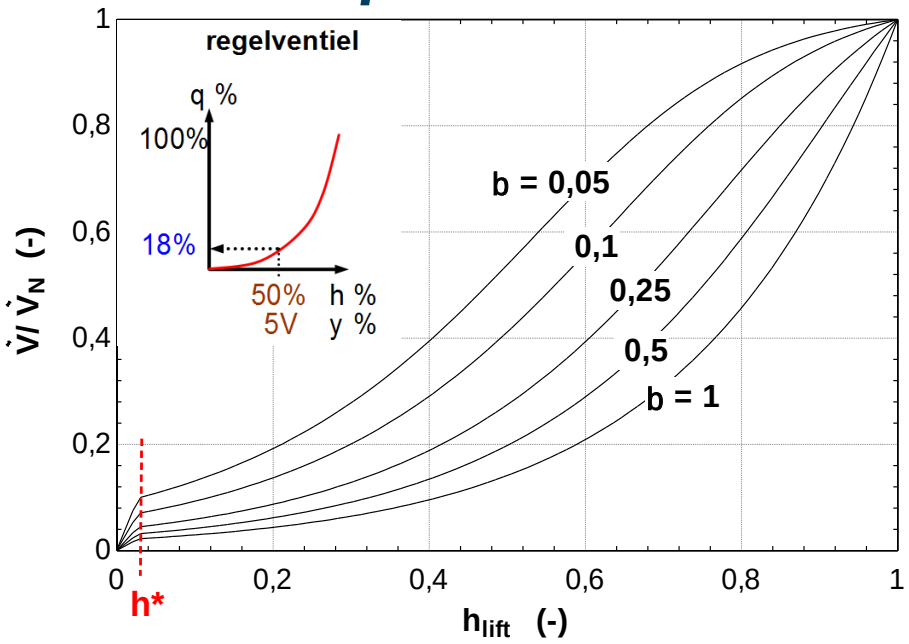
Klepkarakterisitiek

➡ **lineair gedrag indien Δp_{klep} = constant**

maar $\Delta p_{klep} \neq$ constant ➡ klepautoriteit β



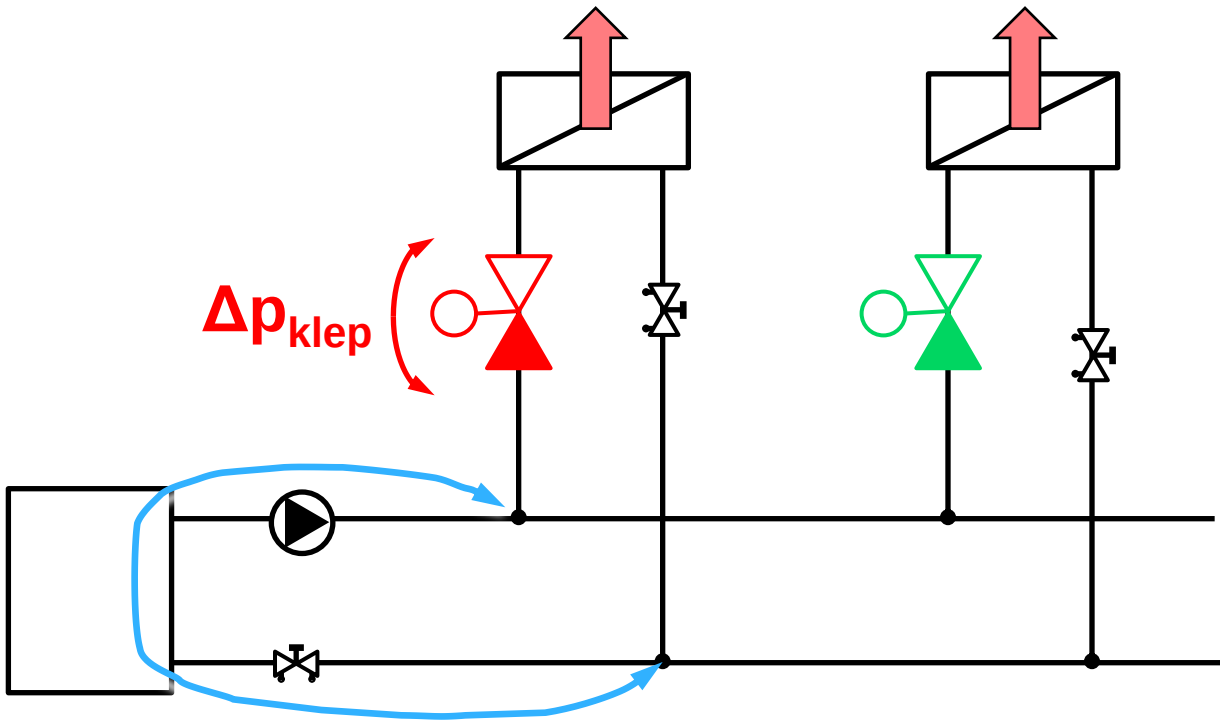
β = 1 … 0,3 …



1. Vermogenregeling via waterdebiet

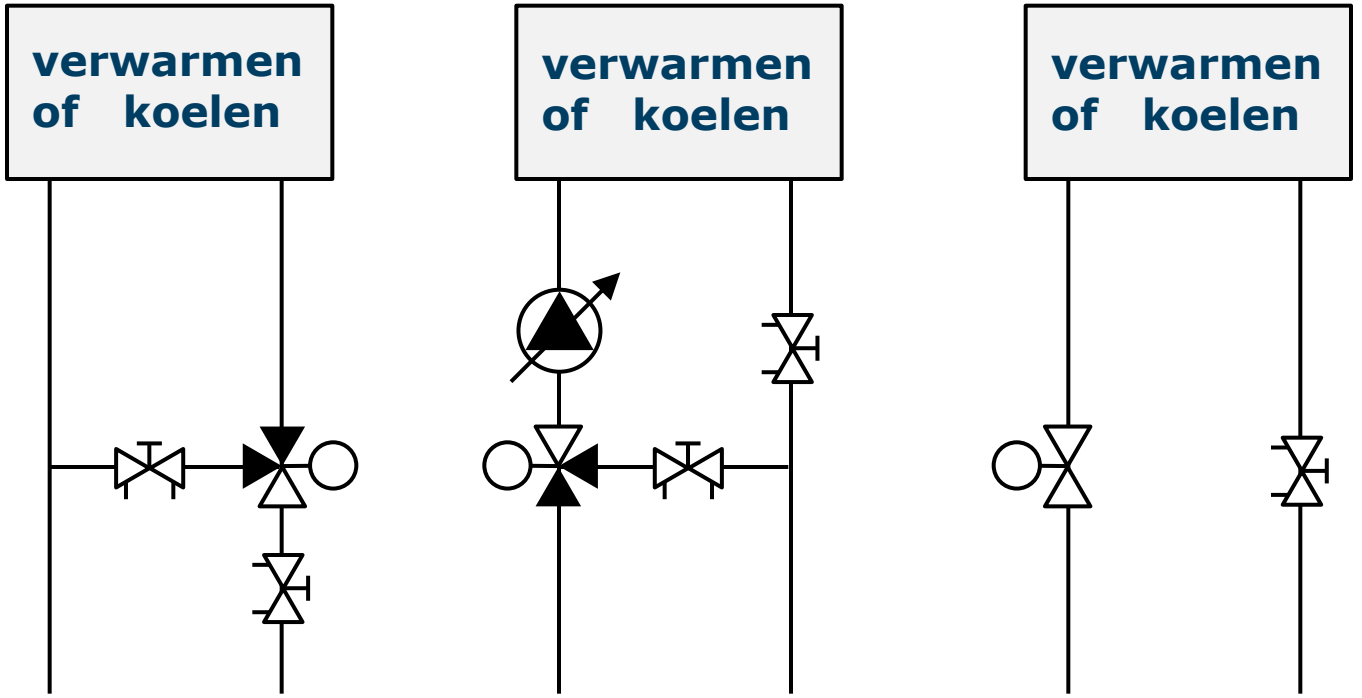
Klepautoriteit: invloed klepstand zelf op Δp_{klep}

Interactiviteit: invloed andere kleppen op Δp_{klep} o.i.v. $\Delta p_{gemeenschappelijk}$



