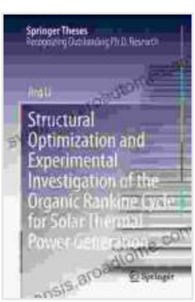
Unlocking the Power of Sustainable Energy: Explore Structural Optimization and Experimental Investigation of the Organic Rankine Cycle

In the face of global energy challenges, the pursuit of renewable and efficient energy solutions has become paramount. Among the promising technologies gaining traction, the Organic Rankine Cycle (ORC) stands out as a viable means to harness low-grade heat sources and convert them into useful power. This article delves into the intricacies of ORC systems, highlighting their structural optimization and experimental investigation, providing valuable insights into their potential for sustainable energy applications.

Organic Rankine Cycle (ORC) Systems: An Overview

ORC systems operate on a closed-loop principle, utilizing an organic working fluid with a lower boiling point than water to capitalize on low-grade heat sources. These sources, typically ranging from 80 to 300°C, can originate from various industrial processes, renewable energy sources, or waste heat recovery systems.



Structural Optimization and Experimental Investigation of the Organic Rankine Cycle for Solar Thermal Power Generation (Springer Theses) by Jing Li

5 out of 5

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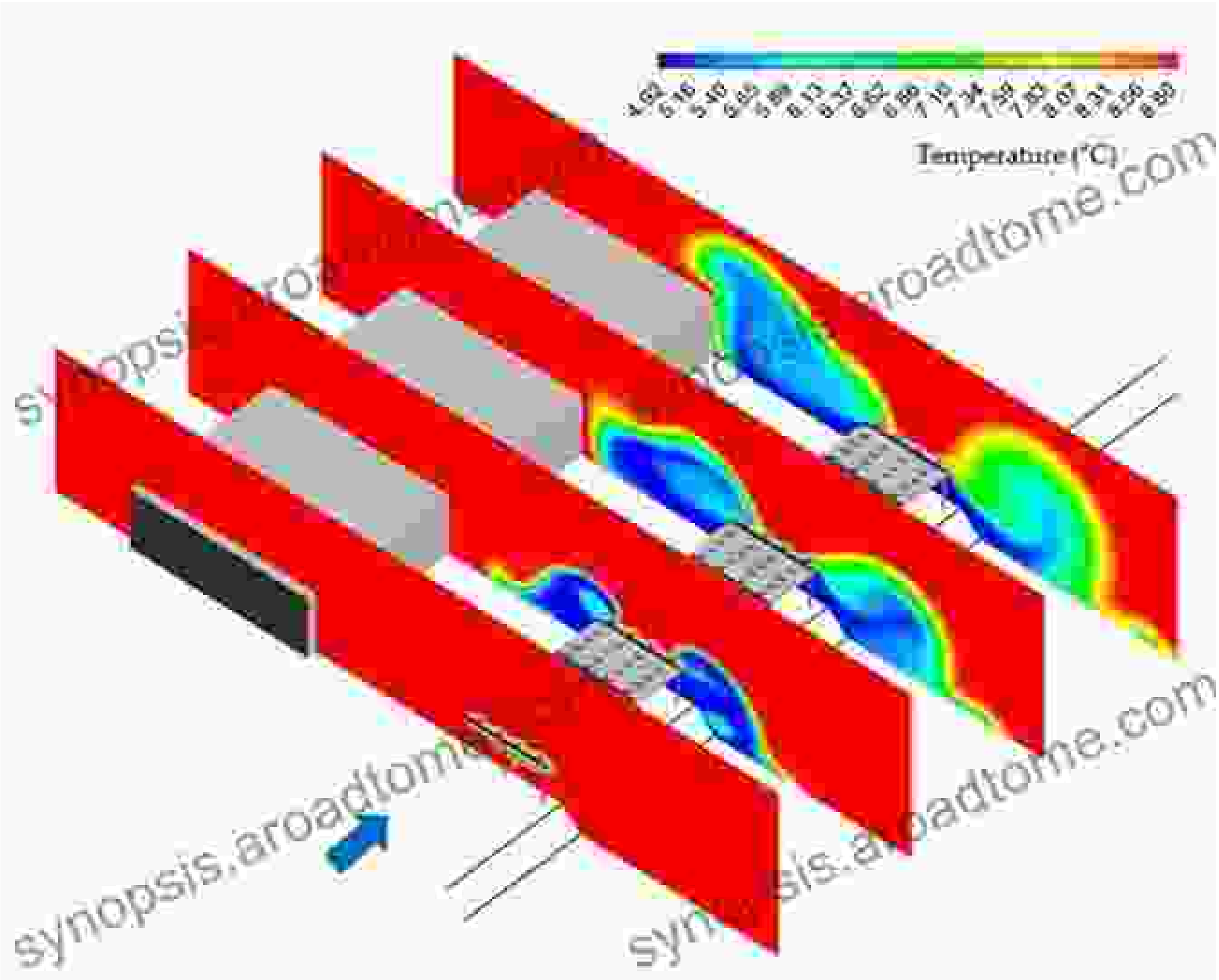
The organic working fluid undergoes a thermodynamic cycle, absorbing heat from the heat source in the evaporator, expanding in the expander (usually a turbine or scroll expander),generating mechanical power, and subsequently condensing in the condenser, releasing heat to a cooling medium. The condensed working fluid is then pumped back to the evaporator, completing the cycle.

