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Welding Procedure and Testing Analysis on Mixing and Nodulizing Drum

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Abstract:
The Mixing and Nodulizing Drum (MND) is a part of Sinter Plant used for mixing the ingredients with blast furnace fines before feeding the same to sinter machine. The drum is a cylindrical vessel which rotates about its own axis during working condition so that all the substances can mix properly. In order to prepare this Nodulizing drum, A Metal plate is taken and is to be passed through the rolling machine which can later acquire the shape of a cylindrical vessel. Now, the ends of the plates are to be joined by welding processes so that it can take the shape of Mixing and Nodulizing Drum. Firstly, the ends of the plate are joined by Metal arc welding processes and in order to acquire a smooth surface finish, Submerged Arc welding process has to be done on the plate and various considerations has to be taken care while doing a proper welding process and are furnished below. The working principle, Electrode size and specifications along with the electrical characteristics of all welding processes are presented in this paper. After welding process, the Nodulizing Drum is to be sent to the testing section where the Analysis of the drum takes place under the application of various Non-Destructive testing methods. During testing, if any crack was found then at that region, the material is removed by grinding operation. The defected pieces are re-structured again by welding process.

Keywords: Mixing and Nodulizing Drum, welding, characteristics, testing (Analysis of weld bead) etc.

I. INTRODUCTION

The Mixing and Nodulizing Drum (MND) is a part of Sinter Plant used for mixing the ingredients with blast furnace fines before feeding the same to sinter machine. The drum is a cylindrical vessel, inclined slightly to the horizontal, which is rotated about its own axis having the dimensions of ø 4m & 15m long. As the drum rotates, material under goes certain amount of stirring and mixing and the hot gases pass along the drum but usually in the opposite direction. The assembly weighing about 65 MT is manufactured and machined in single piece and in single setting for M/s JSW Steel Limited for their 4.0 Million Tonnes expansion project. The Girth Gear is also machined and teeth are cut in shop and sent to site separately. The final machining of the entire assembly of shell fitted with tyres and girth gear flange is carried out on gigantic 20 m lathe by providing two machined spiders at both ends and the longest drum may have 2 pairs of rollers.

II. PROCEDURE FOR PREPERATION OF DRUM

For the development of drum, the plate is to be passed through a rolling machine and Rolling is a metal forming process in which metal stock is passed through a pair of rolls and it undergoes either of the two processes.
1. Hot rolling and 2. Cold rolling is defined as follows.

- If the temperature of the metal is above its re-crystallization temperature, then the process is termed as **hot rolling.**
- If the temperature of the metal is below its re-crystallization temperature, the process is termed as **cold rolling.**

After rolling, the plate is joined by means of welding processes. They are Longitudinal Seam welding and Circumferential seam welding. Both Longitudinal Seam welding and circumferential seam welding processes are achieved by welding processes. They are

1. Shielded Metal Arc Welding (SMAW)
2. Sub-merged Arc Welding (SAW)

So all the above welding processes will be used in order to construct a Mixing and Nodulizing drum. So, The first welding process used in making the drum is Shielded Metal Arc Welding process.

2.1Shielded Metal Arc Welding (SMAW):

Its working, Electrode size, Electrode Specification, features of electrode and Electrical characteristics are presented below.

2.1.1. Working:

The fusing of two or more pieces of metal together by using the heat produced from an Electric arc welding machine is called as

Arc Welding Process. Arc welding is most commonly used to join two pieces of metal. The welder creates an electric arc that melts the base metals and filler metal (consumable) together so that they all fuse into one solid piece of metal.

2.1.2 Electrode Size:
The size of the electrode generally depends on the thickness of the section being welded, and the thicker the section, the larger is the electrode required.

Average Thickness of Plate or Section	Maximum Recommended Electrode Diameter
1.5–2.0 mm	2.5 mm
2.0–5.0 mm	3.2 mm
5.0–8.0 mm	4.0 mm
≥8.0 mm	5.0 mm

2.1.3. Electrode Specification:
E7018-X

- **E** indicates that this is an electrode
- **70** Indicates how strong this electrode is when welded. Measured in thousands of pounds per square inch.
- **1** Indicates in what welding positions it can be used.
- **8** Indicates the coating, penetration, and current type used.
- **X** Indicates that there are more requirements.

Features of E-7018 electrodes:
They are low hydrogen flux coated steel rods, with a high yield tensile strength of 70,000 PSI. These electrodes must be stored in an oven with a temperature between 250ºF and 300ºF.

