STOODY

# RECLAMATION OF COAL PULVERIZING ROLLS & SEGMENTED GRINDING RINGS

Coal Pulverizers

Grinding Rings

Power Plants

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www.stoody.com

*Through extensive research and years of practical experience, Stoody® has proven that coal pulverizing rolls, rings, and other vulnerable components can be effectively and economically reclaimed at a fraction of the new part cost. The correct application of hardfacing can increase roll and ring service life by up to 100 percent and can outlast base casting materials.*

*This brochure provides cost-saving methods to rebuild the most vulnerable parts. The overlay alloys referenced in this document were developed specifically for coal pulverizing rolls and grinding rings. For detailed product information see the Stoody Product Selection Guide or contact your Stoody representative or distributor.*

## Hardfacing Coal Pulverizer Rolls, Rings, and other components

The hardfacing and rebuilding of the coal pulverizer rolls, rings, and other components of the crusher is now a routine maintenance program in most coal fired power plants. Historically this type of maintenance was performed by contractors during major outages. Over the years an increasing number of power generating plants have invested in automated welding equipment and trained their maintenance crews to perform this critical service between major outages, allowing additional time for the more critical repairs of the boiler and other sections of the power plant. The enhancement in wear resistance experienced on the crusher components that have been hardfaced allow this critical repair to be made a part of a scheduled maintenance program, no longer relying on a major outage for completion. This allows the plant to remain online producing energy, thus reducing their outage cost and down time dramatically.

## Advantages

The increase in wear resistance of the coal pulverizer rolls and rings has dramatically improved mill operation efficiency in power plants increasing the BTUs that the individual mill can produce. This can be directly attributed to the more uniform wearing of the surfaces on both the grinding ring and the rolls, and the increased consistency of fines that the mill produces.

An additional advantage has been the increased cycle time on the maintenance of the pulverizers. This time has increased from 9-12 months to 18-24 months on average. In some cases much longer, depending on the type of crusher being operated and the type coal being used.

## Stoody Recommended Alloys

Stoody 100HC, 100HD, CP2000, and CP2001 are the best choices when using a multiple layer hardfacing process to restore worn crusher components in coal fired power plants. These alloys are iron based high carbon, high chromium wires that form a high density of evenly distributed chromium carbides in a high hardness deposit matrix. Hardness ranges between HRC 55 – 64. The unique attribute of these alloys is their ability to be applied in multiple layers when welded using stringer beads and proper welding procedures. All develop a thin cross check in a regular pattern ranging from 3/8" to 1/2" (10-13 mm) between cross checks, which is critical for this procedure.

## Stoody Open Arc Hardfacing Alloys

Open arc welding is the most commonly used welding process for the automated hardfacing of coal pulverizing equipment because it is a simplier process to use and exhibits high deposition rates. Stoody has developed several open arc high-alloy abrasion-resistant wires for overlaying new and for reclaiming worn coal pulverizer equipment parts. With a proven track record, Stoody is the leader in providing cost-effective solutions to wear problems for power generating, cement, and other industries utilizing pulverized coal.

Stoody 100HC is the first generation open arc wire for rebuilding worn coal crusher components. Stoody next developed 100HD, long considered the industry standard due to its high deposition rate and excellent wear resistance.

Stoody's CP2000 is the first in the next generation of chrome carbide overlay products utilizing micro alloying technology to provide improved wear and impact resistance.  Figure 1 compares the microstructure of Stoody CP2000 and 100HD, a conventional iron-based chromium carbide wire. Figure 1A shows the complex carbide microstructure of CP 2001. Figure 2 shows a pulverizer roll after processing 500,000 tons of coal. The roll clad with CP2000 wire exhibited approximately half the wear as the roll clad with conventional carbide.

