Thyristor (SCR) Control vs Rotary Transformer in MPI Bench Applications

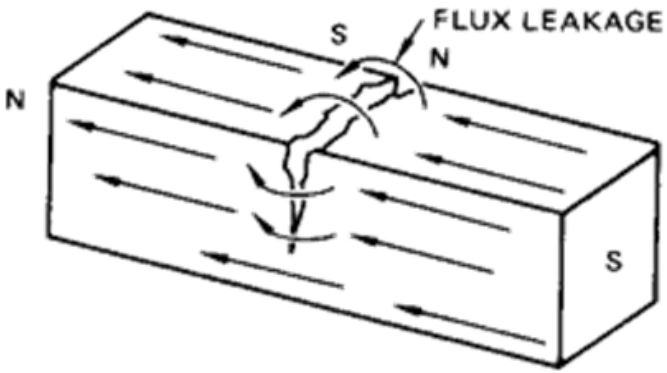
Pete Burrows.
Sales Director
Baugh and Weedon NDE.

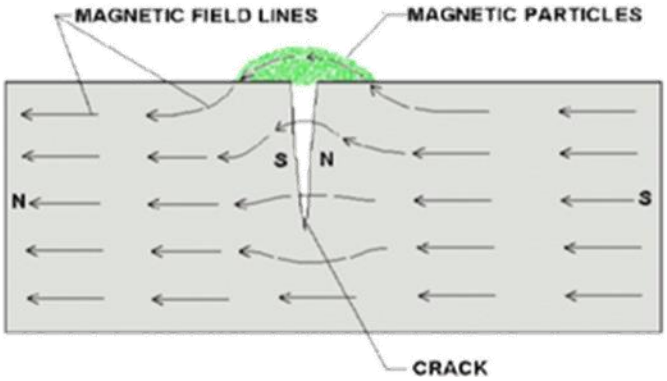
A4A NDT Forum
17th September ‘24

Contents

- MPI General theory
- Waveforms
- Amperage Measurements
- ASTM 1444 and the AS ring test
- Further questions

MPI General





Magnetic field spreads out when it encounters the small air gap created by the crack because the air cannot support as much magnetic field per unit volume as the magnet can.

If iron particles are sprinkled on a cracked magnet, the particles will be attracted to and cluster not only at the poles at the ends of the magnet, but also at the poles at the edges of the crack.

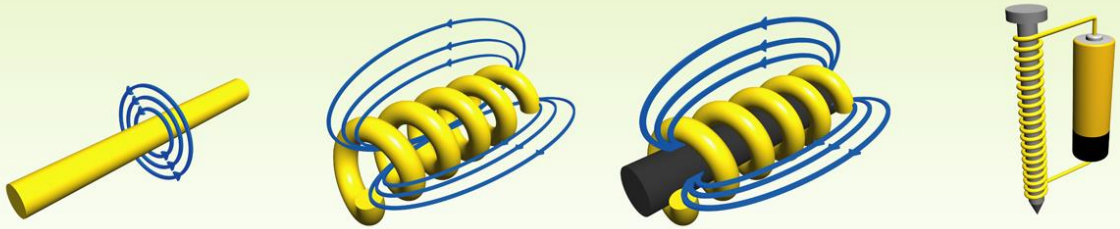
This cluster of particles is much easier to see than the actual crack and this is the basis for magnetic particle inspection.

It is generally accepted that the magnetic field is relative to the peak of the waveform, while producing indications of defects is related to the mobility of the ink particles, which in turn, is related to the amount of power available in the applied current waveform.

BAUGH & WEEDON NDE

MPI General

How Electromagnets Work

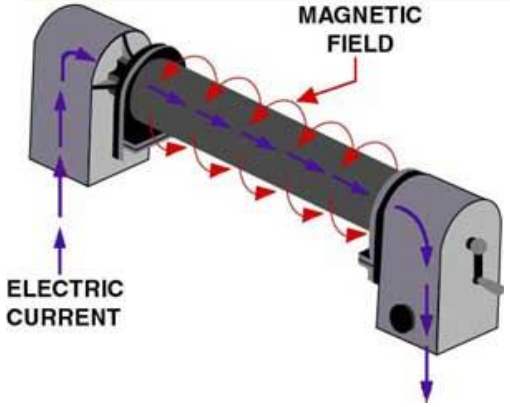


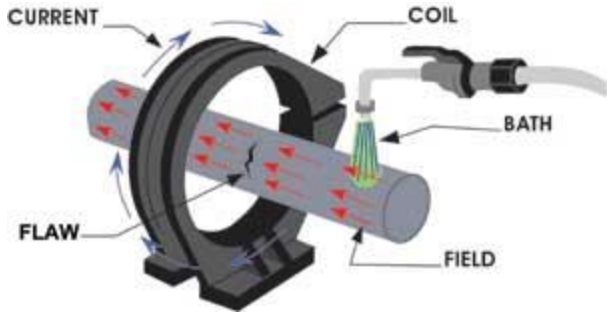
When electric current runs through a wire it generates a magnetic field around it. The magnetic field around a single wire very weak.

