Triboelectric Bag Leak Systems
A viable alternative to Continuous Opacity Monitoring Systems

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Low level (3%) maximum allowable opacity emissions limits promulgated by the USEPA, for certain industrial processing industries, have created a compliance dilemma. However, documented evidence questions the ability of opacity dust monitors to operate reliably at opacity levels below 10%. Triboelectric bag leak detectors have proven to be a viable alternative to COMS in low level dust emissions and permission is sought to substitute COMS with triboelectric bag leak detectors, for dust monitoring applications below 10 %.

Introduction

Triboelectric bag leak detection technology was introduced more than 25 years ago and many thousands have been installed in virtually every industrial dust collection application, worldwide. In the mid nineties, USEPA granted triboelectric systems limited recognition, as a maintenance tool for bag house operators, to be applied as an adjunct to COMS. However, since Continuous Opacity Monitoring Systems (COMS) have problems responding to opacities below 10% and a need exists for a suitable alternative, especially for industries subject to 3% maximum emissions limitations. However, triboelectric systems have been successfully applied for low-level dust monitoring and information is presented as an alternative to COMS.

Opacity Monitors

Continuous opacity and in-situ, light scattering monitors employ optical lenses to detect and measure the amount of light blocked by emissions. However, dust particles and water condensate frequently obscure the surface of the lenses, causing false and misleading signals, necessitating repetitive adjustment and frequent recalibration. Particle size variations also cause false readings, further contributing to the difficulty of maintaining consistent operation. Most important, according to ASTM (D 6216 - 98), COMS are considered unreliable below 10% opacity.

Beta Gauges

Beta Gauges have demonstrated superior performance and ability to measure PM, particularly in wet stacks (those with entrained water droplets in the stack gas). Radioactive source material and high cost have limited widespread acceptance of this technology. Special licensing is required for use in the workplace and they are often accompanied by extractive reheat apparatus designed to maintain the extracted gas temperature above the dew point, contributing to the relative high cost of acquisition. Initial capital investment can exceed $100,000 for a single point.

Triboelectric Systems

The majority of triboelectric devices in service function as bag leak detectors and continuous emissions monitors, tracking deviations from normal baseline emissions set to alarm pre-set levels on a 0-100% scale. Since all dust collectors normally emit a small amount of dust, a continuous baseline signal can be monitored, from which incremental, or rapid dust emission deviations can be tracked and alarmed. Triboelectric systems have a wide dynamic range of operation, operating well below visible opacity levels (as low as 0.005 mg/m^3) and well above the onset of visible emissions.

Principle of Operation

When dust particles collide with, or pass near, an earth-referenced probe placed within the exhaust gas stream, electrical charges transfer to the probe — a phenomenon known as the triboelectric effect. The probe is a stainless steel, rod or other metallic material, maintained at earth potential by the measurement system. Particulates present in the gas stream strike the probe, causing the transference of small electrical charges. Since the probe is maintained at earth potential, the transferred charges flow from the probe as current and no static charge accumulates on the probe. Probe current is measured in pico-amps and quantifies the triboelectric signal.

Independent Correlation Verification

The performance characteristics of triboelectric technology has been independently tested and evaluated. Summaries of The Institute for Polyacrylate Absorbents, W.L. Gore & Associates and IPSCO Steel test results follow.

Rust Report[1]

In 1998, two triboelectric dust detection systems were evaluated for the Institute for Polyacrylate Absorbents[1] and compared with three light scattering, opacity meters. The purpose of the test was to determine which method would be most suitable for filtration leak detection in process recirculated air systems typical of paper converting operations. The evaluation was conducted at ranges between 1000 fpm and 4000 fpm velocities and dust concentrations ranging from 0.005 to 0.794 mg/m^3. Each test consisted of continuous injection of particulates, sampling was conducted in accordance with the procedures in ASTM D436, a procedure for isokinetic sampling of a dust-laden gas stream.

