Magnetic Particle LI/II Testing (24 hours)

Principles of Magnets and Magnetic Fields

a. Theory of magnetic fields
   (1) Earth's magnetic field
   (2) Magnetic fields around magnetized materials

b. Theory of magnetism
   (1) Magnetic poles
   (2) Law of magnetism
   (3) Materials influenced by magnetic fields
      (a) Ferromagnetic
      (b) Paramagnetic
   (4) Magnetic characteristics of nonferrous materials

c. Terminology associated with magnetic particle testing

Characteristics of Magnetic Fields

a. Bar magnet
b. Ring magnet

Effect of Discontinuities of Materials

a. Surface cracks
b. Scratches
c. Subsurface defects

Magnetization by Means of Electric Current

a. Circular field
   (1) Field around a straight conductor
   (2) Right-hand rule
   (3) Field in parts through which current flows (a) Long, solid, cylindrical, regular parts
      (b) Irregularly-shaped parts
      (c) Tubular parts
      (d) Parts containing machined holes, slots, etc.
   (4)Methods of inducing current flow in parts
      (a) Contact plates
      (b) Prods
   (5) Discontinuities commonly discovered by circular fields

b. Longitudinal field
   (1) Field produced by current flow in a coil
   (2) Field direction in a current-carrying coil
   (3) Field strength in a current-carrying coil
   (4) Discontinuities commonly discovered by longitudinal fields
   (5) Advantages of longitudinal magnetization
   (6) Disadvantages of longitudinal magnetization

Selecting the Proper Method of Magnetization

a. Alloy, shape, and condition of part
b. Type of magnetizing current
c. Direction of magnetic field
d. Sequence of operations
e. Value of flux density

Inspection Materials

a. Wet particles
b. Dry particles

Principles of Demagnetization

a. Residual magnetism
b. Reasons for requiring demagnetization
c. Longitudinal and circular residual fields
d. Basic principles of demagnetization
e. Retentivity and coercive force
f. Methods of demagnetization

Magnetic Particle Testing Equipment

a. Equipment-selection considerations
   (1) Type of magnetizing current
   (2) Location and nature of test
   (3) Test materials used
   (4) Purpose of test
   (5) Area inspected

b. Manual inspection equipment
c. Medium- and heavy-duty equipment
d. Stationary equipment
e. Mechanized inspection equipment
   (1) Semiautomatic inspection equipment
   (2) Single-purpose semiautomatic equipment
   (3) Multipurpose semiautomatic equipment
   (4) Fully automatic equipment

a. Forging bursts
b. Voids

Magnetic Particle Test Indications and Interpretations

a. Indications of nonmetallic inclusions
b. Indications of surface seams
c. Indications of cracks
d. Indications of laminations
e. Indications of laps

Types of Discontinuities Detected by Magnetic Particle Testing

a. Inclusions
b. Blowholes
c. Porosity
d. Flakes
e. Cracks
f. Pipes
g. Laminations
h. Laps
i. Indications of bursts and flakes
j. Indications of porosity
k. Nonrelevant indications

Selecting the Proper Method of Magnetization

Principles

a. Theory
   (1) Flux Patterns
   (2) Frequency and voltage factors
   (3) Current calculations
   (4) Surface flux strength
   (5) Subsurface effects
b. Magnets and magnetism
   (1) Distance factor vs. strength of flux
   (2) Internal and external flux patterns
   (3) Phenomenon action at the discontinuity
   (4) Heat effects on magnetism
   (5) Material Hardness vs. magnetic retention

Flux Fields

a. Direct current
   (1) Depth of penetration factors
   (2) Source of current
b. Direct pulsating current
   (1) Similarity to direct current
   (2) Advantages
   (3) Typical fields
c. Alternating current
   (1) Cyclic effects
   (2) Surface strength characteristics
   (3) Safety precautions
   (4) Voltage and current factors
   (5) Source of current

Magnetization by Means of Electric Current

a. Circular techniques
   (1) Current calculations
   (2) Depth-factor considerations
   (3) Precautions – safety and overheating
   (4) Contact prods and yokes
      (a) Requirements for prods and yokes
      (b) Current carrying capabilities
   (5) Discontinuities commonly detected
b. Longitudinal technique
   (1) Principles of induced flux fields
   (2) Geometry of part to be inspected
   (3) Shapes and sizes of coils
   (4) Use of coils and cables
      (a) strength of field
      (b) Current directional flow vs. flux field
   (5) Current calculations
      (a) Formulas
      (b) Types of current required
      (c) Current demand
   (6) Discontinuities commonly detected

a. Alloy, shape, and condition of part
b. Type of magnetizing current
c. Direction of magnetic field
d. Sequence of operations
e. Value of flux density

Demagnetizing Procedures

a. Need for demagnetization of parts
b. Current, frequency, and field orientation
c. Heat factors and precautions
d. Need for collapsing flux fields

Equipment

a. Portable type
   (1) Reason for portable equipment
   (2) Capabilities of portable equipment
   (3) Similarity to stationary equipment
b. Stationary type
   (1) Capability of handling large and heavy parts
   (2) Flexibility in use
   (3) Need for stationary equipment

Use of accessories and attachments

c. Automatic Type
   (1) Requirements for automation
   (2) Sequential operations
   (3) Control and operation factors
   (4) Alarm and rejection mechanisms
d. Liquids and powders
   (1) Liquid requirements as a particle vehicle
   (2) Safety precautions
   (3) Temperature needs
   (4) Powder and paste contents
   (5) Mixing procedures
   (6) Need for accurate proportions
e. Black-light type
   (1) Black-light and florescence
   (2) Visible- and black-light comparisons
   (3) Requirements in the testing cycle
   (4) Techniques in use
f. Light-sensitive instruments
   (1) Need for instrumentation
   (2) Light characteristics

Types of Discontinuities

a. In castings
b. In ingots
c. In wrought sections and parts
d. In welds

Evaluation Techniques

a. Use of standards
   (1) Need for standards and references
   (2) Comparisons of known and unknown
   (3) Specifications and certifications
   (4) Comparison techniques
b. Defect appraisal
   (1) History of part
   (2) Manufacturing process
   (3) Possible causes of defect
   (4) Use of part
   (5) Acceptance and rejection criteria
   (6) Use of tolerances

Q Quality Control of Equipment and Process

a. Malfunctioning of equipment
b. Proper magnetic particles and bath liquid
c. Bath concentration
   (1) Settling test
   (2) Other bath-strength tests
d. Tests for black-light intensity

Practical demonstrations and structured daily exercises

Summary / Final review

End of Course Test and review

Material Reference:
Written material used to support this training course consists of the course manual written and prepared by Mr. R. Harrison with photographs courtesy of Met-l-Chek and Magnaflux.
Other sources:
ASNT NonDestructive Handbook
Handbook of Nondestructive Evaluation (Hellier), Chapter 5, Authored by: Richard A. Harrison
SNT-TC-1A 1996 & 2001
NAS-410 2003
Standards/Codes: ASTM E 1444