

The background of the slide is a photograph of an industrial facility, likely a water treatment plant. It features numerous large, white, curved pipes and valves. In the foreground, a large white pump or motor is visible, connected to a red belt. To the right, there are large red cylindrical tanks. The overall scene is industrial and complex.

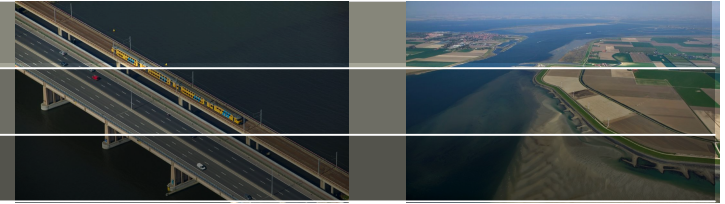
# WANDA

Deltares

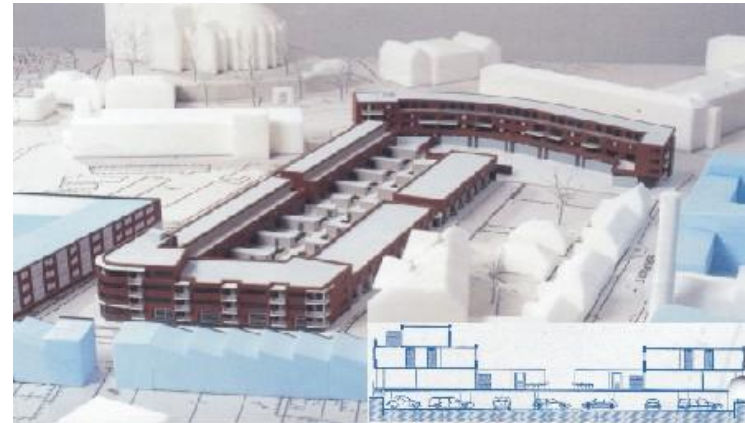
The Deltares logo consists of a stylized white wave or 'S' shape on a green background.

## Wanda 4 Heat

# Toepassing



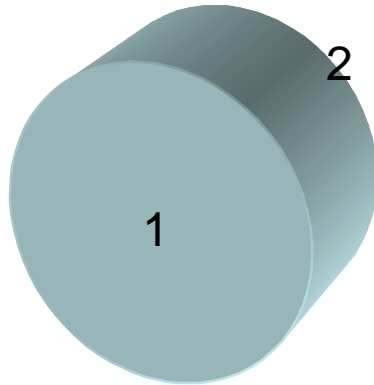
## Stadsverwarming



## Procesindustrie



# Theorie: Variabelen – Wanda 4 Liquid



Primaire rekenvariabelen:

Discharge / debiet  $Q$  [m<sup>3</sup>/s]

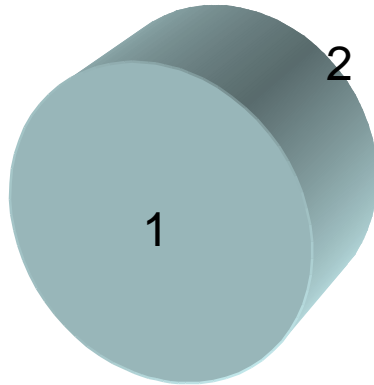
Head / Energie hoogte  $H$  [m]

Afgeleide variabelen:

Druk  $p$  [Pa]

Snelheid  $v$  [m/s]

# Theorie: Variabelen: Wanda 4 Heat



Primaire rekenvariabelen:

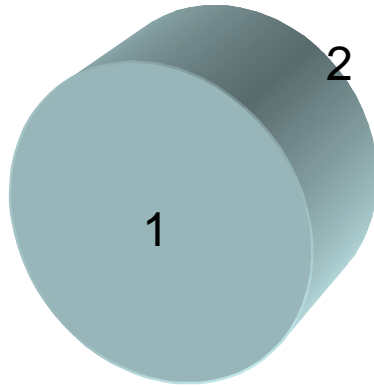
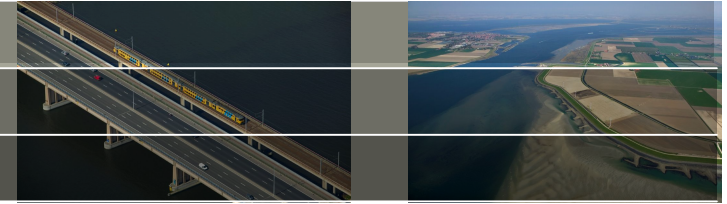
Mass flow rate (i.p.v. $Q$ )	$\dot{m}$	[kg/s]
(Stagnatie) druk (i.p.v. $H$ )	$p$	[Pa]
Temperatuur (nieuw)	$T$	[°C]

Afgeleide variabelen:

Dichtheid	$\rho$	[kg/m <sup>3</sup> ]
Head / Energie hoogte	$H$	[m]
Discharge / debiet	$Q$	[m <sup>3</sup> /s]
Snelheid	$v$	[m/s]



# Theorie: Verband met QH



Primaire rekenvariabelen:

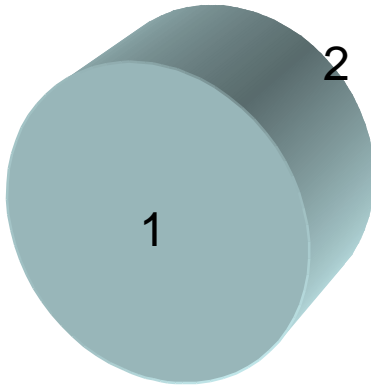
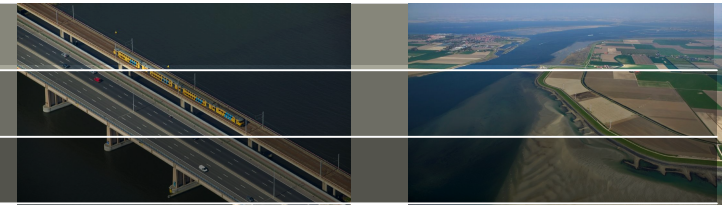
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Temperatuur (nieuw)	$T$	[°C]

$$\dot{m} = \rho Q \quad p = \rho g(H - z)$$

Afgeleide variabelen:

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Massa-behoud:

$$\dot{m}_1 - \dot{m}_2 = 0$$

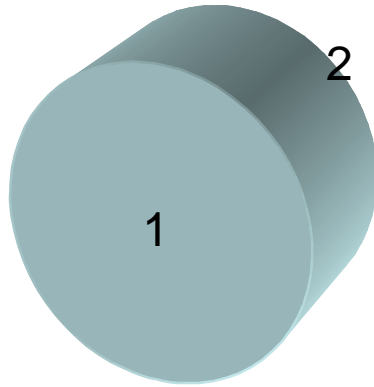
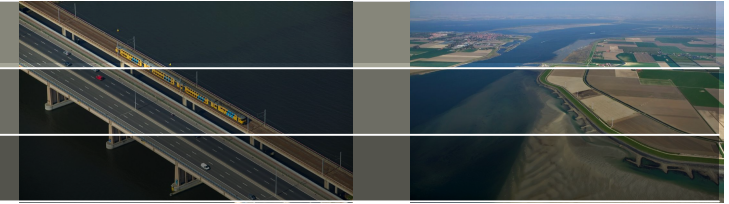
vergelijk met QH:

$$Q_1 - Q_2 = 0$$

Afgeleide variabelen:

