APPLICATION GUIDE

Absolent

CHAPTER 1

1. PROJECT DESIGN FOR OIL MIST AND OIL SMOKE APPLICATIONS

There are times when it is difficult to size the correct filter unit as well as the proper airflow to clean contaminated air for a specific application. This Absolent booklet will help you to do just that!

1.1 GENERAL

Oil mist and oil smoke is generated in various manufacturing operations. In order to properly solve a mist/smoke problem for a customer we need to understand what oil mist and oil smoke really is.

1.2 OIL MIST AND OIL SMOKE

There are four different catagories in which the oil mist and oil smoke can appear. These are shown in table 1. The smaller the particle the more dangerous the particle is for ones health. The really high concentrations of particles (particle loads) are usually generated when straight oil is used, since it can withstand a lot higher temperatures before it gets vapourized.

TABLE 1

Type	**Particle size [µm]**
Spray	10
Oil mist	1-10
Oil smoke	0.1-1
Submicron oil smoke	0.1-0.5

1.3 NATIONAL LIMIT VALUES

It is, of course, unhealthy to inhale these substances and that is why the the National Board of Occupational Safety and Health has drawn up specific limit values.
In table 2, the Threshold limit values for some specific countries are shown.
Please note that emissions from all Absolent filter units are far lower than what these limit values specify.

USA

GERMA-

SWEDEN

UK

1.4 WHERE DOES OIL MIST AND OIL SMOKE APPEAR?

Oil mist is generated when oil or water mixed with concentrated cutting fluid, so-called emulsion, is used for cooling, lubricating or chip removal. It can also appear in the food industry, rubber industry and in machine rooms.
Oil smoke generators are: Cold forming, cold headers, die casting, rolling mills, Heat Treat and high speed machining with straight oil.
The following factors determines the particle size: toolspeed, heat generation and tool diameter.
As machining operations are carried out, these fluids are emitted i form of aerosols and smoke to the surrounding air.

TABLE 2

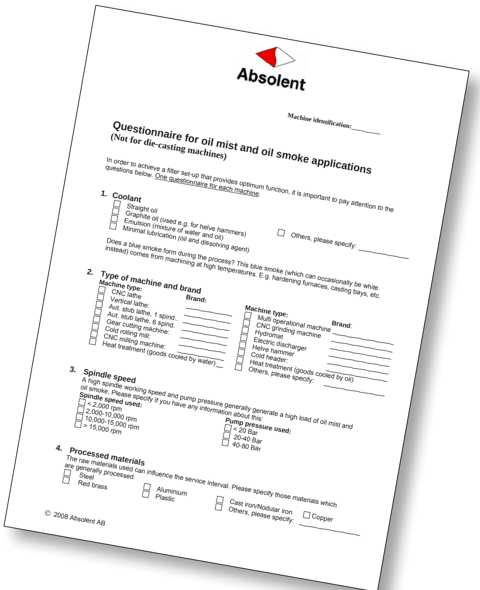
Maximum threshold limit values (TLV) in different countries.

Type	Threshold limit value [mg/m³]
Sweden	1
Germany	5
United Kingdom	5
USA	5

1.5 WHAT ARE THE RISKS?

The risks that are most often associated with large concentrations of oil mist or oil smoke are the following:

- Oil is considered to be carcinogenic, i.e. can cause cancer.
- Oil mist can contain small metallic particles that can cause respiratory problems.
- Skin problems, including oil acne and eczema
- Increased risk of slipping – oil mist eventually settles on the floor.
- Deteriorated indoor air caused by oil accumulating on surfaces inside the ventilation system impairing its function and fouling the air.
- Generally unclean environment due to the oil attracting other impurities causing them to stick to machines and other equipment.
- Aerosols harm the electronics in modern metalworking machines.



PIC 1: The Absolent Questionaire

1.6 THE ABSOLENT QUESTIONAIRE

In order to get all the necessary information for a application, Absolent has put togehter a Questionaire that the end customer and the Absolent representative should fill in together.
With the help from the answers to this questionaire, the Absolent representative could make the correct quotation for a filter unit that matches the customers needs in every aspect.

