AUTOMATIC SYSTEM FOR CONTINUOUS MONITORING OF GAMMA ACTIVITIES IN ATMOSFERIC PARTICULATE

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SUMMARY

This paper describes the design criteria, which were used for the realization of an automatic system for the real time monitoring of the artificial radioactivity in the air.
Special attention was paid to minimize particulate losses along device ducts.
Particulate losses showed to be lower than 10%. The minimum detectable activities and the particulate-collection showed, in every respect, to be equivalent to the traditional system.

DESCRIPTION OF THE AIR MONITORING SYSTEM

The automatic monitoring system allow perform gamma spectrometry at the same time of the filtering operation. Therefore, if the verification of the acquired counts is performed immediately, the air radioactivity values can be obtained almost instantaneously.
The air monitoring system includes:
- air sampler;
- spectra acquisition system;
- computer and various peripheral units.
The air sampler is formed by a filter holder and a suction unit.
The (patented) filter holder is directly mounted on the gamma radiation detector, and was designed so as to optimize both the flow rates of filtered water and the detection geometry of the radiations emitted by the radionuclides eventually present.
The air suction unit includes a centrifugal electric pump with graphite blades, a volumetric counter, and the regulation and protection devices for such components.
The suction unit is interfaced with a computer, by which it is possible to perform the setting and the remote control of every sampling parameter.
The system used for the acquisition of the gamma radiation spectra is formed by a high-purity germanium detector, located in a lead well, and connected to the multichannel.
The fully automatic operation of the monitoring system is managed by a computer, which is interfaced with the analyzing system, the flow meter , the alarm unit, and, finally, the eventual modem for data transmission to the national monitoring center.
Concerning the recognition of the alarm conditions, two different types of warning systems were arranged to distinguish between the malfunction of the devices and the detected air contamination.

DESCRIPTION OF FILTER HOLDER AND SUCTION DUCT

The filter holder (fig. 1) is formed by a cylindrical receptacle with a round opening at the bottom, so that it can be inserted on the detector.

A seal ring prevents air from passing between the detector and the filter holder.
The detector, by penetrating within the filter holder, forms a wall of the toroidal distribution manifold.
The toroidal manifold surrounds the cylindrical surface of the detector, and is connected with the filtering portion by a continuous ring slot.
The distance between detector and filter surface is approx. 1 mm.
The filter support is formed by a metal net, able to withstand 1-atm pressure without creating resistances to air flow.
The collection manifold is formed by a cylindrical-geometry chamber, located downstream of the filter and designed so as to convey the flow of filtered air towards the outlet duct.
The filter holder is kept in the correct position by the pressure generated by the depression of the suction pump.
The filter, with related support, can be reached from the upper side of the filter holder directly.
Every component of the filter holder is realized by electroconductive materials, in order to reduce the deposit of air particulate on the walls of the device itself due to the accumulation of electrostatic charges.
The operating principle of the filter holder is the following (with reference to figure 1):

- the air, coming from the sampling point located out of the laboratory through a properly sized duct, enters the toroidal distribution manifold A;
- due to the vacuum created by the suction pump in the collection manifold B, the air crosses the filter;
- the radioactivity, present in the particulate which is collected on the filter, is continuously measured by the high-purity germanium detector;
- from the collection manifold, the air passes the outlet duct and is sent out by the suction pump again.

Substantially, the device allows to perform the filtration operation on the flat filter directly facing the detection surface.
In addition, the use of the toroidal manifold allows to minimize the distances between filter and detector, and the loss of pressure, necessary to maintain the air flow.
Therefore, such a manifold allows to make the detection efficiency and the quantity of filtered air as high as possible.
The suction duct was designed by the use of some technical solutions so as to minimize the losses of air particulate [1].
The conduit was realized as short as possible. In detail, to reduce the settling, which is not depending upon the whole path of the aerosol in the conduit, but only upon the length of the projection on the horizontal plane of the conduit itself, we try to minimize the horizontal development [2].
Furthermore, the fluid mechanics in the conduit was chosen so as to reduce to a minimum the losses due to settling, diffusion, and impact for the particles having granulometry range of 0.2 to 2 µm [3].