The two side scattering optical devices did not respond to any of the dust concentrations encountered in the high velocity gas streams due to insufficient low-end sensitivity. The light scattering devices are more difficult to install because the mounting flanges require careful alignment to assure proper optical alignment and system operation. In addition, a continuous supply of compressed air is usually required to clear the lens and in many cases, a heated air purge must be installed. Conversely, the setup of the Auburn system is less than one hour and was described as "intuitive", requiring minimal references to the installation manual.

The Auburn triboelectric device rated the highest in overall performance in all categories and provided the best linear correlation between signal output and measured total particulates. At the conclusion of the study, the Auburn equipment was chosen by the study sponsor to be installed in a large diaper manufacturing facility.

TOTAL PARTICULATE CALIBRATION EQUATIONS

Monitor	**Calibration Curve**	**Correlation Coefficient, r**
PCME	M=4.7654 + 0.0845 * P	0.989
SICK	M=18.273 + 0.0300 * P	0.987
BHA	M=19.737 + 0.0017 * P	0.407
MIE	M=10.494 + 0.0013 * P	0.802
AUBURN	M=0.08934 + 0.0174 * P	0.996

(Scanned from Rust Report[1])

W. L. Gore and Associates Report[2]

In another independent study, comparing optical and triboelectric systems, W. L. Gore & Associates (manufactures of Gore-Tex Membrane/Polyester Felt) reported similar results[2]. Comparison tests were performed following the ASTM F21.30 Cleanable Filtration Media Guideline for surrogate dust injection. The study focused primarily on two systems, one triboelectric and one light scattering optical system (BHA CPM 2000).

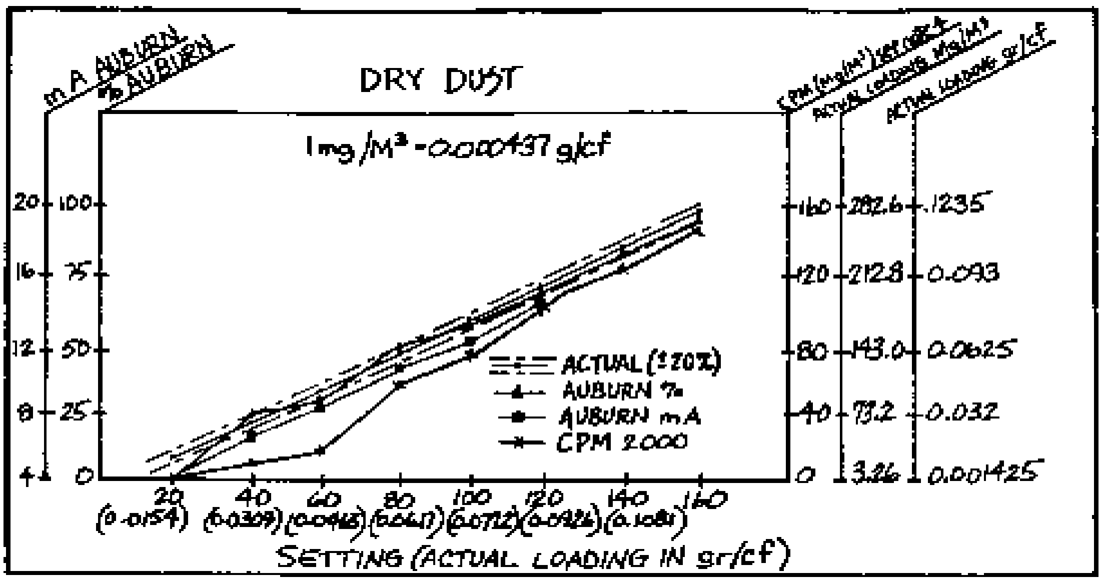


Fig. 7. Graphical Representation of Test 1 Results (dry dust)