1.7 WHAT INFLUENCES THE PARTICLE SIZE

As a guideline, following facts influences the particles to get more and smaller:

- High temperature (usually not a problem with water-based coolants)
- High liquid pump pressure
- High spindle speed
- Neat/Straight oil with low viscosity

If one or more of the mentioned states are involved in the project, the particle loade could be a pretty high and also the particles could be very small. In some cases, for example if the oil has a low viscosity, there is a risk for gas particles. A special particle filter for gas (for example a carbon filter cassette) then needs to be added. Low viscosity oils are often used in combination with mini-lubrication.

PIC 2: Metal working fluid in ”action”

1.8 DIFFERENT TYPES OF METAL WORKING FLUIDS

There are several different types of coolants & lubricants available on the market. They are used for cooling and lubricating metal workpieces when they are being machined, ground, milled etc. The fluid rduces the heat and friction between the cutting tool and the workpiece.
By the application of fluids, the quality of the workpiece is improved, due to the continuous removement of swarfs and chips from the tool. The possible adjustments that needs to be done to our standard filter units, will be coverd later on in this booklet.

- Water based coolant / Emulsion
  The Emulsion is a mix of water, oil and a emulsifier. It is often used in processes, where a big cooling capacity is needed. Emulsion often form oil mist (particles >1 µm. This type of fluid is seldom used in high temperature processes, since the water evaporates.

- Straight oil / neat oil
  Often used in processes where high lubrication and high surface finish is needed. Straight oil often form oil smoke (particles 0.1-1.0 µm).

- Graphite oil
  Graphite lubricants be used at very high temperatures, which makes it ideal for example at hot forging. It ususally forms oil smoke and and sticky particles that needs special attention.

- Wax
  Wax is often used as a release agent by die casting applications. It forms a lot of very sticky particles that needs special attention.

1.9 HOW TO MEASURE THE PARTICLE LOAD

There are different ways to establish the particle load. Experience could be good enough, but it always opens the risk for the unpredictable. Experience from similar applications is commonly good enough but the safest way is to measure (for example with the DustTrak, see pic 4).

With the help of this equipment, the Absolent represenative gets the facts he needs to quote a perfect solution.

PIC 3: The DustTrak device

1.10 A UNIQUE COMBINATION OF A HIGH, CONSTANT SEPARATION DEGREE AND SELF-DRAINAGE.

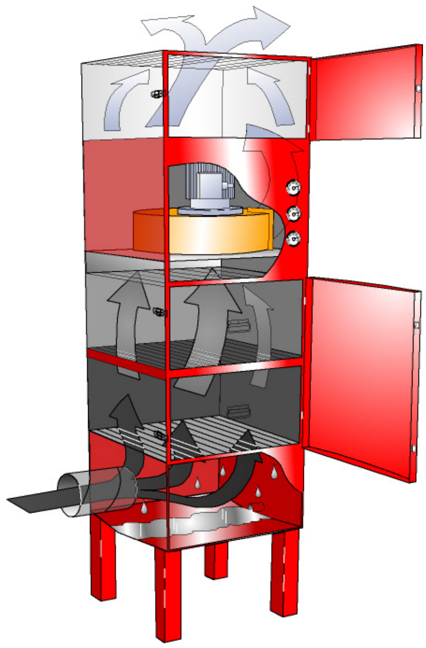
There are several filtration techniques available on the market, such as: mechanical, electrostatic and centrifugal filters. The Absolent filter units are based on mechanical filtration. It is important to remember that all these filtration techniques can achive a high and constant separation degree. All they need to do is to install a HEPA Filter, which is a micro-filter specially developed to filtrate air to clean rooms, surgical theaters, laboratories etc. The only thing is, a HEPA-Filter is very quickly clogged if the pre-separation is poor.

Absolent has solved this problem by developing unique filter cassettes, where a high separation degree is combined with a very effective self-drainage. In the Absolent unit, the particles are catched and then immidiately released from the filter material. Therefore, more than 90% of the oil mist is collected and drained instead of clogging the HEPA-Filter.

The Absolent catch and release technique works perfectly also during continuous operation, which makes the filter units very cost effective.

In pic 4, a Absolent filter unit is pictured. The filtering process occurs here in three stages. The process air first passes through the self-draining Absolent filter cassettes, stage 1 & 2, where most of the particles are collected.

The last filter stage consists of a HEPA filter, filter class H13, which has a guaranteed and consistent collecting efficiency of 99.997% arresting 0.3 µm dia. particles.

