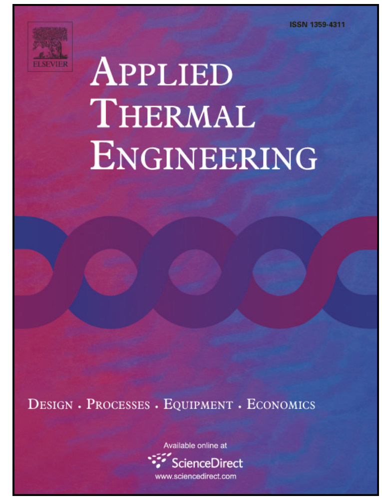
Accepted Manuscript



Methodology to Develop Off-Design Models of Heat Exchangers with Non-Ideal Fluids

Viv Bone, Rob McNaughton, Michael Kearney, Ingo Jahn

PII: S1359-4311(18)32678-4
DOI: https://doi.org/10.1016/j.applthermaleng.2018.09.082
Reference: ATE 12691

To appear in: *Applied Thermal Engineering*

Received Date: 30 April 2018
Revised Date: 18 September 2018
Accepted Date: 20 September 2018

Please cite this article as: V. Bone, R. McNaughton, M. Kearney, I. Jahn, Methodology to Develop Off-Design Models of Heat Exchangers with Non-Ideal Fluids, *Applied Thermal Engineering* (2018), doi: https://doi.org/10.1016/j.applthermaleng.2018.09.082

Methodology to Develop Off-Design Models of Heat Exchangers with Non-Ideal Fluids

Viv Bone[a], Rob McNaughton[b], Michael Kearney[a], Ingo Jahn[a]

[a]*School of Mechanical and Mining Engineering, The University of Queensland, Brisbane, Queensland 4072, Australia*

[b]*CSIRO Energy Centre, Newcastle, New South Wales 2304, Australia*

Abstract

Supercritical CO_2 (sCO_2) closed Brayton cycles are promising heat engines for next-generation thermal power plants since they are efficient, highly scalable, and compatible with a variety of heat sources. A potential application for these cycles is load-following concentrating solar power plants with thermal storage, which will frequently operate at off-design conditions. Accurate and computationally efficient models of the cycle's heat exchangers and turbomachinery are required to assess and optimise its off-design performance. The printed circuit heat exchangers (PCHEs) used in the sCO_2 closed Brayton cycle are challenging to model since they exhibit non-ideal-gas effects and typically use zigzag channels, for which flow patterns and heat transfer mechanisms are not completely understood. Moreover, heat transfer correlations that capture all effects relevant to a given geometry and flow conditions are often unavailable.

We present a methodology to develop accurate and computationally efficient on- and off-design models of heat exchangers that exhibit complex nonlinear behaviours. This methodology involves fitting a 1D discretised heat exchanger model to experimental data using nonlinear least-squares optimisation. Unknown internal heat exchanger geometric parameters are used as fitting parameters.

We demonstrate the proposed methodology by developing numerical models for two PCHEs: (1) an sCO_2–sCO_2 PCHE operating far from CO_2's critical point and (2) an oil–sCO_2 PCHE oper-