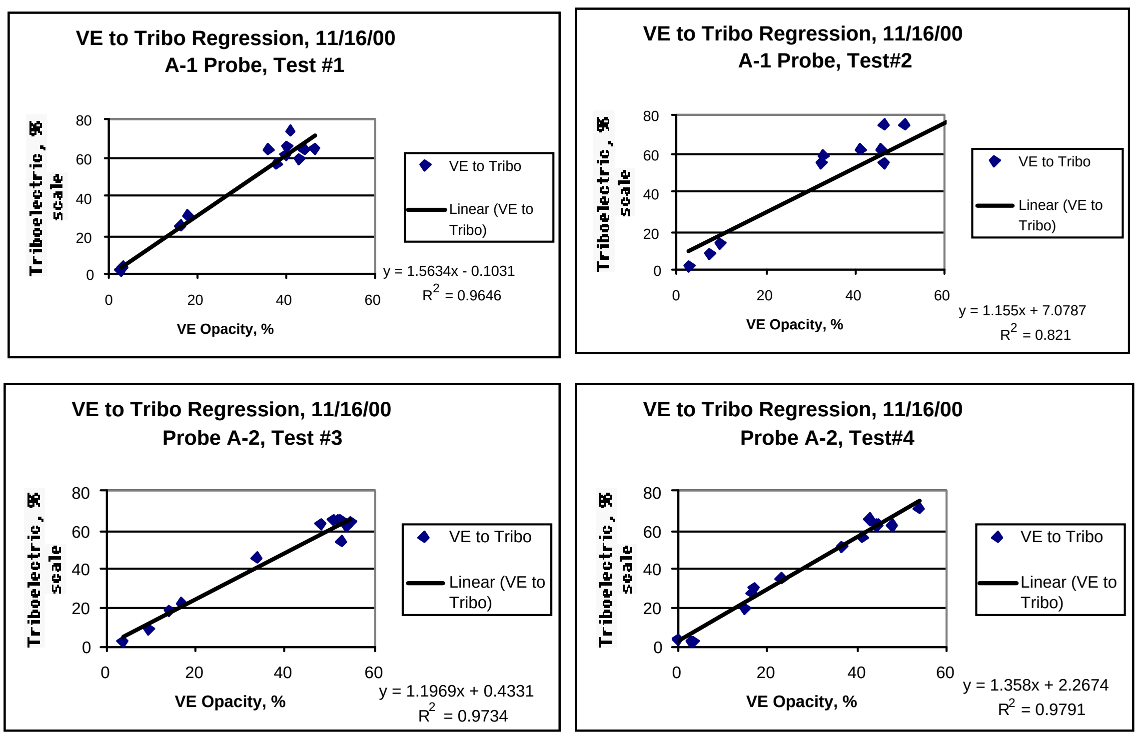
(Scanned from Gore Report[2])

This graph demonstrates triboelectric linearity and poor backscatter, optical device at low dust concentrations.

IPSCO Steel, Inc.[3]

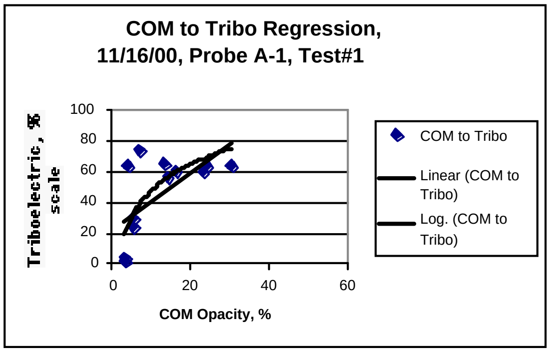
Unsatisfied with the performance of the, NSPS required, Continuous Opacity Monitor (COM), installed on their Electric Arc Furnace/Ladle Metallurgy (EAF/LMF) Baghouse at the Montpelier Works steel plant located in Muscatine, Iowa, IPSCO decided to compare an Auburn triboelectric bag leak detector with the COM. Conditional approval to replace the COM was obtained from USEPA Region 7 pending a successful comparison demonstration. Tests were performed by artificially elevating opacity by controlled injection of surrogate particulates. The simulated opacity generated during the comparisons was concurrently tracked and recorded by the Auburn bag leak detector, the Continuous Opacity Meter and USEPA Method 9, Certified Visible Emission (VE) observations.

