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A Primer to Welding Electrode Manufacture

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This Document aims to describe various phases in manufacturing process of welding electrode in general along with the aspects like machines used, testing, quality control mechanism, efficiency and other environmental friendly activities.

A PRIMER TO WELDING ELECTRODES MANUFACTURE

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I. PRODUCT & SCOPE

Of all the known methods of joining metals, welding has taken the prime importance due to a number of reasons.

a) The joints produced by welding, generally have the same if not superior mechanical proprieties.
b) No reduction in the welded area and hence no special design considerations.
c) Ease of application even at the remotest of places.

Apart from joining, the other welding applications include cladding, correcting machining errors, and building of missing parts; impart special and desired properties to the base metal surfaces such as wear resistance etc. There are also electrodes used for cutting and chamfering operations also.

Welding electrodes are an integral part of any big or small machine shop, workshop or a fabrication shop. Welding electrodes are used in building bridges, fabrication of grills, and transmission towers, vehicle manufacturing, building construction, ship building and scores of other industries.

Welding electrodes manufacturing industry is export and defense oriented industry as well.

The consumption of electrodes in the Middle East, APEC & SAARC regions which are fast developing with heavy construction activities, heavy fabrication, ship building, oil exploration, highway and bridge construction, pile foundation making, transmission lines installation and construction activities etc. etc.

Manual Arc Welding Electrode is a stick of 350mm or 450mm and in some cases 1000mm lengths having diameters from 2.5mm to 6mm of suitable core wire material (mild steel rimming quality in Mild Steel Electrodes) with a suitable concentric flux coating on the same.

II. RAW MATERIALS

The ingredients as explained earlier is Core wire and the Flux (Coating Material)

a) **Core Wire:** Wires are usually supplied in wire rod coils form of 6mm or 8mm diameter. This will have to be drawn to the desired standard diameter of 2.5mm/3.2mm/4.0mm/5.0mm/6.0mm. This is done using a Wire Drawing Unit.

Pictures to be uploaded shortly

Wire Rods prior to drawing

Wire Drawing Unit

b) Subsequently the same will have to be cut into straight lengths of 350mm/450mm and in special cases 1000mm standard. This is done by an automatic wires straightening and cutting off machine.

b-1): Such obtained wires are cleaned to remove any dirt, grease and other surface impurities preferably in a wire cleaning machine.

Pictures to be uploaded shortly

Automatic Wire Straightening and Cutting off Machine

And

Wire De-Greasing and Cleaning Machine

c) **Flux Materials:** Prior to using the flux materials, they are sieved through a Sieving Machine to separate any possible lumps and impurities.

Picture to be uploaded shortly

Sieving Machine

1. **Dry Mixing:** All flux minerals/chemicals (expect the binder i.e. usually Potassium Silicate) are weighed as per the agreed formulations and the same is thoroughly blended in a Ribbon Blender

2. **Wet Mixing:** A portion of the thoroughly blended mix from the Ribbon Blender is then fed into the Wet Mixer. To this, the binder, usually Potassium Silicate is added to obtain uniform dough.

Picture to be uploaded shortly

Ribbon Blender

d) The flux dough thus obtained is pressed in a briquette press to obtain ready slugs to be fed into the extrusion press.

Pictures to be uploaded shortly

Briquette Press

Wet Mixer (Simpson Type)

Wet Mixer (Sigma Type)

NOW BOTH THE WIRE AND FLUX ARE READY TO BE FED INTO THE RESPECTIVE MACHINERY TO START THE WELDING ELECTRODES EXTRUSION PROCESS.

III. EXTRUSION PROCESS

The ***wires*** from item *2 a-1* above are loaded into the Automatic Wire Feeding Machine and the ***flux Slugs*** from item *2 d* are loaded into the Hydraulic Extrusion Press.

