Western Instruments
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Coil Output

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Unfortunately, there seems to be a lot of misinformation in industry on just how powerful an End Area Coil needs to be, and this article is an attempt to rationalize this subject. To start, the output of an End Area Coil is defined in Ampere Turns or the field strength, in Gauss, in the Centroid of the Coil (in air). Unless the field strength is measured, with a Hall Effect Magnetometer, the Amp Turns are calculated by multiplying the number of amps drawn by the Coil, multiplied by the number of Turns. With that simple definition out of the way, how many Amp Turns is enough?

The most obvious use of an End Area Coil is to induce enough magnetism, in the workpiece, to perform Magnetic Particle Inspection. A second use of an End Area Coil is to demagnetize the workpiece (Demag) to either remove or reduce a residual magnetic field. Inducing enough Magnetic Field can be calculated, however the industry has adopted the more practical approach of using monitoring devices such as Flexible Magnetic Flux Indicators (Castrol Strips), QQI's (Quantitative Quality Indicators), or Pie Gauges. Monitoring Devices are placed on a target area, before a magnetic field is applied, then an inspection is performed (Magnetization, Bath Application, and Visual Inspection with UV Light). If an appropriate indication forms on the monitoring device, then the inspector knows he has enough field.

There are many specifications written for the Inspection of Down Hole Tools (Drill Pipe, Shocks, Jars, Mud Motors, etc.) that have been written by individuals with a basic knowledge of Magnetic Particle Inspection, specifically T.H.Hill's DS1 Specification or Fearnley Procter's NS-2. These specifications require between 1000 to 1200 Amp Turns per inch of diameter, however these amounts are far in excess of what is actually required. To be more realistic, these specifications should require the use of a Monitoring Device at or near the target area. Most competent inspectors use a Castrol Strip or a Pocket Magnetometer at the end of the work piece when inspecting a 'tool' that is unfamiliar.

The leakage field at a defect will be 18 to 24 Gauss, and this is normally achieved with less than 500 Amp Turns per inch of Diameter. An indication from a monitoring device is typically over 30 Gauss. These particular field readings can be measured by a technician (or Engineer) who is competent with a Hall Effect Magnetometer, which is a dangerous instruments in the hands of she wrong person. A quick and easy method to check the field is to us a 50-0-50 Pocket Magnetometer at the end of the workpiece, as it should read at least 30 Gauss. The diameter of a downhole tool is not the best reference when calculating an appropriate field, as measurements such as wall thickness or mass (weight) are far more important. In short, we don't see a lot of Pipe Inspectors referring to ASTM specifications to calculate the fill factor of a coil to further calculate the required Amp Turns required, to meet inappropriate specs.

Being a responsible manufacturer, we must recognize DS1 and NS-2 as many of our customers must follow these specifications. Therefore, our nominal outputs are typically very close to these guidelines (1000 to 1200 Amp Turns per inch of diameter). This being said, our W-Series Coils have a great advantage over Aluminum Bobbin Coils or Cable Wraps from a Power Supply (Generator). In simple terms, the Aluminum Bobbins on Competitor's Coils tend to absorb peak amperages, while W-Series Coils allow the 'in-rush' amperage to be induced into the workpiece. When a WD-Series Coil is Energized, current rushes into the coil, causing an immediate magnetization into the workpiece. The field continues to build until the amperage shown on the meter is achieved.

Competent inspectors know that most downhole tools, right out of the hole, need the residual magnetic field removed, prior to any inspection. Applying Wet Fluorescent Media to an over magnetized workpiece, will result in the media simply sticking to the surface. The media must be allowed to flow over the surface, so it is able to adhere to the leaking flux or a crack.

With respect to Cable Wraps from Power Supplies, their output is a function of the rectified DC output, and due to the low inductance of the formed cable, they are typically not Full Wave, DC like End Area Coils. Furthermore, the output from a generator is dependant on the length of cable used to close the electrical circuit, and is often based on short lengths of cables. When 5 Turns of heavy cable are used (4/0 or heavier), to form a Coil, and with the cable connected to and from the power supply, one can expect the output of the Power supply to be 50% of the rated Power Supply. To understand this further, review Western's write-up titled *Coils*, which is a comparison between *Multi-Turn Low Amperage Coils* (End Area Coils) and traditional *Mobile Power Packs* with Cable Wraps that are low voltage and high Amperage.

Lets remember where Aluminum Bobbin Coils came from. They were introduced in the early 1950 as a component for a (then) high tech piece of equipment, the EMI (Flux Leakage or MFL) Drill Pipe Inspection unit. These strong coils were required for two reasons. First, the amplifiers (in the Drill Pipe Consol) used for the Search Unit Coils in the Shoes were not that great (Vacuum Tubes not Semiconductors). Secondly, as the Buggy's Coil operated for longer periods of time the amperage needed to be increased due to heating of the coil, thus affecting the Coils efficiency. It wasn't long until operators used these Drill Pipe Buggy Coils for End Area Inspection, and "why change anything that "ain't broke". 50 years later Western developed WD-Series Coils, specifically designed for End Area Inspection, and never to see a Drill Pipe Buggy.

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