

Analysis of Roller Welding Plant Dust Removal System

Kehua Zhan ^a, Zhongxiang Li, Kunpeng He, Yongzhen Wang, Jie Lu

College of Mechanical and Electronic Engineering, Shan Dong University of Science and
Technology, Qing dao 266590, China

^a1278757146@qq.com,

Abstract

Based on the analysis of the occurrence and damage of welding soot, the diffusion of welding soot is explored. Combining with the actual work environment of the roller welding workshop, the available ventilation modes and airflow organization forms of the workshop are determined, and the position and distribution of suction and exhaust ventilation devices are established in the form of airflow to achieve the purpose of dust removal in the roller welding workshop.

Keywords

Welding, Dust hazard, Roller workshop, Ventilation and dust removal.

1. Introduction

Welding is the use of electric heating, to promote the metal to be welded locally to the liquid or near liquid, and make it combine to form a solid non-removable joints process. Welding produces a large amount of toxic substances, causing harm to the operator's body and causing serious pollution to the atmospheric environment. How to deal with welding fumes has always been a problem in the field of industrial ventilation. Through the on-the-spot investigation of the conveyer belt roller welding workshop and the combination of welding smoke and dust diffusion modes, the available ventilation air flow pattern is analyzed, and the ventilation and dust removal plan of the roller welding workshop are designed.

2. Welding fumes and hazards

During the welding process, the electric discharge generates a high temperature arc of 4000-6000 ° C, which melts the base metal and the metal of the welding material, and volatilizes to generate metal vapor. Steam comes in contact with the air and is rapidly oxidized and condensed to form solid particles of different particle sizes, as showed in Table. 1. Oxidation generates a large amount of harmful gases such as CO₂, NO₂ and O₃. Welding fumes are metal oxides mixed with harmful gases to form a soot mixture, which includes both smoke and dust. The particles whose diameter is less than 0.1 μm are called as smoke and the particles whose diameter is between 0.1 μm and 10 μm are called dust.

Table 1 Chemical composition of soot in common structural steel electrodes

Smoke composition	Dust amount/mg·m ⁻²		
	Knot421	Knot422	Knot507
Fe ₂ O ₃	45.31	48.12	24.93
SiO ₂	21.12	17.93	5.62
MnO	6.97	7.18	6.30
TiO ₂	5.18	2.61	1.22
CaO	0.31	0.95	10.34
MgO	0.25	0.27	—
Na ₂ O	5.81	6.03	6.39
K ₂ O	7.01	6.81	—
CaF ₂	—	—	18.92
KF	—	—	7.95
NaF	—	—	13.71

Harmful to the health of the gaseous and particulate matter (including gas, smoke, dust, etc.) collectively referred to as hazardous substances. Welding fumes are harmful substances, is generated by welding, cutting and other processes. After most of the experimental testing of solid particles of smoke and dust easily inhaled, and the great harm to the human body, long-term exposure to form a pneumoconiosis. Through on-the-spot inspection to the drum welding workshop, the solid particles with the particle size of $0.1\mu\text{m} \sim 0.3\mu\text{m}$ accounted for 83% of the total number of particles, which accounted for a large proportion, indicating that most of the harmful substances in the roller workshop can be inhaled. In addition to solid particles, there are many toxic gaseous substances, such as carbon monoxide, ozone, fluoride, causing human poisoning, suffocation, pulmonary edema, cancer and other diseases.

3. Overall ventilation control measures

3.1 Smoke spread

Welding smoke diffusion is a more complicated process. In the absence of external wind disturbance, while welding fumes are generated, the high temperature arc heats the surrounding air, causing the gas to expand and mix with the soot particles to rise together, floating in the workshop air in an aerosol form in. In the process of rising, it mixes with the surrounding air and floats in the air with vortex motion under the effect of a continuous high-energy electric arc. As the surrounding gas is added, the diffusion rate slows down, the temperature decreases, and the soot density gradually increases, reaching a certain height and starting to decline. Falling soot interacts with ascending soot to form a stable soot concentration zone at a fixed height. The height of this concentration zone is related to the welding current strength of the fume and dust, the ventilation conditions of the plant, and the horizontal disturbance airflow. Through the roller welding workshop welding concentration zone inspection, the workshop height of 6 to 7 meters at the maximum dust concentration, shown in Figure 1.



