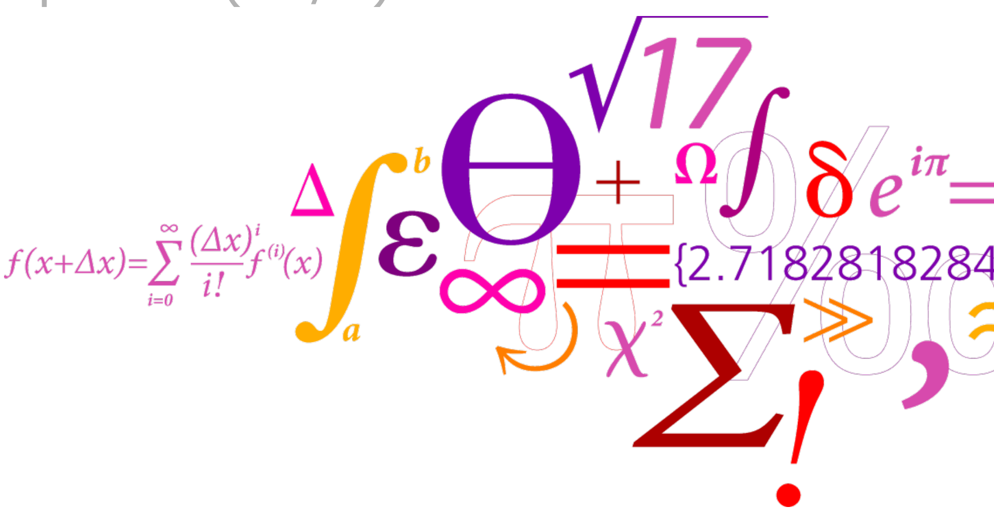
Reguleringsteknik 1

J. Christian Andersen

Kursusuge 2

Plan

- Modellering
  - Eksempel
- Håndtuning
- Håndtuning af Regbot
- Aflevering af rapport 1 – kap 1+2 (13/2)

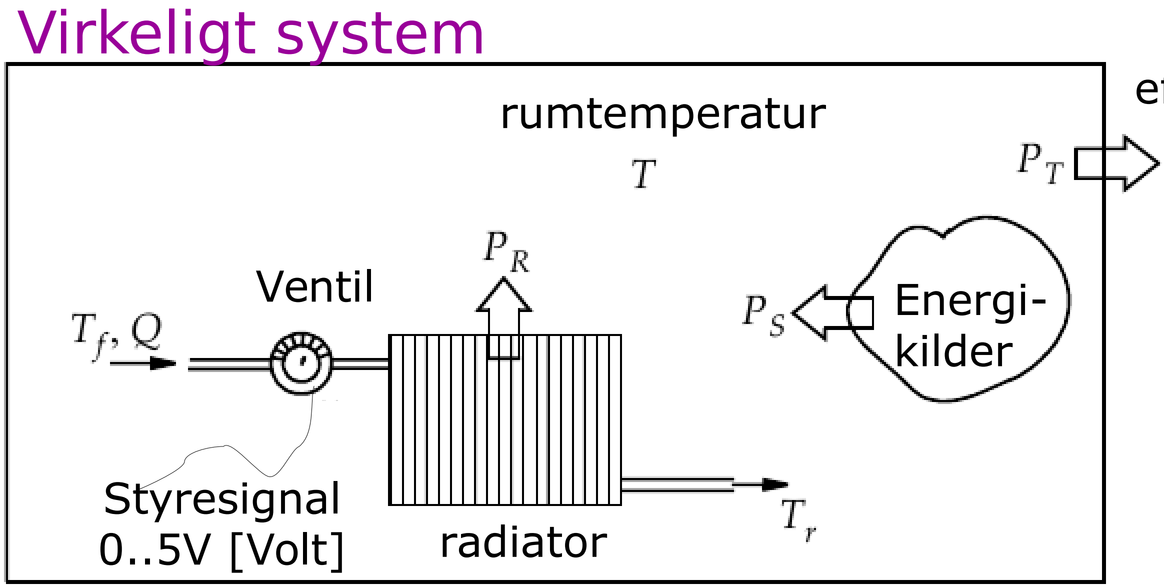


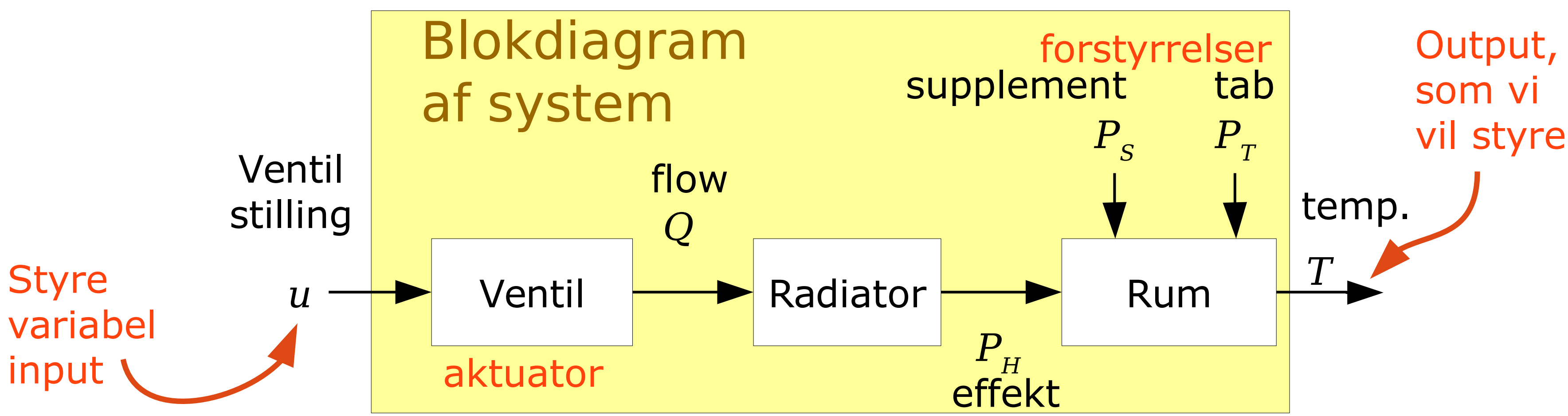
DTU Electrical Engineering
Department of Electrical Engineering