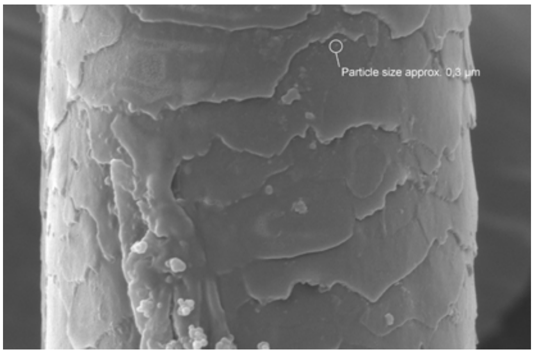


PIC 4: The function of the Absolent ODF 2000

1.11 HOW SMALL PARTICLES DO WE CAPTURE?

How big is a 0,3 µm particle then? In picture 5, a hair straw is shown. The tiny little white dot inside the white circle is a 0.3 µm particle and that is the size of the tiniest particles that are arrested, constantly during the installations lifetime!

Always remember to check the particle size with which the manufacturer bases his collection efficiency. It is, of course, easy to specify really high collection efficiency if the particles involved are large as tennis balls...



PIC 5: The size of a 0,3 µm particle.

1.12 HOW MUCH OIL IS DRAINED?

The example below, shows how much oil that is drained out of the filter unit during one year of continuous operation:

0.002 mg/m^3
0.002 kg/yr

Example:

An air flow of 4000 m^3/h is needed and the particle load is 100 mg/m^3. Due the high load, an ODR 3000 is chosen. The filter unit runs continuously, 24 h/day (46 weeks/year)

1.4 mg/m^3
43 kg/yr

20 mg/m^3
620 kg/yr

With the help of the given separation degrees, in table 3, the particle load after each filter stage can be calculated. The results are also shown in table 3.

100 mg/m^3
3100 kg/yr

The corresponding weight that is separated, can be calculated as follows:

The total weight that enters the filter unit per year is:
100 mg/m^3 = 0,0001 kg/m^3
0.0001 kg/m^3 x 24h x 7 days x 46 weeks x 4000 m^3/h = 3091 ≈ 3100 kg/year

Again, by using the separation degree, the captured oil in each filter stage can be calculated:

Captured in filter stage 1: 0.8 x 3100 = 2480 kg/year
Captured in filter stage 2: 0.93 x (3100 - 2480) = 577 kg/year
Captured in filter stage 3: 0.99997 x (3100 - 2480 - 577) = 42.998 kg/year

The remaining oil, that is let out to the surrounding is:
X = 3100 - 2480 - 577 - 42.998 = **0.002 kg/year!!**

TABLE 3

Inlet load	Separation degree	Particle load [mg/m^3]
Filter stage 1	80%	100
Filter stage 2	93%	20
Filter stage 3	99,997%	1.4
To the premises		0.002

1.13 ALWAYS COMPARE THE FILTER AREAS

The filter material in the different filter cassettes have been carefully mixed to fit different applications. For example applictions for die casting, have their own ”special mix”.
Not only is the material thick and consisting of several layers, it is also pleated back and forth several times to create as big surface area as possible. The lower air velocity and the longer time the air is inside the cassette, the better separation degree is reached. Therefore, it is so important to check filter areas, when comparing filter units from different manufacturers.

Several units on the market offers either small filters panels (like the one you have in your cooker hood) OR perhaps bag filters. If the filter material in filter stage 1 is unfolded, 36 m^2 - an area as big as a living room is covered. If all 3 filter stages are unfolded, 118 m^2 - an area as big

PIC 6: The Absolent filter cassettes

1.14 THE FILTRATION TECHNIQUE

Two different filtration techiques are often discussed: surface filtration or depth filtration.

The surface filtration technique, is for example used in our dust filter range. Here, the filter material should be considered as a mesh. Particles that are bigger than the openings in the mesh, will be separated.

In the oil mist (ODF) and oil smoke (ODR) filter units however, the particles should get into the filter cassette and then get drained out of it. This type of filtration is called depth filtration technique.

The filter material and the filter surface area / air volume differs between our two ranges. The reason for this is that our ODR range deals with much smaller particles than the ODF. The particles are so small that they are moving randomly around the streamlines. They will only be captured if they happen to hit a fiber.