Fig1 Workshop environment

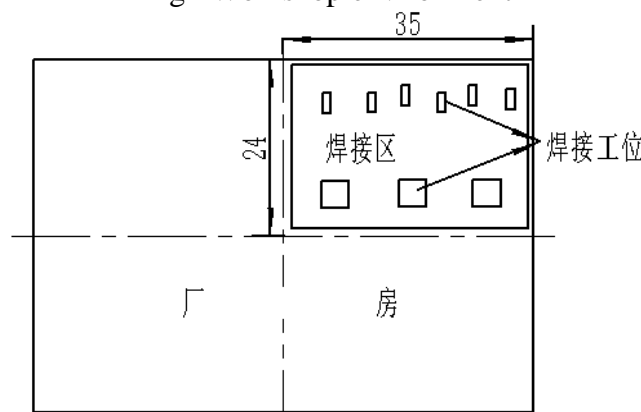


Fig2 Welding Area and Workstation Distribution

3.2 Ventilation options

Roller workshop non-closed working environment, and only the entire plant 1/4 there welding station. Welding area length of 35m, width of 24m, a total of 10 to 12 welding stations. Welding pieces of the drum, drum size, welding length, height are different, as showed in Figure 2. Site and welding area distribution plan is shown in Figure 2.

The purpose of ventilation is to control airborne pollutants and to adopt technologies of purification, removal and dilution to ensure good air quality in the environment, ensure normal air quality for human activities, and provide an air environment suitable for living and production. Ventilation dust removal methods are mainly two kinds, namely local ventilation and full ventilation.

Local ventilation is only suitable for fixed station, fixed-point welding environment, roller workshop welding environment, local ventilation is not suitable. Full ventilation is the ventilation of the entire plant, the fresh air constantly into the workshop, dilute the air pollutants, the diluted harmful substances collected and purified to the shop outside. This method is used in the drum workshop is feasible, you need to rely on the appropriate mechanical equipment to send and exhaust, and the use of good forms of gaseous tissue, ventilation and dust removal to achieve the best results.

3.3 Airflow organization form

Comprehensive ventilation and exhaust ventilation system layout, the outlet form, location and distribution of air volume has an important relationship. Reasonable air flow organization, even with a smaller ventilation can get better ventilation, air flow organization in the ventilation process plays an important role. Airflow organization to avoid short-circuit, reduce eddy currents, to avoid the accumulation of pollutants in a large area, the airflow should be as uniform as possible. According to the roller workshop production location of pollutants, the operating position of workers, pollutant concentration distribution and other specific circumstances, as showed in Figure 3 to determine the form of airflow.

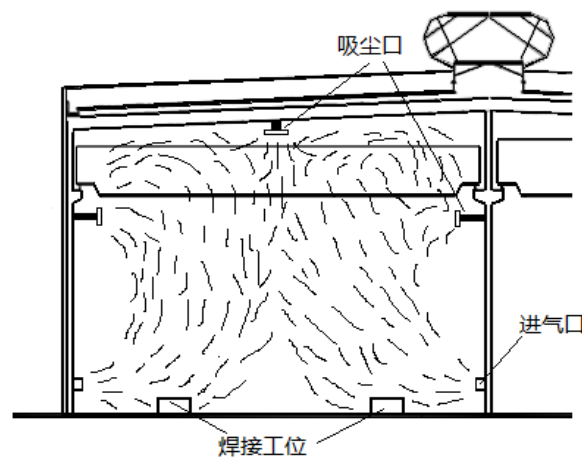


Fig3 Workshop air distribution

As can be seen from the figure, the fresh air into the plant, the first to reach the welding station, the concentration of pollutants in the welding station is diluted, the new airborne pollutants in the form of plug flow to reach the concentration zone. At the workshop for the semi-span plant, only in this cross-plant layout vacuuming, intake pipe, layout to ensure that the amount of suction is greater than the amount of air intake. The purpose is to prevent excessive harmful gas from moving through the middle truss to another workshop to reduce the pollution of harmful substances.

