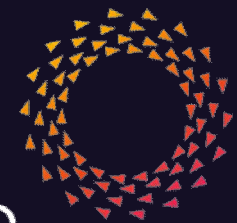


rWGS + FT modelling in Apros

Teemu Sihvonon, VTT

Final Researchers' Seminar,
Lappeenranta

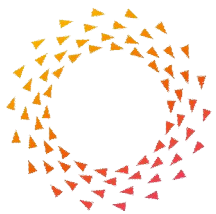
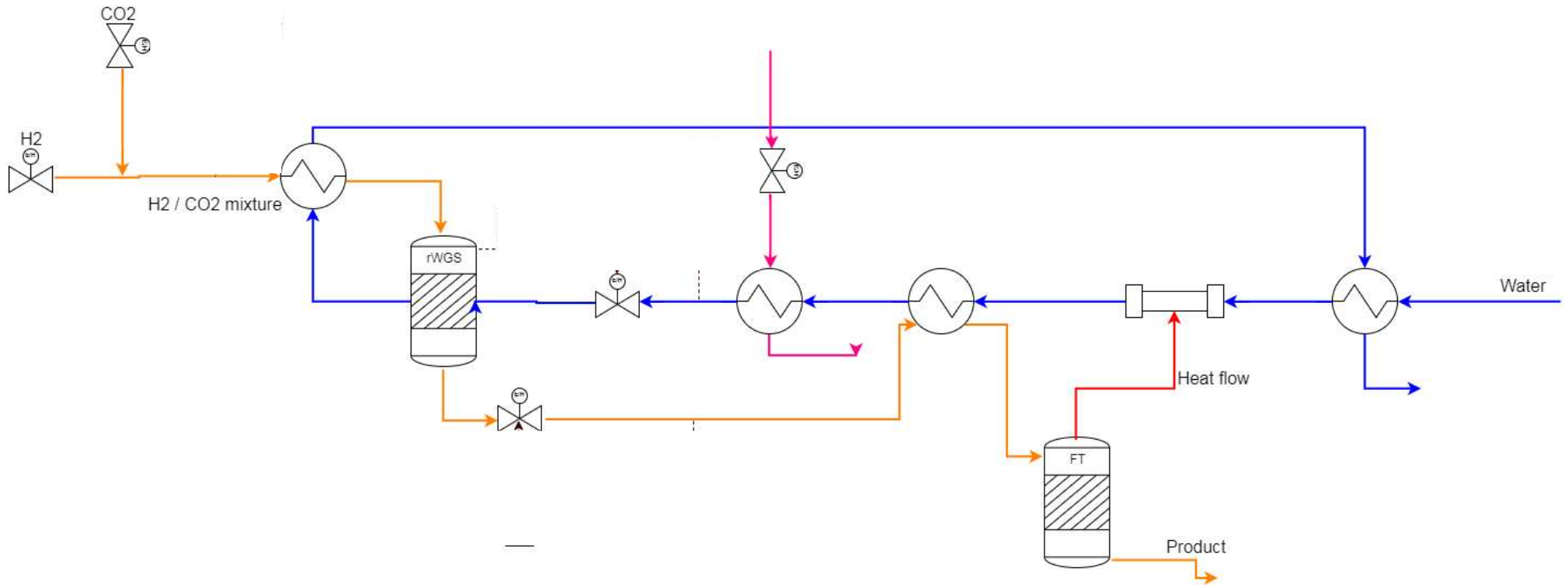
12.12.2017



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TRUST IN RENEWABLE.

Process



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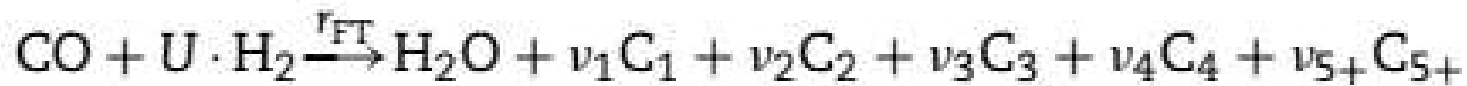
Apros rWGS reactor model

- Ni catalyst, ~800C, 25 bar
 - Pressure could be lower, but high pressure is needed in FT reactor
- H₂ – CO₂ feed
 - In this study with alternating H₂:CO₂ ratio from 2.0 to 3.0
- Xu & Froment reaction kinetics