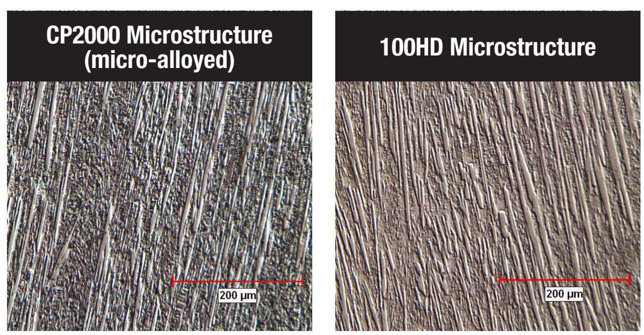



Figure 1 - Microstructure Comparison

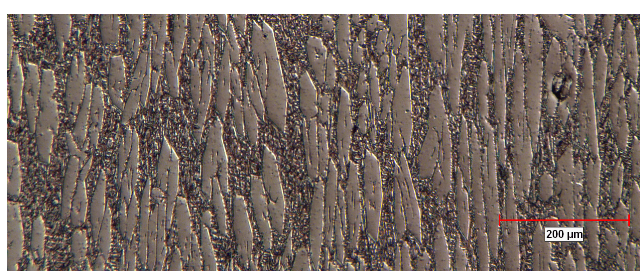



Figure 1A - CP2001 Microstructure


Figure 2 - Roll Wear Comparison

Stoody developed CP2001 to further enhance wear resistance by utilizing secondary carbides of elements that include Mo, Nb, V, and W. Although complex carbide wires of the Fe-6C-19Cr-5Mo-5Nb-2W-2V composition have been available they suffered from two inherent disadvantages: a) relative brittleness and, b) only two layers could be applied without overlay spalling. Stoody CP2001 can be applied in multiple passes and optimizes wear resistance and toughness. Field tests using CP2001 alloy on pulverizing rolls confirm greatly improved performance over conventional chromium carbides.

Stoody alloys for pulverizer roll and ring rebuilds Stoody 100HC, 100HD, CP2000, and CP2001 all have their own special properties that offer big advantages when choosing them for your application.

Stoody 100HC offers the highest ductility of this group, making it the best choice for roll tire type crushers, reducing the chance of the hardfacing spalling from the occasional metal-to-metal contact that can happen during mill operations.

Stoody® 100HD is the industry standard alloy on all types of pulverizer rebuilds for both coal and cement, which has improved wear resistance over Stoody 100HC with lower toughness.

Stoody CP2000, one of the new generation of pulverizer roll and ring hardfacing wires, offers high wear resistance with improved toughness over Stoody 100HD.

Stoody CP2001, the ultimate alloy for pulverizer wear protection, offers a high concentration of complex carbides with good toughness in multiple pass application.

Figure 3 gives comparative ASTM G65 Procedure A abrasion test results for these deposits. Other tests simulating wear that occurs during crushing and grinding include high-stress abrasion and the pin-on-disc test. Tests, shown in Figure 4 that CP2001 deposit ranked highest in both low stress and high stress abrasion.

