Experimental results of a micro-trigeneration installation

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ABSTRACT

Micro-cogeneration is a well-established technology and its deployment has been considered by the European Community as one of the most effective measure to save primary energy and to reduce greenhouse gas emissions. Micro-trigeneration systems are also gaining an increasing interest thanks to the availability of small thermally driven cooling systems and the increasing demand for space cooling during the warm season.

At the Built Environment Control Laboratory of Seconda Università degli Studi di Napoli, a micro-cogenerator based on natural gas fuelled reciprocating internal combustion engine that can be coupled with a thermal-chemical absorption system has been set-up in order to experimentally investigate the on-site performances of both micro-cogeneration system and micro-trigeneration system under real operating conditions.

This paper deals with the description of experimental plant and the results of first experimental tests. The analysis of the measured data is carried out from an energy, economic and environmental point of view, by comparing the performances of the proposed system with those of the conventional system and the best available technology.

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1. Introduction

The growing demand, the limited resources and the negative environmental impacts of mankind’s exploitation of energy have emphasized the need to revise the current usage of the available energy sources. Taking into account that residential applications are likely to be a significant energy consumers in all the industrialized countries, a big effort should be paid in this sector in order to find out the most efficient, cost effective and least polluting energy conversion manner. Among the several options, micro-cogeneration and micro-trigeneration are emerging as the fast growing techniques to increase efficiency and reduce overall emissions in domestic and small-scale applications [1−4].

According to the European directive on the promotion of cogeneration [5], micro-cogeneration (MCHP, Micro Combined Heat and Power generation), is the combined production of electric power (lower than 50 kW) and thermal power, starting by a single primary energy source. Micro-cogeneration systems can reach an overall efficiency significantly greater than the traditional energy conversion systems based on separate energy production, with lower costs and reduced greenhouse gas emissions. MCHP systems have the additional advantage of diversifying electrical energy production, thus potentially improving the security of energy supply in the event of problems occurring with the main electricity grid. The European Union recognized the important contribute coming in perspective from micro-cogeneration systems, and therefore, in the Directive 2004/8/EC [5] it is addressed the need to promote MCHP systems to increase the energy efficiency and reduce polluting emissions. The “heart” of a micro-cogeneration system is a prime mover that can be based on different technologies, such as Stirling, Reciprocating Internal Combustion (RIC), Fuel Cell, Gas Turbine, etc. In recent years a great attention has been focused on the transition from centralized to decentralized cogeneration systems thanks to the fact that the small units can reduce the transmission/distribution and energy cycling losses and costs. As a result, a wide variety of prime movers suitable for residential sector is currently available on the market [6]. Among the alternative technologies, the prime movers based on RIC engines represent the most mature technology and allow to achieve small installation space, high efficiency, limited noise and vibration levels, low maintenance and long life service [7].

However in the last years in many European countries there has been an increasing demand for space cooling for summer air-conditioning, mainly due to the larger thermal loads, higher living standards and occupant comfort requests as well as building architectural characteristics. This trend leads to a summer peak of