External FT reactor model

- Co/Al₂O₃ catalyst, 200 – 225C, 20 – 30 bar
- H₂ – CO feed
 - In literature studied with H₂:CO ratio of 1.0 – 2.5
- Ma et al. reaction kinetics with parameter adjustment by Ostadi et al.*

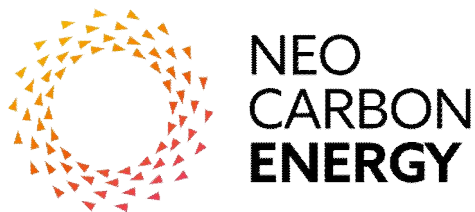


$$\frac{dF_{\text{CO}}}{dz} = \rho \cdot A \cdot (-r_{\text{CH}_4}),$$

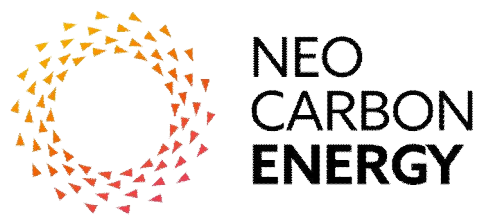
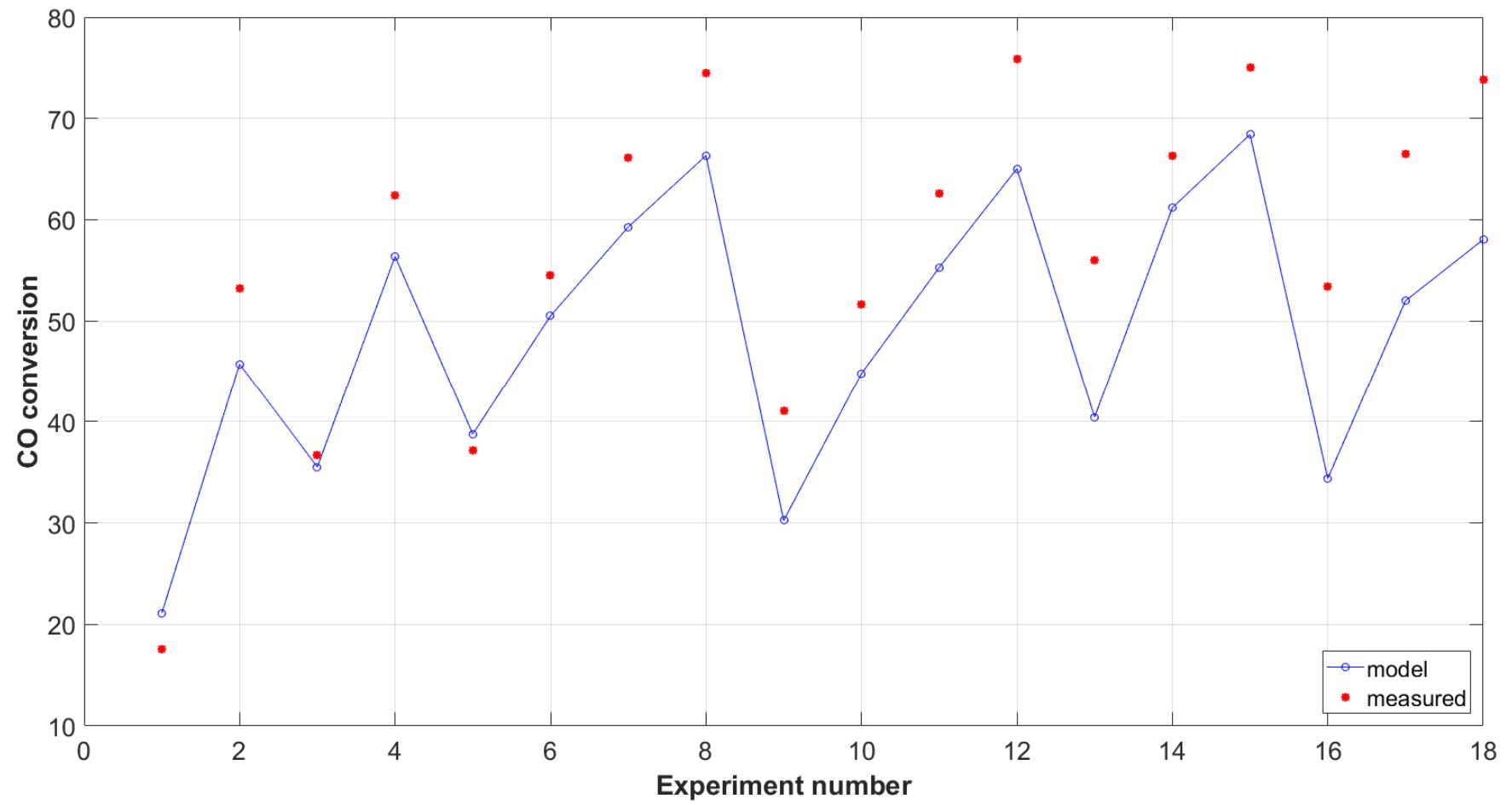
$$\frac{dF_{\text{CH}_4}}{dz} = \rho A r_{\text{CH}_4}$$

