The surprising importance of environmental control in life sciences research

Sponsored by: Air Innovations LLC

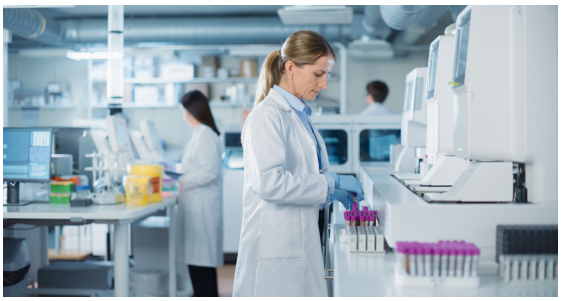

Figure 1: Without proper filtration and climate control solutions, biological samples will quickly lose efficacy and research can suffer greatly. Source: Gorodenkoff/Adobe Stock

The quality of research in the life sciences fields is heavily dependent upon the environments that research can take place in — factors like the temperature and humidity of samples and storage chambers play a role that not many consider. Even small variations can dramatically impact the results, making them inaccurate or nearly impossible to repeat. Therefore, it is essential that temperature and humidity not only be measured during testing, but tightly controlled.

Strict environmental control in these use cases requires customized air handling and unique climate control solutions. From aerospace to semiconductor to life sciences research applications, temperature and humidity must be repeatable values to control rather than complicating variables to account for. Designing customized environmental control units (ECUs) that fit existing storage and workspaces is crucial in such an important industry.

Custom control for life sciences applications

Temperature, humidity and air purity must be controlled in life sciences laboratories. Biomedical research occurs in both cleanroom spaces and in smaller reaction chambers, each of which have their own inherent challenges. Temperature fluctuations, ingress of dust, mold spores, viral load and other contaminants from the outside (or even from the researchers themselves) can compromise research results.

Particularly challenging applications include keeping cell cultures alive and healthy, preventing side reactions, controlling reaction kinetics in pharmaceutical research, and preserving biological samples. Therefore, it is important to have a filtration system and precision temperature and humidity controls to ensure that high-quality research is possible.

Air Innovations combines expertise with the right tools for the job to develop environmental control units for critical life sciences research.

Sponsored by:

AiR INNOVATIONS

Produced by:

GlobalSpec

Effects on cell cultures

Cell cultures are used in numerous biological research applications. As an example, virus cells, cancer cells and other threatening cells must be kept alive and healthy to test the efficacy of treatments. Weakened cell populations may accidentally point to a treatment being effective at combatting these cells when the cell environment was actually the culprit.

Depending on the type of cell under research, cells will need to be kept in an environment of a specific temperature. The whole population of the cells depends on these tight controls. If the cell culture is too hot or too cold, cells will die. Temperature control not only ensures that existing cells are healthy, but also controls their growth rate. If conditions are held constant, cell growth rate is calculable; variations lead to variable growth rates. Cellular activities, such as protein folding, enzyme activation and other essential functions are also drastically impacted by improper temperature control.

Humidity is also a major factor in maintaining healthy cell cultures. Because the cell cultures are often in some type of fluid, if the humidity is too low then the solution will evaporate and potentially dry out cells. The humidity also impacts the osmotic balances of the cell. While the cell itself may be immersed in a fluid, steady evaporation can change the remaining fluid's properties, upsetting the balance inside and outside the cell.

Effects on chemical reactions

Most chemical reactions are accelerated by higher temperatures. At the atomic level, diffusion occurs much more readily, mixing substances more thoroughly. Ultimately, there is more energy for atoms to move at higher temperatures than there is at lower temperatures. Therefore, reactions that are performed without exact temperature control are often hard to repeat.

Humidity also impacts chemical reactions. If the humidity is too high, water may condense on surfaces and flow into the reaction vessel. This can dilute solutions and lower the potency of acids and bases, thus changing the pH and introducing a host of other problems. Adversely, if the humidity is too low, solvents can evaporate, changing the concentration and speeding up reactions.

Small sources of contamination can also drastically impact chemical reaction research. First, they can be the cause of side reactions or take place in the reaction itself. Second, they can sometimes act as a catalyst for the reaction, changing the reaction kinetics and speeding up the reaction. The latter case is harder to find, as the contaminants impact the reaction without directly being part of it.

Common chemical operations, like fluidized bed drying, rely on a chamber with low humidity and closely controlled temperatures to remove moisture from a chemical compound. Drying is performed through high temperatures and low humidity to evaporate the solvent. However, in order for this to work, the chamber must also have a high number of air changes (or else the humidity rises) without introducing contaminants or allowing dried product to escape through the air handling system.

Effects on preserved samples

Another important consideration is the care of preserved biological samples. Tissues, organs, cadavers and other biological material will begin to decay almost immediately in improperly controlled environments. Temperature and humidity largely determine the decay rate of these materials.

Obviously, frozen samples must be temperature controlled down to the degree. However, the humidity control is equally important. As the air cools, any water vapor present will begin to condense or deposit

on the surfaces. In a conventional freezer, this is how things "freezer burn," and in a laboratory, it means ruined biological samples.

Reducing contamination is extremely important for these samples as well. Bacteria and fungi attack exposed tissue. Without proper filtration, biological samples will quickly decay due to these natural processes.

Real-world success of partnering with Air Innovations

Air Innovations develops ECU solutions for exact control of temperature and humidity, while providing the necessary filtration for these and many other applications. They have designed precision systems for the aerospace, semiconductor, pharmaceutical, life sciences and many other industries. The company has ECUs for a wide variety of applications, from wine cellars to linear particle accelerators and more.

It might be tempting to try and utilize off-the-shelf HVAC systems for laboratory environmental control. At best, these systems will be cumbersome and only provide a small amount of control. Most HVAC manufacturers do not offer ECU systems with the precision control and advanced filtration required for life sciences research.

