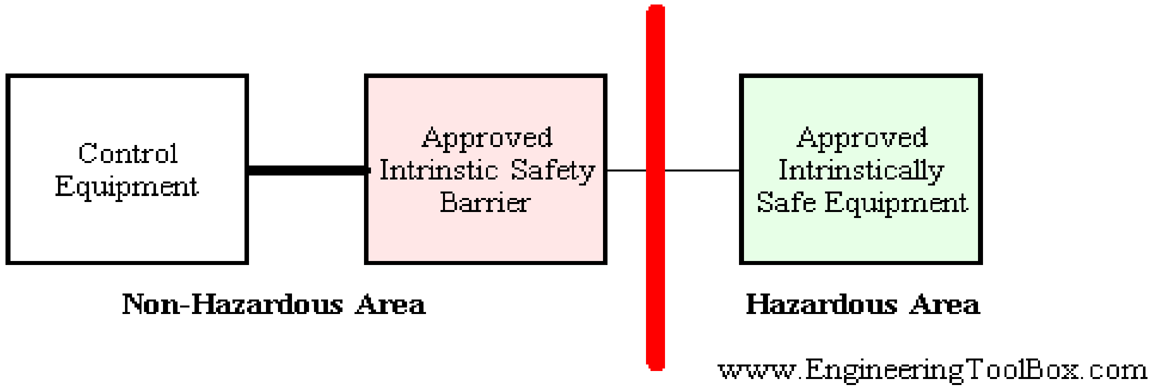
Intrinsically safe electrical circuit

It is because of the terrible condition in underground faces that the electrical faults occur frequently in underground distribution networks, such as earth leakage, short circuit and so on. However, traditional feeder switchgear cannot satisfy the requirements of safety and reliability in power supply system due to complicated protective circuits and various pluggable units. It is hence important to develop a new measurement and control system with high properties

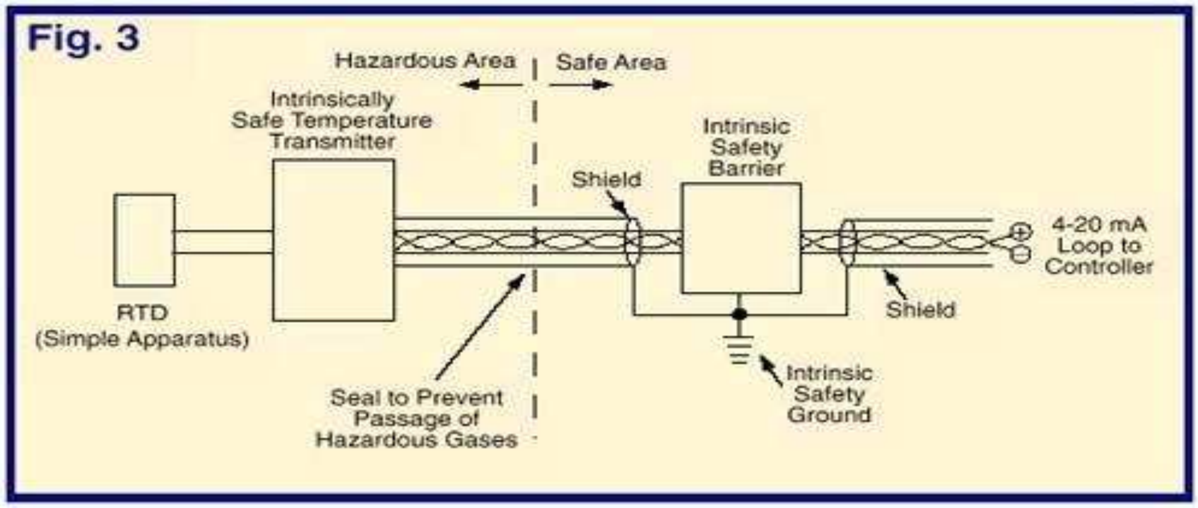
Intrinsic Safety Description

An “intrinsically safe circuit” is defined by the National Electric Code (NEC) as, “A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in the air under prescribed conditions.”



Intrinsic safety is a protection method for electrical equipment used in hazardous locations where the energy allowed into and stored within an area is limited to a level that is incapable of causing ignition. IS equipment is designed and evaluated to ensure that the amount of electrical energy stored within the device is reliably limited to predetermined safe levels. For standard wired systems, an IS barrier must be used to limit the amount of energy entering the hazardous area. The IS barrier must be selected to be compatible with the connected IS equipment both from a safety and functional perspective. Field wiring connected to the hazardous location terminals of the IS barrier must be reliably segregated from non-IS wiring to prevent inadvertent interconnection that may lead to an unsafe condition. Intrinsic safety is fundamentally a low energy technique and consequently the voltage, current and power available is restricted.

