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Inspection and analysis for IAQ at the waiting room in Lingui bus station

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Abstract. Indoor air quality has an important impact on human health.In order to find out indoor air quality (IAQ) condition at the waiting room in Guilin Lingui bus station, in the survey, the waiting room IAQ had been investigated with the carry-home fast inspect instrument from Dec 20th to Dec 30th in Lingui Bus Station. The levels of CO_2, formaldehyde(HCHO), particles with diameters of 10 um or less(PM_{10}) and total volatile organic compound(TVOC) had been inspected mostly. Data were analyzed by the SPSS 11.0 and evaluated with synthetic index method of air quality. Results showed that CO_2 concentration was biggest to 878 ppm(standard limit of 1000ppm), PM_{10} concentration was biggest to 0.14mg/m^3(standard value of 0.15 mg/m^3), HCHO concentration was biggest to 0.08 mg/m^3(standard value of 0.10 mg/m^3). The concentration of other pollutants were lower comparatively. The winter air quality of the waiting room in Lingui bus station belongs to the no pollution. It showed that the levels of indoor pollutant were higher than outdoors', too.

Introduction

People have become more aware of indoor air quality(IAQ), along with the improvement of standard of living. The waiting room of bus station is a special indoor environment. The indoors population density is big there, the personnel is miscellaneous, mobility is big, too. On designing the air conditioning system, we consider primarily the hot environment problem that regards cold and heat as the central symbols. But IAQ usually is neglected. As a result the poor IAQ is caused. The contaminative air can increase the chance of long-term and short-term health problems for people.[1] Guilin is located in the low-latitude, belongs to medium subtropical humid monsoon climate. The coldest month is the 1-2 month , the average temperature is about 8 ℃, the hottest month is 7-8 month, the average temperature is 28.5 ℃ or so, occasionally more than thirty degrees, the annual average temperature is about 19 ℃. In Guilin, summer rainfall is more concentrated, accounting for more than half of total annual rainfall, high humidity. Based on China's energy efficiency design standards, Guilin is hot in summer and cold in winter areas.For finding out the air pollution condition of the waiting room of bus station in Guilin Lingui, a ten-day air pollution investigation at waiting room were carried from the 20th to 30th of Dec.

Materials and Methods

Materials. The measure time was in the morning (10:00-12:00), afternoon (15:00-17:00) and the evening (19:00-21:00). In order to compare with indoor condition, still measure some outdoor parameters at the same time. The measure parameters included primarily: temperature, relative humidity, carbon dioxide(CO_2), formaldehyde(HCHO), benzene(C_6H_6), ammonia(NH_3), toluene(C_7H_8), xylene(C_8H_{10}), particles with diameters of 10 um or less (PM_{10}) and total volatile organic compound(TVOC) etc. Table 1 shows the measurement apparatus.

Table 1. The measurement apparatus

Parameter	Model	Range	Precision
Temperature	U.S. TENMRS K/J single-channel thermometer DT-80	-200℃~1050℃	±0.05% , +0.7 ℃ of reading
Relative humidity	The electronic ventilation psychrometer HM3	10%~100%	± 3%
Atmospheric pressure	The air pressure gauge DYM3	800~1064hpa	≤ 2.0hpa
CO_2	Qingdao Lubo carbon dioxide detector LB-ZG106A-M	0～10000ppm	±50ppm, ±5℃ of reading
HCHO	Shenyang Dalian formaldehyde detector LB-JM4	0-19.99ppm	＜±1.5%（F.S）
PM_{10}	Qingdao Lubo Portable respirable dust concentration continuous Laser tester PC-3A	0.001～10mg/m^3 0.3~10μm	Min 0.001 mg/m^3
HCHO,C_6H_6,NH_3,C_7H_8,C_8H_{10},TVOC	Qingdao Lubo Six-meter Indoor air quality testing LB-3JX	0.05~3mg/m^3	±10% of reading

Methods. The data analysis method is SPSS11.0 mostly, the evaluation method is the method of synthesis index number value of air quality[2]. The indexs are introduced as follows:

The superposition arithmetic index P : it is a superposition of all single index.

$$P = \sum \frac{C_i}{S_i} \tag{1}$$

The mean index Q : it is the single index of the arithmetic mean.