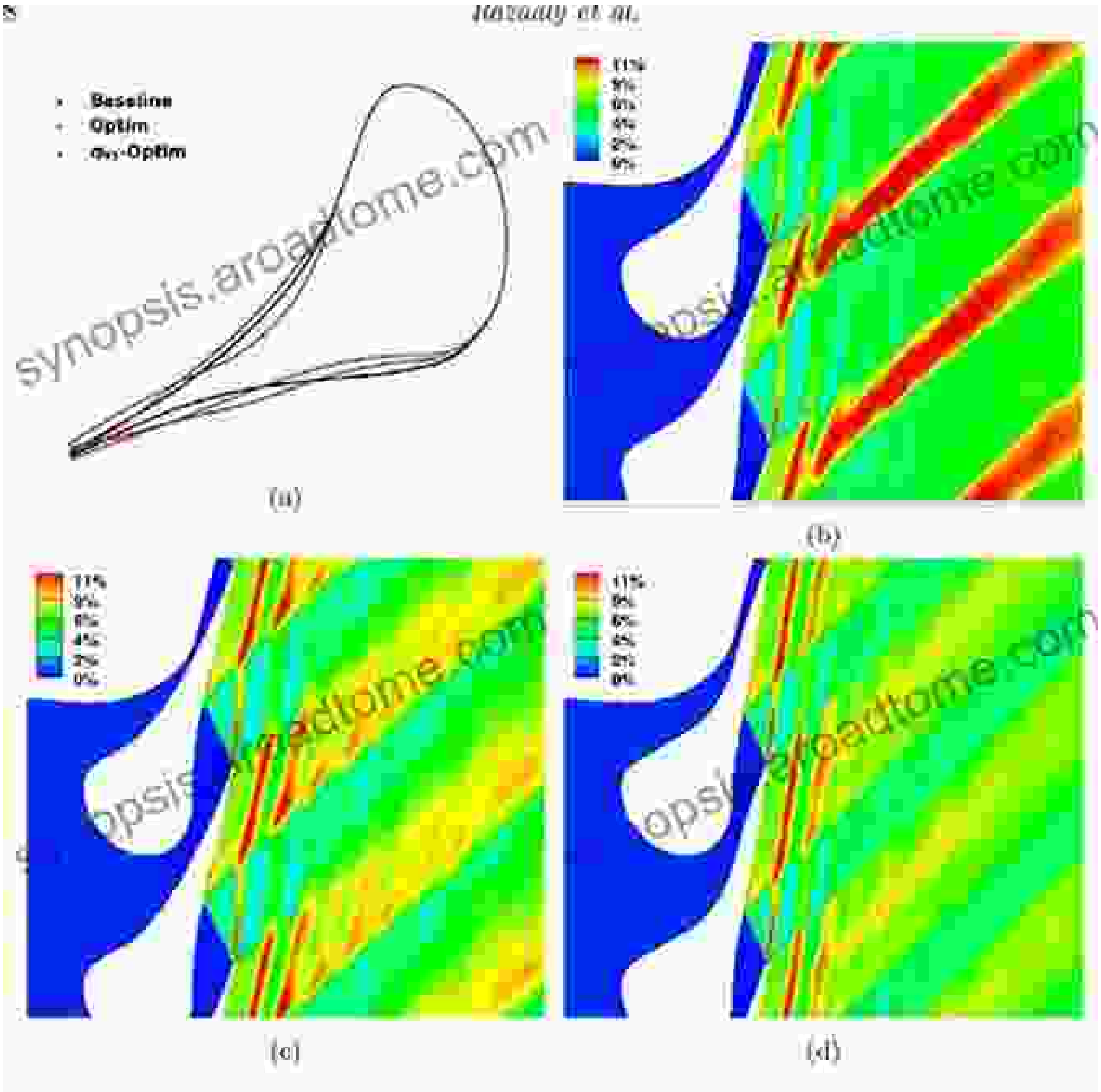
Structural Optimization of ORC Systems

Optimizing the structural design of ORC components is crucial to enhance efficiency and performance. This involves careful consideration of:

