# VENTILATION SYSTEMS USED IN WELDING PROCESSES

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**Abstract:** An overview is made of issues related to the noxes emitted during the welding processes and possible variants to avoid the exposure of welders. Local evacuation (exhaustion) when welding is the most recommended method. The decision to use one system or another one is justified. Case studies presented (rotating exhaust hoods, flexible exhaust arms, rigid metal tube arms, telescopic exhaust arms, exhaust arms for rail channels, exhaust cranes, high-vacuum extraction and filter unit, ducting systems for the high-vacuum extraction and filtration unit)give explicit details to justify options [1-7].

## 1. GENERALITIES

"Environmental protection" and "diminution of noxes" are issues of strict actuality when applying the "durable development" percept. The exposure to noxes emitted during the welding processes is inevitable, a reason for which alternative solutions have been adopted, namely replace, when it is possible, the welding process with another one which produces less noxes (e.g. MIG/MAG welding of thin plates can be replaced with resistance welding); extension of automation and robot welding so that the welding operator is not directly exposed to noxes; elaboration of new welding materials which do not allow the existence of harmful substances in the welding fume[1-7].

## 2. LOCAL EXHAUSTION

The local evacuation (exhaustion) is the most recommended industrial method to control the fume emitted when welding. It provides the moving off, in a rather sufficient way, of fumes and harmful gases emitted when welding from the working space of welding operators [1, 2].
The decision to introduce an exhaustion system is made only after measuring the quantity and composition of harmful fumes and gases emitted when welding. If they exceed the permitted limits regulated by standards, exhaustion is compulsory.
There are numerous situations when experience shows that fumes exhaustion from the vicinity of the source is necessary in order to maintain a healthy working climate. Such a situation is met when using uncovered electric arc welding.
When selecting the exhaustion equipment the following are to be considered [4]:

- concentration of noxes (toxic agents and /or flammable);
- number and type of noxe generating operations;
- air flow speed in the interest area;
- positioning the breathing area of the welding operator, related to the area where noxes are formed and exist.

## 3. CASE STUDIES - OFFERS EXISTING ON THE MARKET OF WELDED STRUCTURE PRODUCERS

### 3.1. Rotating exhaust hoods

The exhaust hood is revolvable by 360° and can consequently be aligned optimally with the welding seam in every position. It is irrelevant whether the welder is standing at the side or behind the machine.

The filter unit has to be repositioned less often to work at optimum conditions. By the use of an ergonomically formed handle the hood can be brought into the designated position, which will retain self-supporting [6,7].

*Figure 1*

European standardization bodies are currently developing specifications for capture instruments that can be used for the extraction of welding fumes.

### 3.2. Flexible exhaust arms

Exhaust arms are extremely suitable for extracting welding smoke, gases, damps, slight dusts and solvents.
The exhaust arm consists of an interior parallelogram which is spring supported, a fibre glass hose with a PVC coating and an internal steel wire spiral.

*Figure 2*

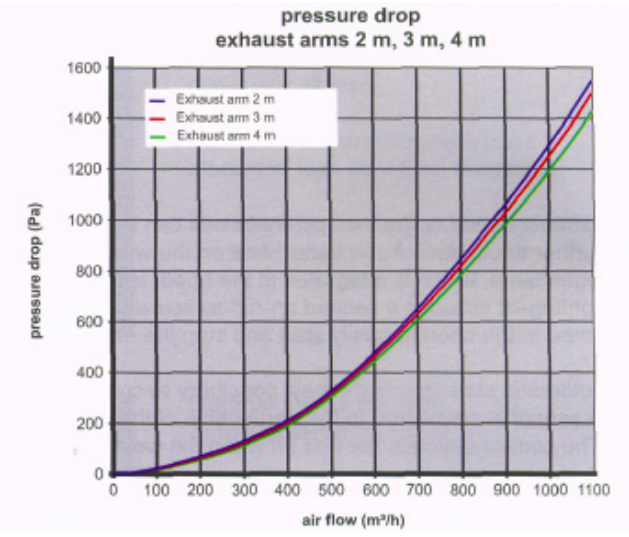


*Figure 3*

The exhaust hood with a damper is rotatable by 360° and can therefore be swivelled in all directions.
Due to its interior parallelogram the exhaust arm can be brought into any desired position within its reach without any additional support [3, 6].
The diagram indicates the pressure drop of the exhaust arms against the airflow[6].

