Electrical Safety in Chemical Processes

Electrical safety is important in any location or situation, but it is especially important in chemical processes because of the hazardous nature of the materials and the severe environmental and operating conditions.

Chemical processes use flammable gases and vapors and combustible dusts, which can be ignited by electrical equipment and wiring (as discussed in Chapter 5), as well as by lightning discharge and static electricity sparks. Lightning discharges can damage structures and buildings and cause momentary power blips or sustained damage to electrical power systems, resulting in major power outages. Both lightning discharges and static electricity can disturb and damage process control and instrumentation systems.

Chemical processes present the most severe operating and environmental conditions for electrical systems. Corrosive and toxic materials in chemical plants attack electrical conduits, panels, connections, cables, and people. Many plants are outdoors and subject to rain, dust, dirt, wash down, and wide temperature extremes. Plants on the Gulf Coast are subject to salt spray and condensation. In those plants, condensation inside conduits, boxes, instruments, power panels, motors, and so on, is a difficult problem. Grounding, protecting circuit and equipment, selecting electrical enclosures, and wiring systems involve technically complex issues and require a high level of electrical engineering capability. The continuity and reliability of electrical power to process equipment motors, heaters, lighting, and other electrical equipment are key issues in chemical processes.

Power interruptions can range from a momentary power blip or dips caused by lightning, power system switching, power system faults, and large motor starting to major long-term outage due to equipment or other power system failures. The result of a loss of power can range from a disruption of production to an explosion, a major release, or equipment failure. It
depends on the type of process and equipment and the duration of the power outage.

Another factor that adds to the severe operating conditions in chemical processes is the fact that many chemical plants operate 24 hours a day, 7 days a week. This situation makes maintaining and repairing equipment difficult. In some cases, electrical equipment and wiring must be worked on while they are energized. Special precautions and work practices are required in these situations.

Operators, for example, may be exposed to special electrical hazards in locking and tagging out electrical equipment. Therefore, specialized electrical equipment and practices are required as a part of vessel entry. In addition, electrical equipment and wiring must be designed so that if a wiring or insulation failure occurs, the sparking and arcing fault current is of short duration and is contained within the electrical equipment. Electrical systems that have the correct circuit and equipment protection (fusing and breaker setting) and are properly grounded do not allow failures to result in burn downs of facilities.

To address these and other electrical safety issues, the following topics will be discussed in this chapter:

- Electrocution and personnel safety
- Lightning protection for chemical-process facilities
- Static electricity as an ignition source
- Protection of electrical systems
- Electrical power reliability and quality
- Cable systems for chemical-process facilities

**ELECTROCUTION AND PERSONNEL SAFETY**

Human beings are extremely sensitive to very small values of electrical currents that may pass through parts of the body as a result of accidental contact with electrically energized conductors. This is because the body is a conductor and functions by millivolt electrical potentials developed within different parts of the body and transmitted within the nervous system. Muscular action, heart action, breathing, and virtually every body action depend on an elaborate and sensitive electrical system that can be upset or destroyed when an external electrical current is superimposed on it.

Tests on people and animals have been performed that provide quantitative data on the sensitivity of the human body to electrical current. As shown in Table 6-1, the smallest perceptible current is about 1 milliamp or one-thousandth of an ampere. The given currents are typical values based on a number of tests or, in some cases, on tests on animals and the results