PhD Public Defence

Title: System Integration, Optimization and Application of Thermoelectric Generators

Location: Pontoppidanstræde 111, auditorium

Time: Thursday 29 November at 13.00

PhD defendant: Seyed Mojtaba Mir Hosseini

Supervisor: Professor Lasse Rosendahl

Moderator: Associate Professor Tom Condra

Opponents: Associate Professor Tom Condra, Dept. of Energy Technology, Aalborg University (Chairman)
Professor David Astrain Ulibarrena, Public University of Navarra, Spain
Dr. Ngo Van Nong, Technical University of Denmark

All are welcome. The defence will be in English.

After the defence there will be an informal reception in Pontoppidanstræde 111 (coffee room).
Abstract:

Due to serious environmental crises in the world emerged from fossil fuels, facing to renewable energies and waste heat recovery systems are the most important strategic solutions. Using thermoelectric generators (TEGs) is one of the waste heat recovery methods, which is proposed due to its advantages. One of the efficient thermoelectric materials in mid temperature range is zinc antimonide (ZnSb) that has been studied here. In this Ph.D. thesis, carried out within the framework of the Center for Thermoelectric Energy Conversion (CTEC), there are two main scenarios for investigation. The first one is about waste heat recovery by thermoelectric systems from Aalborg Portland cement rotary kiln, and the second one experimental investigation and theoretical modeling and analyzing performance of ZnSb thin film, as a candidate for P-type thermoelectric element, for low-power energy harvesting applications such as sensors. In the first scenario, primarily, the best position for the heat recovery system is chosen based on the highest heat loss along the cement rotary kiln. Then two thermal absorbers are designed by comprehensive numerical studies; i.e. annular absorber and arc shaped absorber. For both types of absorber, temperature distributions along the absorber circumferences are obtained and applied as the hot side temperature of the TEG systems. For annular thermal absorber, two efficient TEG systems by using two well-known thermoelectric materials, i.e. Zn₄Sb₃ and Bi₂Te₃ are investigated and compared to each other. In the studied case with arc shaped absorber, geometric parameters and angular position of the absorber are optimized. Moreover, a thermoelectric system including pin-fin heat sink is designed, optimized and evaluated for maximum power generation and minimum investment cost. This project, furthermore, aims to evaluate performance, stability and reliability of the thin film for a long period. Performance of a zinc antimonide thin film specimen is experimentally investigated under unsteady- and steady-state thermal operating condition. Moreover, a theoretical model is developed by finite element method (FEM) to estimate heat loss effect from the side surface on thermo-electrical performance of the thin film in comparison with results obtained by ideal assumptions.