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Optimal Trajectory Finding of IDP Ventilation Control with Outdoor Air Information and Indoor Health Risk Index

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Abstract : A trajectory of set-point of ventilation control systems plays an important role for efficient ventilation inside subway stations since it affects the level of indoor air pollutants and ventilation energy consumption. To maintain indoor air quality (IAQ) at a comfortable range with lower ventilation energy consumption, the optimal trajectory of the ventilation control system needs to be determined. The concentration of air pollutants inside the station shows a diurnal variation in accordance with the variations in the number of passengers and subway frequency. To consider the diurnal variation of IAQ, an iterative dynamic programming (IDP) that searches for a piecewise control policy by separating whole duration into several stages is used. When outdoor air is contaminated by pollutants, it enters the subway station through the ventilation system, which results in the deteriorated IAQ and adverse effects on passenger health. In this study, to consider the influence of outdoor air quality (OAQ), a new performance index of the IDP with the passenger health risk and OAQ is proposed. This study was carried out for an underground subway station at Seoul Metro, Korea. The optimal set-points of the ventilation control system are determined every 3 hours, then, the ventilation controller adjusts the ventilation fan speed according to the optimal set-point changes. Compared to manual ventilation system which is operated irrespective of the OAQ, the IDP-based ventilation control system saves 3.7% of the energy consumption. Compared to the fixed set-point controller which is operated irrespective of the IAQ diurnal variation, the IDP-based controller shows better performance with a 2% decrease in energy consumption, maintaining the comfortable IAQ range inside the station.

Keywords : indoor air quality, iterative dynamic algorithm, outdoor air information, ventilation control system
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