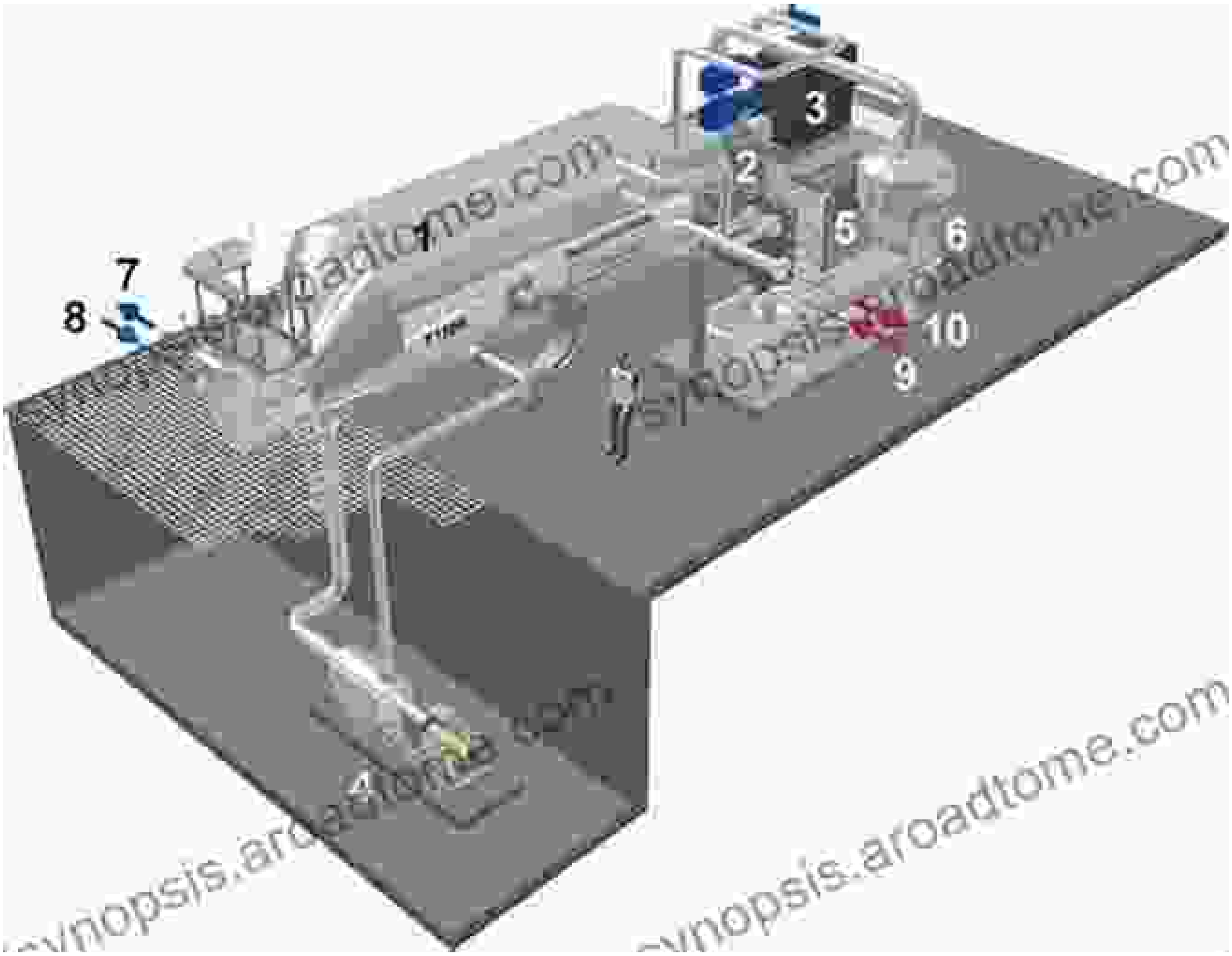


(a) Temperature contour at rows 1, 13, 25 and 37.

Advanced computational fluid dynamics (CFD) simulations aid in optimizing evaporator geometry, ensuring uniform heat transfer distribution and minimizing pressure drops. Advanced techniques like microfin tubes and enhanced surfaces augment heat transfer rates, enhancing overall system efficiency.