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$$\dot{m} = \rho Q \quad p = \rho g(H - z)$$

Verband druk en mass flow rate:

$$p_1 - p_2 = \frac{\xi}{2\rho} \frac{\dot{m}|\dot{m}|}{A^2}$$

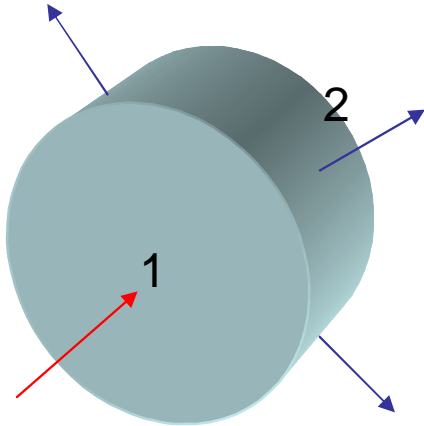
vergelijk met QH:

$$H_1 - H_2 = \frac{\xi}{2g} \frac{Q|Q|}{A^2}$$

Afgeleide variabelen:

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# Theorie: Temperatuur en warmte



1) Warmte door mass flow

2) Gegenerateerde warmte door frictie

3) Warmteverlies aan omgeving

Primaire rekenvariabelen:

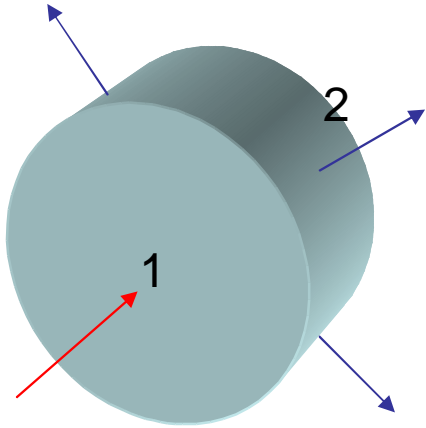
Mass flow rate (i.p.v. $Q$ )	$\dot{m}$	[kg/s]
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Afgeleide variabelen:

Dichtheid	$\rho$	[kg/m <sup>3</sup> ]
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Temperatuur (nieuw)	$T$	[°C]

## 1) Warmte door mass flow

$$\dot{Q}_{\text{input}} = \dot{m}c(T_1 - T_2)$$

$c$ : soortelijke warmte [J/kg K]

## 2) Gegenerateerde warmte door frictie

$$\dot{Q}_{\text{gen}} = \dot{m}g\Delta H$$

## 3) Warmteverlies aan omgeving

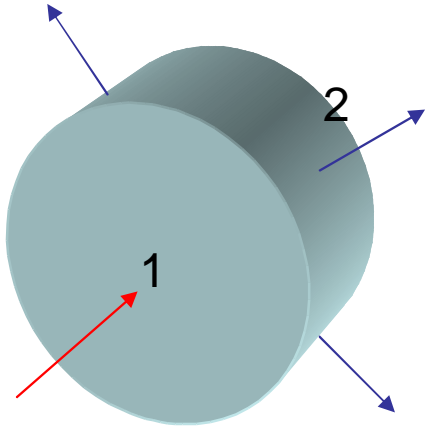
$$\dot{Q}_{\text{loss}} = h_w A_{\text{exposed}} (T - T_{\text{omg}})$$

$h_w$ : warmte-overdrachtscoefficient [W/m<sup>2</sup> K]

Afgeleide variabelen:

Dichtheid	$\rho$	[kg/m <sup>3</sup> ]
Head / Energie hoogte	$H$	[m]
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Verband temperatuur en  
mass flow rate:

$$T_2 = f(\dot{m}, T_1, T_{\text{omg}}, f, D, L, h_w, c, \rho)$$



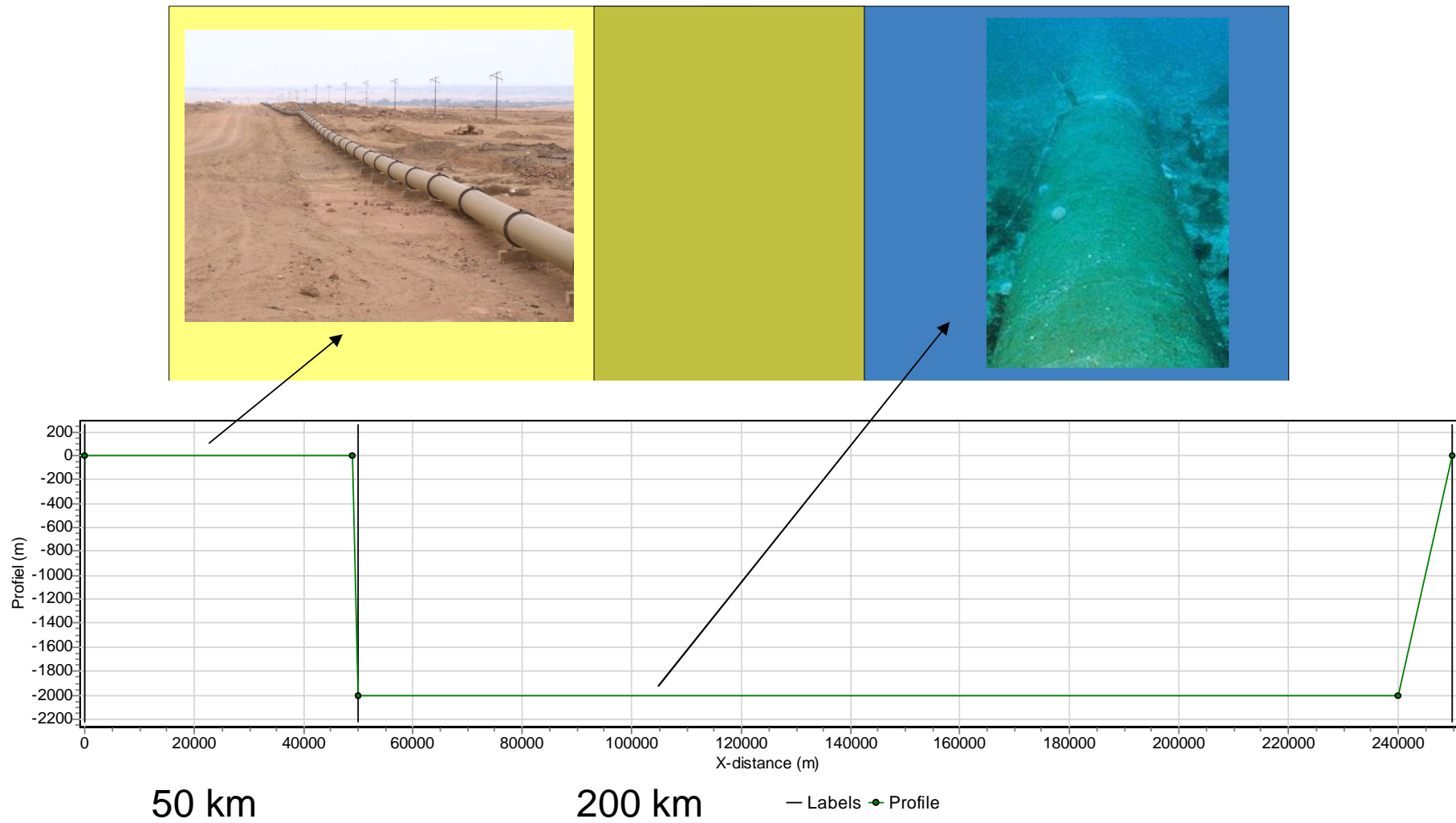
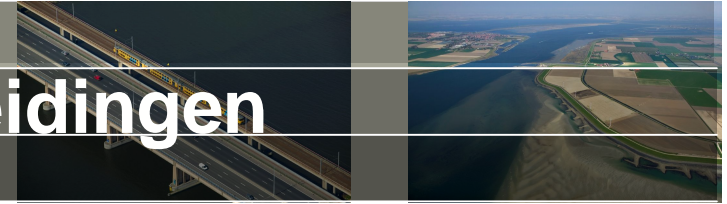
WANDA

