Lecture 24: Process modeling & balance laws

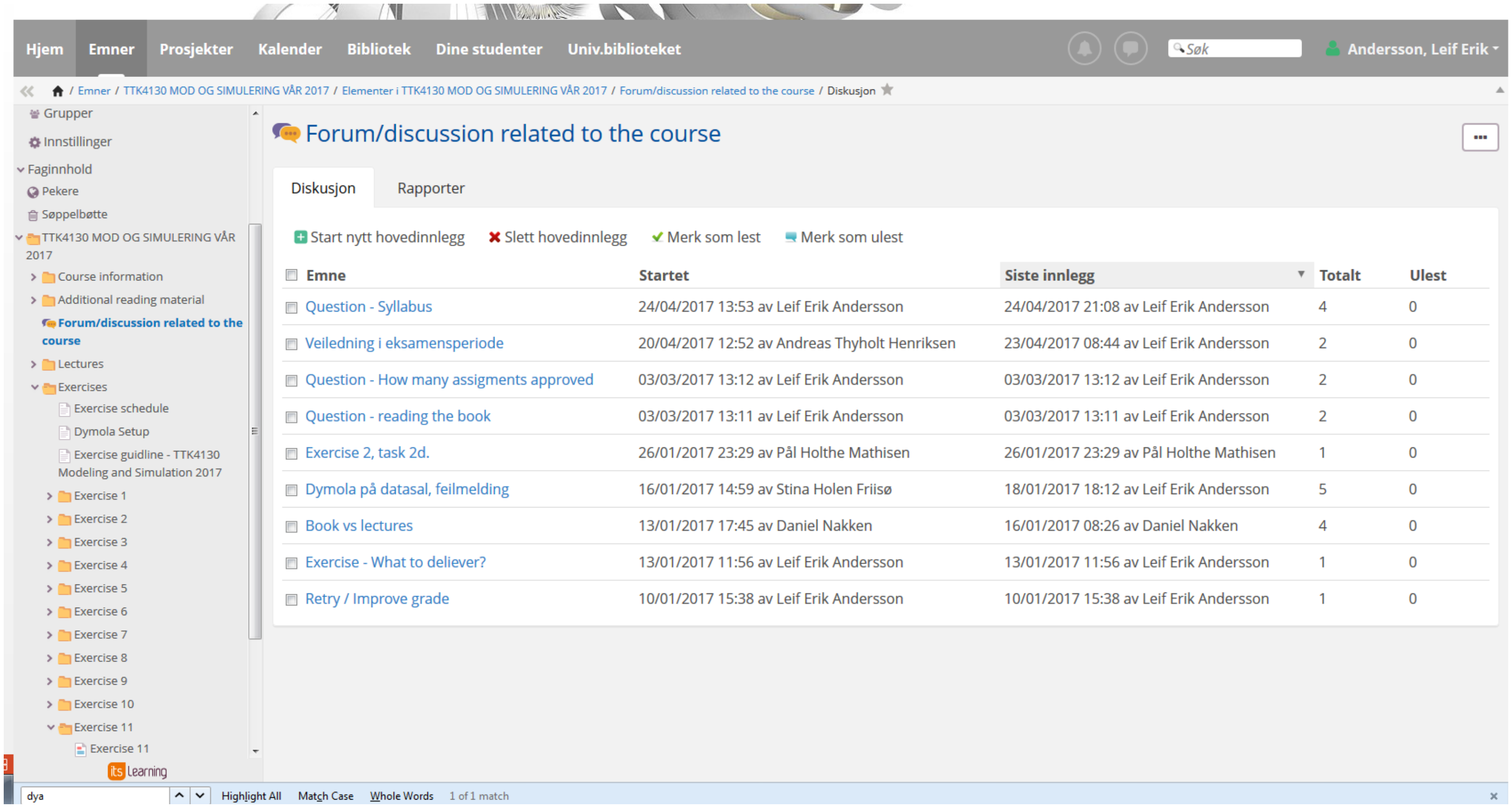
- Process modeling, structure and methodolgy
- Balance laws
  - Closure relations

Book: 10.4, 11.1-11.4

2nd Mai – Exam 2016

15	11.04	No lecture (Easter)	
	13.04	No lecture (Easter)	
16	18.04	No lecture (Easter)	
	20.04	Process modelling and balance laws (differential balance)	E: 10.4, 11.1-4
17	25.04	Process modelling and balance laws (closure relations)	E: 10.4, 11.1-4
	27.04	No lecture (TTK4135 lab.rapport)	
18	02.05	Discussion: Exam 2016 (+Review)	
	04.05	No lecture	

