DESIGN CONSIDERATIONS - LABORATORY

v101

ANTEC controls

The following are considerations when designing a compounding pharmacy. The items listed below help scope out project requirements and provide guidance on designing based on the specific needs.

What is the intended daily use of this laboratory?

The first step in laboratory design is to understand how the end user plans to use the space. Laboratory design is affected by the regular activities performed in the space, the chemicals or processes used and the level of containment that is required.

Is this a teaching laboratory or a research laboratory?

Teaching labs are generally in use less often, but will be used by a larger group of people at a time. These labs can be expensive to operate if they are not capable of setback.

Research labs typically follow a more regular schedule that has the lab more constantly occupied. These spaces will normally have a defined group of people that will use the lab and may also have more strict containment and pressurization requirements.

What is the laboratory operation schedule?

If there are periods where the lab is not in use, the airflow may turn down or turn off entirely. Consider how these operational mode changes will be engaged. This can be accomplished through room occupancy sensors, manual or local switches, the building automation system (BAS) or through a combination of these methods.

Will all fume hoods be in use at once?

In a laboratory where only a portion of the hoods will be in use at a given time, diversity or usage factor (ASHRAE Handbook Chapter 16) can be used to reduce the size of the mechanical systems. In a larger lab that will not be fully used at all times, fan size and duct size can be reduced to service the portion of hoods that will be active.

Are presence sensors or auto sash closers required?

In labs with poor sash management, presence sensors to trigger a setback mode or automatic sash closers can provide energy savings. In some jurisdictions, spaces with high fume hood density require automatic sash closers. Refer to California's Title 24, Part 6, Section 140.9.4, 2019 where applicable.

What is the minimum ventilation rate?

Unlike healthcare applications, there is not one single reference that prescribes the minimum ventilation rate that is required in a laboratory. It falls to the facility owner and engineer to determine the appropriate ventilation rate. ANSI Z9.5 Section 2.1.2 states:

> *"An air exchange rate cannot be specified that will meet all conditions. Furthermore, air changes per hour is not the appropriate concept for designing contaminant control systems"*

2011 ASHRAE Handbook – HVAC Applications Chapter 16 states:

> *"Fixed minimum airflow rates in the range of 6 to 12 air changes per hour when the space is occupied have been used in the past".*

ANSI Z9.5 Section 3.3.2 states that in the closed positon:

> *"Minimum **fume hood** flow rates in the range of 150 to 375 hood air changes per hour (ACH) have been used to control vapor concentration inside hood interiors"*

This value can be used by the design engineer to determine what the minimum exhaust airflow rate from the laboratory will be.

Does the driving room condition change throughout the lab usage?

Laboratories will commonly switch between ventilation rates being driven by thermal demand, air change rate and fume hood demand. It is imperative that the valve system is capable of handling the expected worst case scenario. The primary concern is a design where the air valve turndown ratios do not limit the minimum available flow in a lab.

Will the laboratory employ demand control ventilation (DCV)?

If an air quality measurement system is present in the space, demand controlled ventilation can be used to run the lab at lowest acceptable ventilation rate for safe operation. If the laboratory will use DCV, considerations need to be made for how to handle changing ventilation airflow rates.

What types of fume hood are used?

Different fume hood models and types will require different air volumes and will be associated with different pressure losses in the system. In addition, the selected hood type will affect the type of controls and accessories that are required.

Are the hoods constant volume or variable volume?

Constant volume (CV) hoods are best served by mechanically set CV venturi valves and do not require controls. Variable volume hoods must be served by a variable air volume (VAV) technology like a VAV venturi valve or a high accuracy terminal. Controls will be required for VAV hoods to ensure the required face velocity is achieved. In addition, according to ANSI Z9.5 Section 3.3.3:

> *"All hoods shall be equipped with a flow indicator, flow alarm or face velocity alarm indicator to alert users to improper exhaust flow."*

This means that even CV hoods must have a monitoring system.

Are the hood sashes vertical, horizontal or combination?

Fume hood face velocity can be controlled by using a sash position sensor or a sidewall face velocity sensor. The preferred sensing method depends on the sash configuration of the fume hood:

+ Single Vertical Sash – Sash position sensing
+ Multiple Vertical Sashes – Sash position sensing with multiple sensors
+ Multiple Sashes – Sidewall face velocity sensing

Sash sensing is preferred when there is a single sash configuration as it is fast and simple. When there are multiple sashes, which is often the case in a horizontal sash configuration, sidewall sensing is preferred as the complexity of installing sash sensors increases greatly. When a high speed of response in combination with closed loop control or when redundancy is required, both technologies can be used in combination for a hybrid sensing method.

