WELDING Journal

Update: Using Transparent Welding Curtains

Transparent welding curtains, such as the one shown here, protect passersby from exposure to optical radiation, while allowing supervisors and others to safely view the welding/cutting operations taking place behind them.

A look at what transparent welding curtains can and cannot do to protect workers from optical radiation exposure

BY DEAN R. WILSON

Welding and cutting arcs produce ultraviolet, visible, and infrared radiation, which together are known as optical radiation. It is now known that the most important optical radiation parameters associated with welding/cutting events are the length of time a person views the arcs without any protection, the magnitude of the welding current, the distance from the arc, and the intensity of the optical radiation exposure. Awareness of these parameters is why welders wear eye and skin protection such as gloves, tinted welding shades, helmets, etc. Personnel other than welders — for instance, people just passing by — could be protected by surrounding the immediate welding/cutting area with an opaque enclosure. Historically, these enclosures were made of opaque canvas or, in some cases, black-painted wood or metal partitions.

Reviews of welding accidents have shown most welding injuries were the result of burns or falls that resulted from wearing dark eye-protective shade glasses while in the welding environment. Two types of exposure can take place in the welding environment: exposure to direct welding events or exposure to adjacent welding events. Welders use personal protective equipment (PPE) such as shade glasses and helmets to protect themselves from direct welding events. However, since welders can also be exposed to adjacent welding events, the use of transparent, or semitransparent, curtains affords additional protection. Additional advantages of transparent welding curtains (TWCs) relate to the welder's visibility of work, improved ambient illumination, better organization of work flow patterns, and reduction of the sensation of confine-

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What to Look for When Purchasing Transparent Welding Curtains

The characteristics of the ideal TWC include the following:

- Reduces the ultraviolet radiation hazardous wavelengths to an acceptable energy level.
- Filters out the potentially hazardous blue light wavelengths that contribute only minimally to vision. Currently, the optimum TWC to meet this requirement is orange in color.
- Provides sufficient transparency, limited refractive diffusion, and color rendering properties that permits adequate viewing, but, at the same time, decreases scene contrast and glare. This can be accomplished by placing small scattering particles within the curtain and also by adding small facets on the curtain surface.
- Offers fade resistance and flame-retardant properties.
- Provides supplementary illumination (fluorescence) during the welding/cutting event to further decrease the arc spot glare effect.
- Is available in many sizes and shapes, and can be mounted easily on both movable and fixed framing components. Transparent welding curtains may be designed to be interlockable to ensure complete enclosure around the work area and to prevent passersby and workers from entering an active work area.
- Is protective against the highest current and most hazardous arc that is in present or prospective use.
- Provides for continuous viewing at a distance near 1 meter but at low resolution demand.

ment. It is clearly recognized that the use of TWCs in the welding/cutting environment should never be considered as an equivalent substitute for appropriate eye protection. Fortunately, welding eye protection (rated in shade numbers) exists that permits welders to safely view the arc at close range for many hours each day without introducing a risk to the eye.

Transparent welding curtains are typically made from polyvinyl chloride plastic film and at least three other components. These components include a color dye, a flame-retardant chemical, and an ultraviolet radiation absorber. The intensity and spectral distribution of transmitted optical radiation through a given welding curtain depends on the thickness and composition of the material, color, size, shape, etc. It is important that TWCs have some color (dye) associated with them since clear curtain material would transmit higher optical radiation levels to welders and passersby in the visible wavelength region (Ref. 1).

There are both safety and supervisory advantages for observing the welders and their work tasks during welding/cutting events. In fact, one of the major reasons why TWCs were requested by companies was to assist in the detection of accidents when outside assistance became necessary (e.g., explosions, heart attacks, etc.). While TWCs had been used in the past as a substitute for opaque curtains or barriers, questions arose regarding appropriate protection requirements for hazardous or inadequate viewing conditions. Transparent welding curtains are manufactured with a wide variety of colors and optical density levels to ensure eye safety as well as adequate visibility and visual comfort for bystanders viewing a welding scene through the curtain. Today, there are many more companies throughout the world involved with either manufacturing or selling TWCs than there were 25 years ago. Transparent welding curtains have truly become global safety products.

