Short Communication

Development of a Light Sensing Self-adjusting Hood for Welding Fumes

Jun Ojima
National Institute of Industrial Health, Japan

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Recently, the incidence of pneumoconiosis due to inhalation of welding fumes has become increasingly remarkable in Japan. Although several engineering methods such as local exhaust ventilation, push-pull ventilation\(^1\) and general (dilution) ventilation have been preferred for controlling airborne contaminants released from welding work, thorough reduction of the welder’s exposure to welding fumes is practically difficult in most cases because the working area for common welding work is relatively large and a lot of fumes are released from a moving source. In general, local exhaust ventilation is the most effective and economical approach to engineering control since it captures airborne contaminants very close to their source by minimum suction before dispersal of the contaminants. Nevertheless, conventional local exhaust ventilation is not effective for moving contaminant sources because an ordinary local exhaust hood is not flexible in use and cannot achieve its best performance unless it is located constantly close to the contaminant source.

In this study, the author presented a light sensing self-adjusting hood for capturing welding fumes (Patent Applied for), and carried out a performance test. This self-adjusting hood was devised so as to be moved and adjust its position automatically according to the welding arc movement. Owing to the self-adjusting function, a contaminant source (arc point) is constantly positioned within the suction coverage of the hood.

Materials and Methods

Figure 1 shows the schematic diagram of the devised hood system (bird’s-eye view). The open face of the hood is W30 cm × D20 cm in size. The hood is set on a flat carriage ( W35 cm × D35 cm × H3.5 cm) and connected to the commercial fume collector (Fume hood fan unit, AC100V, AS ONE LTD., Japan) by a 9 cm φ flexible duct. For lateral control of the hood, two Cd-S cell type light sensors are located on the sides of the carriage and connected to dry batteries and a winch motor (1.8 kg/cm torque at voltage of 3V). The terminals (+, −) of each light sensor (R and L) are reverse connected to the winch motor. When a light source such as a welding arc enters the intercepting zone of the light sensor, the sensor switches on the winch motor and shifts the hood to the best position. The range of the light intercepting zone was set at about 30 cm from the light sensor. The hood keeps moving until the light source is beyond the intercepting zone and then the sensor switches off the winch motor. Due to the revere connection of the two sensors (R and L) and the motor, the hood system is applicable to the reciprocating motion of a light source.

The rate and the range of hood movement were set at approximately 50 cm/min and 150 cm respectively. The movement rate of 50 cm/min is sufficient for normal welding speed. The static pressure and exhaust flow rate of the fume collector are 30 mmAq and 6 m³/min respectively. The performance of the hood system for fume exhausting was evaluated in robotic CO\(_2\) arc welding\(^2\). The welding conditions for this study were as follows:

- welding current 100 A
- welding speed 45 cm/min
- welding consumable 1.2 mm φ solid wire (JIS Z 3312)
- CO\(_2\) gas flow rate 20 liter/min

The welding fume concentration was measured by means of a light scattering digital dust monitor (DUSTMATE Model LD-1, SIBATA SCIENTIFIC TECHNOLOGY LTD., Japan). The sampling point was fixed at the welding torch of the robot (approximately 25 cm above the arc point), and sampling was carried out during arcing.

Results and Discussion

Figure 2 shows the performance test scene of the hood. Once the arc was ignited, a thick cloud of welding fumes instantly rose from the arc. The fumes were successfully captured by the hood provided that the arc point was positioned within the range of hood coverage. Table 1 shows the results of the performance test. Fume concentrations are expressed as relative concentrations in the table. In this study, the relative concentrations for cases (①, ② and ③) each approximately correspond to the mass fume concentrations of 53, 47 and 14 mg/m\(^3\) respectively. Comparing the fume concentrations in each case, it is concluded that the ventilating effect of a local exhaust hood will be remarkably improved by the self-adjusting function. When the hood position was fixed (②), exhausting by means of the hood was almost completely ineffective and fume leakage from the hood was remarkable. But when the hood system was at work (③), the fume concentration could be suppressed to

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Correspondence to: J. Ojima, National Institute of Industrial Health, 21-1, Nagao 6 chome, Tama-ku, Kawasaki 214-8585, Japan

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approximately 70% of the case ② concentration.

Although the effectiveness and economy of local exhaust ventilation is well known, it has not been widely adopted in the Japanese welding industry. According to the Japan Welding Society’s survey, the main reason for little adoption of local exhaust ventilation in the Japanese welding industry is “not sufficiently applicable to moving work”. With the aid of the hood system, the effectiveness of local exhaust ventilation will improve, and this may be beneficial in reducing the incidence of welder’s pneumoconiosis. Because of the mechanical limitations, this hood system is only applicable to reciprocating motion work. Further study should consider refinement of the self-adjusting operation function.

**References**
