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Nano- and microparticles in welding aerosol: granulometric analysis

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Abstract

The paper presents the first results of the study of the size of particles appearing in the welding process by means of laser granulometry. It is shown that welding aerosol is the source of nano-and micro-sized particles extremely dangerous for human and animal health. Particle size distribution in the microrange was from 1 to 10 μm and up to 100%. It is shown that in 9 cases out of 28 with the use of various welding modes, welding rods and components the emission of aerosol with nano-sized particles (from 45.5% to 99.4%) is observed.

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Keywords: welding aerosol; nanoparticles; microparticles; toxicity

1. Introduction

It is known that a few harmful to human health physicochemical factors appear in the welding process: dust (sparks and spatter), gases, strong radiation and heat (Lehnert M. et al. (2012)). These factors cause occupational diseases and traumatic injuries (Antonini J.M. (2003), Grishagin V.M. and Lugovtsova N.Yu. (2011)). The proportion of bronchovascular diseases caused by the exposure to welding aerosol is high among the occupational diseases of welders. (Komarova T.A. (2009)) These are: pneumoconiosis diagnosed in welders who have been working in welding shops for more than 15 years, and chronic bronchitis that occurs within 5 years of work as a welder (Grishagin V.M. and Ilyaschenko D.P. (2009)). The risk group for occupational diseases includes each

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welder with over 10 years of experience, even if the welder is operating within permissible concentrations of harmful substances (The site of Rospotrebnadzor in the Volgograd region (2015)). In addition, they have a high risk of cardiovascular diseases (Li H. et al. (2015)), in particular, a connection between ischemia and welding works is determined (Sjögren B. et al. (2002)).

Welding aerosol is a collection of finest particles formed by the condensation of vapors of molten metal, slag and electrodes cover (Grishagin V.M. and Ilyaschenko D.P. (2009), Grishagin V.M. et al. (2010)).

The purpose of this work is to assess the particles sizes of welding aerosol with the help of laser granulometry and author's methods.

2. Materials and methods

The samples were collected as follows: during the process of welding a 3 liter sterile plastic container with distilled water was placed under welding spatter.

After that the samples were transported to the laboratory where 100 ml of liquid were withdrawn from each sample after shaking and analyzed on a laser particle analyzer Analysette 22 NanoTec plus (Fritsch).

During the experiments different types of welding rods and welding components were used and varying strength of current was applied for several days (Table. 1).

Table 1. Summary table of different types of welding rods and welding components

No.	Welding component	Welding rod	Strength of current
1	Steel pipeC245 Ø620x12 mm	UONI-13/55. Ø3 mm. LEZ	80A
2	Steel pipeC245 Ø108x5 mm	UONI-13/55. Ø3 mm	75A
3	Cast iron pipe(high-strength cast iron with spherical graphite) Ø150 mm	Hyundai ESTØ3.2 mm	100A
4	Pipe 25x4 mm	AWS E6013Ø3.2 mm	100A
5	Steel pipeC245 Ø620x12 mm	UONI-13/55. Ø3 mm	90A
6	Pipe Ø180x5 mm	UONI-13/55 Ø3.2 mm	80A
7	Stainless steel pipe Ø89x5 mm	Welding rodsCL-11 Ø3 mm	60A
8	Stainless steel pipe Ø89x5 mm	Welding rods S-309L.16 Ø3.2 mm	60A
9	Stainless steel pipe Ø89x5 mm	Welding rods KST-308L Ø4 mm	60A
10	Double-T ironNo.24 C245	UONI-13/55. Ø3 mm	90A
11	Zinc plated pipe Ø 50x3.5 mm	Welding rodsE46A Ø3 mm by GOST 9467-75*	76A
12	Zinc plated pipe Ø 90x4 mm	Welding rodsOmnia 46 Ø3 mm	60A
13	Zinc plated pipe Ø 90x4 mm	Welding rodsConarc 52 Ø2.5mm	60A
14	Zinc plated pipe Ø 90x4 mm	Welding rodsLB52U Ø2.5mm	60A
15	Bare pipe Ø 89x4 mm	Welding rodsLB52U Ø2.5mm	60A
16	Zinc plated pipe Ø 90x4 mm	Welding rodsMGM-50K Ø3 mm	60A
17	RebarAIII, Ø12 mm	Hyundai S6013Ø3.2 mm	90A
18	RebarAIII Ø12 mm	Lincoln Electric UONI 13/55 Ø4 mm	110A
19	RebarAIII Ø12 mm	Lincoln Electric Omnia 46 Ø3.2 mm	80A
20	RebarAIII Ø12 mm	Lincoln Electric MGM-50K Ø3.2 mm	80A
21	RebarAIII Ø12 mm	Lincoln Electric Conarc 52 7016. Ø2.4 mm	80A
22	RebarAIII, Ø12 mm	JHJ422 Ø3 mm	75A
23	RebarAIII, Ø12 mm	JHJ422 Ø3 mm	80A
24	RebarAIII, Ø12 mm	Lincoln Electric. Omnia 46. Ø3.2 mm	90A
25	Metal sheet t=12 mm. Steel gradeC245	Welding rods ESAB OK 46 E6013. Ø4 mm	80A
26	Silumin	Welding rodAlMni Ø2 mm	90A
27	Angle bar 50x5 mm	UONI 13/55 Ø3.2 mm	80A
28	Channel barNo.20 C235 поГОСТ 8240-97 мм	Welding rodsE46A Ø4 mm by GOST 9467-75*	160A

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