Modellering af system

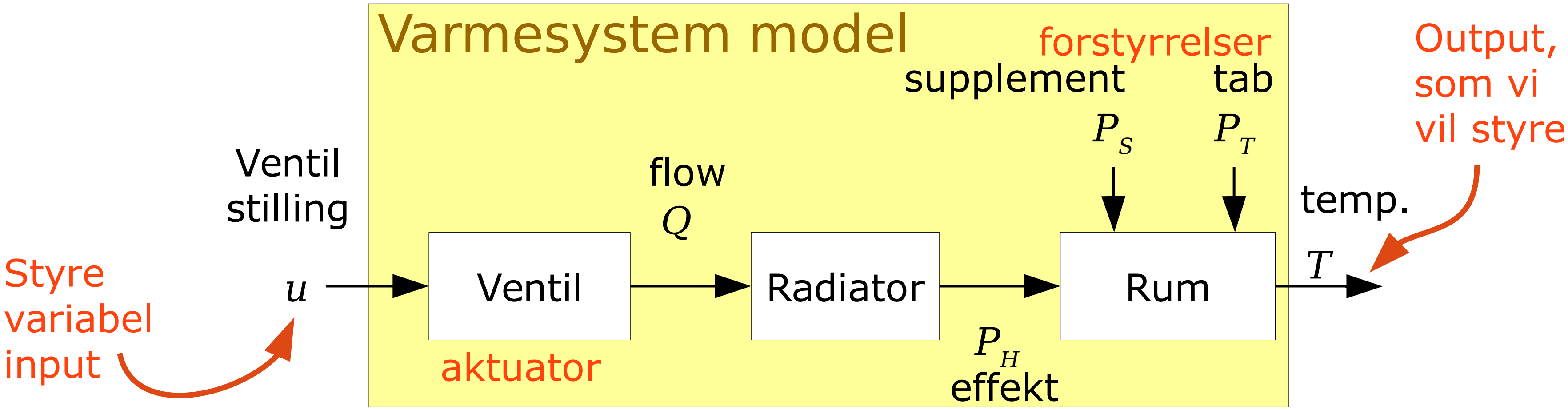
- Varmesystem for lokale
- Input påvirkning-muligheder?
- Output? Hvad vil vi styre?
- Hvad er forstyrrelser?

Virkeligt system





Modellering af system

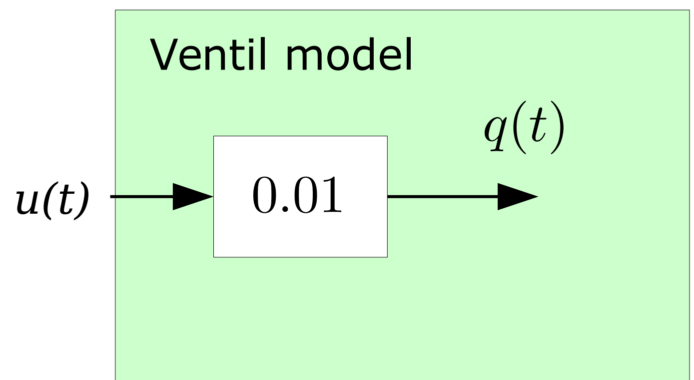


Ventil: flow q(t) i en (simpel) ventil:

$$q(t) = u(t)K_1\sqrt{p_1(t) - p_2(t)}$$

tryk ind

tryk ud



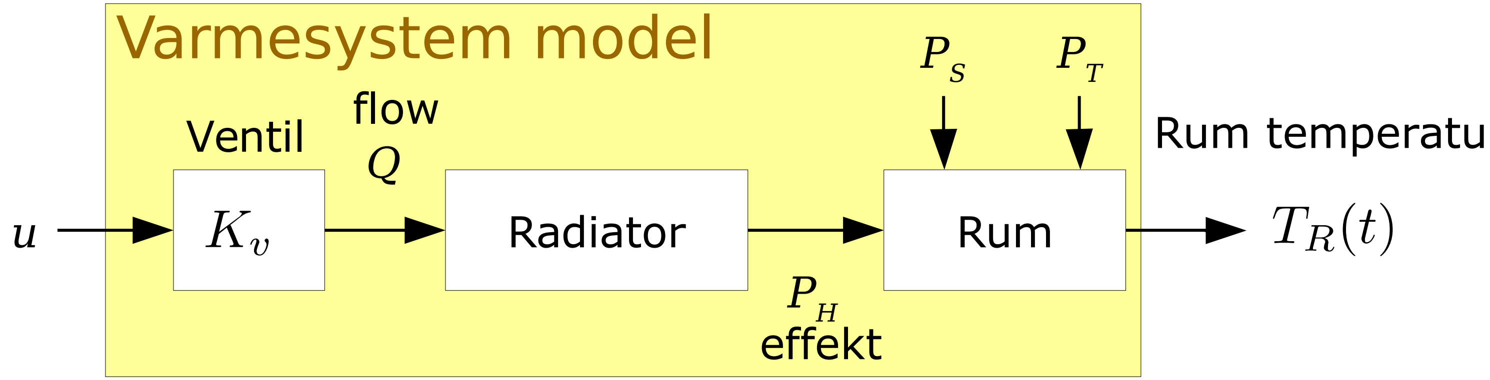
Vi antager at tryk ind og ud af ventilen er konstant
uanset ventilens stilling.