Deltares

Wanda 4 Heat

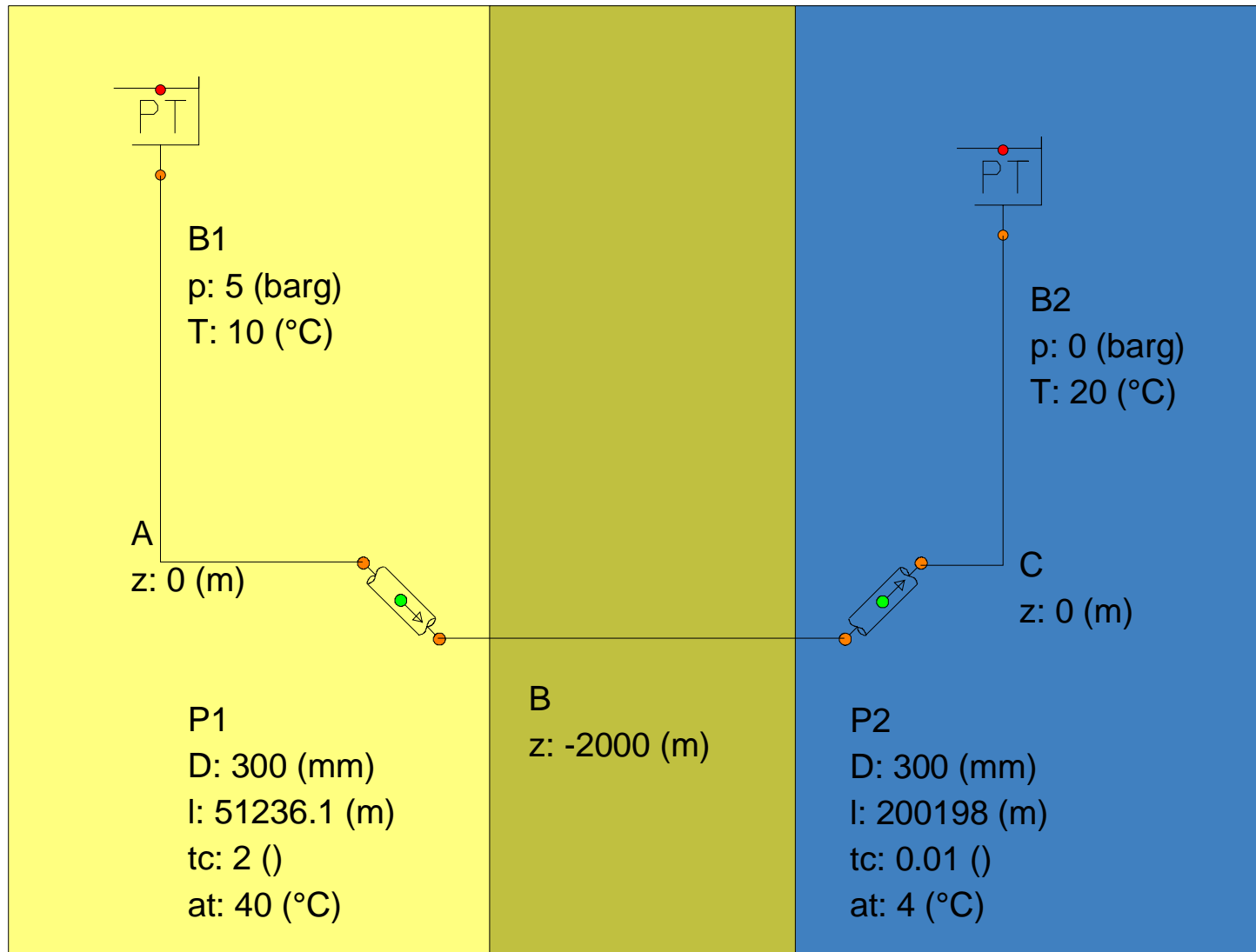
Voorbeelden

# Voorbeeld 1: warmteverlies leidingen



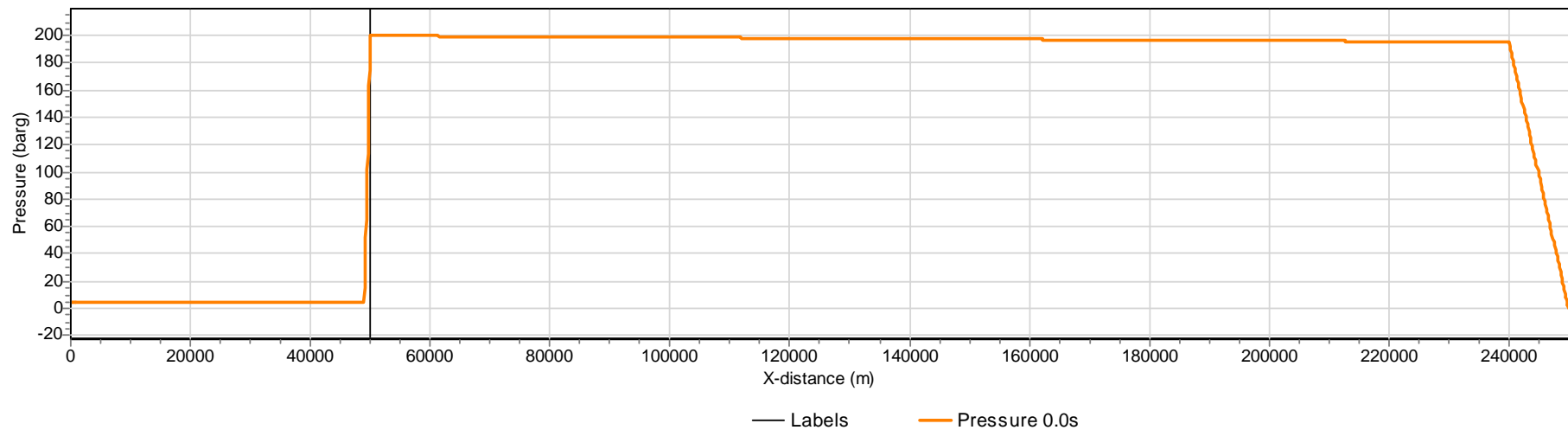
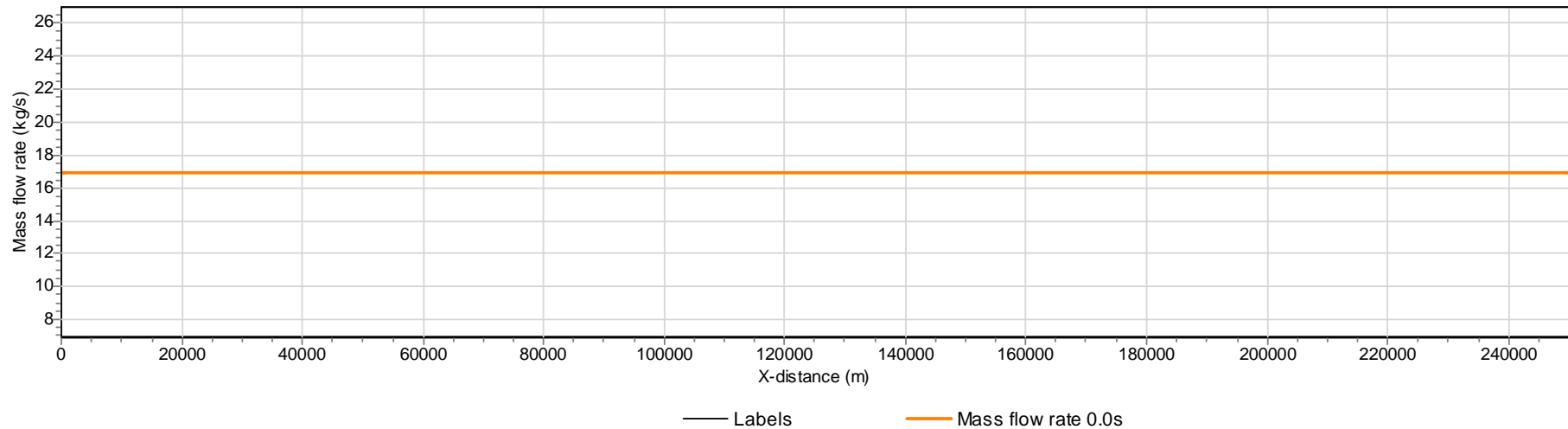


