TECHNOLOGY


# Welding Inspection

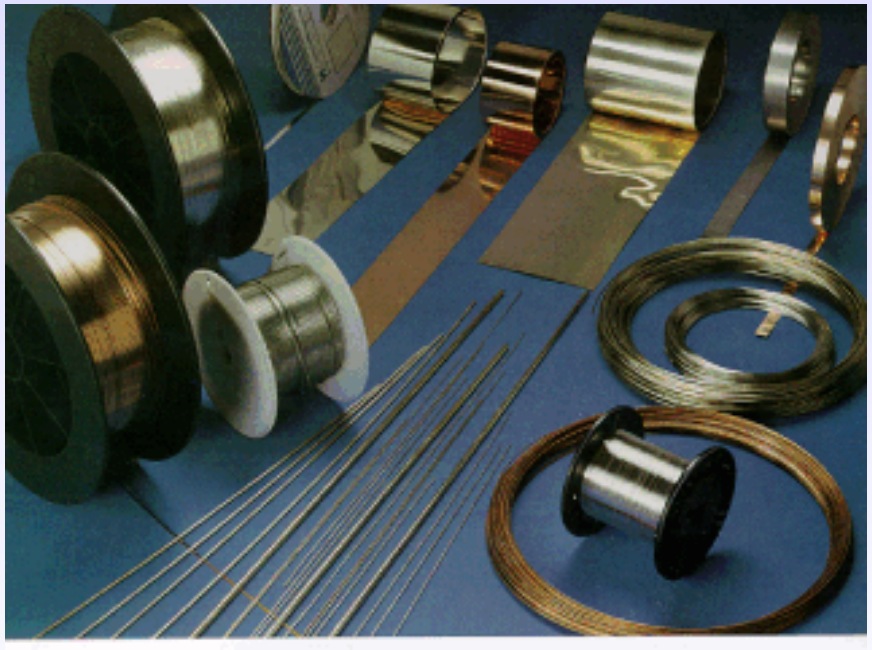
## Consumables

## 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.

# ypical Baking Procedure for Basic Electro

Use in a non-controlled condition

BS 5135
Scale A
>15 ml $H_2$

Unopened packet

Re-dry to ensure *Low hydrogen* condition

Store at 60% RH at 2°C above ambient temperature. packet

BS 5135
Scale B
>10 <15 ml $H_2$

Bake
150-200°C
2 Hrs

Hold
120-150°C
6 weeks

Quiver
70°C min
4 hrs max

BS 5135
Scale C
>5 <10 ml $H_2$

Bake
300-350°C
2 Hrs

Hold
120-150°C
6 weeks

Quiver
70°C min
4 hrs max

BS 5135
Scale D
<5 ml $H_2$

Bake
400-450°C
2 Hrs

Hold
120-150°C
6 weeks

Quiver
70°C min
4 hrs max

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# 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**

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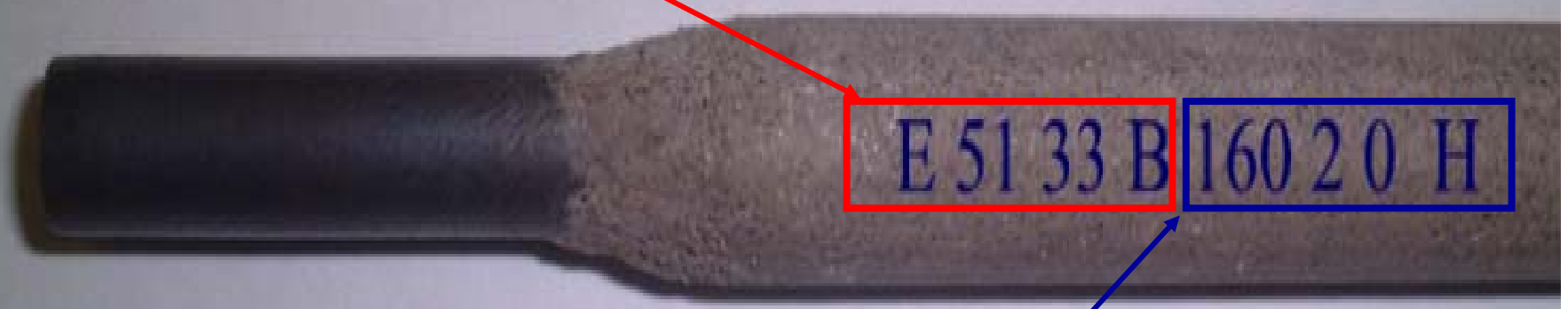
# BS 639 Covered Electrodes