What chemicals will be used in these hoods?

The chemicals and the concentration of the chemicals used inside the fume hoods will dictate the type of coating needed. There are generally four categories of valve coating:

+ Uncoated – Used in clean air applications such as supply air or general exhaust
+ Phenolic and/or Stainless Steel Parts – Typical for most fume hood applications
+ Phenolic with No Exposed Metal – Required when exhausting chemicals corrosive to metal such as chloric acids
+ PVDF and/or Teflon – Required when exhausting highly corrosive chemicals such as nitric acid or hydrofluoric acid

The end users of the fume hood will have a detailed chemicals list with the corresponding concentrations that should be cross referenced with the chosen valve coating for compatibility.

Is perchloric acid going to be used in these hoods?

Perchloric acid fume hoods cannot be used with air valves or with a manifold system. These hoods must be serviced by a dedicated fan and a seamless set of ductwork per ANSI Z9.5 section 3.2.5. Perchloric acid vapor (perchlorate) forms highly explosive crystals in the ductwork and pose a high risk to lab personnel. Due to this, these hoods must be regularly washed down.

What air valve technology will be used?

Venturi valves are the preferred air valve technology for use in a laboratory environment. The mechanical pressure independence of a venturi valve allows for instantaneous response to changes in duct static pressure which occur frequently and rapidly as fume hoods are opened and closed. High accuracy terminals are also an acceptable solution for laboratories, but should be applied with discretion as they do not respond as quickly to changes in duct static pressure.

Is a lower air change rate required for setback?

Venturi valves can have a turndown ratio as high as 20:1, high accuracy terminals will have a turndown of 10:1.

Is sound a concern?

High accuracy terminals are generally quieter than venturi valves, but silencers can be used in conjunction with venturi valves if required. Reference ANSI Z9.5 Section 5.1.2:

> *"Such regulations vary but provide for sound pressure levels (SPL) in the range of 50 dBA and limit the increase in SPL above background levels when the ventilation systems are operating."*

Is a low system static pressure required?

Venturi valves are offered in both low and medium pressure ratings that allow them to work down to 0.3 in.w.c. or 0.6 in.w.c. of differential pressure respectively. When using venturi valves, the design engineer is responsible to denote which model has been selected. High accuracy terminals vary in pressure drop depending on valve size and target airflow, but typically have a minimum pressure drop between 0.01 in.w.c and 0.45 in.w.c.

Will the installed valve need to be horizontal, vertical up or vertical down?

Venturi valves must be installed in their ordered configuration to ensure the valve is able to regulate airflow while accounting for the effect of gravity on the plunger. High accuracy terminals can be mounted in any orientation.

What room control strategies will be used?

ANSI Z9.5 Section 5.2.1 states:

> *"Flow offset control is the most commonly applied approach"*

This is in reference to a room airflow control strategy. Flow offset control is employed by maintaining a constant volumetric offset between supply and exhaust flow in the space. Pressure control, where the room is controlled to a constant pressure, is also an acceptable control strategy, but should be employed with caution as it is less stable and introduces the risk of overshoot or undershoot.

What is the required room setpoint?

When employing offset control, an offset setpoint between 10 – 20% of maximum flow is acceptable in most cases. Some facilities use an offset dependent on the number of doors to the space. The ASHRAE Laboratory Design Guide Chapter 11 – Controls states:

> *"Typical offset values are 75 to 100 cfm per door"*

When using pressure control, the room setpoint is a differential pressure value measured between the laboratory and an adjacent space. The magnitude of this value depends on the required level of containment.

Is pressure monitoring required?

When employing offset control, pressure monitoring can be beneficial, however it is not strictly required. A separate pressure monitoring system can aid facilities staff in maintaining crucial pressure relationship after initial balancing is performed.

What other exhaust equipment should be considered?

The following are examples of other lab exhaust equipment:

+ Biological Safety Cabinets (Class I, Class II, Class III)
+ Snorkel
+ Snorkel bank
+ Canopy hoods
+ Cage Racks

It is important to note that these pieces of equipment are not fume hoods. They can be constant volume or variable volume and must be considered as part of the room control strategy.

Will controls be required for this equipment?

If possible, constant volume venturi valves or two-position venturi valves can be used to reduce complexity. A two-position venturi valve has two airflow setpoints that are toggled using a binary switch. A mechanically set CV venturi valve or a VAV venturi valve with a two-position actuator will not require dedicated controls.