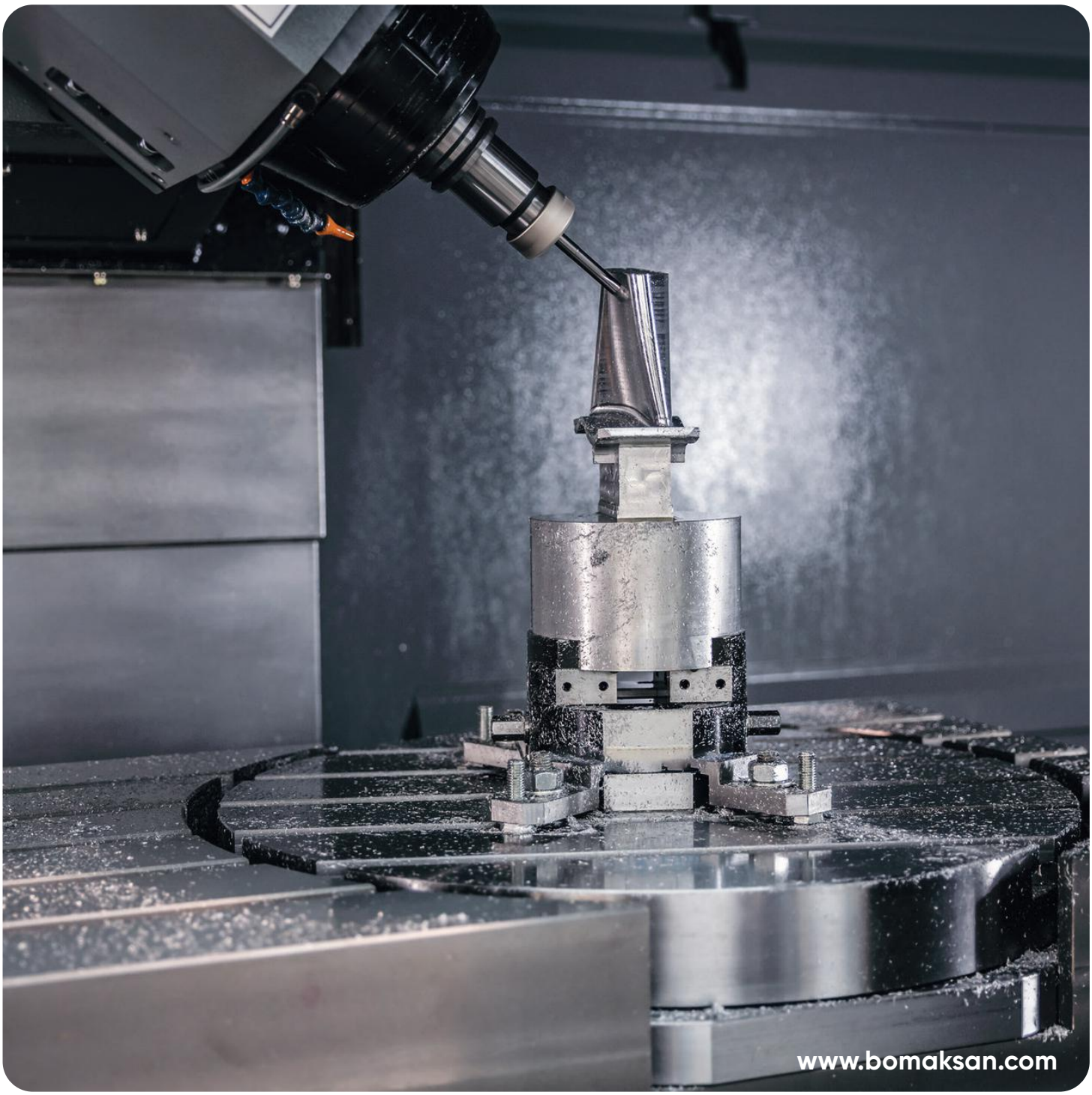
bomaksan®
INDUSTRIAL AIR FILTRATION SYSTEMS



CNC MACHINING
LATHE & MILLING

Oil Mist Filter Unit
SELECTION GUIDE

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1) What is Oil Mist?

Oil Mist or Oil Smoke (Burnt Oil Smoke, Oil Smoke), is the name given to the vapor / fog released as a result of the evaporation or burning of various coolant and lubricating liquids used in the industry due to contact with a heat source.

The main difference between Oil Mist and Oil Smoke is particle sizes. Oil smoke consists of particles less than 0.1 micron in size, while oil mist consists of particles above 0.1 micron. For this reason, it is important to have clear information about the pollution to be filtered.

What is Oil Mist?

Mist is generally thought of as a small droplet of liquid, but the definition of mist may be different for each sector. For this guide, mist is defined as:

• Liquid particle between 20 micron - 0.1 micron.

What is Oil Smoke?