# 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**

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# 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

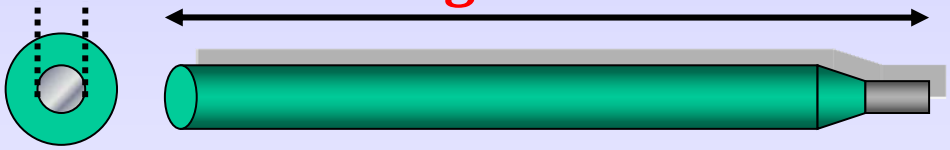
  E5012, E6012, E6013, E6014

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

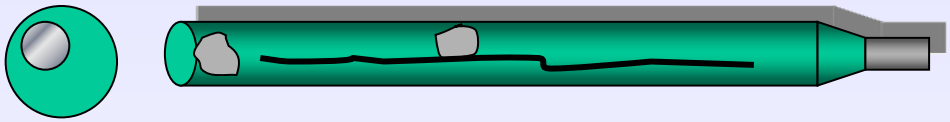
  E6016, E7017, E8018, E9018

# MMA Electrode Inspection Points

1: Electrode size **Diameter & length**



2: Electrode condition **Cracks, chips & concentricity**



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

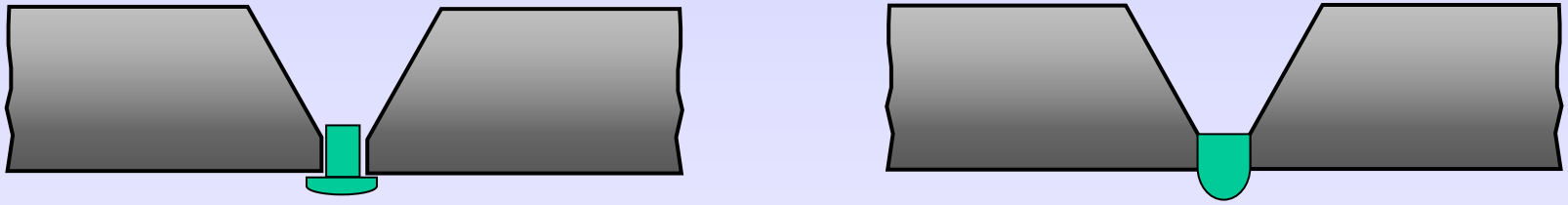
# MIG˜MAG Welding Consumables

## 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 $CO_2$, $CO_2$+Argon mixes and Argon+2%$O_2$ mixes (stainless steels).

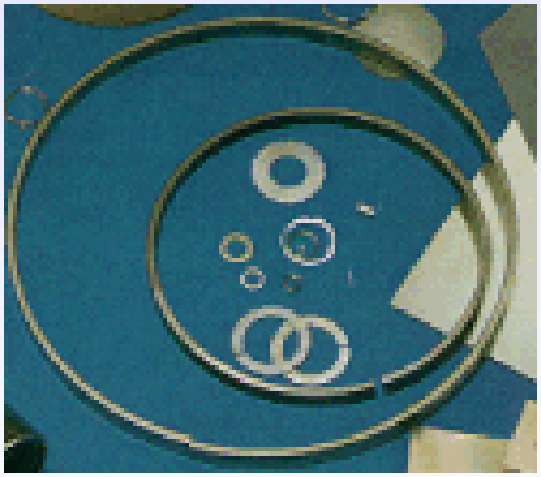
# Fusible Inserts

## 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 alterative 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