**CAHN -Technical Note**
**Copyright Text Courtesy of Orion Research, Inc.**

# STATIC CONTROL FOR BALANCES

by Jerry Weil

One of the major problems when using a sensitive balance is "static". Some of the more technical names for this phenomenon are static electricity, electrostatic, triboelectric charge and static charge. In order to control the effects of static, an understanding of the causes and the methods of treatment are needed.

## CAUSES OF STATIC

Static is the accumulation of electrical charges on the surface of a non-conductive material. The surface will have a negative charge when it has an excess of electrons, and will be positive when the surface has a deficiency of electrons. A surface that has an excess or deficiency of one electron in every 100,000 atoms is very strongly charged and may have several thousand volts potential compared to a conducting surface.

The most common method of generating static is to rub two different non-conducting surfaces together. In this process, the material in the higher position of the Triboelectric Series Table (see page 4) will give electrons to the material beneath it in the Table. For example, if Nylon and Polyethylene are rubbed together, the Nylon will become positively charged and the Polyethylene will carry the negative charge. The further apart the materials are located within the series, the easier it is to generate a static charge. However, rubbing is not the sole means of creating static. Strong static charges can be generated by simply separating the surfaces of the two materials. The stronger the two materials are pressed together, the stronger will be the static charge when the materials are separated. This is how static is created even when great care is taken not to rub the two surfaces together.

Static can also be induced onto a surface from another surface that is strongly charged. An example of this "induced charge" occurs when a person wearing a strongly charged Nylon jacket approaches a balance. The charge on the Nylon jacket sets up an electrical field that reaches out for several feet. This field will induce a strong attractive charge on the material on the weighing pan causing very erratic readings. The human body itself can induce a strong static charge on a non-conductive surface. The body can become charged as it walks due to the separation of surfaces between the shoes and the floor. Since the body is an excellent conductor, the charge will quickly migrate to surfaces having the least radius of curvature, namely the fingers and toes. When the fingers touch a non-conductive surface, the charge will be transferred. When the fingers touch a conductive surface, the transfer can be shocking. In a static prone environment, touching a door knob first with the palm of the hand will reduce shock. Clean, dry gases flowing through glass tubing, will not generate static. However, if the gases contain any moisture or particles, they will generate significant amounts of static.

EFFECTS OF STATIC

Like charges repel each other and unlike charges attract. These forces can be very strong if the static charges are intense. A negatively charged sample on the balance weighing pan can be strongly effected by a positively charged glass chamber window or glass hangdown tube, resulting in erroneous and unstable weight readings. Samples like membrane filters and dry powders are particularly susceptible to static and, therefore, are difficult to weigh. Charged samples are difficult to handle and portions of them may be lost in the transfer process. STATIC can also degrade a sample by attracting contaminating particulates.

CONDUCTIVE SURFACES

One of the methods of removing static is to conduct the static charge off the surface. Since the surface is originally non-conducting, it must be coated with a conducting material that will remain on the surface long enough to remove the static charge. On humid days, a moisture layer may form on the surface with sufficient conductivity to drain the static charge. However, the moisture coating is not dependable. The surface coated with a metal foil or compound offers the best solution to static problems. Silver and tin oxide coatings are the most popular for this purpose. However, metal coatings sometimes are difficult to bond to the surfaces and obscure visibility in glass vessels. A conductive surface can be created with anti-static solutions. The type of anti-static solution used will depend on the surface material, permanency of protection needed, and environmental conditions. There is a wide variety of solutions available that will provide conducting surfaces for many laboratory needs. The Cahn #2027 Anti-Static Solution is intended for static control for use with balances. It has a water base and is not toxic by oral ingestion or inhalation and is not a skin irritant, but it is an eye irritant. It has long life on nonconductive surfaces and can be used up to about 400 degrees C. Both the inside and outside glass and/or plastic surfaces of the balance weighing chamber should be coated with this solution. After the coating has completely dried, the surfaces will remain conductive for several months, even with repeated handling. The solution should not be used on the inside of sample containers since the coating can contaminate the contents.

Since the human body is such a large source of static, efforts should be made to conduct static charges off of the body and clothing. Most computer supply catalogs now offer static control floor mats and work-station mats that will drain the static charges from the body through the feet and fingers respeclively. These mats have conductive surfaces that are grounded. Conducting static off clothing is a more dificult problem. Natural fibers usually hold less static than man-made fibers because they will absorb more moisture. Anti-static compounds introduced either in the washing or drying cycles of the laundry are not generally effective in controlling static in severe conditions. For these cases, there are several good anti-static sprays available specifically designed for clothing.

IONIZING UNITS

Usually, the sample that is to be weighed can not be coated with a conductive surface to remove the static charge. The best method of eliminating this static is to neutralize the static charges. This means that positively charged surfaces are exposed to negatively charged air molecules. The opposile is true for negatively charged surfaces. Airborne moisture, ionized by the sun's ultraviolet radiation, acts as an abundant reservoir of available ions. Under normal environmental conditions, with relative humidities above 60%, the moisture will neutralize static charges as they occur. As the humidity drops below 60%, the lack of ionized moisture will allow static charges to build and become more objectionable.

When the air does not normally have enough ions to neutralize the charged surface, additional ions can be created with radioactive or electrical ionizers. The most popular radioactive units for the laboratory emit alpha particles. These particles are the largest of all the nuclear radiated particles and consist of two protons and two neutrons. Alpha particles travel at extreme speeds (10,000 miles/sec) but, because of their size, very short distances. In air, they travel only a few centimeters before colliding with a gas molecule. This collision will ionize gas molecules, which are now available to neutralize a static charge.

