The Basics of Intrinsic Safety

Introduction

The concept of intrinsic safety is completely different from any of the other recognised methods of protection, and, as a starting point, it is worth considering why it has its name.

If something is intrinsically safe, this means that it is safe by its own nature, without any help from outside. So to make use of this valuable quality we have to be sure to use it properly, and not to do anything which will interfere with its inherent safety.

So the protection technique is not a matter of creating intrinsic safety, but instead it is a matter of preserving the intrinsic safety which the device or apparatus already possesses.

Definition

The following abbreviated definitions are typical:-

- **Intrinsic Safety**: A protection technique based upon the restriction of electrical energy to a level below that which can cause ignition by either sparking or heating effects.
- **Intrinsically Safe Circuit**: A circuit in which any spark or thermal effect produced in normal operation and specified fault conditions is not capable of causing ignition.

Illustrations

To help the reader to understand the basic underlying principle, we will quote some examples.

A switch on its own is intrinsically safe. You can carry one in your pocket into the hazardous area and, providing it is not connected to anything else, you may operate its contacts as many times as you like without causing an explosion. However, if you connect it into a circuit in which 40 amps are flowing at 200 volts dc, you will ruin its intrinsic safety, and when you operate the contacts the big spark would most probably ignite any hazardous mixture.

Again, a resistance thermometer element (e.g. Pt100) on its own is intrinsically safe because it is not capable of self-heating nor is it able to create any sparks. However, if you were to connect the 100ohm element directly across a 24-volt supply you would destroy its intrinsic safety because it would now get dangerously hot and might ignite a hazardous gas or vapour.

Preserving intrinsic safety

So the preservation of intrinsic safety depends entirely on the strict control of energy in a circuit so that incendive sparks or hot surfaces cannot possibly arise. This includes restricting voltage and current to low values, and ensuring that no parts of the circuit can store or generate excessive levels of energy.

So we have to consider the whole circuit, not just the field apparatus in isolation.

The minimum ignition curves

The minimum ignition curves, or ‘gas curves’ as they are usually known, summarise the results of thousands of experiments which have been carried out to determine the magnitude of currents over a range of voltages which are just capable of igniting a critical mixture of gas and air at normal temperature and pressure. The size of the igniting spark varies greatly according to the particular gas tested and it has been found to be convenient, when considering the very large numbers of gases and vapours which occur, to divide them into Gas Groups.

For surface industries (i.e. excluding mines) the Group II is divided into Gas Groups IIA, IIB and IIC, in which the gases in Group IIC are the most easily ignited. In this way after applying generous margins of safety, the levels of voltage current which are intrinsically safe (i.e. which cannot interfere with the intrinsic safety of equipment in the field) are established.
**Associated apparatus**

Associated apparatus is the name given to that most important piece of equipment which is responsible for controlling the level of voltage and current which will be permitted to enter the hazardous area. It takes the form of an interface between the safe area and the hazardous area, usually a zener barrier or intrinsically safe isolation interface.

Associated apparatus is located in the safe area near to where its intrinsically safe connections can be passed into the hazardous area. Other types of associated apparatus might include such things as safe area alarm panels with IS inputs, or temperature recorders having IS terminals which connect to thermocouples in the field.

**Field equipment**

The equipment which is to be located in the hazardous area will be one of two types. It may be classed as Simple Apparatus (see RTKtec 108 “Simple Apparatus - or not so simple?”) in which case it is so obviously safe that it does not need to be certified, or it will be non-simple equipment which will be certified as being intrinsically safe for use in a specified Zone in the presence of a specified (or less easily ignited) Gas Group.

Compatibility between the interface (barrier, etc.) and the field equipment must be established, see RTKtec 107 “Assembling an Intrinsically Safe System”. The safety parameters describing both the maximum output of the interface and the maximum permitted input of the certified field equipment will be found in the relevant certificates and marked on the apparatus.

**Cables**

Interconnecting cables include reactance (capacitance and inductance) which will have an effect on the storage of energy in the circuit. RTKtec 107 includes information on this aspect, and the reader will gain more help from RTKtec 105 “Uwhat?– Understanding IS terminology”, and from RTKtec 110 “Cables for IS installations”.

**Benefits**

The use of intrinsic safety for instrumentation circuits brings with it a number of benefits, for example:-

- The lack of incendive energy means that circuits can be tested, adjusted and repaired in the presence of gas without disconnecting power.
- Safety does not depend on enclosure, so there is no benefit whatever in enclosing field equipment within certified housings. However, protection of terminals to IP20 is required to prevent gross intrusion.
- Usually the low costs of installation, including inexpensive cables and the ability to use perfectly ordinary items of simple apparatus.

**Bibliography**

This introduction to the basic principles of intrinsic safety is not intended to be a complete review of the subject. The following Standards should be referred to for more information:-

- EN 60079-14:1997 “Electrical installations in hazardous area (other than mines)".
- EN 50014: 1997 “Electrical apparatus for potentially explosive atmospheres – General requirements
- EN 50 020:2001 “Electrical apparatus for potentially explosive atmospheres – Intrinsically safe ‘i’ “.
- pr EN 50 039: 2001 “Electrical apparatus for potentially explosive atmospheres
- Specification for intrinsically safe electrical systems ‘i’ “.