



Welding Inspection

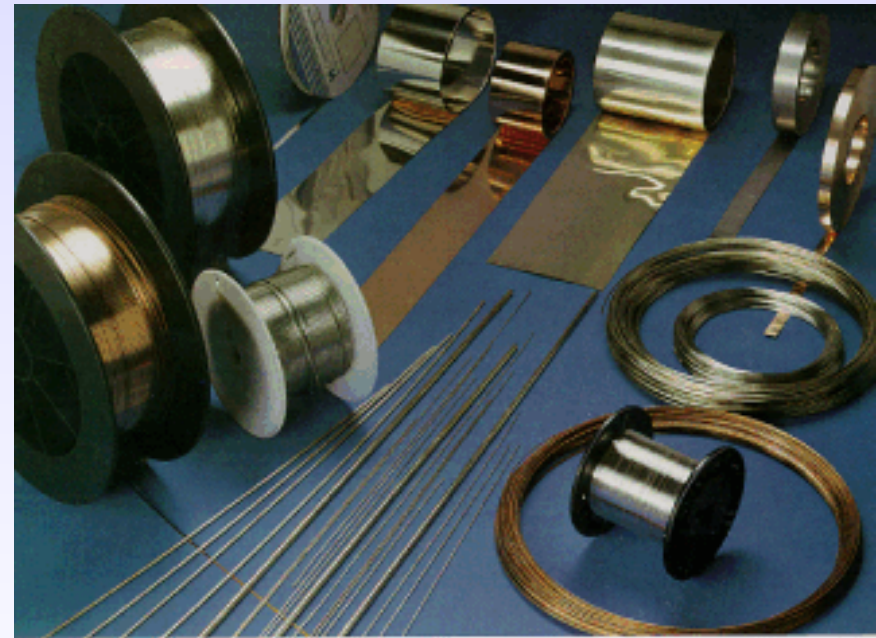
Consumables

Course Reference WIS 5

Welding Consumables

Welding consumables may be:

- Shielded arc filler wires, lengths or rolls
- Covered electrodes
- Shielding gases
- Separately supplied flux
- Fusible inserts



Welding Consumables

Each consumable is critical in respect to:

- Size
- Classification / Supplier
- Condition
- Handling and storage
- Treatments e.g. baking / drying

Handling and storage is critical for consumable control

MMA Welding Consumable.

Welding consumables for MMA

- Consist of a core wire typically between 350-450mm in length and from 2.5-6mm in diameter
- The wire is covered with an extruded flux coating
- The core wire is generally of a low quality rimming steel
- The weld quality is refined by the addition of refining agents in the flux coating
- The flux coating contains many elements and compounds that all have a variety of functions during welding

MMA Welding Consumable.

Functions of flux constituents:

- To aid arc ignition
- To improve arc stabilisation.
- To produce a shielding gas to protect the arc column
- To refine and clean the solidifying weld-metal
- To add alloying elements
- To control hydrogen contents in the weld
- To form a cone at the end of the electrode, which directs the arc

Welding Consumable Standards

MMA (SMAW)

- BS 639: Steel electrodes
- BS EN 499: Steel electrodes
- AWS A5.1 Non-alloyed steel electrodes
- AWS A5.5 Alloyed steel electrodes
- AWS A5.4 Chromium electrodes

MIG/MAG (GMAW) TIG (GTAW)

- BS 2901: Filler wires
- BS EN 440: Filler wires
- AWS A5.9: Filler wires
- BS EN 439: Shielding gases

SAW

- BS 4165: Wire and fluxes
- BS EN 756: Wire electrodes
- BS EN 760: Fluxes
- AWS A5.17: Wires and fluxes

MMA Welding Consumable.

Common flux types

- Rutile
- Cellulose
- Basic
- Acidic

MMA Welding.

Consumables

Rutile electrodes

- Used mainly on general purpose work
- Low pressure pipework, support brackets.

Flux constituents include:

- Titanium dioxide, slag former
- Clay - binding agent
- Sodium silicate - main ionizer

Rutile Electrodes

Advantages

- Easy to use
- Low cost / control
- Smooth weld profiles
- Slag easily detachable
- High deposition possible with the addition of iron powder

Disadvantages

- High in hydrogen
- High crack tendency
- Low strength
- Low toughness values

MMA Welding.