# Voorbeeld 1: warmteverlies leidingen: inputs

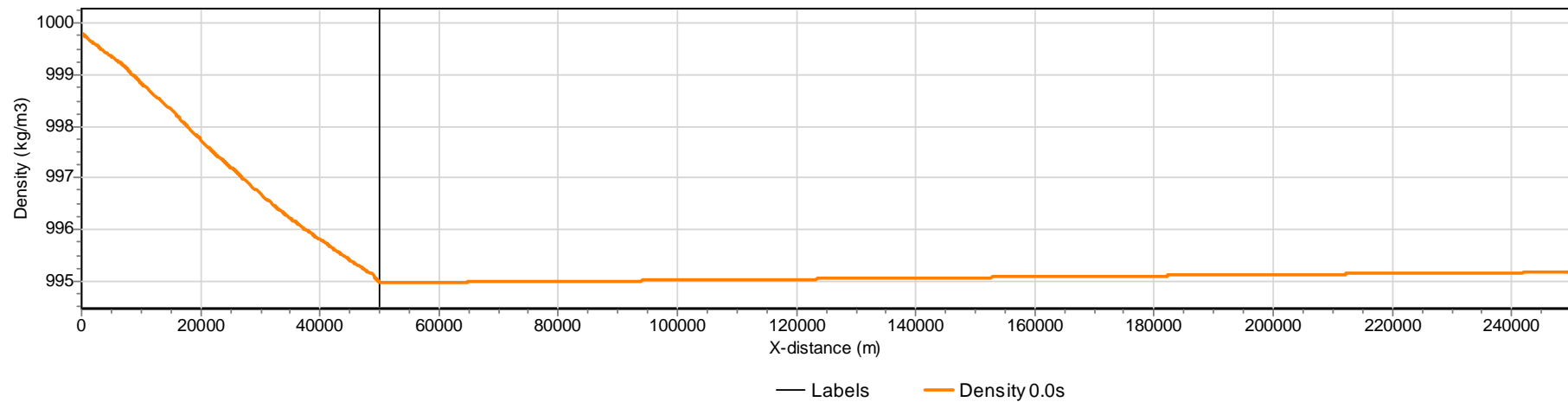
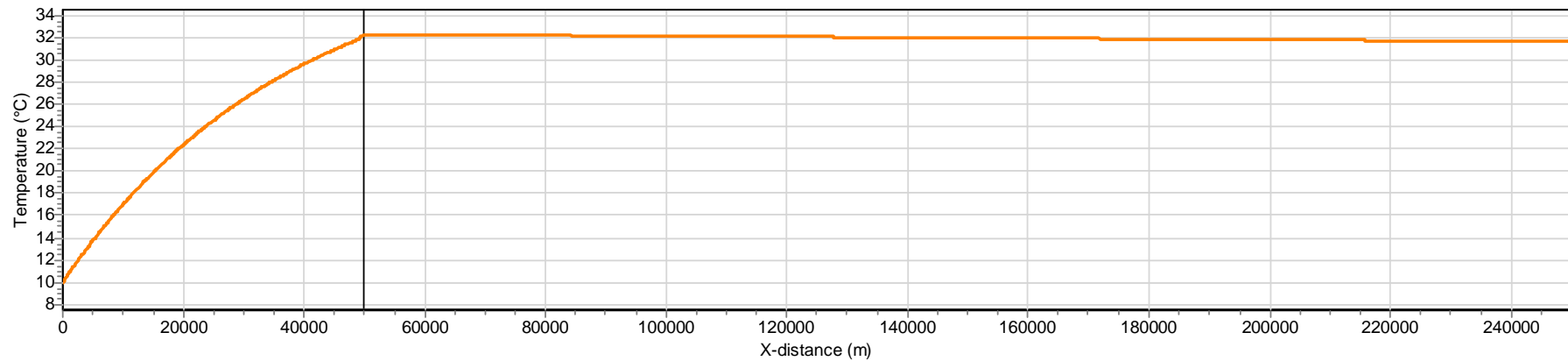




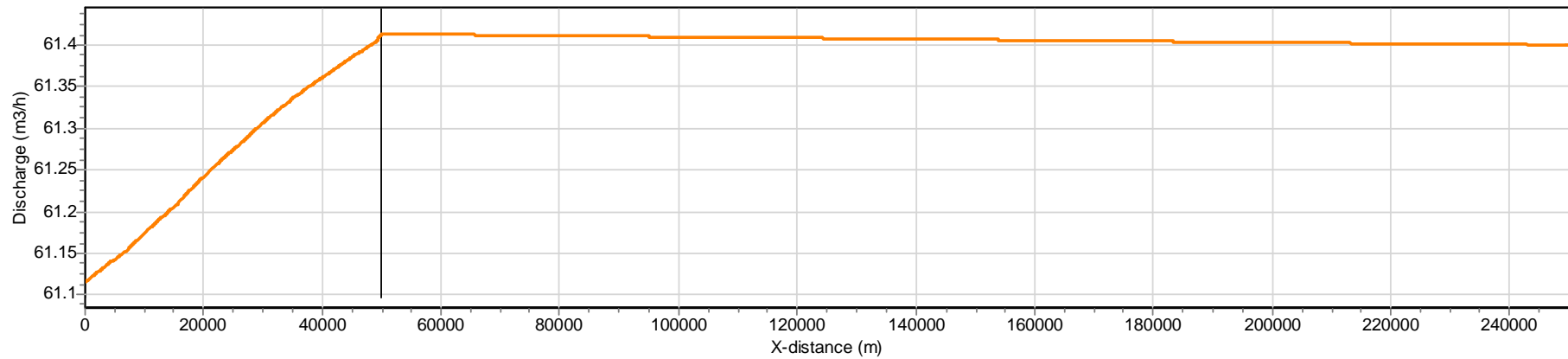
# Voorbeeld 1: warmteverlies leidingen: outputs