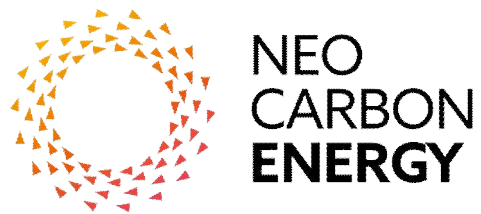
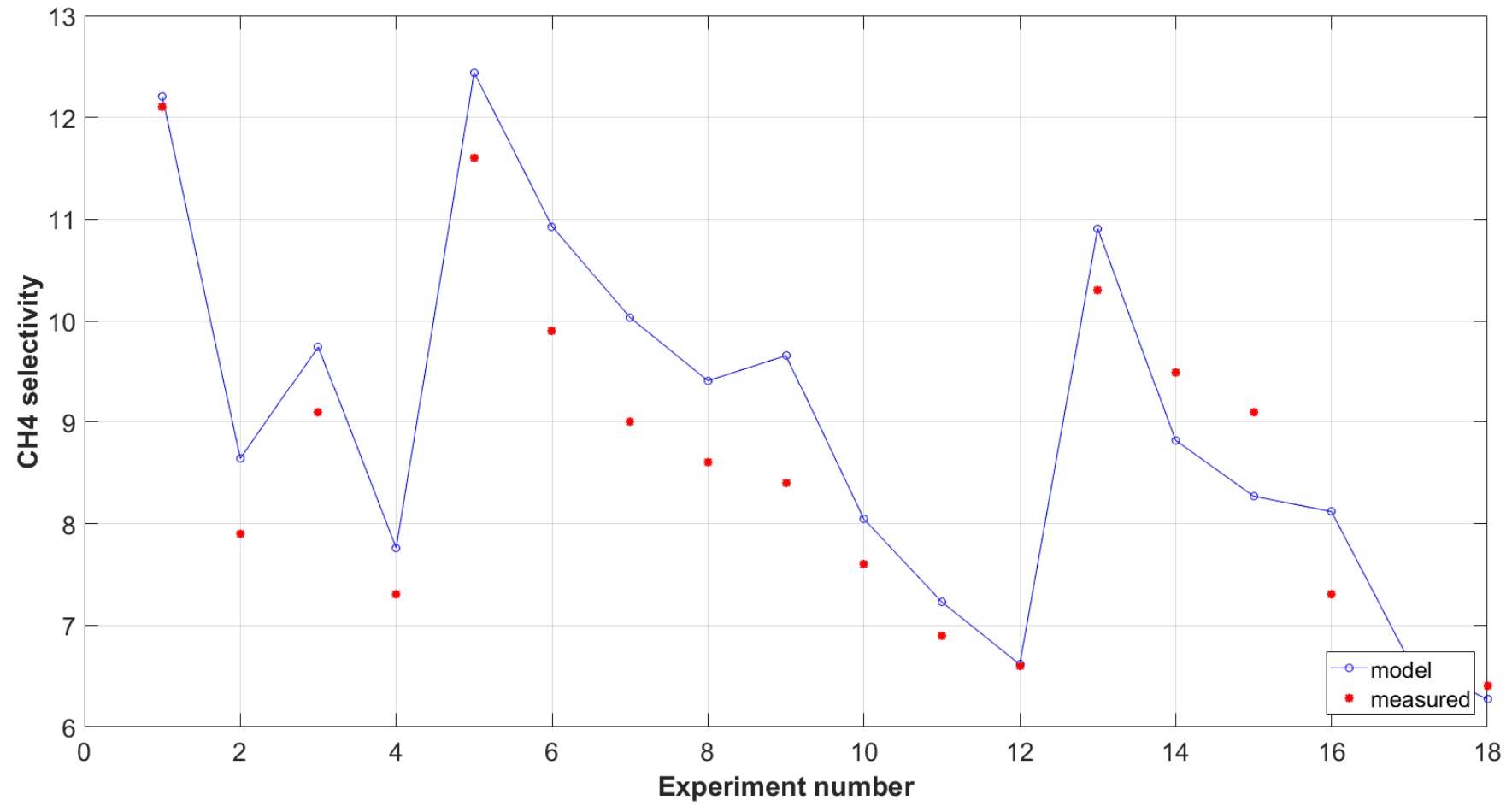
$$\frac{dF_{\text{H}_2}}{dz} = \rho \cdot A \cdot (-2r_{\text{CH}_4}),$$

