Notice ref.. 12091-1

Processing of oil mist in ambient air of a metallic parts machining workshop (gravimetric analysis)

Preamble.

The processing operation described in this notice is performed in a workshop which is purposely kept close, in order to « keep » at best the concentration of oil mist contained in the ambient air.

The working machining tools use nothing but aqueous cutting emulsions in order to cool and lubricate the tool.

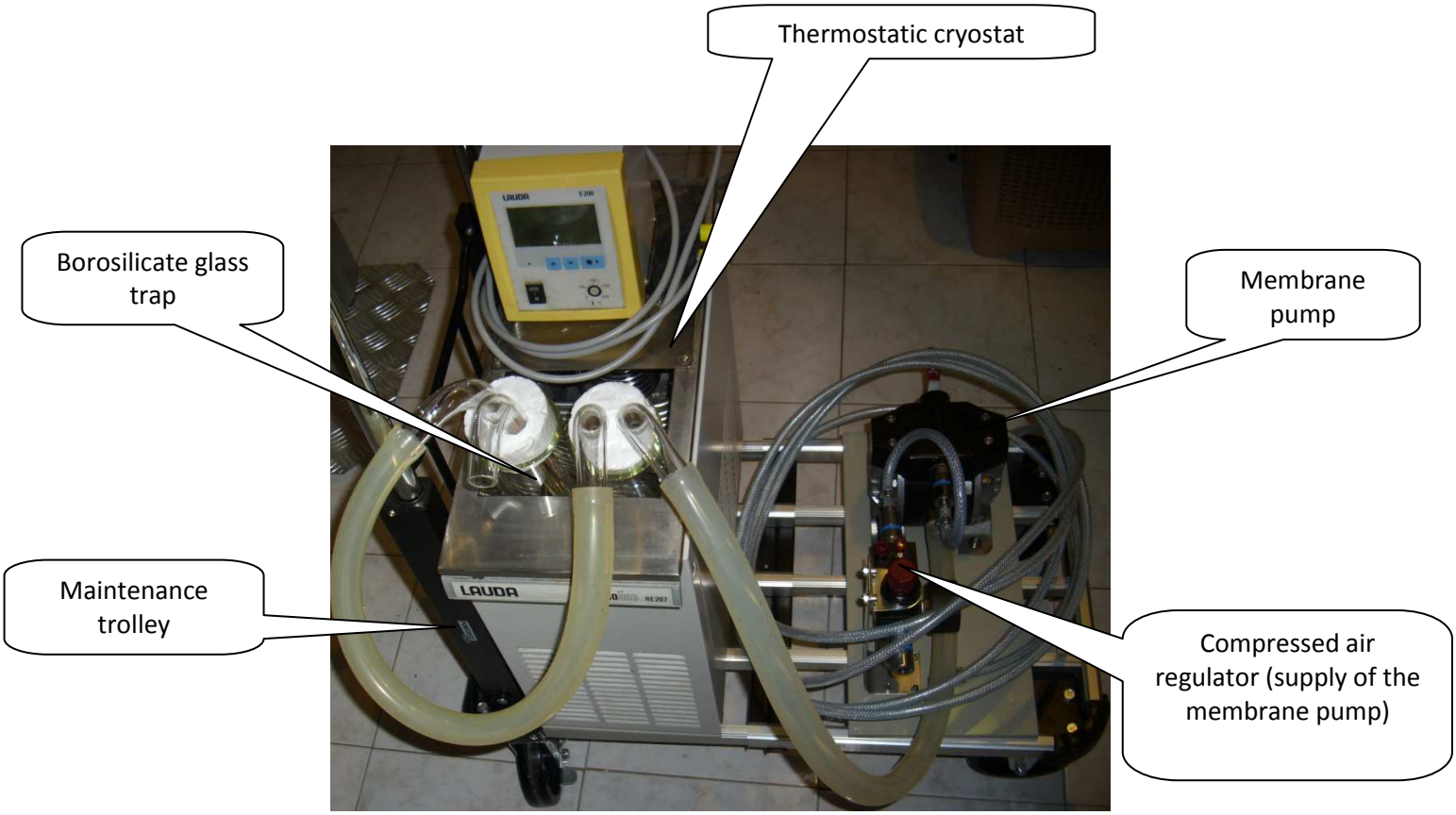
The purpose of processing is to verify the oxidation of oil mist contained in the ambient air of the workshop as vapour and/or micelles, generally speaking with a diameter of about 0.2 and 5µm (micron), knowing that the *oxidation of the concerned micelles is of course higher on the thinnest particles,* due to the bigger specific surface in comparison to their weight.