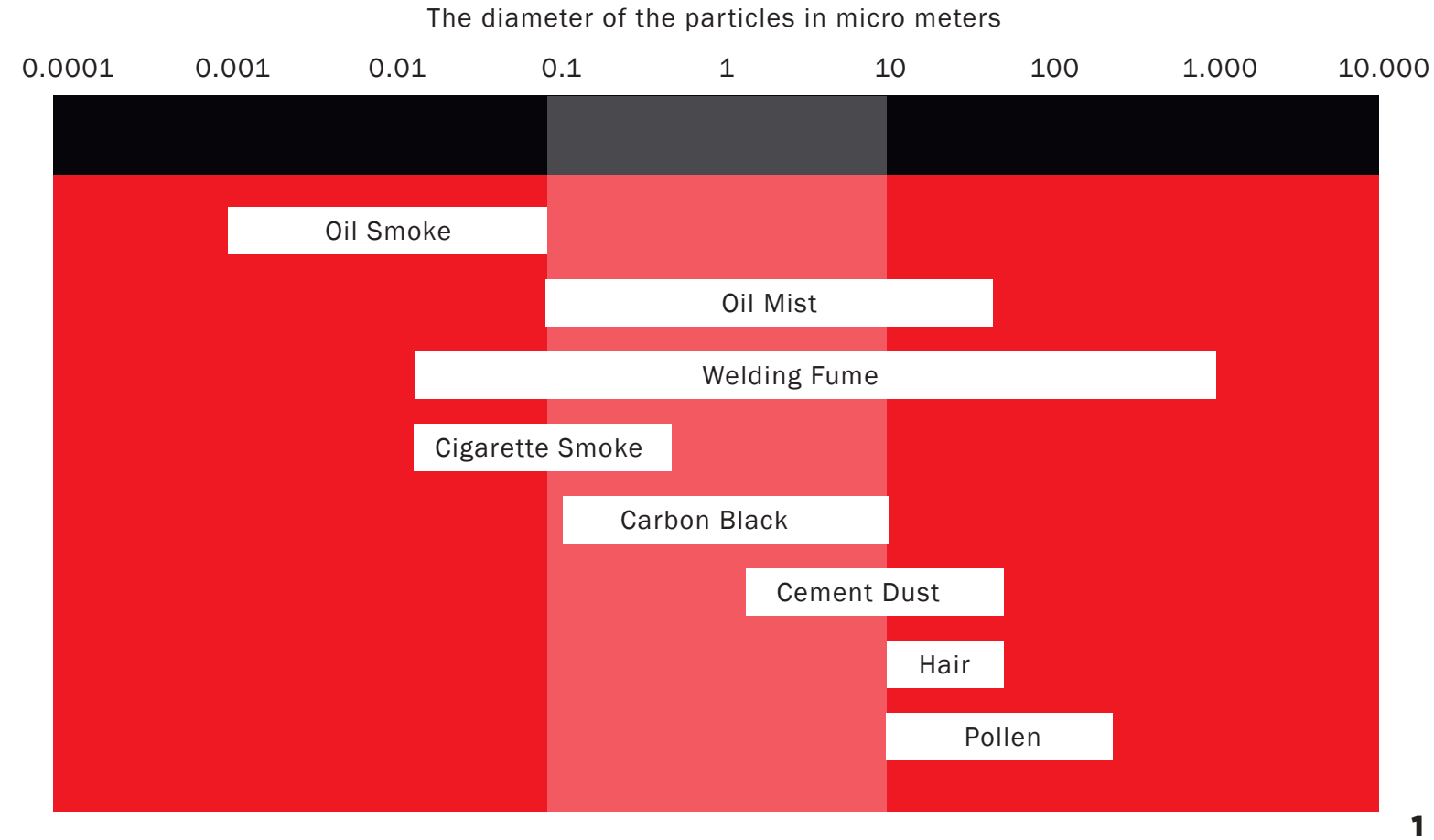
Smoke is often thought of as the gray to black colored air pollution emanating from burning wood, or the pollution you see and smell when someone is smoking. However, smoke is not defined as such in this manual.

Smoke in this guide;

A liquid particle, typically 0.07 to 1 micron in size, condensed from vapor to liquid.

• Thermally generated fog.

• Oily smoke.



1.a. Oil Mist Filter

History of Oil Mist Filters

Since the industrial revolution, coolants, oils and lubricants have been used to improve manufacturing quality, increase production efficiency, and extend tool life.

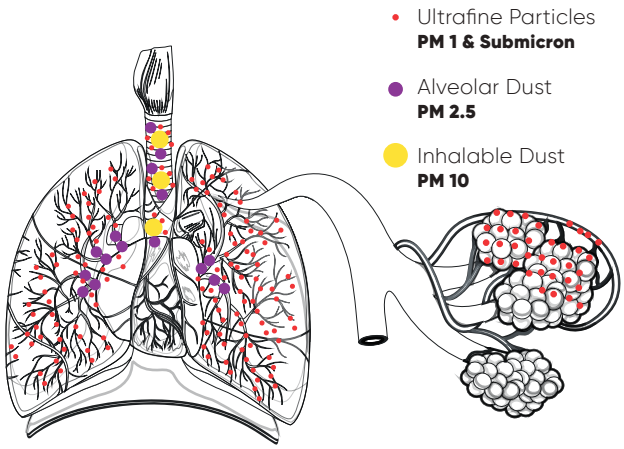
Especially with the growth of the automotive industry and household appliances industry and the transition to mass production to meet the rapidly increasing demands, more efficient production technologies that can tolerate less errors have gained importance. In order to meet this demand, the amount of coolant / lubricant used by the machining industry, the pressure to which these coolant / lubricants are sprayed and the speed of the machining tools have increased. With each increase in the amount of coolant / lubricant used, the spray pressure, and the speed of the machine tools, the particle size of the oil mist / oil smoke decreased while the amount of mist / smoke produced increased. This results in a steady decline in the indoor air quality of manufacturing facilities. So it requires new controls to reduce pollution levels in the air.

