New Report Indicates “AC” Inductance/Electrodynamic Dust Detectors May Be Hazardous

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Summary

An independent study has concluded that polymer jacketed, or coated, sensor probes utilized by inductance/electrodynamic dust monitors (variously marketed as: AC electrodynamic; tribokinetic; induction-sensing) could be hazardous when ignitable dust particles are present. It may not be commonly known that dust fires and explosions are not limited to dust particles generally classified as “combustible” (i.e. food, coal, sawdust, etc.). In fact, “The most prevalent accident occurring in the industry during the past 50 years has been metal fires,” (JOM, May, 2000). For this reason, Auburn intrinsically safe, DC, triboelectric dust monitors ***do not*** *utilize polymer jacketed sensor probes in potentially hazardous applications.*

For ultimate safety, if there is any question about the incendiary characteristics of a particular dust detector application, only intrinsically safe, DC triboelectric systems should be considered for dust detection and monitoring applications.

Background

The charge imparted to the surface of a polymer jacketed dust detector probe in a dry dust flow stream can discharge stored energy and could become an ignition source if the flow stream contains a hazardous material (appendix). For a fixed set of physical conditions, the energy available from the charge is proportional to $V^2/2$, thus requiring careful review of the operating conditions when installing an insulated probe.

Auburn occasionally employs jacketed (insulated) probes for certain difficult applications wherein moisture or conductive particulates could electrically bridge the insulator of a jacketed probe. However, under either of these conditions ***the moisture, or conductive particulate, provides a leakage path to ground (earth), thereby preventing excessive charge build-up on the jacket of the probe.*** The vast majority of dust collection applications are non-conductive and relatively moisture free, eliminating the need for probe insulation. In potentially hazardous applications Auburn DC triboelectric systems, employing non-jacketed sensor probes, provide the safest dust monitoring alternative.

Intrinsic Safety

In addition to our prohibition of polymer jacketed sensor probes in potentially hazardous applications, all Auburn triboelectric dust detectors monitoring systems are designed intrinsically safe and comply with the following design guidance standards: EN 50-014 / EN 50-020, CSA STD C22.2 No. 142-M1987 & No. 157-92, FM Class 3600 & 3610.

Basic Design Concepts Employed:

•Use of an infallible power (mains) transformer to insure that no more than 30 vrms can appear in the low voltage circuitry of the instrument.

•Inclusion of a fused redundant Zener diode barrier to insure that an excessive voltage can not appear in the low voltage circuitry of the instrument due to the application of a foreign voltage at the 4-20mA output terminals.

•Where a relay output is installed, installation of a relay that provides adequate coil to contract spacing and isolation.

•Installation of an infallible current limiting resistor in series with the, sensor connection terminal as an integral part of the encapsulated front-end module.

•Inclusion of a permanently connected Over Voltage Protector at each sensor probe to prevent excess voltage build-up on the probe, if the electronics should become disconnected.

•Maintain adequate creepage and clearance distances on circuit boards.

Infallible Transformers: Signal Transformer Co. Part Number 14A-10R-28, Part Number 14A-56-28 both of which are Type B construction with completely separate and consolidated primary and secondary winding, thus providing 4000 vrms primary to secondary isolation. These transformers also pass the 1.5 X fuse current rating temperature rise test required for qualification as infallible component.
Another smaller transformer is used depending on the product enclosure size and is a modified version of Signal Transformer Co. Part Number 14A-5.0R-28. Although the VA rating of the standard transformer is adequate for the application, the smaller wire size used in the primary caused a higher than acceptable temperature rise during the 1.5 X fuse current rating temperature rise test. For this reason, Signal Transfer manufactures a custom version of the transformer, with a single primary winding incorporating an integral thermal fuse, for us with a special Part Number 14A-5.0R-1274 (for 115/120 v operation) or Part Number 14A-5.0R-1315 (for 230 v operation).

