TECHNICAL REPORT

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Health and safety in welding and allied processes — Arc welding fume components

Hygiène et sécurité en soudage et techniques connexes — Composants des fumées de soudage dans l'arc

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Foreword

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ISO/TR 13392 was prepared by the International Institute of Welding, Commission VIII Health and Safety. IIW is recognized as an international standardizing body in the field of welding in accordance with Council Resolution 42/1999.

Introduction

This Technical Report constitutes the considered judgement of experts on the range of principal components of fume which can be emitted from arc welding processes and identifies, as key components, those which are of greatest occupational hygiene significance and therefore require the most stringent control measures to ensure that a welder is not exposed to an excessive level of the substance concerned.

The report is intended to assist in hazard appreciation, risk assessment and risk control and thus contribute to improving the health and safety of welders and those working with them. It is also intended to assist medical professionals in their care of welders and others exposed to welding fume.

The constituent components of particular consumables and the fume arising from their use should be gained from the Safety Data Sheet produced by the manufacturer and supplied with the consumables.

Health and safety in welding and allied processes — Arc welding fume components

1 Scope

This Technical Report provides guidance, based on the experiences of experts, on the components of fume emitted from a range of arc welding processes and consumable types.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TR 25901, *Welding and related processes — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 25901 apply.

4 Background

Arc welding processes emit fume. This is a complex, dynamic mixture of particulates derived mainly from the welding consumable but also the metal and any coatings and contaminants present. Most of the particles are in the respirable range which means that they can penetrate to the innermost area of the lung where they have the greatest potential to do harm. Many particles contain metal compounds, often as complex oxides and sometimes within a core surrounded by a shell. Some of the components of the fume are at least potentially biologically active. It is essential to be aware of these components when undertaking health and safety risk assessments of welding processes.

Table 1[1)] provides a general awareness to those responsible for making assessments or for the health care of welders and those who work with them. It identifies the principal and key components likely to be contained within the fume from a range of welding processes and consumable types. In this context, a *principal component*[2)] is a component that is of some occupational hygiene significance while the *key component*[3)] is the one that has the greatest occupational hygiene significance and therefore requires the most stringent control measures to ensure that a welder is not exposed to an excessive level of the substance concerned, i.e. it is the component whose limit value is exceeded at the lowest welding fume concentration.

1) This table is derived from that shown in ISO 15011-4.

2) A principal component is a component of occupational hygiene significance.

3) Key components have the greatest occupational hygiene significance and therefore require the most stringent control measures to ensure that a welder is not exposed to an excessive level of the substance(s) concerned, i.e. a component whose limit value is exceeded at the lowest welding fume concentration.

Table 1 — Principal and key components of commonly encountered arc welding fumes

Type of process[a]	Type of consumable	Typical principal components	Other possible principal components	Typical key component
MMA (SMAW) 111	Unalloyed and low alloy steel [b]	Fe, Mn, Cr, Cr(VI) Ni, Cu	F	Mn, Cr or Cr(VI) [d]
	High alloy steel [c]	Cr, Cr(VI), Fe, Mn, Ni	F	Cr(VI) or Ni
	Aluminium	Al, Cu, Mg, Mn, Zn	Be, Cl, F	Al, Mn or Zn
	Cast iron	Ni, Cu, Fe, Mn	Ba, F	Ni or Cu
	Hardfacing	Co, Cr, Cr(VI), Fe, Ni, Mn	V	Co, Cr, Cr(VI) Ni or Mn
	Work hardening	Fe, Mn, Cr		Mn
	Nickel-based	Co, Cr, Cr(VI) Fe, Ni, Mn	Fe	Cr, Cr(VI) or Ni
	Copper-based	Cu, Ni		Cu or Ni
MIG/MAG/TIG (GMAW/GTAW) 131, 135, 141	Unalloyed and low alloy steel [b]	Fe, Mn, Cr, Cr(VI) Ni, Cu		Mn, Cr or Cr(VI) [d]
	High alloy steel [c]	Cr, Cr(VI), Fe, Mn, Ni		Cr, Cr(VI) or Ni
	Aluminium alloys	Al, Mg, Mn, Zn		Al, Mn or Zn
	Nickel-based	Co, Cr, Cr(VI), Mn, Ni	Fe	Cr, Cr(VI) or Ni
	Copper-based	Cu, Ni		Cu or Ni
Gas-shielded tubular cored arc welding (FCAW) 132, 133, 136, 137, 143	Unalloyed and low alloy steel [b]	Fe, Mn, Cr, Cr(VI) Ni, Cu	F	Mn, Cr or Cr(VI)
	High alloy steel [c]	Cr, Cr(VI), Fe, Mn, Ni	F	Cr(VI) or Ni
	Hardfacing	Co, Cr, Cr(VI), Fe, Ni, Mn	V	Co, Cr, Cr(VI) Ni or Mn
	Nickel-based	Co, Cr, Cr(VI). Mn. Ni	Fe	Cr, Cr(VI) or Ni
Self-shielded tubular cored arc welding (FCAW) 114	Unalloyed and low alloy steel [b]	Fe, Mn, Cr, Ni, Cu, Al	Ba, F	Mn
	High alloy steel [c]	Cr, Cr(VI), Fe, Mn, Ni, Al	Ba, F	Cr(VI) or Ni
	Hardfacing	Co, Cr, Cr(VI), Fe, Ni, Mn, Al	V	Co, Cr, Cr(VI) Ni or Mn

[a] For welding process numbers, see ISO 4063.

[b] Unalloyed and low alloyed steels are here considered to have < 5 % combined alloying elements.

[c] High alloyed steels are here considered to have ≥ 5 % combined alloying elements.

[d] For the unalloyed and low alloyed steels, the Cr(VI) amount can be considered negligible compared to Cr(VI) from high alloyed steels (e.g. Cr(VI) in high alloyed steels is 3–6 % and in low alloyed steel 0,05 % in the fume box, see ISO 15011-1).