By wounding the wire into a coil and concentrating the magnetic field it produces a stronger field. More electrical current produces a stronger magnetic field.

The magnetic field can be made even stronger by placing an iron bar in the centre of the coil. This have a big effect on the electromagnets power.

Try it your self by coiling a copper wire around a nail. Then connect the wire to a 1.5V battery. See how many staples you can pick up by changing the numbers of loops. You can also see what happens if you connect it to two batteries.



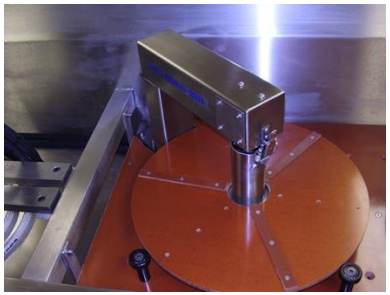


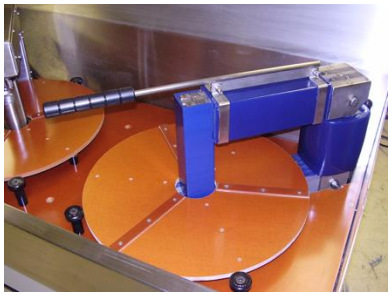
BAUGH & WEEDON NDE

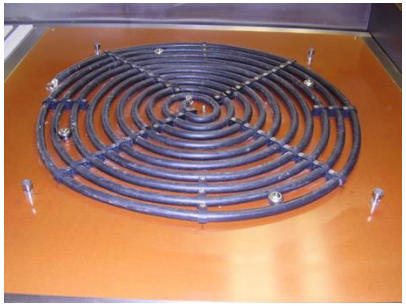
Magnetising Methods

Standard MPI Bench.