The processing doesn't need any additional chemical product; it is nothing but a catalytic reaction inside of network water circulating on a cartridge which is able to generate Reactive Oxygen Species (ROS).

Description of the material used.

1) - Oil mist trapping device.
The material is designed in order to trap simultaneously the particle and the vapour phase, gathered as aerosols.
A membrane pump aspires and transports the air through two, full-flow borosilicate glass traps, cooled in a cryogenic bath, at a thermostatic temperature of -35°C set by means of a thermostat.

The membrane pump (Teflon) is supplied by compressed air, which is available in any metal machining workshop.
The type of pump chosen allows a supply of compressed air which can contain aqueous or oily aerosols without damaging its correct functioning.



The airflow is measured on the pump inlet and on the outlet of the second cryogenic full-flow trap by means of an anemometer; both the identical flows (manifolds with absolutely analogous sections) allow to confirm that there is no leak at all from the air circuit transported through the device).
The volume capacity of the membrane pump is of 30cm^3/impulsion.

2) - Humidifier.
The lambda device used has a water tank built in its lower part, in which a drum equipped with an « absorbent » synthetic foam moves with a slow rotation in order to be permanently humidified.
A fan built on the back of the device sweeps the water micelles along in an air flow of 800 m^3/hour, getting through the above mentioned media, charged with synthetic foam, over the upper part of the device.

The device has been equipped with a built-in hygrometer which has been set, for the purpose of the operation described in this notice, at the maximum level of relative humidity « displayable » on the material, in order to operate within a continuous aqueous flow along the whole processing phase.

Technical characteristics

Humidification at 21°C 30% R.H.	2,5 l/h
Adjustable air outlet	yes
Electrical power	53W
Ventilation speed	2
Air flow in low speed	350m^3/h
Air flow in high speed	800m^3/h
Power supply	230V (Ph+N)
Regulation	With adjustable hygrostat
Wheels	4
Auto-restarting after electrical break	Yes
Noise level at 1 m	29dBa / 42 dBa
Water tank capacity	34 litres

3) - Processing operation of ambient air in machining workshop.
The processing operation of oil mist in the ambient air of the concerned metallic parts machining workshop, with a cutting fluid in the form of emulsion, is broken down into two phases:

-control by means of cryogenic trapping of particles and aerosols « normally » contained in the ambient air under effective working conditions;

-cryogenic processing and trapping of particles and aerosols contained in the air in the course of functional humidification by oxidation of organics, essentially of oil in suspension type, in form of micelles and/or vapour.
Every phase of sampling is maintained for 3 hours.

The flow of pumped ambient air for each phase is of 478.5 litres/hour, i.e. 1435 litres over 3 hours [or 4.5 impulsions/second of 0.03litre (30 cm^3) each of the membrane pump].
The speed of air displacement is of 0.6 metre second (m/s) in the pipes and of 0.035 m/s in the cryogenic full-flow traps; consequently the trap which is downstream (second trap at the end of the processing circuit), contains nothing but some traces of organic residues localized at the time of gravimetric exploitation whilst performing the extraction operations in the laboratory.

The processing phase for the concerned operation consists in humidifying the premises, at a humidified air flow of 800 m^3/h for an amount of released water in form of micelles of 2.5 litre/h.

The water spread on the ambient air is conveyed in a closed circuit by means of a micropump into a catalytic charge of 100 cm^3 with a flow (water from the humidifier tank) of 200 litres/hour, with formation of oxidizing OH° radicals obtained in aqueous medium - of short life – in contact with a carbonaceous material with a large specific surface and a metal of very high purity grafted in the micropores of the mineral structure/support..

The volume of the processed workshop is of 1200m^3, being an hourly circulation of two thirds of the concerned volume.
As for the control sampling phase, the phase of air processing by means of functional humidification has also to go for 3 hours.

The relative humidity (RH) of the place where the operation occurs doesn’t practically vary between the beginning of the control sampling (31%), and the end of the so called « humidification » sampling (32%).

