

Installation and Grounding of Magmeters in Typical and Electrolytic Process Applications

KEY POINTS

- Purpose of Application
- Background including Magmeter Operating Principle, Faraday's Law, Basic Grounding, Ground Rings vs. Ground Electrodes, Safety Grounding, and Electrolytic Process Applications
- Recommendations for Electrolytic Process Applications
- Summary

APPLICATION

Magnetic Grounding Technical Recommendations

PURPOSE

As a major manufacturer of magnetic flowmeters, Rosemount Inc. often receives questions from customers regarding the proper grounding and installation of magnetic flowmeters, such as:

- When should I use grounding rings or electrodes?
- When should I use ground rings versus ground electrodes?
- Should I always connect the flowmeter to earth ground?

The purpose of this paper is to address some of the basic questions about magmeter installation and grounding, and to address these same issues in the more complicated situation of electrolytic process applications.

Proper installation and grounding of magnetic flowmeters is important for accurate, reliable measurement performance. Stray AC or DC currents through the fluid or instrument can produce noise signals that may in turn interfere with the relatively low flow signals generated in today's modern pulsed DC magmeter. Manufacturers provide a variety of elements (ground straps, ground electrodes, ground rings) and directions for the standard grounding of the magmeter.

Applications exist in which the user cannot or should not make use of the traditional grounding connection to adjacent piping and to earth ground. These flow measurement applications are frequently encountered in electrolytic processes. In this case, the fluid passing through the magmeter flowtube may be at a potential significantly higher or lower than earth ground, and a connection to earth ground may be detrimental to the performance and even the reliability of the magmeter. These applications are typically compounded by the use of non-conductive or lined pipe and may feature acid or caustic flows which may necessitate the use of expensive wetted electrodes and grounding materials such as titanium, platinum, or tantalum.

For the remainder of this paper, the term "grounding" will be defined as: the arrangement of process wetted metal materials (piping, ground rings, ground electrodes), cabling (ground straps, ground wires), and connections to stable references (often, but not always earth ground) required to achieve satisfactory operation of a magnetic flowmeter. As such, it applies to the instrumentation aspect of grounding, rather than to "safety grounding". However, the subject of "safety ground" will also be addressed for these specific applications.

BACKGROUND

Magmeter Operating Principle

The operating principle of the magnetic flowmeter is based on Faraday's law of electromagnetic induction, which states that a voltage will be induced in a conductor moving through a magnetic field.

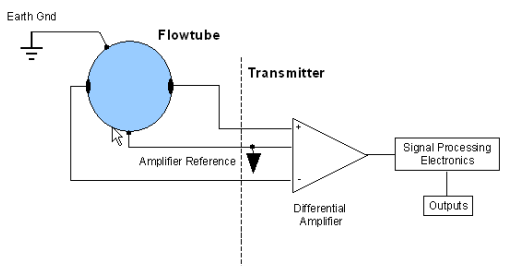
Faraday's Law: $E = kBDV$

The magnitude of the induced voltage E is directly proportional to the velocity of the conductor V , conductor width D , and the strength of the magnetic field B . The secondary (or transmitter) supplies the controlled current to the coils to generate the magnetic field, and amplifies, filters, and converts the resulting signal to user outputs such as 4 - 20 mA, frequency, or digital communication information (HART, Fieldbus). In the modern pulsed DC magmeter, the generated signal is actually quite small: on the order of 100 μV per foot per second flow velocity (300 μV per meter per second velocity). Because this signal is so small, magmeter designers and users must take steps to minimize noise and to maximize noise rejection. One of these steps is proper grounding of the system.

Basic Grounding

Establishing a process ground is one of the most important installation details. Proper process grounding ensures that the flowtube and fluid are at the same potential so that only the induced flow signal is measured. Why is this necessary? To answer this question, let's look at how the magmeter flowtube and the transmitter are connected electrically (Figure A.). In a typical pulsed DC magmeter, the flow signal is connected to a differential amplifier that is electrically isolated from the case of the transmitter. The process of grounding provides a stable reference for this differential amplifier. In the majority of applications, the best and most stable reference is earth ground itself. By connecting the magmeter flowtube, the fluid, and the reference for the amplifier to a stable, noise free reference point, the user is ensured of getting the best performance from their magnetic flowmeter.

Figure A: Basic electrical connection between flowtube and transmitter



The grounding arrangement is determined primarily by the type of pipe in which the magmeter is installed. The recommended grounding arrangements for conductive unlined pipe, conductive lined pipe, and non-conductive pipe are shown in Figures B - E.

