Recent Improvements In Salt Plant Electrical Systems

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ABSTRACT

The electrical system is an important part of any salt plant today and is growing more important and critical all the time. As salt plants have an unusually corrosive atmosphere, there are special problems in electrical systems which can be improved or eliminated by using some of the new materials available. These materials are enclosures of fiberglass, special sealing systems and cable trays of corrosion resistant materials.

Although corrosion is the biggest problem affecting salt plant electrical systems, another major problem is safety. New safety systems with ground fault sensors and trips do much toward the elimination of shocks and fire hazards.

A third and growing problem is the lack of adequately trained electrical personnel. Planned training sessions must be organized to improve and maintain the skills of electrical personnel. Some publishing companies have established training courses which can be used to upgrade electrical personnel to an acceptable level or to assure a continued supply of electricians for plants which are not located near large labor markets.

A good reference for any proposed electrical work is the National Electric Code *which, while not guaranteeing efficiency or economy, if followed does guarantee a safe electrical system.*

GENERAL DISCUSSION

The electrical system of a plant is its lifeline, as anyone who has seen a plant with a power failure will attest. A plant without electric power today is a plant losing money. Electric power usage in industrial plants on the average has doubled for each plant in ten years, but is now beginning to double every six years. This dramatic rise in the use of electric power illustrates the growing dependence on electric power and why reliability in a plant's electric system is so important. The basic fact today is that when the plant lacks electric power there is no production and no profit. Therefore, the prime consideration for any electric system is reliability and, in the salt industry where there is a high volume, low profit product, reliability becomes even more important.

In a salt plant there are problems which are not found in most other types of plants. The salt plant environment is corrosive and, with the ever-present moisture, electrically conductive. It is evident that we cannot change the environment of a salt plant, so an electrical system for a salt plant must be specifically designed for this environment.

IMPROVED ELECTRICAL EQUIPMENT

In the past few years, the manufacturers of electrical equipment have made some improvements which can be utilized well by the salt industry. Among these improvements are corrosion resistant, watertight enclosures made of polyester fiberglass with 316 stainless steel hardware, standard motors with encapsulated windings, plastic cooling fans, epoxy coatings, stainless hardware and, very important, a 1.15 service factor in totally enclosed fan cooled (Totally Enclosed Fan Cooled TEFC) motors, heat shrinkable tubing (approved by the Bureau of Mines), polyvinyl chloride (PVC) conduit or PVC conduit and fittings.

There are now companies which will coat any metal equipment with PVC to make it corrosion resistant, including items such as lights, receptacles, conduit fittings and electrical hardware. Also commonly available are plastic cable clamps, tie wraps, nuts, bolts and cable trays for small wires.

In many instances now it is feasible to eliminate conduits and pulled wires by using aluminum cable trays of

6061 aluminum and multi-conductor cable. This eliminates the problem of open junction boxes where the salt and moisture get into the conduits and corrode the system. Such corrosion from the inside usually causes a few preliminary short circuits prior to complete circuit failure.

A source of electrical components for salt plant electrical systems is the new Underground Residential Distribution (URD) equipment which is being developed for the electric utilities to use in underground distribution systems. The nature of this equipment, designed for direct burial or submergence, dictates that it be watertight and corrosion resistant to withstand its design environment. These same features make it ideal for use around a salt plant. Among the equipment available are cable splicing kits, cable connectors, tap-off connectors and transformer enclosures, with new items being added frequently. It is well worth while keeping abreast of the new URD developments for possible incorporation into salt plant electrical systems.

Although many of these products have been available for years, many of the electrical installations in the salt industry are of the standard type used to wire commercial buildings and industrial plants where conditions are considerably different than those of a salt plant and, therefore, not suited to the use to which they are put. With the harsh service a salt plant puts on an electrical system, every effort should be made to keep up with the latest state of the art.

