Performance analysis of different organic Rankine cycle configurations on board liquefied natural gas-fuelled vessels

Gas-fuelled shipping is expected to increase significantly in the coming years. Similarly, much effort is devoted to the study of waste heat recovery systems to be implemented on board ships. In this context, the organic Rankine cycle (ORC) technology is considered one of the most promising solutions. The ORC favors comparison to the steam Rankine cycle because of its simple layout and high efficiency, achievable by selecting a working fluid with desirable properties. This paper aims at assessing the fuel savings attainable by implementing ORC units on board vessels powered by liquefied natural gas (LNG). The study compares the performance of six different ORC configurations both in design and off-design operation, and provides guidelines with respect to the most promising heat sources and sinks to be utilized by an ORC unit in order to maximize the annual fuel savings. In addition, this paper describes a novel ORC layout rejecting heat to two heat sinks. The results indicate equivalent fuel savings up to 8.9 % when harvesting heat from the exhaust gases, and that the novel configuration ensures an increment of the ORC design power output up to 41 % when utilizing the jacket cooling water as heat source.