RESEARCH ARTICLE

A storage cabinet design for research chemicals for developing nations

This work describes a novel, in-house built laboratory chemical storage cabinet that is designed for simultaneous control of storage conditions and security. The design includes cabinet ventilation, temperature and humidity controls, smoke detection and a security access panel to prevent unauthorized access. The build is appropriate for areas where there are no current regulations regarding storage cabinets for chemicals.

By Abdullah Hussein Kshash

INTRODUCTION

The safe and secure storage of research chemicals is an essential part of overall chemical management. Chemicals need to be stored properly, generally in temperate conditions to control degradation and separated to prevent incompatible chemicals from inadvertently mixing.[1] While research chemical misuse is uncommon, it can and does occur[2,3] and the control of research chemicals for security purposes is an important consideration with compounds such as cyanides.[1] The construction is borne out of necessity, as conventional flammable liquid storage cabinets are rare in the research and industrial environments in the country and the need for chemical safety and security has become more important in the recent years.

CABINET DESIGN

It is recognized that the cabinet and its design below does not yet meet current United States guidance regarding flammable liquid storage cabinets, such as that found in NFPA 30.[4]

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All materials were locally purchased and consisted of:

- Galvanized steel plate (thickness 2 mm).
- Poly-epoxy resin.
- Electronics (timer, fan/motor, thermostat, relays, sensors and control panel).

The cabinet body is made of galvanized steel plate coated with poly-epoxy resin. Its dimensions are 90 cm × 54 cm × 50 cm. A shelf (12 cm high) was built on the top of the cabinet and contained the controllers for the security and ventilation system. Storage shelves are made of galvanized steel plate; they were reinforced and coated with poly-epoxy resin. The exterior of the cabinet is shown in Figure 1.

The cabinet is ventilated; with an airflow of about 20 cubic feet per minute (CFM). The centrifugal exhaust fan is located in the top-most shelf and is connected to both a timer and a thermostat. The fan serves two purposes: First to vent vapors from volatile organic compounds in the cabinet outside the laboratory through a tube connected of the exhaust duct of the laboratory and second, to maintain an even temperature in the cabinet. There are three ventilation modes: "Normal" is a 10-s run every 10 min. "Demand" mode operates the fan continuously when the door is open. The third ventilation mode is temperature-driven where the fan operates when the temperature reaches a "high" setpoint and stops when the temperature drops below the "low" setpoint.

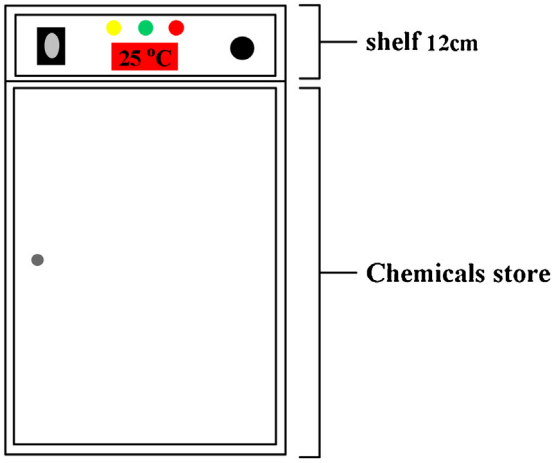

Figure 1. Cabinet body.

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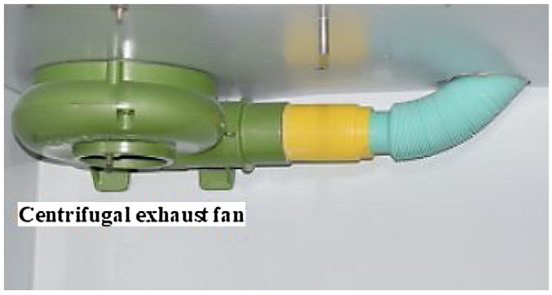

Figure 2. Cabinet ventilation system.

Figure 3. Device and peripheral for system security.

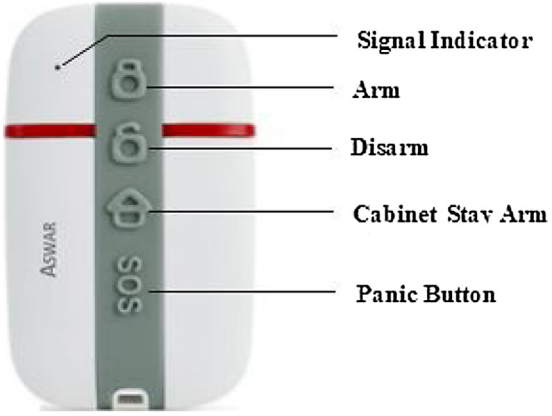

Figure 4. Remote control buttons.