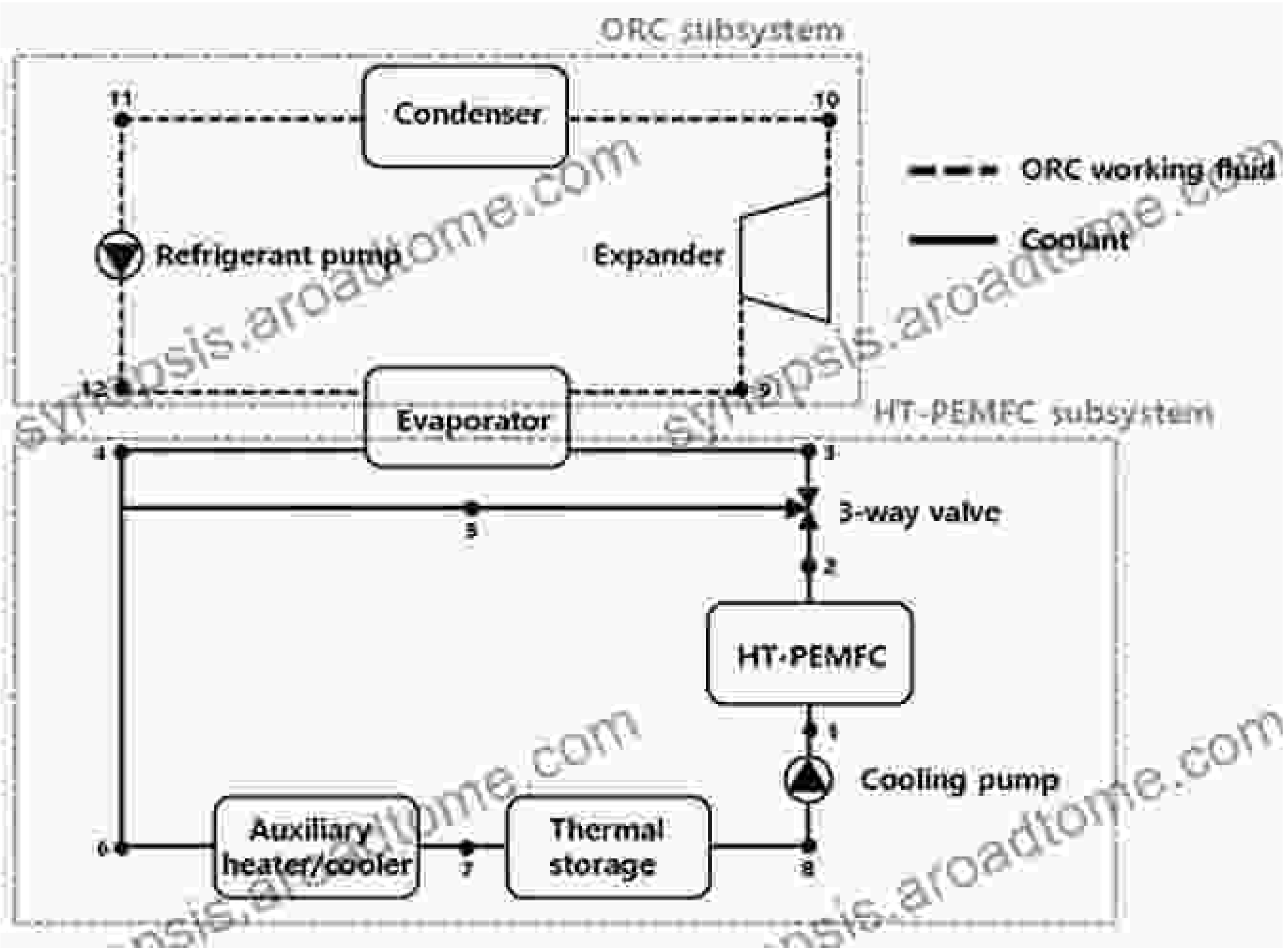
Turbine design and selection play a vital role in converting thermal energy into mechanical power. Advanced aerodynamic optimization techniques are employed to maximize turbine efficiency, considering factors like blade geometry, stage configuration, and operating conditions.



