

# 1. INTRODUCTION

'Static electricity' arises when materials in contact are separated and the speed of charge movement on one or other surface is slow.

If the time for charge movement is very short then charges of opposite polarity can move to the last point of contact and neutralise each other - then little charge is retained. This occurs when, for example, two metals are separated. If the time for charge movement on one material is very long, then charge will remain effectively static on that material when the surfaces separate. If the other surface is a good conductor, but it is electrically isolated, then although charge can move across its surface it remains trapped on the conductor. With static 'charging' no charges are actually created - only separated.

The 'charge' separation arises from differences in the electronic structure of the two surfaces. It is very much a surface effect and so very much influenced by the materials and by surface cleanliness.

Charge separation occurs at individual surface separation events and in multiple and repetitive events. In the later case the repetitive separation is effectively a 'charging current' generator. The difficulty experienced by charge leaking away is then usually thought of, and described, as a 'resistance'. The limitations of this way of thinking will become apparent later.

The present Notes are concerned primarily with static electricity in industry. Much of the interest is associated with the hazards and problems which static can cause. However, static is also used constructively. The following list indicates the range of ways that static can be of importance:

- **ignition of flammable gases:** petrochemical, explosives, plastics and printing and pharmaceutical industries (loss of plant/production, damage to personnel)
- **shocks to personnel:** paper, packaging and printing industries (indirect risks of accidents and damage)
- **attraction of dust and debris:** packaging and printing (affects performance and cosmetic appearance)
- **cling of thin films:** packaging film handling, lingerie (cling causes difficulties in handling, in wear and in appearance)
- **damage to semiconductor devices:** (added costs in production and poor reliability)
- **upset operation of microelectronic systems:** relevant to malfunction of computer equipment, instrumentation and process control

The constructive uses of static are mainly in relation to transport and holding of particles to surfaces - for example: electrostatic precipitation, paint spraying, electrostatic clamping, electrophotographic copying. Electrostatic forces can also be used for particle alignment – for example, in flocking.

The aim of the Lectures and these Notes is to inspire confidence:

- in the ability to appreciate how, where and why static arises
- in making electrostatic measurements and assessing their significance
- in considering actions to control or use static

With a better appreciation of static there is a better chance to recognise prospective problems in advance and choose materials and/or adjust processes to avoid risks and problems.

It is important to appreciate that electrostatics is only ever a part of the overall 'system'. Electrostatic aspects must be viewed in conjunction with many other practical, personnel and economic factors.

These Notes start with an outline of basic electrostatics followed by a discussion on measurements. These topics may seem to some a bit 'academic'. They are important because they form the basis for understanding and assessing practical problems. Not many people think about electrostatics as easily as they think about current flow and Ohm's Law - so it is important to come to terms with the basic concepts. In addition to references of published papers, at the end of each main section, a number of sources of information are listed such as books, organisations running meetings, Websites and sources of standards documents.

It is hoped these notes will be a useful guide and reference source - and will stir the imagination and enthusiasm!