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Fiberoptics in Lighting Design, A Whole New Direction

Working under the belief that Edison's light bulb would not realize major successes, William Wheller patented a device in 1880 that quite literally "piped" light from a central light source to a number of independent locations. Although Wheller's invention laid substantial ground work for the conceptual development of "remote source" illumination, it was because of the improvements in glass fibers developed for the telecommunications industry that allowed fiberoptic technology to become a realistic tool in the field of lighting design.

Similar to a basic three-part fiberoptic signal transmission system, a typical fiberoptic illumination system also consists of three components. The first component is termed the "illuminator." The illuminator houses the light source and all of the electrical components needed to make the system work. The second part of the system is the fiber. Fiber is typically referred to as a "light guide" or "tail" and is used to transmit visible light. The third component of the system is a device located at the end of a fiber run and is used to assist in controlling or directing the light emitting from the fibers.

Light sources used in the illuminator vary depending on the application, but halogen and metal halide are most common. Recent developments have allowed xenon metal halide to become increasing popular with sulphur lamp technology showing the most promise for the future. Lamps are typically specified based on a required illumination level, but spectral distribution, service life and costs are often equally important. Regardless of the light source used, optical accessories are usually employed to direct the maximum amount of light emitting from the lamp into the acceptance angle of the fiber utilized.

Fibers used in lighting fall into two categories, "end-emitting" and "side-emitting." End-emitting fibers are available in glass or plastic and are used to transmit light to specific points. Side-emitting fiber is made of plastic (although some specialized glass products are available) and are uniquely manufactured with imperfections at the boundary of the core and cladding. Light traveling within the fiber's acceptance angle will refract from side-emitting fiber whenever it encounters a core/cladding interface disruption. In this fashion, side-emitting fiber emits light along its entire length, often resembling neon.

The third component of a fiber optic illumination system is commonly referred to as a fiberoptic "fixture." Although light emitting at an angle similar to a fiber's acceptance angle is ideally suited to certain applications, the majority of end-emitting fiberoptic applications do utilize a fixture to assist in obtaining the desired lighting results. Some fixtures are purely decorative surface devices while others provide a high degree of optical control. Designers often develop custom fixtures based on the lighting design requirements and other specifications related to interior design.

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The number of fixtures that can receive light from one illuminator varies depending on the application. In decorative applications where light levels are based strictly on brightness, the designer can expect to supply anywhere from a handful up to several hundred fixtures with light from one illuminator. The maximum numbers become significantly less as increased light levels are required. However, utilizing one lamp to provide light to numerous fixtures allows for reduced energy and maintenance costs in many applications.

Other benefits apply. No electricity is associated with the fiber or fixture allowing fiberoptics to be used in a variety of environments where traditional lighting is prohibited. These areas include underwater locations, areas with limited access for lamp replacement, dangerous environment and locations where the damaging elements of light can not be tolerated.

Managing ultraviolet and infrared is an absolute necessity in certain lighting applications. These damaging elements are easily controlled when fiberoptics are utilized. Depending on the exact components employed in the system, light transmitting to the end of the fiber can be virtually free of ultraviolet and heat.

Infrared is not the only heat-related issue to consider when selecting a lighting system. The electrical components required by any light source will also generate a certain amount of heat. In a fiberoptic system however, these heat-generating components are located away from the designed environment. Because infrared is controlled, and electrical components are remotely located, the illuminated environment does not experience any heat build-up usually associated with traditional lighting systems.

Special effects are accommodated by positioning a rotating color wheel or gobo between the lamp and the light input ends of the fibers. As the color wheel rotates, light transmitting in the fiber changes in color and intensity as per specifications developed by the designer. Spectacular light and color displays are achieved by simply pushing a button or activating a control device.

Many variables need to be addressed if the lighting design is to be successfully implemented. System designs must allow for even light distribution to occur at the light input end of the fibers because any light inconsistencies at the illuminator will show up in the designed environment as well. Fiber type and length will also play a major role in how much and what quality of light reaches the designed environment. Different fibers possess varying light transmitting characteristics and light will diminish as lengths increase. Special care should always be taken to ensure that operating temperatures are adhered to and that fiber is installed according to the manufacturer's specifications. Any deviation could seriously impact system longevity and light output.

Technological advancements are occurring rapidly. Although there are limitations, mainly related to system efficiency, continued improvements in system components are allowing for new applications to occur at an ever increasing rate.

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