Air Innovations specializes in these types of systems and can provide a highly customized, turn-key solution to fit existing storage, bench or laboratory space. Their systems can be designed to be explosion proof, which is often a design requirement in the chemical process industries, chemical development research and powdered product research.

To verify system operation, Air Innovations has cutting-edge simulation and psychrometric testing capabilities. This allows them to tailor the ECU to a laboratory's needs, assess its effectiveness, and ensure that the best solution is available. Their advanced modeling and testing procedures provide confidence and system verification before installation begins.

Tablet coating

In the pharmaceutical industry, one of the more challenging problems is coating tablets for medicine. Tablet coating is necessary as it improves the ease with which the patient can swallow the medicine, as well as controls the release of the active ingredient.

The coating itself must be uniform, free of contaminants and of an exact thickness. To do this, the temperature and humidity of the coating process must be tightly controlled and the air entering the system must be extremely clean.

When a global pharmaceutical supplier needed an HVAC system for tablet coating, they recognized that an off-the-shelf solution would not suffice. They reached out to Air Innovations,

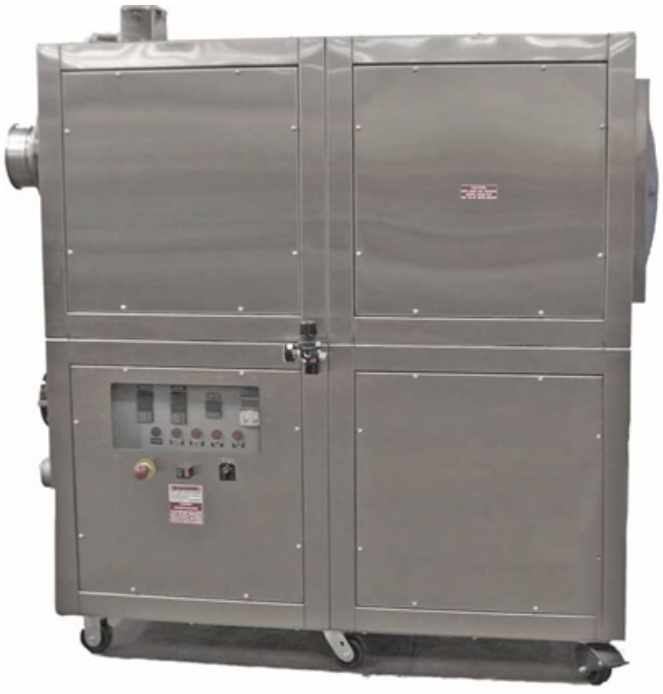

Figure 2: An ECU for tablet coating. Source: Air Innovations

who developed a highly customized system to meet their tolerances in temperature, humidity and filtration.

Biotherapy effectiveness testing

A biotherapy research company needed an ECU to test the effectiveness of a biotherapy treatment. The ECU had to be able to control relative humidity to under 3% and maintain a specific temperature within 2° F. They also needed the environment to meet incredibly clean-ISO 8 standards. If the humidity or temperature strayed out of this range, the effective ingredients in the biotherapy would be damaged. One major challenge with this system was keeping the humidity so low with the amount of air entering the system.

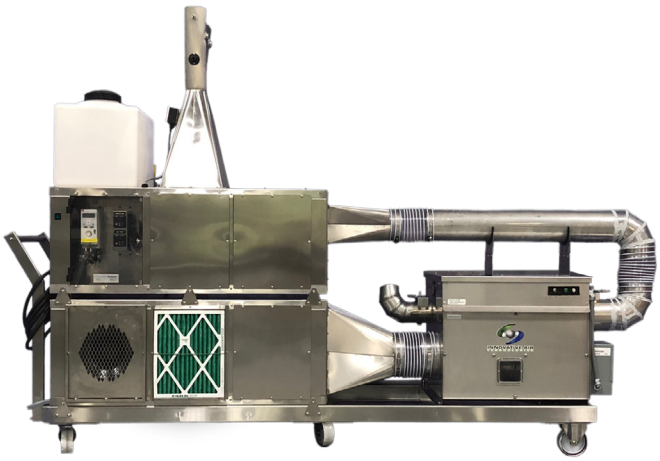

Figure 3: Desiccation, temperature control and HEPA filtration in one unit for biotherapy research. Source: Air Innovations

Air Innovations was able to develop an ECU that could maintain these demanding specifications. It could control the humidity to within 0.5% RH, the temperature within 2° F and had high air change rates through a HEPA filter system.

Superior environmental control solutions

Air Innovations combines expertise with the right tools for the job to develop ECUs for critical life sciences research. Reach out to the experts at Air Innovations for more accurate, repeatable environmental control systems for research and explore the possibilities of customized air handling and climate control.

AIR INNOVATIONS LLC

7000 Performance Drive
North Syracuse, NY 13212
Tel: (315) 452-7400

GLOBALSPEC

187 Wolf Road
Suite 300-022
Albany, NY 12205
Tel: (800) 261-2052

ABOUT AIR INNOVATIONS LLC

Air Innovations is a world leader in designing and building environmental process control systems for applications that can't be addressed with standard HVAC equipment. We customize packaged solutions for temperature, humidity, filtration, pressurization, and with direct-expansion, chilled-water, or thermoelectric capabilities. If you want to learn more about our environmental control capabilities visit Our Areas of Expertise. Many of Air Innovations customers fall into two categories: businesses integrating our solution into their OEM equipment or businesses requiring a complete HVAC solution. We can meet almost any need in environmental control across almost any industry with major projects in Aerospace, Military, Semiconductor, Pharmaceutical and Life Sciences, Clean Rooms.