Calibration and validation of a model for simulating thermal and electric performance of an internal combustion engine-based micro-cogeneration device

A. Rosato*, S. Sibilio

Dipartimento di Cultura del Progetto, Seconda Università degli studi di Napoli, Built Environment Control Laboratory, via San Lorenzo, 81031 Aversa, Italy

Abstract

The growing worldwide demand for more efficient and less polluting forms of energy production has led to a renewed interest in the use of micro-cogeneration technologies in the residential. Among the others technologies, internal combustion engine-based micro-cogeneration devices are a market-ready technology gaining an increasing appeal thanks to their high efficiency, fuel flexibility, low emissions, low noise and vibration.

In order to explore and assess the feasibility of using internal combustion engine-based cogeneration systems in the residential sector, an accurate and practical simulation model that can be used to conduct sensitivity and what-if analyses is needed. A residential cogeneration device model has been developed within IEA/ECBCS Annex 42 and implemented into a number of building simulation programs. This model is potentially able to accurately predict the thermal and electrical outputs of the residential cogeneration devices, but it relies almost entirely on empirical data because the model specification uses experimental measurements contained within a performance map to represent the device specific performance characteristics coupled with thermally massive elements to characterize the device's dynamic thermal performance.

At the Built Environment Control Laboratory of Seconda Università degli studi di Napoli, an AISIN SEIKI micro-cogeneration device based on natural gas fuels reciprocating internal combustion engine is available. This unit has been intensively tested in order to calibrate and validate the Annex 42 model. This paper shows in detail the series of experiments conducted for the calibration activity and examines the validity of this model by contrasting simulation predictions to measurements derived by operating the system in electric load following control strategy. The statistical comparison was made both for the whole database and the segregated data by system mode operation.

The good agreement found in the predictions of net electric power production, useful thermal output and primary power consumption allowed to conclude that the Annex 42 model can be used to carry out a detailed performance assessment in order to examine the applicability of the AISIN SEIKI unit for supplying building electrical and thermal energy requirements according to different load profiles during annual or multi-year operation.