$$Q = \frac{1}{n} \sum \frac{C_i}{S_i} \tag{2}$$

The synthesis index I : It gives attention to both the maximum index and the mean index number properly.

$$I = \sqrt{\left(MAX \left| \frac{C_1}{S_1}, \frac{C_2}{S_2}, \ldots \frac{C_n}{S_n} \right| \right) \times \left(\frac{1}{n} \sum \frac{C_i}{S_i} \right)} \tag{3}$$

where C_i is for the real-time measuring concentration of the indoors pollutant, S_i is for the standard limit value of the indoors pollutant, C_i / S_i is for the single index number value of the indoors pollutant.

Evaluation standard: Saying from environment quality index number method, thinking generally that the single index number and the synthesis index number are cleanly if they are both below 0.5, which can acquire the maximum acceptance rate from the indoors personnel. Judging from it up to 1for light pollution , up to 2 and above for heavy pollute, according to the synthesis index number, the indoor air quality grade can is divided into 5 class, such as table 2, table 3 [3].

Table 2． Environment quality rating standard

Ratings	characters
Cleanly	It is fit for living in mankind
No pollution	The elemental pollutant in each environment does all not go beyond the limit, mankind live normal
Light pollution	There is a factor going beyond limit in environment pollutant at least, in addition to the allergy, can't take place the acute chronic poisoned generally
Moderate pollution	There are 2-3 factors going beyond limit in environment pollutant generally, the crowd health victimizes obviously, the allergy victimizes more seriously
Heavy pollution	There are 3-4 factors going beyond limit in environment pollutant generally, the crowd health victimizes serious, the allergy may die

Table 3. Indoor air quality grade

The Synthesis index number	≤0.49	0.50-0.99	1.00-1.49	1.50-1.99	≥2.00
Indoor air quality grade	I	II	III	IV	V
Grade evaluation	Cleanly	No pollution	Light pollution	Moderate pollution	Heavy pollution

Measure and Analysis

According to《indoor air quality standard GB/ T18883-2002》[4], combining the actual condition of this laboratory, on the first time measure this study selects eleven parameters, such as temperature, relative humidity, atmospheric pressure, CO_2, HCHO, C_6H_6, NH_3, C_7H_8, C_8H_{10}, PM_{10} and TVOC. We were in the morning (10:00-12:00) on the waiting room on either side of the air quality in a detailed inspection. The analysis found that the main indoor pollutants are CO_2 and PM_{10}, in Table 4. Detection in the future, the detection parameters were adjusted to reduce some of the parameters. Table 4 shows IAQ in the morning (10:00-12:00), afternoon (15:00-17:00) and the evening(19:00-21:00) of the different days.To understand the changes in the waiting room of pollution within the day, and all day on December 30 in the same period (morning, afternoon and evening) on the indoor air quality was tested and also detected outside of the parameters for comparison, in Table 5. Figure 1 shows the waiting room of PM_{10} are obtained.

Table 4. Indoor air quality for different days

Parameter	Standard value	Morning east side		Morning west side		Afternoon		Evening	
		Mean value	Cent index	Mean value	Cent index	Mean value	Cent index	Mean value	Cent index
Temperature /℃	16～24	15	-	14	-	16	-	13	-
relative humidity/ %	30～60	56	-	56	-	55	-	55	-
CO_2/ ppm	1000	616	0.62	667	0.67	878	0.88	725	0.73
PM_{10}/mg/m^3	0.15	0.12	0.77	0.12	0.78	0.14	0.93	0.12	0.81
HCHO/ mg/m^3	0.10	0.05	0.50	0.05	0.50	0.06	0.60	0.08	0.80
C_6H_6/mg/m^3	0.11	0.05	0.45	0.05	0.45	0.08	0.73	0.06	0.55
NH_3/mg/m^3	0.20	0.07	0.35	0.08	0.40	0.12	0.60	0.15	0.75
C_7H_8/mg/m^3	0.20	0.05	0.25	0.06	0.30	0.10	0.50	0.12	0.60
C_8H_{10}/mg/m^3	0.20	0.08	0.40	0.05	0.25	0.08	0.40	0.10	0.50
TVOC/mg/m^3	0.60	0.10	0.17	0.12	0.20	0.18	0.30	0.20	0.33
The maximum index		-	0.77	-	0.78	-	0.93	-	0.81
The synthesis index		-	0.58		0.59		0.76		0.71
Air quality grade and evaluation		II No pollution		II No pollution		II No pollution		II No pollution	