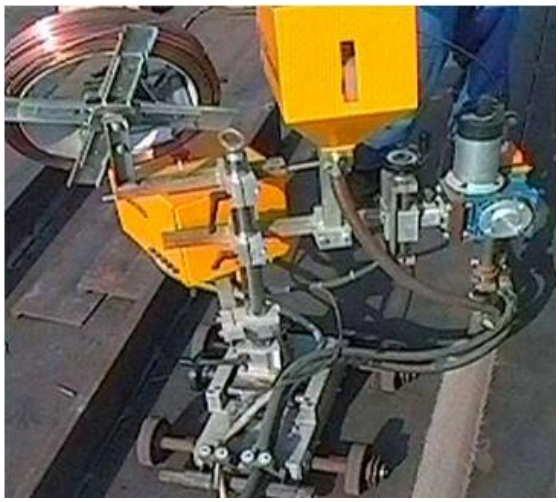
2.1.4. Electrical Characteristics of E-7018X:
For Low Hydrogen Electrodes

- **Current** : **DC**
- **Polarity:Electrode positive**
- **Amps:**
  For
  2.5mm DIA --- (60-90) Amps
  3.15mm DIA --- (110-140) Amps
  4mm DIA --- (140-180) Amps
  5mm DIA --- (180-230) Amps
- **Volts:** **70 V**

All the features said above can make a welding to certain extent. In order to make the welding without any inclusions or cracks inside the weld bead, the Submerged Metal Arc welding process will be used.

2.2. SUBMERGED ARC WELDING (SAW)

Submerged Arc Welding or SAW welding is a high quality, high deposition rate welding process and the arc is sub-merged under a blanket of granular flux. SAW welding is commonly used to join multiple plates of metal together. It is a common arc welding process. It requires a continuously fed consumable solid or tubular (flux cored) electrode.



The process is normally limited to the flat or horizontal-fillet welding positions (although horizontal groove position welds have been done with a special arrangement to support the flux).

2.2.1. FEATURES of SUBMERGED ARC WELDING
2.2.1.1. Base metal:

- Material specification**: SA 516**
- Grade : **GR 70**

2.2.1.2 Filler metals:

- SFA Specification: **5.17**
- AWS Classification: **EH14**
- Filler metal F.NO. : **6**
- Size of filler metal: **Ø 4 mm**
- Weld metal thickness: **44 mm**

2.2.1.3Electrode:

- SAW filler material usually is a standard wire as well as other special forms. This wire normally has a thickness of **1/16 in. to 1/4 in. (1.6 mm to 6 mm).**

2.2.1.4 Position: Position of groove: **FLAT**
2.2.1.5 Pre-heat temperature: The welded material is to be pre heated in order to remove the presence of moisture content in it and the minimum temp is **100 Degrees**
2.2.1.6. Post weld heat treatment:
Post-weld heat treatment is most generally used for stress relief. The purpose of stress relieving is to remove any internal or residual stresses and the temperature for post weld heat treatment is **600 Degrees.**
2.2.1.7. Electrical characteristics:

- **Current: DC**
- **Polarity: Electrode positive**
- **Amps : For 4mm thickness 550Amps**
- **Volts : For 4mm thickness 30V**

2.2.1.8Travel speed:
Travel speed affects penetration and bead size. High speeds decrease penetration and increase tendencies for Undercut, Arc blow, Porosity and non-uniform bead shape.
Travel speed for **SAW** is: **4 mm to 400 mm**
Multi pass or single pass: **Multiple**
Electrode : **single**
This is the complete explanation of Submerged Arc Welding and its role in constructing a Nodulizing drum. After these two welding processes, the drum is to be taken to Testing section where the analysis of the weld bead is done in order to confirm

that the weld bead is free from cracks, inclusions etc. If it has cracks, then the weld bead is to be grinded by grinding wheel and is treated again with welding processes.

III.TESTING OF WELDS

Weld testing is usually done to determine the strength of the weld and to overcome the defects by detecting them and repair them. Testing Analysis of Mixing and Nodulizing Drum can be done by means of Non-destructive testing (NDT).With the help of these testing, high accuracy is maintained. It is a highly-valuable technique that can save both money and time in product evaluation, troubleshooting and research.

The Common NDT methods which are applied on the Nodulizing Drum are as follows:
3.1. Visual inspection
3.2. Dye penetrant inspection
3.3. Magnetic Particle Inspection
3.4 Ultra-Sonic Testing
3.5. Radiographic inspection

3.1. VISUAL INSPECTION

Visual inspection (**VT**) relies upon the detection of surface imperfections using the eye. VT can be improved by using aids such as a magnifying glass to improve its effectiveness and scope and VT is considered to be the primary NDT method.