Barriers at 4-20mA Outputs: All output barriers use a redundant (parallel pair) of 16 volt 5 watt Zener diodes and a fast acting 1/16 A (63mA) 250-v fuse. This ensures that no more than +16 volts or -.06 volts can enter the low voltage circuitry, due to a foreign voltage at the output terminals. Each diode will individually withstand a continuous current of more than 3 times the fuse current rating, thus assuring that the 1_{2} T of the diode will always exceed that of the fuse. Also, an infallible current limiting resistor is included to insure that the current breaking capacity of the fuse cannot be exceeded.
Output Relay: For certain models with output relays, American Zettler Number AZ 2732-053-52 which provides 4000 vrms isolation between the coil and contacts, is used.

Infallible Current Limiting Resistor: An infallible resistor must be constructed such that no failure mode (usually burnout) cannot cause it to short circuit or become more conductive. An infallible resistor must also have a continuous power rating of at least 1.5 X the power that it would dissipate, should the sensor connection be shorted to the ground and a circuit fault cause line (mains) voltage to become present at the resistor. A 150K ohm, 0.5w, MIL type RL20 resistor is included in the encapsulated front-end module for each sensor connection. The resistor meets the aforementioned requirements, protects the input circuit from voltage spikes and the encapsulation insures isolation of the sensor connection from comprise by other voltage sources.

Over Voltage Protector (OVP): During normal operation, the sensor probe is maintained very near ground (earth) potential (<0.1). If the ground (earth) return path for the sensor probe is broken by removal of the electronics from the housing or the disconnection of the coaxial cable, a static charge could accumulate on the probe. If a remote sensor is involved, the coaxial cable could become charged as well. Such a situation could be an ignition hazard, unless the maximum voltage is limited to a safe level. All sensor probes are provided with on or more gas discharge OVP’s that will conduct to ground (earth) and limit the probe voltage to ~ 90 v. Also, the special coaxial cable used for remote sensors is designed with a resistive center conductor thereby limiting the discharge current to a save level should the cable become damaged at any point in its length while charged to 90 volts.

Creepage and Clearance Distances: Generally, a minimum of 6mm clearance and 10mm creepage distances are maintained where required. However, in some cases, the 10mm creepage requirement becomes impossible to maintain on the circuit board. To resolve this problem, a grounded (earthed) and non-insulated guard conductor was interposed.

Conclusion

We have, obviously, devoted considerable effort to produce the safest dust detection system available. DC triboelectric dust detectors, invented and introduced by Auburn nearly a quarter century ago, have been successfully proven safe and reliable. Serious questions exist concerning the safety of available, AC triboelectric monitors in certain dust collector applications. For safety reasons, only intrinsically safe, DC triboelectric dust monitors should be employed for dust collector applications.

Appendix
Test Report

A Professional Process Safety Firm

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ELECTROSTATIC TESTING

OF

STEEL ROD

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FOR AND ON BEHALF OF CHILWORTH TECHNOLOGY, INC.

Report #	**:**	**R/3748/0302/YD**
Date	**:**	**March 29, 2002**
CTI Reference	**:**	**AU3748RP**

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INTRODUCTION

A sample was received from **Auburn Systems** for purposes of electrostatic testing. Testing on the sample included measurement of breakdown voltage and propensity for propagating brush discharges. This report provides: (1) relevant background information; (2) a description of the test methods employed; and (3) a summary of the test results.

BACKGROUND

Propagating brush discharges are highly-energetic electrostatic discharges capable of igniting many flammable atmospheres including dust clouds. These discharges -- exhibiting effective energies of as much as several Joules -- derive their energy from the formation of a double layer charge on both sides of a thin surface, such as a fabric or film. A double layer charge forms when the charge on one side of an insulating surface is sufficiently strong so as to induce an equal and opposite charge on the other side by atmospheric ionization. Propagating brush discharges may occur when the double layer charge is exposed to plant, equipment, or personnel.

Only materials possessing a certain dielectric strength are capable of supporting the double layer charge needed to produce propagating brush discharges. The measure of dielectric strength relevant to propagating brush discharges is breakdown voltage. Breakdown voltage refers to the point at which the insulating property of a material breaks down upon application of high voltage. Breakdown voltage can be used to evaluate the propensity for a material to produce propagating brush discharges.

