INDOOR QUALITY ANALYSIS OF CO₂ FOR KASTAMONU UNIVERSITY

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Today in the world there are people who go through life largely confined to urban areas, that human health and performance is directly affected by air quality in places. One of the fastest changing gas inside is one of the components can be installed indoor air quality was off the CO₂ is caused by human activity. Many international organizations identified to air quality. In particular, EPA determined the amount of CO₂ is 800 ppm, sometimes in spite of the fact that these values into the community in the area of 1000 ppm maximum level in the internal environment. The amount of CO₂ in the atmosphere constantly above this level can cause serious harm to human health. To educate young people who are particularly adversely affected by age and exposure in Daily life where high concentrations of CO₂.

Therefore, knowing the amount of CO₂ inside is of great importance for children and young people’s lives. This study aimed to determine the amount of indoor CO₂ of Kastamonu University. For this purpose, Kastamonu classes in university, canteens, cafeterias, hallways, meeting rooms, instructor rooms and laboratories. According to EPA this study results is not suitable for standart values. The results exceed limit values of CO₂ concentration. This situation pose an obstacle for teenagers students.

Keywords: Air quality, Indoor, Student, Carbon dioxide (CO₂), Kastamonu University.

Introduction

According to the data provided by the Turkish Statistical Institute, the 2014-2015 academic year was completed in 53,574 schools with 889,695 teachers and 16,403,328 students. Of these schools, 27,544 were primary schools with 295,252 teachers and 5,434,150 students; 16,969 were junior high schools with 296,065 teachers and 5,278,107 students; and 9061 were secondary education institutions with 298,378 teachers and 5,691,071 students (URL1). During the 2014-2015 academic year, educational activities were carried out in formal education with a total of (including pre-primary education) 59,509 schools, 919,393, teachers and 17,559,989 students (URL2). The number of students attending universities is over 2 million (URL3). Each student breathes within school buildings for 20,000 hours from primary school to university. This figure corresponds to nearly 23% of average life span (Bulgurcu et al., 2006).

Human activities can change rapidly depending on the CO₂ concentration. 0.033% CO₂ and 21% O₂ in the breathing process, is taken up by people from the atmosphere and converted 16-17% O₂ and 4% CO₂ was discharged from the lungs. The oxygen sublim is 17% to 18% during working conditions. The Hazardous limit of the oxygen level is under 15%. The oxygen level changes, especially in schools, shopping malls and crowded seems likely to reveal itself in the hospitals (Bulgurcu,2005).
As a result, indoor air, constant fatigue, and sleepiness occurs as people sense the absence of rising CO\textsubscript{2} levels may cause some of the symptoms (Sevik and Kanter, 2012). The causing loss of performance of CO\textsubscript{2} will cause many side effects even if the reasons are not easily detected. While CO\textsubscript{2} levels above 1000 ppm, dizziness, fatigue, headache and smell like symptoms get annoyed observed; 1500 ppm, cough, runny nose, nasal irritation, throat irritation and eye discharge will take place during (Ercan, 2012). Where people spend most of the time these symptoms are adversely affected and people manifests itself, especially in closed environments with performance and health indoor air quality decline (Sevik and Kanter, 2012). According to the EPA, indoor permissible maximum CO\textsubscript{2} level of 800 ppm. Conference rooms and public areas such as schools are allowed a maximum of 1000 ppm this level (Sevik and Belkayal, 2012).

This study aimed to determine the amount of indoor CO\textsubscript{2} of Kastamonu University. For this purpose, Kastamonu classes in university, canteens, cafeterias, hallways, meeting rooms, instructor rooms and laboratories.

Material and Method

In this study, she worked with Kastamonu University Faculty of Engineering and Architecture building. Faculty of Engineering and Architecture building, but also for education and training, 24 classrooms, 4 laboratories used the same faculty and a canteen on the ground floor has two computer labs used various engineering department. Altogether, the capacity is 40 students per class (Isinkaralar et al., 2015).

Portable indoor air quality due to experimental measurements of CO\textsubscript{2} meter for today is done. These measurements were made at different times, each different classrooms and laboratories at least 4-5 times. The results were obtained by considering the number of students in each class. In conclusion, this analysis is done by specifying the current situation in such an environment.

Carbon dioxide measurements were performed via “Extech Desktop Indoor Air Quality CO\textsubscript{2} Datalogger”. The device is capable of measuring at a precision of 1 ppm with a data logger feature. The device was programmed to make measurements once in 5 minutes, and the data was transferred to a computer for evaluation.