2. Hydronische configuraties

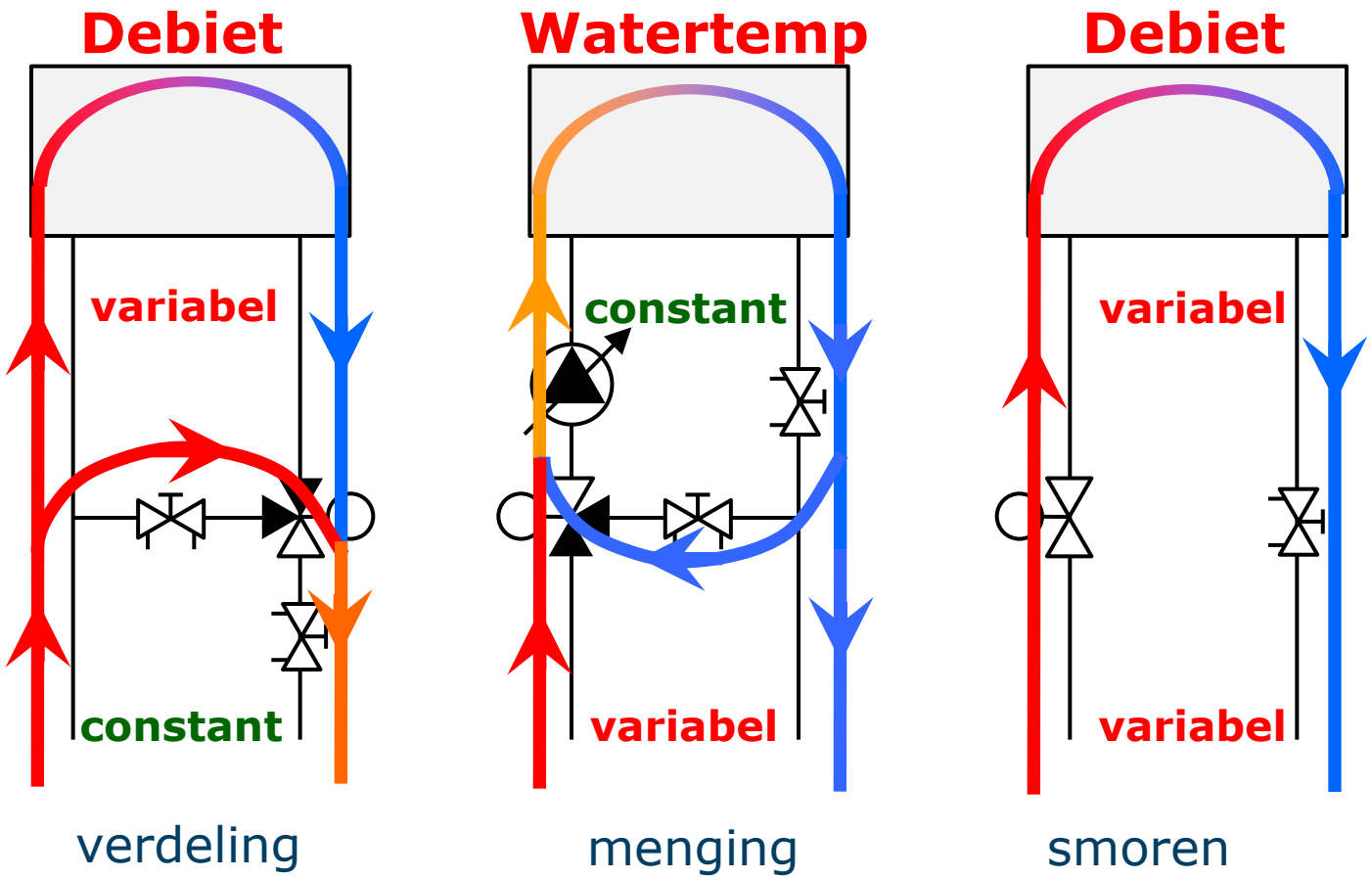
hydronische basisschakelingen: principe



verdeling menging smoren

2. Hydronische configuraties

hydronische basisschakelingen: principe



2. Hydronische configuraties

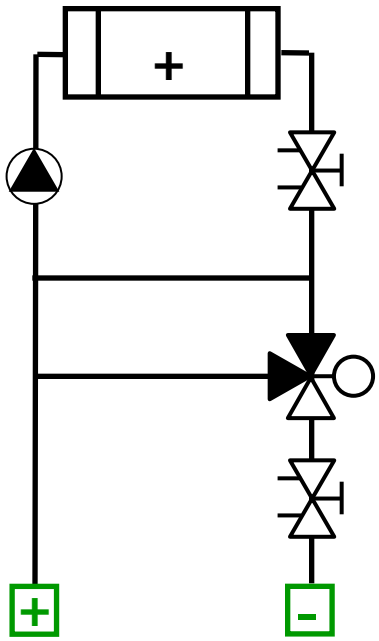
hydronische basisschakelingen: eigenschappen

	Verdeling	Menging	Smoor
Primair debiet	c^{te}	var.	var.
Secundair debiet	var.	C^{te}	var.
Principe regeling	debiet	T_{su}	debiet
Stabiliteit regeling	gevoelig	stabiel	gevoelig
Dode tijd lange afstand	nee	ja	ja
T_{retour} bij deellast	↗	↘	↘

Combineren van eigenschappen → combinatieschakelingen

2. Hydronische configuraties

hydronische combinatieschakelingen

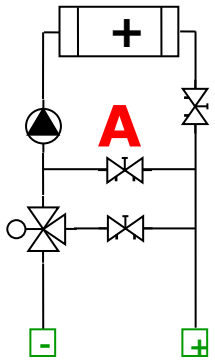


Verdeling	Menging	Smoor
c^{te}	var.	var.
var.	C^{te}	var.
debiet	T_{su}	debiet
gevoelig	stabiel	gevoelig
nee	ja	ja
↗	↘	↘

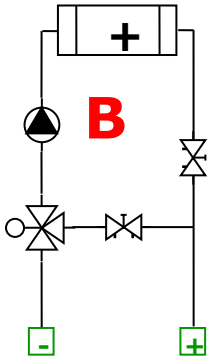
Combineren van eigenschappen → combinatieschakelingen

2. Hydronische configuraties

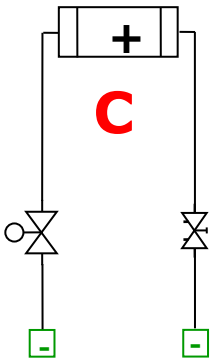
hydronische combinatieschakelingen



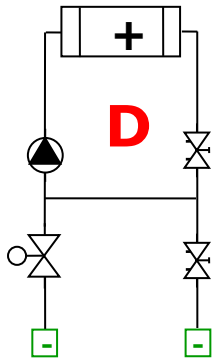
Actieve mengschakeling met vaste voormenging



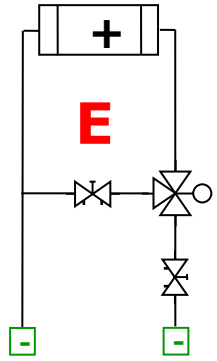
Actieve mengschakeling



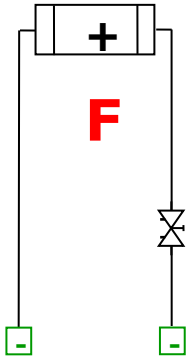
Passieve smoorschakeling



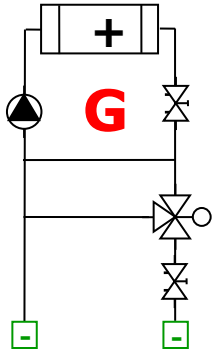
Passieve mengschakeling



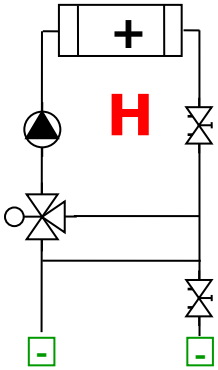
Passieve verdeelschakeling



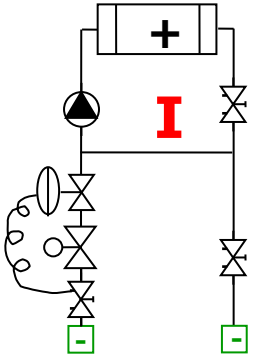
Passieve moduul



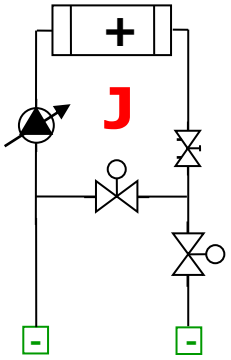
Passieve Verdeel- en mengschakeling met vaste menging



Passieve Verdeel- en mengschakeling met vaste verdeling



Passieve meng-schakeling met drukverschilregalaar

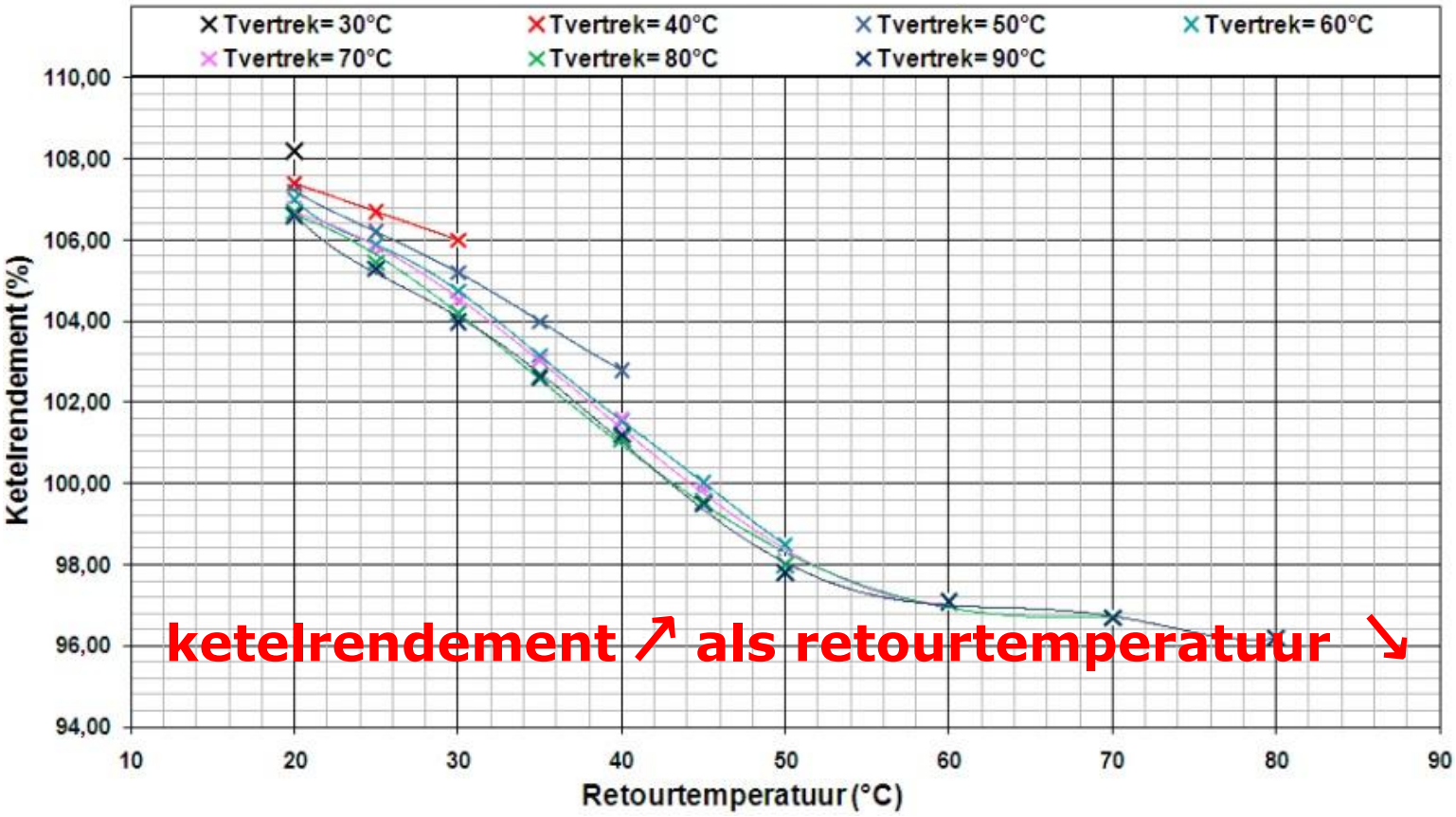


Actieve mengschakeling met 2 regelkranen

2. Hydronische configuraties

Hoe retourtemperatuur verlagen ?

