

ACCURACY IMPROVEMENT IN LEAK DETECTION OF CHARCOAL ADSORBERS  
BY HALIDE PULSE INTEGRATION METHOD.

Bela J. Kovach, Eric M. Banks  
NUCON International, Inc.  
Columbus, Ohio

Abstract

Due to the phaseout of the supply of R-11, which is used as a charcoal adsorber leak-testing agent, several new substitutes have been suggested and tested. <sup>(2)</sup> Pulse testing using agents with higher boiling points produced longer response times (due to prolonged evaporation and dispersion times). This longer evaporation time alters the pulse shape and lowers the peak concentration. Since the dispersion and evaporation time under different ambient condition are unpredictable, the peak concentration becomes unpredictable as well. One way to eliminate this unpredictability is to determine the area under the curve (of concentration versus time) after test-agent injection rather than the peak concentration (height). This value should be independent of the injection time and evaporation rate as long as the volume of the test agent injected remains constant.

Thus, tests were performed with a constant volume injection of test agent but with different injection times and evaporation rates. The area under the curve of concentration versus time was then compared with the peak concentration for each injection.

Introduction

Testing with a pulse of challenge agent has an advantage over testing with continuous injection, as described by several authors. <sup>(1,3,4)</sup> During pulse mode leak testing, the leak is calculated from the ratio of the pulse height detected simultaneously on the downstream and upstream side of the adsorber bed. This calculation is correct as long as the referenced two detectors have identical characteristics and they are working in their linear range. Several institutions have pushed the permissible leak threshold level from  $10^{-2}$  % to  $10^{-4}$  %. This is a new challenge for the detectors, since there is no sensor with linear characteristics over 6-7 orders of magnitude. Therefore, such tests are performed by comparison of a calculated upstream concentration with the detected highest peak concentration detected downstream of the adsorber. The comparison of a calculated concentration value on the upstream side of the adsorber to a detected peak height on the downstream side can be a significant source of error, varying with ambient conditions.

However, if the area under the curve of concentration versus time is used rather than the peak concentration (with constant volume injection of test agent), then this source of error can be reduced. Tests were performed to confirm this hypothesis.

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### Test and Equipment Description

A test was performed on a full size air cleaning unit at the NUCON® facilities to check the validity of the concept. The purpose was to show that no matter what the geometric shape of the pulse, the integrated value would provide an accurate measurement of the quantity of challenge agent.

The challenge agent was injected at the inlet of a 6,000 scfm. air cleaning unit in which the air flow is provided by a downstream fan. A long length of duct (approximately 30 ft) and three stages of filtration (mist eliminator, pre-filter and HEPA filter) provided enough time for complete evaporation and dispersion. A syringe was used to dispense 0.1 cc of 1-Bromobutane liquid onto a hot plate. Injection time varied from 2 seconds to 155 seconds.

A NUCON® F-1000 BBD detector was used to measure the concentration continuously. This instrument has a threshold sensitivity of 1 VPPB and the response is linear over the range of 1 - 450 VPPB. A single point sample was taken and pulled through the instrument by the internally mounted pump. A YOKOGAWA analog recorder recorded the concentration curves and a Hewlett-Packard integrator was used to analyze the output signal from the detector. The points on PPB curve represent the maximum concentrations recorded while the points on the integral curve are proportional to the mass of injected 1-Bromobutane.

### Results and Interpretation

The test results shown on Figure 1 proved that if a constant volume of 1-Bromobutane is injected in the air stream, an open diode continuous halide detector will detect a constant integral value with less than  $\pm 10\%$  error although the injection and dispersion time is varied between 2 second and 155 seconds. With pulses shorter than 2 second, larger error is expected, since the open diode response time is in the 1 second range.

### Conclusion

1. When using a single downstream continuous Halide detector with calculated upstream injection, the integral value under the detected curve should be used for leak calculation rather than the highest peak concentration.
2. If the mass (or volume) of injected halide is proportional to the air flow rate, a single downstream continuous detector using pulse integration will display the leakage as ratio of masses, even if the pulse height and shape are varied by the injection time. Using this method, the detector can be calibrated to display the leak rate, for fast, easy and accurate operation.