Applications of IS systems



Because IS protection is clearly more applicable to low-power and particularly to very low-voltage equipment, it has been widely adopted for the explosion protection of instruments, electronic process control and telemetering where all or part of the circuit has to be within a hazardous area A hazardous area in this context means a zone where an explosive atmosphere could be present, a tank farm or pumping area for example.

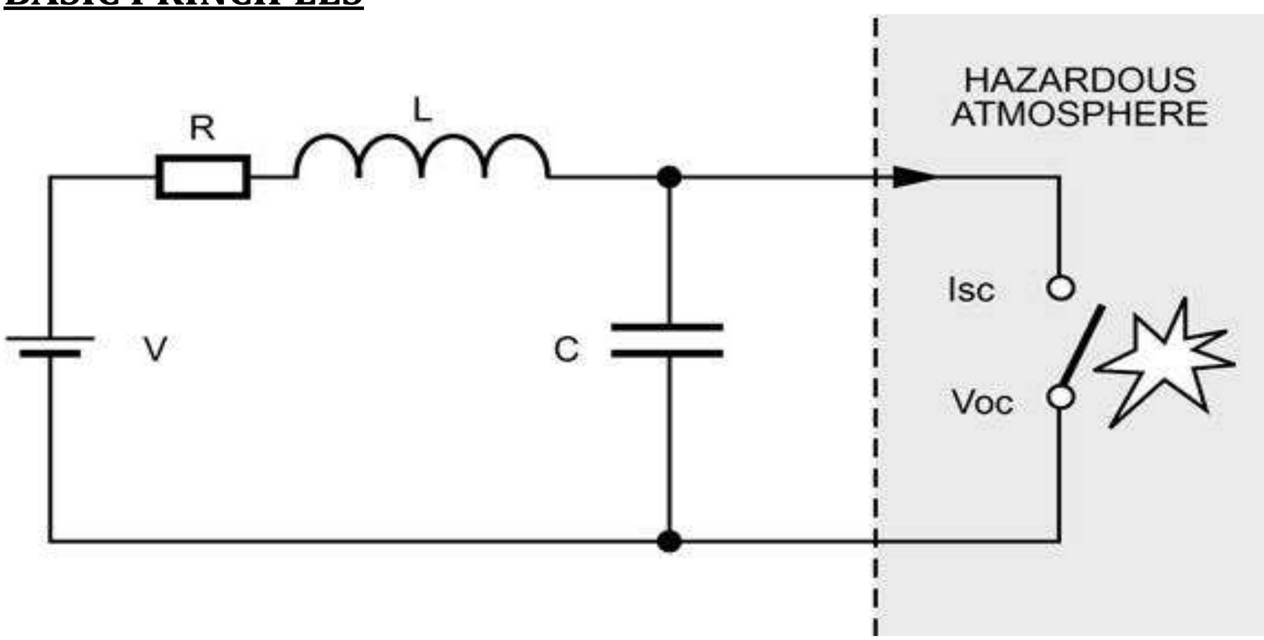
Low voltage solid-state technology and IS techniques have advanced rapidly together, so that, in the last ten years or so, more electrical equipment has bee designed and certified for intrinsic safety than for any other form of explosion protection

Most of the circuit wiring and apparatus forming an IS system are normally installed and operated in a safe area, such as a control room Those parts of the IS system which have to be in a hazardous area are usually restricted to simple probes and devices such as float switches, (in the UK, 240 V AC) to some part of the IS circuit. intensive development of IS systems has been concerned, not with hazardous area apparatus at all, but with the safe area equipment which may be connected to it. In fact, IS protection has very little to do with apparatus in the hazardous area, but is almost entirely concerned with what the hazardous area items are connected to in the safe area; for, in general, this is where the dangerous sources of energy will lie.

In Intrinsic Safety applications three basic parts have to be considered:

- Hazardous Area devices (Simple Apparatus), or equipment (Intrinsically Safe Apparatus).
- Safety interfaces (Associated Apparatus).
- Interconnecting cables.