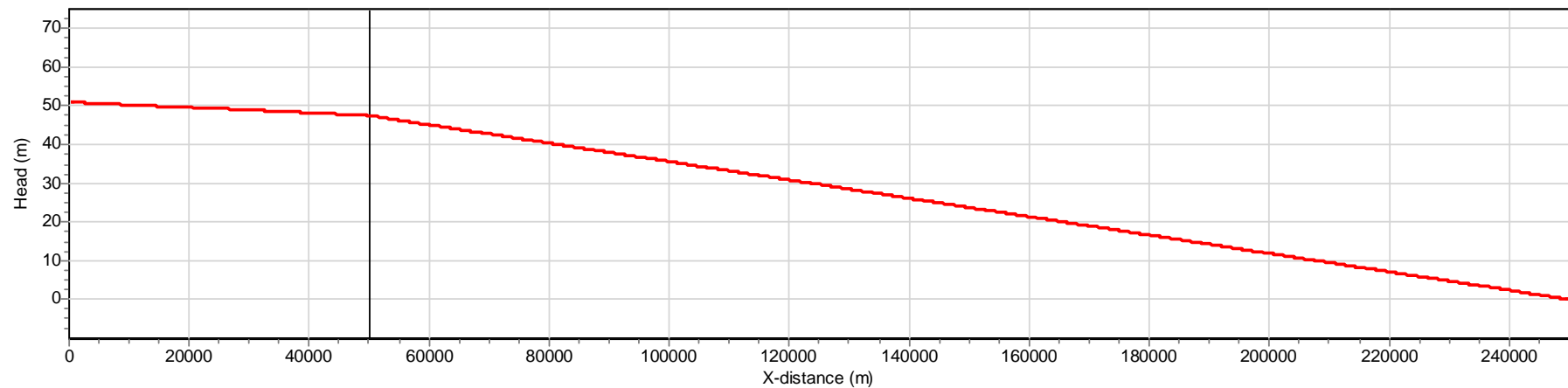
# Voorbeeld 1: warmteverlies leidingen: outputs



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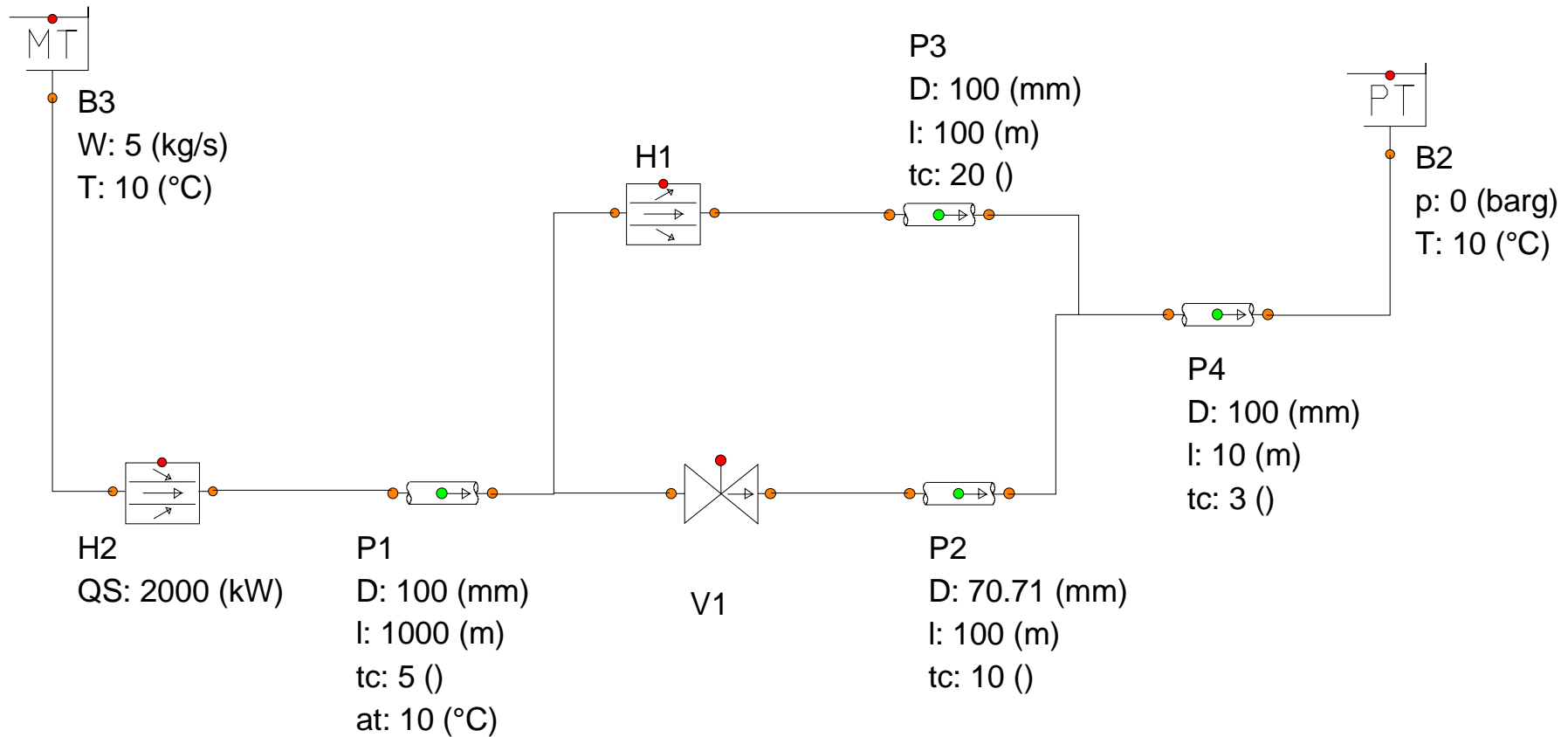