For over 50 years, governments, occupational safety and health organizations, and other organizations have studied the risks of exposure to cutting, cooling, and lubricating fluids commonly used in metal cutting and forming processes.

Numerous studies have shown that contact with the skin, ingestion by mouth, and repeated exposure to these materials through inhalation is likely carcinogenic.

As a result of the exposure of these risks, governmental organizations all over the world have determined their exposure limits. Since the late 1990s, OSHA has to reduce the 8-hour exposure standards for metalworking fluids to 1.0 mg / m^3, 0.5 mg / m^3, 0.2 mg / m^3.

Submicron Particles



As a result of the latest researches, it has been confirmed that particles under 1 micron, mix into our blood from the lung bronchi and cause cancer. For this reason, capturing and filtering particles below 1 micron, also called submicron particles, without breathing, is extremely critical for healthy and efficient working environments.

Occupational Disease Risk!

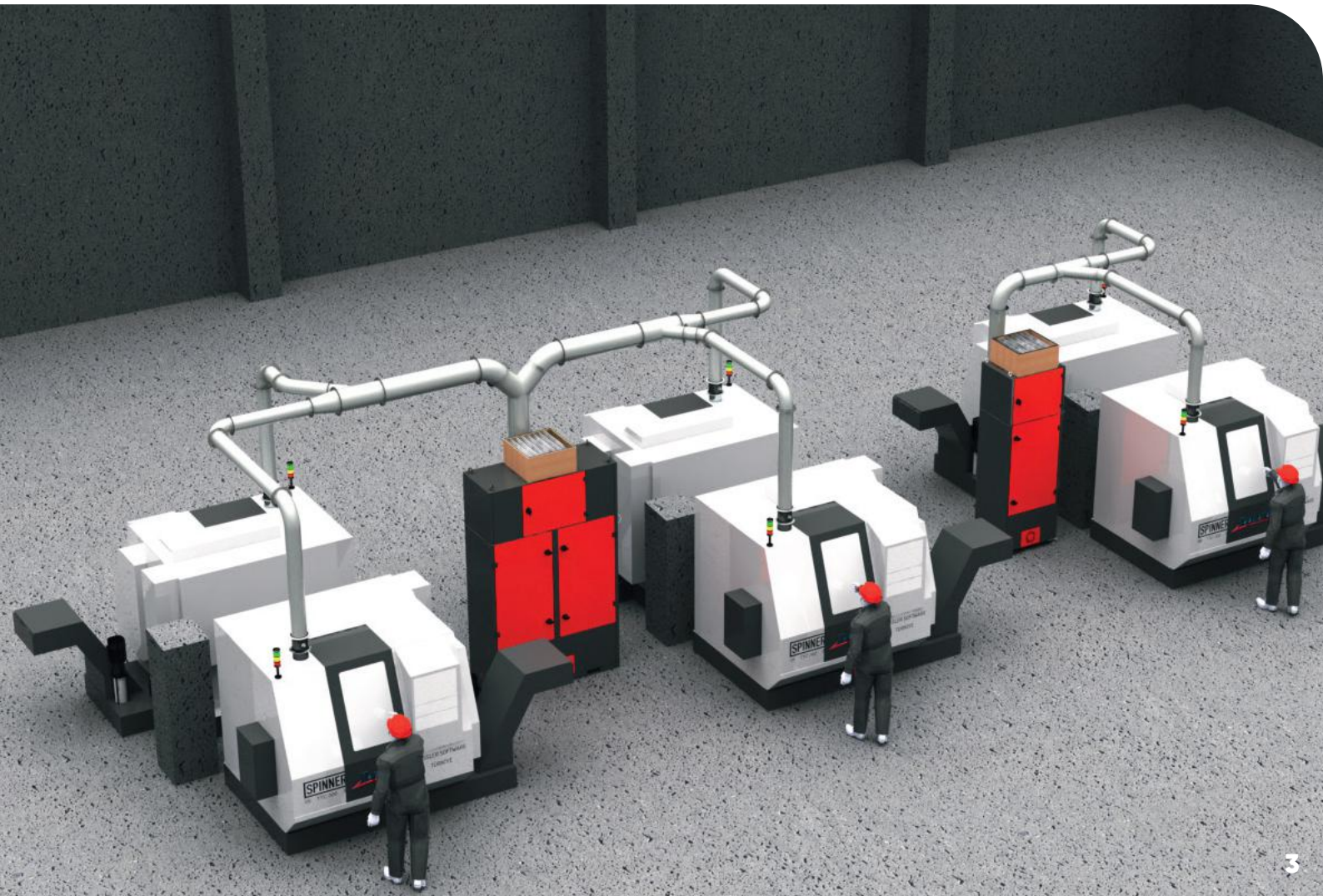
Exposure to mist and smoke from metalworking and shaping processes cause occupational diseases. Occupational disease both takes away the health of the sick employee and puts him in a difficult situation, and also causes the employers to be crushed under heavy compensation burdens.