From the table 4 we can see, the air quality in the waiting room belongs to the no pollution in II class. The pollution index number of the afternoon is the largest(0.76), the most polluted, followed by the evening, morning east of the index is the lowest (0.58), pollution lightest.Showing from the spot recording, the indoors the smoking crowd are not much, only have 2; the waiting crowd increase gradually from east to west; the indoors has no obvious strange smell, but the yawp is bigger. The indoor air conditionings and fans were not enables. From the maximum index we can see, PM_{10} contributes mostly to indoor pollution. From the cent index we can see, the main pollutants are CO_2,HCHO and PM10. It showed that CO_2 concentration was biggest to 878 ppm(standard limit of 1000ppm), PM_{10} concentration was biggest to 0.14mg/m^3(standard value of 0.15 mg/m^3), HCHO concentration was biggest to 0.08 mg/m^3(standard value of 0.10 mg/m^3). The concentration of other pollutants were lower comparatively. Although these pollutants did not exceed the limits specified in the standard, but their contents were near the limits specified in the standard.

Table 5 Air quality index number of indoor and outside for the same day

Parameter	Indoor			Outdoor		
	Morning	Afternoon	Evening	Morning	Afternoon	Evening
CO_2/ ppm	0.78	1.01	0.82	0.47	0.47	0.46
PM_{10}/mg/m^3	0.81	1.10	1.00	0.78	0.90	0.85
HCHO/ mg/m^3	0.55	0.85	0.68	0.50	0.80	0.60
C_6H_6/mg/m^3	0.60	0.60	0.75	0.50	0.55	0.65
NH_3/mg/m^3	0.46	0.80	0.62	0.35	0.75	0.50
C_7H_8/mg/m^3	0.25	0.76	0.35	0.25	0.56	0.35
C_8H_{10}/mg/m^3	0.65	0.75	0.65	0.45	0.55	0.50
TVOC/mg/m^3	0.30	0.70	0.48	0.20	0.56	0.30
The maximum index	0.81	1.10	1.00	0.78	0.90	0.85
The synthesis index	0.67	0.95	0.82	0.58	0.76	0.67
Air quality grade and evaluation	II No pollution	II No pollution	II No pollution	II No pollution	II No pollution	II No pollution

Table 5 shows air quality index number of indoor and outside for the same day, and briefly with the outdoor concentration of contrast. From synthesis index we can see, the pollution index of the afternoon in indoors is the largest(0.95), the most polluted, followed by the evening, morning east of the index is the lowest (0.67). Comparing with the table 4, the index has the good consistency(namely index of the afternoon>that of the evening>that of the morning). The pollution index of the outdoors is lower obviously than that of the indoors, variation of the pollution concentration has the good consistency with indoors, then the index of the afternoon is the largest(0.76), the evening takes second place, the index of morning is the lowest(0.58).

From the source analysis, indoor air pollution is mainly from indoor staff activities and outside the spread of organic compounds in indoor.When the waiting crowd increased, indoor CO_2 concentration increased obviously, such as contrast in east and west; PM_{10} would increase, too. Because the outside personnel's carry-on luggage would increase, activity was great. In addition to the waiting room waiting to implement continuous, the indoor pollutant would stay indoors partly from morning to afteroon. Thus it made the index of the afternoon higher than the other time. On the north of the waiting room was truck park, during the boarding the engine had been running. Where gathered a large amount of exhaust gas. So the organic compounds concentration was higher than the indoor.

Conclusion

In sum, winter air quality of the waiting room in Lingui bus station belongs to the no pollution, namely, the elemental pollutant in each environment does all not go beyond the limit, mankind live normal. Mainly due to good indoor ventilation.But the concentration of indoor pollution in afternoon is larger, main pollutants in indoors are CO_2,HCHO and PM_{10}, the concentration of other pollutants are lower comparatively, all not go beyond the air quality standard limit. The pollution indoors is obvious higher than outdoors.

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