— Labels — Discharge 0.0s

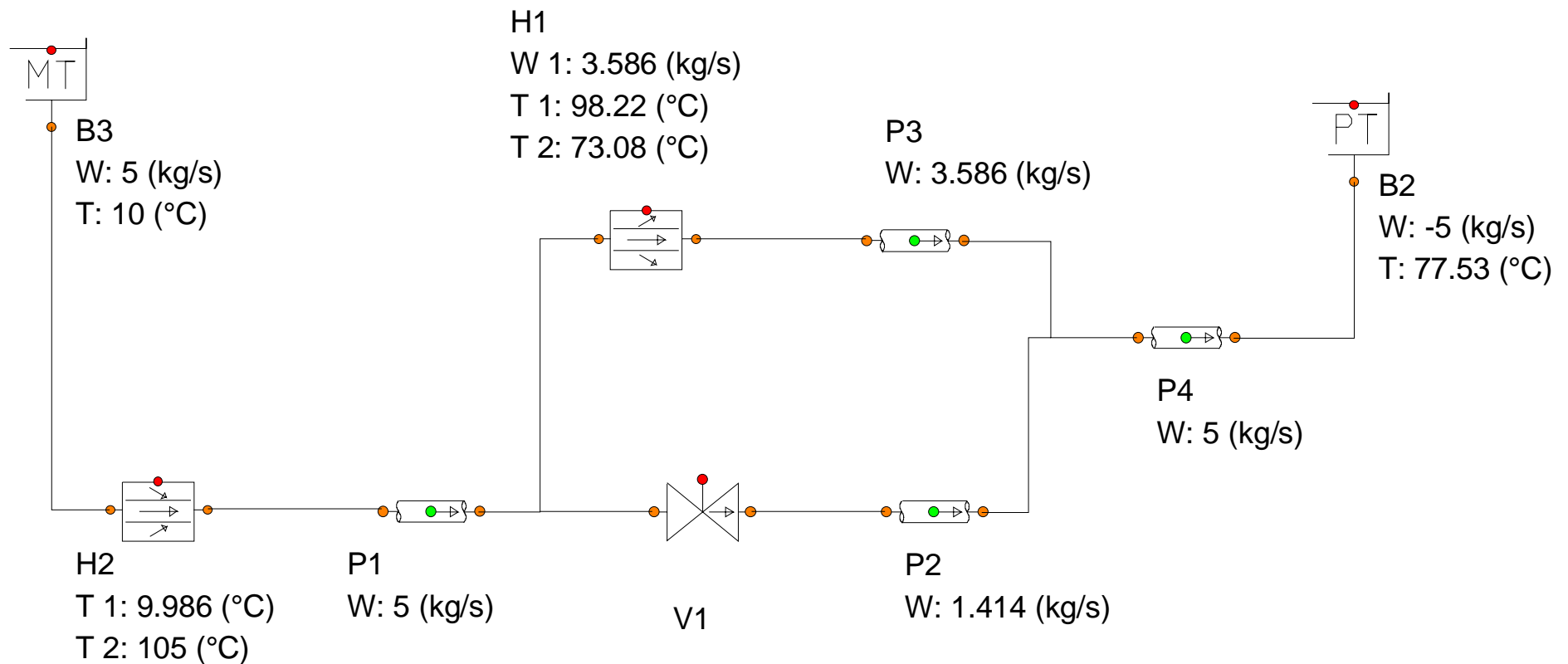


— Labels — Head 0.0s

# Voorbeeld 2: Warmte uitwisselen: inputs

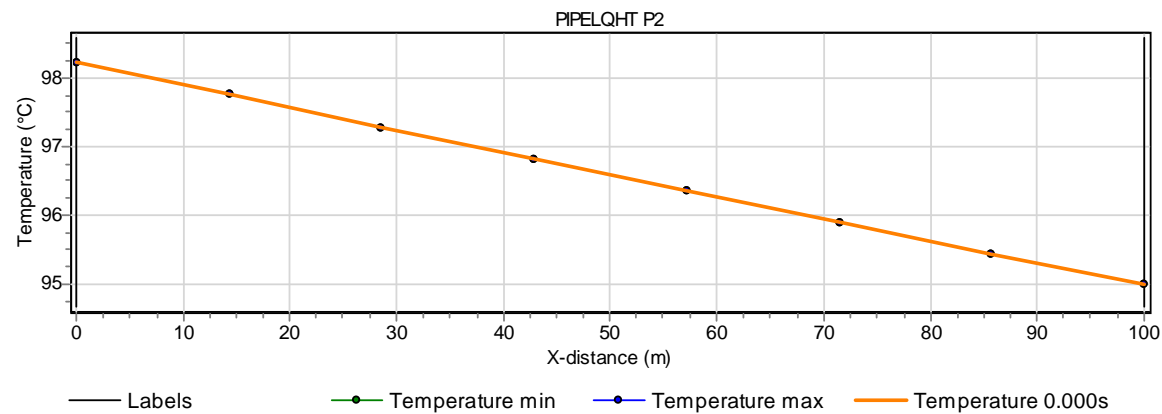
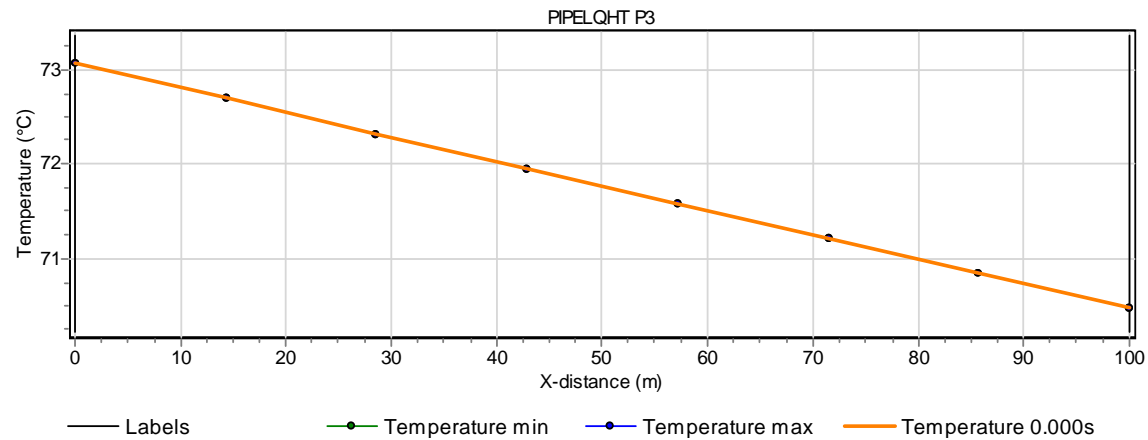


