BUILD SIMUL
DOI 10.1007/s12273-013-0154-3

Building energy simulation and optimization: A case study of industrial halls with varying process loads and occupancy patterns

Bruno Lee[1,2] (✉), Marija Trcka[2,*], Jan L.M. Hensen[2]

1. Materials innovation institute (M2i), Delft, the Netherlands
2. Department of the Built Environment, Eindhoven University of Technology (TU/e), Eindhoven, the Netherlands
** Marija Trcka is currently at United Technologies Research Center (UTRC), East Hartford, CT 01608, USA*

Abstract

Industrial halls are mainly low-rise rectangular-shaped structures of simple construction. The relatively loose requirements in space conditioning and the comparatively high internal heat gain make the approach in industrial hall design quite different from that of office building design. The simplicity in building geometry and construction method allows the investigation of energy consumption for building services to be limited to a few demand-side parameters, namely, resistance of the roof and wall insulation, airtightness, and amount of daylighting. This paper investigates the impact of varying these demand-side parameters on the energy consumption for space conditioning and lighting for a typical industrial hall. Through building energy simulation, such impacts can be investigated, and by applying optimization, the configurations of the most optimal combinations of demand-side parameters with the lowest energy consumption can be identified. The result suggests that there is a significant energy-saving potential. For industrial halls, energy consumption for building services can be very sensitive to changes in the process load and occupancy pattern, which in reality, fluctuate widely due to economic cycles, and other factors. Optimized design solutions for industrial halls intended for a particular process load and occupancy pattern might not perform as predicted due to potential changes. To account for potential changes, uncertainty analysis can be performed to determine if the optimized design solutions are in fact robust enough to such changes and to identify solutions that are less susceptible to uncertainty.

Keywords

industrial halls,
energy performance simulation,
optimization,
uncertainty analysis,
energy consumption,
robustness

Article History

Received: 20 March 2013
Revised: 13 June 2013
Accepted: 5 August 2013

1 Introduction

The industrial sector is one of the heaviest consumers of energy. In the USA, the sector used up 32 % of the total energy consumption in 2009 (LLNL 2010), while in Europe, this sector consumed 24% in the same year (Eurostat 2011). Some of this energy was consumed in the manufacturing processes, while much of the rest was spent in lighting and space conditioning. Industrial halls, which are mainly single floor structures, maintain a relatively high roof-to-floor area ratio as compared to other types of buildings. Thermal comfort is seldom a concern for industrial halls, in which space conditioning (cooling and heating) is provided to maintain the building within a reasonable or legally allowable temperature range. By contrast, saving in energy consumption for space conditioning and for lighting is a big issue since even a modest percentage reduction in energy consumption could be translated into a large monetary sum.

With relatively loose requirements in space conditioning and comparatively high internal heat gains, the approach to industrial hall design is quite different from that of office building. In fact, what is potentially an energy efficient design for office buildings might not be appropriate for high internal heat gain halls.

Moreover, the comparatively simple building geometry and construction method of industrial halls, as compared to office buildings, allow the investigation of energy consumption for space conditioning to be limited to a small number of demand-side parameters (e.g. insulation value of walls), where a change in value of some of the parameters

E-mail: b.lee@tue.nl