1.b. Alternative Technologies in Oil Mist Filtration

Filtration of Oil Mist is an extremely difficult task. This is because the contaminated air that is collected and needs to be filtered is the evaporated or burnt state of the cutting, cooling and lubricating fluids used during metalworking and forming processes. This polluted air is moist and sticky. Especially when combined with dry dust, difficulties of filtration increases a lot and special techniques are required. This makes it one of the most difficult filtration tasks. Although the number of companies producing oil mist filtration devices is large, the number of companies specialized in this field is quite low. Selling lots of products is not the same as selling the right products.

For this reason, it is difficult to get accurate information in the oil mist filtration industry. Many companies in the market confuse consumers as they market their moderately efficient technologies as the top technologies available.

The main purpose of this booklet is to **introduce consumers to the technologies** used in the field of oil mist filtration and **which technology should be preferred** in which application in the light of scientific facts. Each of these solutions has advantages and disadvantages. You can get support from Bomaksan Clean Air Experts to choose the most suitable solution for you.

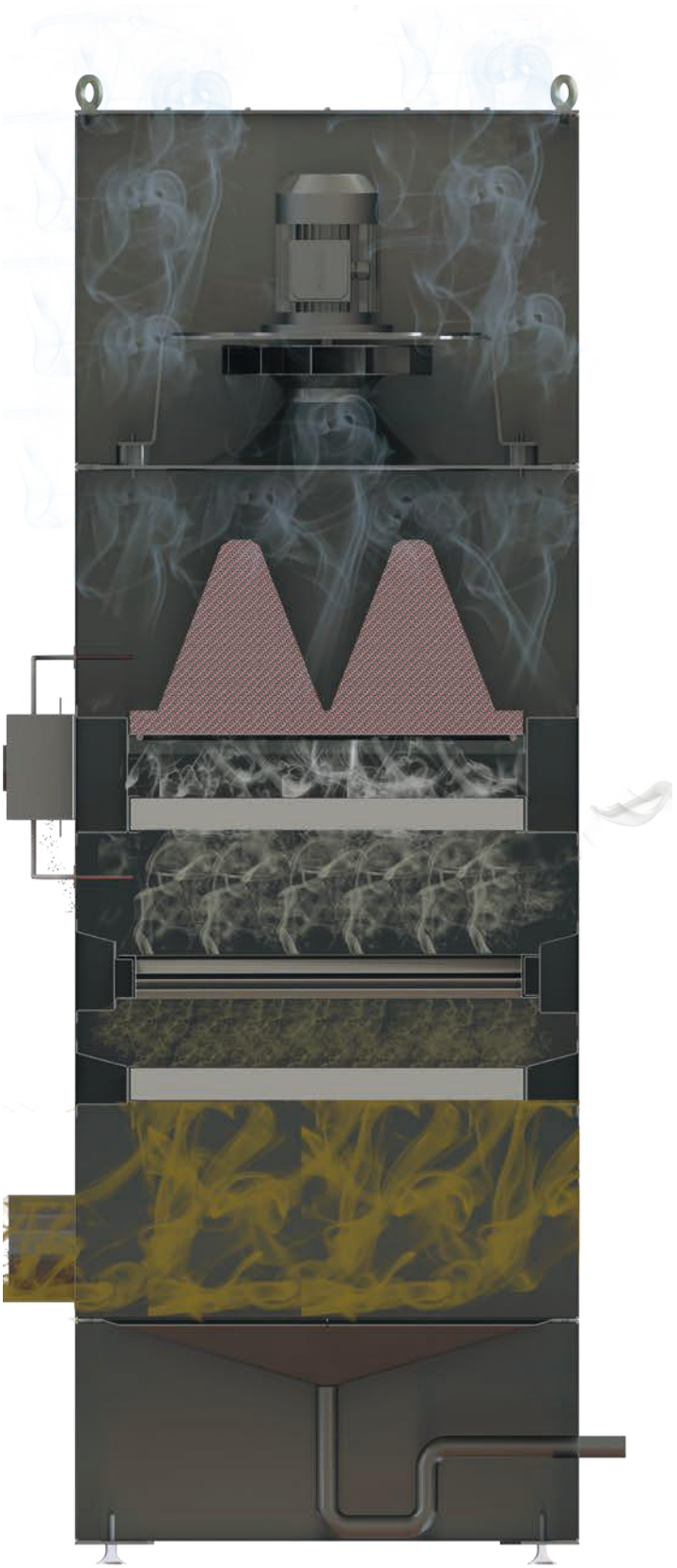


A. Multi Stage Filtration Technology

The most efficient and stable operating systems in Oil Mist Filtration Systems are multi-stage filtration systems. There are different filtration stages up to 3, 4 or 5 stages depending on the technology in filtration systems. In general of these systems;

1. Washable Pre-filter - Mist Condenser
2. Replaceable Pre-Filter - Increasing Main Filter Life
3. Main Filter - long-lasting special filter that captures small oil mist particles
4.. Absolute Filter - HEPA filter (Optional, required when Oil Smoke exist).

