METHOD FOR HEPA FILTER LEAK SCANNING WITH DIFFERENTIATING AEROSOL DETECTOR

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Abstract

While scanning HEPA filters for leaks with "Off the Shelf" aerosol detection equipment, the operator's scanning speed is limited by the time constant and threshold sensitivity of the detector. This is based on detection of the aerosol density, where the maximum signal is achieved when the scanning probe resides over the pinhole longer than several detector time-constants.

Since the differential value of the changing signal can be determined by observing only the first small fraction of the rising signal, using a differentiating amplifier will speed up the locating process. The other advantage of differentiation is that slow signal drift or zero offset will not interfere with the process of locating the leak, since they are not detected.

A scanning hand-probe attachable to any NUCON® Aerosol Detector displaying the combination of both aerosol density and differentiated signal was designed.

Introduction

The scanning of HEPA filters is described in numerous articles and the general conclusion is that the size of the smallest leak detected is the function of the threshold sensitivity, reduced by the photometer response time versus scanning speed of the operator. The explanation is that the bell shaped curve of the aerosol concentration behind the pinhole is the highest in the center of the hole. Consequently, while scanning, the probe should reside over the center of the hole long enough to build up the maximum aerosol concentration in the optical chamber of the photometer. Since this is seldom the case, the conclusion is that with any given photometer there is a compromise between "missing some of the holes or working unnecessary long hours." Instead of such compromising, a mathematical solution of "enhancing" the data by differentiation of the exponential response curve was suggested.

The Method of Measuring the Aerosol Density and its Limitations

An isokinetic sampling probe for 100 feet per minute (fpm) face velocity using the 1 CFM pump was designed with an opening of 3" long and 0.5" wide. At a scanning speed of 10 fpm., it passes the pinhole leak in 0.5 sec

The response curve of the aerosol detector to a sudden increase of the aerosol concentration is an exponential function. The time constant of this function is independent of the pulse height. [3] The time constant of the NUCON® aerosol detector used for our experiment on the sensitivity range of 0.1 microgram/ liter is 0.62 sec. The detected pulse, with previously mentioned scanning speed of 0.5 seconds, reached approximately 30% of the maximum value. Scanning over the pinholes where this signal value is equal to the drifts generated by the detectors electrical system and/or drift of the aerosol concentration, no leaks were detected. To improve the threshold sensitivity, the following steps could be taken:

1. Slow the scanning speed
2. Decrease the time constant of the aerosol detector
3. Decrease the electrical drift

As neither of those should significantly improve the threshold sensitivity, the logical approach was to use a differentiating "enhancing" amplifier.

The Differentiating Method: Advantage and Limitations

The differentiating amplifier does not recognize the constant signal value; in our case it is the analog value of the background aerosol concentration combined with the slow electronic drift. The time constant chosen for this amplifier selectively enhances the functions, having the rise time similar to the optical chamber. This approach ensured the recognition of aerosol concentration increase in the optical chamber, while suppressing all other slow drifts signals.

The output signal of this amplifier is displayed on a 99 segment LCD display. The display is electrically preset to 50% value to allow movements in both positive and negative directions. When the scanner approaches the vicinity of the hole, the meter moves first in one direction, returns to zero and, as the probe is moved away from the hole, moves in the other direction. Due to the long sample line, this reading is delayed and the operator has to practice using the hand probe.

The Combination of Measuring the Aerosol Concentration and Differentiated Signal

As a final solution, a double display fast LCD meter was built in a hand-probe with two operational amplifiers. The first meter displays the aerosol concentration transferred from the aerosol detector meter. The second meter, adjusted to the 50% value, makes positive and negative movement only during changes of the aerosol concentration. The operator, observing this movement, returns on the same path to locate the hole and read the concentration on the first meter.

Conclusion

Tests performed using a NUCON® aerosol detector with the added differentiating hand-probe confirmed that the time spent scanning for leaks can be decreased by as much as 50-90% of the standard scanning method. The benefit of this is a reduction in the total time spent in radiation fields and confined spaces, and an increase in the total number of filters scanned in any given time.