3.2. DYE PENETRANT INSPECTION

•Dye penetrant inspection (DPI) is a widely applied and low-cost inspection method used to locate surface-breaking defects in all non-porous materials (metals, plastics, or ceramics).
•LPI is used to detect casting, forging and welding surface defects such as hairline cracks, surface porosity, leaks in new products and fatigue cracks on in-service components.

3.2.1. MATERIALS:
1. Cleaner
2. Penetrant
3. Developer

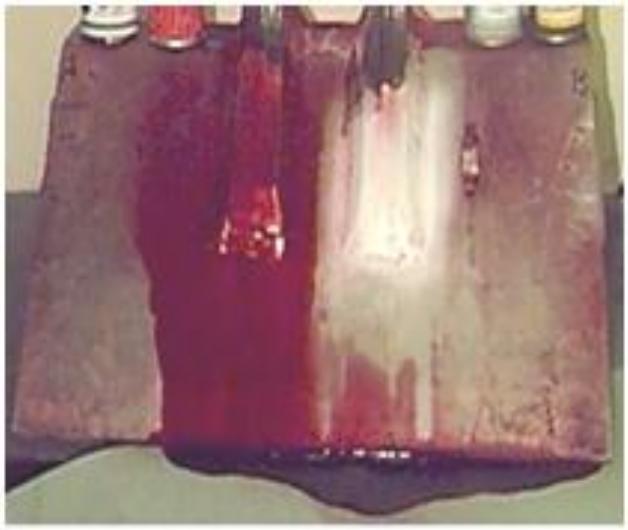


Figure.1. Detection

Figure.2. Dye Penetrants

3.2.2. INSPECTION STEPS:
1. Pre-cleaning
2. Application of Penetrant
3. Excess Penetrant Removal
4. Application of Developer
5. Inspection
6. Post Cleaning

Figure.3. Application of Penetrant

Figure.4. Application of Developer

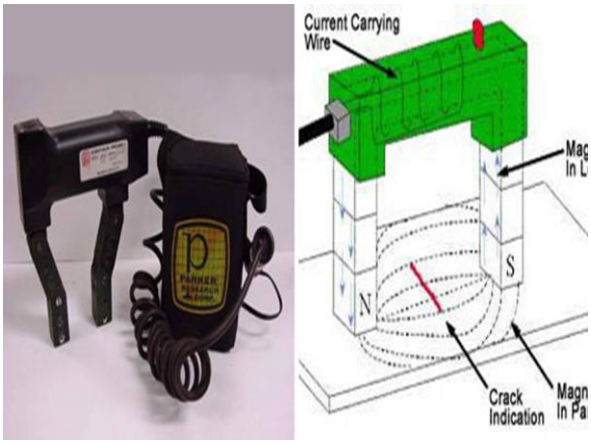
3.3 MAGNETIC PARTICLE INSPECTION

It is a process for detecting surface and slightly subsurface discontinuities in ferroelectric materials such as iron, nickel, cobalt and some of their alloys.
It can detect both production discontinuities (seams, laps, grinding cracks and quenching cracks) and in-service damage (fatigue and overload cracks)

- Mainly for surface defects
- Some sub surface defects can be found
- Applicable only for ferrous metal

3.3.1 HOW IT WORKS:

- A ferromagnetic test specimen is magnetized with a strong magnetic field created by a magnet and the piece can be magnetized by direct or indirect magnetization. A common particle used to detect cracks is iron oxide, for both dry and wet systems.
- If the specimen has a discontinuity, the discontinuity will interrupt the magnetic field flowing through the specimen and a leakage field will occur.
- Finely milled iron particles coated with a dye pigment are applied to the test specimen.
- These particles are attracted to leakage fields and will cluster to form an indication directly over the discontinuity. This indication can be visually detected under proper lighting conditions.



IV. WELDING DEFECTS AND PROBLEMS

Defects that can occur when using the shielded metal arc welding process are:

- Slag inclusions
- Porosity
- Under cutting
- Lack of fusion
- Over lapping

V. CONCLUSION

The Mixing and Nodulizing drum is being fabricated by using above welding processes and then it undergoes various testing procedures with which the defects are visualized and are removed by grinding Process. The defected pieces are re-structured again by welding process to construct the Nodulizing drum.

VI. REFERENCES

[1]. For the Welding Concepts, refer Manufacturing Engineering and Technology by Kalpakjian.