$$q(t) = u(t)K_v$$

Måling viser at med fuld åben ventil (5V)
tager det 20 sekunder for en liter (1kg)

$$K_v = \frac{1\text{kg}}{5\text{V} \cdot 20\text{s}} = 0.01$$

Modellering af system



Radiator opvarmning

$$\dot{T}_H = \frac{1}{c_{Fe} m_H}\left(q(t) c_{H_2O} \Delta_T - P_H(t)\right)$$

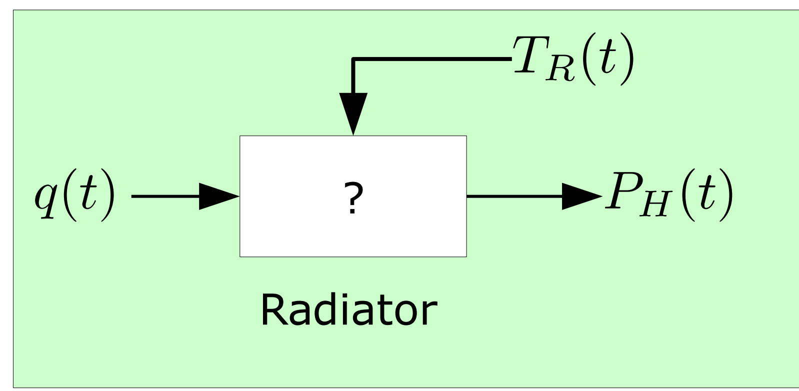
Varmekapacitet tilført [W] afgivet [W]

Afgivet effekt

$$P_H(t) = \frac{1}{R_{th}}(T_H - T_R) + \rho A (T_H^4 - T_R^4)$$

konvektion stråling

Strålingsvarme anslås til at være ubetydelig

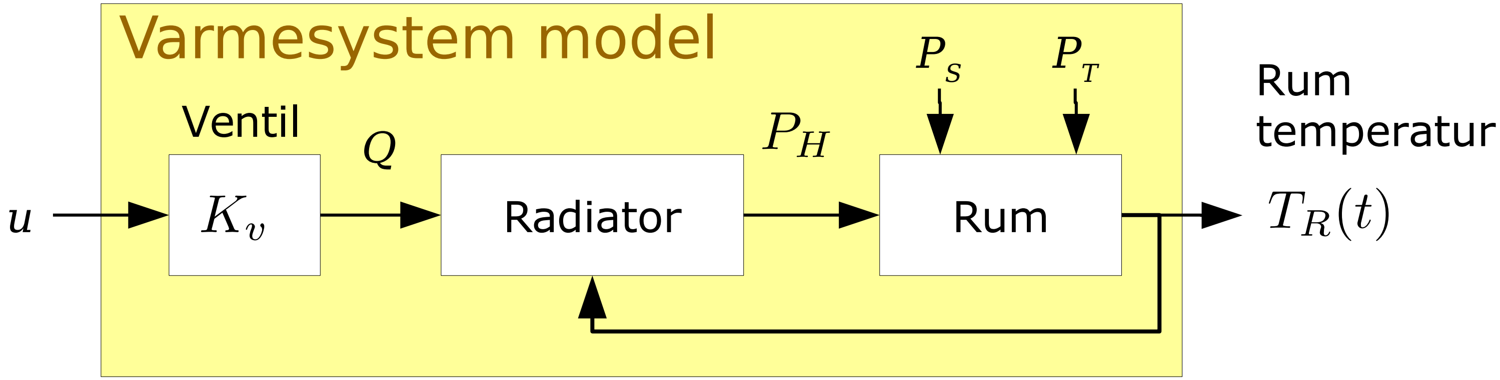


$$c_{Fe} = 444, c_{H_2O} = 4185$$

Måling: $P_H(t) = 1000W|_{T_H - T_R = 10\mathrm{C}^o} \Rightarrow R_{th} = 0.01KW^{-1}$

$\Delta_T = 10\mathrm{C}^o \,|_{P_H = 1000W}$ *NB! ringe model af varmeveksler*

Modellering af system



$$\dot{T_H} = \frac{1}{c_{Fe} m_H}\left(q(t) c_{H_2O} \Delta_T - P_H(t)\right)$$

$$P_H(t) = \frac{1}{R_{th}}(T_H - T_R)$$

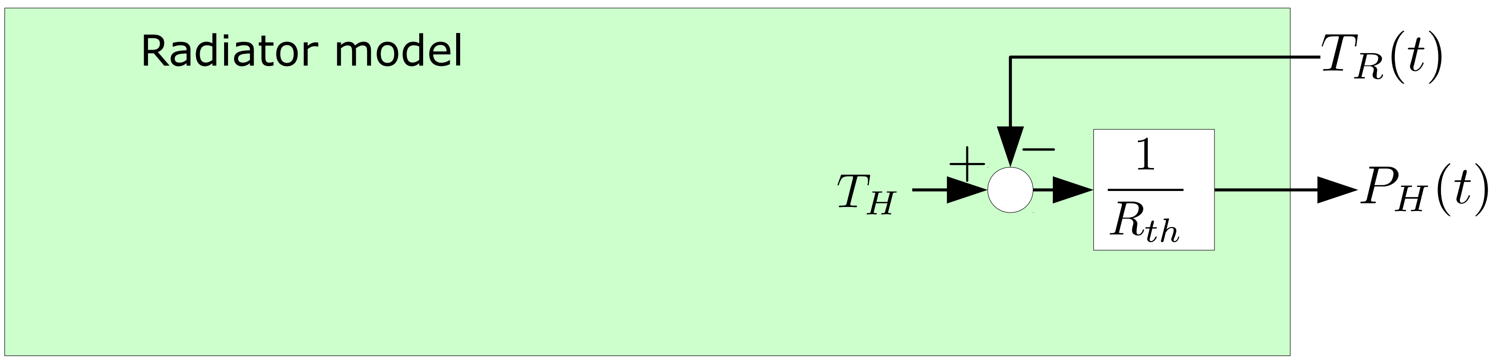
$c_{Fe} = 444 \;\; [\mathrm{J\ kg^{-1}\,^oC^{-1}}]$

