FUNDAMENTALS OF EGM — ELECTRICAL INSTALLATIONS

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INTRODUCTION

The areas of gas measurement and communications have seen substantial changes in the last few years as the natural gas industry adapts to effects of the economy, fluctuating gas prices, warm winters and government deregulation. Every energy delivery company has studied, debated, hired consultants, and finally determined how gas flow data is to be measured and collected. All gas companies have hundreds and even thousands of points which must be accurately measured. Data is retrieved from very remote and rugged locations. Climate conditions can range from humid off-shore platforms to desert conditions with both temperature extremes included. No commercial power is available, allowed or even desired at these locations making the solar-powered electronic gas measurement equipment the ideal method of gathering flow data.

Companies have standardized on one or more models of EGM equipment that meets its particular requirements. Its associated components usually include the computer, differential pressure transmitter, pressure transmitter, solar-panel, battery, and possibly a communications system of some type. This could be a modem for a telephone line, radio data system, or cellular data collection unit.

The manufacturers of the solar-powered computers provide recommended installation procedures based upon agency approvals that they applied for. There are many other techniques that can be utilized to insure that optimum performance is realized from the EGM equipment. Solar-powered EGM equipment must use a low amount of power from the battery source in order to keep the PV system small enough to remain cost effective. Low power consumption makes the system a high impedance device. Solar-powered EGM equipment requires special attention to installation details for proper operation under most conditions.

This paper will look at the installation of solar-powered flow computers of the most common configurations available. There are several recommendations presented to improve upon the manufacturer's installation procedure based upon isolation, insulation, and grounding.

ENCLOSURE MOUNTING

All solar-powered EGM equipment is designed to be mounted out in the open, exposed to the elements. It is constantly exposed to the daily intense ultra-violet rays and infrared heat from the sun. The best of painted surfaces becomes faded and chalky after only a few years of exposure. The temperature extremes that occur within the enclosure literally “bakes” the semi-conductor components and shortens the life-expectancy of all electronic parts. Ideally, the EGM should be located in a walk-in meter house or mounted in a small metal enclosure mounted on the meter run, but realistically, it will be mounted completely exposed. At minimum, an effective sun-shield protecting the enclosure should be utilized. This raises the cost of each installation but the longer life expectancy of the equipment will offset the investment.

Most enclosures have mounting hardware for attaching the enclosure, to a vertical 2” diameter pipe usually mounted over or to the side of the orifice fitting or the positive displacement meter. This will insure that all mechanical and electrical lines will be as short as possible. The 2" diameter pipe is the first area of concern because it will be a path between the EGM enclosure and the pipeline for electrical surges that will surely occur.

Insulating the enclosure from the pipeline can be accomplished several ways. The first method to consider is to install an insulating union at the bottom of the 2” pipe where it attaches to the leveling saddle. The cost of the union is high and it's electrical integrity will eventually degrade. Other installations use a 2”, schedule 80 CPVC pipe to mount lighter weight devices, such as process transmitters. It is not recommended for heavy enclosures due to its weakness where the threads are made and exposure to the elements will cause it to become brittle. A third way is the 2” pipe can be covered with a strong heat-shrink material used by the electrical industry to insulate high voltage splices. It is RAYCHEM WCSM 68/22 EU 3140, a black tubing that will slip over a 2” pipe and then after being symmetrically heated by a rose-bud torch, will make a very strong insulated pipe stand. It must be acknowledged that if the manufacturer designs the EGM to *not* use the case in the ground system (floating ground), there is no need to insulate the enclosure from the pipeline. It is still a good practice to isolate an EGM as much as possible. This provides an extra measure of protection above the manufacturer's requirements.

If the EGM is to be mounted at a power generating plant or near over-head, high-voltage power lines, even more protection is needed. Ground currents around these locations during an electrical storm are potentially harmful. In some instances, EGM with an enclosure made of heavy steel works better in these locations because of steel's ability to shield EMI (electromagnetic Interference). Aluminum or a composite material may not shield EMI even though it may work well against RFI (radio frequency interference). Think of each wire entering the enclosure as an antenna.