It is therefore very important to have a slow air flow through the ODR-filter cassette. The reason is simply, that the chance of catching one of these tiny particles increases. That is why the filter area is so much bigger in the ODR range compared to what it is in the ODF range.

1.15 WHERE TO USE WHAT

Where should the different filter ranges be used then? Following guidelines could be used:

ODF

The ODF range is perfect for following applications: Grinding (cutting fluid emulsion), Turning (cutting fluid emulsion), Milling (cutting fluid emulsion), Machining, using straight oil and moderate loads

The spindle speed and the pump pressure is often at moderate levels. This kind of operations often have particle loads lower than 15 mg/m³, which makes them ideal for our ODF Range.

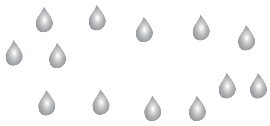
ODR

The Absolent ODR range is well suited for use in applications such as:

Heat Treatment, Cold drawing, Gear cutting, Grinding with neat oil, CNC turning with straight oil, Forging operations and cold pressing.

The pump pressure is often higher as well as the spindle speed. The particle loads are often very high, it could be over 150 mg/m³. The correct choice for this type of application is the ODR range.

Please remember always to use the checklist and some kind of measuring device to be sure!



PIC 7: The draining function in the Absolent filter cassette.

ODF ODR

TABLE 4

Filter type	Inlet load [mg/m³]
ODF 800	10
ODF 1000 and bigger	20
ODR 2000	70
ODR 3000 and bigger	150

If the guaranteed filter cassette life time should be reached, the recommended max. particle load shouldn't be ex-

1.16 HOW TO CALCULATE THE PROCESS AIR FLOW

Most Machine manufacturers have recommendations for the required evacuation air flow. This can usually be found in the user's manual. If there are no recommendations available, there are two methods for airflow calculation:

the door principle or the air exchange principle. The door principle should always be the first choice when making an air calculation because it guarantees a good functionality. For big machines and/or low particle concentrations the air exchange principle can be an alternative because it usually gives a lower airflow.

1.16.1 THE DOOR PRINCIPLE

To avoid leakage of contaminated air from a machine it needs to be a negative pressure inside the machine, which means that if there are any leakage at all it needs to be continuously evacuated. When the machine doors are closed, the evacuation need (requested air flow) is low. But as soon as the doors are opened, the negative pressure inside the machine will disappear and contaminated air will leak out. To avoid this leakage the air velocity through the open doors need to be 0.5 m/s.

For applications, where the temperatures are reasonable, 0.3 m/s usually is enough. But for applications with high loads of oil smoke, typically at higher temperatures, an air speed of 0.5 m/s is necessary.

By using the open door area, the requested process air flow need can be calculated, see formula in Pic. 9.

If a machine has several doors, an assessment of the probability that all doors are open at the same time needs to be done.

Example 1:

A machine has two 1 m² doors and one opens up every 5 minutes and the other one every 3 minutes, the dimensioning door area for the machines air flow need would be 2 m².

Example 2:

The same machine but if the first door would open up every 3 minutes and the other one every 30 minutes, the dimensioning door area would be 1 m².

Please note, that the air flow can be reduced, if the doors aren't opened directly after machining is finished (compare "air exchange principle").

PIC 8: Machine with a open door

The process air flow (q_p), is calculated with the formula:

$$\dot{q}_p = v \times A$$

where:

$\dot{q}_p$ = The process air flow in m³/s

v = The air velocity in m/s normally set to 0.5

A= The open area in m²

PIC 9 Formula for calculation of needed process air flow.

PIC 10: Turning machine

Example 3:
A Turning machine (see Pic 10) needs to be evacuated. The inspection doors are 1 m² totally. There is also a goods loading hatch at the side of the machine, which measures 0,15 m². In total there is an open area of 1,25 m² . The need of air velocity is 0,5 m/s.

Air flow calculation: $\dot{q}_p$ = v x A = 0,5 x 1,15 = 0,575 m³/s x 3600 = 2070 m³/h
A filter unit for 2000 m³/h would be suitable in this case!

1.16.2 THE AIR EXCHANGE PRINCIPLE

As mentioned earlier, there is a second way to calculate the process air need which can be used for big machines and/or low particle concentrations. (Pic. 11).