### 3.3. Rigid metal tube arms

As well as the flexible exhaust arm, the rigid metal tube arm is extremely suitable for the local extraction of welding fumes, gases, damps, slight dusts and solvents.
The rigid metal tube arm consists of an interior spring supported parallelogram linkage and two epoxy-coated aluminium pipes as well as three flexible hose pieces at the joints.
The exhaust hood with a damper can be swivelled by 360°.
The standard fan is fastened to the wall bracket with a toggle tip fastener.
Due to the construction of the parallelogram, the exhaust arm can easily be brought into every position without any additional support [2, 3, 4, 6].

*Figure 4*

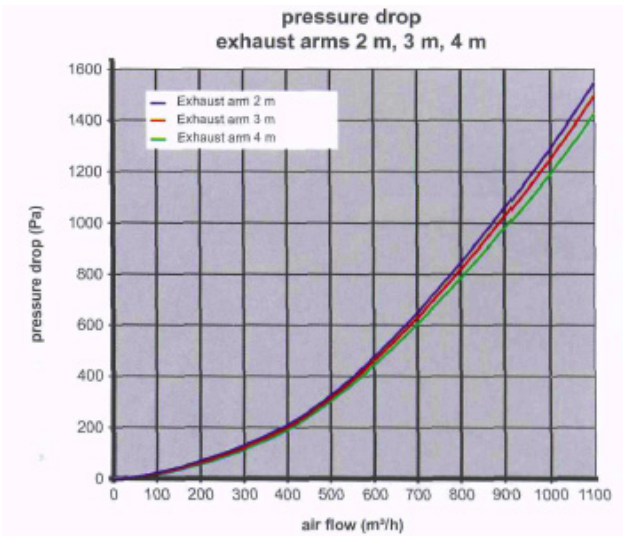


*Figure 5*

The diagram indicates the pressure drop of the tube arms against the airflow [6].

### 3.4. Telescopic exhaust arms

The telescopic arm has been designed especially for welding schools where small welding tables are in use.
In these places it is difficult to use the standard exhaust arm, which would disturb the trainee with its wide swivel range.
The telescopic arm allows a smooth vertical movement and can also be swiveled to the left and right.
The exhaust hood is fitted with an universal joint and allows also to be directed into any position.
These features make this arm the ideal solution for all applications with restricted space [5, 6].

*Figure 6*

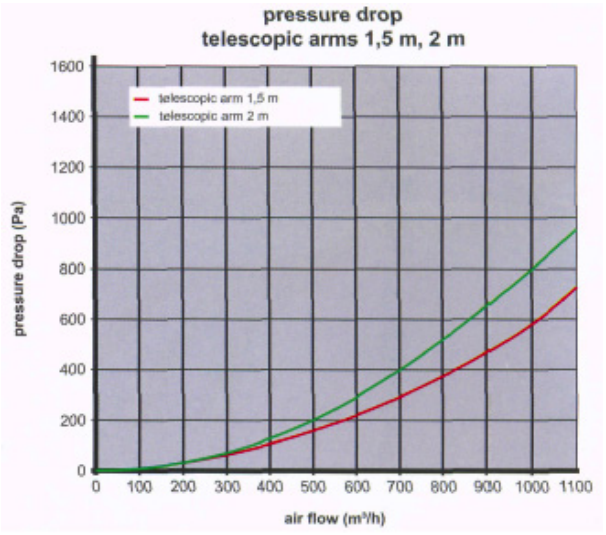


*Figure 7*

The diagram indicates the pressure drop of the telescopic arms against the airflow [6].

### 3.5. Exhaust arms for rail channels

In order to expand the range of the exhaust arms they can be connected to carriages on an extraction rail channel.
Then, the exhaust arm can be moved across the full length of the channel. This is an advantage especially when working on huge workpieces.

*Figure 8*

The exhaust arm is rotatable by 360° underneath the carriage, so that every position within its range can easily be reached.
System rail channels can be connected to fans or to a central filtration system [3, 6].