Current Flow/Coil/Flux Flow

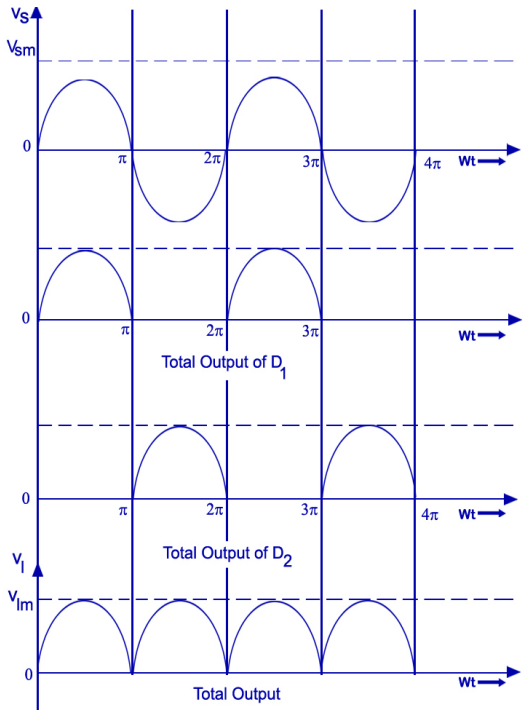






BAUGH & WEEDON NDE

Waveforms

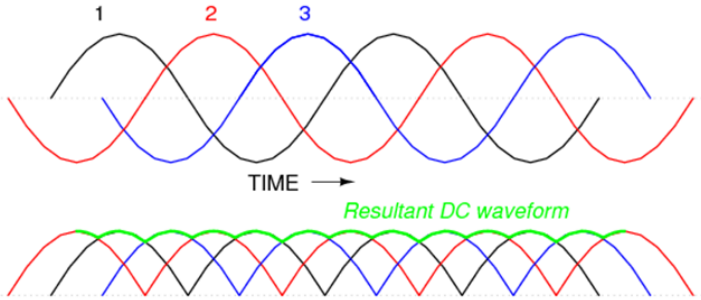


AC

HWDC, Half Wave DC

Full Wave DC, Single Phase

Full Wave DC, Three Phase

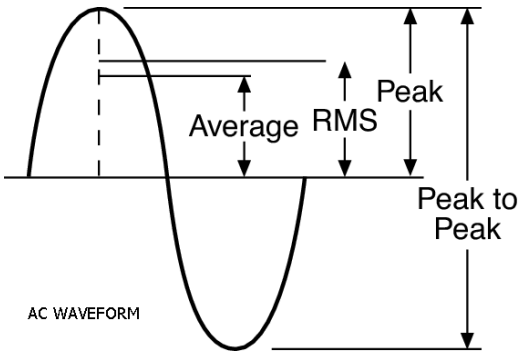


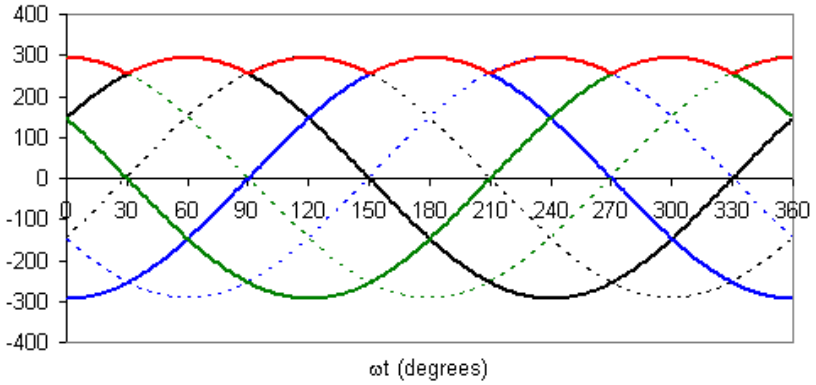
BAUGH & WEEDON NDE

Amperage Measurements

AC, Peak or RMS?

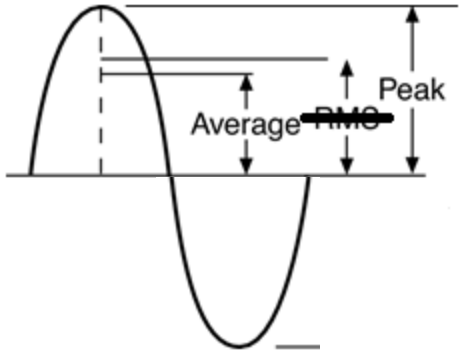
- RMS, Peak x 0.707
- Average, Peak x 0.637





HWDC, Half Wave DC

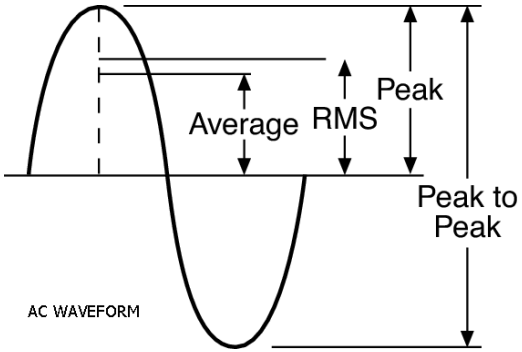
- Average/Mean, Peak x 0.637/2
- To make HWDC measurements 'sound better' the idea of 'twice mean' or 'MagAmps' was derived.