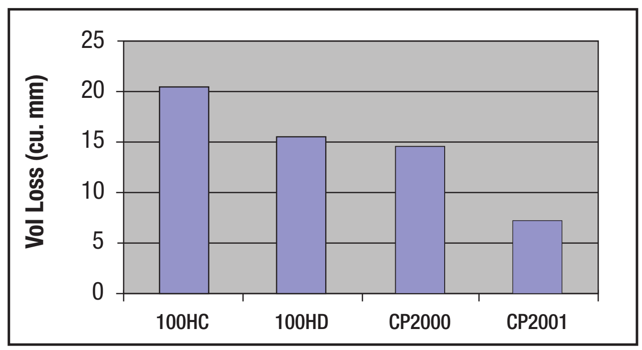



Figure 3- G65 Low Abrasion Tests, Cr Carbide Wires

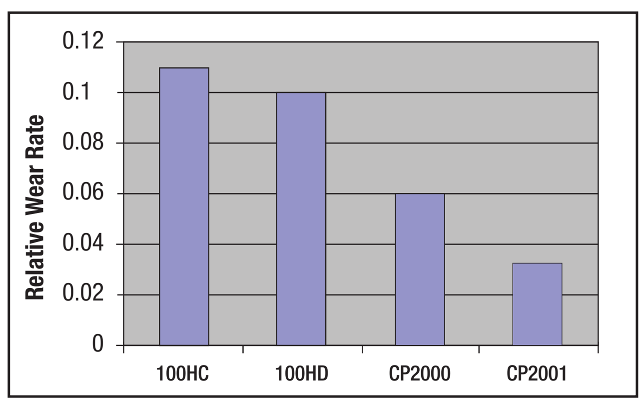



Figure 4- High Stress Pin-on-Disc Tests

## Tips For Open Arc Welding on Coal Pulverizing Rolls

When hardfacing Ni-Hard or ductile cast iron material, the part to be welded should be preheated slowly to 200° F (95° C). This accomplishes two things: **1)** it reduces the amount of thermal shock the part experiences during welding, and **2)** it promotes a tight cross-check pattern in the weld deposit. Allow larger rolls to "soak" for one hour per inch of thickness until a temperature of 200° F (95° C) is reached. To achieve uniform heating, use a ring burner or furnace. This temperature must be maintained throughout the welding operation, followed by a very slow cool-down to room temperature. Using thermal blankets or other suitable insulation will help control cooling rates, allowing the part to cool down evenly.

If the roll has been previously hardfaced, inspect the roll for soundness before welding. One simple test is to strike the suspected spalled areas with a hammer. A ringing tone indicates soundness, while a dull thud sound indicates spalling. Remove all loose weld metal and use a power-brush to clean the part surface before preheating and welding. If you prefer, use a high pressure washer to remove residual materials from the weld interface quickly and easily. If any major defects are found, do not rebuild the part – replace it.

For removing spalled weld metal down to the sound base metal, you can use arc gouging rods or a plasma arc gouging system. For best results, you can automate the process using Arcair® N7500 automatic gouging system. **Note**: When removing spalled weld metal, you will need to be sure to cut material off as evenly as possible so that material can be reapplied using an automatic welding process (see Figure 5).

Figure 5 – Thermadyne® Arcair N7500

## Multiple Layer Hardfacing Welding Tips

For best results apply stringer beads with little or no tie-in to establish a uniform and tight cross-check pattern (see Figure 6). Cross-check cracks are perpendicular hairline fractures spaced approximately 1/4" to 5/8" (6 to 16 mm) apart along a single bead.

### Horizontal Welding: Stringer Bead Profile

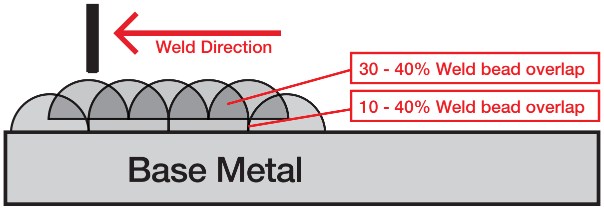



Figure 6

It is recommended that the first layer of hardfacing is applied at least 1" (25 mm) from either edge of the roll to prevent possible bi-axial stresses that can lead to spalling. Gradually widen succeeding layers to achieve the desired roll contour. The three factors that determine cross-check frequency and spacing are the interpass temperature, cooling rate and bead configuration. If the interpass becomes excessively high or the bead width too wide, the cross-check pattern will grow to greater than 1 1/4" (32 mm) apart, with large cracks, as opposed to the desired hairline stress fractures perpendicular bead. Cooling rates that are either too fast or too slow also may lead to undesireable cross-check patterns. Large cracks can lead to catastrophic failure (spalling).

A proper cross-check crack pattern in the cladding is critical to avoid disbanding. Rotation travel speed controls bead thickness and width. String beads should be 3/8" (10 mm) wide and 1/8" (3 mm) thick for best results (see Figure 7).

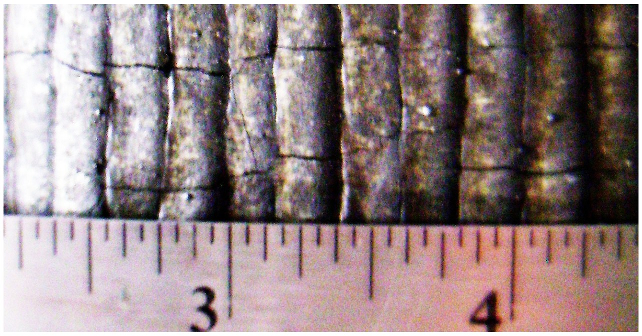



Figure 7

Lead distance – how far the arc is ahead of the top dead center – should be 1/2" to 3" (13 to 76 mm), depending on the roll diameter. Lead distance determines the bead profile (convex, concave, or flat). A flat bead profile will achieve consistent fusion.