$c_{H_2O} = 4185 \;\; [\mathrm{J\ kg^{-1}\,^oC^{-1}}]$

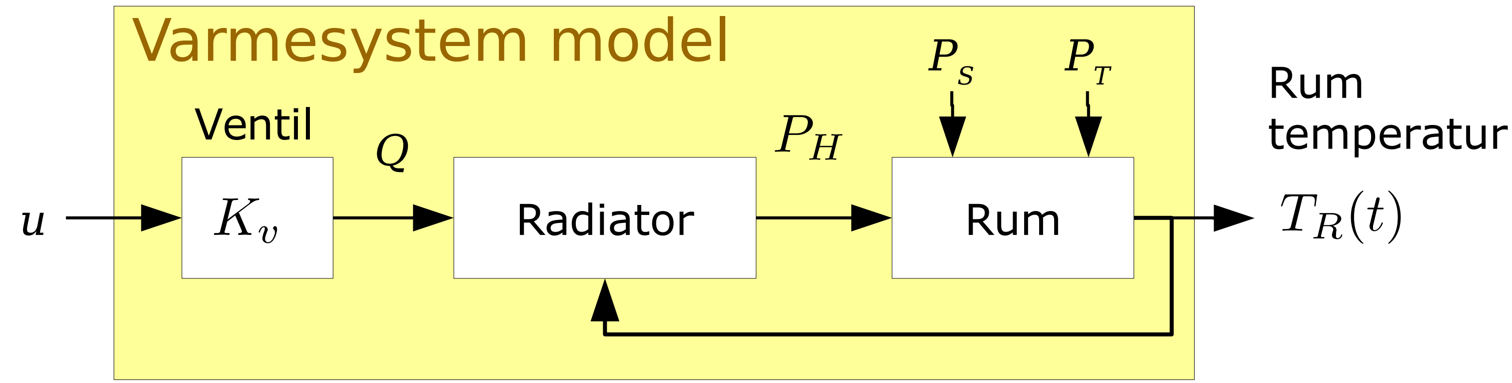
$\Delta_T = 10 \;\; [^o\mathrm{C}]$

$R_{th} = 0.01 \;\; [KW^{-1}]$

$m_H = 75 \;\; [\mathrm{kg}]$



Modellering af system



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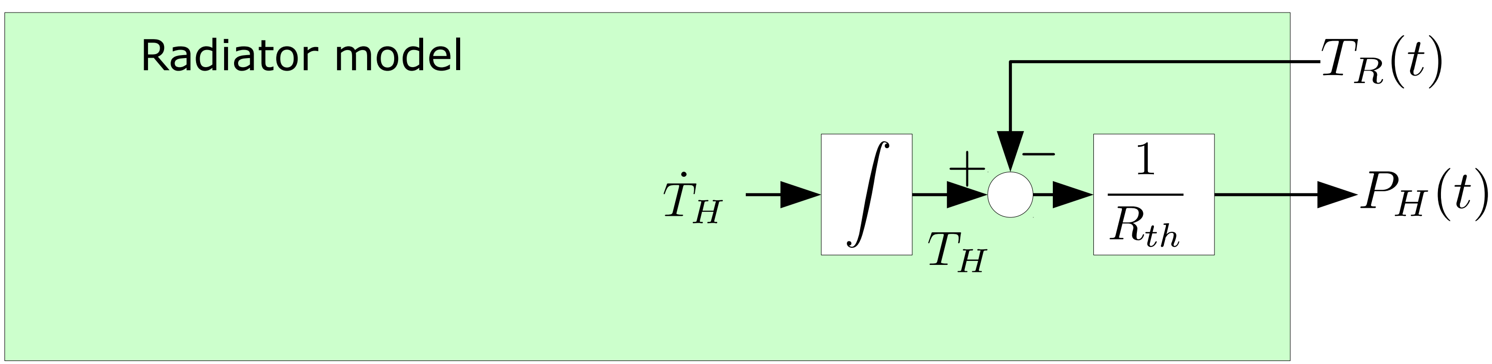
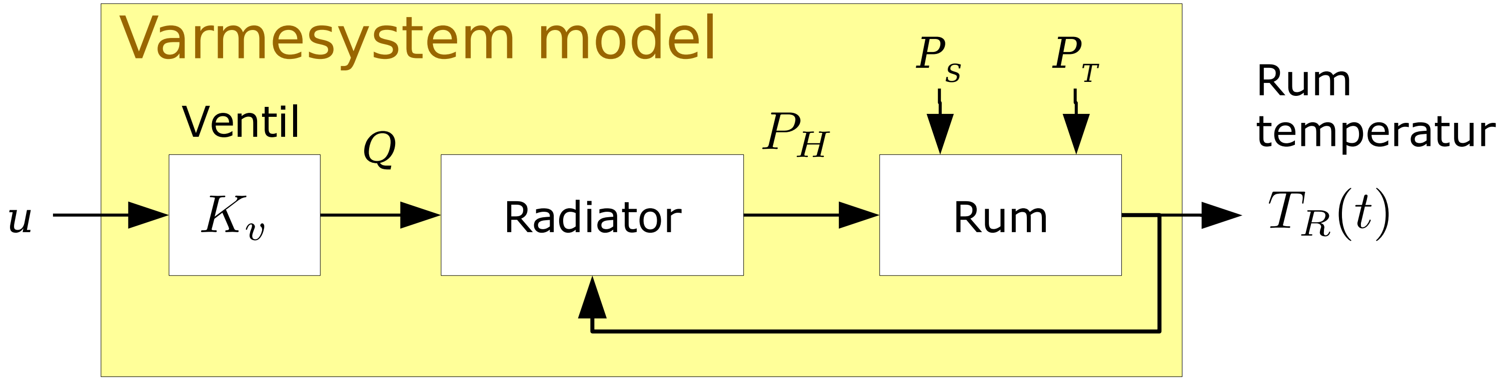