EXPERIMENTAL MEASUREMENTS

To estimate the losses of particulate along the suction duct experimentally, some measurements of gross-alpha, gross-beta, and gamma spectrometry were carried out on the particulate, which collected on pairs of filters (type of filter: SCHLEICHER & SCHUELL-498/1) [4]; the measurements were obtained by contemporary filtering of the air both by

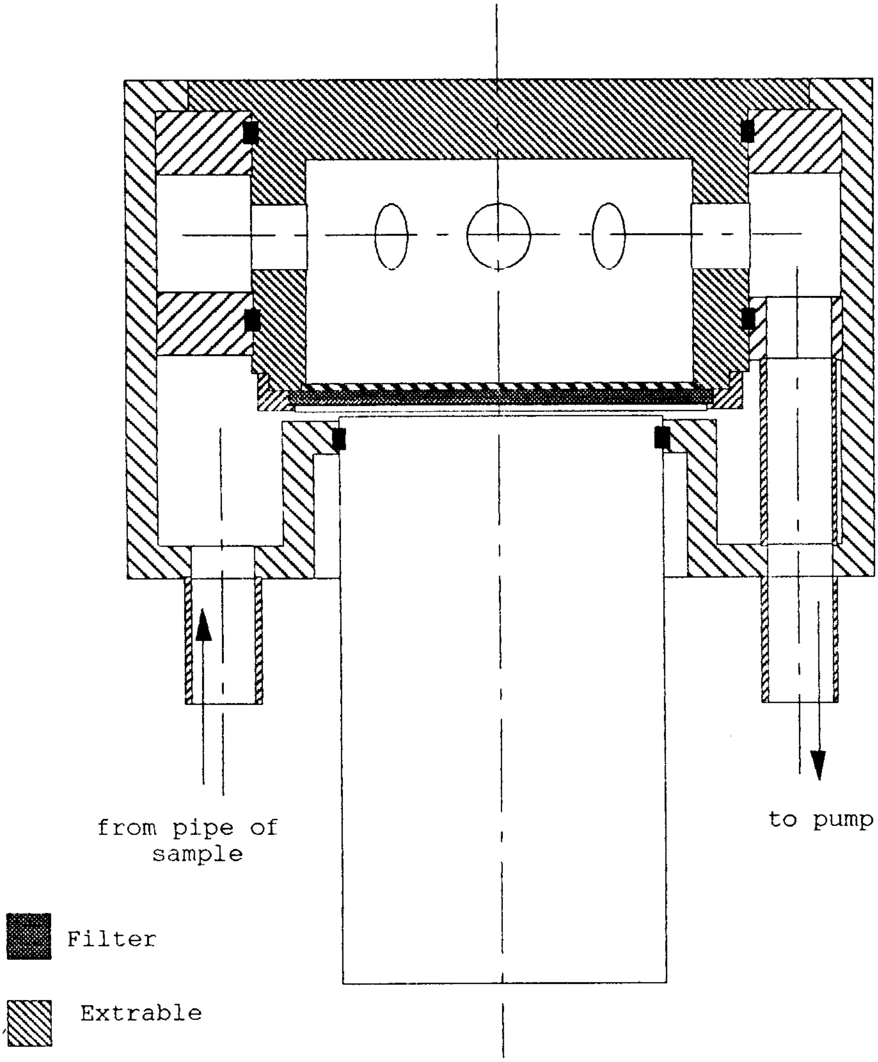

Figure 1 - Conventional representation of the filter holder

traditional system (without conduit upstream of the filter) and by automatic system.

At first, the measurements of gamma spectrometry were carried out; they allowed to estimate the content of Pb-212 for each filter. The losses showed to be lower than 6%.

Then, the measurements of gross-alpha and gross-beta radioactive emission were carried out.

The losses showed to be lower than 4%, if estimated as gross alpha, and lower than 6% as gross beta.

The analysis of the percentage differences obtained for the three types of measurements showed that, in the worst hypothesis, the loss of particulate can be estimated to be lower than 10%.

Furthermore, the minimum detectable activities and the detection efficiency were estimated; they showed, in every respect, to be equivalent to the traditional system.

CONCLUSIONS

The designed automatic monitoring system allows to carry out the monitoring of air radioactivity complying with the same operating parameters, which are used in the traditional manual procedure.
In addition, it allows to reduce, even to few minutes, the time intervals between different measurements and, therefore, a continuous alarm system is available.

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