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MCycle: A Python package for 1D sizing and analysis of thermodynamic power cycles

Momar G-O Hughes[1]

1 University of New South Wales, Sydney, Australia

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Software

- Review
- Repository
- Archive

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Introduction

MCycle allows users to analyse thermodynamic power cycles and their individual components, as well as size cycle components to defined cycle design parameters. It was developed due to a need for an open source tool with easy scripting for sizing heat exchangers that would allow control over individual component parameters. Users may now analyse a growing collection of thermodynamic power cycles and cycle components, including heat exchangers, expanders, compressors, heaters and coolers. Each type of component has models of varying complexity, allowing MCycle to be equally applicable to simplistic cycle analyses as to detailed sizing optimisations. The project page is found at https://github.com/momargoh/MCycle and the documentation is hosted at https://mcycle.readthedocs.io.

Summary

To evaluate a cycle's fluid properties, MCycle uses the Python wrapper of the open-source thermodynamic properties library CoolProp (Bell et al. 2014). A library of heat transfer and component analysis methods is provided , containing theoretical relations and semi-empirical correlations sourced from published research articles (refer to the documentation for specific references). These methods are simply functions that take key-word arguments and return a dictionary of computed variables. Thus, users also have the freedom of creating and using custom correlations that adhere to these conventions. As previously mentioned, component models vary in complexity; for example, a plate heat exchanger could be modelled with a `HxBasicPlanar` or a `HxPlate` object. A `HxBasicPlanar` object requires the heat transfer coefficient of the working and secondary fluid flows to be defined by the user, whereas a `HxPlate` object requires the user to define a plate geometry and subsequently uses a user-selected heat transfer method to evaluate the heat transfer coefficient of each fluid flow. MCycle components have two primary analysis functions: `size` and `run`. `size` calculates the required value of a desired attribute for each component in order to satisfy the selected analysis method using defined incoming and outgoing flow-states. `run` calculates the outgoing working fluid flow-state of a fully defined component. Hence, `size` is used for sizing a component or cycle to design conditions whereas `run` is moreso used for analysing components and cycles at off-design conditions. Cycles are initiated by selecting the components (either user-created designs or from the included library based on commercial component designs) and optionally defining the cycle design parameters. MCycle also provides functions for producing customisable cycle plots and outputting formatted text summaries of components or cycles.

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References

Bell, Ian H., Jorrit Wronski, Sylvain Quoilin, and Vincent Lemort. 2014. "Pure and Pseudo-Pure Fluid Thermophysical Property Evaluation and the Open-Source Thermophysical Property Library CoolProp." *Industrial & Engineering Chemistry Research* 53 (6). American Chemical Society (ACS):2498–2508. https://doi.org/10.1021/ie4033999.