Modellering af system



$$\dot{T}_H = \frac{1}{c_{Fe} m_H} \left(q(t) c_{H_2O} \Delta_T - P_H(t) \right)$$

$$P_H(t) = \frac{1}{R_{th}} (T_H - T_R)$$

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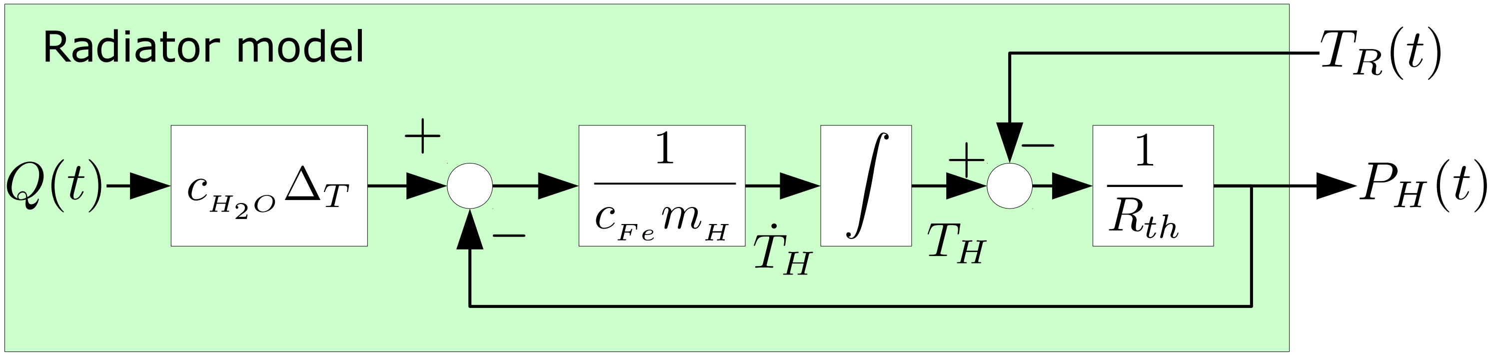
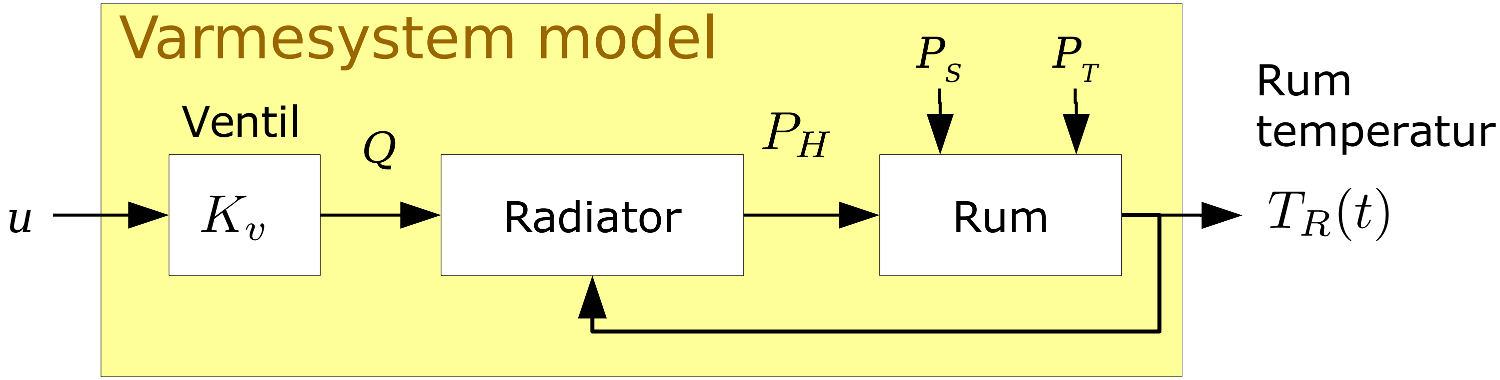


Modellering af system



Rum og forstyrrelser

$$\dot{T}_R = \frac{1}{C_R}\left(P_H + P_S - P_T\right)$$

Supplerende kilder

$$P_T(t) = \frac{1}{R_T}(T_R - T_U)$$

Udendørs temperatur

Rum temperatur

Måling:

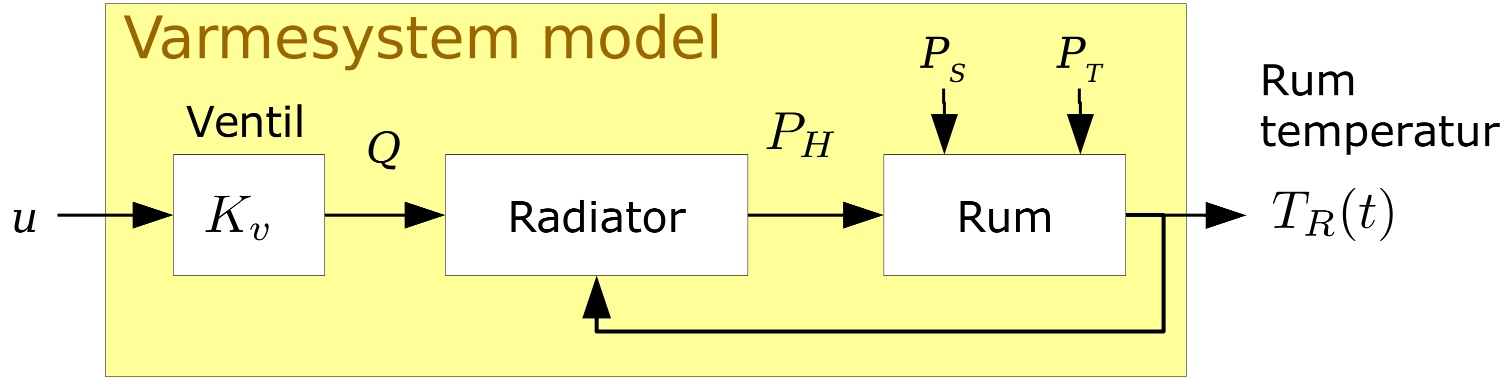
$$P_T = 1000W \Big|_{(T_R - T_U) = 20^o\mathrm{C}}^{t\to\infty}$$

