**Air Quality Issues in Jockey Club Postgraduate Hall 2 & 3**

1. **Current Situations**

In accordance with Campus Development Office (CDO), upon completion of any construction projects in CUHK, all buildings will be reviewed by the project consultant and their environmental sub-consultant. The Buildings Authority, Fire Services Department, Water Supply Department would advise if the premises are operable with the issue of an Occupation Permit and Certificate of Practical Completion. In Jockey Club Postgraduate Hall (JCPGH) 2 & 3, all statutory requirements for regulatory compliance, which included building completion and occupation, are satisfied and with relevant permits in place. Both hostels have been inspected by the Fire Services Department and Buildings Authority to their satisfaction with the issue of the Occupation Permit in November, the architect and consultant team have also inspected the buildings and tested the systems before certifying Practical Completion and arranged the handover of particular floors / areas.

Apart from checking on the certificates provided by CDO, University Safety Office (USO) would also arrange spot checks to obtain the general picture of air quality in the new buildings. Having considered the construction method, materials used and main concerns from the potential occupants, two parameters namely Total Volatile Organic Compounds (TVOC) and formaldehyde were usually selected for carrying out the spot checks. Owing to the homogenous nature of the indoor environment with no other anthropogenic source and activity, spot grab sampling method was used in JCPGH to quickly identify if there is any abnormality in these new premises.

1. **Statutory Requirement of Indoor Air Quality in Residential Premises**

In Hong Kong, there is no regulation and statutory requirement to govern air quality within residential or domestic buildings. Statues and government regulations including the Building (Planning) Regulations, Building (Ventilation Systems) Regulations, Air Pollution Control Ordinance, Occupational Safety and Health Ordinance and etc. stipulate the requirement of provision of ventilating system and/or the amount of fresh air supplied to certain buildings under certain circumstances. The Indoor Air Quality (IAQ) Certification Scheme administered by the IAQ Management Group under the Environmental Protection Department (EPD) of Hong Kong is on voluntary basis and it applies only to the areas served with mechanical ventilation and air conditioning (MVAC) system (it does not cover window-type air-conditioners or split-type air-conditioners) for human comfort except any area or any part of the building which is constructed, used or intended to be used for domestic purposes. Legislative provisions stipulated in the regulations should be complied with as minimal standard while the IAQ objectives set out in the IAQ Certification Scheme should be considered as good practice.

1. **References and Standards**

Due to the carcinogenicity of formaldehyde, strict environmental standard has been adopted for monitoring formaldehyde levels in hostels. In accordance with IAQ Management Group, the Good Class IAQ Objective of formaldehyde is 81 ppb (parts per billion). In this case, 81 ppb (IAQ Management Group, 2003) has been adopted as the reference standard for formaldehyde exposures in indoor environment.

Volatile Organic Compounds (VOCs) are chemical compounds that may enter from the outdoor environment, or be emitted from building materials. Since the TVOC level could be originated from multiple sources and there is no proof that it is carcinogenic at lower level. The Good IAQ Objective of TVOC was set at 216 ppb, which is for good reference only. In accordance with Molhave (1991), no effects are expected as a result of TVOC exposure lower than 0.2 mg/m3 (87 ppb), at 3mg/m3 (1,305 ppb) or higher, complaints from occupants occurred in all investigated buildings with occupants having symptoms. TVOC concentration in between 0.2 mg/m3 and 3 mg/m3, it is regarded as a range of multifactorial exposures that any symptoms experienced by the testing occupants could be caused by multiple factors other than TVOC within the premises. In this case, there are uncertainties in this range and it has no evidence to demonstrate the causative relationship between the exposure and ill health of occupants. As such, we have adopted the level between no effect (i.e. 87 ppb) and the significant level of showing adverse health effect at 1,305 ppb (i.e. apprx. 700 ppb) to benchmark the situation of TVOC within hostels not served by MVAC. Despite there is no definite standard, the instant TVOC reading taken served as a good indicator to quantify air quality problem in an indoor environment and identify area for improvement (e.g. particular areas needing more purging or ventilation).

Nonetheless, it is noteworthy that IAQ Management Group (2003) suggested that measurement should not be made in any part of the premise/building where it is totally enclosed but not served by MVAC system. The reference levels should be considered and comparable only if the measurement was taken with continuous fresh air supply.