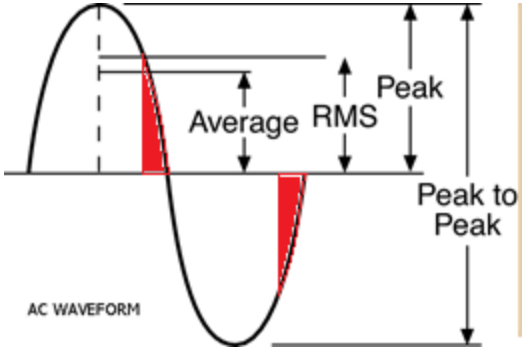


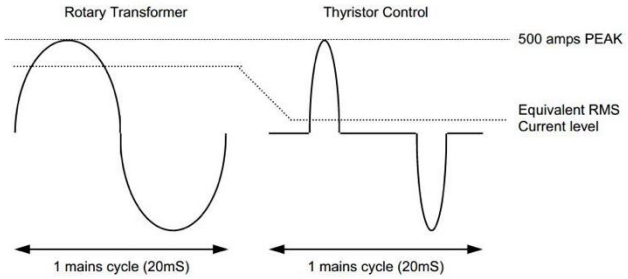
Full Wave DC, Three Phase

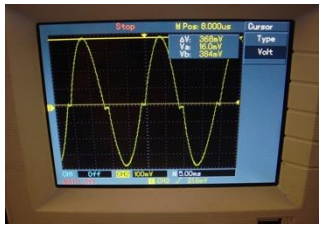
Amperage Measurements

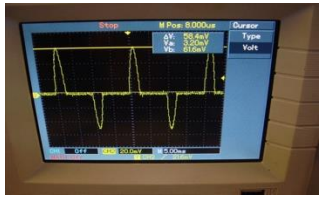
THYRISTOR CONTROL vs ROTARY TRANSFORMER





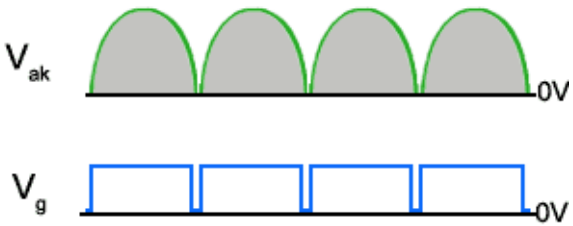






AC, P[illegible]MS?

- RMS [illegible] x 0.707
- Ave[illegible] x 0.637



Same applies to HWDC and FWDC

BAUGH & WEEDON NDE

Real Waveforms, SCR Benches

AC, 500Amps RMS

AC, full power

900 Amps Peak

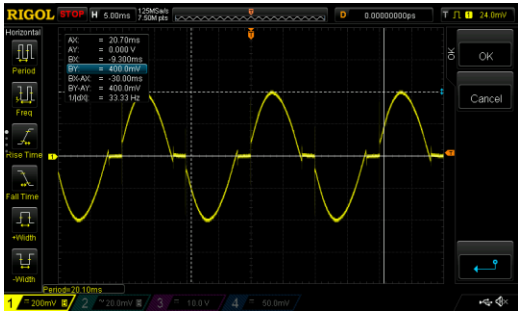
PBU Bench, max 1000 Amps AC RMS, actual 1480 Peak

1032 Amps Peak

SBU Bench, max 2500 Amps AC RMS, actual 3520 Peak

At 500Amps HWDC (2xmean), 707Amps peak, three holes on the AS Ring won't show.

1280 Amps Peak



EBU Bench, max 5000 Amps AC RMS, actual 8000 Peak

BAUGH & WEEDON NDE

AS5282 Ring Test - History

- Lots written on difference between the Ketos Ring and the AS5282 ring. Credit to George Hopman of NDE Solutions and Patrick Jenkins of Magwerks for papers produced on the subject
- Not much written on the way the amperage requirements now in ASTM 1444 on were derived
- However, Patrick Jenkins told me that a batch of rings were sent around the US for round-robin tests to see how many amps were required to light-up each hole. In all probability the bench predominantly used was a Magnaflux, probably a 54”, 5000Amp HWDC or single phase FWDC.

E1444/E1444M – 21

TABLE A3.1 Amperage and Hole Indication Requirements for AS 5282 Rings

NOTE 1—All amperage values have a tolerance of ±50A.

Type of Suspension	Amperage FW or HW Rectified	Minimum Number of Holes Indicated
Fluorescent Oxide (Wet)	500	3
	1000	5
	1500	6
	2500	7
	3500	9

Issues Meeting ASTM 1444

TABLE A4.1 Amperage and Hole Indication Requirements for AS 5282 Rings

Type of Suspension	Amperage FW or HW Rectified	Minimum Number of Holes Indicated
Fluorescent Oxide (Wet)	500	3
	1000	5
	1500	6
	2500	7
	3500	9
Visible Oxides (Wet)	500	3
	1000	4
	1500	5
	2500	6
	3500	8
Dry Powder	500	4
	1000	6
	1500	7
	2500	8
	3500	9

TABLE A4.2 Amperage and Hole Indication Requirements for Ketos 01 Tool Steel Ring Specimen

Type of Suspension	Amperage FW or HW Rectified	Minimum Number of Holes Indicated
Fluorescent Oxide (Wet)	1400	3
	2500	5
	3400	6
Visible Oxides (Wet)	1400	3
	2500	5
	3400	6
Dry Powder	1400	4
	2500	6
	3400	7