$$\Rightarrow \quad R_T = 0.02\left[{}^o\mathrm{C}W^{-1}\right]$$

$$\tau_R = R_T C_R = 3600[s]$$

$$\Rightarrow \quad C_R = 190000\left[J^o\mathrm{C}^{-1}\right]$$

Modellering af system

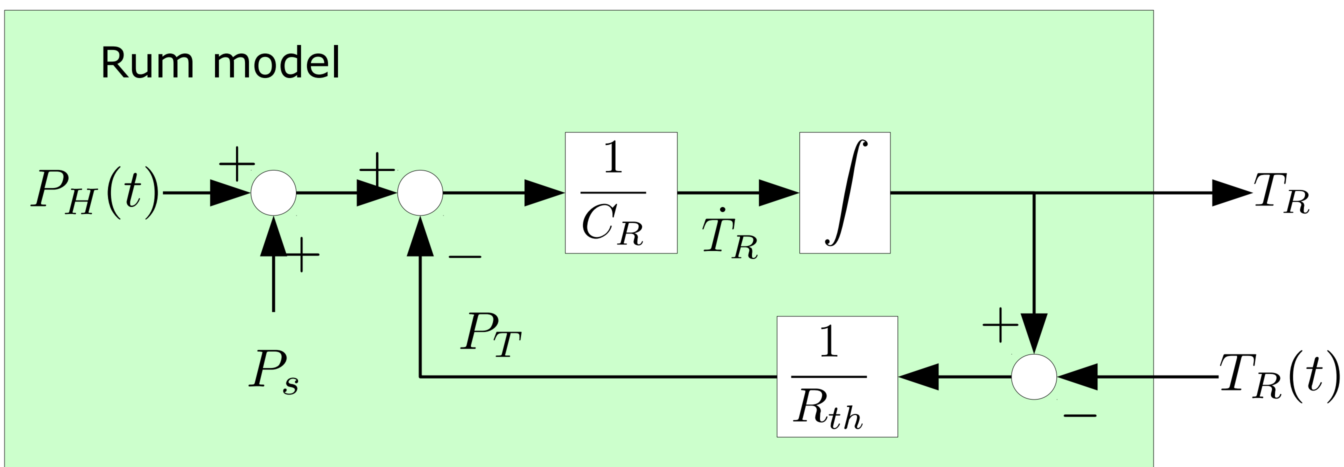


$$\dot{T}_R = \frac{1}{C_R}\left(P_H + P_S - P_T\right)$$

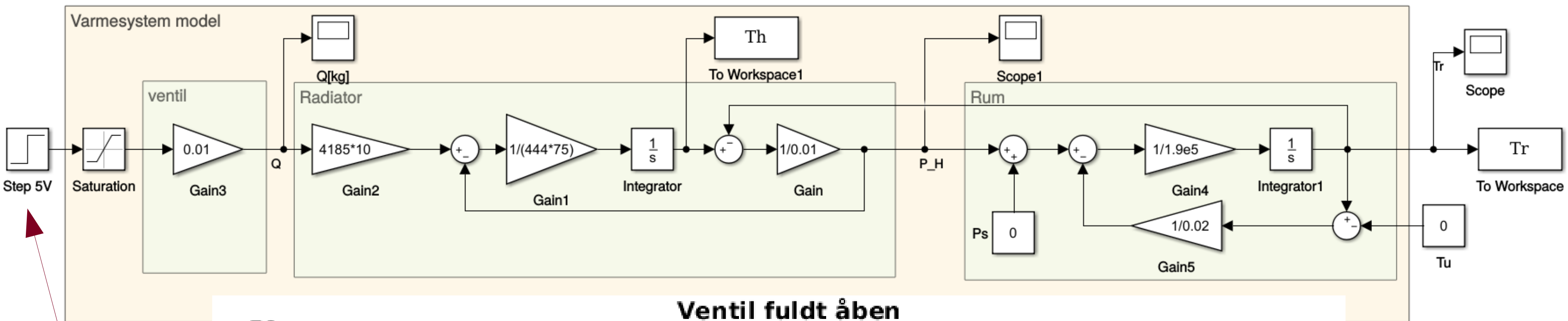
$$P_T(t) = \frac{1}{R_T}(T_R - T_U)$$

$$R_T = 0.02\left[{}^o\mathrm{C}W^{-1}\right]$$

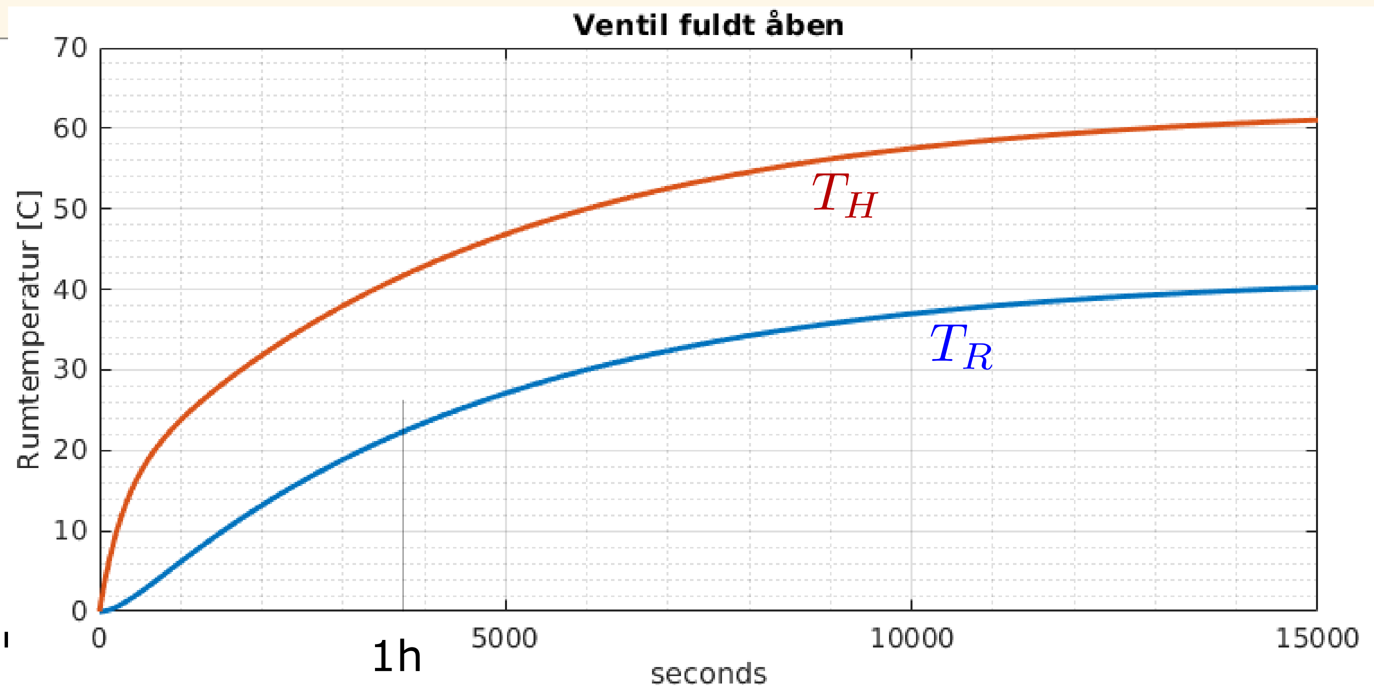
$$C_R = 190000\left[J^o\mathrm{C}^{-1}\right]$$



Simulering (Simulink)