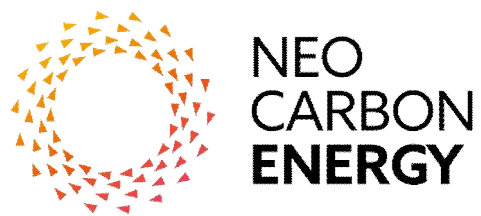
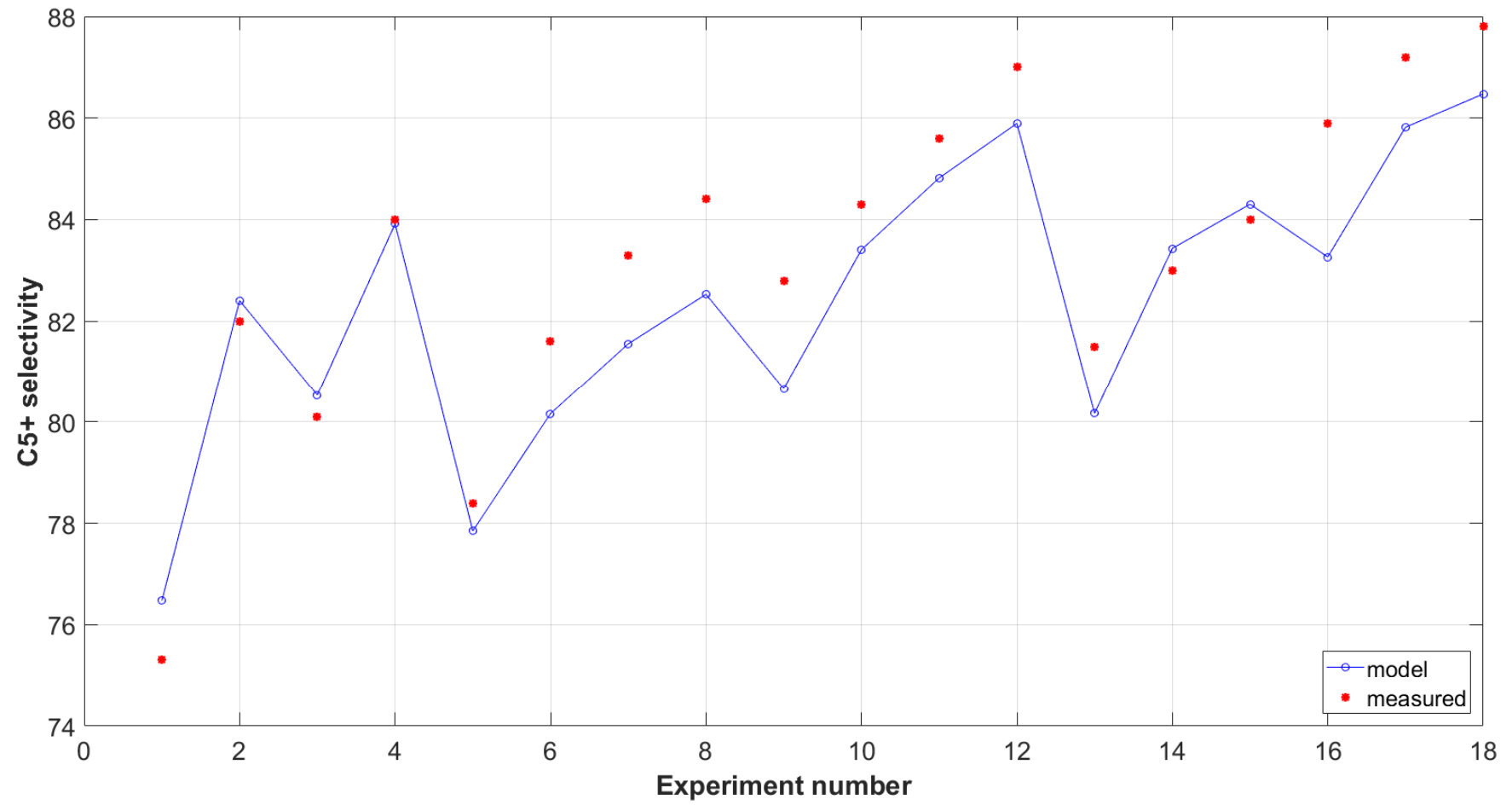
$$\frac{dF_{\text{H}_2\text{O}}}{dz} = \rho \cdot A \cdot (r_{\text{CH}_4}),$$