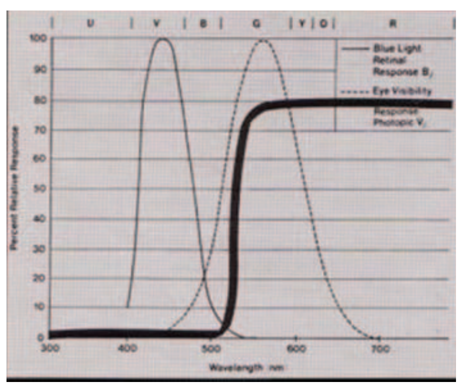

Fig. 1 — The spectral transmittance curve for a welding curtain that will minimize blue-light (BA) hazard and maximize visibility (V_a). The curtain curve is shown as a heavy line: the light lines are the blue-light hazard function and the CIE photopic visual response. Such a curtain would be perceived as an "orange" curtain although it is not monochromatic.

Optical Radiation Biological Effects

Welding and cutting processes can produce different types of radiation energy, but it is the optical radiation energy that is altered by use of TWCs. Wavelengths that are shorter than ultraviolet radiation or longer than medium infrared radiation are either too weakly generated to produce a health hazard or are absorbed in the atmosphere near the arc and thus do not constitute a health hazard. "Welder's flash" or "arc eye" are common expressions for the inflammatory response of the cornea and conjunctiva of the eye that occurs following exposure to ultraviolet radiation generated by the arc if appropriate eye protection is not worn. Less familiar to welding personnel are health hazards from the visible and infrared radiation that can create biological effects. Some of these effects are thermal skin burns or retinal thermal burns, erythema (UV skin burn), photokeratitis (arc flash), and blue light retinal injury (blindness).

It is now known that there is a specific photochemical damage mechanism to the retina of the eye caused by light. This particular damage mechanism tends to occur strongly in the wavelength region between 400 and 500 nm, but the effect does exist weakly at longer wavelengths. Figure 1 shows the "blue-light hazard function," which is used to evaluate this hazard. Blue-light hazard injuries are caused by extended exposure (several seconds or longer) to sources that are too weak to cause retinal thermal burns (Ref. 2). Since the blue-light hazard is a photochemical effect, it is strongly wavelength dependent and follows an additive law for exposure. It has been shown that the blue light irradiance associated with welding arcs increases with the current, and is proportional to the 1.8 power of the arc current (Ref. 3).

Infrared radiation wavelength longer than 1400 nm does not cause a retinal problem because it does not travel to the retina. It can be absorbed in the anterior portion of the eye and superficially in the skin (Ref. 4). Acute injury from wavelengths greater than 1400 nm can occur at very high irradiances and, at irradiance levels above 80 mW/cm^2, may create lenticular opacities (cataracts) (Ref. 5). Studies by Pitts indicated that several W/cm^2 were required to produce acute IR cataracts (Ref. 6). At viewing distances of 1 to 2 meters, such high IR irra-

Fig. 2 — Transparent welding curtains can be designed to interlock to completely enclose a work area. The ideal TWC allows those passing by to safely view the interior of the booth in detail.

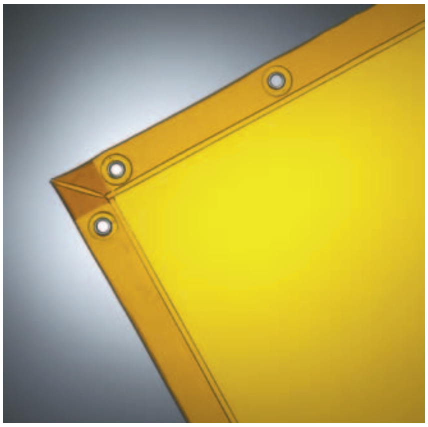

Fig. 3 — The curtains come in a wide variety of colors and optical density levels. Never select one by color alone.

diances are not generated in present nonlaser welding events. It is generally considered prudent to limit IR exposure to 10 mW/cm^2 on the cornea (Ref. 7).