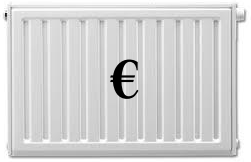
Condensatieketel



2. Hydronische configuraties

evaluatie op retourtemperatuur

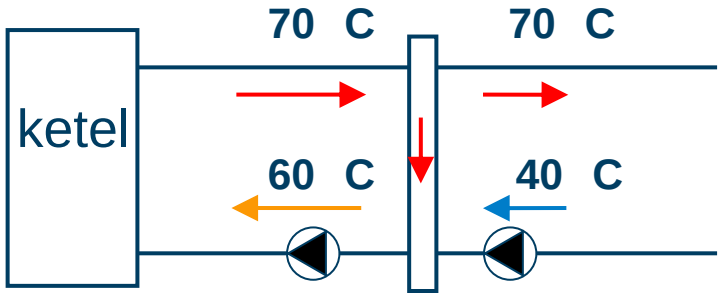
radiatorkeuze



80-60°C

70-50°C

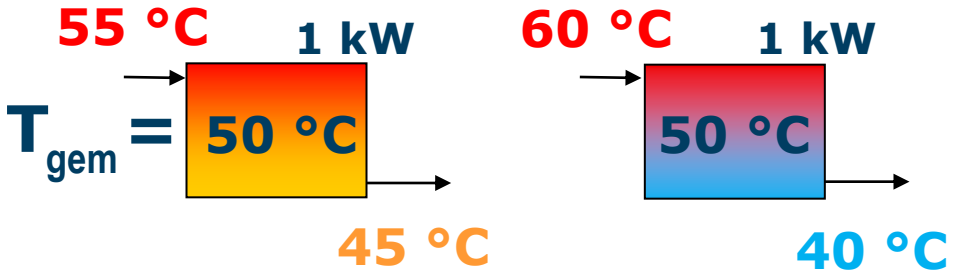
mengpunten vermijden



constant ⟺ variabel debiet

$$P_{out} = U \cdot A \cdot (T_{gem} - T_{omgeving})$$

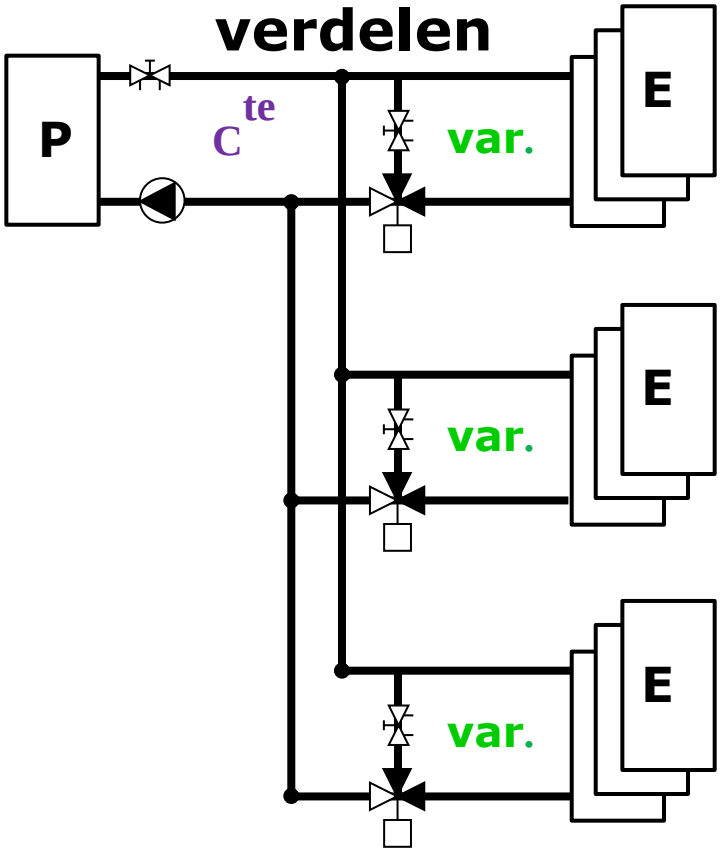
$$P_{in} = \Phi_m \cdot c \cdot (T_{w,in} - T_{w,out})$$