3.4 Pipeline distribution

Vacuum mouth OK. According to the maximum concentration zone of smoke and dust, the air flow organization and the actual working condition of the roller workshop, the combination of top suction and side suction is determined. The purpose of side suction is to minimize the spread of soot to another cross-plant area to avoid air pollution. Side suction port to determine the location of the maximum

concentration zone, this height is supplemented by vacuum equipment, can achieve good dust removal effect, top suction position is determined at the top of the factory central axis.

Air inlet to determine. Inlet position relative to the welding station to determine the work of equal welders when the height of 1 meter. Assuming the air inlet height is lower than 1 meter, the air inlet is too close to the ground, affecting the placement of welding parts and the movement of workers. Air intake is more likely to blow dust on the ground and cause secondary the dust. If the air inlet position is too high, can not reach the required air flow organization forms, easy to cause the welder to vacuum twice and make the side suction not reach the best effect. Into the wind pipe to set the wind speed control device, as showed in Figure 4 shows three-dimensional pipe distribution.

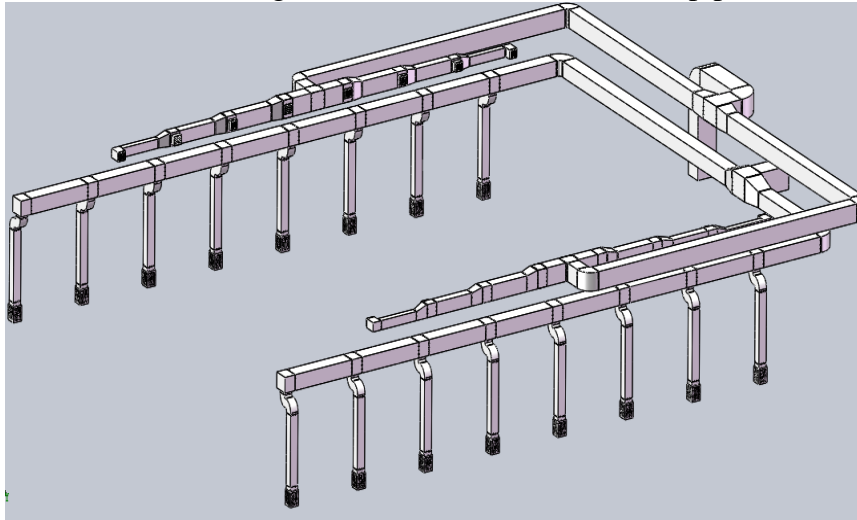


Fig4 Pipeline distribution

4. Conclusion

In the welding and related manufacturing process, the smoke generated not only pollute the environment, and endanger the health of welding workers, select the appropriate welding fume treatment, the layout of the dust removal equipment targeted to achieve the goal of green production, green manufacturing .

References

- [1] Zhang Dian-yin et al., Dust removal engineering design manual (2nd edition). Chemical Industry Press. Place of publication: Beijing, 2010.10.
- [2] Jiang Kelin, HVAC design guidelines and engineering examples. China Electric Power Press .2015.10.
- [3] Qu Na, Li Ke-bin, Wang Nan. A welding workshop dust removal system design. China High-tech Zone, 2017, (19): 124.
- [4] Xu R Rong. Welding smoke pollution and purification of filtration technology [J]. Machinery Workers, 2006, (10): 33-38.
- [5] Li Bo, Hu Guangsheng. Hazard of welding plant smoke and dust and overall treatment program [J]. Metal Processing (Hot Working), 2011, (02): 37-39.