Assessment of nanoparticles emissions resulting from arc welding of mild steel

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Abstract

Welding is the principal industrial process used for joining metals. However, it can produce dangerous fumes that may be hazardous to the welder's health and it is estimated that, presently, 1-2% of workers from different professional backgrounds (which accounts for more than 3 million persons) are subjected to welding fume and gas action. With the advent of new types of welding procedures and consumables, the number of welders exposed to welding fumes is growing constantly in spite of the mechanization and automation of the processes. Simultaneously, the number of publications on epidemiologic studies and the devices for welders' protection is also increasing. Apart from that, the influence of very ultrafine particulate, lying in the nanoparticles range, on human health has been pointed to be of much concern as airborne nanoparticles are resulting both from nanotechnologies processes and also from macroscopic common industrial processes such as welding. In fact, nanotoxicological research is still in its infancy and the issuing and implementation of standards for appropriate safety control systems can still take several years. Yet, the advanced understanding of toxicological phenomena on the nanometre scale is largely dependent on technological innovations and scientific results stemming from enhanced R&D. Meanwhile, the industry has to adopt proactive risk management strategies in order to provide a safe working environment for their staff, clients and customers, and obtain products without posing health threats at any point of their lifecycle. Understanding the relationship of airborne nano sized particulate and human health, under different environmental conditions is of great importance for improving exposure estimates and for developing efficient control strategies to reduce human exposure and health risk and for establishing, evaluating and improving regulations and legislation both on air quality, airborne emissions and the incorporation of nano sized materials in other products and commodities [1].

The fusion welding processes generate fumes that contain nanoparticles, however it is not known a relationship between the welding parameters and the emitted nanoparticles. From the most common welding processes in the industry there are two more widespread, the shielded metal arc and the active metal arc welding. Therefore it is important to study these two processes. The main objectives of this study were the analyses of released particles from this processes, the characterization of the particles by concentration and composition and the correlation between the operating conditions of the welding processes. Welding tests were performed using different welding parameters, quantifying nanoparticle emissions. Nanoparticles were also collected and characterized by transmission electronic microscopy.

In this study, which covered two welding processes Shielded Metal Arc Welding (SMAW) and (Metal Active Gas) MAG, it was possible to determine the existence of nanoparticles having a high deposition rate in the alveolar tract, possibly causing a decrease on the respiratory capacity of welders as other technical personal involved in welding operations. Studies such as this enable the determination of the alveolar surface area of nanoparticles deposited, concentration, morphology and composition resulting from various process conditions.

With this aim, a Nanoparticle Surface Area Monitor, TSI3550, was used for assessing exposure to nano particles produced and manipulated in laboratory and industrial facilities. This equipment indicates the human lung-deposited surface area of particles expressed as square micrometers per cubic centimeter of air ($\mu m^2/cm^3$), corresponding to tracheobronchial (TB) and alveolar (A) regions of the lung. Also, granulometry of particles was measured in the nano range using a Scanning Mobility Particle Size Spectrometer, TSI3034. Particles were sampled using a Nanometer Sampler Analyser, TSI3089 and observed further on using scanning electronic microscopy.

The obtained results clearly demonstrated the existence of airborne nanoparticles, as shown in figures 1 and 2, in the analyzed welding processes [2-4].

References
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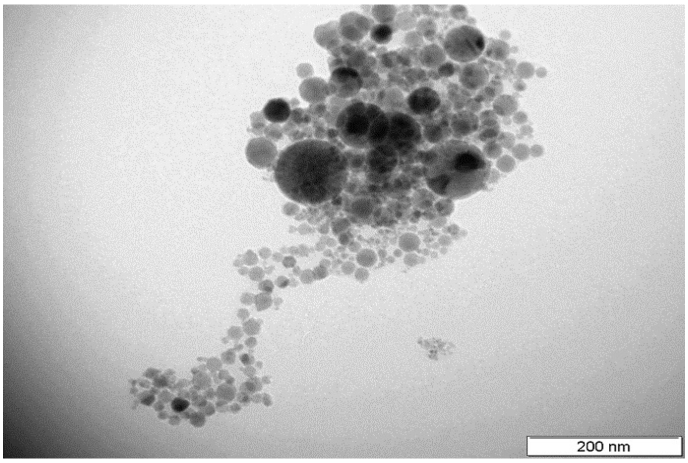

Figure 1 – TEM image of nanoparticles resulting from arc welding of mild steel using gaseous mixture Ar+ 18% CO2 in globular transfer mode

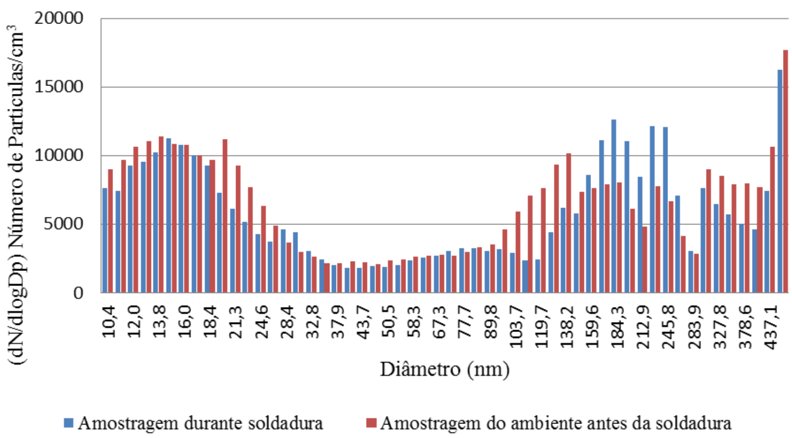

Figure 2 – Size distribution of nanoparticles resulting from arc welding of mild steel using gaseous mixture Ar+8% CO2 in globular transfer mode