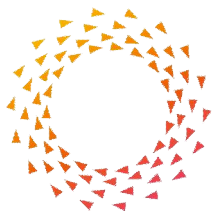
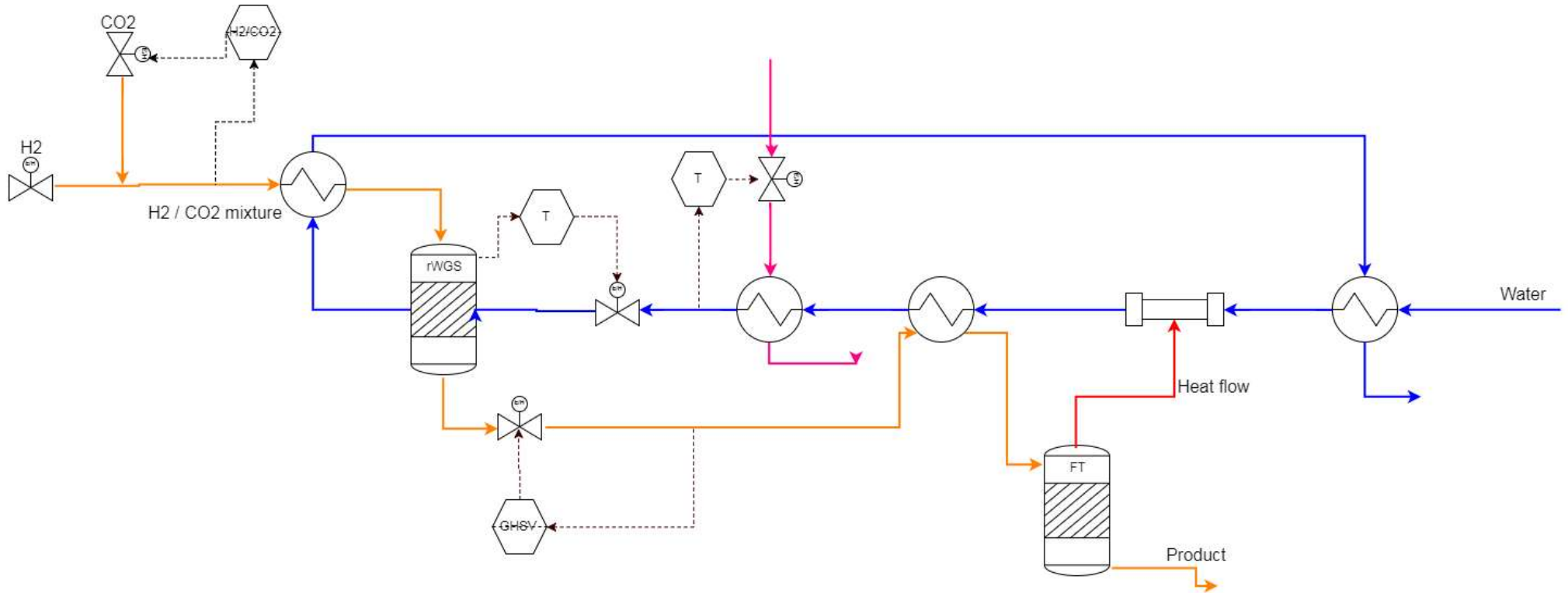
* Mohammad Ostadi, Erling Rytter, Magne Hillestad, Evaluation of kinetic models for Fischer–Tropsch cobalt catalysts in a plug flow reactor, In Chemical Engineering Research and Design, Volume 114, 2016, Pages 236-246, ISSN 0263-8762, <https://doi.org/10.1016/j.cherd.2016.08.026>. (<http://www.sciencedirect.com/science/article/pii/S0263876216302775>)







