U.S. Army Public Health Command (Provisional)
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Just the Facts...

Radiation Hazards with the Use of Tungsten Welding Rods Containing Thorium

Purpose

This fact sheet provides information regarding potential ionizing and non-ionizing radiation hazards encountered during industrial operations with the use of tungsten welding rods containing thorium.

Background

The process in which an electrical arc is struck between an inert, gas-cooled, non-consumable electrode (also known as a welding rod) and the associated metal work pieces is known as tungsten inert-gas (TIG) arc welding. The TIG arc welding process is one of the more costly welding processes and is used primarily in industries, e.g. aircraft industry, that require high-quality and low-contamination welds. Most of the TIG welding machines are used in automated processes that do not require the continuous presence of an operator. However, some processes might require the presence of an operator; for example, should a significant amount of TIG welding be required. Many welding rods consist of tungsten wire that contains a metal oxide, but this fact sheet will focus on only those that contain a thorium oxide (in this case, thorium dioxide (ThO_2)). Typically, these widely used welding rods contain approximately one or two percent by weight of ThO_2 (hereafter referred to as thoriated tungsten welding rods), however some contain higher percentages. Thoriated tungsten welding rods have been used in TIG arc welding since 1951. The International Organization for Standardization color code of yellow and red indicates approximately 1% and 2% by weight of ThO_2, respectively.

Because thoriated tungsten rods contain thorium, which is a low-level radioactive material, they could pose health and environmental concerns if proper precautions are not taken. All quantities of thorium contained in welding rods currently in use are exempt from any Nuclear Regulatory Commission licensing requirements as outlined in Title 10, Code of Federal Regulations, Part 40.13(c)(1)(iii), where they are classified as unimportant quantities of source material.

Potential Hazards

Both ionizing and non-ionizing radiation hazards are associated with the use of thoriated welding rods.

Ionizing radiation hazards. These welding rods contain a small amount of radioactive material; therefore, potential low-level external and internal radiation hazards exist.

For typical operations, external radiation from thoriated tungsten welding rods is negligible. Required protection, if needed, would vary with time of exposure, distance from source, and shielding used. Shielding for storage of a one-day supply requires no special precautions. A metal box or cabinet would be appropriate storage for a few hundred thorium welding rods. For depot-level storage (thousands of thorium welding rods), a separate storage room would be appropriate.

Dust from grinding and fumes from welding will deposit on surfaces if not adequately ventilated. Therefore, potential internal hazards exist during grinding (pointing) operations involving thorium welding rods. Also, the use of these welding rods can produce detectable levels of airborne radioactive material from welding fumes as a result of volatilizing the tip during the welding process without adequate ventilation. Internal exposure during welding is negligible in most circumstances since the thoriated welding rod is consumed at a very slow rate. NUREG-1717 provides dose estimates for the potential inhalation of thorium when using thoriated tungsten electrodes for TIG welding as measured by Ludwig et al. (1999). The estimated doses, assuming welding was performed for 1000 hours in a year with no local exhaust, were 0.02 rem (0.4% of the occupational dose limit) per year for direct current (DC) operations and 0.5 rem (10% of the occupational dose limit) per year for alternating current (AC) operations.

Non-ionizing radiation hazards. Infrared, visible, and ultraviolet (UV) radiation exposures contribute to the non-ionizing radiation hazards associated with TIG welding operations. Like other arc welding processes, TIG welding can cause injury to the eyes and skin in the absence of proper precautions. The intense UV radiation from the arc can cause swelling of the cornea (also known as a photokeratitis or "welder's flash"), severe erythema or "sunburn" to the skin, and can increase the risk of skin cancer for prolonged exposures. Additionally, staring at the blue color of the arc can cause photochemical changes in the retina, creating permanent loss of vision unless proper protective filters are used. Finally, the visible and infrared radiation emitted by the arc can cause heating effects within the eye, which can also produce injury.

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Appropriate Radiological Controls

Ionizing radiation controls. Inhalation of the thorium dust from grinding is of concern. Factors in determining the magnitude of the hazard and whether additional assessment is needed include the total amount of time spent welding with thoriated electrodes, type and adequacy of ventilation, amount of time grinding thoriated electrodes, and direct current versus alternating current welding. If the hazard assessment suggests that an individual could receive elevated exposures while working with thoriated tungsten welding rods, then a review of the work place controls is warranted, e.g., local exhaust ventilation, to ensure that exposures are appropriately controlled. All radiological concerns can be addressed by following standard accepted industrial hygiene work practices, such as:

- ventilation
- local exhaust
- respirator
- good housekeeping
- position of the welder's head relative to the welding materials
- Material Safety Data Sheets (MSDS)
- training in the safe and efficient operation of the welding and grinding equipment.

Contact your local Industrial Hygienist for a specific worksite assessment or additional information for these work practices.

Non-ionizing radiation controls. It is essential that the welder wear suitable protective clothing, including leather gloves, a closed shirt collar to protect the neck (especially the throat), a protective long sleeve jacket, and a suitable welding helmet to protect the face and prevent retinal and/or corneal damage. Welding filters are specially designed to protect an individual from a combination of UV, visible, and infrared radiation, while still permitting a clear view of the arc. The shade of welding lens should be selected for comfortable viewing and is dependent upon the welding process, including the electrical current, the type of electrode, and the material being processed. Due to the absence of smoke in TIG arc welding, the arc appears brighter than for shielded metal arc welding and more UV radiation exposure may occur. Exposure of bare skin near a TIG arc for even a few seconds may cause painful sunburn. Transparent welding curtains, made of a polyvinyl chloride plastic film, dyed in order to block harmful levels of UV, visible and infrared radiation, are often used to shield nearby personnel from exposure.

A Welding Operation

Summary

Using thoriated tungsten welding rods can result in ionizing and non-ionizing radiation exposures. Potential ionizing radiation exposures are expected to be well below occupational safety limits. Appropriate industrial hygiene and welding safety controls will minimize employee exposures to non-ionizing and ionizing radiation hazards. If thoriated tungsten welding rods are used or handled, workers must be informed that the electrode contains radioactive material. Workers should be knowledgeable of the information provided in the MSDS, trained in the safe use and handling of thoriated welding rods, and apply accepted welding safety and industrial hygiene work practices for the particular job. Other safety precautions and associated hazards other than radiation when performing Gas Tungsten Arc Welding can be found in Section 1-2 of Guidelines For Gas Tungsten Arc Welding (Miller Electric Mfg. Co.).

Information Sources

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