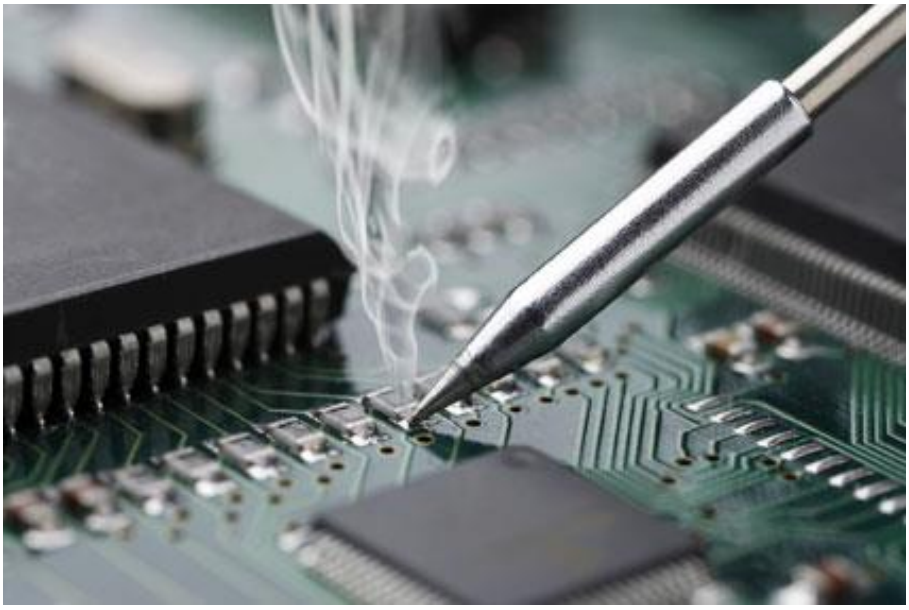
The Influence of Clean Air on the Value-Added Chain in Electronics Production

How to protect values in electronics manufacturing by the utilisation of technology for air purification



The value-added chain – what is this actually?

"The idea of the value chain is based on the process view of organizations, the idea of seeing a manufacturing (or service) organization as a system, made up of subsystems each with inputs, transformation processes and outputs".[1] The definition of a value-added chain by Michael E. Porter is one of many that can be found in reference books, works and on websites. In principle, it involves a sequence of activities, executed by a manufacturing company to develop, produce, sell, ship and maintain products or services.

Three main parameters essentially influence a value-added chain:

- Direct activities – research, development, production, shipment etc.
- Indirect activities – maintenance, operation, occupational safety, environment etc.
- Quality assurance – monitoring, test/inspection; quality management etc.

In particular, indirect activities and quality assurance generate a greater part of the costs in product manufacturing. This article principally focusses on the indirect activities.

[1] Porter, Michael Eugene, *Competitive Advantage*, Free Press, New York 1985

Indirect activities and their influences

The indirect activities within a value-added chain comprises of three subdivisions:

● Maintenance – this includes production resources and rooms as well as the entirety of all systems and plants

● Product quality – this includes precision of manufacture, accuracy, functionality and cleanliness

● Occupational safety – this includes work clothing, ESD protection, injury potential and clean air

All three issues have one common factor: they depend on clean air in the production rooms. How is this the case?

In modern electronics production, there is a multitude of different processes: from connection and separation technologies, surface processing such as marking, drilling, sintering and milling, the utilisation of fluxes, up to production processes such as 3D printing or rapid prototyping by means of laser, soldering, welding and gluing – all these processes generate harmful substances that might have extreme health impacts.

Airborne contaminants and their impacts

To put it shortly, all airborne pollutants have negative effects on employee health but also on production plants and products.

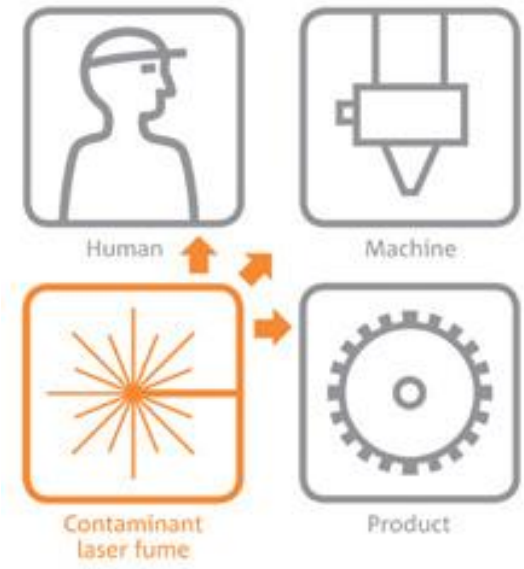


Image 1: the threefold damaging effect of laser fume on humans, machines and products

In principle, airborne pollutants are classified due to particle sizes. This classification primarily focusses on the influence of emissions on the human body. In addition to the possibilities of brain damages, neurotoxic effects or airway injuries, they are differentiated in terms of being inhaling (E fraction) or alveolar (A fraction).

The capture of contaminants is regulated by law in various countries. These regulations determine categories of danger for specific hazardous substances, e.g. in terms of fire and explosion risks, or in types of health damaging effects (cancerogenic, mutagenic or toxic for reproduction).

Airborne contaminants may additionally have negative impact on production systems and products. Depending on technology (laser, soldering, welding, etc.), they consist of various inorganic and organic substances, which might have partly dramatic effects based on chemical reactions.