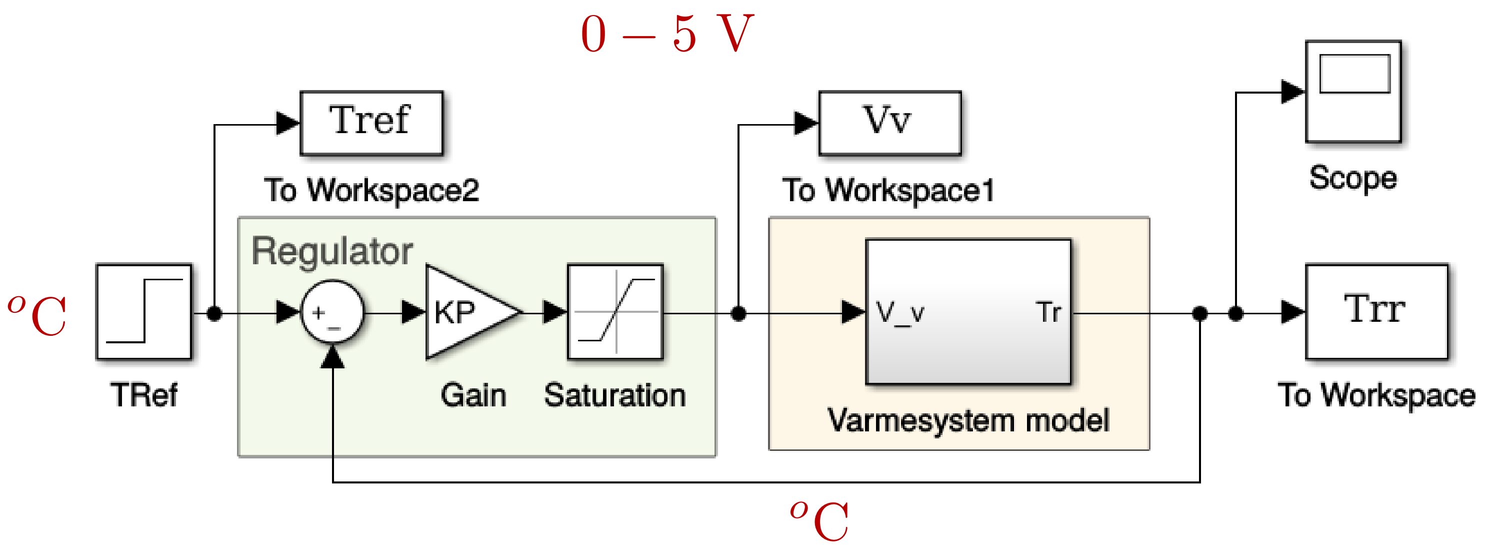
5V



40 °C

1h

Håndtuning

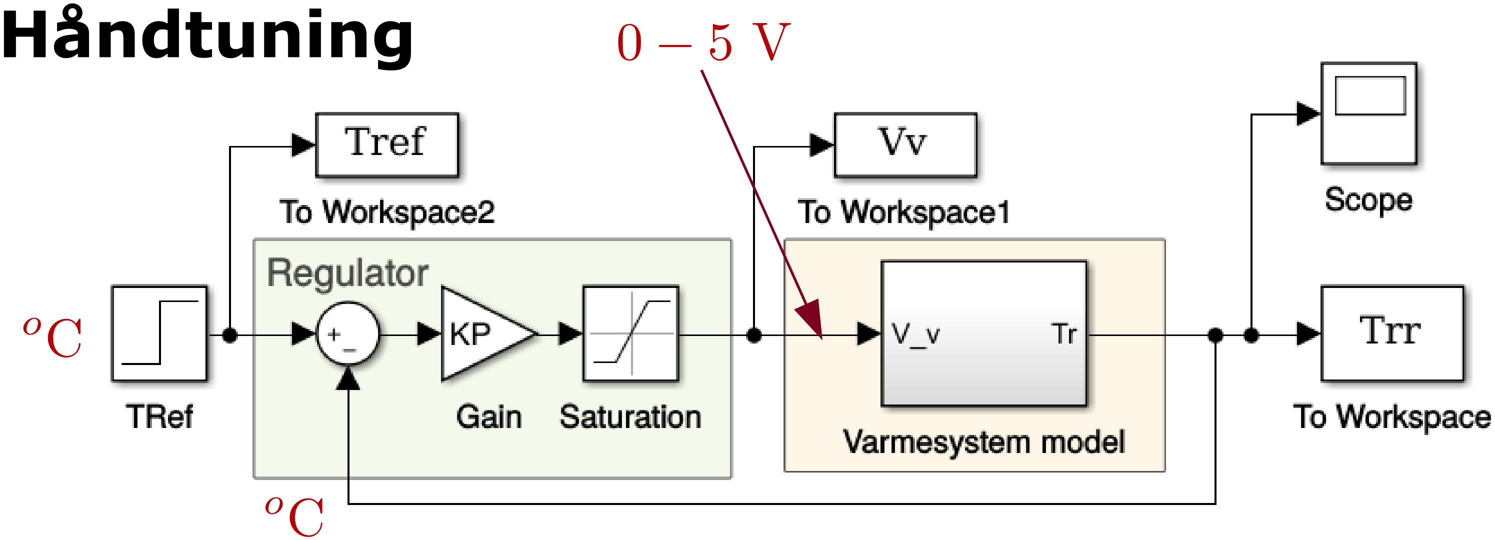


$$K_P = ?$$

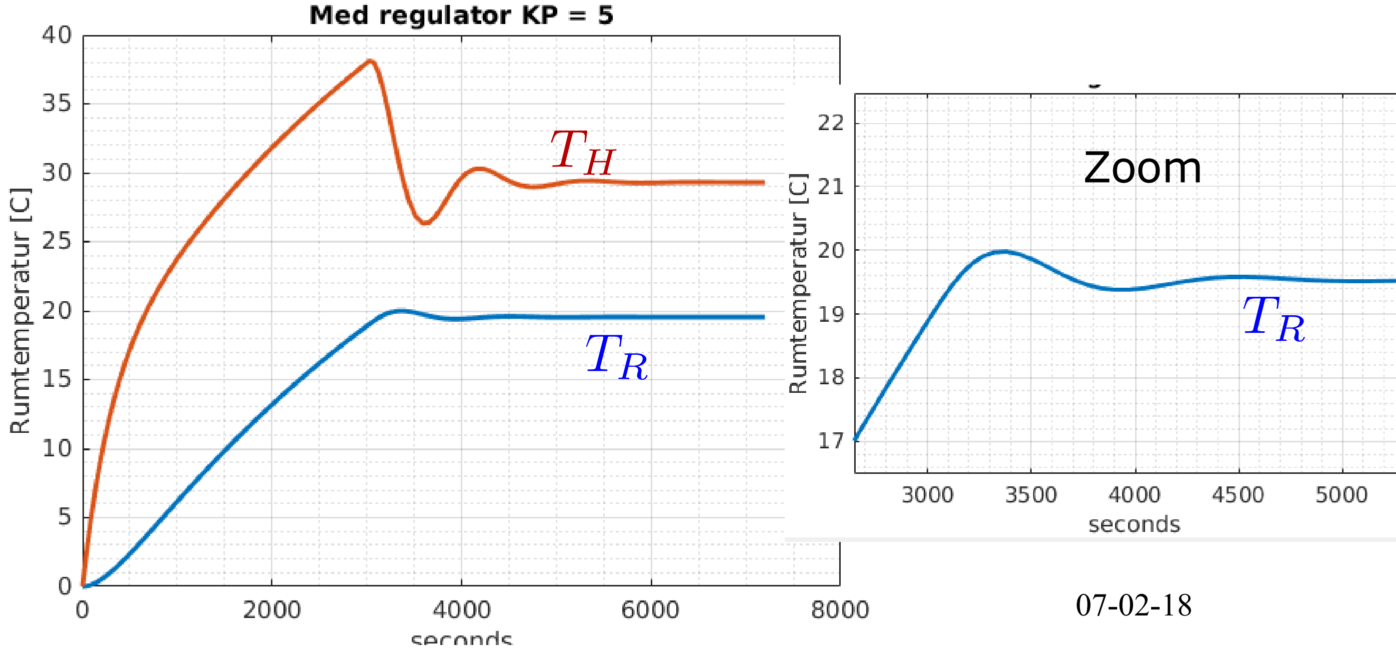
Hvornår skal ventilen åbne helt?
Et bud kunne være, når der er 1 grad forskel.

$$K_P = 5 \ \left[\mathrm{V}^o\mathrm{C}^{-1}\right]$$

Håndtuning



$$K_P = 5 \ \left[\mathrm{V}^o\mathrm{C}^{-1}\right]$$



Er det så godt?
- godt nok?

P-regulator og betegnelser

- P-regulator gain K:
  - Højere gain kan give mindre stationær fejl (forskel mellem ønsket og stationær)
  - Højere gain kan give hurtigere stigetid
  - Højere gain kan give oversving og måske ustabilitet
  - Lavere gain kan give større stationær fejl
  - Lavere gain giver langsommere indsvingningstid