Technologies used in main filters are what makes companies different. Many companies in the market use standard air filters in the main filter stage. As a result of this situation, business owners have to stop their production frequently for filter changes.



Advantages;

- High filtration efficiency
- Low maintenance frequency, longer non-stop working
- Long filter life

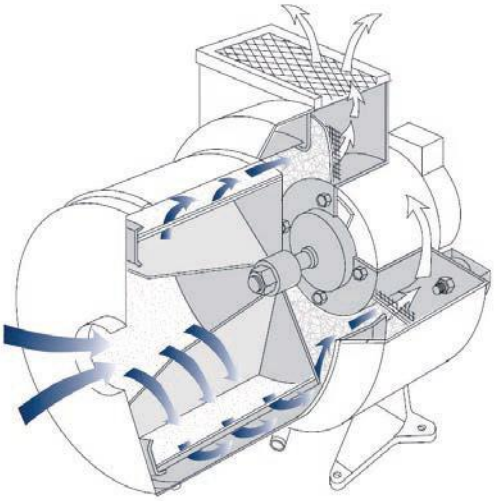
Disadvantages;

- More expensive initial investment cost compared to other technologies

B. Centrifugal Filtration

It is the oldest oil mist filtration technology. The main logic is to filter the collected oil mist by hitting it against the unit walls with the effect of centrifugation in a rapidly rotating drum. When the oil mist adhering to the surface as droplets gradually come together and reach the weight to overcome the gravity force, they filter down the wall into the oil collector.

The biggest handicap of centrifugal filtration is that **they only work with large vapor droplets**. So filtration efficiency is very low. For this reason, HEPA Filters should be used with these products. However, the HEPA Filters used with these units also clog in a very short time and require frequent maintenance.



Since oily and dirty air passes through the drum rotating at high speed, the rotating drum will be out of balance very frequently. Oily and dirty air passing through the drum adheres to the blades of the drum or rotor and starts to disturb the balance in the blades. Such imbalances in very fast rotating systems both pose a risk of work accidents and require frequent maintenance.

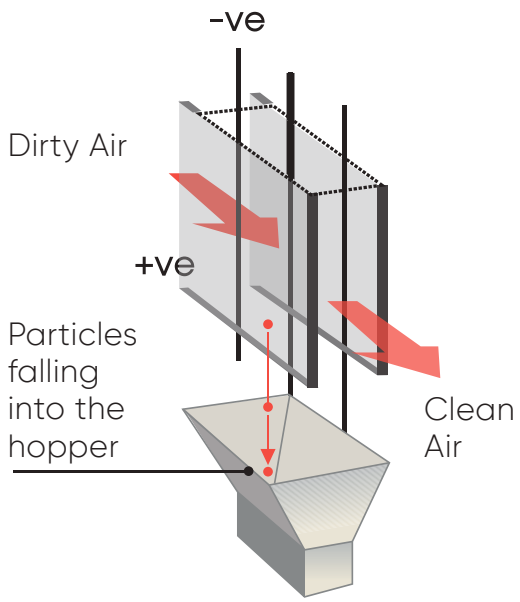
Advantages;

- Low initial investment cost

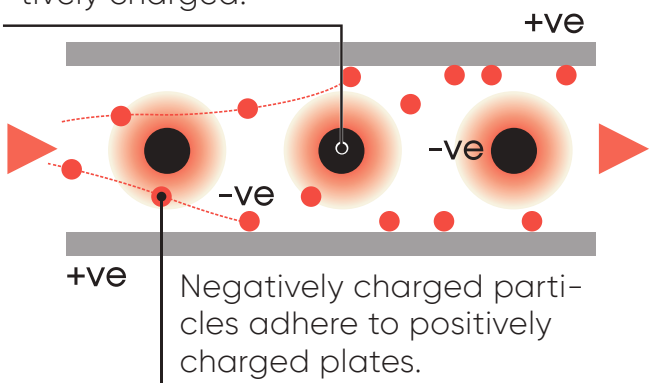
Disadvantages;

- Frequent downtime for maintenance
- Too frequently maintenance
- Expensive HEPA Filters need to be changed very frequently. (High Total Cost of Ownership)
- The drum needs to be re-balanced pretty frequently. (High Total Cost of Ownership)

ELECTROSTATIC FILTERS



CROSS SECTION AREA IMAGE



C. Electrostatic Filters

The working principle of electrostatic filters is about electrically charging the dirty particles passing through the filter unit as + and - and catching them in the plates inside. The filter efficiency of electrostatic filters varies according to the power used.

The biggest challenge for electrostatic filters is that they require constant cleaning. This situation turns into a nightmare for many maintainers and is not used over time. However, electrostatic filters with automatic cleaning systems are life-saving solutions for many production processes. The biggest problem of these systems is that the investment and running costs are very high.