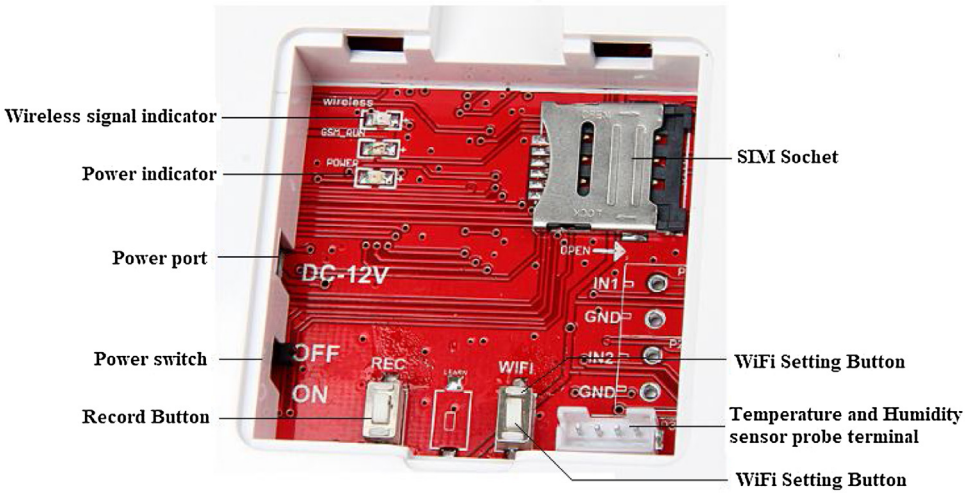

Figure 5. Backside of control panel.

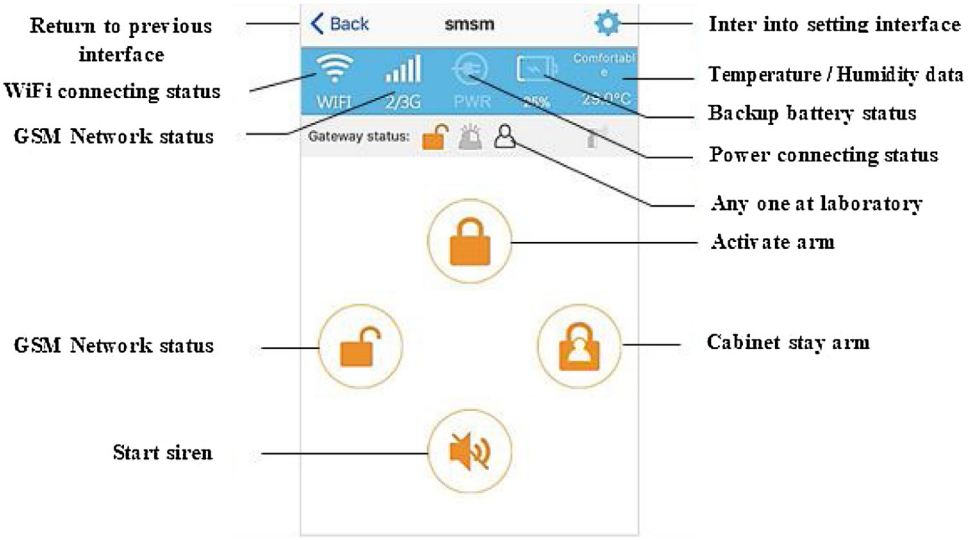

Figure 6. Application main interface.

In addition to the ventilation system, the cabinet also features a security system which monitors and alerts chemical mangers in the event of unauthorized access, smoke detection, and out of specification temperature or humidity.

Construction details are shown in Figures 2–4. Figure 5 shows the reverse side of the control panel that contains the sensor locations.

Temperature, humidity, smoke, and access sensors connect to in-house WiFi. Should there be an alarm, the cabinet owner is notified by text messaging, either performed via an Internet-available messaging system or through a dedicated number on a programmable SIM card in the electronics. The control panel itself has anti-theft protection associated with its electronics and will alert the cabinet owner in the event of tampering. We utilized an App-Store available security application for these cabinets. The control panel has the capability of monitoring 50 cabinets on a single application. Figure 6 shows the application interface for the cabinet.

The cabinet works to secure research chemicals, and may be used to store incompatible chemicals by using containment inside it. Figure 7 shows chemicals in the storage unit.

Figure 7. Chemicals in the storage unit.

CONCLUSION

The working environment and need to secure research chemicals led us to design a multi-functional storage solution for Al-Anbar University. One cabinet was made in 2018 and more are planned for 2019 using locally available materials, we were able to meet our immediate needs for safety and security.

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