

Improving Air-conditioners' Energy Efficiency Using Hydroponic Roof Plants

F. Wang and H. Yoshida

Kyoto University

M. Yamashita

Taisei Corp.

ABSTRACT

Experimental study was conducted on improving air-conditioners' energy efficiency using hydroponic roof plants. The air-cooling effect caused by the solar-shading and transpiration of hydroponic-cultivated sweet potato was measured. Using the measured data, it is estimated that how much the energy efficiency of an air-conditioner can be improved if the cooled air is introduced into the outdoor unit of air-conditioners. The measured air temperatures and cooling loads were used to calculate the energy consumption of the air-conditioner. 1) The measurement results show that the air temperature differences cooled down by the roof plant are 1.3°C in average for clear day and 3°C in average when water was sprinkled. 2) The energy consumption estimation shows that about 1%-4% energy can be reduced in clear days and 2%-9% energy can be reduced if one-hour-water-sprinkle is conducted two times a day.

1. INTRODUCTION

Environment and energy issues are considered to be most urgent nowadays even in future. A lot of researches have been conducted to protect environment and reduce energy consumption. In the field of building and urban environment, green roof attracts a lot of researchers' attention because it is considered to be a good solution for improving urban thermal environment by mitigating heat island and to reduce building cooling energy consumption by reducing cooling load. Alexandria et al. (2008) analyzed how much the urban canyon temperature can be

decreased due to green walls and green roofs. Takebayashi et al. (2007) compared the building surface heat transfer of green roofs with common roofs and high reflection roofs. Di et al. (1999) measured an actual green wall to analyze how much cooling effect is achieved. Elena (1998) analyzed the cooling potential of green roofs. Kumar et al. (2005) developed a mathematical model to evaluate the cooling potential and solar shading effect of green roofs. Wong et al. (2003) analyzed the thermal benefits of green roofs in tropical area. Besides studying the green roofs' benefits of heat island mitigation and thermal isolation, the cost vs. benefit is also analyzed (Clerk et al., 2008) and green roof plants selection is analyzed as well (Spala et al., 2008).

However, the research cannot be found on how to improve air-conditioners' energy efficiency utilizing the cooling effect and solar shading of green roof. Therefore this research proposes a system combining the hydroponic-cultivated green roof plants with air-conditioners for the purpose of utilizing the cooling effect and solar shading of green roof plants (Fig. 1). The outdoor unit of air conditioners is set under the plants to let air flow through plants and cooled by plants. Also the plants shade solar radiation to prevent the outdoor unit from absorbing solar energy and raising surface temperature. Compared with soil-cultivated green roof, hydroponic-cultivated green roofs are light enough to set on existing buildings, which did not consider the weight of soil-cultivated green roof plants during design phase so it cannot burden the weight. Furthermore, the hydroponic-cultivated green