Figure B: Recommended GNDing for conductive pipe or conductive lined pipe with GND electrode

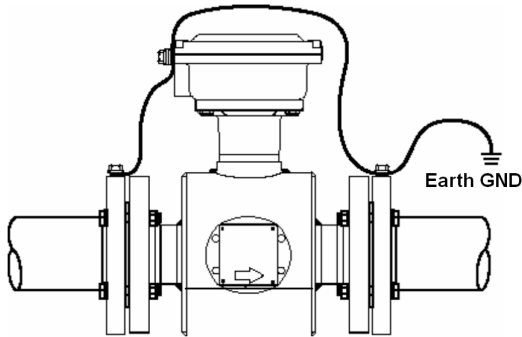


Figure C: Recommended GNDing for conductive lined pipe with GNDing rings or Lining Protectors

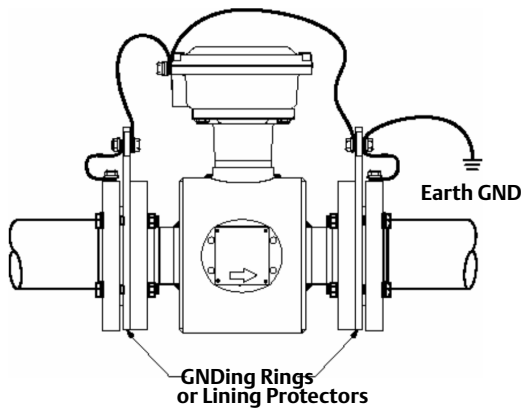


Figure D: Recommended GNDing for Non-conductive pipe with GND rings or Lining Protectors

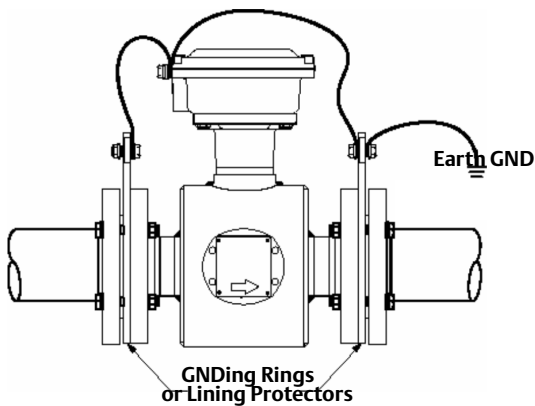
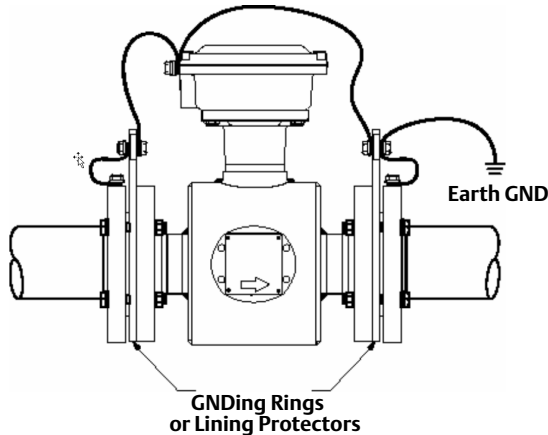


Figure E: Recommended GNDing for Non-conductive pipe with GND electrodes



Ground Rings vs. Ground Electrodes

As shown in the previous figures, ground rings or ground electrodes are required when the piping adjacent to the magmeter does not provide a good electrical connection to the fluid; i.e., the pipe is lined or made of non-conductive material. Ground rings or ground electrodes provide this electrical connection. Ground electrodes are integral to the flowtube, so installation is easier and less expensive, particularly when “exotic” materials are required. Ground rings provide a larger surface area connection to the process fluid, and limit the effects of the conductivity of the adjacent piping, which is important for wafer style flowtubes. Therefore ground rings are recommended over ground electrodes in the following situations:

- The fluid conductivity is less than 50 uS/cm
- Wafer style flowtubes installed in non-conductive piping or lined piping
- Electrolytic process applications (described in the next section)

Safety Grounding

To prevent hazards to operating personnel, electrical equipment must always be installed and wired per local electrical code. For AC powered equipment, this usually takes the form of connection of the case of the equipment to safety ground. This is usually done through the connection of the earthed green wire to the ground lug provided in the wiring area of the magmeter transmitter. If the transmitter is integrally mounted to the flowtube, this automatically connects the flowtube to earth ground as well.

Electrolytic Process Applications

In typical electrolytic processes, magmeters are used to measure the flow of feedstock fluids into the cell(s). Large DC currents (1000's of amps or higher) are fed into the cells to drive the electrolytic process. The resultant liquids and gasses may also be monitored by additional flowmeters. The electrolytic process may occur in one reactor or very many cells. In the latter case, each cell may have its own magmeter for feedstock flow measurement.