Consumables

Cellulose electrodes

- Used mainly for pipeline welding
- Suitable for welding in all position especially vertical down, stove technique
- They produce a gas shield high in hydrogen
- Deep penetration/fusion characteristics

Flux constituents include:

- Cellulose, natural organic compounds
- Titanium dioxide - slag former
- Sodium silicate/potassium silicate - main ionizers

Cellulose Electrodes

Advantages

- Deep penetration/fusion
- Suitable for welding in all positions
- Fast travel speeds
- Large volumes of shielding gas
- Low control

Disadvantages

- High in hydrogen
- High crack tendency
- Rough cap appearance
- High spatter contents
- Low deposition rates

MMA Welding.

Consumables

Basic electrodes

- Used mainly for high pressure work and for materials of high tensile strength
- They are capable of producing welds of a low hydrogen content
- Prior to use they may be baked to give a low hydrogen potential typically 300°C for 1 hour plus

Flux constituents include:

- Limestone (calcium carbonate) - gas former
- Fluorspar - slag former
- Sodium silicate/potassium silicate - main ionizers

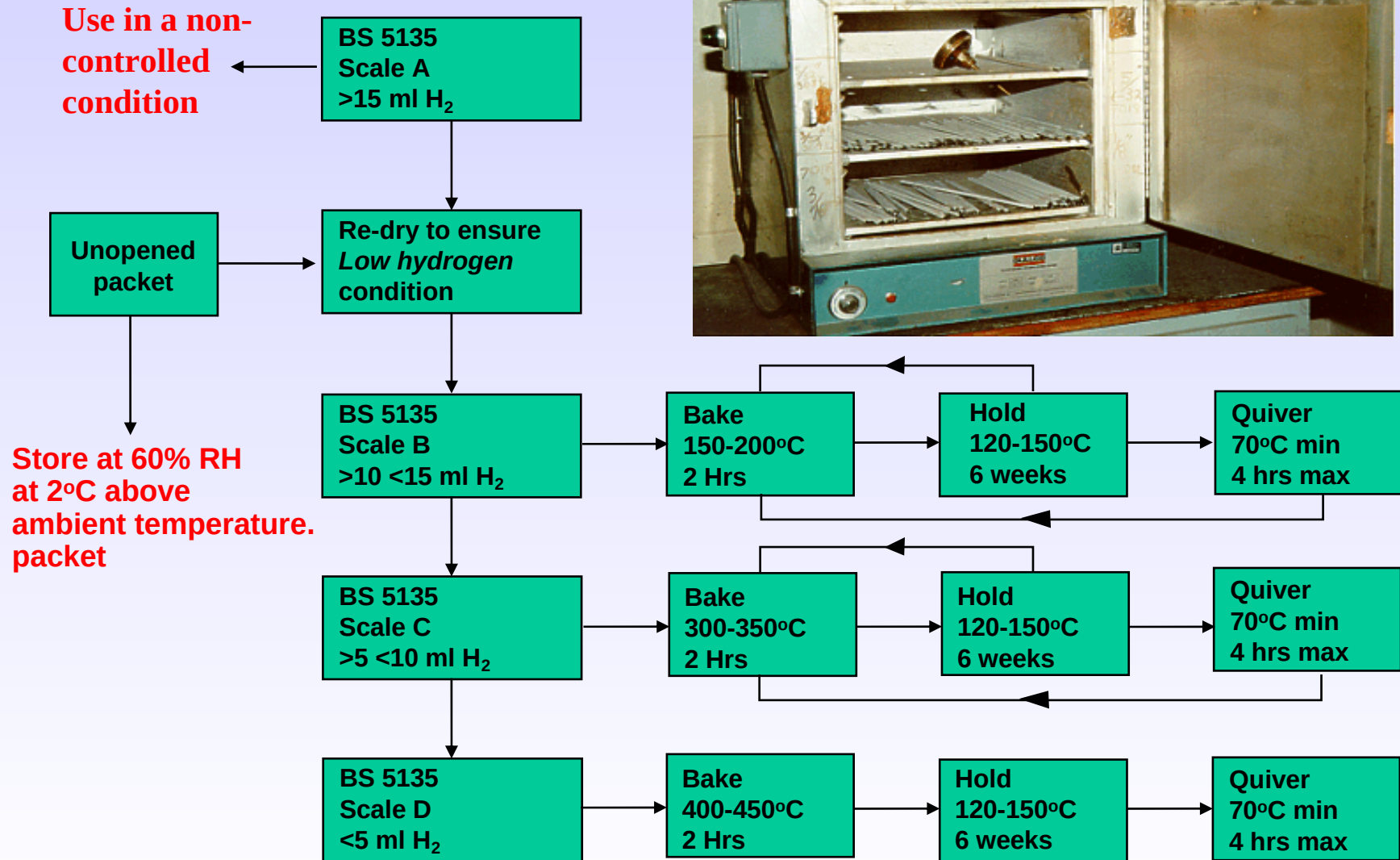
Basic Electrodes

For basic coated electrodes to be classified as hydrogen controlled, they must produce welds with a hydrogen content below 15 ml of hydrogen per 100g of weld metal deposited as.

The above statement depends on many factors.

- The electrodes must be baked as to manufactures recommendations. This is to drive off any moisture in the electrode flux. Vacuum packs are available and do not require pre-baking.
- The electrodes must be used with a minimum weave.
- The electrodes must be used with a minimum arc gap.
- The parent material must be free from moisture and contamination.

Typical Baking Procedure for Basic Electro



Basic Electrodes

Advantages

- High toughness values
- Low hydrogen contents
- Low crack tendency

Disadvantages

- High cost
- High control
- High welder skill required
- Convex weld profiles
- Poor stop/start properties

BS. 639. Covered.

