Int. J. Exergy, Vol. 11, No. 4, 2012

Introduction

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Biographical note: Christopher Koroneos is a chemical engineer. He did all his studies at the Department of Chemical Engineering of Columbia University in New York, USA, where he later was a professor. Now he is at the Unit of Environmental Science and Technology of the Department of Chemical Engineering at the National Technical University of Athens and the Laboratory of Heat Transfer and Environmental Engineering, Aristotle University of Thessaloniki. He is teaching at the Interdisciplinary Programme of Post Graduate Studies ''Environment & Development'' of the National Technical University of Athens and at the Hellenic Open University. His research interests are in Renewable Energy, Exergy Analysis, Life Cycle Assessment

In buildings, high-grade energy is often used in heating, cooling and ventilation systems to meet low-grade heat demands, resulting in a mismatch between the quality levels of energy supply and end-use. Exergy is a thermodynamic concept which is useful for quantifying the mismatch between the low quality of heat required in buildings and the high quality level of electricity and fossil fuels often used in heat supply systems.

Application of exergy analysis to the built environment is likely to favour systems supplying and using low-grade thermal energy, and hence to support thermally neutral buildings. Exergy also provides a thermodynamic basis for developing sustainability indicators for construction, considering materials and energy through the entire life cycle of buildings.

Exergy is a thermodynamic concept which enables articulation of what is consumed by all working systems (for example human-made systems such as thermo-chemical engines and heat pumps, or biological systems including the human body) when energy and/or materials are transformed for human use. Exergy analysis can give insight into the: a) extent to which the quality levels of energy supply (such as high-temperature combustion) and demand (e.g. low-temperature heat) are matched; b) location and magnitude of energy degradation spots, resulting from heat transfer (temperature drop) or energy conversion (electricity or solar radiation into low-grade heat); c) environmental impact of producing, reusing and recycling building materials; d) limitations (such as maximum thermodynamic efficiencies) and breakthrough needs (for example technology substitution) of complex systems.

There has been pioneering research on the exergy of the human body, aimed at articulating why low temperature systems are essential for creating a rational and comfortably built environment. These insights can assist a designer, researcher or educator/student in selecting proper technologies (or combinations thereof) most likely to minimise energy resource depletion in a given context.

Exergy analysis also has a potential for stimulating innovation and improving energy and material resource utilisation, but the exergy concept is still often regarded as complex and hard to understand by non-specialists.

These works published in this issue were presented at the first Exergy Life Cycle Assessment and Sustainability Workshop and Symposium that took place the from 4th to 6th of June of 2009 in the Island of Nisyros, Greece.