Forum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Andersson, Leif Erik
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Grupper
Innstillinger
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TTK4130 MOD OG SIMULERING VÅR 2017
Course information
Additional reading material
Forum/discussion related to the course
Lectures
Exercises
Exercise schedule
Dymola Setup
Exercise guidline - TTK4130 Modeling and Simulation 2017
Exercise 1
Exercise 2
Exercise 3
Exercise 4
Exercise 5
Exercise 6
Exercise 7
Exercise 8
Exercise 9
Exercise 10
Exercise 11
Exercise 11
its Learning
Forum/discussion related to the course
Diskusjon
Rapporter
Start nytt hovedinnlegg
Slett hovedinnlegg
Merk som lest
Merk som ulest
Emne
Startet
Siste innlegg
Totalt
Ulest
Question - Syllabus
24/04/2017 13:53 av Leif Erik Andersson
24/04/2017 21:08 av Leif Erik Andersson
4
0
Veiledning i eksamensperiode
20/04/2017 12:52 av Andreas Thyholt Henriksen
23/04/2017 08:44 av Leif Erik Andersson
2
0
Question - How many assigments approved
03/03/2017 13:12 av Leif Erik Andersson
03/03/2017 13:12 av Leif Erik Andersson
2
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Question - reading the book
03/03/2017 13:11 av Leif Erik Andersson
03/03/2017 13:11 av Leif Erik Andersson
2
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Exercise 2, task 2d.
26/01/2017 23:29 av Pål Holthe Mathisen
26/01/2017 23:29 av Pål Holthe Mathisen
1
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Dymola på datasal, feilmelding
16/01/2017 14:59 av Stina Holen Friisø
18/01/2017 18:12 av Leif Erik Andersson
5
0
Book vs lectures
13/01/2017 17:45 av Daniel Nakken
16/01/2017 08:26 av Daniel Nakken
4
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Exercise - What to deliever?
13/01/2017 11:56 av Leif Erik Andersson
13/01/2017 11:56 av Leif Erik Andersson
1
0
Retry / Improve grade
10/01/2017 15:38 av Leif Erik Andersson
10/01/2017 15:38 av Leif Erik Andersson
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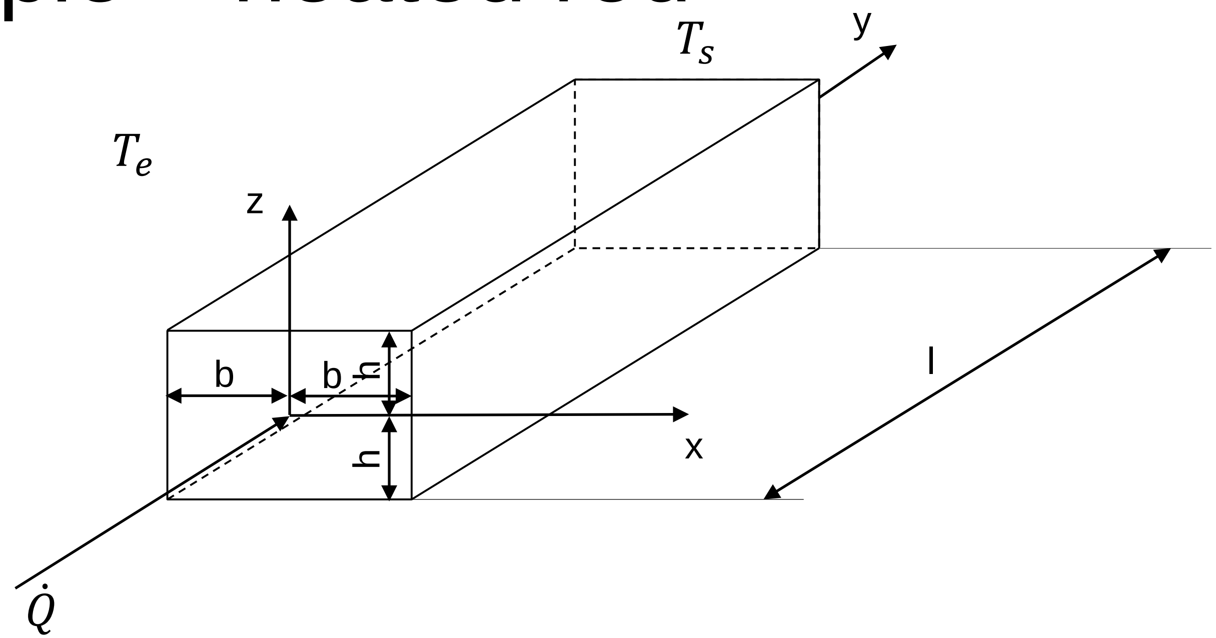
dya
Highlight All
Match Case
Whole Words
1 of 1 match

