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Dynamic Glazing

Introduction

Buildings account for a significant portion of the world's energy usage so it is imperative that all elements are optimized to provide energy savings. In the US, the energy lost through windows is upwards of 30% of a building's heating and cooling energy.[2] With the development of ribbon windows and much of modern architecture being characterized by large expanses of glass, glazing has become an even more critical factor in building performance and occupant comfort.

Due to major advances in material science, a new generation of glazing products known as dynamic glazing is beginning to emerge in the marketplace. Dynamic glazing may help to dramatically reduce building energy consumption, in addition to providing many other benefits. Dynamic glazing, also referred to as smart windows, are glazing units whose properties can be controlled either manually or autonomously based on environmental conditions. Passive systems respond autonomously to natural stimuli such as light (photochromic glass) or heat (thermochromic glass). Active systems, such as electrochromic glass which respond to an applied voltage, can either be manually controlled or connected to a building management system to adjust glazing properties based on a variety of setpoints. Though not every system has all the following benefits, dynamic glazing can provide self-cleaning, self-heating, solar radiation adaptation, glare modulation, and even energy generation.

There are currently numerous technologies being developed for dynamic glazing; among them, electrochromic glass is the most advanced and the most readily available for use in construction. This article will focus on electrochromic glazing, how it works, and its potential benefits.

Electrochromic Glazing

Electrochromic windows come in a variety of designs. A typical design is often constructed of five thin film layers either on a glass substrate or sandwiched between two glass substrates. These film layers consist of an electron accumulation layer, an ion conductor layer, an electrode layer, and two outer layers made of transparent conductive oxides. When a voltage is applied to the unit, lithium ions move to the electrode layer and cause a change in opacity from transparent to dark. This reaction is generally controlled through a low voltage DC power supply, and it takes less than 5 Volts to change the visual properties.[2]

Electrochromic windows are currently available in a variety of pane sizes and shapes, with numerous control and power options to choose from. Certain manufacturers are now even providing self-powered units which use photovoltaic battery systems. Most units are of a bluish color due to the tungsten trioxide often used in the electrochromic film layer. The switching of color states in electrochromic windows is relatively slow when compared to other dynamic windows and may take up to 15 minutes depending on the glazing size. This slow reaction is not necessarily disadvantageous, though, as it allows occupants to naturally adjust to daylighting changes. As with all windows, electrochromic windows need to be able to cope with a variety of environmental conditions and temperature ranges. Many manufacturers now state that they are durable for up to 30 years.

Benefits

The main benefit of electrochromic windows is that they can provide automated adjustments for solar heat gain, daylighting, and glare while still providing visual access to the outdoors. In many modern buildings, solar heat gain and glare are controlled through shading devices such as blinds. While these may effectively reduce glare, they do very little to stop solar heat gain. They also negate the main function of a window, which is to provide visual access to the outdoors. Electrochromic windows accomplish the same goals that blinds do, but more effectively and without the drawbacks - when connected to control systems and used in an appropriate building type, these windows may provide up to a 60% reduction in lighting needs and up to a 26% reduction of the cooling load.[1]

Technology is currently being developed to further improve electrochromic windows. One such technology is dual-band electrochromic glazing. This glazing provides three states the window can be set to: "bright," "cool," and "dark." The novel aspect of this technology is that, while in the "cool" state, it allows for nearly all visible light transmittance but can simultaneously block virtually all near infrared light and eliminate most solar heat gain through the window.

Conclusion

All developing technologies are riddled with challenges and hurdles to overcome. Dynamic glazing is no different. Not all buildings make use of building management systems, and for dynamic glazing to meet its potential it must be utilized in a building of the appropriate type with a well-designed building management system. Additionally, for this product to become fully accepted in the current marketplace, the technology's performance must improve, and the payback time must shrink; the current payback time for a residentially used electrochromic window is 30 years, ands for a commercially used electrochromic window it's 60 years.[1] These issues, however, are not insurmountable, and will likely be overcome as material sciences and nanomaterials continue to advance. Even with the current challenges, dynamic windows will certainly play a pivotal role in advancing building envelope construction, allowing greater freedom in future architectural design, achieving increasingly stringent energy targets, and, perhaps most importantly, reducing the building industry's overall carbon footprint.

References

1 Casini, Marco. "Active dynamic windows for buildings: A review." *Journal of Renewable Energy*, vol. 119, April 2017, pp. 923-934.

2 Sbar, Neil L., et al. "Electrochromic dynamic windows for office buildings." *International Journal of Sustainable Built Environment*, vol. 1, no. 1, 2012, pp. 125-139.