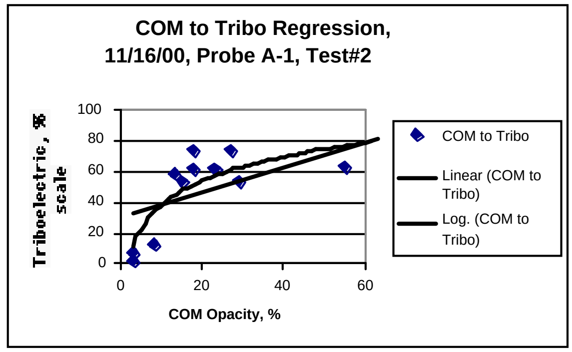
Comparison of VE Opacity Observations and Triboelectric Signals

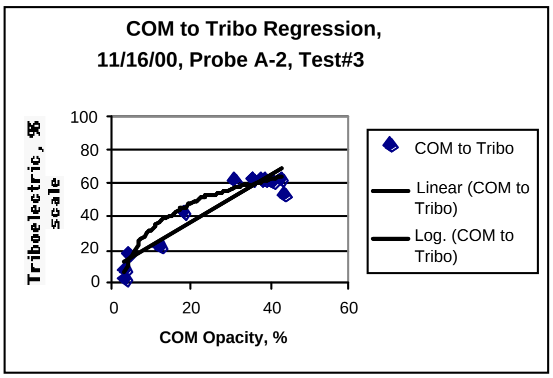


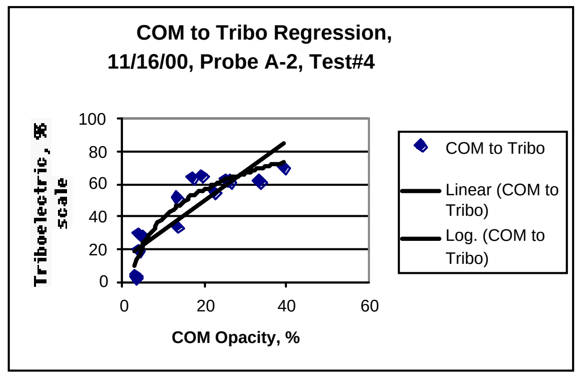
This IPSCO[3] chart illustrates the comparison of VE opacity observations and triboelectric signals. The R^2 values, ranging from 0.821 to 0.9791, indicate a high degree of correlation.

Regression of COM Opacity to Triboelectric Signals









The IPSCO[3] chart above was produced by comparing COM opacity data with concurrently obtained triboelectric data. The COM response is logarithmic, according to the Beer-Lambert Law (light penetration in a fluid), i.e. as emissions increase, opacity can never exceed 100%. The data is also plotted linearly, demonstrating relative linearity at low dust levels (between 0 to 40%).

The authors concluded: “It is clear that triboelectric signals can be correlated to opacity, and that particles of less than 1µ can be tracked by the system. Generally, the linear comparison function for triboelectric signals to opacity data is most directly applicable for opacities below 40%. This correlation range presents no problem for the EAF baghouse operations, which must comply with a 3% opacity standard. The Tribolink™ system provides a more precise and proactive tool for baghouse operators to maintain compliance with the no visible emission standard imposed by the 3% opacity level.”

CONCLUSION

Continuous Opacity Monitoring Systems have difficulty responding to particulate emissions below 10% opacity. This is particularly problematical for industries subject to 3% maximum opacity limitations. Triboelectric dust emission monitors operate reliably, well below visible emissions levels, which is demonstrated by archival and recent test data. We urge recognition of this technology as a suitable replacement for COMS when low-level dust emissions applications are encountered.

REFERENCES

(1) Rust Engineering & Infrastructure; "EVALUATION OF FILTRATION LEAK DETECTION INSTRUMENTS IN CONVERTING PROCESS RECIRCULATED AIR SYSTEMS," Institute for Polyacrylate Absorbents February, 1998

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(3) Wesselman, J., Askins, C.; "COMPARISON OF A CONTINUOUS OPACITY MONITOR and Method 9 OBSERVATIONS to BROKEN BAG DETECTOR SYSTEMS on an EAF BAGHOUSE," Association of Iron and Steel Engineers, Annual Convention, September, 2001