Electrodes



E 51 33 B 160 2 0 H

Covered Electrode

Yield Strength N/mm²

Tensile Strength N/mm²

Toughness

Flux Covering

**Weld Metal Recovery
Iron Powder content**

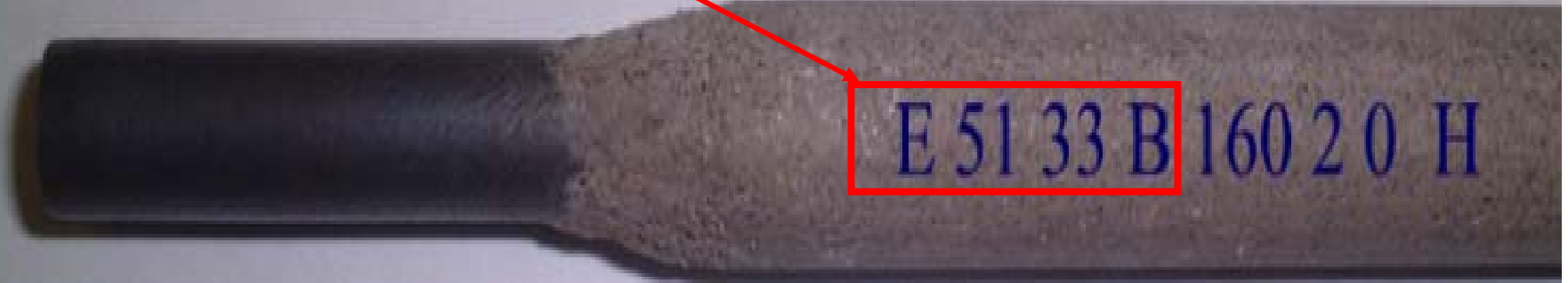
Welding Position

Electrical characteristic

Hydrogen Content

BS . 639 . Covered . Electrodes

Compulsory



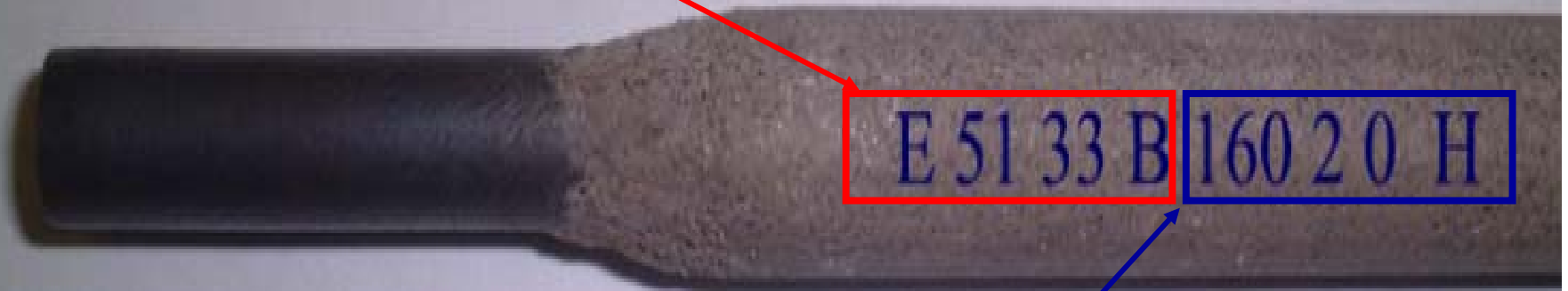
BS. 639. Covered. Electrodes



Optional

BS . 639 . Covered . Electrodes

Compulsory



Optional

BS . EN . 499 . Covered . Electrodes

Electrodes classified as follows:

- **E 35 -** Minimum yield strength 355 N/mm²
Tensile strength 440 - 570 N/mm²
- **E 38 -** Minimum yield strength 380 N/mm²
Tensile strength 470 - 600 N/mm²
- **E 42 -** Minimum yield strength 420 N/mm²
Tensile strength 500 - 640 N/mm²
- **E 46 -** Minimum yield strength 460 N/mm²
Tensile strength 530 - 680 N/mm²