2. Hydronische configuraties

evaluatie op retourtemperatuur

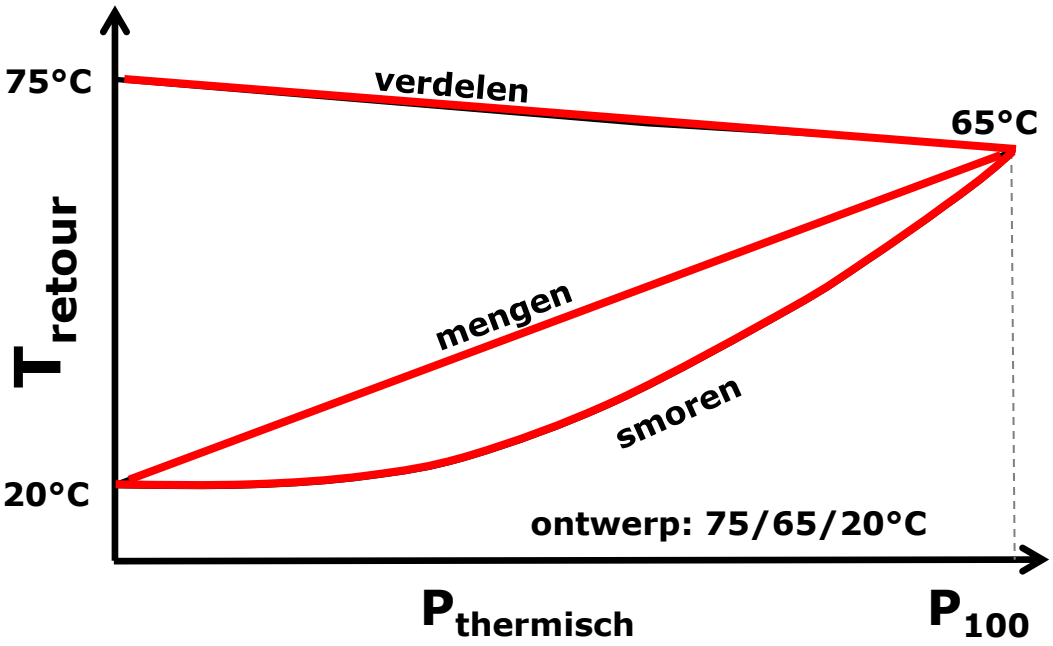
$T_{ketel} = c^{te} = 75\ °C$

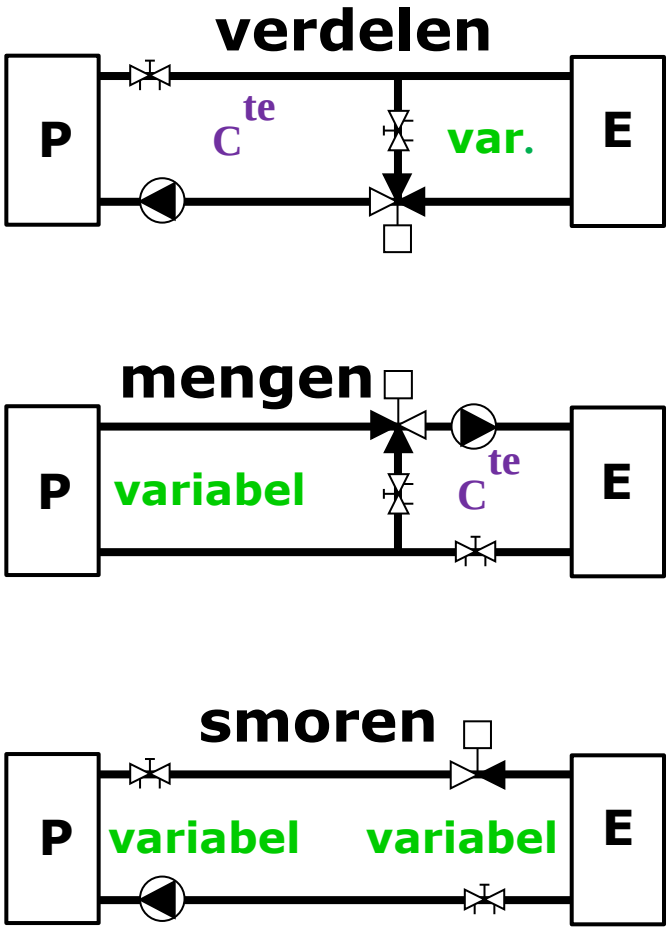


2. Hydronische configuraties

evaluatie op retourtemperatuur

$T_{ketel} = c^{te} = 75\ °C$

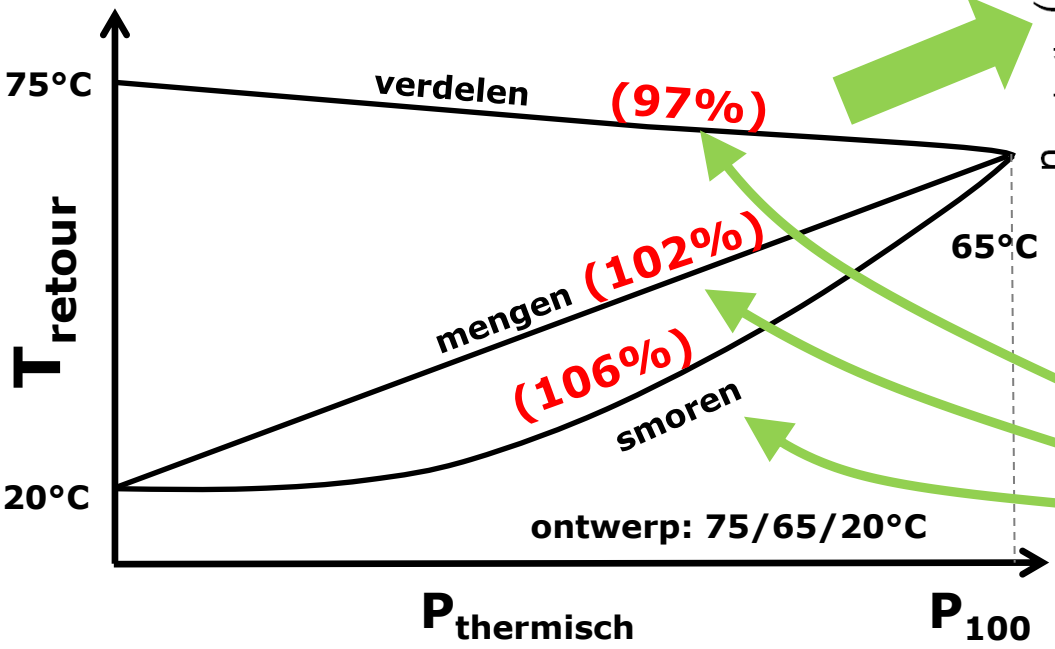


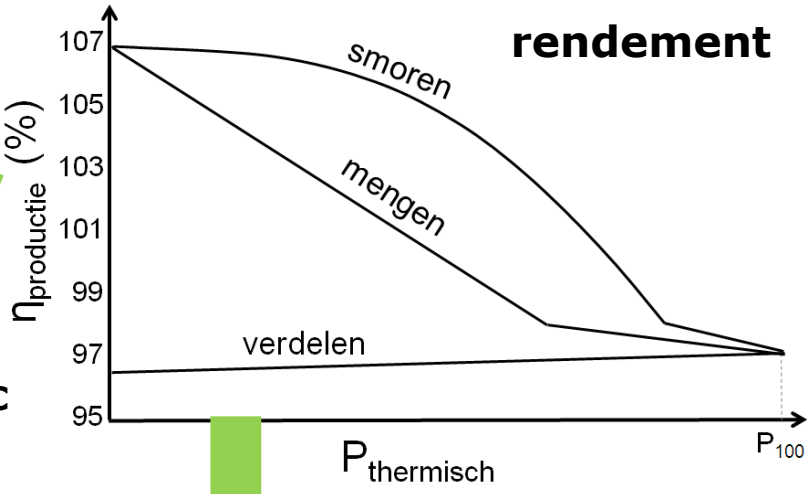


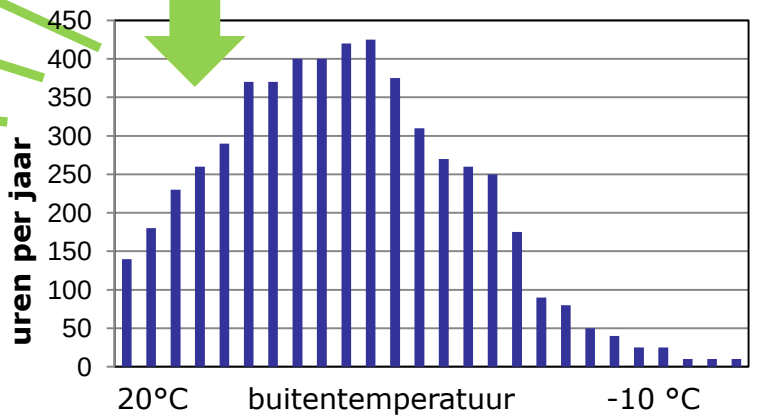
2. Hydronische configuraties

evaluatie op retourtemperatuur

$T_{ketel} = c^{te} = 75\ °C$



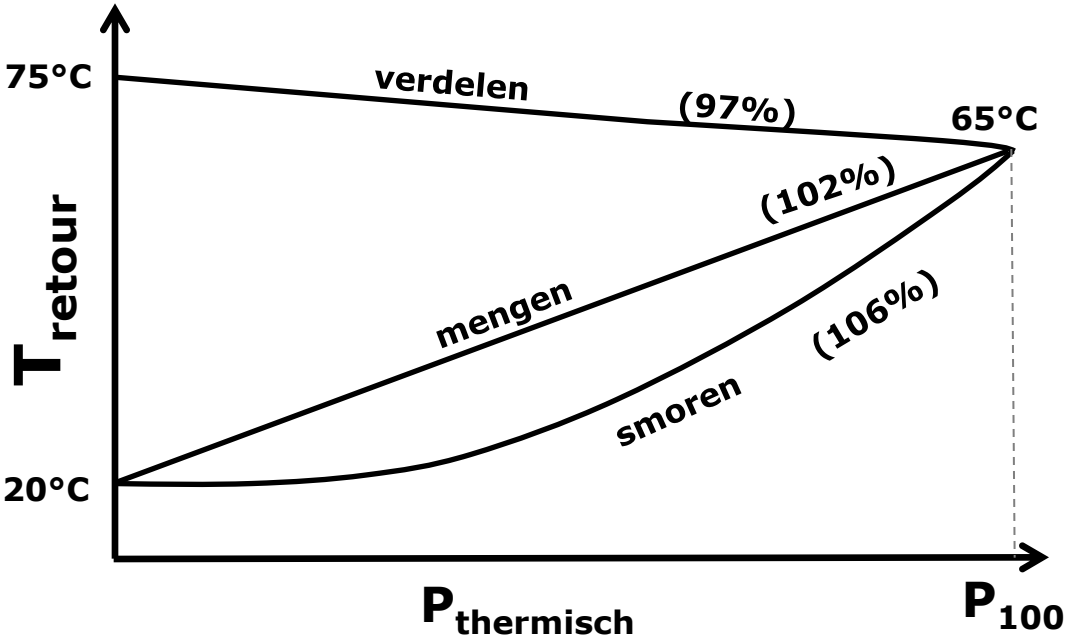


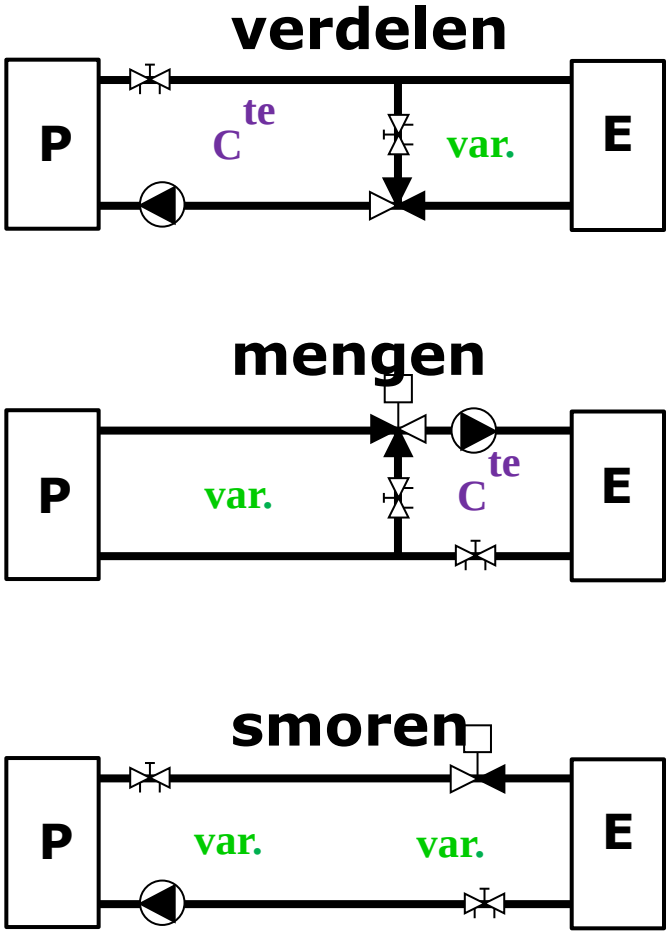