In some cases, the first layer over an existing overlay may exhibit gas porosity in the weld deposit. This is caused by welding over residues trapped in the cross check cracks. If the gas porosity is excessive, spalling may occur at the fusion zone between the existing deposit and the new overlay being applied. Use Stoody® PR2009, a newly developed first layer and second layer repair wire, to reduce the gas porosity and spalling potential at the fusion zone.

Figure 8 – Fosterwheeler Type Mill Rolls

Figure 9 – Raymond Mill Roll

## Recommendation For Hardfacing Build Up of Coal Pulverizing Rolls

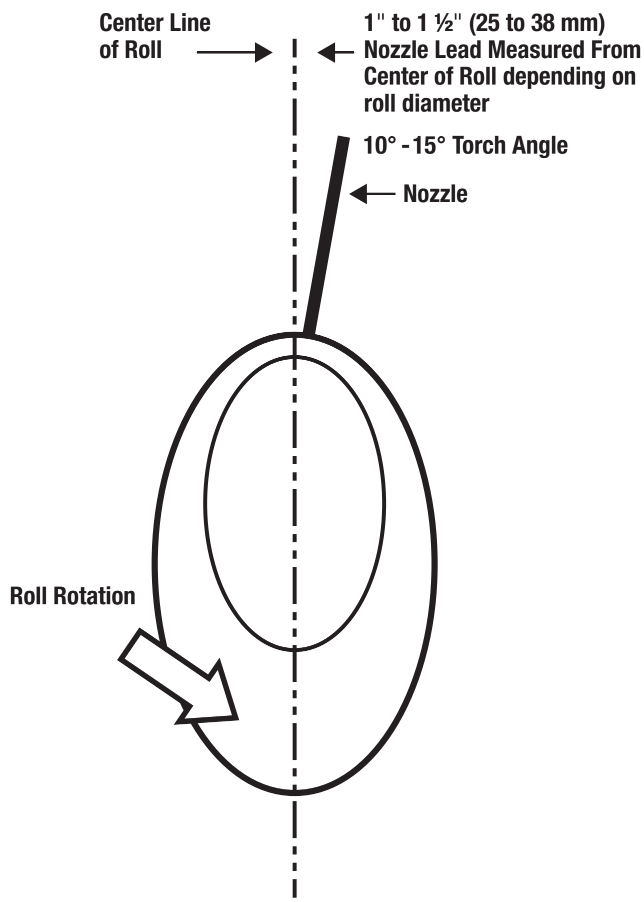
Preparation:

- **Roll Inspection**: It is best to dye-penetrate inspect ID Bore and visual inspect roll surfaces to determine base metal soundness. If Bore ID has excessive wear, contact Stoody for repair procedure.
- **Preheating**: For Ni-Hard and Ductile Iron base metals, preheat to 200° F.
- **Interpass Temperature**: Not to exceed 500° F.
- The key to multiple pass hardface build up is the proper selection of hardface materials and the use of high-speed stringer weld beads that produce a thin cross check in a regular pattern (ranging from 1/4" to 5/8" (6 to 16 mm) between cross checks). This combination creates a self stress relieving welding process allowing for multiple layers of hardfacing to be applied without lifting or spalling.
- Weld bead shape plays an important role in achieving a good cross check pattern. Convex type beads ranging from 5/16" to 3/8" (8 to 9 mm) width and 1/8" to 3/16" (3 to 5 mm) in thickness produce the best cross check pattern. Caution: Heavy thick weld beads can and will cause lifting and / or spalling.
- Weld bead overlap or step over distance; best results are with 30% - 40% overlap.
- Weld travel speed range is 50 to 65 (13 to 17 cm) inches per minute. Adjust as required to maintain bead shape and dimensions.
- Welding power source recommendation: it is recommended that a constant potential (constant voltage) power source, with a minimum of 650 amps of continuous duty cycle.