- **E 50 -** Minimum yield strength 500 N/mm²
Tensile strength 560 - 720 N/mm²



BS . EN . 499 . Covered . Electrodes



E 50 4 2Ni B 7 2 H10

Covered Electrode

Yield Strength N/mm²

Tensile Strength N/mm²

Toughness

Chemical composition

Flux Covering

**Weld Metal Recovery
and Current Type**

Welding Position

Hydrogen Content

AWS A5~5 Alloyed. Electrodes



E 70 1 8 M G

Covered Electrode

Tensile Strength (p.s.i)

Welding Position

Flux Covering

Moisture Control

Alloy Content

AWS A5~1~5 Alloyed Electrodes

Example AWS electrode flux types

- Cellulose flux- ends in 0,1

E6010, E6011, E7010, E8011

- Rutile flux-ends in 2,3,4

E5012, E6012, E6013, E6014

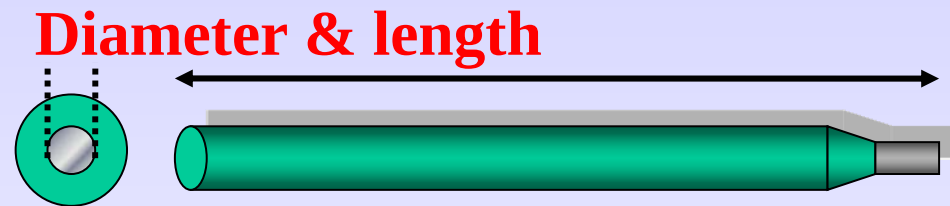
- Basic flux-ends in 5,6,7,8

E6016, E7017, E8018, E9018

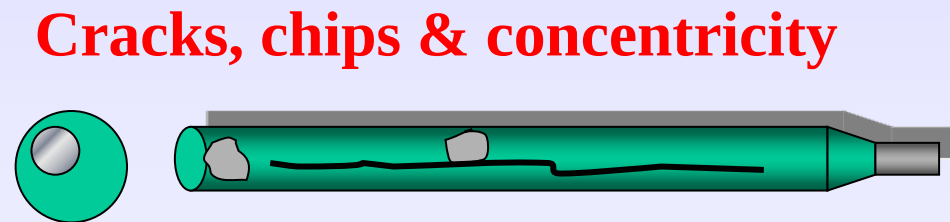


MMA Electrode Inspection Points.