Advantages;

- Working in harsh conditions when appropriate choices are made
- Suitable to work with Oil Smoke (Burnt Oil Mist)
- Low maintenance frequency in automatic washing systems
- No filter replacement costs in automatic washing systems

Disadvantages;

- The initial investment cost is high.
- The frequency of maintenance is high in systems with manual washing. A maintenance team should constantly wash the batteries on a weekly basis.

2) Applications

Oil Mist Filters can be used in a variety of applications where oil mist or oil smoke is released. The most common applications with Oil Mist filters

- CNC Lathe & Milling Machines
  - o Vertical Machining
  - o Horizontal Machining
- Die Casting Machines
  - o Aluminium Die Casting
  - o Zamak Die Casting

2.a. CNC Lathe & Milling Machines

Milling operations include vertical and horizontal spindles and drilling, honing, hobbing and drilling. In the milling machine, a rotary cutting tool moves on the product while the machined product is stand still.

These processes use water-soluble coolants (water-boron oil mixture) or lubricating oils and produce oil mist ranging in size from 20 microns to less than 1 micron. While water soluble coolants create larger diameter oil mist particles, lubricating oils produce much smaller oil mist and sometimes oil smoke.

2 types of oil mist can be generated in milling machines;

• When the coolant or oil contact with the rapidly rotating cutting tool. The tool swing the fluid at high speeds and create the oil mist mechanically.

• When the rapidly rotating cutting tool contact with the product, a high temperature occurs at the contact point. When water-soluble coolants contact with this heat, they evaporate and form oil mist. On the other hand, oils used as lubricants burn when they contact with this heat and form oil smoke.

Mist or Smoke?

By observing the room where the machining is carried out inside the machine, you can observe whether the resulting pollution is oil mist or oil smoke. High temperatures are required for smoke formation. You can look for a "blue" color on the edges of the steel chips to see if a process is generating this temperature. If there is a blue color, this indicates that sufficient heat is being produced for oil smoke. If oil smoke are emitted from your process, you can request a special solution by contacting Bomaksan officials.

Lathe operations can be found on different types of machines as well as CNC lathes. While the cutting tip is fixed in lathes, the produced part rotates at different speeds. As in milling machines, water-soluble coolant (water - boron oil mixture) or lubricating oils are used to keep the cutting edge and the produced product cold, to prevent the cutting tool from being deformed due to friction, and to prevent the chips formed during the process from damaging the product.

Different sizes of oil mist or oil smoke can occur on lathes;

• In lathes operating at low speed, large oil mist up to 20 microns can be generated from water-soluble boron oil-containing coolants..
• Submicron particles (oil smoke) are released from the burning of lubricating oils at high temperatures (encountered in hard alloy metal processes or high-speed lathes) and in systems that spray 55 bar and above liquid.

Dust & Chips

Dust and chips often remain in lathe centers and are generally not a problem for mist collection systems.

Lathe operations usually take place in a closed cabinet. By looking at the oil mist in the sealed cabinet, you can easily tell if thermally generated mist or smoke is present.

If the chips start to turn blue when you look at the chips on the conveyor, you can tell that there is a "hot" process that produces oil smoke / fumes.

Requirement for HEPA

In cases where oil smoke is seen, it is recommended to place a HEPA filter in the last stage of the filters. When pure oil is fed to the cutter at pressures of 55 bar and above, large amounts of 0.5 to 2 micron fine oil vapor are generated. At such high pressures, very fine (below 1 micron) oil mist may also be generated mechanically. In this case, it is recommended to place a HEPA Filter in the last stage of the filter unit used.

However, it is necessary to use HEPA Filter in cases where centrifuge type units are used as filter technology.

CNC Machining Center

What Should Be Considered When Designing the Right Filtration System?

The oil mist and oil smoke released in CNC Lathe and Milling machines must be collected and filtered. The things to be considered in the filtration system to be established for this are as follows;

A. Extraction Method / Hood

a. On CNC Lathe and Milling machines, the process usually takes place in a closed cabinet. Oil mist extraction and collection is performed from this closed cabinet.

B. Piping (Ducting) Design

a. Sealing is the most important challenge in oil mist piping. If the correct type of sealing elements are not used, leaks will occur at the joints of the pipes.

b. In-channel transport speed should be at least 20 m / sec. Otherwise, oil mist will settle in the pipe and accumulate. This situation causes serious security risks, especially fire.

c. Dry type, dust, smoke or gas should not be conveyed in the same suction line. Otherwise, the oil mist will become muddy and cause the filters to clog quickly

d. Piping design should be done by a competent firm.

C. Oil Mist Filter Unit

a. The type of coolant / lubricant used, the rotation speed of the machining tip and the spray pressure of the cooling / lubricating fluid play an important role in the selection of the filtration technology of oil mist or smoke released from CNC Lathe and Milling machines. Multi-stage filtration technology is the professional's choice for the collection and filtering of oil mist and smoke

b. When choosing a radial fan, fans which can provide sufficient air flow while overcoming the pressure of the line and the unit should be preferred.

c. If the Filter Unit will be located indoors;

i. Sound pressure level should be max 80 dB (A). If this is not possible, the unit should be located outside.

ii. Minimum H13 class HEPA filters should be preferred as the final filter in applications with submicron particles (lower than 1 micron particles)

d. Electric panel;

i. Panels with appropriate power for the electric motor used should be preferred.

ii. The panel must be manufactured in accordance with the machine safety directives and must have the necessary electrical equipment.

iii. If remote operation or operation is requested from the process, the electrical panel must be designed and manufactured accordingly.

iv. It must have a filter-full sensor and a filter level indicator.