# Voorbeeld 2: Warmte uitwisselen: outputs

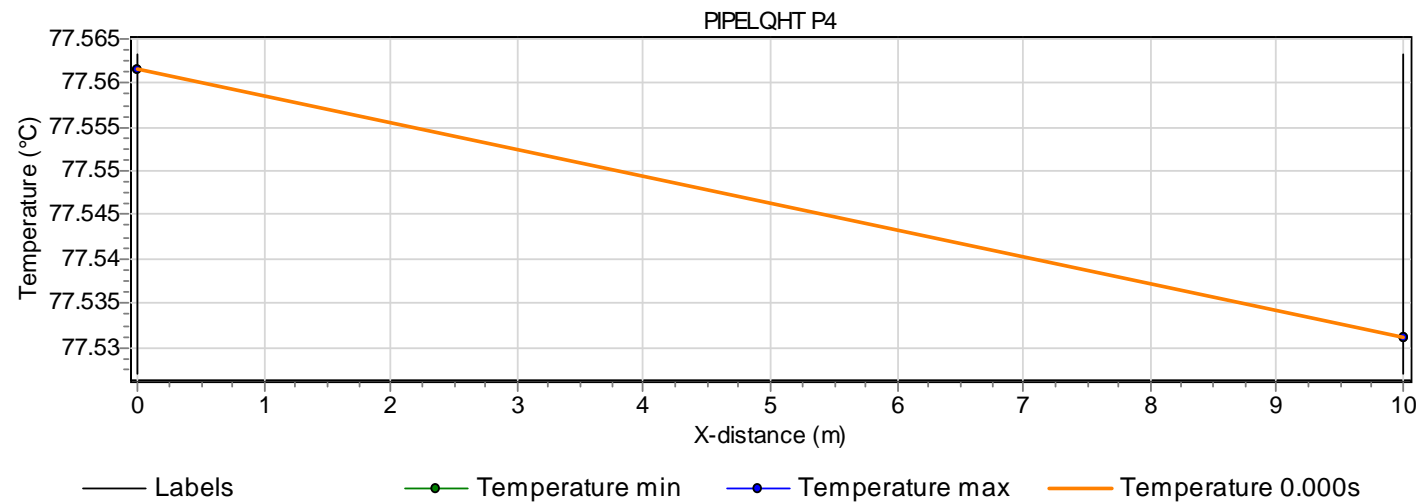




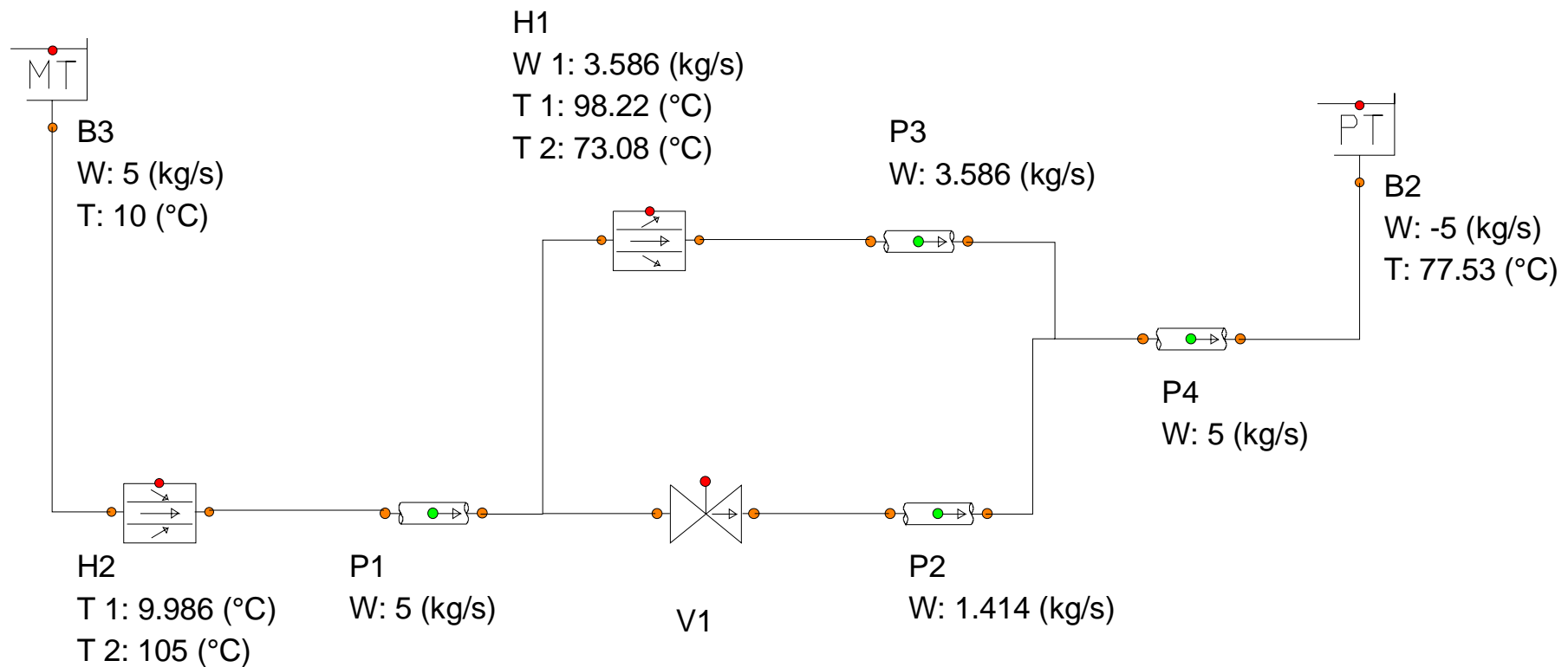
# Voorbeeld 2: Warmte uitwisselen: temperatuur



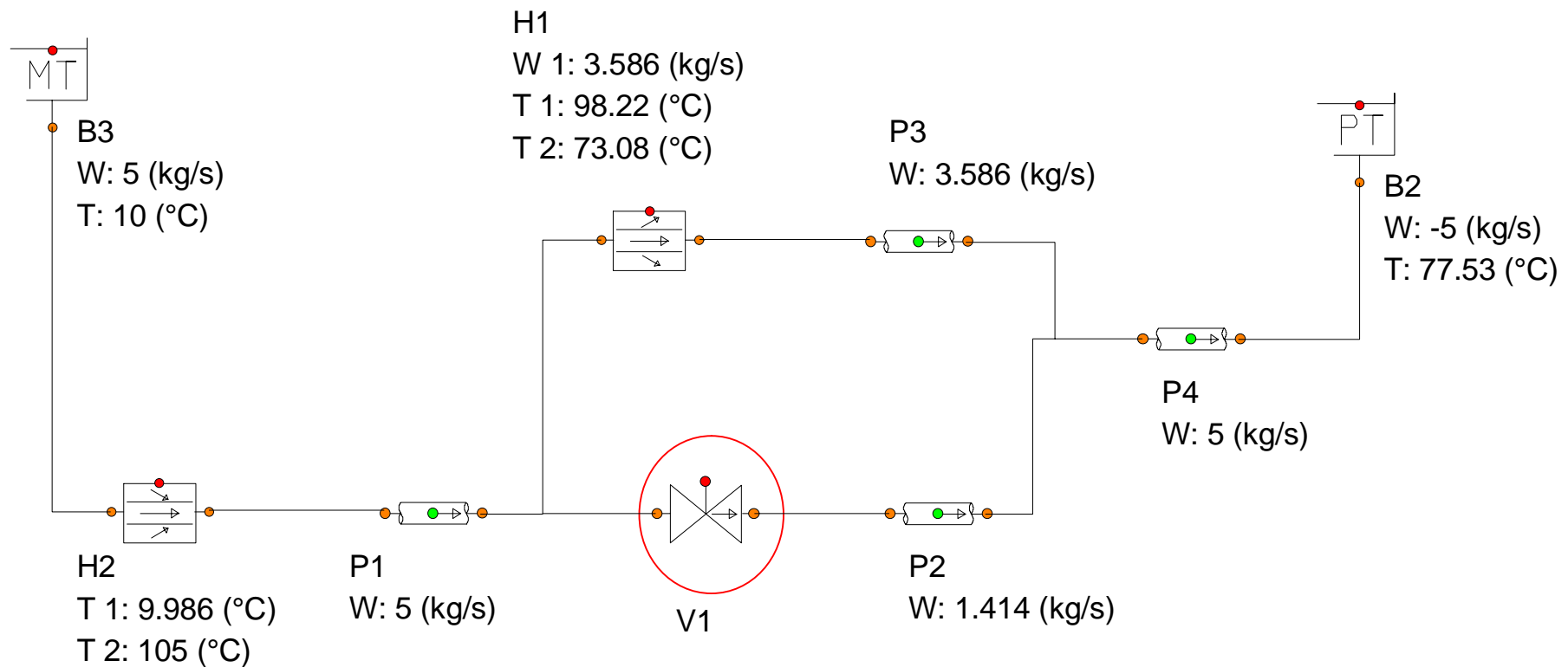
## Voorbeeld 2: Warmte uitwisselen: temperatuur



