

PERFORMANCE OF AN ADVANCED AIR CONDITIONING SYSTEM DURING EXTREME WEATHER CONDITIONS IN A GENERATOR PLANT

J. Räisänen, A. Paakkari and R. Niemelä
Finnish Institute of Occupational Health, Finland

ABSTRACT

This technical note considers the performance evaluation of an advanced air-conditioning system in a plant manufacturing electrical generators. The extensive field measurements of thermal climate and indoor air quality were performed during five periods of extreme weather conditions in 1994-1996. In order to describe the performance of the air-conditioning system, the thermal climate and indoor air quality were determined. The air-conditioning system was able to maintain the thermal climate within the range recommended in the ISO standard 7730 for most of the time. The total volatile organic compound (TVOC) concentration was normally 0.6 mg/m³, close to the levels typically found in non-industrial environments. Apart from the summer of '94 and the winter of '95 the dust concentrations were slightly higher than those in offices. In conclusion, it seems that the thermal climate and indoor air quality in production rooms with advanced air-conditioning system is approaching to that of offices.

INTRODUCTION

Increasing attention has been paid to the evaluation of the performance of modern, advanced air-conditioning systems in industrial premises from the viewpoint of air quality and thermal climate. Nowadays many companies consider a good work environment to be a productivity factor. A good indoor climate has an impact on the personnel's performance and well-being, as well as on the production machines and final products. The purpose of this paper is to evaluate the performance of an advanced air conditioning system in a generator plant in terms of air quality and thermal climate.

MATERIAL AND METHOD

The factory hall with a floor area of 5500 m² and a height of 8 m, is equipped with a microprocessor-controlled integrated heating, cooling, ventilating and heat recovery system. Field measurements of thermal climate and indoor air quality were performed during five periods in 1994-1996. The measurements focused on extreme seasonal weather conditions, with outdoor temperatures ranging from -17.1 °C to +31.5 °C. In order to determine the thermal conditions, long-term monitoring and temporary measurements of the key thermal parameters were performed. The indoor air quality was quantified by determining the concentrations of total dust and solvent vapours. The dust concentration was measured by taking filter samples at six fixed sampling points in the working zone of the hall. The TVOC concentration was determined by the absorption tube method at a fixed sampling point in the hall, close to the adjacent painting room.

RESULTS

In summer the day-average indoor air temperature varied from 21 - 25 °C with a temporary maximum value of 28°C (Fig. 1). In winter the day-average indoor air temperature was approximately 3°C lower, varying from 19 - 21 °C, with a temporary minimum value of 13.3 °C (Fig. 1). The mean air velocities in the working zone varied from 0.14 - 0.16 m/s with the temporary maximum values being typically below 0.3 m/s. Except for one value of 1.0 mg/m³, the total dust concentrations in the hall varied from 0.08-0.6 mg/m³ (Fig. 2). Normally, the TVOC concentration in the hall was 0.6 mg/m³. However, the TVOC concentration during painting, when solvent vapours dispersed from the adjacent painting room, rose to 6 mg/m³.

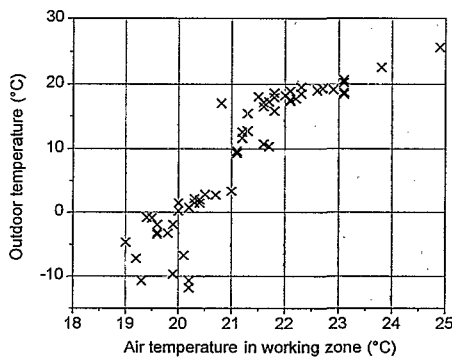


Fig. 1 The outdoor air temperature vs. air temperature in working zone (daily ave.).

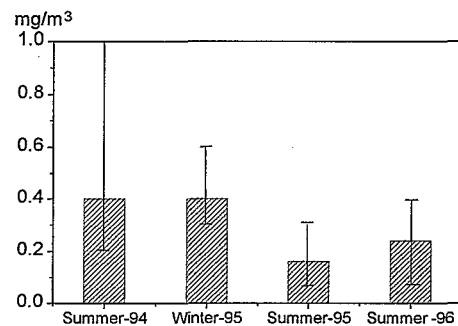


Fig.2. The mean dust concentration, minimum and maximum values.

DISCUSSION

The air-conditioning system was able to maintain the thermal climate for most of the time within the range recommended for medium activity level work in the ISO standard 7730 [1]. Excluding two observations in summer, the range of air temperature in the working zone was 4°C while that of the outdoor temperature was 38°C. The period mean total dust concentrations varied from 0.2 - 0.4 mg/m³, with the highest concentrations occurring in the summer of '94 and the winter of '95. In the summers of '95 and '96 the mean dust concentrations fell by 40-50%, close to the level typically found in offices [2]. Normally the TVOC concentration in the hall was 0.6 mg/m³, nearly at the level of non-industrial environments [2]. However, the TVOC concentration in the hall rose to 6 mg/m³ due to painting.

The measurement showed clearly that it is possible to achieve a satisfactory thermal climate and good indoor air quality in a production room with an advanced air-conditioning system when contaminant emissions are low. The development trend shows that the indoor climate of a manufacturing hall approaches that of the indoor climate in an office

REFERENCES

1. ISO. 1994. *ISO Standard 7730, Moderate thermal environments - Determination of PMV and PPD indices and specification of conditions for thermal comfort*, International Organization for Standardisation.
2. Nordic Committee on Building Regulations. 1991. *Indoor Climate - Air Quality*. Pub. No. 61E.