Pictures to be uploaded shortly

Hydraulic Extrusion Press

Automatic Wire Feeding Machine

Now both the Hydraulic Extrusion Press and the Automatic Wire Feeding Machine are operated simultaneously. The Hydraulic Extrusion Press presses the flux slug within its cylinder and the Automatic Wire Feeding Machine continuously pushes the pre-cut and cleaned wires one after other continuously for form a uniform flux coating on the wire.

The coated electrodes fall on to the conveyor Unit. They are then carried alongwith the Conveyor belt and along the way they are brushed for the grip end the end sanded for the strike end.

After this process, finished but wet electrodes thus obtained are carried on trays and then these trays onto the trolleys.

Picture to be uploaded shortly

Conveyor unit

IV. BAKING UNIT

The trolleys as above are carried into the Oven (into the Furnace for higher temperature baking for low hydrogen electrodes etc.) and the same is baked for the prescribed time.

Picture to be uploaded shortly

Baking Unit

V. BRANDING

a. Printing unit

After cooling from the Oven/ Furnace electrodes are end tipped for identification and are brand printed in the Printing Machine.

It is also possible to print on the wet electrodes while on the conveyor unit using special heat resistant inks; this method is called *Online Printing*.

Picture to be uploaded shortly

Printing Machine

b. Packing unit

Electrodes coming from the Printing Machine are again visually checked for any sort of manufacturing defects prior to packing them. They are shrink wrapped in the Shrink Wrapping machine prior shipping.

Picture to be uploaded shortly

Shrink Wrapping Machine

VI. QUALITY CONTROL

As is known, quality is not an accident but is a carefully and painstakingly inculcated product feature which takes a lot of dedication, calculation and effort.
Quality Control is affected in 3 different stages.

1. Pre-production checks
2. In-production checks
3. Post-production checks

a. Pre-Production Checks

Wires:

Chemical Check- This is done in the Chemical Laboratory of the Plant or approved agents who certifies about the quality regarding its various chemical contents. Special checks are required for wires used for low hydrogen welding electrodes.

Physical Check- Wires are checked for their diameter tolerances prior to cutting operation and also the ovality of the wires is confirmed within tolerance. Length also must be checked for their uniformity and tolerance. Wires must be without burrs and kinks. After cleaning operation, there must not be any dirt or grease on the wires. Suitable measuring devices must be available.

Chemicals:

Chemical Check- As in the case of wires, this is done in the Chemical Laboratory of the Plant or approved agents who certifies about the quality regarding its various chemical composition.
Physical Check- A sieve analysis is recommended for determining the batch is within its mesh size tolerance.

b. In-Production Checks**

Routine Checks- Die Selection and checking them for diameter and ovality and polish.

Flux is physically checked for its consistency and feel. During extrusion process, the concentricity is checked in very frequent intervals using both manually and using the Concentricity Meter

Picture to be uploaded shortly

Concentricity Meter

It is recommended at every stage of operation, physical checks on the condition of the electrodes are a must.

c. Post-Production Checks

Weld Test: A couple of electrodes are subject to physical welding tests for every batch. See that the current required and recommended are the same in all cases.

Metallurgical Test: An all weld sample is prepared as recommended and the same is subject to Universal Testing and Bend test and also Impact Tests and Hardness as prescribed.

Chemical Test: Drillings from the all weld sample is also subject to chemical analysis to prove that the same is in concurrence with the prescribed norms.

Pictures to be uploaded shortly

Universal Testing Machine | Impact Tester | Hardness Tester

VII. RECOVERY

It may be noted that there is at least a remote chance for a batch of production goes not up to the quality standards expected. Rejecting the lot will be highly un-economical. By adding a flux striping machine and a flux grinding machine will solve this problem up to a great degree. However it is to be stressed that care must be taken to avoid such situations.

Pictures to be uploaded shortly

Flux Stripping Machine

Flux Grinding Machine

VIII. CONCLUSION

Quantity of Welding Electrodes consumed in a country is the direct measure of its construction activities and therefore directly linked with its growing economy. Therefore, manufacture of Welding Electrodes in a fast developing country is a highly recommended activity.