<u>BASIC PRINCIPLES</u>



Simple Apparatus

Passive components (switches, resistive sensors, potentiometers), simple semiconductor (LEDs, photo-transistors) and simple generating devices (thermocouples, photocells) are regarded as

Simple Apparatus if they do not generate or store more than: 1.5 V, 100 mA, 25 mW (IEC 60079-11 and EN 50020 standards).

Intrinsically Safe Apparatus
Transmitters, I/P converters, solenoid valves and any other “energy storing” device must be certified as Intrinsically Safe Apparatus suitable for use in Hazardous Area, according to the zone, or division, classification and gas characteristics (group and temperature class).

Associated Apparatus
Interfaces between field and control room equipment, usually called “Barriers or Isolators”, protect the Hazardous Area circuits by limiting the voltage and current in normal and in fault conditions. Two types of intrinsically safe interfaces exist: “Zener Barriers” and “Galvanic
Isolator Barriers”; they basically differ for the way the potentially dangerous energy, from control room equipment, is diverted to prevent it from passing through to the Hazardous Area circuits. Associated apparatus are the key to any intrinsically safe system because they define maximum allowable safety parameters of the circuits connected to the Hazardous Area terminals of the barriers.

Interconnecting Cables
Low voltage and current, in intrinsically safe circuits, allow the use of ordinary instrumentation cables provided that capacitance and inductance are taken into account in assessing the safety of the system; cable parameters seldom are a problem and long distances can be easily achieved.

Defining the Classification

Defining the product classification for the desired market determines how certain sections of the standard are applied when the product's design is evaluated.
For intrinsic safety, the Maximum Power Theorem is applied to circuits in order to determine the conditions that need protection. The maximum energy that is transferred must be below the ignition curves and meet the de-rating criteria of the intrinsic safety standard under fault conditions. This step determines the protective components that need to be added to the design. The intrinsic safety standard applies faults to the design and the standard defines faults as follows:

- Fault: Any defect of any component, separation, insulation or connection between components, not defined as infallible by the standard, upon which intrinsic safety depends.
- Countable Fault: Fault which occurs in parts of electrical apparatus conforming to the constructional requirements of the standard.
- Non-countable fault: Fault which occurs in parts of electrical apparatus not conforming to the constructional requirements.
- Infallible: Considered not subject to certain fault modes as specified in the standard

The circuit is reviewed under these fault definitions. In addition, the rules in the standard define how a component is considered infallible and faulted. In the case of the top-level of intrinsic safety, the voltage applied to the circuit cannot be capable of causing ignition in any of the following conditions:

• In normal operation and with the application of those non-countable faults which give the most onerous condition.
• In normal operation and with the application of one countable fault plus those non-countable faults which give the most onerous condition.
• In normal operation and with the application of two countable faults plus those non-countable faults which give the most onerous condition.
• The non-countable faults may differ in each of the above cases.

Advantages of Intrinsic Safety

- it is the only technique that is allowed to be used even under Zone 0 of the IEC Classification system for hazardous areas. One cannot use any other technique like explosion proof (or increased safety or non incendive methods or any of the many other methods of protection) in Zone 0.
- Other advantages are that since it uses the entity concept, the designer can mix and match various compatible components to make the circuit intrinsically safe. It gives him/her greater flexibility.
- Also, using this technique eliminates the need for explosion proof junction boxes in the hazardous area, one can use weatherproof junction boxes too, with IS (intrinsically safe) loops.

Disadvantages of Intrinsic Safety

The main disadvantage of this method is that, it can be used for only low power circuits; thus you cannot have heavy duty intrinsically safe motors for example. Typically the circuits are powered by 24 V dc power supplies. So Intrinsic Safety is mainly used for only measuring and control instruments like pressure transmitters, control valve positioners, small capacity solenoid valves and so on.

Some people feel that Intrinsic safety is complicated because it requires more engineering effort as one needs to select the instruments, select appropriate barriers and isolators, design proper grounding schemes and even select the right type of cable.

However it is not complicated at all.All we need to do a step by step method, with examples, to understand how the process works.

CONCLUSION

It will be seen that protection by the method of intrinsic safety has grown rapidly in recent years due to its eminent suitability for programmable process control and information transfer It differs essentially from all other methods of protection of electrical apparatus for use in potentially explosive atmospheres because the flow of energy from the safe area must be carefully controlled Its growth has been greatly accelerated by the development of barrier devices which protect the hazardous area from the effects of possible intrusion of dangerous sources of energy from the safe area parts of the system.In future it is possible that fibre-optic transmission of data will supersede many existing barrier applications for IS systems.