Oil Mist Filter Unit

3) How to Compare Offers?

Since oil mist extraction and filtration systems require a technical and very special purchasing process, it is very difficult to compare apple-apple. Our goal is to help our customers choose the best solution for them while investing.

The first thing you need to do when choosing an oil mist extraction and filtration system is to have each company fill in the "Oil mist extraction and filtration system offer collection table" for the offers you have received. Descriptions of the cells in this table are given in detail later in this guide.

3.a. What is Air Flow?

Different terms such as Suction Flow, Extraction Capacity can be used. Extraction capacity is the name given to the air flow that the fan can extract at a certain pressure value. What is critical here is to specify the value given by the extraction flow at the pressure to be used. The flow rate in some technical catalogs is specified as the maximum flow rate that the fan can deliver, which is quite misleading. Because the fan will never reach that value in real conditions.

The most accurate approach in this matter is to determine the air flow delivered by the fan at the calculated fan pressure, based on the fan performance curve.

3.b. What is Fan Pressure?

Fan total pressure is the name given to the total pressure loss that the fan can overcome. In suction lines;

- Extraction Hood
- Dust / Fume transport channels (Elbows etc.)
- Pre-Seperators (Cyclone etc.)
- Filter Unit
- Duct between Filter and Fan
- Silencer
- Chimney / Stack
- Accessories such as Jet-Cap

There are areas that resist suction. Each of these areas are areas that resist suction or in other words cause pressure loss. The total pressure loss created by these areas creates the total pressure that the fan you will buy has to be overcome. While choosing the fan, it should be noted that the fan reaches the requested flow at this total pressure.

3.c. What is Fan Drive Type?

Fan drive type specifies how the motor drives the rotor in the used fan. Generally 3 types of drive type are used in radial fans;

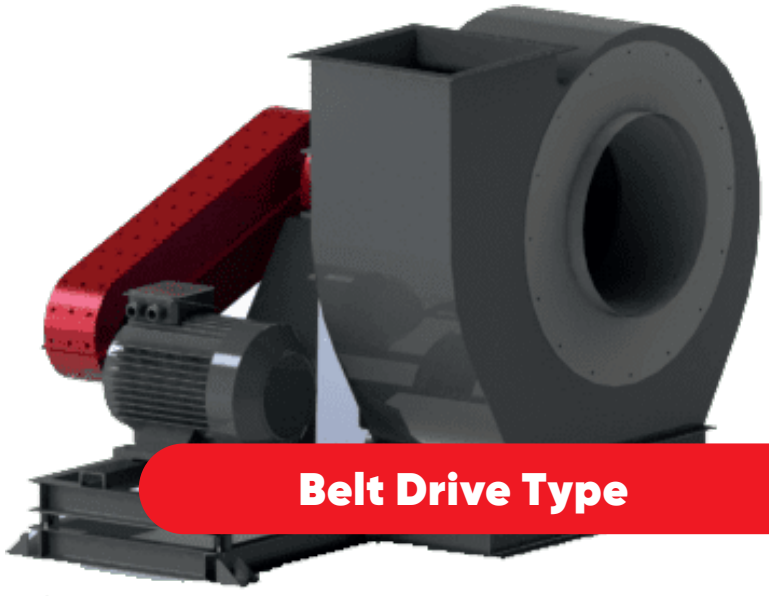
- Direct Drive: These are the fans that the motor drives the rotor directly through a shaft.
- Direct Coupled: These are the fans that the motor drives the rotor through a coupling shaft.
- Belt Drive: These are the fans that the motor drives the rotor with a belt pulley.

Which One is Better?

It will not be correct to say one is better than another. Any of them can be the right choice, depending on the needs of the process.

Caution When Evaluating the Fan!

When examining the technical features of the fans, the point to be considered is that the required flow rate can be obtained at the required pressure. Some manufacturers give their maximum fan capacity information, not the capacity the fan receive at the required pressure. However, this value has no meaning since it will never deliver this maximum air flow in your process. Therefore, it is useful to examine the fan capacity and motor power together.



Belt Drive Type

3.d. What is Shaft Power?

Shaft power is the total power required to rotate the shaft according to the extraction capacity of the fan and the total fan pressure. Shaft power calculation is a mathematical calculation. The formula is given below;

Shaft Power Calculation

P = (P(t) x Q) / (102 x η(m) x η(mech.) x 3.600)
P : Shaft Power (kW)
P(t) : Fan Total Pressure (mmSS)
Q : Air Flow (m^3/h)
η(m) : Motor Efficiency
η(mc) : Mechanical Efficiency

The critical factor here is fan efficiency. Fan efficiency can never be 100% and general acceptance;

- Motor Efficiency: 85% (Standard acceptance, may differs according to the IE class and power of the motor)
- Mechanical Efficiency;
  - Direct Drive : %90-95 efficiency
  - Direct Coupling : %80-85 eff.
  - Belt Drive: %80-85 eff.