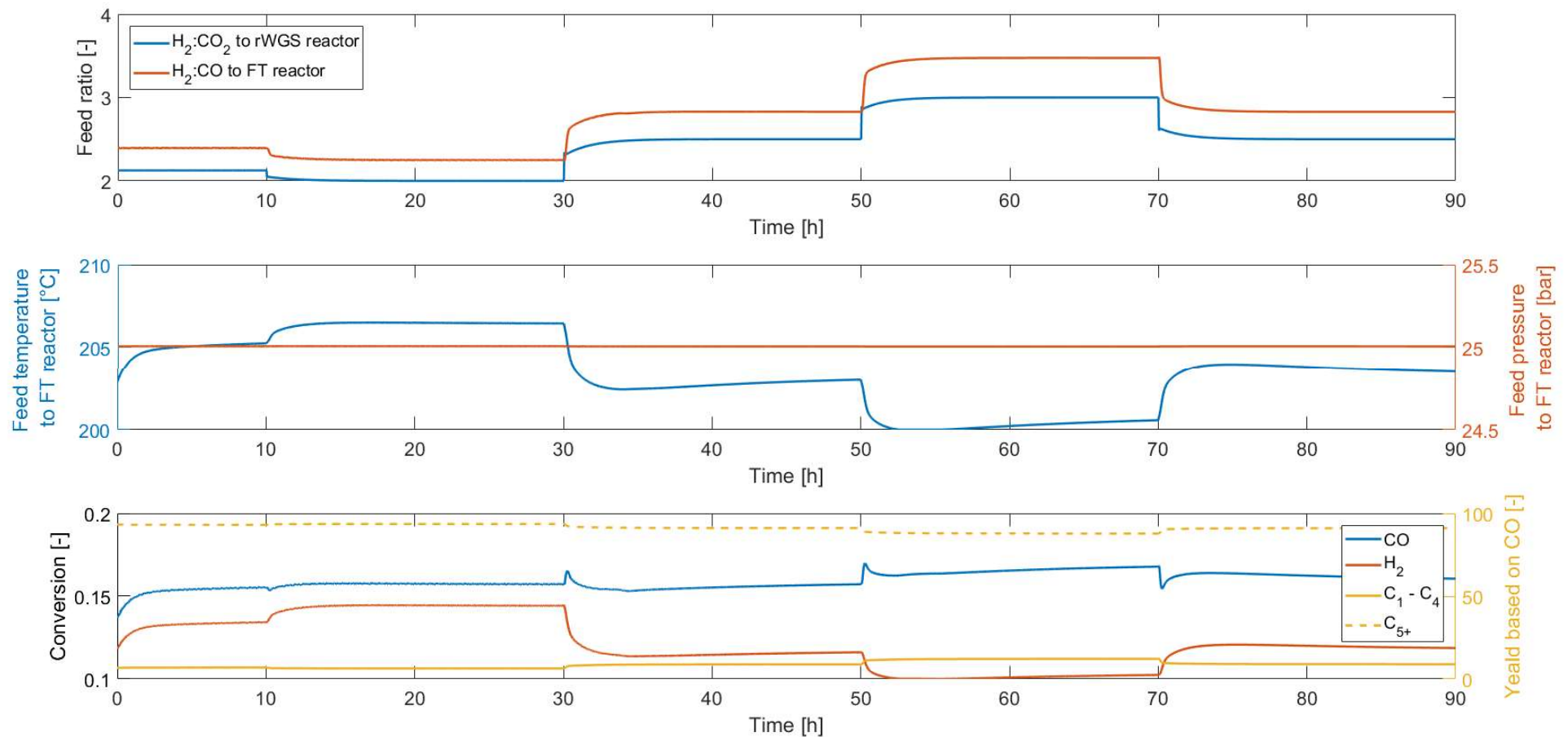
Control logics



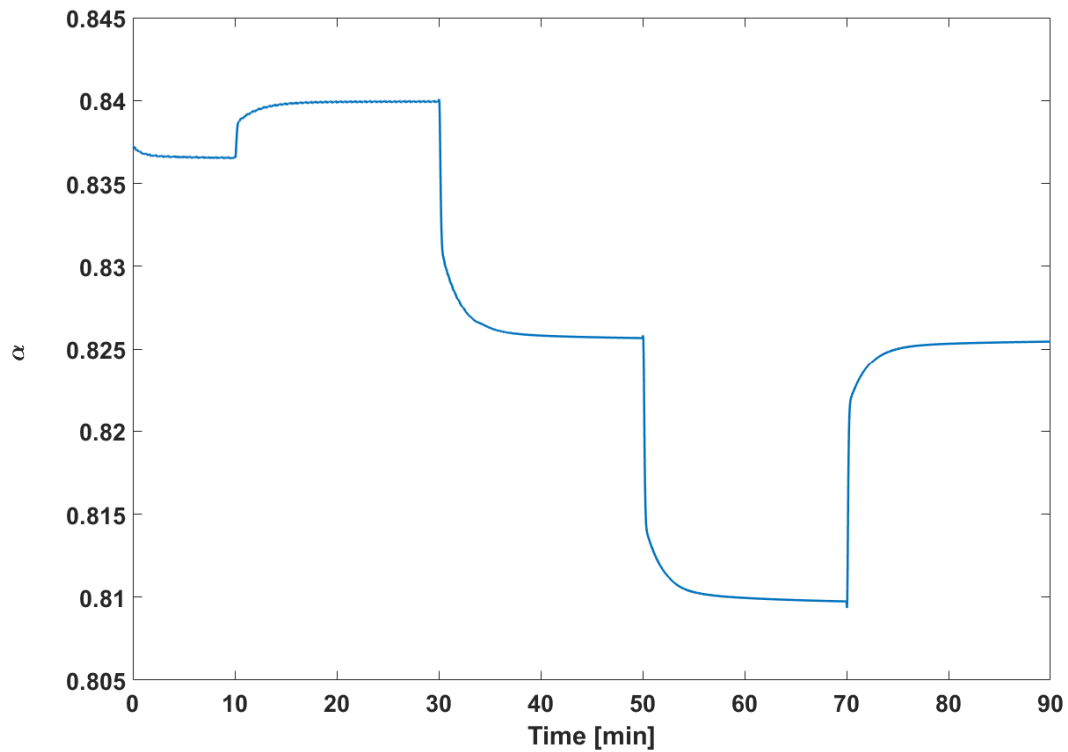
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Simple simulation case