## Trouble Shooting Welding Process:

- **Inconsistent weld bead:** Check wire feeder. Check travel speed. Check voltage and amperage settings.
- **Weld bead too flat:** Check and reduce voltage if required. Check and increase amperage if required. Check nozzle position.
- **Weld beat too ropy:** Check and increase voltage if required. Check and reduce amperage if required. Check nozzle position.

**Recommended Nozzle for Roll Position**



## SEGMENTED BOWL REBUILDING, OPEN ARC

Segmented bowls are constructed of cast Ni-Hard segments that form a continuous ring. Stoody open-arc 100HC, 100HD, CP2000, and CP2001 hardfacing alloys should be applied to these components to greatly improve wear resistance. All worn components in the bowl assembly can be hardfaced, including bowl segments, hub, and extension ring.

Welding should start on the inside diameter and progress outward, with the rotation speed being slowed to keep travel speed under the welding head constant. As the weld moves out it will have to “step” up as well. Though bowl segments often have deep cracks, gouges, or pits, these areas do not have to be filled in prior to automatic rebuilding. The welding process compensates for these depressions and fills them to the proper thickness during the course of welding.

Figure 7 - Mavrix* Dual Arm Pulverizer Table Rebuilding System

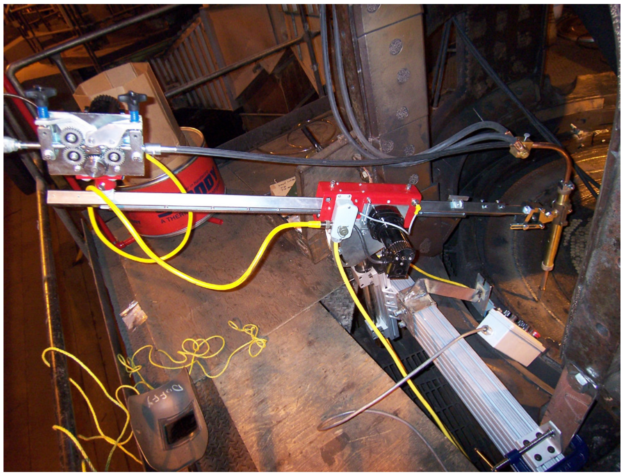


Figure 8 - Mavrix* Single Arm Pulverizer Rebuilding System

Wire stick-out, amperage, voltage, and drag angle are the same for both roll and segmented bowl rebuilding. The weld puddle should be centered on the fusion line of the previous bead for approximately 35 percent tie-in. Rotation speed of the bowl directly under the welding heads should be 50" to 65" (13 to 17 cm) per minute, except for the first layer. To allow proper fusion and outgassing, the first layer may be welded at a slightly lower application rate.

Typical welding parameters for 7/64" (2.8 mm) and 1/8" (3.2 mm) wires are shown in Table A. Note that 1/8" (3.2 mm) wires have been designed to weld at a higher amperage and deposition rates.

### Table A - Typical Welding Parameters

| | 7/64" / 2.8 mm Wire Diameter | 1/8" / 3.2 mm Wire Diameter |
|---|---|---|
| **Volts** | 28 - 31 | 30 - 32 |
| **Amps** | 375 - 550 | 450 - 650 |
| **Wire Stickout** | 1" / 25.4 cm | 1 1/4" / 31.7 cm |
| **Wire Feed Rate, per minute** | 100" - 220" / 254 - 558 cm | 150" - 200" / 381 - 508 cm |
| **IPM Travel** | 50" - 60"/ 127 - 152 cm | 50" - 65"/ 127 - 165 cm |
| **Preheat Temperature** | 200° F / 93° C | 200° F / 93° C |

### Additional Tip for Build Up and Hardsurfacing of Coal Pulverizers Segmented Grinding Rings

The following are suggestions for rebuilding coal pulverizer segmented grinding rings in place, using automated equipment. The recommendations listed below are to help understand proper technique when refurbishing worn grinding rings.

- LOCK OUT all start controls for the pulverizer mill functions before entering pulverizer unit.
- Clean the pulverizer of all debris, including reject areas; this is to ensure proper rotation of bowl during the welding operation.
- Clean and inspect segmented grinding ring. Broke segments should be replaced using a segment having similar wear whenever possible. Uneven segments normally will level out during the welding process, usually after 2 to 3 layers.
- Use a sizing template to ensure proper angle and height of grinding ring. It is important to mark the bowl at the highest wear area and in the lowest wear area and gauge from these two marks only. Set electrical stick out distance to work surface at the lowest wear area or the highest point on the grinding ring. This is important to help even out uneven wear areas during the welding process.