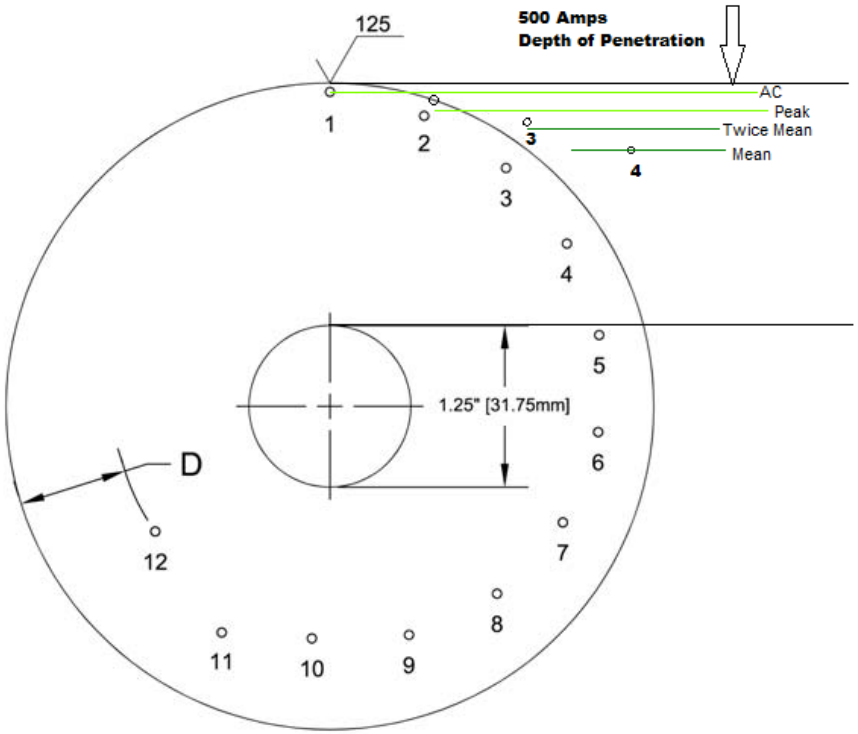
For HWDC:-

500 Amps Peak = 159 Amps Mean

500 Amps Mean = 1572 Amps Peak

500 Amps Peak = 318 Amps Twice Mean

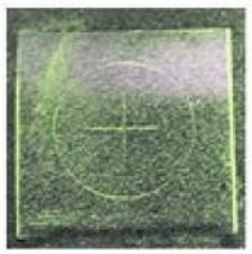
500 Amps Twice Mean = 786 Amps Peak

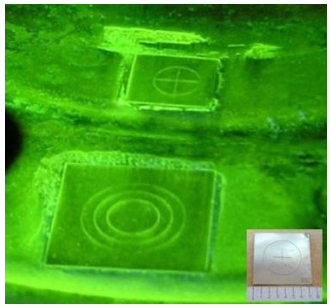


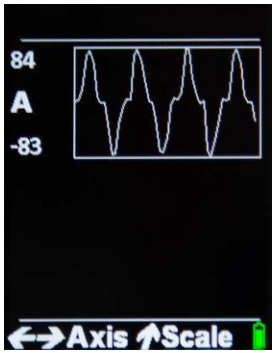
BAUGH & WEEDON NDE

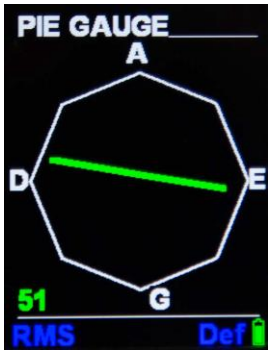
Further Questions

- Rumours of issues on both sides ‘of the pond’ on achieving the requirements of table A3.1 in ASTM 1444
- Given the reported variations in AS 5282 Rings have all the issues with the old Ketos ring been eradicated?
- The RMS to Peak Amperage ratio must have some effect on the ability to show the required holes as per table A3.1 in ASTM 1444
- As little seems to have been recorded on the metering used during the round-robin AS Ring trials are these values valid?
- Now that the final requirement for magnetising levels in parts is based on QQI results is the AS Ring required at all?
- Should training notes be altered to inform NDT Students of the way MPI benches work today









BAUGH & WEEDON NDE

Thyristor (SCR) Control vs Rotary Transformer in MPI Bench Applications

Pete Burrows.
Sales Director
Baugh and Weedon NDE.

A4A NDT Forum
17th September ‘24