The normal self-protective mechanism of the human eye against a bright light source — called the aversion response — is a rapid blink, constriction of the iris, and movement of the head. The aversion response prevents retinal injury from momentary viewing of essentially all arcs, even at very close distances. However, many repeated instances of momentary viewing would present a cumulative blue-light hazard. The aversion response may be overcome by the conscious will. A passerby or supervisor who wishes to examine the scene in detail could conceivably force himself to stare at the arc.

It has been found that the "safe" viewing time for a TWC decreases as the welding current increases. Such safe use time for any curtain can be increased for darker curtains, but this approach will decrease visibility (Ref. 8). However, visibility can be increased without sacrificing safety if the transmission spectrum of the TWC is chosen so as to minimize the "blue" component of the arc spectrum. Eye comfort can also be aided by minimizing brightness contrast ratios as viewed through the curtain.

The Ideal Transparent Welding Curtain Design

Using the information presented about welding/cutting biological effects, it is now possible to design TWCs that will eliminate or minimize those hazards to passersby or nonwelding personnel.

An ideal TWC allows bystanders and observers outside a welding booth to see the whole interior of the booth in sufficient detail to fulfill safety and supervision functions — Fig. 2. The curtain must protect the eyes of the bystanders from hazardous optical radiation, for any part of an 8-hour shift, without eliminating external visibility. See the boxed item on page 30 to learn the characteristics of an ideal transparent welding curtain.

Issues Associated with Transparent Welding Curtains

1. One observation noted on Web sites of companies involved with transparent welding curtains is the emphasis placed on curtain color, rather than percent spectral transmission levels, as the important occupational criterion for preventing welding/cutting exposure to optical radiation. Placing more emphasis on minimizing potential exposure by using curtains that attenuate hazardous wavelengths would encourage users to properly select the appropriate curtain. Manufacturers are constantly developing dyes for the curtains that will block certain wavelengths from transmitting and it is these dyes (that have color associated with them) that have caused curtains to be identified by those colors. However, color alone should never be the sole criterion for selecting personal protective equipment mainly because workers have different sensitivities to and perceptions of color — Fig. 3.

2. A problem that exists in welding/cutting environments is that transparent curtains attract dirt and fumes, spectral transmission levels may change as dirt level increases, they may have burn holes in them, and they can become less transparent with time. It is strongly suggested that these curtains be cleaned on a regular basis using a mild liquid window cleaning agent. Another method is to use a wet pad, soft cloth, or sponge mounted on a small pole to wipe the curtain surface using a 5% ethanol-95% water solution.

3. Since these curtains can be sold throughout the world, there has become more emphasis on developing manufacturer and user standards that address the use and application of such products. National and international TWC standards (Refs. 9–14) exist that help TWC manufacturers design appropriate curtains and provide basic safety and health information about their use to the welding and cutting community. These standards generally give information about ways and methods to test, select, and use TWCs and screens. The standards emphasize two important facts: 1) TWCs are designed to provide outside viewers, who are located at some distance from the welding arc or operation (typically 1 meter), a safe view of the operation and/or operator, and 2) TWCs are not to be used as replacements for appropriate welding viewing components such as welding filter plates.

4. One issue that still arises is what to include on the label attached to the TWC. It is generally understood that such information about the composition of the curtain, its flammability rating, optical transmission levels as a function of wavelength, and its luminous transmittance are minimum uniform requirements that should be identified by TWC manufacturers.

5. In addition to their use in welding and cutting environments, it should be noted that TWCs can be used as large-scale

optical filters for a number of optical sources that are rich in both ultraviolet and visible (blue) radiation. Unfortunately, most TWCs would not attenuate infrared radiation sources very well.

Conclusions

In reviewing the literature associated with TWCs, four facts emerge. First, the topic of transparent welding curtains has been well researched and technical information exists that clearly illustrates their advantages and disadvantages. Unfortunately, such information is not always transferred to new users and safety issues can arise in not understanding TWC limitations. Second, the use of these curtains in no way should be confused with the requirement to wear appropriate eye and skin protection when directly involved with welding and cutting processes. Third, these curtains do offer increased illumination in the work area, as well as offer outside observers a protected view of the work going on inside. Fourth, national and international standards exist that better define the safety requirements associated with the use of such curtains in the workplace. Unfortunately, there appears to be little understanding or knowledge about these standards and even less enforcement.◆

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