* Details on Mavrix equipment can be obtained from www.mavrixweld.com

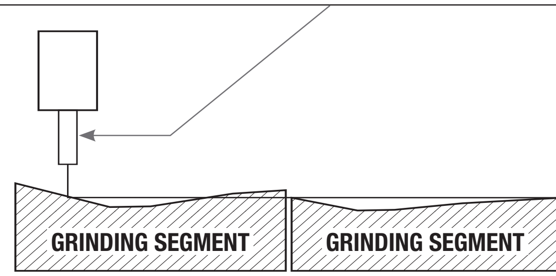
- **Equipment Installation Warning!** Caution should be taken to reduce the chances of welding current passing through the mill bearings when welding on the pulverizer housing and grinding ring. The risk can be mitigated during installation of the automatic equipment by attaching the welding ground to the parts being welded. This will help to reduce the chances of welding current passing through the mill bearings.
- **Rotary Ground**: Improper installation of the rotary ground can greatly affect the quality of the welding process. The installation of the rotary ground on to the center of the hub (cover plate), may sometimes produce a poor connection between center hub and the segmented ring. It may be necessary to tack-weld two or three ground straps from the base of the rotary ground to the toe of the segments, equally spaced. This will ensure proper grounding.
- **Warning!** When starting the welding process, caution should be taken to control heat input. If pulverizer bowl is cold, it's best to warm the crusher using heater blowers. Welding on cold parts causes uneven heating and expansion leading to higher stresses being exerted on the grinding ring and bowl. This can lead to bowl breakage and failure. Pausing between first and second weld layers will allow the heat to transfer from grinding ring to bowl and equalize expansion. Air cooling may be necessary between passes during the welding process in the third and fourth weld layers to keep parts from over heating. Do not cool below 200° F minimum preheat.

**WARNING:** Protect yourself and others. Before you use this product, read and understand this label, the appropriate Material Safety Data Sheet (MSDS), the manufacturer's instructions and your employer's safety practices. The MSDS is available upon request from your distributor, your employer. **HEAT RAYS (INFRARED RADIATION from flame of hot metal), from oxyfuel process can injure eyes. ELECTRIC SHOCK can kill. ARC RAYS can injure eyes and burn skin. FUMES AND GASES can be hazardous to your health.**

- Keep your head out of fumes. The primary entry route for welding fumes and gases is by inhalation. Short-term over-exposure to welding fumes may result in fever, dizziness, nausea, or dryness or irritation of nose, throat or eyes and may aggravate pre-existing respiratory conditions. Long term over-exposure to welding fumes may harm your respiratory function and pulmonary function and may lead to siderois (iron deposits in the lungs). Manganese over-exposure may affect the central nervous system, resulting in impaired speech and movement. OSHA considers chromium and nickel compounds carcinogens.
- Use enough ventilation and exhaust at the arc (flame) to keep fumes and gases from you breathing zone and general area. If you are concerned about the ventilation of your work area, request that your employer conduct appropriate testing.
- This product contains or produces a chemical known to the state of California to cause cancer and birth defects (or other reproductive harm). (California Health and Safety Code 25249.5 et seg).
- Wear correct eye, ear, and body protection.
- Do not permit electrically live parts to touch skin, clothing or gloves. Insulate yourself from work and ground.
- IN CASE OF EMERGENCY: Immediately call for medical aid. Employ first aid techniques recommended by the Red Cross.
- See American National Standard Z49.1 Safety In Welding, Cutting and Allied Processes, published by the American Welding Society, PO Box 351040, Miami, FL 33135: OSHA Safety and Health Standards. 29 CFR 1910, available from the US Government Printing Office, Washington, DC 20402.