2. Hydronische configuraties

evaluatie op retourtemperatuur

T_{ketel} = stooklijn

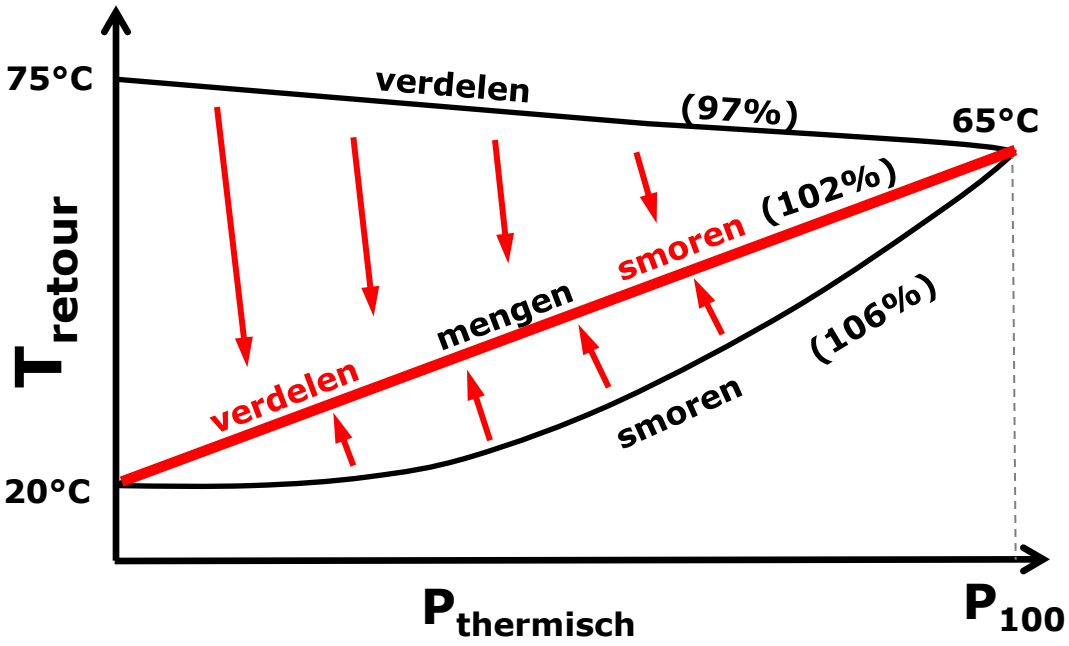


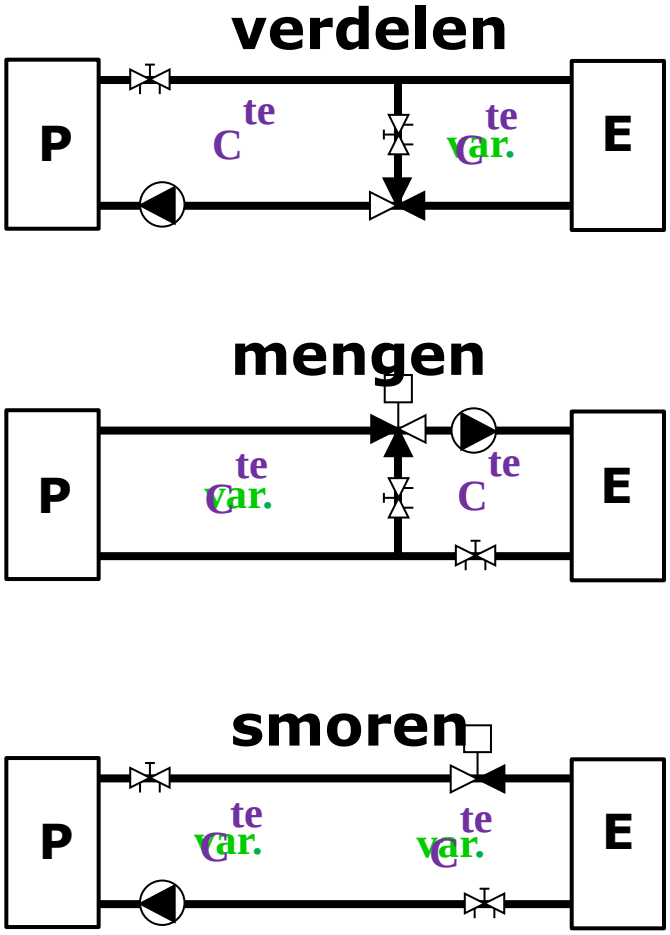


2. Hydronische configuraties

evaluatie op retourtemperatuur

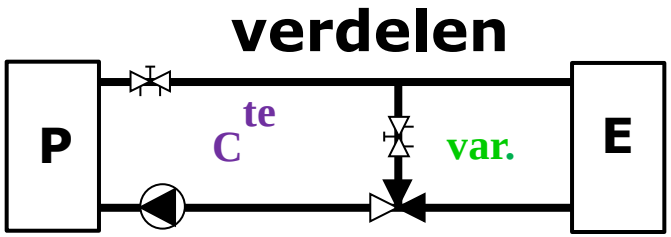
T_{ketel} = stooklijn

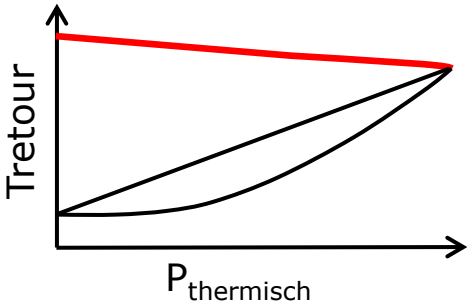


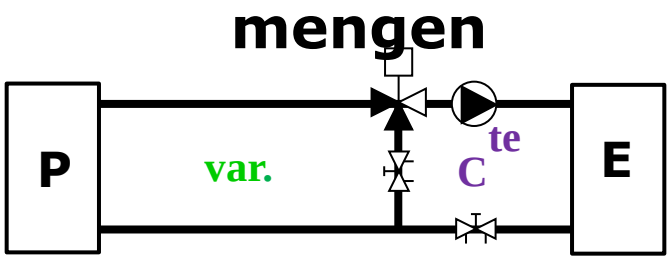


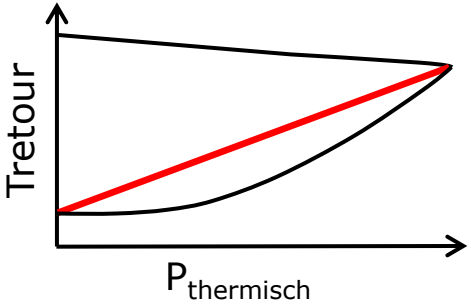
2. Hydronische configuraties

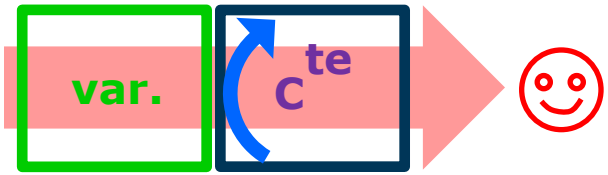
evaluatie op retourtemperatuur

