Storage and handling of welding consumables

Storage and handling of welding consumables consist of the following parts:

- Hydrogen induced cracking
- Coated electrodes
- Flux Cored Wires
- Submerged arc welding fluxes

Hydrogen induced cracking

Hydrogen in welded joints in ferritic materials can give rise to hydrogen induced cracking, also known as cold cracking and delayed cracking. The major factors which influence the risk of this type of cracking are chemical composition of the steel (Carbon Equivalent factor CE), cooling rate and hydrogen content of the weld metal.
The most common sources of hydrogen are:

- Moisture in electrode coatings or SAW flux
- Drawing lubricants on cored wires
- Moisture in the atmosphere or shielding gas
- Condensation, rust, oil, paint or primer in the weld joint area

Moisture, lubricant etc. decomposes in the arc during welding to give hydrogen,(H), which is readily dissolved in the weld pool. On cooling this (H) tries to escape via diffusion because it is less soluble in the solid weld metal compared to the molten weld pool. Any (H) that remains trapped in the joint can cause hydrogen induced cracking. Cracks generally form in the coarse-grained, HAZ of the base material but for very high strength weld metals cracks can also arise in the weld metal itself.
By following the recommended storage and handling procedures for welding consumables, moisture levels can be minimised, along with the associated hydrogen induced cracking risk.

Storage and handling of coated electrodes

Coated electrodes always contain a certain amount of moisture in the coating, even after the final drying operation during manufacture. This moisture decomposes in the arc during welding to give hydrogen, (H), and consequential risk for hydrogen induced cracking.
The moisture is bound in the crystalline structure of some of the minerals in the coating and requires a relatively high temperature to remove it. Basic-coated electrodes are designed to be dried at high temperatures, resulting in a low coating moisture level, and are often referred to as “low hydrogen electrodes”.

Coated electrodes can be divided into:
1) Non-alloy C-Mn, rutile or acid-rutile coated electrodes , with H>15 ml/100g weld metal.
2) Non-alloy C-Mn and low alloy, basic-coated electrodes, with H<10 or <5 ml/100g weld metal.
3) High alloy austenitic stainless steel electrodes, rutile or basic coated, where hydrogen diffusion does not occur because hydrogen is soluble in the austenitic atomic structure, even at room temperature.

Of the above listed groups, it is only types 1 and 2 which can give rise to hydrogen induced cracking. For steel grades with a yield strength > 355MPa the use of type 2 electrodes is recommended. Type 3 electrodes are also dried at high temperature, but this is to minimise the risk of porosity, also caused by moisture in the coating.

Unfortunately, electrode coatings are hygroscopic, i.e. they pick up moisture from the surrounding atmosphere if freely exposed to it. Suitable coating formulation design can minimise this effect but not eliminate it. For this reason it is necessary to ensure that electrodes are not able to absorb moisture (by correct choice of packaging, storage and handling) or, alternatively, to re-dry them before use.

Types of packaging

Elga's non-alloy and low alloy electrodes are supplied in two different types of packaging, depending on the required level of resistance to moisture pick-up from the atmosphere in the unopened condition.

A) Cardboard box with shrink plastic wrapping. This is the most common packaging for electrode type 1 and type 2 non-alloy C-Mn electrodes.
B) Hermetically sealed steel can or aluminium-laminated plastic foil vacuum pack (DryPac). This is the most common packaging for type 3 stainless electrodes and type 2 low alloy electrodes.

Of these two packaging forms, it is only for type B that Elga guarantees low moisture content at point of opening. Products delivered in packaging type A are guaranteed to have been tested to comply with low moisture content following final baking in the factory, but no guarantee can be given that they have not subsequently picked up moisture during delivery to, or storage at, the customer. Electrodes in type A packaging must therefore be re-dried before use if low hydrogen weld metal is specified.

Points to consider when handling and storing unopened packaging

Storage

In general, moisture pick-up of electrodes depends on the temperature and humidity of the surrounding atmosphere, which can be measured as the relative humidity (RH) at a given temperature.
However, moisture pick-up occurs relatively slowly with storage under the following conditions:

5-15 °C	<60% RH
15-25 °C	<50% RH
>25 °C	<40% RH

Electrodes in **packaging type A** must be stored with the plastic wrapping unbroken in a climatically controlled environment according to the above. If low hydrogen weld metal is specified then electrodes in packaging type A must be re-dried before use, following the instructions in the data sheet or on the label.

Electrodes in **packaging type B** are completely moisture diffusion-proof and do not therefore require any special storage instructions. Electrodes taken directly from newly opened packaging of this type do not require re-drying before use.
To avoid condensation forming on electrodes that have been stored at a lower temperature than ambient, unopened packaging should be allowed to reach ambient temperature before being opened, independent of packaging type.

Type 2 and 3 electrodes from opened packaging can be stored in a storage cabinet held at 105-150 °C without the risk of moisture pick-up. It is important here that these electrodes are not mixed together with type 1 electrodes in the same cabinet, because the latter can transfer moisture to the former.

Handling in the workshop

Elga's type 2 and 3 electrodes are manufactured according to the MR-design concept (Moisture Resistant) which ensures low initial moisture content together with a slow moisture pick-up rate.

