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System impact of heat exchanger pressure loss in ORCs for smelter off-gas waste heat recovery

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Abstract

Applying Rankine cycles to smelter off-gas could increase the required off-gas fan power in an order of magnitude equivalent to the power production. Predicting the fan power is not straightforward since it is affected in two contradictory ways: 1) the heat recovery heat exchanger creates additional off-gas pressure loss, increasing fan power; 2) off-gas cooling reduces pressure loss in the off-gas handling system downstream of the cycle, reducing fan power. The purpose of our study is to analyze the effect of fan power on optimum system performance. While additional fan power can be calculated based on heat exchanger pressure loss, the reduction in fan power depends on the total pressure loss downstream of the cycle, which is unknown. As an alternative to calculating fan power reduction, we account for the off-gas cooling effect by including only parts of the fan power caused by heat exchanger pressure loss. Results from three cases show that both heat exchanger and cycle performance strongly depend on the potential for downstream pressure loss reduction. Thus, the total pressure loss in the downstream off-gas handling system has a significant impact on the optimum heat exchanger and cycle performance, and should be accounted for during system design.

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