Student Evaluation

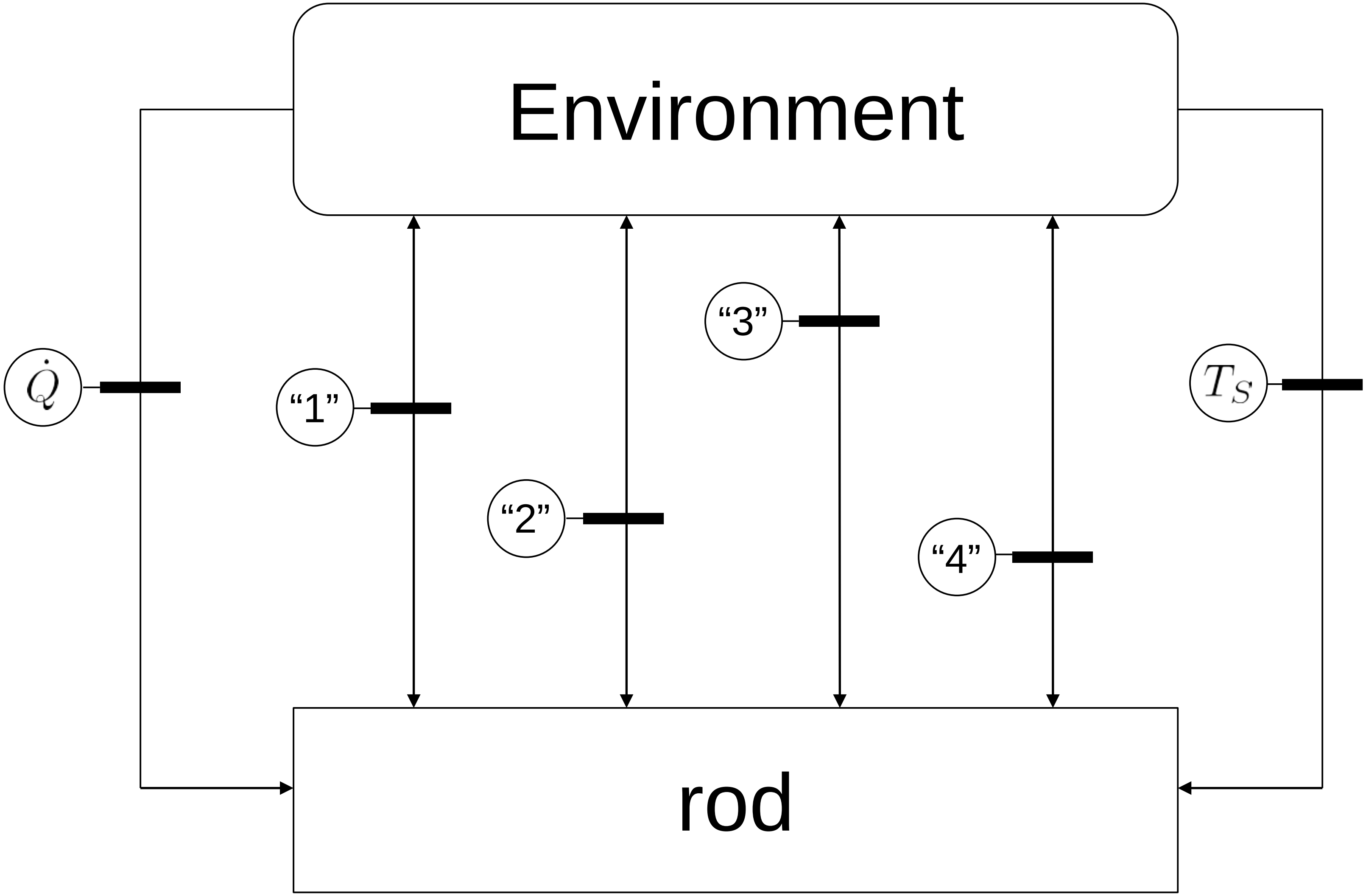
- Please fill out the student evaluation on itslearning

Example – heated rod



- At all sidewalls there is heat exchange with the environment (T_e, heat exchange coefficient α)
- At the front side there is a heat flux $\dot{Q}$
- At the back side there is a constant temperature T_s

Abstraction of process



Process equations

- Balance laws
  - Mass
  - Momentum
  - Energy
  - ...

- Constitutive equations
  - For (generalized) flows
  - Thermodynamic equations of state (e.g. ideal gas law)
  - Phenomenological relationships (e.g. between friction force and flow in a pipe)
  - ...

- Constraints
  - Geometric relationships
  - Equilibrium conditions
  - ...