IX. DISCLAIMER

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X. APPENDIX - A

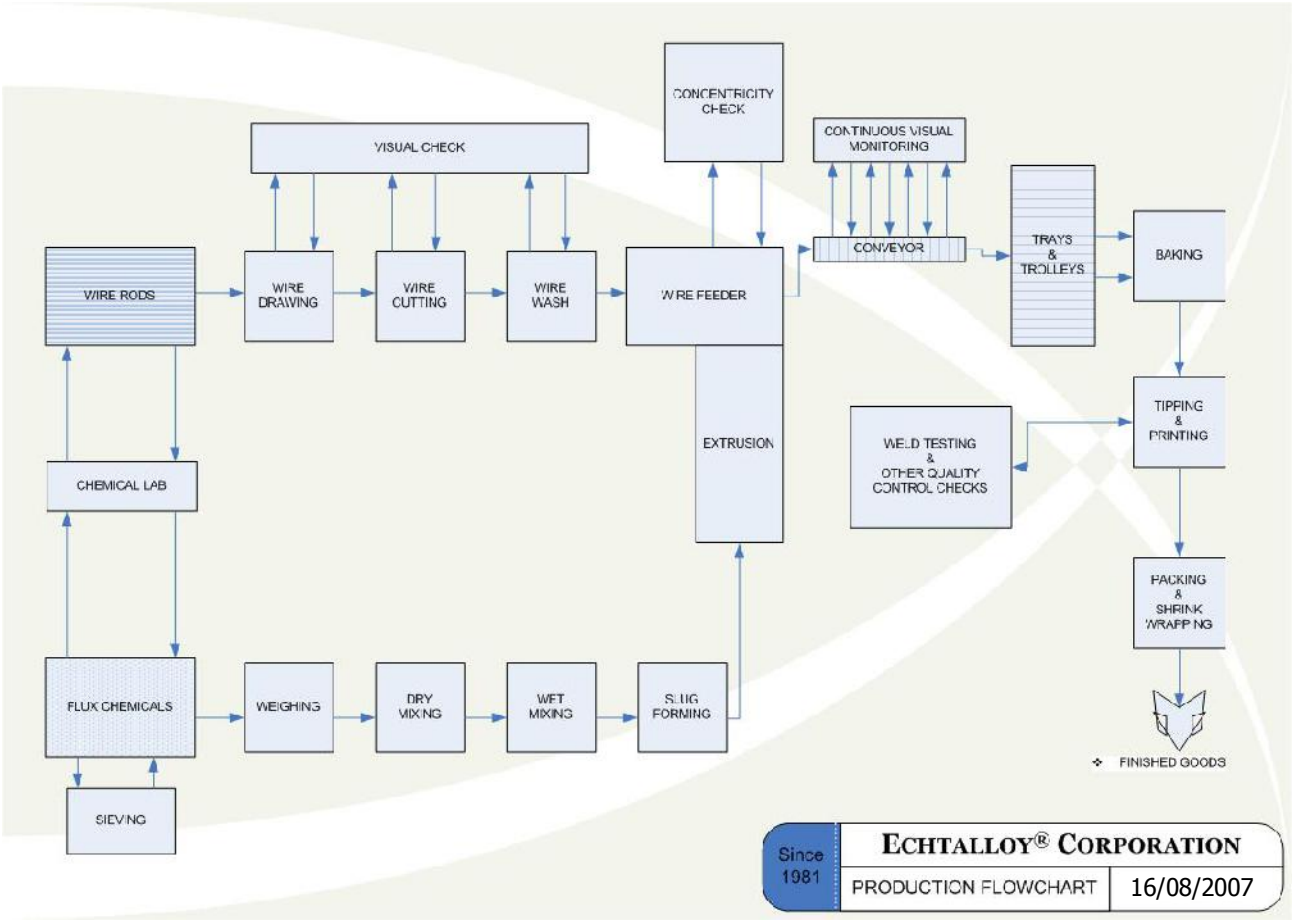
List of Machinery Recommended for the Plant