Soldering fume, for instance, mainly consists of fluxes, soldering material and detergent residues, which often join up to adhesive aerosols. They also compromise machinery and products – and finally product quality – as they create firmly attached dirt layers. Contamination of electronic assemblies with tacky dusts may lead to conductor track corrosion, which can lead to partly or complete functional failure. Product quality suffers from the impact of hazardous emissions in the long term.

Extraction and filtration technology and its support

The early removal of airborne pollutants prevents their impact. Extraction and filtration systems provide an effective solution. The variety of systems on the market is high. Extraction and filtration units are determined by type, composition and amount of pollutants; system utilisation in automated, semi-automated and manual production as well as mobility or flexibility.

Image 2: mobile extraction and filtration system for larger amounts of soldering fume, the LRA 1200 from ULT

Modern extraction and filtration systems clean process air to such a high degree that the purified air can be moved back to the working area. This is based upon innovative filtration concepts, which can additionally be configured to special requirements.

The capturing of airborne pollutants is another decisive aspect in air purification. Closest proximity to the source of pollution is of critical importance – the closer, the better. Not only to capture the majority of all particles but to minimise economic efforts.

A general rule says that twice the distance between emission source and capturing element requires four times the exhaust performance in the extraction and filter system. Capturing elements are nozzles mounted on extraction arms. They guarantee the ideal capturing of airborne contaminants.
Due to pollution amount and type as well as airflow principles, they are available in various versions – up to complete housing solutions.

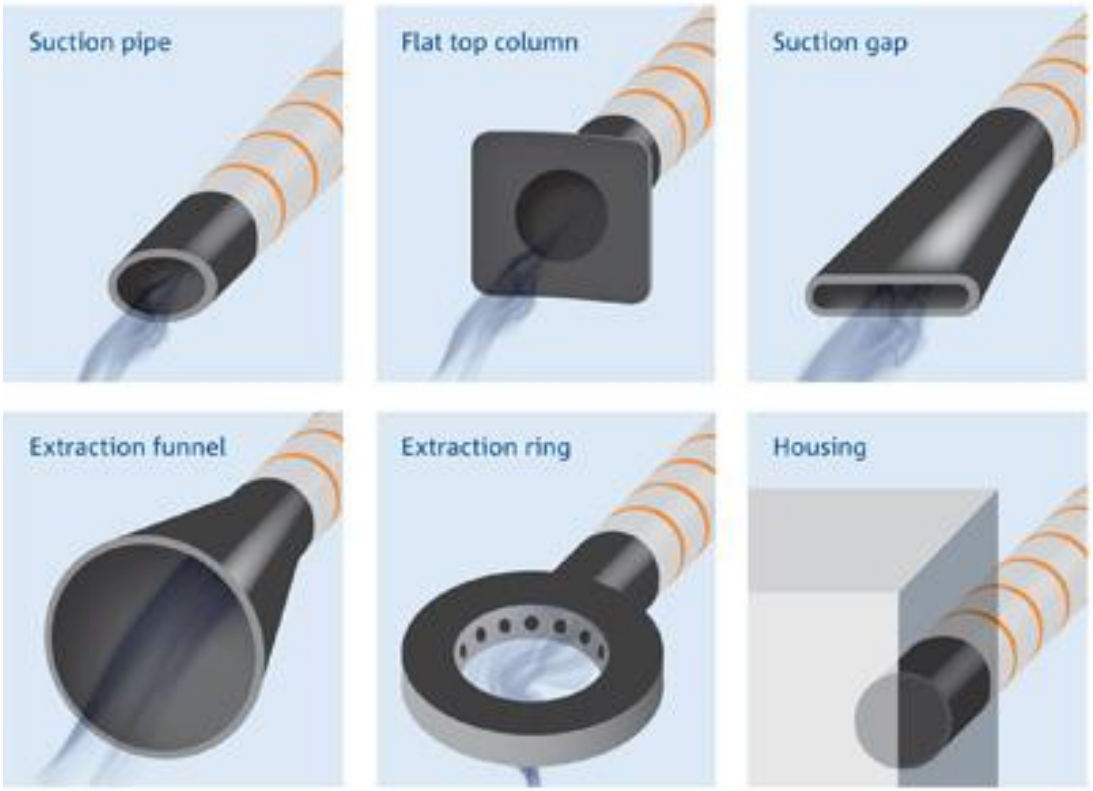


Image 3: selection of capturing elements

Basically, the appropriate capturing element can deliver a substantial contribution to the quality of the extraction and filtration device. The degree of capture rate forms the basis for subsequent high-grade filtration, finally providing high overall efficiency and low residue in the returned clean air.

Image 4: soldering fume extraction at manual workplace – utilisation of a suction pipe mounted on an extraction arm

The value-added chain and its dependence on clean air

Analysis of possible impacts of airborne pollutants on indirect activities within the value-added chain shows that all three subdivisions are concerned.

- Production resources and rooms must not be polluted
- Product quality and cleanliness must be guaranteed under all circumstances – restricted functionality is intolerable
- Employee protection is of highest importance – regulatory bodies determine the demands to be achieved

Extraction and filtration in electronics production goes far beyond the vacuum cleaner principle. It is not just a case of dirt removal but to eliminate hazardous substances in the air that may have negative impacts on humans, machines and products – consequently on the entire value-added chain.

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