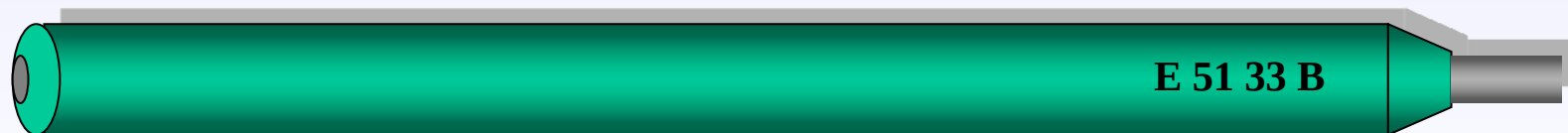
1: Electrode size



2: Electrode condition



3: Electrode specification **Correct specification/code**



TIG Welding Consumables

Welding consumables for TIG

- Consist of a wire and gas, though tungsten electrodes being classed as non-consumable may be considered consumables (dia 1.6-10mm)
- The wire needs to be of a very high quality as normally no extra cleaning elements are added
- The wire is copper coated to resist corrosion
- The wire normally comes in 1m lengths with the applicable code stamped onto the wire for traceability
- The shielding gases used are mainly Argon and Helium, usually of the highest quality (99.9% pure).
- Ceramic shields, the size and shape depends on application

MIG ~ MAG Welding.

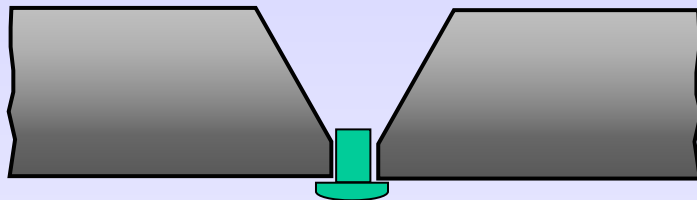
Consumables

Welding consumables for MIG/MAG

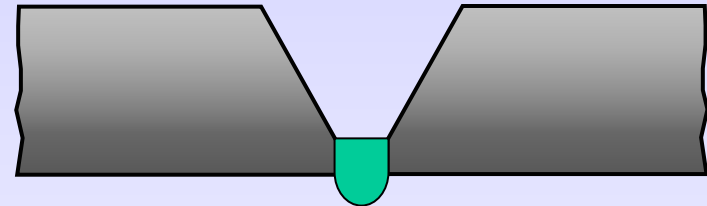
- Consist of a wire and gas, the same quality as for TIG wires
- The wires are copper coated, main purpose corrosion resistance and electrical pick-up
- Wires are available in sizes from 0.6-1.6 mm in diameter
- Most wires are supplied on a 15kg spool, with finer wires supplied on a 1kg spool
- Gases can be pure CO₂, CO₂+Argon mixes and Argon+2%O₂ mixes (stainless steels).

Fusible Inserts

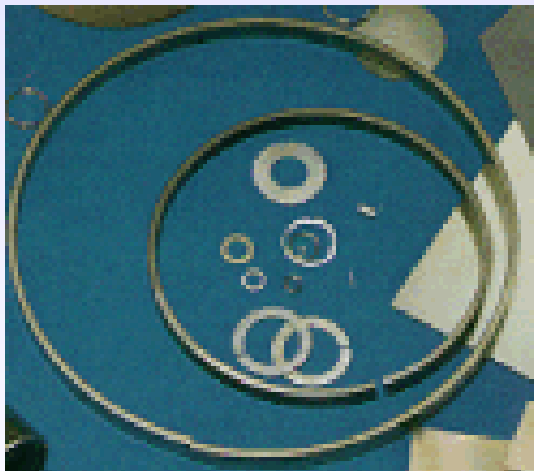
Pre-placed filler material



Before Welding



After Welding



Other terms used include:

- E B inserts (Electric Boat Company)
- Consumable socket rings (CSR)

Any Questions



Questions

- QU 1. Why are basic electrodes used mainly on high strength materials and what controls are required when using basic electrodes
- QU 2. What standard is the following electrode classification taken from and briefly discuss each separate part of the coding **E 80 18 M**
- QU 3. Why are cellulose electrodes commonly used for the welding of pressure pipe lines
- QU 4. Give a brief description of fusible insert and state two alternative names given for the insert
- QU 5. What standard is the following electrode classification taken from and briefly discuss each separate part of the coding **E42 3 1Ni B 4 2 H10**