The "air exchange principle" is about how often the air in the machine should be exchanged. The guideline is to exchange the air 4 times/min. By using the approximate internal machine volume the requested process air flow need can be calculated with the formula in Pic 12. At common applications these air changes will give an air quality in the machine that is acceptable when the door is opened.

Example 4:
A Cutting machine (see Pic 13) needs to be evacuated. The inspection doors are 6 m² totally. The internal volume in the machine is 32 m³.

How big must the process air flow then be?

$$\dot{q}_p = V \times k \times 60 = 32 \times 4 \times 60 = 7680 \text{ m}^3/\text{h}$$

If the service doors are opened instantly after the machining has stopped, a filter unit for 8000 m³/h would be suitable in this case!

In some applications when very high loads of oil mist / oil smoke is generated, the concentration of the oil mist in the machine might be high and will not be acceptable when the door is opened. The machine doors then need to be shut for a while (typically = one air change, 15s) after the operation is finished so that the remaining oil mist is sucked out. The customer can normally accept this if the machining cycle time is long.

Big machines with internal volume larger than 50 m³ with big doors larger than 10 m² the standard "air exchange principle" formula gives very high airflows (= large filters = high cost).

PIC 11: Machine with semi-large doors

The process air flow (q_p), is calculated with the formula:

$$\dot{q}_p = V \times k \times 60$$

where:
$\dot{q}_p$ = The process air flow in m³/h
V = Internal volume in the machine in m³
k = No of air exchanges Normally set to 4 times / min.

PIC 12: Machine with semi-large

PIC 13: Cutting machine with large service doors

Because of the big internal volume, the particle concentration inside these type of machines usually isn't that high. With a lower particle concentration less air changes/minute can be accepted. The Absolent guideline is then 3 times/min. But the machine doors then need to be shut one air change after the machining has finsished, so that the remaining oil mist is extracted by the filter unit.

The formula that helps calculate how many seconds the doors needs to remain shut after machining is done, is shown here beside.

When the "air exchange principle" is used, it is very important to check that there is no leakage from the machine when the doors are closed. Use the "Door principle" and check that the air velocity is at least 0,5 m/s) in all open areas. If the air speed is to low, the openings need to be sealed or reduced.

The necessary time (t) to wait before the doors are opened, is calculated with the formula:

$$t_{doors} = V_i / (\dot{q}_p/3600)$$

where:

t_{doors} = Time the doors need to remain shut for 1 air change.

$\dot{q}_p$ = The process air flow in m³/h

V_i = The inner volume in the

FAQ

What is the max air and/or ambient temperature for filter units with integrated fan?
40°C (104°F)

Are the filter cassettes washable?
ODF - Filter cassette No. 1 (lowest) and No. 2 centre (does not apply ODF 800, 1000, 1000C) can be washed several times). Wash with water-based degreasing agent, max. permissible water temperature: 194°F / 90°C. After washing, the filter must be left to dry until it no longer drips.
Please note: The useful life of the filter may vary after washing from comparable to a new filter to reduced, depending on the type of impurities it is exposed to.
The last filter stage (HEPA) must be replaced when clogged.

ODR - No, all cassettes needs to be replaced.

What is the max air and/or ambient temperature for filter units without fan?
80°C (176°C), because of the sealing strips and gaskets. With special sealings and gaskets 120°C (248°F).

Does the Absolent filter unit capture the gas molecules in the polluted air?
No, the filter units are made for particle filtration and the gas will pass through. It is possible to use an adsorbing carbon filter cassette that captures the gas (limited life time).

Does the Absolent filter unit capture odour?
Some, teh filter units are made for particle filtration and som odour are carried by particles, but other odours will pass through. It is possible to use an adsorbing carbon filter cassette that captures the odour (limited life time).

Is there any risk that a filter unit with filber beds will form gas from oil or coolant?
No - common machining oils and coolants
Yes - light oils with a lot of volatile hydrocarbons.

What happens if the filter cassettes are in operation even if the manometers show that they should be changed/washed?
The filter unit will not be damaged, if operated with a clogged filter stage, but the required air flow will not be attained. Also, it might be difficult to wash the Absolent cassettes with a good result.

What happens if the filter unit is in operation at higher air flows than stated?
The life time of the filter cassettes get shorter than guaranteed.