THE BONAIRE PLANT SYSTEM

As an example of the use of new equipment and techniques, the solar salt plant on Bonaire in the Netherlands Antilles has an electrical system specifically designed to be as trouble free as possible in a salt installation. The first rule of design was to use as little exposed metal as possible in the system. To this end, all motor starters, including a 250 HP and 200 HP wound rotor motor starter are in polyester fiberglass, watertight enclosures. All junction boxes are also of the same material, as are all push button stations. All splices were made using heat shrink tubing and all cable was of the multiple conductor type with a PVC outer sheath.

To date, there has been very little trouble with this system, even though many of the starters are in exposed positions where they are scoured by a constant wind and, in effect, sandblasted so that some of the starters have now taken on what could be called a "suede" appearance where the hard top layer of the polyester fiberglass has been eroded away leaving some of the glass fibers exposed. Nevertheless, there has been no failure on any of these starters due to water leakage and no corrosion. All motors at this plant are of the TEFC type and, where possible, a standard motor of the type previously mentioned. To date, we have had no motor failures due to external moisture getting into the windings or due to corrosion of bearings.

While this installation is unique in the fact that most of the equipment is outside exposed to the weather, it does give an indication of what can be done with some of the new equipment being developed.

OTHER NEW DEVELOPMENTS

One commonly overlooked new development in many installations is the use of current limiting fuses (CLF). The CLF fuse has the ability to clear a short or fault in less than one cycle at currents up to 200,000 amps, as compared to 10,000 amps maximum in most fuses in use today. Anyone who has seen the door fly off an enclosure or a starter seem to explode, can appreciate the advantage of having CLF fuses in their system, if only from a safety standpoint, without regard to damage to the electrical system. The CLF fuse can be fitted into existing electrical systems since the manufacturers now produce them in standard sizes for this purpose. In any new electrical installation using fuses, the equipment should be specified as having fuse clips which will accept only the CLF fuses.

Another development that has received too little attention is ground fault detection. This will change with the advent of the Occupational Safety and Health Act (OSHA), since it becomes mandatory to install ground fault protection on many systems that were formerly without it. Simply stated, ground fault protection is the detection of a small current flow from an electrical system into any ground. Familiar ground faults occur when one stands in a puddle of water and touches something electrical, getting a shock. In the ground fault detector, a current flowing to ground either trips the circuit or sounds an alarm so that the hazard can be removed. It is preferable to trip a breaker than sound an alarm, due to the fact of human nature that it is easier to shut off the alarm than to remove the cause of the alarm. In the case of breaker tripping, the ground fault must be removed before the circuit can be reactivated. Incidentally, it only takes .05 to .1 amps of current to cause death through ventricular fibrillation, a condition in which the heart flutters instead of beats. There is no simple remedy except another electrical shock administered to the heart under carefully controlled conditions, so shock induced fibrillation usually results in death unless immediate medical assistance is available.

It should be noted that whereas all of the new equipment mentioned has a greater cost than standard construction equipment, an equipment life of up to 30 times can be expected, as a result it is not really as high priced as it may appear, especially when the increase in reliability is taken into consideration.

PERSONNEL

Shortage of trained electrical personnel is a problem that seems to affect most salt producing installations. This stems in part from the location of salt plants in areas far from skilled labor pools, and in part from inability to pay the skilled labor rate when near skilled labor pools.

A satisfactory solution to this problem is to train the available personnel to bring them up to an acceptable level of performance. This can be done by using trained instructors from a company that offers this service, or through self-teaching courses that are being offered by publishing companies. Even trained employees must be periodically upgraded to use the new methods and materials which are available to avoid the common problem that accepted methods are hard to change. As previously stated, the way it was always done is not now the safest, best or most reliable. Even though it takes time and money to train electrical personnel, it is well worth it.

SAFETY THROUGH THE NATIONAL ELECTRIC CODE

The National Electric Code (NEC) has been in existence for a long time now and has been used, or not used, as the local conditions dictated. Now OSHA has declared that the NEC is the standard to be adhered to for all new installations and for some reworked systems, whether preferred or not. The NEC is not a design guide for an economical system, but for a safe system.

