School building energy performance and classroom air environment implemented with the heat recovery heat pump and displacement ventilation system

Abstract:
Recent built low energy school buildings have adopted a novel heat recovery heat pump and classroom ventilation system. School building energy conservation performance and classroom air quality enhancement will be simultaneously investigated in the present work. Heat recovery efficiency of the heat recovery facility and energy conservation ratio of the heat pump unit were analytically modeled, taking the classroom ventilation network into account. Following that, classroom displacement ventilation and its thermal stratification have been investigated concerning the effects of delivering ventilation flow rate and supplying air temperature. Representative thermal comfort parameters, percentage dissatisfied, temperature difference between ankle and head, and draft dissatisfaction have been evaluated. Indoor air quality indicated by the CO2 concentration was also investigated in terms of different levels of ventilation flow rate. Classroom energy demands for ventilation and winter heating have been shown to decrease with the promotion of heat recovery efficiency of the ventilation facility, and the energy conservation ratio of the heat pump increases with temperature of supplying fresh air. Detailed correlations of heat recovery ventilation and heat pump
energy conservation have been presented. This research illuminated that enhancement of classroom air quality and reduction of school building energy consumption could be simultaneously achieved with the appropriate operation of heat recovery heat pump and ventilation system. © 2013 Elsevier Ltd.

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