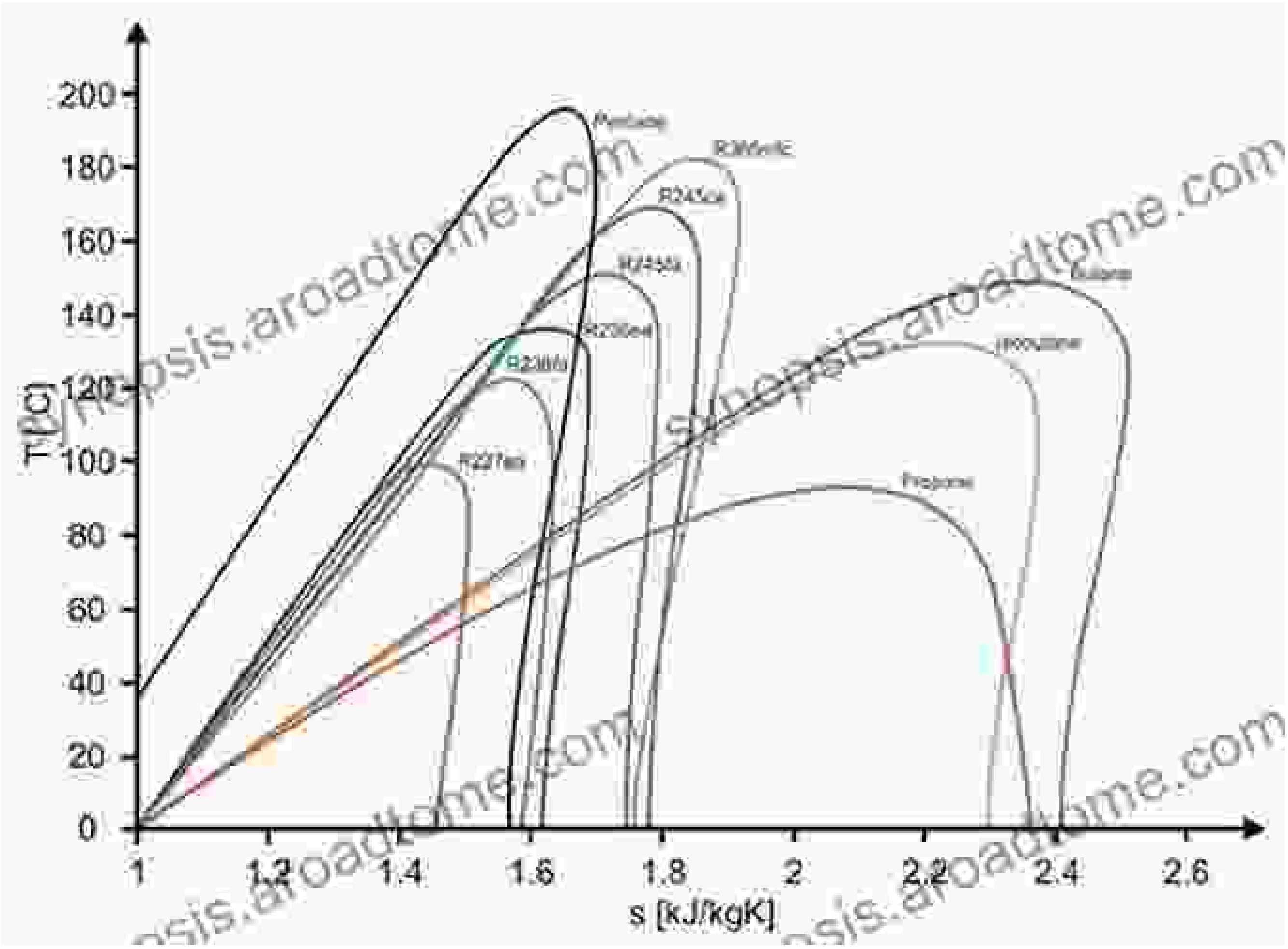
Effective heat transfer in the condenser is essential for maximizing cycle efficiency. Computational modeling and experimental investigations guide the optimization of condenser geometry, including tube arrangement, fin spacing, and flow distribution, to enhance heat rejection and minimize pressure losses.