The maximum humidity rating for any EGM is 95% condensing. The enclosure should have desiccant material in the enclosure to absorb moisture. There is a new product called "Humidisorb" that replaces the common desiccant known as *silica gel*. It regenerates itself and does not have to be "dried out" or replaced as often as silica gel. If there is corrosion inside the enclosure, an inhibitor package should be replaced every 2 years. Seal all openings and keep the enclosure door secure.

Use a carpenter's level to mount the enclosure straight and keep it at a good level to work with. The way an installation looks is a reflection on the technician(s) that installed it and will be a source of pride when it looks professional. When an installation looks good it is usually going to operate well.

PRESSURE TRANSMITTERS INSTALLATION

The installation of the differential pressure transmitter and pressure transmitter requires special attention if they are not an integral assembly inside the EGM enclosure. Mount the transmitters on an insulated pipe stand to insure that the transmitter mounting brackets are not a path for electrical surges from the pipeline. The pressure transmitter is normally connected to the down-stream pressure of the orifice fitting or to the case of a pulse, type meter. The pressure transmitter can also be mounted just above the differential transmitter to minimize the tubing connection length and reduce the number of isolating valves required.

A direct connection type manifold has the ability to connect the transmitters directly to the orifice fitting without the use of tubing. It presents several advantages despite it's higher cost over an installation using tubing, fittings and valves. The direct connect manifold option provides a mounting for the transmitter(s), isolation valves, unrestricted bore from the taps of the orifice fitting to the transmitters bellows, valving for testing, and dielectric isolation parts.

TUBING AND FITTINGS

The differential transmitter and the pressure transmitter will require block valves, tubing and a five-valve manifold for testing and operation of the measurement equipment. Just as the 2" pipe used for mounting the EGM enclosure can be an electrical path to the pipe line, so can the gauge lines from the transmitter to the orifice fitting. Even if the meter run has flange insulating kits installed on each end, they will deteriorate in time. To isolate the gauge lines between the transmitters and the meter-run piping, di-electric fittings should be installed. For 3/8" stainless steel gauge lines, a common one to use is the CAJON SS-&DE-6, 3/8" tube to tube connector or the Imperial Eastman P/N 962-DC-06xO6.

After installation of the transmitter, tubing, manifold and dielectric fittings, measure with an ohm-meter across the dielectric fitting to insure that isolation has been achieved.

TEMPERATURE PROBE AND TRANSMITTER

The most popular method of temperature measurement is to mount a 100-ohm or a 500-ohm temperature sensor in a thermowell downstream of the primary device and the EGM electronics will convert the resistance changes for the, corresponding temperature value. A cost savings is realized because there is no need for a process transmitter to convert the probe's resistance value to a standard voltage range that some EGM computers require.

Temperature Probe

The 100-ohm temperature sensor means that the resistance of the probe will measure 100.0 ohms when it is exposed to 0 deg. C or 32 deg. F. The 500-ohm temperature sensor will measure 500.0 ohms resistance at 0 deg. C or 32 deg. F. They are not inter-changeable. The temperature sensor is also known as a Resistance Thermal Detector or just "RTD."

The construction of temperature probes has the sensing point located at the tip of the probe. It is isolated by a potting material to keep it from contacting the protective metal sheath. The actual spacing between the sensor and the metal sheath is very small and could breakdown if the voltage surge is high enough. This may be the weakest point for isolation of the EGM from voltage surges.

The probe is mounted in a thermowell and the tip of the probe should touch the bottom of the thermowell. This will insure good transfer of heat from the gas stream to the probe tip. The interconnecting wiring from the probe to the EGM is surrounded by a flexible armored protection to prevent damage from normal use. When the armored cable enters the EGM enclosure, it stops inside an insulated compression connection. This is to secure the cable and insulate the enclosure from the pipeline via the metal armored cable. Surround the armored cable with a piece of plastic tubing from the enclosure to a point past any isolating devices to insure the metal cable does not compromise the isolation from the pipeline. Make a resistance measurement between the armored cable and the case to insure that the insulation integrity is maintained.

Temperature Transmitter

If the EGM does not have a direct resistance input but requires a voltage signal that is designated as the temperature value, a process transmitter will be required to convert the resistance to a voltage range of 0.8 to 3.2 volts or 1.0 to 5.0 volts.