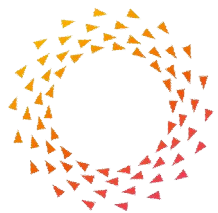
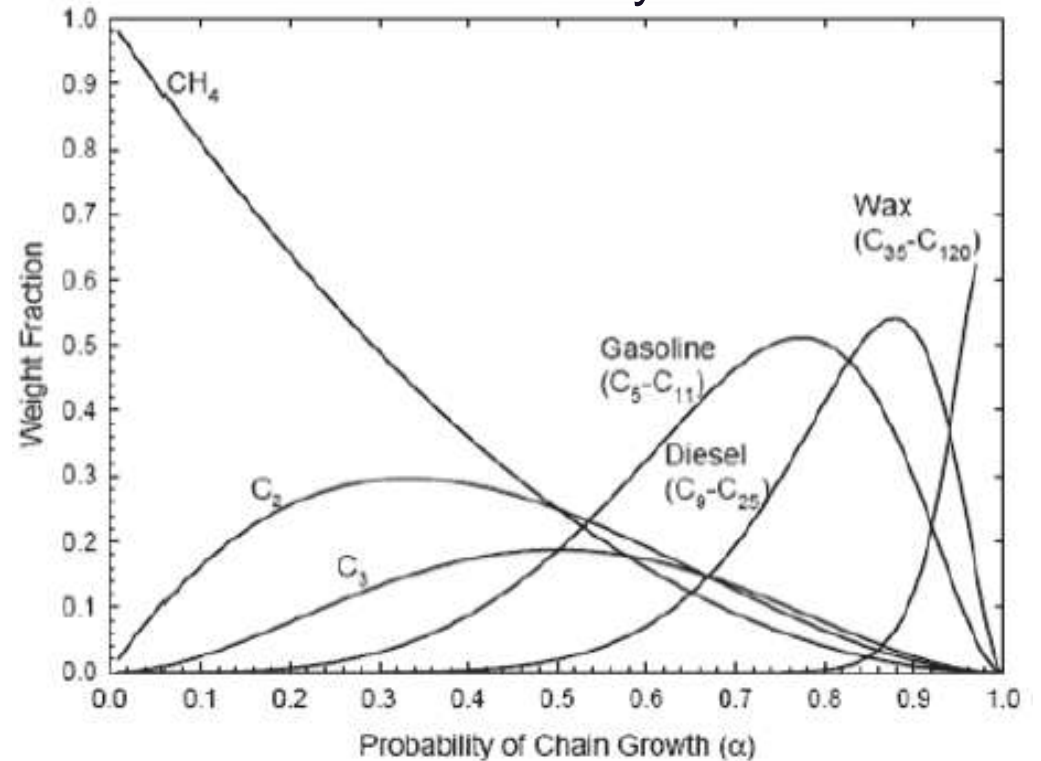
- Alternating H₂:CO₂ ratio to rWGS reactor
 - Everything else is tried to be kept constant with the controls



