<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th>Appropriate ventilation and fume extraction in welding shops</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author(s)</strong></td>
<td>Kulmala, Ilpo</td>
</tr>
<tr>
<td><strong>Citation</strong></td>
<td>68th IIW Annual Assembly and International Conference, IIW2015, 28 June - 3 July 2015, Helsinki, Finland, Welding Society of Finland (2015), presentation slides, 26 p.</td>
</tr>
<tr>
<td><strong>Date</strong></td>
<td>2015</td>
</tr>
<tr>
<td><strong>Rights</strong></td>
<td>This presentation may be downloaded for personal use only.</td>
</tr>
</tbody>
</table>
IIW 2015
The 68th IIW Annual Assembly and International Conference
Helsinki, Finland
June 28 - July 3, 2015
Ilpo Kulmala
Appropriate Ventilation and Fume Extraction in Welding Shops
Contents

- Contaminant control measures
- Ventilation systems
- Local ventilation
  - Capture efficiency
  - Design of LEV systems
- General ventilation
- Air distribution
- Ventilation energy consumption
- Summary
Contamination control measures
Hierarchy of control measures

- **Elimination**
  - Replacement of the welding process with an alternative joining technique

- **Substitution**
  - Modification of welding processes to generate less fumes

- **Isolation**
  - Automating and isolating the welding operation

- **Ventilation**
  - Local ventilation
  - General ventilation

- **Personal protective equipment**
  - Powered filtering helmet
Welding shop ventilation systems
Ventilation system

- Consists of local and general ventilation

General exhaust

General ventilation
- Controls air temperature and humidity
- Dilutes contaminants not captured by the local exhaust system
- Replaces exhausted air

Local exhaust
- Removes contaminants at their source
Local exhaust ventilation systems
Local Exhaust Ventilation

- Removes contaminants at the source before they are released into the workplace air
- Creates controlled air flows towards the exhaust hood
- Components:
  - Hood to capture the contaminants
  - Ducting to transport the contaminants
  - Fan to provide sufficient air flow rate
  - Discharge
Types of welding fume extractor solutions

Central Low Velocity High Volume extraction

Portable fume extractor with built-in filter and fan (HVLV)

Welding bench hood

Fume Extraction Gun

01/07/2015
Capture efficiency

- LEV performance is characterised by capture efficiency, which is defined as the percentage of emissions directly captured by the exhaust ventilation.
Measured capture efficiencies for Shielded Metal Arc Welding

ACGIH recommended values for welding exhaust:
0.5 – 0.87 m/s (100 – 170 fpm)
These correspond to measured capture efficiencies 85 - >95%
Velocity fields generated by exhaust hoods

Low velocity high volume (LVHV): face velocity 3.4 m/s

High velocity low volume (HVLV): face velocity 15 m/s
Challenges with local ventilation

- Welding operations are characterised by frequent changes in location and welding position.
- This makes it more difficult to control fume exposures than in fixed workplaces.
- The effective working range of local exhausts is limited, especially with HVLV systems.
- Correct positioning of the hood and sufficient exhaust flow rates are essential for efficient operation.
- Work practices which include the active operation and management of the exhaust device are critical for successful outcomes.
General ventilation air distribution
General ventilation air distribution

- Mixing ventilation
- Displacement ventilation
- Hybrid ventilation
Mixing ventilation

- Air is supplied with high velocity near the ceiling which causes the air in the room to mix
- This results in nearly uniform temperature and contaminant concentration distributions
- Suitable for heating
Displacement ventilation

- Air is supplied at slow velocity into the occupied zone
- Convection from heat sources creates vertical air motion into the upper zone, where the air is extracted
- Weak momentum – operation easily deteriorated by disturbances

Cool air flows near the floor

Warm air rises up – not suitable for heating!
Hybrid ventilation

- Air is supplied through a displacement type diffuser assisted with a downward directed slot jet
- Facilitates a longer efficient operating range than with displacement ventilation
- Can provide a supply of warm air
Hybrid ventilation
Correct position of the welder relative to the supply air

Supply from the front: exposure due to air flow towards the breathing zone

Supply from the back: exposure due to recirculation

Supply from the side: the best solution!
A welding shop was renovated by installing a new ventilation system which included heat recovery and hybrid air distribution systems. After the renovation, the workers exposure to contaminants was reduced significantly. The improved air quality is clearly evident in the following chart results.
Ventilation energy consumption
Energy required to heat the supply air

\[ \phi = \rho \cdot q \cdot c \cdot \Delta T \]

- \( \phi \): Temperature difference, \( C \)
- \( \rho \): Air density
- \( q \): Heat capacity of air, \( c=1 \text{ kJ/kg K} \)
- \( \Delta T \): Air flow rate

1 degree \( C \) temperature difference means 1.2 kW heating power for an air flow of 1 m\(^3\)/s

Average annual temperature difference in Finland is about 14 \( C \)
Average heat power is thus 17 kW per 1 m\(^3\)/s airflow

Heat recovery from exhaust air could provide savings from 50 % up to 80 %
Heat recovery – energy savings
Summary

- Welding operations need control measures to keep welders contaminant exposure below occupational limit values.
- Local extraction can be the most performance-effective and cost-effective control method.
- Efficient control requires the proper use of the system (e.g. frequent replacement of the exhaust hood).
- General ventilation is needed to dilute contaminants that are not captured.
- Hybrid ventilation distribution offers advantages over conventional air supply methods, in that it provides clean air to the breathing zone.
- To avoid the clogging of the heat exchanger and maintain high efficiency levels, cleaning of the exhaust air is needed.
TECHNOLOGY FOR BUSINESS