Example;
Q = 4.000 m^3/h
P(t) = 275 mmWG
Fan Drive = Direct Drive

Shaft Power:
= (4.000 / (102*0,85*0,90*3600))*275
= 3,92 kW

Shaft power calculation is critical in motor selection. The motor to be used should be selected at least 5% higher than the calculated shaft power.

3.e. What is Motor Power?

Motor power is the motor power of the fan in the compact filter unit you will purchase. As mentioned on the previous , it should be selected above the shaft power. It is expressed in HP in the imperial system and in kW in the metric system.

Motor power is one of the most important parameters in a oil mist filtration system, because motor power directly affects extraction performance. Mathematically, it is not possible for 2 fans with different motor powers to show the same performance, unless they are using different filtration technologies and one has terrible filter unit design.

Unfortunatelly, some manufacturers' design their filter unit so small that the pressure loss of the filter unit is 3x higher than it should be. In such cases, 2 fans with different motor can deliver same air flows.

In such cases, even the filter unit with bigger motor seems to have higher extraction capacity, well they don't because of the huge pressure loss of the filter unit.

Attention When Comparing Filter Units!

Some manufacturers designs their oil mist filter unit so small that the pressure loss of the filter unit becomes 3x higher than it should be. In such cases, 2 fans with different motor can deliver same extraction performance.

3.f. What is Filtration Technology?

Filtration technology is the area where the technology is used in oil mist suction and filtration. It should be noted that the most common technologies in Oil Mist Filtration systems have to reach the demanded air flow at total fan pressure.

A. Centrifugal Filtration

o This technology is one of the oldest technologies on the market.

o On the basis of the technology, there is condensation and filtration by hitting the extracted oil mist particles against the walls of the filter with the effect of centrifuge.

o **Advantages:**

- Küçük ve kompakt bir yapıdadır.

o **Disadvantages:**

- The drum /impeller which makes centrifugal effects might be out of balance very frequently. This means high total cost of ownership.

- Since the filter efficiency is insufficient for today's requirement, HEPA filter will be required at the end. In this case, expensive HEPA filters need to be changed frequently.

- It can only be used in processes with large droplets.

B. Multi-Stage Filtration Technology

o It is the most reliable technology in oil mist applications.

o The basis of the technology is the filtering of the extracted oil mist particles and oil smoke through a 3 or 4 stage filter, respectively.

o Each stage provide different type of filtration and thus, at each stage a certain amount of pollution is filtered. The main purpose is to extend the life of expensive end-stage filters, thereby providing lower maintenance costs.

o **Advantages:**

- Low total cost of ownership due to long filter life

- Less frequent maintenance

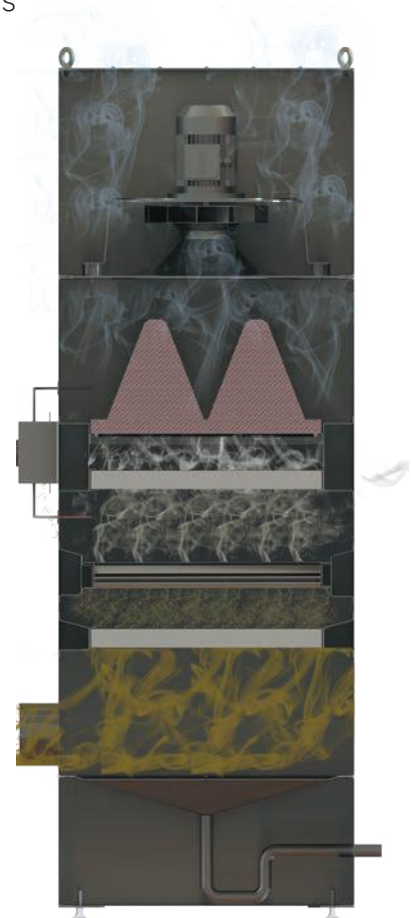
- Option to be connected to many CNC Centers at the same time

- Suitable and energy efficient use even in high capacity applications

- It is suitable for mass production CNC Lathe & Milling machines.

o **Disadvantages;**

- Takes up more space than centrifugal filters



C. Electrostatic Filtration Technology

o At the heart of the technology are plates that electrically charge the particles passing through them. Negatively charged particles adhere to positively charged plates.

o It can be divided into 2 types as automatic washing and manual washing. These 2 devices are located in very different places from each other.

o **Advantages of Auto Cleaning:**

- Containing paraffin wax can even retain oil vapor and heat.
- Very low maintenance cost
- There is no maintenance work such as filter replacement and cleaning.
- It is suitable for mass production machines.

o **Disadvantages of Auto Cleaning:**

- High initial investment cost

o **Advantages of Manual Cleaning:**

- No filter replacement cost
- Low initial investment cost

o **Disadvantages of Manual Cleaning:**

- High maintenance cost
- Require weekly high duty maintenance.
- Not suitable for mass production CNC Centers

Manuel Cleaning Type

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