Some temperature transmitters are mounted directly onto the temperature probe and thermowell. This puts the transmitter case in direct contact with the pipeline and it now becomes an area of concern when installing EGM equipment. The connection size between the transmitter is normally 1/2” NPT threads. CPVC plastic collars and short nipples can be installed for insulating the transmitter housing from the pipeline (See Figure 1). The plastic CPVC parts are not as strong as steel and can break as they age.

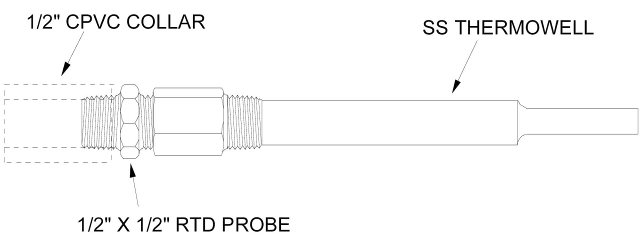

FIGURE 1. Temperature Transmitter With CPVC Coupling

As with the enclosure and the pressure transmitters, the temperature transmitter can be mounted on an insulating pipe stand and the wiring between the temperature probe and the transmitter can be insulated by using all-plastic flexible conduit or by rugged inter-connecting wire accepted for mounting intrinsically safe devices in a hazardous area.

SOLAR PANEL AND BATTERY

The power required to operate remote EGM equipment can be obtained from different sources but the most common is the PV (photo-voltaic) system consisting of a solar-panel, deep-cycle battery and a charging system. The size of the panel and battery is determined by several factors:

- Geographical location
- Average current consumption
- Number of days autonomy required
- Voltage requirements

Many EGM manufacturers size their PV systems to provide power to their equipment over an average number of days without sunlight to recharge the battery. The is referred to as ‘autonomy.’ This can be seven, ten or even up to fifteen days. During January of 1992, northwest Louisiana and east Texas went 22 days without sunshine. PV systems failed and batteries were being replaced, recharged, or supplemented to insure that the EGM continued to operate. Size your systems with the worst case conditions and the extra cost of a larger panel and battery will be worth the investment.

Solar Panels

The more sunshine the solar panel is exposed to, the more power they will produce to charge the battery. Locate the panel where there is nothing to shade it especially during the peak sunlight hours of 9 a.m. to 4 p.m. Even the thin shadow of an electric wire can significantly reduce the panel’s output.

In northern latitudes solar panels should face south and in southern latitudes should face directly north. Don’t guess at the direction to point the panel, use a compass to correctly orient the panel. Tilt the panels for maximum exposure. Mounting the panel at the best angle mean that the panel will get maximum exposure to the sun. The best possible tilt angle puts the flat surface at right angles to the midday sun.

If the panel is remote from the EGM and is to be clamped to a pipe that is connected to the pipeline, install a piece of the heat shrink wrap around the pipe to insulate the panel. Attach an insulated ground wire to the panel’s metal frame and connect it to the grounding system. Do not ‘daisy chain’ any ground system wiring.

Batteries

The most common type of battery used in solar power systems is the deep-cycle, lead-acid battery. They are designed to be repeatedly cycled (charged and discharged). An automobile starting battery is different. It is designed to provide a powerful, short burst of current to get an engine started. At that point, the alternator takes over and recharges the battery. An automobile battery is not designed for deep-cycle applications and will prematurely fail.[1]

The battery of choice for EGM solar-power systems is the “gel cell”. This is a lead-acid battery with additives that turns the electrolyte into a non-spillable gel. These batteries can be mounted sideways or even upside down if needed because they are sealed and with gel technology, they will not spill. They are more expensive but the savings in maintenance can justify the additional cost.

Temperature will have the strongest influence on battery behavior and life. High temperatures will increase the deterioration in a cell due to accelerated chemical reactions. On the other extreme, freezing of the electrolyte can cause damage to the internal plates. The battery life is generally estimated to be between 3-5 years under normal conditions.

Charging Systems

The charging system will prevent the over-charging of the battery during the intense summer sunshine and also disconnect the load when the battery approaches it’s minimum state of charge. When the battery is below 20% of it’s state of charge for a long period of time, the battery will not recover to it’s previous capacity or it may fail.