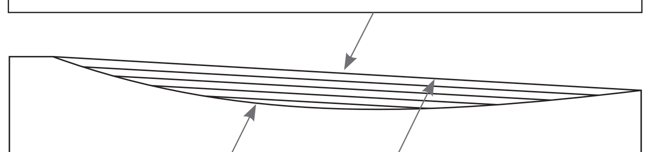
**THIS INFORMATION IS INTENED FOR THE END USER OF THIS PRODUCT**
**DO NOT REMOVE OR OBSTRUCT THIS INFORMATION**

**Electrical stick out to work surface set at highest point:** During the welding process, the tip passing over the low areas of the grinding ring will increase the electrical stick out cooling the weld puddle down, causing the weld bead to increase in thickness. As the tip passes over the high areas of the grinding ring the electrical stick out will decrease, causing the weld bead to flatten as the temperature increases. After 2 or 3 layers, reasonably low areas of the grinding ring will fill in and level out.




Stoody recommends using a contour pattern or a simple straight edge (on C.E. units) to check for low areas. These areas should be marked and filled evenly prior to applying the last passes.

Build up worn grinding ring by starting at the highest wear are determined by sizing template and overlay that section. Repeat this process until grinding ring is to size and shape required or specified.



**First Pass:** Highest Wear Area.

**Second Pass:** Continue this process until level with sizing template.

Segmented Grinding Ring: Before Hardfacing

Segmented Grinding Ring: After Hardfacing

STOODY®

## Recommended Stoody® Open Arc Welding Wires

| Stoody Product | 100HC | 100HD | PR2009 | CP2000 | CP2001 |
|---|---|---|---|---|---|
| Alloy Type | Primary Cr Carbides in Austenitic Matrix | Primary Cr Carbides in Austenitic Matrix | Primary Cr Carbides in Austenitic Matrix | Primary Cr Carbides in Austenitic Matrix | Primary Cr Carbides and Secondary Nb +V Carbides in Austenitic Matrix |
| Deposit Characteristics (typical) | | | | | |
| Abrasion Resistance | Excellent | Excellent | Excellent | Excellent | Excellent |
| Impact Resistance | Moderate | Low | Moderate | Moderate | Moderate |
| Deposit Layers, Maximum | Multiple | 3[b] | 2 | Multiple | Multiple |
| Hardness, Rockwell C[a] | | | | | |
| On carbon steel | HRC 58 – 62 | HRC 55 – 62 | HRC 59 – 62 | HRC 58 – 64 | HRC 58 – 63 |
| On manganese steel | HRC 51 – 55 | N/A | N/A | N/A | N/A |
| Machinability | No | No | No | No | No |
| Magnetic | | | | | |
| On carbon steel | Slightly | Slightly | Slightly | Slightly | Slightly |
| On manganese steel | No | No | No | No | No |
| On iron | Yes | Yes | Yes | Yes | Yes |
| Hot Wear Applications (up to) | 900° F / 482° C | 900° F / 482° C | 900° F / 482° C | 900° F / 482° C | 900° F / 482° C |
| Wire Diameters Available | 7/64" / 2.8 mm | 7/64" / 2.8 mm | 7/64" / 2.8 mm | .045" / 1.2 mm<br>1/16" / 1.6 mm<br>7/64" / 2.8 mm | 1/16" / 1.6 mm<br>7/64" / 2.8 mm |
| Packaging | | | | | |
| 33# WB | – | – | – | 11907600 (.045")<br>11886500 (1/16") | – |
| 60# Coil | 11001000 | 11848200 | 11983200 | 11890000 (7/64") | 11961200 (7/64") |
| 200# HP | 11141700 | 11501100 | 11996500 | 11870400 (7/64") | 11925000 (7/64") |
| 500# POP | 11235400 (7/64")<br>11807700 (1/8") | 11484500 (7/64")<br>11489700 (1/8") | | 11879800 (7/64")<br>11870500 (1/8") | 11923400 (7/64")<br>11923300 (1/8") |
| 750# POP | | 11905600 (7/64") | | | |

[a] Unless stated otherwise, all hardness values shown are based on two applied layers of hardfacing overlay.
[b] When used in rebuilding of coal pulverizer rolls, greater than three layers can be applied using proper welding procedures.
N/A = not applicable / not available

For detailed information, contact your Stoody representative or distributor.

Or, visit our website at www.Stoody.com