1. Wire Drawing Unit with Accessories and Capstans Suitable to the Plant Capacity.
2. Automatic Wire Straightening and Cutting off Machine with Accessories.
3. Wire Washing and Cleaning Machine.
4. Automatic Wire Feeding Machine with Accessories and attachments.
5. Ribbon Blender.
6. Simpson Mixer
7. Sigma Mixer.
8. Briquetting Press.
9. Sieving machine.
10. Hydraulic Extrusion Press with Accessories and attachments.
11. Concentricity Meter.
12. Conveyor Unit with Brushing and Sanding Attachment.
13. Trays and Trolleys. *
14. Baking Oven.
15. Baking Furnace for low Hydrogen electrodes.
16. Printing Unit.
17. Packing Unit.
18. Shrink Wrapping Unit.
19. Weighing Machine.
20. Flux Stripping Machine and Flux Grinding attachment.

* In case of continuous baking arrangement this can be partially avoided.
** Equipment required for Testing Laboratories not included.

Pictures listed above are currently available with info@echtalloy.com

XI. APPENDIX – B



XII. APPENDIX – C

Typical Functions & Composition Ranges of Constituents of Coverings on Mild Steel Arc Welding Electrode

	Function of Constituents		Class						
			Composition Range %						
Constituent of Coating	Primary	Secondary	E6010 E6011	E6012 E6013	E6020	E6027	E7014	E7016	E7018
Cellulose	Shielding Gas	...	25to 40	2 to 12	1 to 5	0 to 5	2 to 6	...	...
Calcium Carbonate	Shielding Gas	Fluxing Agent	...	0 to 5	0 to 5	0 to 5	0 to 5	15 to 30	15 to 30
Flurospar	Slag Former	Fluxing Agent	...	...	...	...	...	15 to 30	15 to 30
Dolomite	Shielding Gas	Fluxing Agent	...	...	...	...	...	...	...
Rutile	Slag Former	Arc Stabiliser	10 to 20	30 to 55	0 to 5	0 to 5	20 to 35	15 to 30	0 to 5
Pottassium Titanate	Arc Stabiliser	Slag Former	(a)	(a)	...	...	...	...	0 to 5
Feldspar	Slag Former	Stabiliser	...	0 to 20	5 to 20	0 to 5	0 to 5	0 to 5	0 to 5
Mica	Extrusion	Stabiliser	...	0 to 15	0 to 10	...	0 to 5	...	...
Clay	Extrusion	Slag Former	..	0 to 10	0 to 5	0 to 5	0 to 5	...	...
Silica	Slag Former	...	...	...	5 to 20	...	...	...	...
Asbestos	Slag Former	Extrusion	10 to 20	...	...	...	...	...	...
Manganese dioxide	Slag Former	Alloying	...	...	0 to 20	0 to 15	...	...	...
Iron Oxide	Slag Former	...	...	...	15 to 45	5 to 20	...	...	...
Iron Powder	Depositon rate	Contact Welding	...	...	...	40 to 55	25 to 40	...	25 to 40
Ferro Silicon	Deoxidizer	...	...	...	0 to 5	0 to 10	0 to 5	5 to 10	5 to 10
Ferromanganese	Alloying	Deoxidizer	5 to 10	5 to 10	5 to 20	5 to15	5 to 10	2 to 6	2 to 6
Sodium Silicate	Binder	Fluxing Agent	20 to 30	5 to 10	5 to 15	5 to 10	0 to 10	0 to 5	0 to 5
Pottassium Silicate	Arc Stabiliser	Binder	(a)	5to15(a)	0 to 5	0 to 5	5 to 10	5 to 10	5 to 10

(a) Used in E6011 and E6013 electrodes to facilitate welding with Alternating Current E&OE