Preventive Maintenance

Here is a check list of suggested preventive maintenance items to keep solar power systems in good condition:

1. Keep a record of the date of installation of the PV system and measure the voltage after five days of operation.
2. Summer time will cover up the performance of weak batteries because of the intense sunshine and fewer cloudy days. In the fall, begin to record the battery voltages just before sunrise. This will give you your first clue to which batteries have low capacities.
3. Start a battery refurbishment program that will replace batteries at a maximum of five years installation life.
4. Have an appropriate amount of spare battery assemblies that are fully charged and ready for use.
5. Check all battery and solar panel connections for corrosion. Repair and water-proof.
6. Keep the solar panel clean.

GROUNDING SYSTEMS

A good grounding system is vital to any EGM installation. All equipment must be connected to a low impedance ground system to provide transient dissipation. Earth/ground resistance testers are used to determine the resistance of earth surrounding a ground rod. It should be less than 25 ohms. Some of the devices used to test the ground resistance are:

1. "Biddle-250260"; James G. Biddle Co.
2. "Vibrogound"; Associated Research, Inc.
3. "Groundmeter"; Industrial Instruments, Inc.
4. "Ground-ohmmeter"; Herman H. Sticht Co., Inc.

Resistance from all pieces of equipment to the earth ground connection should be less than 1 ohm as measured with a quality DVM (digital volt meter).

The actual ground system may consist of a single ground rod, multiple ground rods, or an elaborate, grounding grid system.

Ground Conductors

Every conductor has measurable inductance (resistance to the flow of AC current not DC current). Solid conductors exhibit more inductance than stranded wire conductors but the most effective conductor is a copper strap.[4] The best practical compromise is to use #10 AWG copper stranded wire with a green colored insulation for proper identity. If you use a bare copper wire, it may contact piping and bypass all of your isolation efforts.

Soil Doping

The earth is a conductor due to the large amount of ionic salts that exist in soil. Conductivity can be increased by adding more ions to the soil especially if the soil is rocky. Augmentation back-fill material that is used by cathodic protection systems is one method of increasing the conductivity but a simpler way is to add Epsom salt to the soil around the ground radial.[1] Depending upon how wet the soil is due to rainfall and water drainage, doping the soil with about 4 pounds of Epsom salt around the ground rod should last about two years.

Ground Radials

Large gauge copper wire and copper-clad steel rods makes copper the most commonly used grounding material. Joints between copper wire and the ground rods should be made by exothermic welds or by using an anti-oxidant, joint compound such as the Ideal "Noalox," in high-compression clamps. After the connection is made, it should be wrapped and made water tight with 3-M Mastic tape to prevent corrosion.

INTER-CONNECTING WIRING

Most EGM enclosures that are solar powered are located near the primary measurement device and the wiring length required for transmitter connections are minimal. Wiring requirements will also be minimal if the pressure and differential pressure transmitter electronics are internally mounted in the enclosure. The temperature probe/cable assembly is with a fixed length and no special connections are required.

If an extra process signal is to be included in the installation, a good quality wire with the appropriate amount of conductors, surrounded with a strong shield should be used. The wire size should be #16 AWG stranded and the shield should have a stranded "drain" wire for connection. If it is to be exposed to the elements the outer covering should be ultraviolet (sun light) resistant and have a direct burial rating. When terminating this type of wire under compression connectors, the wire will eventually conform to the area of the connector and become loose due to temperature cycling. It is a good practice to moderately re-tighten all connections every six months. Terminate the shield's drain wire in the enclosure at the recommended termination point and do not connect it in the transmitter. This will prevent ground loop currents from occurring during a transient surge. Wrap a piece of electrical tape around the cable at the cut-off drain wire. Remember to leave some extra wire neatly routed in the enclosure before it is terminated. You will need that extra length of wire in the future. If the transmitter is fully isolated from the pipeline connect a #10 AWG ground wire from the transmitter case to the ground radial. Do not "daisy chain" any ground system and keep the resistance below 1 ohm from the case to the ground system.

