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Improvement of a Chemical Storage Room Ventilation System

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Abstract

Scientists at universities across Iraq are actively working to report actual incidents and accidents occurring in their laboratories, as well as structural improvements made to improve safety and security, to raise awareness and encourage openness, leading to widespread adoption of robust Chemical Safety and Security (CSS) practices. This manuscript is the third in a series of five case studies describing laboratory incidents, accidents, and laboratory improvements. We summarize an improvement to the chemical storage room ventilation system at Al-Nahrain University to create and maintain a safe working atmosphere in an area where chemicals are stored and handled, using US and European design practices, standards, and regulations.

Keywords: Science Laboratory; Chemistry Laboratory; Scientific Practical Skills, Ventilation.

1. Introduction

Proper room ventilation with adequate air exchanges will eliminate most unsafe vapours in a chemical laboratory. A safe working atmosphere is characterised by the presence of sufficient oxygen to breathe; concentrations of hazardous gases, vapours, mists, fumes and dusts below established exposure limits; concentrations of flammable gases, vapours, mists, fumes and dusts below 5% of their lower explosion limit; and avoidance of temperature extremes. There are three main types of ventilation systems that may be used to maintain such a safe working atmosphere: natural ventilation, exhaust ventilation and mechanical ventilation [1-2].

In this manuscript, we briefly describe each type of ventilation system before summarizing a project undertaken to improve chemical storage room ventilation at Al-Nahrain University to create and maintain a safe working atmosphere in an for staff and students using mechanical ventilation systems built and installed in conformance with US and European design practices, standards, and regulations. Highlighting specific improvements and suggestions for future projects of a similar nature.

2. Background

There are three main types of ventilation systems: natural ventilation, exhaust ventilation and mechanical ventilation. Each type is useful in selected situations, but it is important to match the ventilation system to the type of work and associated chemical hazards likely to be encountered.

The first type of ventilation system is commonly referred to as natural ventilation. Natural ventilation has limitations and should only be considered for airborne contaminants or irritants of low toxicity. Natural ventilation requires external walls with openings to the outside air.

The second type of ventilation systems is local exhaust ventilation. Where minor quantities of chemicals are being stored or handled, local exhaust ventilation is a minimal measure that may be sufficient for certain hazardous processes to capture above ground contaminants at the source. This type of ventilation removes chemical hazards from the environment before they reach the breathing zone of a person working in the area. There are specific design requirements for local exhaust ventilation depending on the nature and quantity of the chemical hazard, and include fume cupboards, ducts or spot hoods attached to woodworking equipment or in welding bays, and vents in photo development laboratories. Expert advice should be sought prior to installing, or when maintaining this type of ventilation

The third type of ventilation system is mechanical ventilation [3]. Where quantities or toxicity of chemical hazards present cannot be adequately handled using local exhaust ventilation, mechanical ventilation, either in volving the use of single or multiple fan systems. In case, fresh air intake and exhaust ducts should be installed on opposite walls of the laboratory, separated by a distance of no more than 5 metres. If a single fan system is used, it should be installed in the exhaust duct. However, if the ventilation system incorporates fans on both the supply and exhaust `ducts, the capacity of the fans need to be adjusted so the fan on the exhaust duct is pulling air out of the laboratory with greater force than the fan pushing fresh air into the laboratory. Adjusting the air flow in this manner creates negative pressure ventilation, allowing sufficient air flow into the room while minimizing the possibility of health effects due to the presence of chemical hazards [4-8].

3. Old Ventilation System

The Department of Chemistry at Al-Nahrain University converted its basement rooms to store chemicals in 1990. Many of these rooms and corridors were exploited for the storage of chemicals, equipment and glassware. The storage rooms were each outfitted with small exhaust fan fixed directly to the upper windows. With this system, the exhaust was routed directly into the student movement area, at a height of two meters from the ground (Figures 1-3).

Figure 1. Side view of a small fan fixed directly to the upper windows that made up the old ventilation system

Figure 2. One of the small fans fixed directly to the upper windows that made up the old ventilation system

Design was developed to improve system to ventilate the store, which is a two fans working alternately to ensure a proper ventilation throughout the day. Also, fully distributed circular tubes (made of aluminium) all over the rooms and corridors of the store.

Figure 3 In the old system, the exhaust was routed directly into the student movement area

4. Ventilation Improvement Project

On October 2015, the Iraqi Ministry of Higher Education and scientific research announced funding of $11000 for improving ventilation in the rooms used to store chemicals for undergraduate and postgraduate studies at Al-Nahrain University's Department of Chemistry, using US and European design practices, standards, and regulations. The work ended on December 2015.