Findings

According to measurements which are conducted in classrooms, workshop, canteen, library, refectory, laboratories, and computer laboratories, Table 1 is created and all measurements are shown in this table. These measurements are assumed to be calculated in surroundings involving students. If these surroundings are deaerated, CO\textsubscript{2} level will be equal to the outdoor air. After aeration, CO\textsubscript{2} level is expected to be lower than 400 ppm. Yet, in this study these values are not taken into consideration.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Lowest (ppm)</th>
<th>Highest (ppm)</th>
<th>Average (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom</td>
<td>698</td>
<td>4297</td>
<td>2298</td>
</tr>
<tr>
<td>Canteen</td>
<td>649</td>
<td>1476</td>
<td>1125</td>
</tr>
<tr>
<td>Cafeteria</td>
<td>601</td>
<td>1112</td>
<td>769</td>
</tr>
<tr>
<td>Laboratory</td>
<td>682</td>
<td>1694</td>
<td>1273</td>
</tr>
<tr>
<td>Hallways</td>
<td>598</td>
<td>1579</td>
<td>998</td>
</tr>
<tr>
<td>Meeting rooms</td>
<td>651</td>
<td>1496</td>
<td>1214</td>
</tr>
<tr>
<td>Instructor rooms</td>
<td>704</td>
<td>1908</td>
<td>1457</td>
</tr>
</tbody>
</table>
The lowest rates in the table refer to the measurements made in the early hours of mornings when there was no human activity. With the start of human activities, CO\textsubscript{2} amount rapidly increased and exceeded the threshold on average in all the areas except for cafeteria and hallways. CO\textsubscript{2} amount is much higher than the threshold especially in classrooms and reaches up to 4297 ppm in these spaces. The areas where the average rate is the highest are classrooms (2928 ppm) and laboratory (1273 ppm). Student activities are the most intense and size is limited in these areas. The average value detected in instructor rooms is 1457 ppm. High values of CO\textsubscript{2} in instructor rooms may stem from their small sizes and numerous entries-exits made by students. Instructor rooms are connected to a long hall that does not have air-conditioning. The windows are not opened as frequently as needed especially in cold winter months. Therefore, these rooms are not ventilated adequately, which leads to high values of CO\textsubscript{2} in these places.

The lowest average CO\textsubscript{2} values are observed in canteen, cafeteria, and hallways, which have something in common: ceiling is very high, and there is a constant entry-exit to and from these areas, which increases air circulation compared to other areas.

All in all, it is possible to say that in areas where people are intensely active, but ventilation is inadequate, the amount of CO\textsubscript{2} is much higher than the threshold; however, in areas where ceiling is very high and ventilation is constant (even if it is for short intervals), the amount of CO\textsubscript{2} is lower.

Discussion

The results of this study indicate that the amount of CO\textsubscript{2} in areas which are frequently used by students and where educational activities take place is much higher than the threshold values specified by EPA. Especially classrooms have a CO\textsubscript{2} value as high as 4297 ppm. However, EPA states that the acceptable carbon dioxide rate in indoor areas is 800 ppm at most. For crowded areas such as schools and conferences halls where people stay together, it is 1000 ppm at most (Favvccett, 1988). However, CO\textsubscript{2} rate in classrooms is much higher than the specified value. Bulgurecu (2005) reports that average amount of carbon dioxide in classrooms in Turkey reaches up to 5475 ppm in January, and carbon dioxide values are drastically higher than the threshold value in almost all classrooms, particularly during winter. Previous studies conducted in Turkey found out similar results as well. Isinkaralar et al. (2015) report that the amount of CO\textsubscript{2} reaches up to 4318 ppm in classrooms, 2159 ppm in computer laboratories, and 1568 ppm in student laboratories. Sevik et al. (2015a) state that the amount of CO\textsubscript{2} reaches up to 3918 ppm in classrooms, 2699 ppm in workshops, and 1897 ppm in computer labs.

Similar studies were conducted in various countries all around the world. Similar results are reported by Lee and Chang (2000) for Hong Kong, Ahman et al. (2000) for Stockholm, Lundin (1999) for Sweden, Fuji et al. (2002) for Japan, Zhang et al. (2006) for Australia, and Godwin and Batterman (2007) for the United States.

The results of the present study indicate that the amount of CO\textsubscript{2} is lower in the areas where ceiling is very high and ventilation is constant. Previous studies suggest that the most efficient way to decrease the amount of CO\textsubscript{2} in such environments is to ventilate them (Sevik et al., 2015a). This is because CO\textsubscript{2} in outdoor environments is 5 to 100 times as clean as CO\textsubscript{2} in indoor environments (Cetin et al., 2015). The lowest values detected in this study are thanks to the air quality in outdoor environments. The lowest values were detected to be in the range of 598 to 704 ppm. Sevik et al. (2015b) states that the amount of CO\textsubscript{2} in the central district of Kastamonu province ranges from 517 to 720 ppm in winter months. The lowest values obtained in the present study are generally close to these values, and they are the values in newly ventilated environments.

Conclusion

The results of the study can be summarized as follows: in areas where there is intense human activity and which are not adequately ventilated, the amount of CO\textsubscript{2} exceeds the threshold value to a great extent. On
the other hand, the areas where ceiling is very high and ventilation is constant have lower CO₂ values. In addition, it is possible to say that the amount of CO₂ can be reduced most efficiently by ventilating the environment, and low CO₂ values depend on the outdoor environment. Therefore, each phase of school construction, from the selection of place to architectural plans, should take into account indoor air quality. Indoor CO₂ level rapidly changes depending on human activities. It influences people’s and especially children’s health and performance to a great extent. It should be kept in mind that capacity of classrooms, ventilation, outdoor air quality, and the size of the place are the main factors determining the increase in the amount of CO₂ within the environment. These are remarkable points to be considered while planning schools.

Acknowledgments

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