References

1. Nuclear Aircleaning Handbook
ERDA 76-21

2- Procedure Standards for Certified Testing of Cleanrooms.
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3- Scanning HEPA Filters with Photometers
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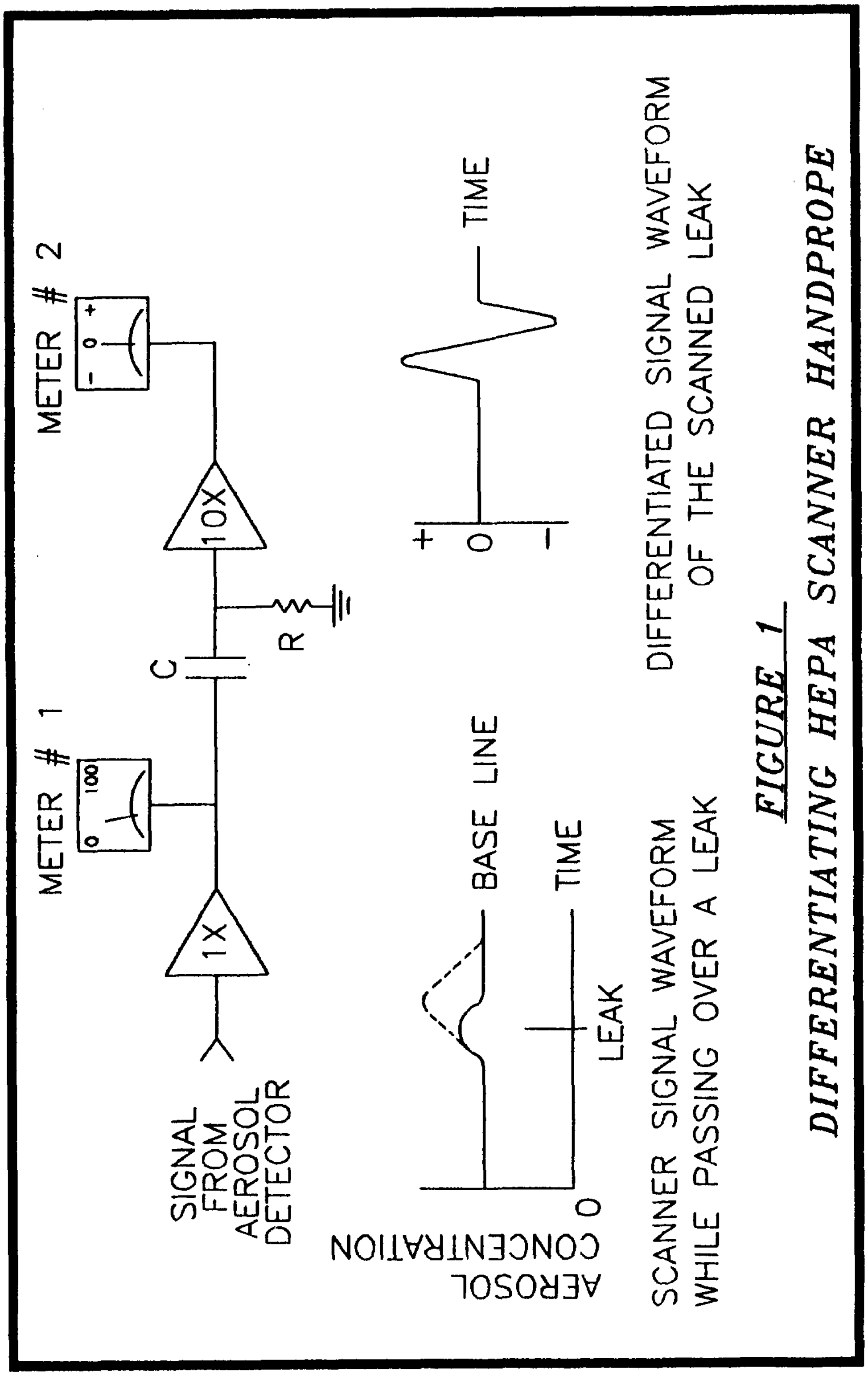

FIGURE 1

DIFFERENTIATING HEPA SCANNER HANDPROPE

DISCUSSION

RICKETTS: You mentioned that if you stay at the location of the leak long enough, after you have found it, that you can make an absolute measurement. Do you have to switch modes, somehow?

KOVACH, B: No, both instruments are on the same probe. You can see the display on both sides. One is a differential display which has the zero in the middle and the other is the number reading, the absolute value.