At the end of the operation, the full-flow borosilicate glass traps are taken out of the -35°C cryogenic bath, hermetically sealed, and intermittently degassed whilst the temperature is rising back to ambient.
These traps are 4: i.e. 2 traps for the control sampling and 2 traps for the operation of humidifying the ambient air.
Both the samplings are performed the same day.
Finally, the perfectly sealed samples are forwarded to an analytical laboratory.

4) - Laboratory gravimetrical study of the trapped products.

a) - Extraction of the control catch.

The 2 full-flow borosilicate glass traps of the control sampling have to be washed with dichloromethane (CAS 75-09-2) in order to be analyzed, under strong magnetically shaking with a Teflon bar, i.e. 5 minutes for each extraction of organics by means of the chlorinated solvent.
Number of washings: 3

Every extraction has to be separated in a separating funnel; the aqueous phase, mechanically swept along by the mass of dichloromethane, is separated from the organic phase.
The products of the 3 extractions put together are:
-an aqueous phase,
-an organic phase.

Aqueous phase: vacuum oven drying at 20°C for 3 minutes under a pressure of 0.45 mbar* in order to eliminate the dissolved dichloromethane (solubility in water at 20°C: 13g/litre).
Weight obtained: 1,558 g water.

Organic phase (extraction with dichloromethane) : evaporates at 35°C under a flow of nitrogen of 15 litres/hour, then vacuum oven drying at 20°C for 3 minutes under a pressure of 0.45 mbar* in order to eliminate the traces of dichloromethane.
Weight of the de residue obtained: 58 mg.

b) - Extraction of the catch after humidification.

The 2 full-flow borosilicate glass traps of the sampling after humidification have to be washed, as for the control sampling, with dichloromethane (CAS 75-09-2) in order to be analyzed, under strong magnetically shaking with a Teflon bar, i.e. 5 minutes for each extraction of organics by means of the chlorinated solvent.
Number of washings: 3

Every extraction has to be separated in a separating funnel; the aqueous phase, mechanically also swept along by the mass of dichloromethane, is separated from the organic phase.
The products of the 3 extractions put together are:
-an aqueous phase,
-an organic phase.

Aqueous phase: vacuum oven drying at 20°C for 3 minutes under a pressure of 0.45 mbar* in order to eliminate the dissolved dichloromethane (solubility in water at 20°C: 13g/litre). Weight obtained: 1,550 g water.

Organic phase (extraction with dichloromethane) : the organic phase has to be evaporated at 35°C under a flow of nitrogen of 15 litres/hour, then vacuum oven dried at 20°C for 3 minutes under a pressure of 0.45 mbar* in order to eliminate the traces of dichloromethane.

**Boiling point of dichloromethane: 40°C under 1013mbar.*
Weight of the residue obtained: 6 mg.

5) - Comments.

First of all, one will notice that the quantity of water extracted from the control sampling is identical to that one extracted from the sampling after humidification by a few milligrams (8mg), i.e. a difference of weight of 0.5%, acceptable for this type of extraction in an organic medium, being aware that this Δ, regarding its scientific interpretation, is of secondary importance in connection with the purpose to be achieved, i.e. the extraction and quantization of in ambient air suspended organics, namely oil in form of aerosols and/or vapours in this particular case.

One can also notice that the quantity of residual organics extracted is lower after air humidification, (in comparison with the quantity of organics extracted before humidification), ***knowing that the latter is made possible (concerning the health integrity of the workforce) because of absence of bacterial proliferation in presence of the aerosol which is also bactericidal - deriving from the catalytic charge equipping the humidifier used- sprayed around the ambient air.***

The reduction of the organic phase in the ambient air of the metal machining workshop, where the above mentioned operation is performed, is of 89.65%, for a processing duration voluntarily restricted to 3 hours.

This operation brings us to deduce that oil in the form of micelles and/or in vapour phase is oxidized because of the great specific surface offered to air oxidation by the above mentioned free radicals (oxidants) sprayed in an infinitesimal amount by the aqueous aerosol proceeding from the concerned humidifier, *knowing that at an identical, or in any case approaching concentration, the mass oxidation of the organic matter, in oil bath for example or in emulsion, doesn't exist.*