The first step in the improvement project was determining the level of exhaust required for adequate ventilation and purchasing the appropriate type and amound of ducting to accommodate it. According to Discharge to Atmosphere from Laboratory-Scale Processes,1 laboratory ventilation systems should be capable of exhausting 0.3 m3 per square metre of floor area per minute or 5 m3 per minute, whichever is greater, and the air velocity at the air supply outlet shall exceed 300 metres per minute. In addition, any intake or exhaust duct shall terminate in open air at least 2 metres from any opening into a building, or 4 metres from the outlet of any chimney or flue and 3 metres above the ground. Finally, the system shall be designed so that it operates continuously. The air ducts installed in this project were chosen to meet all of the above criteria. The ducts dimensions varied from 5-14 inches and all ducts were connected using suitable joints, designed for connection of varying duct sizes where necessary, as shown in Figure 4.

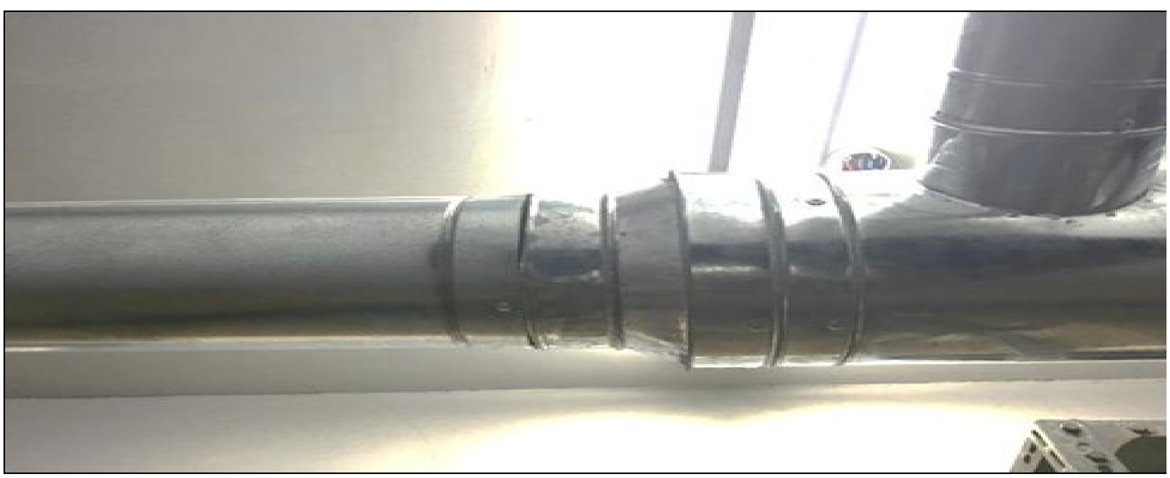

Figure 4: The ducts dimensions varied from 5-14 inches and were connected using suitable joints, designed for connection of varying duct sizes where necessary.

The ventilation ducts were distributed throughout the chemical storage area, and were joined to the main ventilation box to minimize the possibility of creating an vacuum in one area (Figures 5 and 6). The main exhaust duct has been tied to the outside wall using proper clamps as shown in Figures 5 and 6.

Figure 5. Close-up of ventilation ducts.

Figure 6. Ducting was installed throughout the storage area.

According to the US standard, air should circulate in the chemical storage room at a rate of 2500 cfm (cubic feet per minute). To satisfy this requirement, two alternating exhaust fans were installed that can provide 6000-7000 cfm., each working four hours at a time **(Figures 7 and 8).** These fans were installed at the end of the ducts to increase suction efficiency. The motor is situated outside the air stream to prevent transmission of sparks to potentially explosive fumes.

5. Conclusions

Proper ventilation is critical to ensuring a safe and secure working environment for staff and students alike. As technology has advanced over the years, along with relevant safety standards, it has become increasingly important to design and install modern ventilation equipment that complies with such standards. Furthermore, to the extent that an institution achieves its goals in a renovation project such as the one reported here, certain features stand out that are worth sharing – such as the manner in which the project enabled compliance with accepted ventilation requirements while improving the quality of the work environment for the university's staff and students

Figure 7: Two alternating fans have been installed.

Figure 8: Close-up of alt ernating fans.

It is our sincere hope that these experiences encourage other Iraqi universities to undertake other projects to further improve safety and security in laboratories throughout Iraq.

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