Also called «closure relations» as they «close» the balance laws (such that #equations = #variables)

Process variables

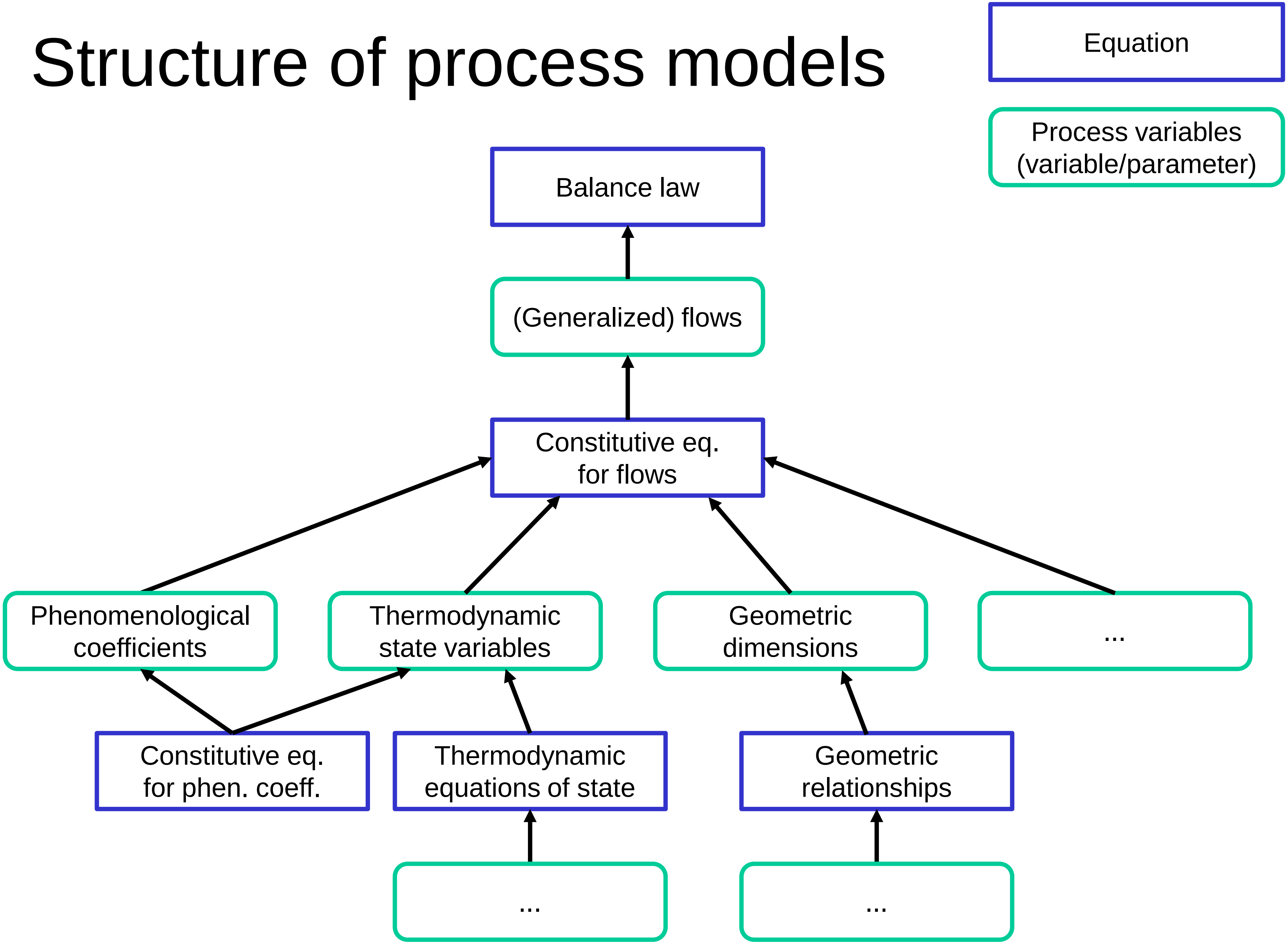
- Thermodynamic state variables
  - Mass, pressures, levels, ...
  - Velocities
  - Temperatures
  - ...

- (Generalized) flows
  - Transport (single phase)
  - Exchange (between phases)
  - Sources (reactions)
  - ...

- Phenomenological coefficients
  - Viscosity
  - Reaction rates
  - Valve constants
  - ...

- Geometric dimensions
  - Lengths, Areas, Volumes
  - ...

Structure of process models



Example: Bubble reactor

Model reactor as quasi-homogenous

- Assumptions:
  - Ideally mixed
  - Inflows are pure substances
  - Substance A and C are in liquid phase, substance B is gaseous
  - The total surface area of the bubbles depends on the inflow B
    - $S_R = S_R\left(N_{B,in}\right)$
  - The reaction rate can be calculated based on the concentration of A and the pressure in the reactor
    - $R_0 = R_0\left(c_{A,liq}, p\right)$
  - Densities ρ_A and ρ_C and mole masses M_A and M_C are constant and known
  - The gas phase can be described by the ideal gas law
    - $p\, V_{gas} = n_B R_m T$
  - The volume of the reactor is constant and known