The most common source of alpha particles for static control is Polonium 210 as manufactured by the 3M Co. The Cahn #1269 Ionizing Unit is an example of a static control device using this 3M Polonium source. This device is extremely safe and neither State or U.S. Nuclear Regulatory Commission specific licenses are required to possess these ionizing units. Tlhe Polonium is absorbed into ceramic micro-spheres which are then heated to very high temperatures. This results in shrinkage and loss of porosity so that a solid, almost completely insoluble sphere is obtained. An acid wash is used to remove any surface activity and a nickel coating is applied to provide additional integrity. The microspheres are bonded to a thin aluminum substrate with a radiation resistant binder. Finally, the aluminum strips are cemented into a protective grid which prevents direct contact with the surface of the Polonium source. The microspheres are inert, so if dislodged and ingested, the Polonium would not be absorbed by the body. The average diameter of the spheres is 30 microns which is considered non-respirable. An alpha particle can not penetrate the dead layer of skin on the human body to reach live cells. For all these reasons, this device is a safe method of creating ionized air for static control.

The Cahn Ionizing Units are supplied with 500 microcuries of radioactivity. Since Polonium 210 has a half life of 138 days and the device loses its effectiveness when the activity is below about 100 microcuries, the ionizing units will be effective for about one year from date of manufacture. This date is stamped on the back of the device. The effective life of the device will also depend on ambient humidity and the type of non-conductive surface containing the static charge.

To use the Ionizing Unit, bring it to within one-half inch of the surface or material containing the static charge. Only a couple of seconds are required to neutralize the surface. After being neutralized, handle the material carefully to prevent the static charge being formed again. The Ionizing Unit can be left in the weighing chamber near the pan to provide a source of ionized air around the sample.

Because of the relatively short life of Polonium 210, Radium 226 is sometimes used as an alpha particle source. Though it has a half life of 1600 years, it also emits some gamma radiation and must be used under careful control and requires a license. Beta emitters, like Thorium 233 and Nickel 63 are also used for special conditions.

The other method of creating additional ions is with electrical ionizers. Though these units have been available for 80 years and are extensively used on production lines, they are now first being used in the laboratory. These devices have a 5000 ACvolt emitter point recessed in a grounded collar. This high voltage ionizes the air passing through the field. Compared to radioactive units, the electrical ionizers do not require a license, will not deteriorate with time, and are often more effective. For the lab, the air gun is the most convenient configuration of the electrical units. The Chapman 33575-001 Air Gun plus 10798 Power Supply is a good example. The gun is shockless, weighs about 1/2 pounds, supplied with a three meter cable and has a pistol grip. The gun and the power supply must all be reliably grounded. With a 10 to 20 psi dry air supply, the gun is held 1 to 2 feet from the surface and is useful for removing static from containers and enclosures. Without the air supply, the tip of the gun is still effective from 1/2 to 1 inch from the surface and is useful for removing static from powdered samples. Pass the Run slowly and evenly across the surface.

## AVOIDING STATIC

The most effective method of controlling static is by not generating it in the first place. Plan your work such that the touching of the surfaces is kept to a minimum. Handle the surfaces with moist cotton gloves. Obviously, do not rub two surfaces together. If friction from rubbing is difficult to avoid, there are anti-static liquids that lubricate the surface in order to reduce the static generated. Use grounded floor mats and workstation mats to reduce the charge being carried on your body. Make sure that any piece of equipment with moving or rotating parts is grounded. Wear clothing that has been sprayed with an anti-static compound. If possible, use sample containers that have a conductive surface. Humidifiers can be very effective in reducing the overall static problems in a work area. However, the best way of avoiding static problems is to understand the causes and the methods of treatment.

# TRIBOELECTRIC SERIES TABLE

| | |
|---|---|
| (Positive) | Asbestos |
| | Rabbit fur |
| | Glass |
| | Mica |
| | Human hair |
| | Nylon |
| | Wool |
| | Fur |
| | Lead |
| | Silk |
| | Aluminum |
| | Paper |
| | Cotton |
| | Steel |
| | Wood |
| | Amber |
| | Sealing wax |
| | Hard rubber |
| | Nickel copper |
| | Brass silver |
| | Gold platinum |
| | Sulfur |
| | Acetate rayon |
| | Polyester |
| | Celluloid |
| | Orlon |
| | Saran |
| | Polyurethane |
| | Polyethylene |
| | Polypropylene |
| | PVC (vinyl) |
| | Kelf |
| | Silicon |
| | Teflon |
| (Negative) | Silicone rubber |

REFERENCES:

"Static Electricity 1983", National Fire Protection Association, Quincy, Mass.

"Electrostatic Effects in Microbalances", Robert E. Hawley and Colin J. Williams, J. Vac. Sci. Technol., Jan/Feb 1974.

"Topical Antistatic Primer", Stephen A. Halperin, Evaluation Engineering Sept/Oct 1979.

"Bulletin #210", Nuclear Products. "Conductive versus static-free plastics", Ralph L Mondano, Safety Engineering, June, 1968.

Chemistry and Physics Handbook. 62nd ed. CRC Press, Inc.

Harper Encyclopedia of Science, edited by James R Newman, Harper & Row Pub., 1967. “Application Note 13", Chapman Corp., P.O. Box 10700, Portland, Maine 04104 Tel: 207-773-4726

CAHN INSTRUMENTS, INC.
16207 S. Carmenita Road, Cerritos, CA 90701 USA
Phone (213) 926-3378, FAX (213) 926-6969, TLX 3724174.