Product distribution



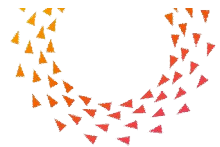
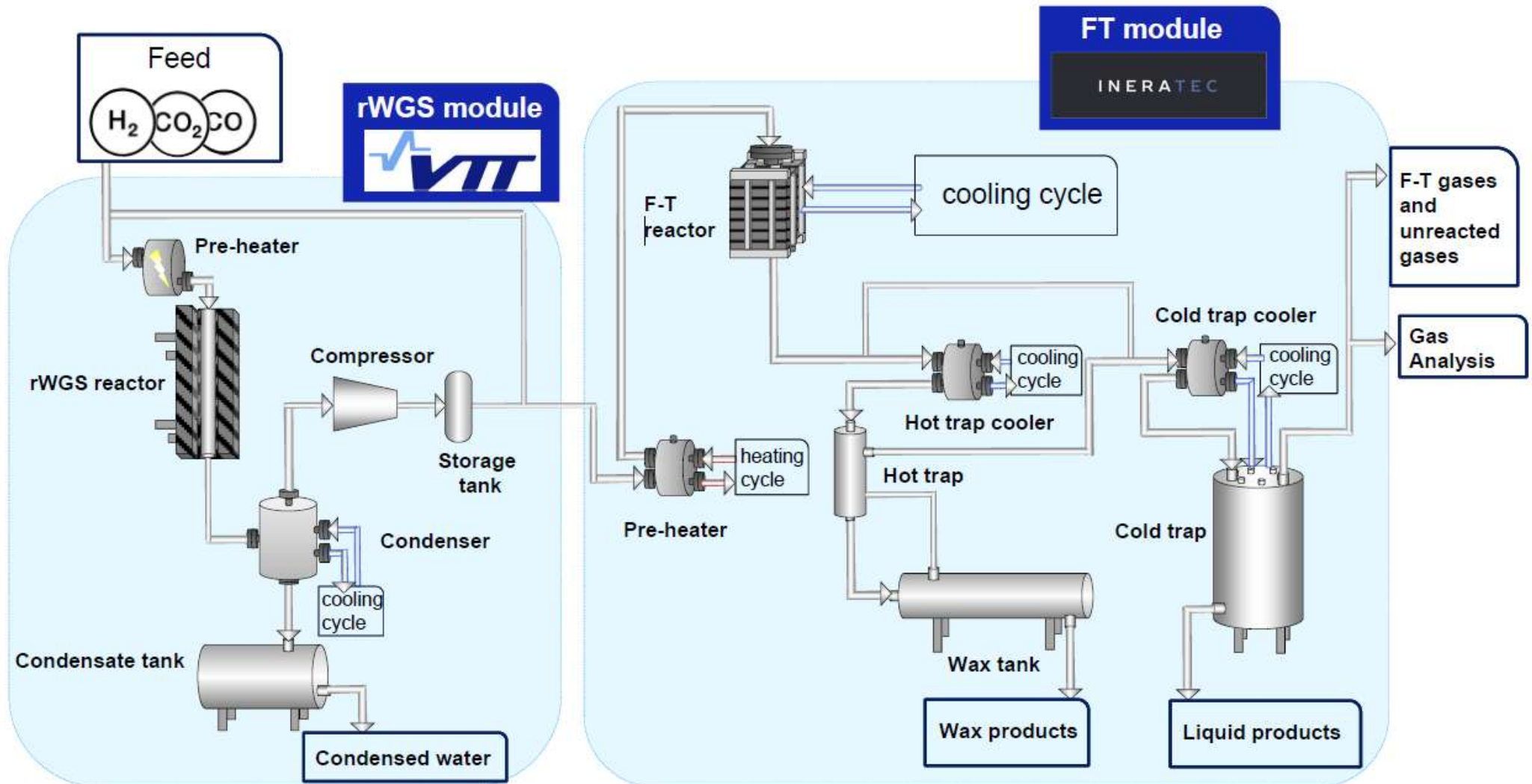
Anderson-Schulz-Flory distribution



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<http://wiki.gekgasifier.com/w/page/6123715/Gas%20to%20Liquids>

Next?



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