

# Comparative Performance Analysis of Working Fluids for Small-Scale Organic Rankine Cycle

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**Abstract:** Small-scale Organic Rankine Cycle (ORC) systems have emerged as promising technologies for waste heat recovery and distributed power generation. The selection of an appropriate working fluid is critical to system performance, as it directly impacts thermal efficiency, safety, environmental impact, and economic viability. This paper presents a comprehensive comparative analysis of various organic working fluids including hydrofluorocarbons (HFCs), hydrofluoroolefins (HFOs), hydrocarbons, and siloxanes for small-scale ORC applications. The analysis evaluates thermodynamic properties, environmental characteristics, safety parameters, and system performance across different heat source temperatures ranging from 100°C to 200°C. Results demonstrate that HFO-1234yf and HFO-1234ze(E) offer superior environmental profiles with Global Warming Potential (GWP) <1, while cyclopentane and R-245fa provide balanced thermodynamic efficiency. This study provides practical guidance for engineers in selecting optimal working fluids for specific ORC system designs and operating conditions.

**Keywords:** Organic Rankine Cycle, Working Fluids, Thermodynamic Analysis, Waste Heat Recovery, Environmental Impact