Experimental Investigation of ORC Systems

Alongside structural optimization, experimental investigations provide valuable insights into the performance and behavior of ORC systems. Key areas of investigation include:



Experimental testing under varying operating conditions provides a comprehensive evaluation of system efficiency, power output, and heat transfer characteristics. Performance maps are generated to guide the design and optimization of ORC systems for specific applications.



The selection and characterization of organic working fluids are crucial. Experimental investigations are conducted to assess fluid properties, stability, and compatibility with system components. Advanced fluid property measurements and computational modeling aid in predicting system behavior and optimizing fluid selection.

Characterization analysis of dynamic behavior of basic ORC under fluctuating heat source

Xiaoli Yu [a,b], Yan Huang [a], Zhi Li [a,b,c], Rui Huang [a,b], Jinwei Chang [a], Lei Wang [a,c,*]

[a] Department of Energy Engineering, Zhejiang University, Hangzhou, 310027, China

[b] Ningbo Research Institute, Zhejiang University, Ningbo, 315100, China

[c] Ningbo C.S.I Power & Machinery Group Co., Ltd., Ningbo, 315020, China

HIGHLIGHTS

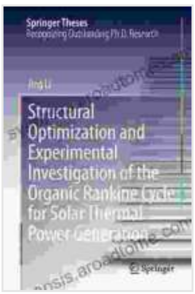
- Dynamic response of basic ORC system under fluctuating heat source are studied
- Amplitude, period and average value of fluctuating heat sources are considered
- Effects of characteristics of heat source on safety and efficiency are analyzed
- Efficiency and safety are negatively related to fluctuating amplitude and period
- Operating rules and maximum allowable fluctuating ranges for basic ORC are obtained

Abstract: Organic Rankine Cycle (ORC) is widely investigated for low-grade waste heat recovery, but its performance deteriorates under heat source with thermal power fluctuations. As the effects of fluctuating heat source on ORC system performance is less investigated, the operating rules of ORC systems under fluctuating heat source are not clear. In this study, the effects of fluctuating amplitude and period for fluctuating heat sources on the performance of

Email address: (L. Wang)

Understanding the dynamic behavior of ORC systems is essential for stable operation and control. Experimental investigations focus on studying system dynamics during start-up, transient conditions, and load variations. This knowledge helps in designing control strategies and optimizing system response.

Structural optimization and experimental investigation of Organic Rankine Cycle (ORC) systems play a pivotal role in unlocking their potential for sustainable energy applications. By optimizing component designs and conducting thorough experimental investigations, engineers can enhance system efficiency, improve performance, and ensure reliable operation. This comprehensive approach paves the way for the widespread adoption of ORC technology in harnessing low-grade heat sources for power generation and contributing to a more sustainable energy future.



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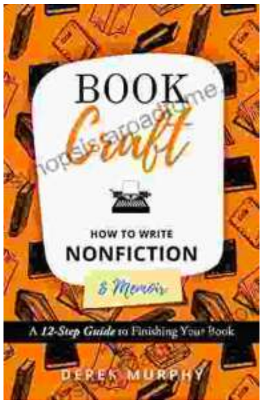

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