Solar panel wiring should be as large as possible to prevent any voltage drops from occurring. If the panel has to be located away from the battery or EGM enclosure, make sure the wire splices are solid to prevent corrosion from occurring. Connectors between the solar panel and the battery have been known to have problems and should be avoided. Soldering the connections is the best method but a good quality butt-splice, crimping tool and the use of 3-M Mastic Tape will make the connection water-tight. The wire should be sun-light resistant and the shield should be connected to ground in the enclosure only. As with the transmitter cases, if the solar panel is isolated from the pipeline connect a #10 AWG ground wire, from the metal frame to the ground radial. Keep the resistance below 1 ohm from frame to the ground system.

Put a “drip loop” curl in any wire or cable before entering an enclosure to prevent rain water from running along the wire. Protect the wire from any sharp edges that will eventually cut it's way through the protective insulation.

CONDUIT

Your company may require that conduit be used to protect all inter-connect wiring. Special precautions should be utilized to maintain the integrity of the isolation between the pipeline and the grounding system. CPVC couplings and fittings are available to isolate metal and flexible conduit runs. Chemical resistant flexible conduit is a viable alternative.

If seals are required, follow your company's installation guidelines to properly install the fittings. A standard, multi-conductor cable that passes through a seal must be separated and the sealing compound poured around it.[2] The multi-conductor “gel-filled” cable will not let a vapor pass through its wrap. if the enclosure is in a hazardous area and a conduit will be run to a safe area for connections to other equipment, a seal must be installed as it leaves the hazardous area. Each company follows certain standards concerning the classification of the operating areas and have specific requirements for hazardous area installations.

Long conduit runs that are buried at a new installation will eventually move due to settling of the soil. It will put a strain on equipment and CPVC couplings if they are utilized. Reinforce the conduit as it comes above ground level by using stable supports such as Uni-strut bracing anchored separately from the piping. Before installation, check ***inside*** of each joint of rigid galvanized conduit to look for any galvanizing residue left over from processing. This could cut into wiring as it is being pulled through it. Do not use pipe-dope or thread tape to water proof underground connections of conduit.

TRANSIENT PROTECTION

Each transmitter should have some type of transient protection at each transmitter. Transient protection will also be built into the EGM's point of termination for all outside connections. These items usually consist of devices such as MOVs (metaloxide varistors), transorbs, resistors, zener diodes, fuses or a combination of these. Install transient protection at each external device. The temperature probe cable that terminates directly in the EGM's enclosure has transient protection only at the point of termination.

Some of the transient protection devices are sacrificial and have to be replaced after they perform their designed task. The MOV (Metal Oxide Varistor) can deteriorate and become less effective after each surge. MOVs will partially fail and begin to interfere with transmitter signals causing incorrect values to be measured. The best protection is a non-sacrificial protector that win continue to operate correctly after repeated suppressions of surges.

LIGHTNING PROTECTION

There are two areas of thought on just how to provide the best lightning protection system for different installations. One area of engineering thought is to dissipate the static charge build-up into the earth before a strike occurs and the other is to control the strike current by spreading the strike's charge in the earth at survivable levels.[5] By taking the best practices from each, an effective lightning protection system can be installed on the EGM equipment. Installation of EGM for lightning protection should be based on isolation, prevention or dissipation, and control.

According to Underwriters Laboratories, Inc., central Florida has the most annual days per year of electrical storms in the United States of approximately 100[6]. The utility companies in Florida are experienced in lightning protection for its EGM equipment and have utilized several techniques to prevent lightning surge damage. Consider some of these when installing any type of equipment in the field:

1. Ground all fences at each comer or angle change with a deep ground rod.
2. Ground any metal buildings.
3. Provide surge protection on the cathodic rectifier equipment and its power source.
4. Install surge protection on the pipeline insulator connections to prevent arc over.
5. Have a good grounding system.
6. Install transient protection devices on data circuits, telephone lines and field devices.

CONCLUSION

Electronic gas measurement equipment is rapidly replacing the mechanical chart recorders to respond to the changes that are occurring in the way that natural gas companies are doing business. Careful installation of the computers and attention to details will result in a dependable and accurate measurement of gas flow over a long period of time.

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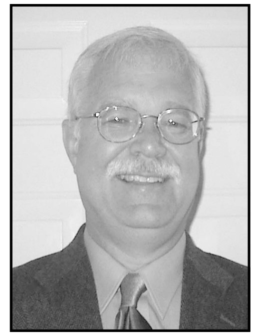

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