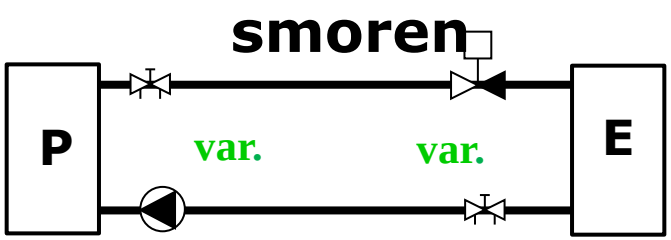


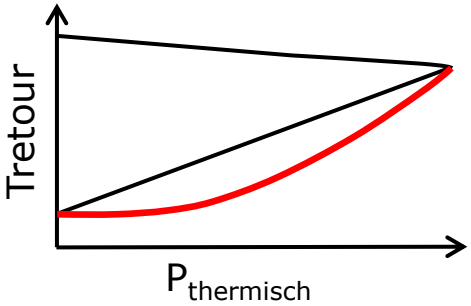






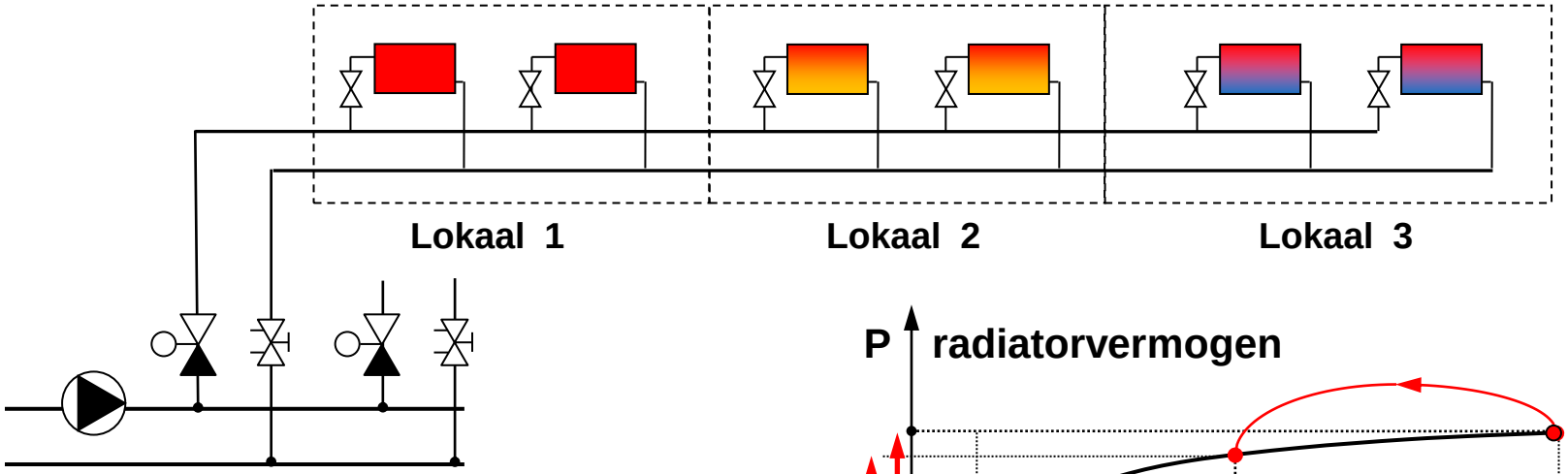




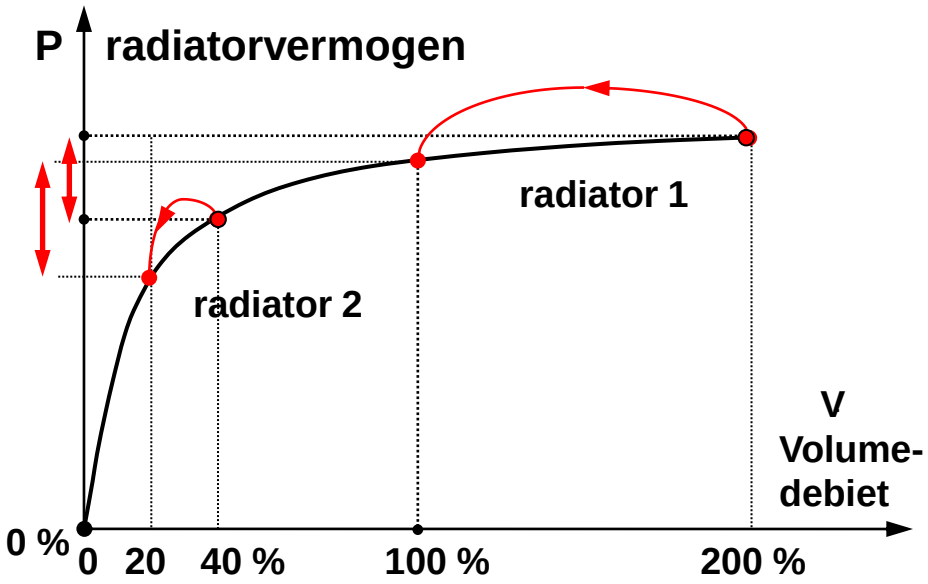


3. Constant versus variabel debiet

Debietregeling

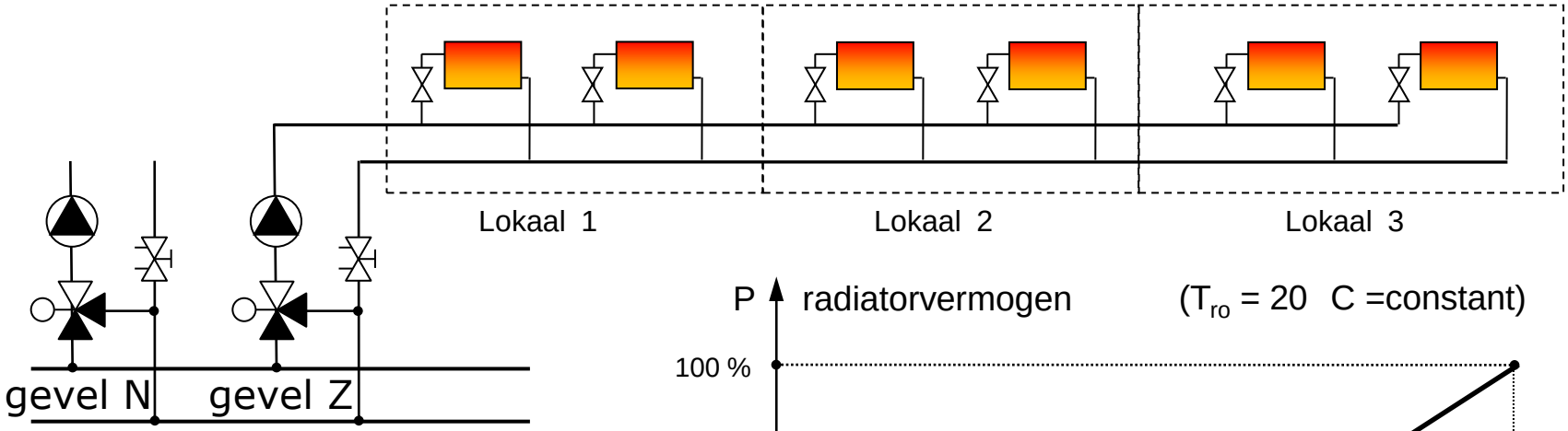


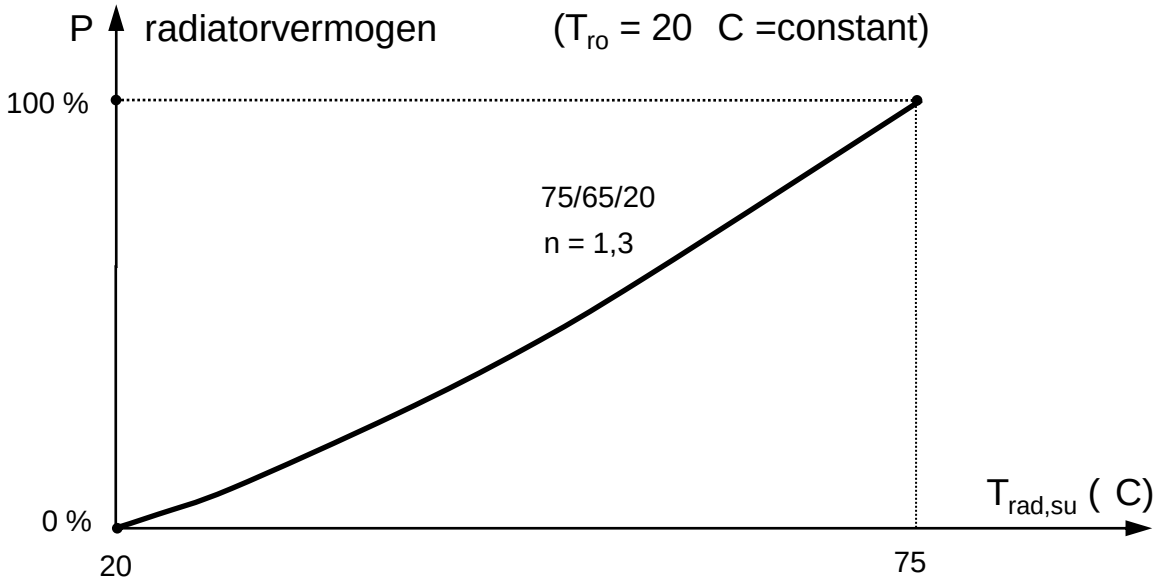
- eenvoudig
- onbalans (debiet, vermogen)
- meer onbalans bij deellast



3. Constant versus variabel debiet

Temperatuurregeling





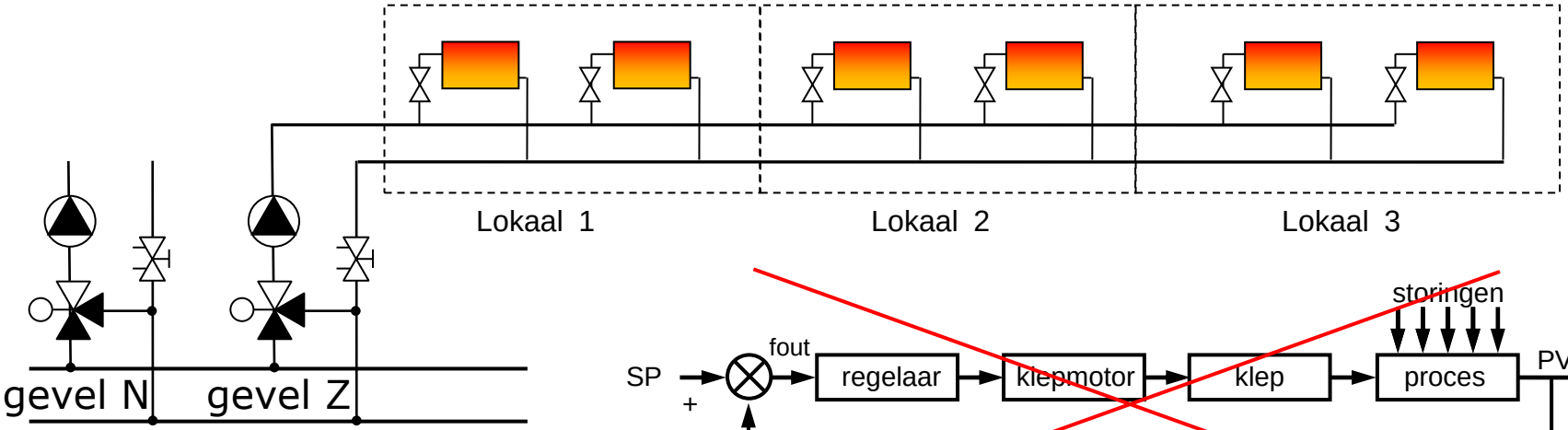
gelijkmatiger maar

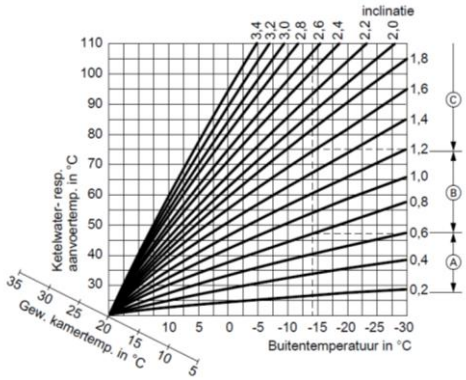
duurder (pomp)