For electrodes in type B packaging the following exposure times are valid for conditions of 26.7 °C and 80% RH, in order to guarantee low hydrogen level in the weld metal or sufficiently low moisture content in the coating (stainless electrodes).

Condition of packaging	Max. storage time
Unbroken	Unlimited
Opened but electrodes left in packet	12 h
Electrodes exposed outside the packet	4 h

For type 2 electrodes in type A packaging the following recommendation is given:
During the working period, keep the electrodes in heated portable canisters at a minimum temperature of 70 °C. After the work period, store the remaining electrodes in a heated storage cabinet. This recommendation is also valid for electrodes in opened package type B, if the electrodes are not likely to be consumed within the times specified above.

Re-drying
Rutile electrodes, type 1, which show any signs of damage from moisture pick-up (poor arc stability, heavy spatter, poor slag detachability) can be re-dried at around 90 °C for 1 h in order to restore welding characteristics.
Basic coated C-Mn and low alloy electrodes (type 2) are normally re-dried at a temperature of around 350 °C for 1-2 h, in order to reach a hydrogen content of the level 4-10ml/100g weld metal as given in the data sheet. The guiding rule is to follow the re-drying instructions in the data sheet or on the label. Re-drying should be limited to 5 cycles.
To obtain an extremely low hydrogen level, i.e. <4ml/100g, it is possible in certain cases to re-dry at higher temperatures than 350 °C. However, under these circumstances Elga must be contacted first for detailed instructions, otherwise there is a risk that the coating can be damaged. Normally this will reduce the maximum allowed number of re-drying cycles.

5-15°C	<60% RH
15-25°C	<50% RH
> 25°C	<40% RH

Storage and handling of Elga cored wires.

Storage:
1. Cored wires shall be stored in their original, undamaged packaging under properly maintained climatic conditions of 10-30°C and relative humidity as low as possible, maximum 80%.
2. Packaging shall not be placed directly on the floor, but on a wooden pallet or equivalent, at a distance of at least 10 cm from the ground and outside wall.
3. Transportation to and from the storage place shall be carried out in covered vehicles and direct exposure to rain and snow avoided.

Storage of cored wires outside the original packaging.
When the wire has been taken out of the original packaging, it can be stored in normal heated premises, (workshop etc.), for up to 5 days.

Handling

• If welding is conducted in an environment that is subject to snow, rain, marine conditions or dust, covered wire feed units should be used.

• During outdoor usage, or when used in unheated workshops or premises, the wire should be moved to a dry, heated storage area when not in use for a period of 8 hours or more.

• If the wire is to be put back in storage, the spool shall be protected with its plastic bag, or equivalent.

Scrapping

• If traces of rust/corrosion are found on the wire surface, this indicates that the wire has not been stored or handled correctly. A wire with rust traces should be scrapped.

If there is any suspicion that the wire has not been stored correctly, Elga recommends that the wire be SCRAPPED.

Storage and handling of submerged arc welding fluxes

Elgaflux and Cromaflux fluxes are supplied as standard in 25kg moisture resistant plastic bags, 25kg hermetically sealed aluminium-coated plastic bags, 25kg plastic lined moisture resistant paper bags and 600kg coated fabric BigPac bags. All fluxes have a guaranteed low as-manufactured moisture content that can be maintained by observing the following recommendations for storage and handling.

Transport

Flux is normally supplied on plastic shrink wrapped pallets with a net weight of 1000kg or 1200kg. BigPac bags are supplied individually on shrink wrapped pallets. Transportation should be carried out in covered vehicles and direct exposure to rain and snow avoided.

Main storage

Agglomerated and fused fluxes should be stored in their original, undamaged packaging under properly maintained climatic conditions as follows :

Temperature	15-35°C
Relative humidity	As low as possible, maximum 70%

Stored under these conditions the lifetime for agglomerated fluxes is 3 years and that for fused fluxes 5 years. Stock control should encompass the first-in, first-out principle.

Storage and handling in the workshop

When handled and stored according to conditions described above, flux can normally be used direct from the bag. For non-critical applications, flux may be stored on the shopfloor in unheated flux hoppers, provided these are closed units and protect the flux from open contact with the prevailing atmosphere.

For critical applications, shopfloor storage should be in heated flux hoppers maintained at 120-150°C.

Flux in opened bags, not used during an 8 h period, should be placed in a storage cabinet or heated flux hopper, at 120-150°C.

Recycling

Unused flux recovered from the welding area must be cleaned from mill scale, slag, metal particles and other impurities by use of a suitable fine-mesh sieve, before being recycled.
Addition of new flux to that being recycled should be done regularly, in the ratio 1: 3

Redrying

The need for redrying only arises under two circumstances:

1. If the flux has picked up moisture due to unfavourable storage and handling, and needs to be restored to its original condition.

2. For critical applications demanding guaranteed very low weld metal hydrogen levels, redrying of the flux is recommended.
Redrying should be carried out in an appropriate oven with free air circulation or purpose made drier, as follows:

Agglomerated fluxes	300-350°C for 2 h
Fused fluxes	150-250°C for 2 h

The most important factor here is for the complete flux bed to reach the given temperature. Redried flux that is not for immediate use should be stored in a storage cabinet or heated flux hopper, maintained at 120-150°C.