# FILL FACTOR EFFECTS ON EXERGETIC EFFICIENCY OF PHOTOVOLTAIC MODULES

*D. Rusirawan[1] and I. Farkas[2]*

[1]Department of Mechanical Engineering, Institut Teknologi Nasional (ITENAS)
Jl. PKHH. Mustapa No.23, Bandung 40124, West Java – Indonesia
Tel.: +62 22 7272215, Fax.: +62 22 7202892, Email: danir@itenas.ac.id

[2]Department of Physics and Process Control, Szent István University
Páter K. u. 1., Gödöllő, H-2103 Hungary
Tel.: +36 28 522055, Email: Farkas.Istvan@gek.szie.hu

The thermodynamic efficiency of various devices (included Photovoltaic system) is wide interest because of the relevance of this parameter for energy conversion. In thermodynamic point of view, photovoltaic (PV) system (cell/module/panel/array) performance (efficiency) can be evaluated in terms both energy and exergy (availability). Energy analysis (energetic) is based on the first law of thermodynamics meanwhile exergy analysis (exergetic) is based on both the First and the Second Laws of Thermodynamics. Exergy based analysis method is employed to detect and to evaluate quantitatively the causes of the thermodynamic imperfection of the process under consideration. Therefore, it can indicate the possibilities of thermodynamic improvement of the process under consideration.

This work is part of an exergy analysis of two types of photovoltaic (PV) modules technologies - materials, i.e. polycrystalline technology (crystalline technology) and amorphous silicon (thin film technology), as a main component of 10 kWp grid-connected PV array system at Szent István University, Gödöllő – Hungary.

In previous research, exergetic efficiency both PV modules have been performed through the "solar energy parameters" method and "photonic energy" method, under Gödöllő – Hungary climatic conditions with the surface orientation of PV modules placed on position $5^o$ to East face to South ($\gamma$) and a tilt angle $30^o$ ($\beta$). An actual operational data (empirical data), such as solar irradiation ($G$), current ($I$), voltage ($V$) and electrical power ($P$) are used in order to characterize both of above module technologies. Based on both methods, it clear that PV exergy assessment gives the realistic values than the PV energy assessment (if compares to an actual electrical efficiency).

In this paper, effects of fill factor (FF) on the exergy efficiency of two different Photovoltaic (PV) modules technologies - materials (flat plate type), i.e. polycrystalline technology (ASE-100) and amorphous silicon technology (DS-40), under Gödöllő - Hungary climatic conditions, will be investigated. As a long term target of this research, a possibility to optimize or increase the PV modules performance can be found and observed.

*Acknowledgement*: This work was supported/subsidized by TÁMOP-4.2.2.B-10/1-2010-0011 "Development of a complex educational assistance/support system for talented students and prospective researchers at the Szent István University" project.