International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

Electrochromic Windows in Educational Buildings

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Abstract – *One of the critical factors in school design which affects student's health, learning and visual performance is daylight in classroom. Providing adequate amount of evenly distributed daylight and glare prevention are important challenges in classroom design. This paper aims to illustrate the use of Electrochromic windows (ECW)in Educational building. ECW have been used to reduce solar heat gains, while improving indoor thermal comfort and energy efficiency in summer time. In this study ECW have been used in Educational buildings around the world and have been proved to be effective in controlling heat transmittance.*

Key Words: Smart window's, Electrochromic, Daylight, Visual performance, Heat transmittance

1. INTRODUCTION

During the last decade, energy conservation has become increasingly necessary due to the fast depletion of conventional energy resources which is one of the most significant problems in the present world [1, 2]. Buildings energy consumption is over growing [3, 4]. Today's world consumes a quantity of the primary in buildings and maintaining human-made structures for heating, cooling, and lighting [5, 6]. In particular, air conditioners are responsible for a large part of the energy usages [7].

In accordance with data of energy survey one of the reasons of energy loss is glazing in old wooden frames, which is installed mostly in budgetary organizations (kindergartens, schools, etc.). Obviously, these windows are subjected to be replaced. Energy and economic effectiveness depend on choice of type of window construction. Heat losses through the window occur for several places: window units, air conduction losses and radiation [11].

One effective way of reducing the amount of consumed electricity in buildings is to apply solar-control coatings to glass windows, so-called smart windows [8]. Smart windows have a significant influence on energy consumption in the built [9]. Up to 50% of the energy consumed in the building for lighting, cooling, and heating can be saved by controlling the heat passage through the window [10].
It is clear that value of heat losses through the window unit directly depends on window construction, materials and manufacturing quality. In reality it is about 10% of whole heat losses [11].

In case of constant rate increase on electricity and heat, improvement of thermo technical characteristics is consider to be one of the most effective ways to decide the problem of energy consumption [11].

Several active smart windows were introduced for energy saving in building such as thermochromic and electrochromic. The thermochromic window has the potential to offer energy savings only in warm climates. In cold climates, the thermochromic glazing system affects the indoor temperature negatively and causes an increase in the energy requirements for heating [12, 13]. Electrochromic windows can control the daylight and solar heat passing inside the buildings due to an electrochemical reaction induced by applied potential voltage [14]. The transmission of light for the colored state is below 50% under an applied voltage; this is too low for the most applications in architecture [15, 16].

2. Application of ECWs in Educational Buildings

Daylighting as a visual sensory element of physical interior environments [1] is a predominantly critical issue in school design. Since reading and writing are the most important tasks that take place in schools, visual performance is considered the main outcome for lighting design [2] and is defined in terms of speed and accuracy of processing visual information [3,4]. Moreover, daylight can influence reading, task involvement, productivity [5, 6], sense of wellbeing, mood and health, comfort, perceptions of space, emotions, students‟ experiences and behaviors.

The ability of ECWs to control light and heat transmittance could make them extremely advantageous as a building envelope material. They have been used as outer windows and skylights in multipurpose buildings. Along with reducing cooling load of those buildings they have also created a pleasant internal environment.

Table -1: ECW in Educational buildings

Buildings/ Country	Image	Application technologies
La Rochelle's university library, France		External light sensors, with the application of ECW, detect weather conditions and that helps control glass transparency accordingly.

Bowie state University, USA		ECW is implemented to around 25,000 ft ^{2} of the school's exterior. This allows for the dynamic control and regulation of sunlight that optimizes visual pleasure.
EPFL University, Switzerland		Using light sensors, ECW glazing automatically and silently alters its tint to sun exposure levels throughout the day, providing exceptional comfort within the lecture halls.
Swiss International Scientific School, UAE		Electronically tintable glazing darkens to prevent sunlight and heat from entering the building, a function which can significantly reduce energy consumption and the need for HVAC.
Girls' Grammar School, Australia		The atrium skylights are integrated into a system in which light sensors automatically activate the tinting and clearing throughout the day based on sun orientation. Up to 98% of solar radiation that can damage interior spaces is blocked.

3. CONCLUSIONS

As stated earlier, daylight plays a crucial role in improving students‟ performance which is in turn largely affected by window configurations. ECW has been designed and optimized for energy saving and providing thermal comfort. Future studies may evaluate other windows configurations to avoid glare, excessive sunlight, and visual discomfort and simultaneously provide enough daylight level.

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