

The formulae $\frac{\partial \rho U_i}{\partial t} + \frac{\partial (\rho U_i U_j)}{\partial x_j} = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial U_i}{\partial x_j} \right) + g_i (\rho - \rho_s)$ for building $\frac{\partial}{\partial x_j} (\rho \bar{U}_j \bar{U}_i) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial \bar{U}_i}{\partial x_j} - \rho \bar{u}_i' \bar{u}_j' \right) + g_i (\rho - \rho_s)$ state of the art $\frac{\partial}{\partial x_i} (\rho \bar{U}_i \bar{H}) = \frac{\partial}{\partial x_i} \left(\lambda \frac{\partial \bar{T}}{\partial x_i} - \rho \bar{u}_i' \bar{h}' \right)$ biomedical research facilities.

Light Control for Laboratory Glazing

A welcome trend in laboratory design is increased use of interior and exterior glazing, especially in spaces formerly considered 'back-of-house' which are relegated to basements or deep within floorplans. There are many reasons to use glazing in any regularly occupied space, including:

- The benefits of natural light and views on human physiology and psychology
- Credits awarded by green and healthy building certification programs for direct and indirect access to natural light
- Less artificial lighting usage
- Improved work environment for staff
- Increased security and control, in the form of observation and situational awareness
- Increased transparency and a sense of openness where literal openness is not possible

However, increased glazing also leads to increased issues of light level control. The selection and use of control devices on glazing is therefore key to successful glazing implementation.

The Necessity of Light Control in Laboratories

Although an abundance of natural light is usually beneficial, too much can cause problems. Light levels, along with other environmental parameters, must be controlled for a laboratory to perform optimally.

Specific issues related to excessive light levels include:

Glare. Direct sunlight can cause glare, which can make computers and instrumentation unreadable.

Comfort. Excessive light may be physically uncomfortable. An important aspect of comfort is the ability to adjust one's workplace environment, including light levels, ergonomics, and temperature, to optimal conditions for an individual's comfort.

Function. Low light levels may be required for reading films and other detailed tasks. Imaging and optics rooms may require near or total black-out conditions during operations.

Flexibility. Rooms may serve multiple purposes and must be able to accommodate varying light conditions depending on the planned activity.

Privacy. Although the aesthetics of openness are generally desired, there are times when visual privacy is necessary for an office or

conference room. Labs also may generally desire openness but require privacy during sensitive procedures.

Glazing Light Control Devices

Unlike temperature or humidity, light from glazing cannot be programmed, and unlike artificial lighting it cannot be dimmed or turned off. Laboratory glazing must be accompanied by appropriate light control devices. Common devices allowing control and adjustability include:

- Standard horizontal blinds. These are economical and widely adjustable, but they are not light-tight, and their dust-collecting horizontal surfaces are not appropriate in many types of clinical or controlled environments.
- Between-the-glass horizontal blinds. These solve the issue of horizontal surfaces and can be used in many clinical and controlled applications.
- Roller shades. These are available with a range of features, including light-tight and non-absorbent fabrics.
- Electrochromic glass (a.k.a. smart glass or dynamic glass). These provide a range of opacities and colors.

In addition to the type of control device, it is important to consider the method of operation (manual vs. automatic). Manual control provides occupants with direct and immediate control over their environment. Automatic control, operated by the building automation system, allows devices to be adjusted relative to various factors, such as the time of day or position of the sun, to minimize solar heat gain and reduce artificial lighting usage for optimal energy efficiency.

Fixed devices that do not allow adjustability include light shelves, sunshades, films, and tinted glass.

Conclusion

The increased use of interior and exterior glazing brings many advantages and is a positive trend in lab design. Increased glazing introduces light, however, which as an environmental aspect must be addressed during the design process. If excessive light is a concern, glazing can be reduced or eliminated, but a better approach is to manage the light with appropriate control devices.