1. **Action Taken and Methodology of Measurements**

After meeting with the student representatives on 28 December 2018, the following arrangement for additional air monitoring exercises were agreed and implemented:

1. A RAE3000 (Photo-Ionization Detector) real time TVOC monitor, which has been officially calibrated, was used in the monitoring;
2. Four 30-min measurements were conducted in a designated room;
3. The monitor was placed inside the room at a place where it was at least 0.5 m from windows, not within 2 m of doors, about 1.1 m above the floor (inlet of monitor), not under direct sunlight;
4. All windows and the door were closed with fan off *(Note: This method is not recommended by the IAQ Management Group as mentioned in the last paragraph of Section 3 of this paper but insisted by the students)*;
5. A 30-min Average TVOC level was recorded after the measurement;
6. Other three monitoring were conducted as the same way as the first one on the same day under the same condition; (Note: one 30-min measurement is conducted in the existing PGHs for comparison);
7. A total of four 30-min measurement data were collected in each designated room for further analysis. The average of 30-min measurements conducted at four time-slots would be used as it is also considered acceptable (IAQ Management Group, 2003).
8. **Results**

The monitoring results of TVOC and formaldehyde in last three days are tabulated as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| **Sampling Date** | **Sampling Location** | **Formaldehyde (ppb)** | **TVOC (ppb)** |
| 31 Dec 2018 | PGH 2 Room 816 | <10 | 194 |
| 31 Dec 2018 | PGH 2 Room 904 | <10 | 244 |
| 31 Dec 2018 | PGH 3 Room 819 | <10 | 289 |
| 31 Dec 2018 | PGH 3 Room 918 | <10 | 288 |
| 2 Jan 2019 | PGH 2 Room 701 | <10 | 505# |
| 2 Jan 2019 | PGH 2 Room 621 | <10 | 547# |
| 2 Jan 2019 | PGH 3 Room 706 | <10 | 466 |
| 2 Jan 2019 | PGH 3 Room 615 | <10 | 485 |
| 2 Jan 2019 | PGH 3 Room 419 | Not measured(Notes) | 611 |
| 2 Jan 2019 | PGH 3 Room 509 | Not measured (Notes) | 583 |
| 3 Jan 2019 | PGH 2 Room 502 | <10 | 759# |
| 3 Jan 2019 | PGH 2 Room 410 | <10 | 775# |
| 3 Jan 2019 | PGH 3 Room 311 | Not measured (Notes) | 340\* |
| 3 Jan 2019 | PGH 3 Room 218 | Not measured (Notes) | 392\* |
| 3 Jan 2019 | PGH 3 Room 114 | <10 | 706# |
| 3 Jan 2019 | PGH 3 Room 109 | <10 | 731# |

Notes: formaldehyde was not measured in some locations due to the unavailability of equipment

# measurement was taken by the equipment borrowed from PolyU

\*representing the averaged reading for the first three 30-min measurements. The last 30-min measurement was discarded as it was measured by another equipment from PolyU since the original instrument was out of service.

1. **Interpretation of Data**

From the air monitoring taken in past few days, the concern over formaldehyde exposure could be excluded. Students could also be reassured by the declaration from Director of Campus Development that it has been CUHK practice of using no or low VOC materials and not using formaldehyde-containing materials and furniture in all construction projects within CUHK.

As for TVOC, care should be taken for data measured by using the equipment borrowed from PolyU as the equipment does not come with the external filter (PTFE filter) for trapping dusts and moisture. The students witnessing the measurement were also aware of the missing external filter of that equipment. According to the user’s manual of ppbRAE 3000, dirty filter and excessive moisture would yield abnormally high reading and thus the reading should only be used with caution (Troubleshooting of ppbRAE 3000 User’s Guide). Therefore, the readings should be reasonably discounted.

From the monitoring results of 16 hostel rooms, it was found that the TVOC levels were generally lower than 700 ppb (194 to 611 ppb) in an unfavourable (or inhabitable) conditions of having all the room windows closed with no fresh air supply throughout the sampling period. Since the testing conditions differ from the method suggested by the IAQ Management Group, another TVOC testing was also conducted in two hostel rooms at Chiangs Building with doors and windows closed. It was found that the TVOC levels (four 30-min measurement) in two currently occupied hostel rooms were 450 ppb and 515 ppb that they were quite similar to reading taken at the new buildings. It was also noted that the instance TVOC readings in two occupied rooms were even exceeding 800 ppb but no complaint was received from the occupants.

Despite the prevailing TVOC readings are within the range of multifactorial exposure suggested by Molhave (1991), it is still far below the range of discomfort (i.e. <1,305 ppb) suggested by the same author. Therefore, there is no evidence to prove that the existing TVOC level would induce any adverse health effects in general public.

1. **Conclusion**

There is no legislative requirement in Hong Kong to require developer to conduct thorough IAQ measurement at pre-occupational stage of any premises. The IAQ Objectives is by no means being the statutory requirement but serving as a good practice and reference. According to the recent visit by the Environmental Protector Officers of EPD on 31 December 2018, they also considered the condition in JCPGH 2 & 3 acceptable and the IAQ complaint was not justifiable and substantiated. Having reviewed by various governmental departments, no breach of prevailing rules and regulations is observed. Since the result of TVOC measurement presented in this paper represents the worst case scenario when the measurements were taken with door and windows closed, it is believed that the IAQ within the premises could be greatly improved by opening the window when they are occupied.

1. **References**

Indoor Air Quality Management Group (2003). Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places. Environmental Protection Department. Hong Kong Special Administrative Region Government.

Molhave, L. (1991). Volatile organic compounds, indoor air quality and health. Indoor Air, 4, 357-376.

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