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Dynamic HEX model using SRK thermodynamics

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Outline

- Project objectives
- HEX model
  - assumptions
  - illustration
  - states, inputs, outputs
  - equations
- Future work

Project Objectives

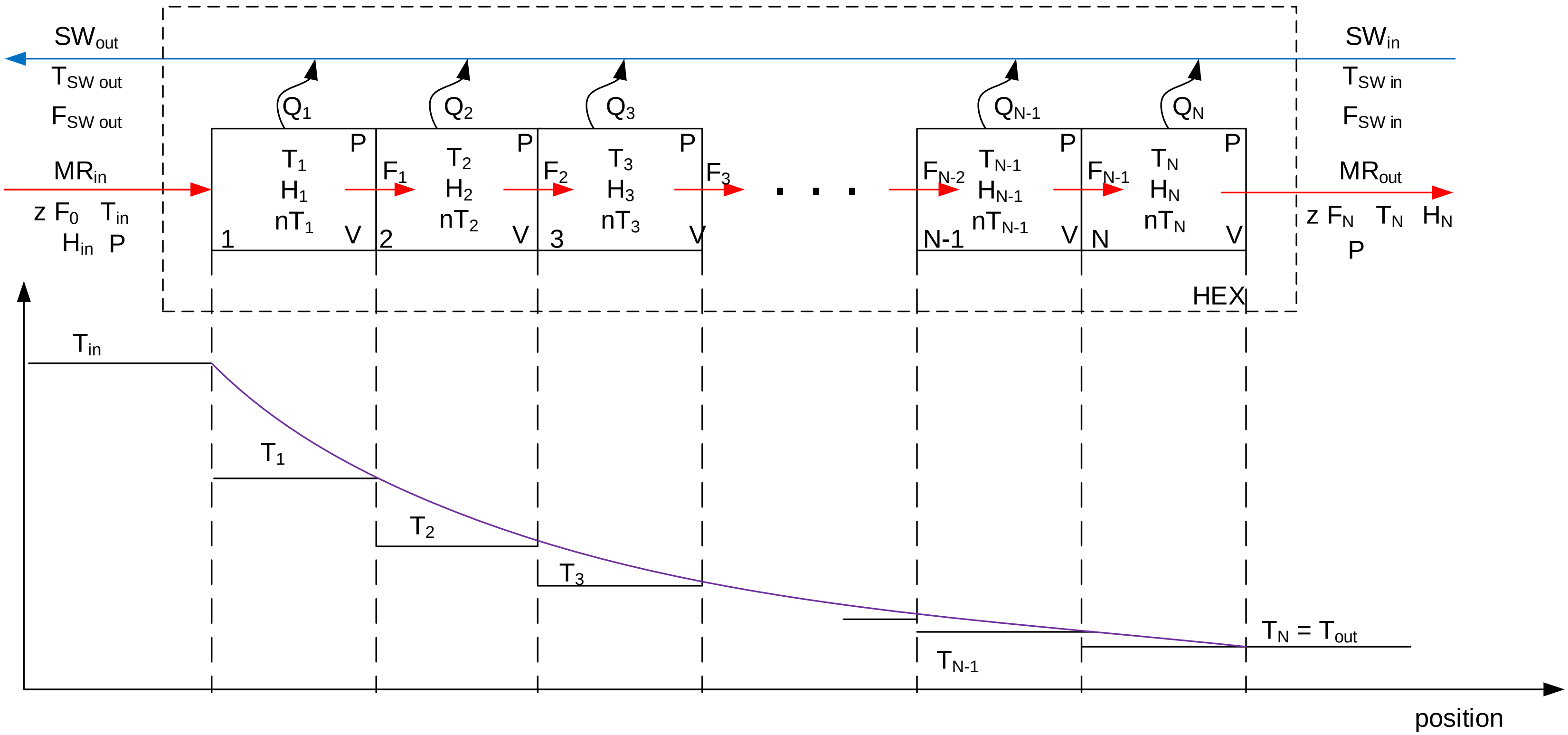
- HEX model which can handle L, V-L, V
- SRK EOS as part of the model
- main application: a small LNG cycle

HEX Model - Assumptions

- counter-current flow
- N cells with constant volume
- perfect mixing
- homogenous mixing (no slip)
- series of flash calculations
- no pressure drop
- cooling agent as one lump

HEX Model - Illustration

- Cell division & temperature profile



HEX Model – States

Nr	State definition	State symbol	Total number
1.	total holdup	nT	N
2.	component holdup	n	(NC – 1) x N
3.	internal energy	U	N
4.	temperature	T	N
5.	liquid composition	x	(NC – 1) x N
6.	vapour composition	y	(NC – 1) x N
7.	liquid volume	VL	N
8.	vapour compressibility	Zg	N
9.	liquid compressibility	ZL	N

Total states 6N + 3 (NC – 1) x N

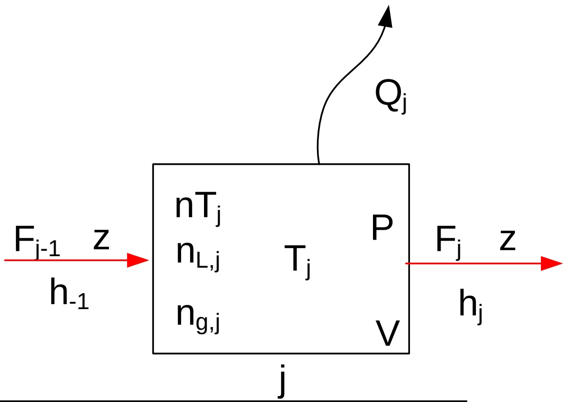
NC = nr components; N = nr cells

HEX Model - Inputs & Outputs

- Inputs
  - HEX dimensions (volume)
  - MR inlet: flow rate, temperature, composition
  - SW
  - number of cells

- Outputs
  - MR outlet temperature
  - temperature profile in HEX

HEX Model - Equations



Nr	Equation	Formula	State attributed
1.	Overall mole balance	$\frac{dnT_j}{dt} = F_{j-1} - F_j$	nT
2.	Component mole balance	$\frac{dn_{i,j}}{dt} = z_i(F_{j-1} - F_j)$	n
3.	Energy balance	$\frac{dU_j}{dt} = F_{j-1}(h_{L,j-1} \cdot n_{L,j-1} - h_{g,j-1} \cdot n_{g,j-1}) - F_j(h_{L,j} \cdot n_{L,j} - h_{g,j} \cdot n_{g,j}) - Q_j$	U
4.	Internal energy	$U_j + PV - h_{Lj} \cdot n_{Lj} - h_{gj} \cdot n_{gj} = 0$	T
5.	Component holdup	$n_{i,j} - x_{i,j}n_{L,j} - y_{i,j}n_{g,j} = 0$	x
6.	VLE	$y_{i,j} - K_{i,j}x_{i,j} = 0$	y
7.	Holdup	$nT_j - n_{L,j} - n_{g,j} = 0$	VL
8.	Vapour compressibility	$Z_{g,j}^3 - Z_{g,j}^2 + Z_{g,j}(A_{g,j} - B_{g,j} - B_{g,j}^2) - A_{g,j}B_{g,j}$	Zg
9.	Liquid compressibility	$Z_{L,j}^3 - Z_{L,j}^2 + Z_{L,j}(A_{L,j} - B_{L,j} - B_{L,j}^2) - A_{L,j}B_{L,j}$	ZL

Future work

- model proofing
- initial conditions
- develop the model to a generic one