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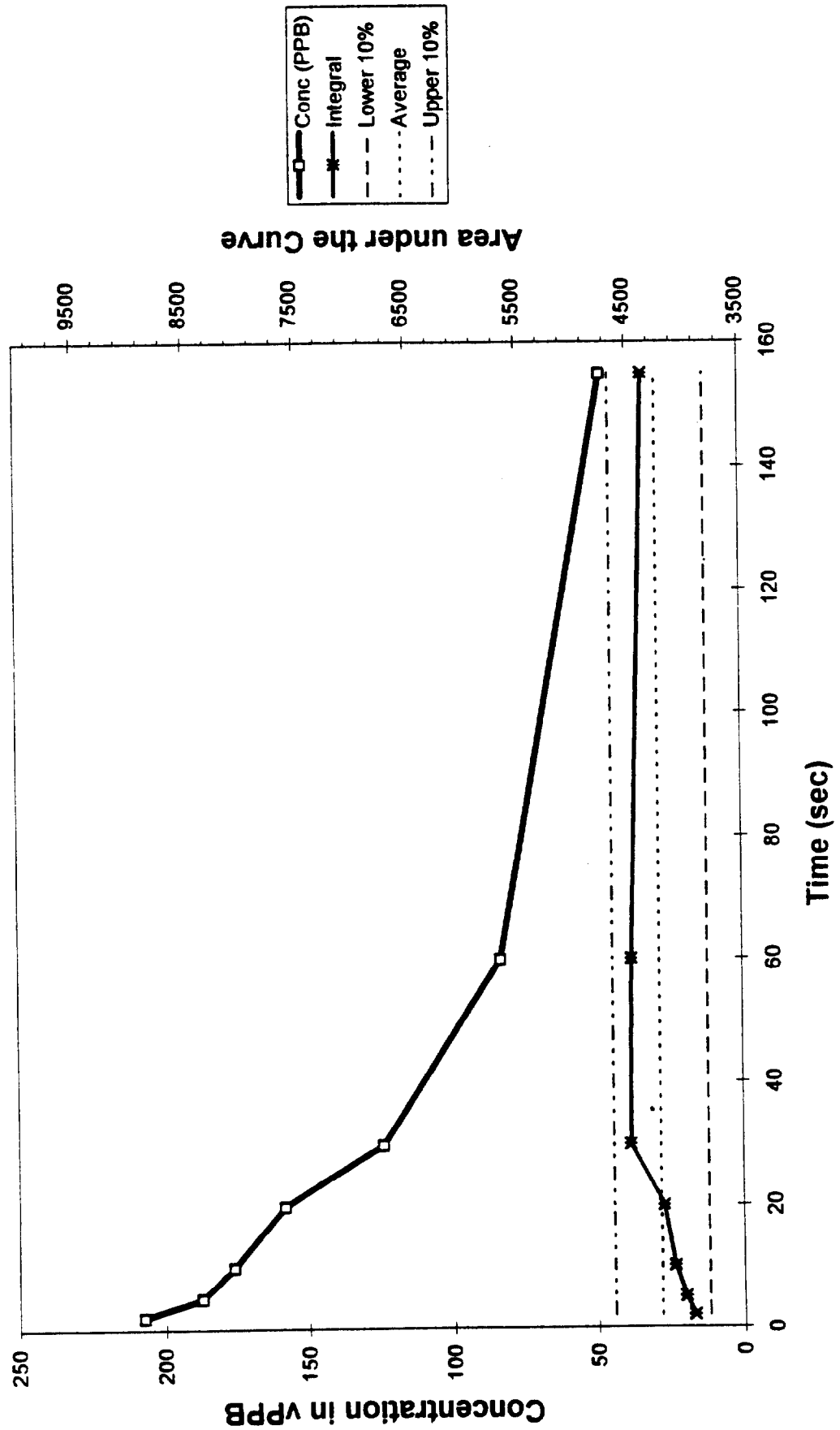
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# Constant Volume vs Time & Integral of Injection



**DISCUSSION**

**ANON:** Is this replacement for R-11 a problem?

**B. KOVACH:** This is a R-11 replacement solution rather than a problem.