### 3.6. Exhaust cranes

The ball bearing swivel exhaust crane is as well as the exhaust arm ideally suitable for local extraction of hazardous substances. The two part crane boom is suitable to suspend 50 kg from the first boom (e.g. wire feed unit) and 10 kg from the second. The complete profile steel construction is epoxy powder coated. The joints with adjustable snappers, an

extraction pipe with flexible hoses at the joints and a self supporting telescopic arm including the exhaust hood guarantee a very high flexibility. The exhaust crane can be connected to fans with different performances and also to filter units via a ducting system. Accessories like automatic start-stop and lighting can be fitted [5, 6, 7].

***Figure 9***

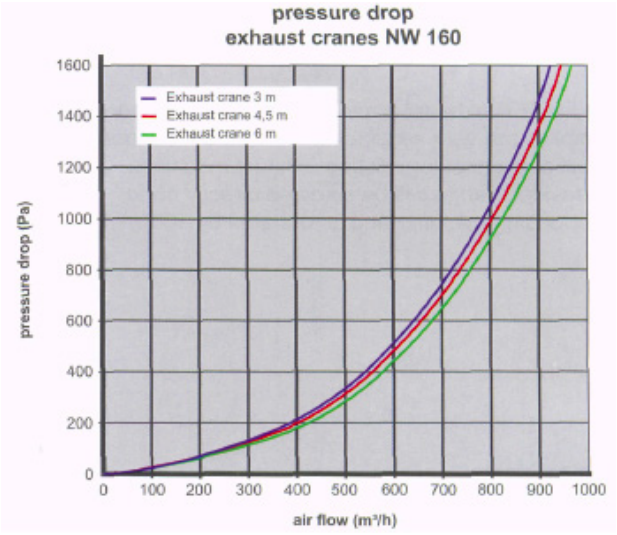


***Figure 10***

The diagram indicates the pressure drop of the exhaust cranes against the air flow [6].

### 3.7. High-vacuum extraction and filter unit

With four suction ports, this extraction and filter unit offers a flexible way of extracting the contaminated air directly at the source.
The system is equipped with a side channel compressor that remains effective even under extreme conditions.

***Figure 11***

The system can be used in almost any metalworking application. It is especially flexible when used with welding torches with integrated extraction and makes an updating of the extraction elements unnecessary. Naturally, all sorts of nozzles, high-vacuum exhaust arms or suction shields from the extensive range of accessories can be attached [6].
The rugged device has a 10 $m^2$ KemTex® ePTFE membrane filter cartridge, monitored by the electronic control system and, depending on the saturation level; it is automatically

cleaned during operation. This is carried out by means of compressed air using a rotating nozzle.
The compressed air tank for this is also built-in, as is a large 40-liter dust collector.
The high-vacuum extraction and filter unit is equipped with an automatic start / stop. With optional start / stop clamps, the high-vacuum extraction and filter unit can be switched on or off at four different locations [2, 3, 4, 6].

**Table 1. Technical data [6]**

| | |
|---|---|
| Fan performance: | max. 680 $m^3$/h |
| Motor power: | 5.5 kW |
| Amperage: | 11 A |
| Pressure: | 20.000 Pa |
| Voltage: | 3 x 400 V / 50 Hz |
| Filter efficiency: | > 99.9 % (BGIA classification M) |
| For alveole exchangeable dusts | |
| Compressed air supply: | 5,0 -6,0 bar |
| Weight: | 250kg |
| Dimensions (w x d x h): | 655 x 1,200x 1,370 mm |
| Noise level: | 74 dB (A) |

### 3.8. Ducting systems for the high-vacuum extraction and filtration unit

A ducting system is used to transport the contaminated air from where it is collected to the extraction and filtration system. The system will be designed and assembled according to your wishes.

***Figure 12***

The complete system is galvanized and consists of pipes, clamps, connectors, T-pieces, reducers and all other necessary pipe parts.
All components are wear resistant because they are made of steel [1, 2, 4, 5, 6].

## 4. SELECTION CRITERIA FOR MOBILE FILTER EQUIPMENT

When welding metals, different sizes of dust particles are generated. The diameter of the particles is between 0.1 microns and 1.0 microns, mainly in the range under 0.4 microns.