Whatever the arrangement, the large voltages and currents present may cause currents to flow in unexpected ways. The current flows of interest here are generally of two types:

- Current flow in the fluid through the magmeter
- Current flow through grounding components

Both types of current may be present in a typical application of these types. In the first case, the flow of current in the fluid passing through the flowtube generates noise that may interfere with the low-level flow signal. Testing at Rosemount indicates that this noise varies with current level and has components that can easily interfere with the flow signal. The result is usually not an inaccurate flow measurement, but rather an unstable flow measurement that can make control difficult or impossible. In this situation, ground rings provide a path to shunt the current around the fluid in the magmeter.

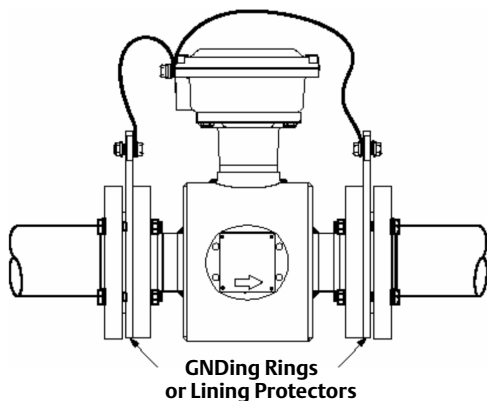
Current flow through grounding components may occur if:

1. multiple magmeters are used in a system;
2. they are at different potentials and;
3. the grounding components for multiple magmeters are tied to a common point. The most frequent common point may be through the grounded green wire. Situations like this have resulted in high corrosion of grounding components, up to and including the loss of sealing around ground electrodes. In addition, current through grounding components generates noise that can result in an unstable magmeter output.

Recommendations For Electrolytic Process Applications

- Isolate from Earth Ground: In these situations, the magmeter should be connected electrically only to the process. Because the magmeter is not earth grounded, to avoid safety issues isolated DC power (~24 VDC) should be used.
- AC Power: If the only available power is standard AC then additional steps must be taken to isolate the flowtube from earth ground. A remote mounted transmitter must be used. To completely float the flowtube the shield wire for the coil signal should be disconnected, eliminating the connection between the flowtube and the grounded transmitter chassis.
- Use ground rings, not ground electrodes: Ground rings expose more surface to the process; if currents flow, less noise will be produced, providing a more stable reference for the amplifier.
- Connection specifics: Ground rings should be connected as shown in Figure G.
- Select 30 Hz coil drive frequency: The noise generated in these applications typically has a $1/f$ characteristic; i.e., the amplitude of the noise decreases with increasing frequency. Because of this characteristic, there is less noise at a higher coil drive frequency, and a more stable output is attained.
- Disable the Empty Pipe Detector: Empty pipe is detected by making a low frequency impedance measurement. These applications can generate high levels of low frequency noise that can cause sporadic false Empty Pipe indications.
- High Signal Magmeter: In extreme cases, noise levels cannot be reduced sufficiently through the recommended grounding. In these cases, RMT recommends use of an 8712H/8707 High Signal magmeter. The High Signal magmeter produces signals which are significantly higher than standard DC mags, in turn providing higher signal to noise ratios. This magmeter is only available in a 115 VAC version so the steps recommended above (AC Power) must be followed.

Figure G: Recommended connection for electrolytic process applications.



Summary

Proper grounding of a magmeter is one of the most important installation details. Grounding arrangements for typical applications have been discussed, including recommendations for the use of ground electrodes versus ground rings. Different grounding arrangements are required when magmeters are installed in electrolytic process applications where the traditional connection to earth ground could actually create problems. While this paper provides general recommendations for these applications, each application is different. Please contact your Rosemount salesperson if you have any questions. Above all, user safety should always be first and foremost in the wiring and installation of any instrument. Electrolytic processes can create special safety considerations for all equipment, not just the magnetic flowmeters.

The Emerson logo is a trade mark and service mark of Emerson Electric Co.
Rosemount and the Rosemount logotype are registered trademarks of Rosemount Inc.
All other marks are the property of their respective owners.

Emerson Process Management

Rosemount Division
8200 Market Boulevard
Chanhassen, MN 55317 USA
T (U.S.) 1-800-999-9307
T (International) (952) 906-8888
F (952) 949-7001
www.rosemount.com

Emerson Process Management Flow

Neonstraat 1
6718 WX Ede
The Netherlands
T +31 (0)318 495555
F +31(0) 318 495556

Emerson Process Management

Emerson Process Management Asia Pacific
Private Limited
1 Pandan Crescent
Singapore 128461
T (65) 6777 8211
F (65) 6777 0947
Enquiries@AP.EmersonProcess.com

ROSEMOUNT[®]

For more information:
www.rosemount.com


EMERSON[™]
Process Management