METHODS

Breakdown Voltage Determination

Breakdown voltage testing was performed in accordance with German Standard DIN 53,481 (VDI 0303) and ASTM D3755-97. The sample was warped up with aluminum very tight and the end was connected with grounded wire and a cylindrical electrode connected to a high voltage power supply was placed on top of aluminum. The voltage to the electrode was increased gradually until the insulating property of the sample broke down and a large current passed through to the grounded plate. The voltage at this point -- the breakdown voltage -- was recorded.

Breakdown voltage testing was performed at several locations on the sample, on all sides of the sample, and under both ambient and low humidity conditions. For low humidity testing, the laboratory was maintained at less than 20 percent humidity and the samples were conditioned at less than 20 percent humidity for 12 hours prior to testing.

Propagating Brush Discharge Testing

One end of sample was connected with grounded wire and sample charged using a corona probe connected to a high voltage power source. Attempts were made to produce propagating brush discharges by steadily approaching the charged sample surface with a grounded spherical electrode.

Propagating brush discharge testing was performed on all sides of the sample, and under both ambient and low humidity conditions. For low humidity testing, the laboratory was maintained at less than 20 percent humidity and the samples were conditioned at less than 20 percent humidity for 12 hours prior to testing.

RESULTS

The breakdown voltage of the sample was 19.5 kV under ambient humidity and 23 kV under low humidity conditions. Notably, only materials having a breakdown voltage of 4.0 kV or greater have been observed to give rise to propagating brush discharges when highly charged.

Very low energy propagating brush discharges were observed from the sample under the test conditions. The energy of the discharges may have been limited by the voltage applied to the sample using the carona. Thus, more energetic and incendiary discharges may be expected under higher electrostatic charging scenarios in the field.

<u>TABLE 1</u> **BREAKDOWN VOLTAGE MEASUREMENT**

Sample Information

Company Name	:	Auburn Dechene
Test Material	:	Steel Rod
Reference Number	:	N/A
Sample Origin	:	N/A
Comment	:	Steel stick covered with polymer

Test Information

Test Purpose	:	To measure the breakdown voltage of a sample.
Apparatus	:	High Voltage Power Source Cylindrical Brass Electrode, Grounding Electrode
Test Date	:	03.21.02 – 03.22.02
Analyst	:	Y. Dai
Ambient Humidity	:	41%RH, 21°C
Low Humidity	:	15%RH, 21°C

Results:

Breakdown Voltage (Maximum of Measured Values)	:	**19.5 kV @ Ambient; 23 kV @ Low Humidity**

Trial	**Ambient Humidity (kV)**	**Low Humidity (kV)**
1	19	20
2	19.5	19
3	19	8.5
4	17.5	22
5	18	23
6	19	23
7	19	20.5
8	17	20
9	18	19.5

10	17	18

TABLE 2 **PROPAGATING BRUSH DISCHARGE TESTING**

Sample Information

Company Name	:	Auburn Dechene
Test Material	:	Steel Rod
Reference Number	:	N/A
Sample Origin	:	N/A
Comment	:	Steel stick covered with polymer

Test Information

Test Purpose	:	To attempt to produce propagating brush discharges from an electrostatically charged sample.
Apparatus	:	Corona Charging Probe, Grounding Electrode High Voltage Power Source
Test Date	:	03.22.02 – 03.25.02
Analyst	:	Y. Dai / V. Ebadat
Ambient Humidity	:	41%RH, 22°C
Low Humidity	:	18%RH, 25°C

Results:

Propagating Brush Discharges: **Positive**

Comment: Low energy propagating brush discharge was observed

Trial	Ambient Humidity Propagating Brush Discharges?	Low Humidity Propagating Brush Discharges?
1	Yes	Yes
2	Yes	Yes
3	Yes	Yes
4	Yes	Yes
5	Yes	Yes