**Table 2. Typical distribution of particles in welding fumes [6]**

| particle Ø in µm | <0.2 | <0.4 | <0.6 | <0.8 | <1.0 | >1.0 |
|---|---|---|---|---|---|---|
| number | 800 | 251 | 9 | 0 | 1 | 2 |
| % of the number | 75.3 | 23.6 | 0.9 | 0 | 0.1 | 0.2 |
| % of the mass | 15.9 | 38.7 | 7.5 | 0 | 8.2 | 29.7 |
| *Source: Spiegel-Ciobanu (AWS-study)* | | | | | | |

The table 2 shows that 98.9 % of the particles fall in the range of up to 0,4 microns. These particles are hardly removed at all by class M filters [6].

**Correct capturing of contaminants during welding [4]:**

- Capture at source
- Easily controlled hood
- Rotating hood
- Alignment of the hood to correspond to the weld
- Making secure Investments: meeting future regulations

**Filtration efficiency**

- 98.9 % of the contaminants created are in the nanoparticle range, i.e. less than 400 nanometers
- These particles are alveolar and cause cancer
- The usual filtration efficiency measurements of 99 % for particles of over 0.4 microns are not sufficient, and do not include the nanoparticles (Table 3).
- Systems plants with ePTFE filters achieve filtration efficiencies of over 99 % even with particles under 0.4 µm [1, 3, 4, 6].

*Figure 13*

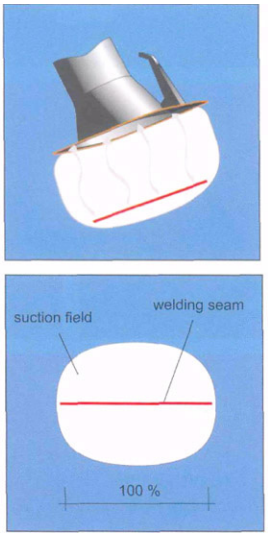


*Figure 14*

**Table 3. Selection criteria for mobile filter equipment [6]**

| ***Welding procedure*** | ***Welding procedure on alternating work stations*** |
|---|---|
| *Arc welding*<br>- non alloy materials<br>- low alloy materials | • Filter-Master XL<br>• Filter-Master<br>• Mechanical welding smoke filters, BGIA-certified |

| | |
|---|---|
| - Aluminium | • Mechanical welding smoke filters, mobile<br>• Cartridge filter units, BGIA-certified<br>• Cartridge filter units, mobile<br>• Electrostatic filter units, mobile<br>• Dusty<br>• Mini-Weldmaster |
| *Manual arc welding*<br>- high alloy materials<br>- non - ferrous materials | • Mechanical welding smoke filters, BGIA-certified<br>• Cartridge filter units, BGIA-certified<br>• Filter-Master XL |
| *MIG - MAG welding*<br>- non alloy materials<br>- low alloy materials<br>- Aluminium | • Filter-Master XL<br>• Filter-Master<br>• Mechanical welding smoke filters, BGIA-certified<br>• Mechanical welding smoke filters, mobile<br>• Cartridge filter units, BGIA-certified<br>• Cartridge filter units, mobile<br>• Electrostatic filter units, mobile<br>• Dusty<br>• Mini-Weldmaster |
| *MIG - MAG welding*<br>- high alloy materials<br>- non - ferrous materials | • Mechanical welding smoke filters, BGIA-certified<br>• Cartridge filter units, BGIA-certified<br>• Filter-Master XL |
| *TIG welding*<br>- non alloy materials<br>- low alloy materials<br>- Aluminium | • Filter-Master XL<br>• Filter-Master<br>• Mechanical welding smoke filters, BGIA-certified<br>• Mechanical welding smoke filters, mobile<br>• Cartridge filter units, BGIA-certified<br>• Cartridge filter units, mobile<br>• Electrostatic filter units, mobile<br>• Dusty<br>• Mini-Weldmaster |
| *TIG welding*<br>- high alloy materials<br>- non - ferrous materials | • Mechanical welding smoke filters, BGIA-certified<br>• Cartridge filter units, BGIA-certified<br>• Filter-Master XL |

## 5. CONCLUSIONS

5.1. An overview is made of issues related to the noxes emitted during the welding processes and possible variants to avoid the exposure of welders.

5.2. Local evacuation (exhaustion) when welding is the most recommended method. The decision to use one system or another one is justified.

5.3. Case studies presented give explicit details to justify options.

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