Application Note 2 :
Powders

Oxygen Monitoring & Inerting Control Systems
For Explosion Prevention in Powder Processing Applications

In plants where a high proportion of processed products end up in powder form, the uncontrolled handling of products during processing can easily lead to the generation of electrostatic sparks and the risks of fires and explosions.

A typical conveying/milling plant as shown above encompasses a high level of engineering complexity and design. This complexity is further heightened when, due to the potential hazards from static electricity, the design engineer must also take into account the safety and inert gas control functions.

Application:
In industry where flammable materials are processed, the risk of explosion arises. The resultant flammable atmospheres can be divided into three groups.

•Gasses and Vapors
•Mists and Aerosols
•Powder and Dust Clouds

Within all three groups the atmosphere only becomes a fire risk when it is exposed to, or is mixed with, air. There is a "flammability range" associated with each type of flammable material. This is defined by the volume percentage of the material in air. The lower percentage range is commonly referred to as the "LEL" (lower explosive limit) and the upper range is commonly referred to as the "UEL" (upper explosive limit).

Combustion Triangle:
The combustion triangle is composed of the three elements required for combustion. These elements are:

•Fuel (solvent, powder, etc.)
•Ignition (spark, static discharge, etc.)
•Oxygen (ambient air)

In theory, if one of these elements can be removed, then the explosion risk can be eliminated. In practice however, it is very difficult to reliably remove the flammable material, or avoid all of the potential sources of ignition for many processes.

As the fuel and ignition corners of the triangle cannot be eliminated, explosion safety can only be obtained by controlling the oxygen corner. Without sufficient oxygen in the space around the dust particles, combustion cannot be supported.

Electrostatic Charges:
In powders, an electrostatic charge is generated whenever two materials make and then break contact.

Flake from a flaker will become charged as it leaves the drum. Powder in a pneumatic transfer line will become charged on impact with the pipe. Micronised powder will become charged as it leaves the mill.

The chemical composition, surface properties of the powder, as well as the surface contact area are the major factors in determining the quantity and polarity of the charge.

For electrostatic charges to accumulate in the product, some components must be relatively insulating. The increased use of plastics as well as composite pipes and linings contribute to an increased hazard in powder processing.

In brief, static electricity is an unpredictable hazard which can ignite airborne dusts by invisible sparks.

Grounding:
Electrostatic problems can become insignificant if the generated static charge can be conducted to earth. the ability of the powder to dissipate it's static charge to ground (charge decay time) is governed by it's bulk resistivity i.e. it's impedance to current flow.

Most dry powders processed in the organic chemical industry have resistive values greater than 109 ohms/meter and as such are capable of retaining their static charge. It is not uncommon for some powders with resistive values of 1015 ohms/meter to take days or weeks of decay time even when they are laced in earthed metal vessels.

Inert Gas Control:
Inert gas control is the process of diluting the oxygen level in an enclosed space to reduce the oxygen level below the Minimum Oxygen for Combustion (MOC). This involves measuring the oxygen level at one or more points in the process and then, based on the measurement, injecting controlled amounts of Nitrogen or other Inert Gas into the air space.

The introduction of Inert Gas into the process stream will dilute and displace the oxygen. Although Inert Gas is used as the motive force for the movement of the process material, there are several ways which oxygen may infiltrate the system. The most common method of infiltration is entrained air between the powder particles. This oxygen is introduced into the process stream with the material to be processed is introduced to the system for outside of the "Closed Loop". If the relative volume of Inert gas remains unchanged, the aforementioned oxygen will remain in the process stream until the material is discharged.