

Multi-Stage Optimization of Local Environmental Quality by Comprehensive Computer Simulated Person as Sensor for Air Conditioning Control

Authors : Sung-Jun Yoo, Kazuhide Ito

Abstract : In this study, a comprehensive computer simulated person (CSP) that integrates computational human model (virtual manikin) and respiratory tract model (virtual airway), was applied for estimation of indoor environmental quality. Moreover, an inclusive prediction method was established by integrating computational fluid dynamics (CFD) analysis with advanced CSP which is combined with physiologically-based pharmacokinetic (PBPK) model, unsteady thermoregulation model for analysis targeting micro-climate around human body and respiratory area with high accuracy. This comprehensive method can estimate not only the contaminant inhalation but also constant interaction in the contaminant transfer between indoor spaces, i.e., a target area for indoor air quality (IAQ) assessment, and respiratory zone for health risk assessment. This study focused on the usage of the CSP as an air/thermal quality sensor in indoors, which means the application of comprehensive model for assessment of IAQ and thermal environmental quality. Demonstrative analysis was performed in order to examine the applicability of the comprehensive model to the heating, ventilation, air conditioning (HVAC) control scheme. CSP was located at the center of the simple model room which has dimension of 3m×3m×3m. Formaldehyde which is generated from floor material was assumed as a target contaminant, and flow field, sensible/latent heat and contaminant transfer analysis in indoor space were conducted by using CFD simulation coupled with CSP. In this analysis, thermal comfort was evaluated by thermoregulatory analysis, and respiratory exposure risks represented by adsorption flux/concentration at airway wall surface were estimated by PBPK-CFD hybrid analysis. These Analysis results concerning IAQ and thermal comfort will be fed back to the HVAC control and could be used to find a suitable ventilation rate and energy requirement for air conditioning system.

Keywords : CFD simulation, computer simulated person, HVAC control, indoor environmental quality

Conference Title : ICHB 2018 : International Conference on Healthy Buildings

Conference Location : London, United Kingdom

Conference Dates : November 19-20, 2018