Safe is a word that belongs in the design of any electrical system for the salt industry. Possibly in some other industry it would be feasible to get along with a less protected system, but in our industry there are all the elements for instant fatality. There is brine, which can be called a superconducting water and is frequently underfoot. The same brine works on the equipment, where it not only provides the conductor, but also corrodes the equipment and jams the safety devices. Brine seeps into conduits, seeking flaws in the insulation, which in turn provide a path either to ground, or worse, cause the conduit to become "hot", floating above ground as a hazard to the worker who might touch it. In addition brine eats away the electrical boxes so that the doors no longer close and the salt accumulates inside where it can collect moisture. All these conditions are potential killers. Although appearing alarmist superficially, the danger is clearly apparent when one remembers that one out of every twenty electrical work injuries results in death.

Clearly, adherence to the NEC should be required in the design of an electrical system for a salt plant. The NEC provides a comprehensive guide for the installation of such an electrical system and as stated in the front of every code book: "The purpose of this code is the practical safeguarding of persons and of buildings and their contents from hazards arising from the use of electricity." The methods dictated by this code provide for at least the minimum provisions necessary for safety. There are also many recommendations made which, while not mandatory under the code, are definitely desirable. One such recommendation is that all present unground electrical systems supplying industrial systems at more than 150 volts and less than 600 volts be equipped with ground detectors. Many of the electrical systems in existance now are of the "it works" type, in that they are 3 phase, delta-delta connections without grounds, rather than the now commonly used 4-wire, Y circuit which has its own integral ground. The delta-delta ungrounded system has been used in the past primarily for the fact that it has no ground to which it can fault. However, there are very few of these systems in existance which do not have an unintentional ground somewhere in the circuit which is usually not detected until a second accidental ground occurs and, even then, only one of the faults is usually corrected. A ground fault detection system installed on these circuits would indicate when the first ground occurred and either cut off the circuit or give a visible or audible signal to indicate that an unintentional ground has occurred and corrective measures can be taken.

Many ground fault systems which have been installed in the past have been disconnected because of nuisance tripping. This is, a ground occurs and trips out the circuit breaker. This puts the particular circuit out of operation until the ground is removed. The nuisance trips are usually the result of a ground detection system which is set to maximum sensitivity. The sensitivity of the system should actually be set to a point where it is determined to be safe from the standpoint of personnel and equipment. Ground faults are in many cases thought of as only minor nuisances, but ground faults are the cause of many electrical fires because a ground fault can cause a conduit to actually melt without drawing enough current to blow a fuse or trip out a circuit breaker. This fire hazard in itself should be sufficient reason for having a ground fault system.

Ground faults are not predictable or consistent. There have been occasions where a ground fault has caused a voltage of as high as 1200 V to ground to appear on the conduit system of a 480 V circuit. In this case, at least 40 motors were burned out before the fault could be located.

SUMMARY

As electrical system voltages increase (the trend is now from 4160 volts to 7200 volts for internal plant distribution) more and more emphasis must be put on the safety aspect of the electrical system.

Electrical systems can be made more reliable by:

1. Use of electrical equipment more suited for the corrosive salt plant atmosphere.
2. Well designed grounding systems.
3. A continuous, high quality maintenance program.
4. A comprehensive, working ground fault system.
5. Adherence to the National Electric Code.

In addition, electrical systems can be made relatively safe by:

1. Use of high quality electrical system components.
2. Adequate equipment grounding system.
3. A continuous, high quality maintenance program.
4. A comprehensive, working ground fault system.
5. Strict adherence to the National Electric Code.

Although this paper outlines in a general way what is being done or what should be done to provide safe, reliable electric distribution in salt plants, it can only be a guide. After a long period in which the electrical industry for the most part ignored corrosion problems, electrical products more suitable for the salt industry are beginning to be introduced with increasing frequency. Therefore, close attention must be given new products and methods of potential interest to salt producers.

REFERENCES

National Electric Code, 1971 Edition. National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts 02110

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