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New Weld Fume Chamber Design to Assess HAP Emissions Potential and Promote Cleaner Production

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Abstract

Metal welding is an important production process in many industry sectors including automotive, aerospace, oil and gas exploration/refining/transportation, heavy manufacturing, and maritime. Though welding emissions are insignificant based on a mass basis within the maritime industry, their contribution to the overall risk to human health and the environment is significant because of the high toxicity associated with heavy metals emitted. These heavy metals include Cr, Cr^{+6}, Mn, Ni, Pb and others which may pose carcinogenic and non-carcinogenic effects to exposed workers and the public. United States regulatory agencies including the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (U.S. EPA), have recently increased pressure on the industrial sector to reduce their annual emissions of these heavy metals. This recent concern from the regulatory commumity has led to increased research efforts to better quantify the actual amount of these metals emitted, and to develop a better understanding of their potential to cause adverse effects to public health and the environment.

Welding emission characteristics and quantities depend on a number of factors such as electrode and base metal composition, welding method, shielding gas characteristics and power supply characteristics. When considering the various combinations of these factors, thousands of welding scenarios are expected in the field, each of which presents a unique emissions scenario. Emission factors for the numerous welding scenarios are not available, and will require an extensive amount of research to develop and document. However, these emission factors are essential for several purposes including facility permitting, risk assessment, compliance demonstration, and to achieve cleaner production.

This paper documents the unique challenges faced by the authors to design and fabricate a weld fume chamber capable of captuing 100 % of weld fumes on filter media suitable for heavy metals analysis. The weld fume chamber had to meet the requirements of regulatory agencies, data quality objectives, approved analytical methods, and filter efficiency. Design parameters such as chamber size, blower capacity, experimental speed, filter size and type, and fume loading, along with their inter-relationships will be discussed. This paper provides valuable insight into welding emission evaluation methodology, which should be useful across many sectors.

Keywords: Welding emissions, heavy metals, health risks, fume chamber design, emission factors