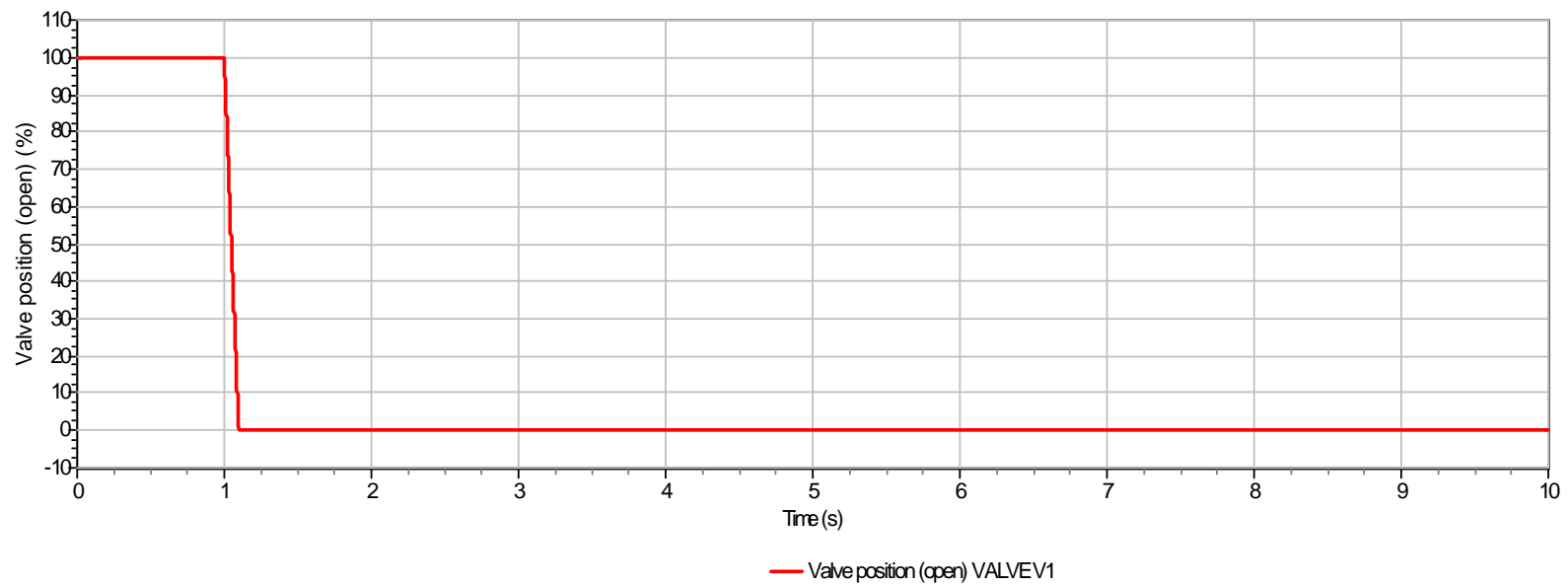
# Voorbeeld 2: Warmte uitwisselen: klepsluiting



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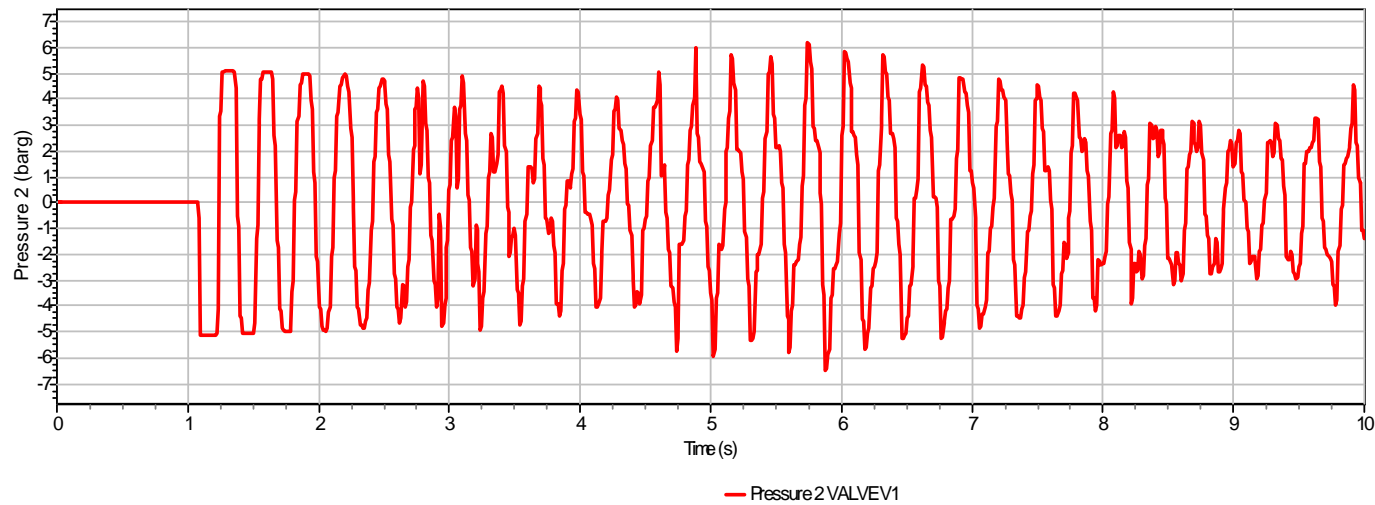
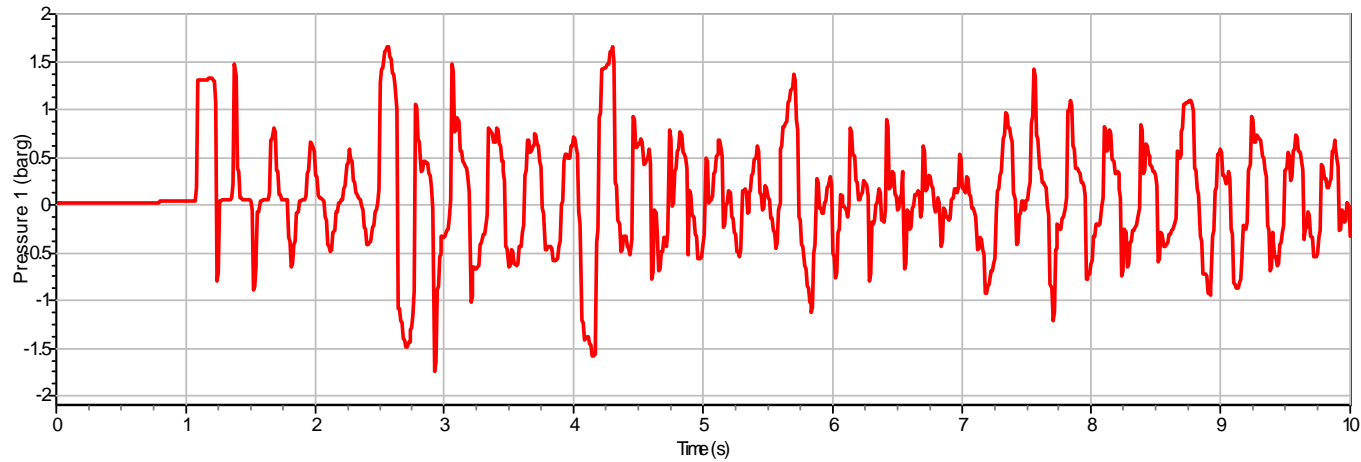


## Voorbeeld 2: Warmte uitwisselen: klepsluiting

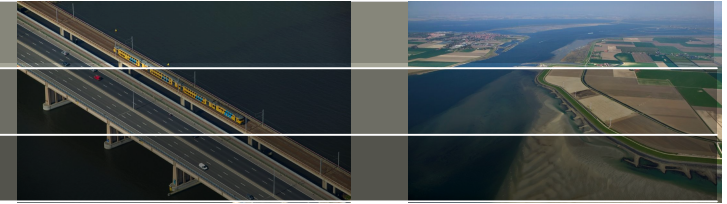




# Voorbeeld 2: Warmte uitwisselen: klepsluiting



# Conclusies



Wanda 4 Heat versus Wanda 4 Liquid

Temperaturen in het systeem & warmtestromen

Unsteady: waterslageffecten