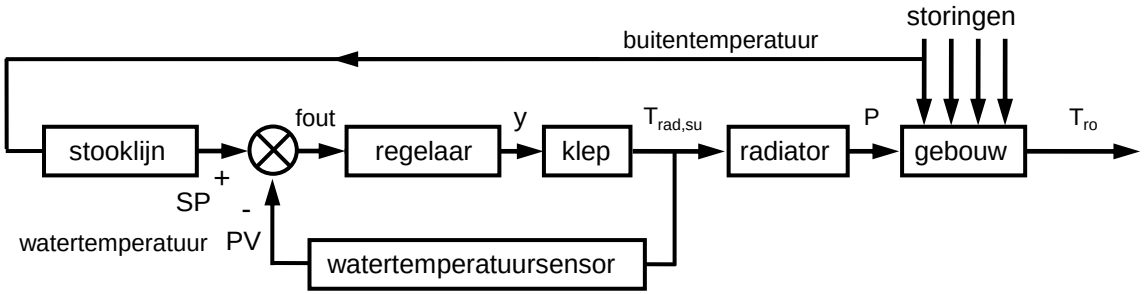
daarom per gevel

3. Constant versus variabel debiet

Temperatuurregeling

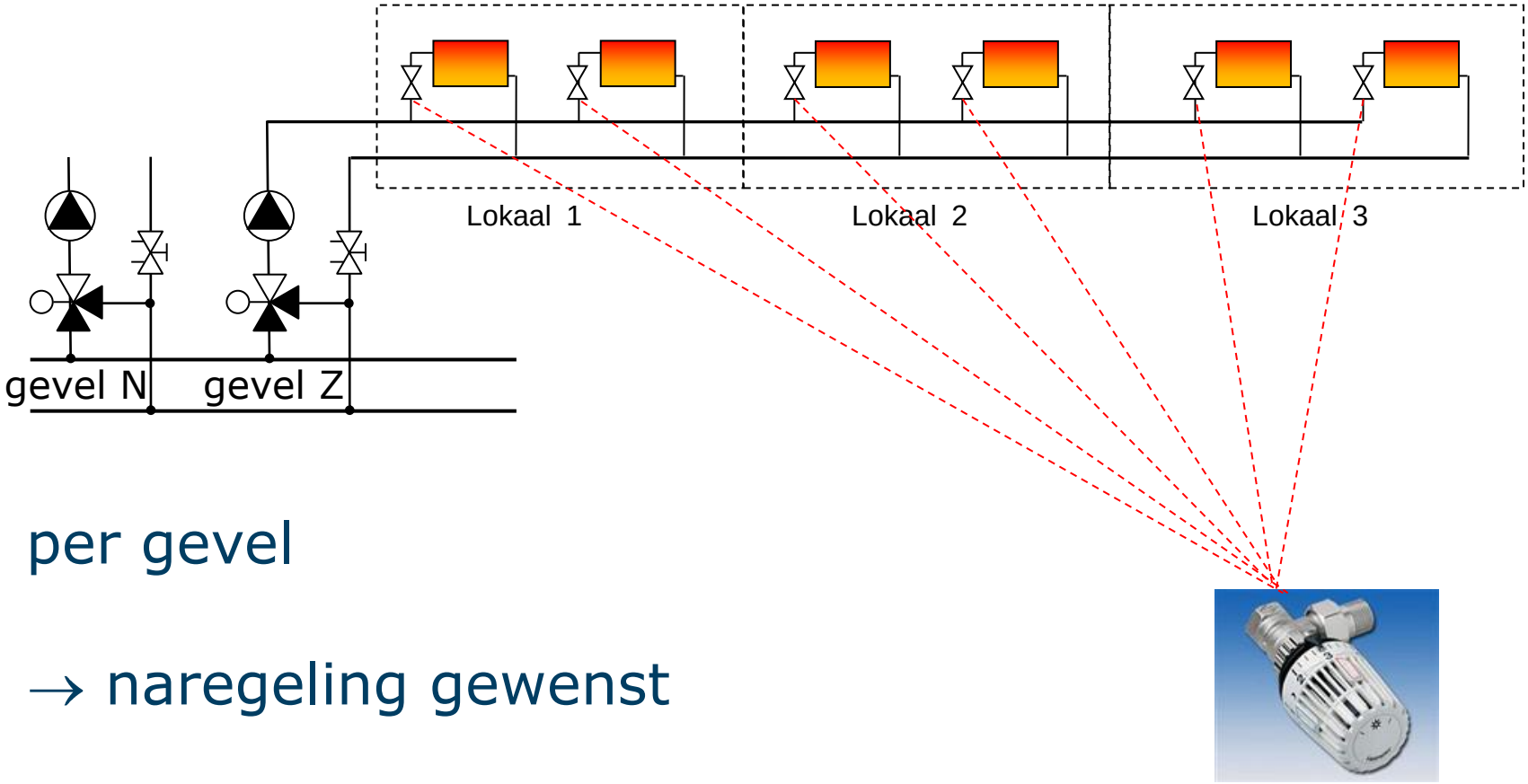






3. Constant versus variabel debiet

Temperatuurregeling

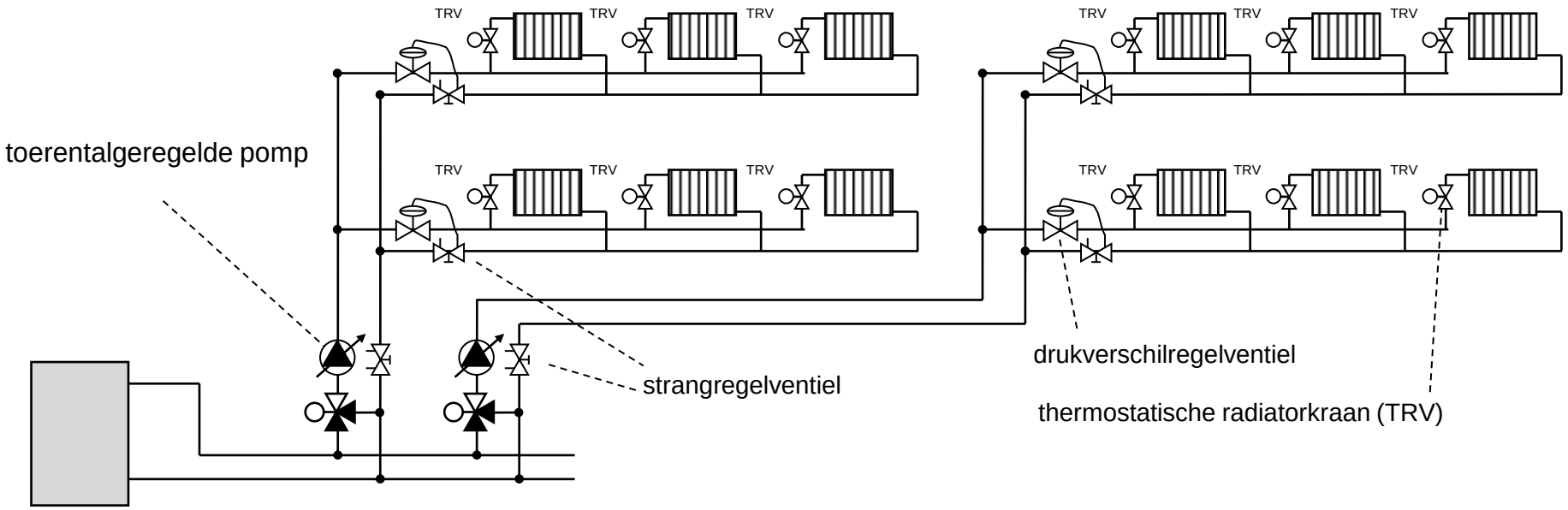


per gevel

→ naregeling gewenst

3. Constant versus variabel debiet

Temperatuurregeling



complexiteit neemt toe

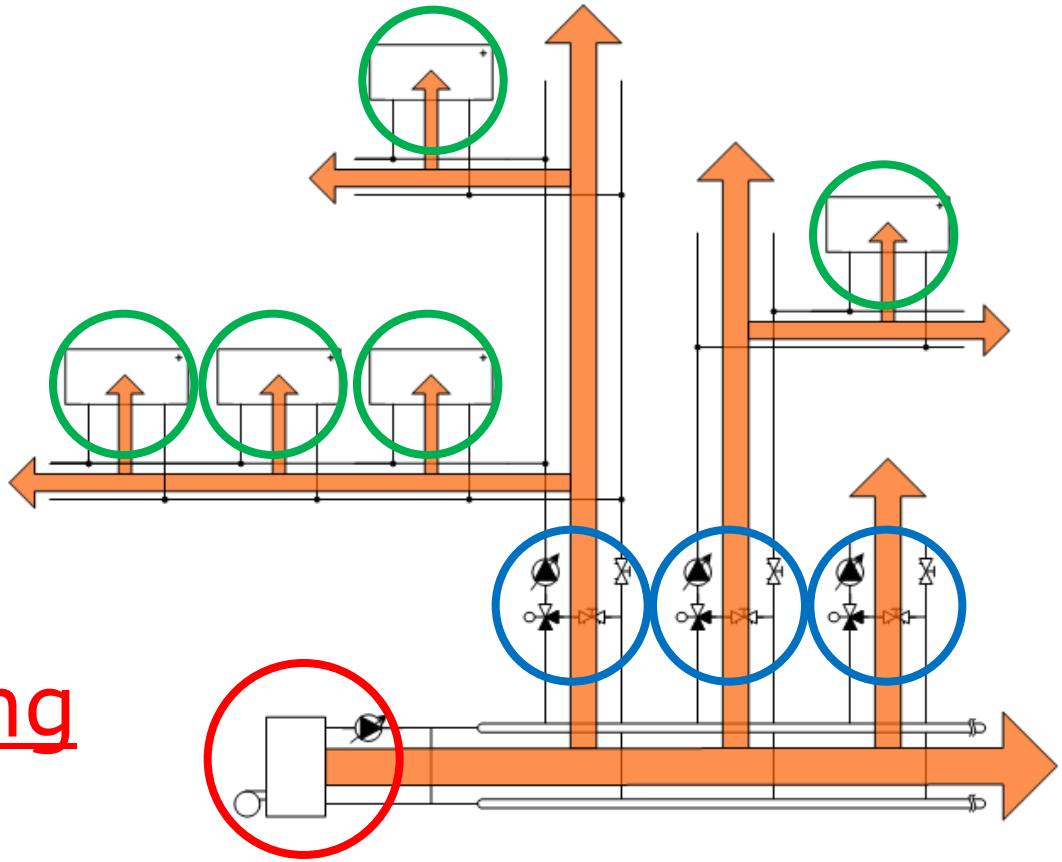
3. Constant versus variabel debiet

Traditionele installaties hebben 3 regelniveaus:

naregeling

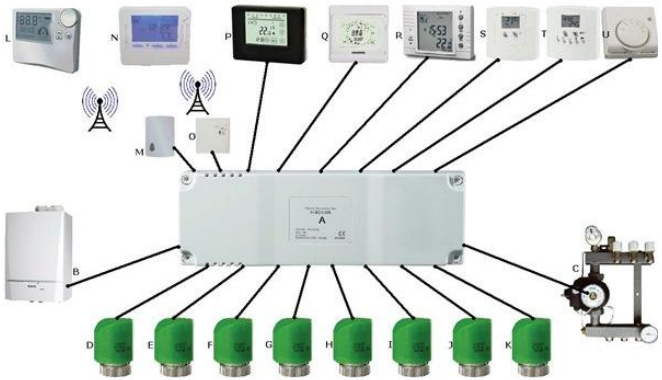
voorregeling

productieregeling



3. Constant versus variabel debiet

Individuele ruimteregeling performanter



thermostaatkraan:

- P-regelaar, statische fout
- T-meting op slechte plaats
- geen klokfunctie

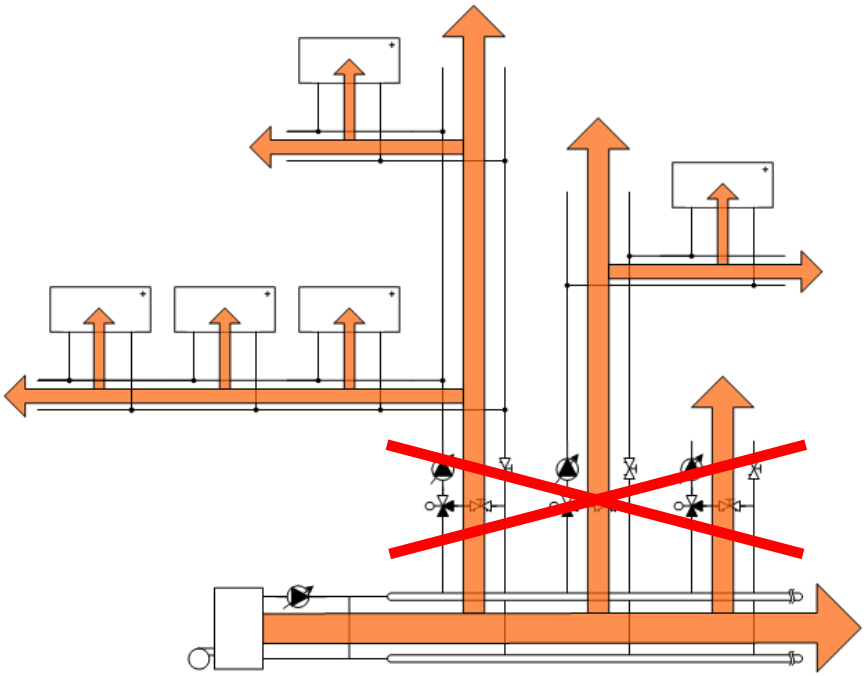
elektronisch:

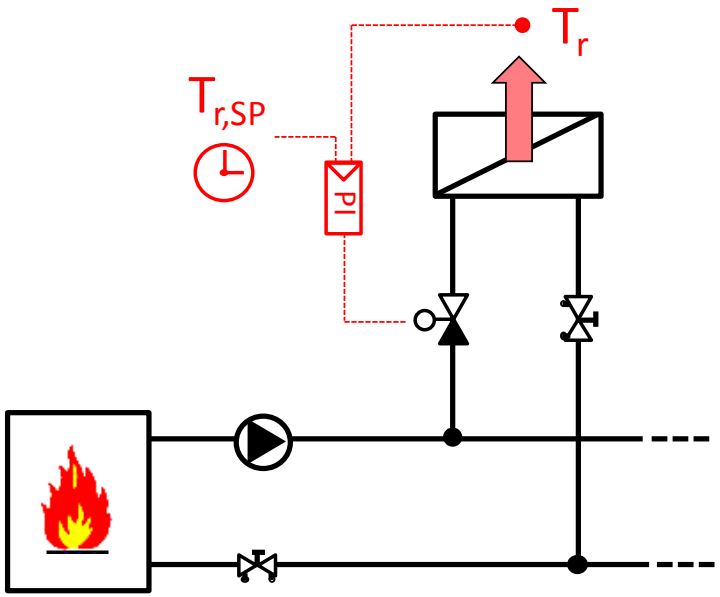
- PI-regelaar, geen statische fout
- T-meting op vrij te kiezen plaats
- centraal beheer

3. Constant versus variabel debiet

Individuele ruimteregeling performanter

→ voorregeling weglaten ?

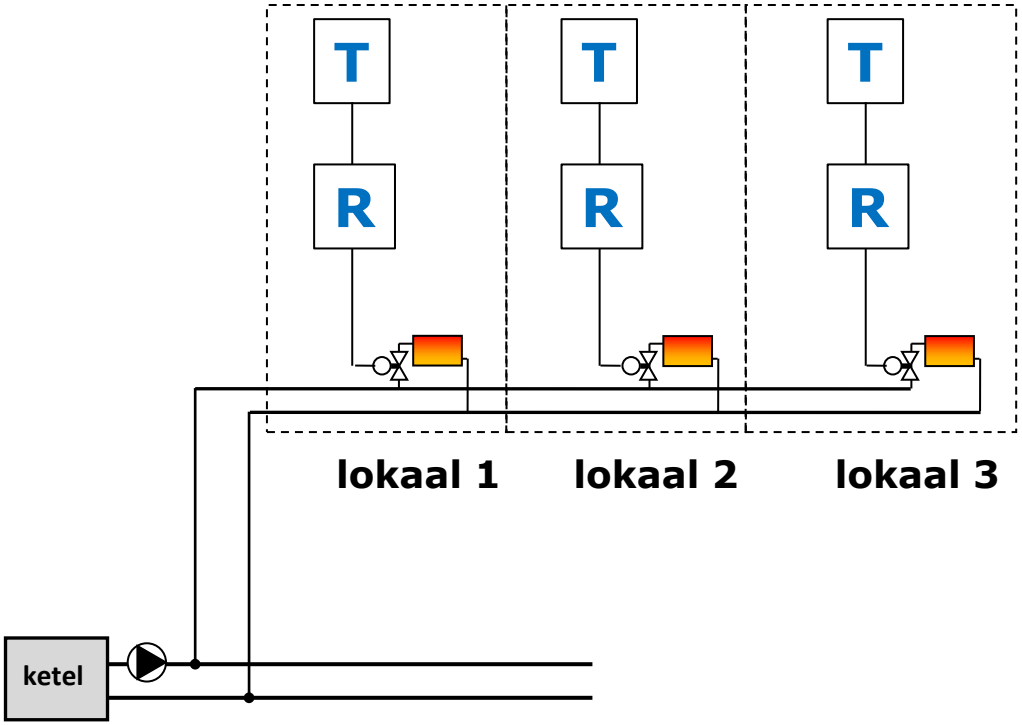




3. Constant versus variabel debiet

Waterdebiet regelen lokaal per lokaal:

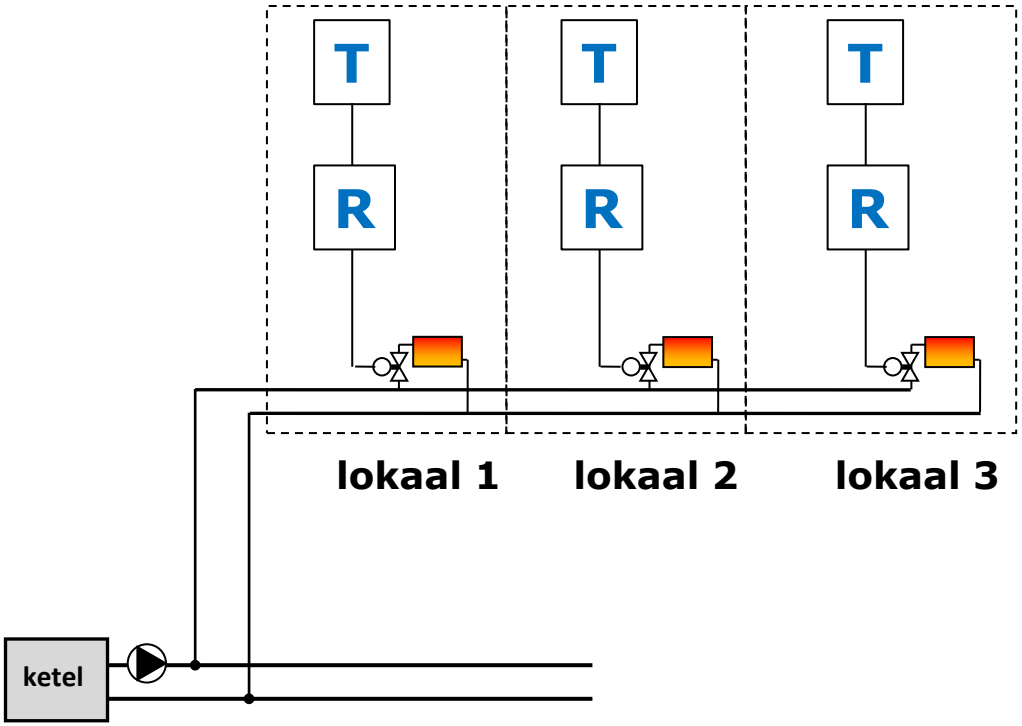
betere naregeling



voorregeling weglaten

3. Constant versus variabel debiet

Waterdebiet regelen lokaal per lokaal:



betere naregeling

- meer comfort
- minder brandstof
- minder pompenergie

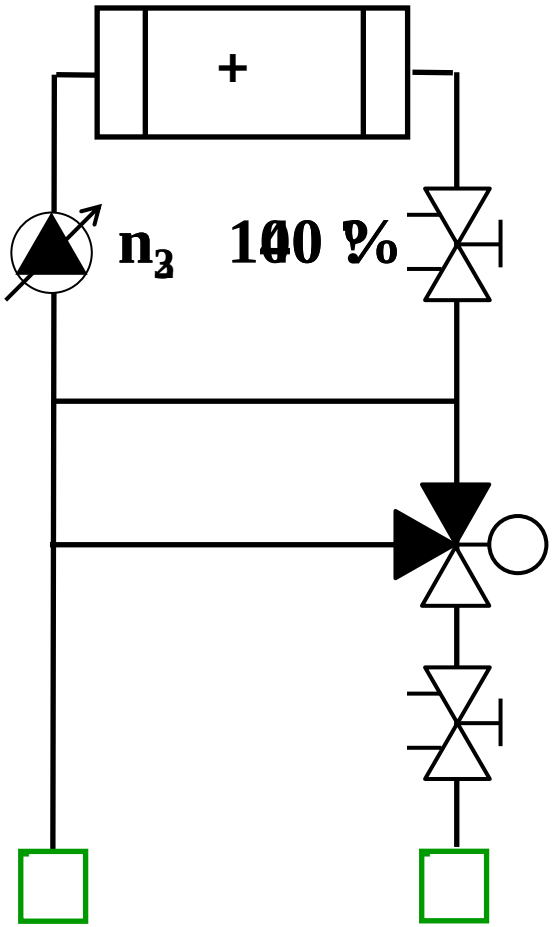
voorregeling weglaten

- lagere investering

4. Inregelen

Case: pomp gebouw B

	ingreep	vermogen
1980	nieuw: G UPS n_3	500 W
1990	$n_3 \rightarrow n_2$ inregelventiel	300 W
2013	nieuw: G MAGNA3	270 W
"	debiet ingeregeld	80 W
"	inregelventiel ↗	30 W



<u>Besluit</u>: belang van hydronisch concept, regelstrategie, inregelen en opleiding