HARD SURFACING ELECTRODES

Hard facing electrodes are used to reduce wear caused by abrasion, impact, erosion, corrosion and heat.

Various hard facing and build-up alloys have been designed to perform specific functions with predictable results. The selection of the proper hard facing alloys requires a
knowledge of:

1. The wear factors under which it must operate.
2. The function of the part or equipment.
3. The base metal to which it must be applied.

Before hard facing the base metals to be preheated. Preheating temp depends on type of Base metals.

Carbon Steels - Carbon content of

0.20% to 0.30%, preheat temperatures from 200°F to 300°F

0.30% to .45%, preheating to 300°F for thin sections, 500°F for heavy sections,

0.45% to 0.80%, preheat temperatures of 500°F for thin sections, to 800°F for heavy sections,

Carbon up to 1.7% are difficult to hard face because they are prone to cracking.

After hard facing, parts should be allowed to cool slowly.

Low Alloy High Strength Steels - Preheat and post heat temperatures must be maintained and in some alloys, stress relieving may also be required.

Preheat temperatures of 100°F to 600°F are used for most alloys,

Low alloys carbon content over 0.35% require preheat temperatures in the 800°F to 1100°F

Austenitic Manganese Steel - Austenitic manganese Steel containing 11-14% manganese and approximately 1.2% carbon.

Preheating of high manganese steels is not recommended.

The lowest welding current, which produces good fusion with the base metal, should be used to minimize heat input. Welding in one area for long periods of time should be avoided.

A skip-welding technique should be used. This means that each succeeding pass should be made as far as possible from the preceding pass.

Type of Steel	% Carbon	Preheat Temp.F
Plain Carbon Steels	Below 0.20	
	0.20-0.30	200-300
	0.30-0.45	300-500

Type of Steel	% Carbon	Preheat Temp.F
Nickel-Chromium Steels		
SAE 3115	0.15	200-400
SAE 3125	0.25	300-500

	0.45-0.80	500-800
Carbon-Molydenum Steels	0.10-0.20	300-500
	0.20-0.30	400-600
	0.30-0.35	500-800
Manganese Steels		
Silicon Structural	0.35	300-500
Medium Manganese	0.20-0.25	300-500
SAE 1330	0.30	400-600
SAE 1340	0.40	500-800
SAE 1350	0.50	600-900
12% Manganese(Hadfield)	1.25	Not required
High Strength Steels		
Manganese -Molybdenum	0.20	300-500
Chromium-Copper-Nickel	0.12 Max	200-400
Chromium-Manganese	0.40	400-600
Nickel Steel		
SAE 2015	0.10-0.20	Up to 300
SAE 2115	0.10-0.20	200-300
Nickel Steel	0.10-0.20	200-400
SAE 2320	0.15	200-500
SAE 2320	0.20	200-500
SAE 2330	0.30	300-600
SAE 2340	0.40	400-700
Molybdenum Steels		
SAE 4140	0.40	600-800
SAE 4340	0.40	700-900
SAE 4615	0.15	400-600
SAE 4630	0.30	500-700
SAE 4640	0.40	600-800
SAE 4820	0.20	600-800

SAE 3130	0.35	400-700
SAE 3140	0.40	500-800
SAE 3150	0.50	600-900
SAE 3215	0.15	300-500
SAE 3230	0.30	500-700
SAE 3240	0.40	700-1000
SAE 3250	0.50	900-1100
SAE 3315	0.15	500-700
SAE 3325	0.25	900-1100
SAE 3435	0.35	900-1100
SAE 3450	0.50	900-1100
Low Chromium-Molybdenum Steels		
2.0% Cr, 0.5%Mo	Up to 0.15	400-600
2.0% Cr, 0.5%Mo	0.15-0.25	500-800
2.0% Cr, 0.1%Mo	Up to 0.15	500-700
2.0% Cr, 0.1%Mo	0.15-0.25	600-800
Medium Chromium-Molybdenum Steels		
5.0% Cr, 0.5%Mo	Up to 0.15	300-500
5.0% Cr, 0.5%Mo	0.15-0.25	300-500
8.0% Cr, 1.0%Mo	0.15 Max	600-500

Stainless Chromium Steels		Usually do not require preheat but it may be desirable to heat 32F
Type 410	0.07	
Type 430	0.07	
Type 446	0.1	
18-8 Columbium, Type 347*	0.07	
18-8 Columbium, Type 316*	0.07	
18-8 Columbium, Type 317	0.07	

*When Ambient temperature is below 50F, preheat to 100 F. Inter pass temperature over 500 F should be avoided

CLASSIFICATION OF HARDFACING ALLOYS

Iron Base Alloys - Low alloy steels 2-12% Alloying, High alloy steel 12-50% alloying element.

Used for abrasion resistant & Impact resistant

When surfacing with the high chromium-iron base alloys or other brittle alloys, a number of small cracks across the weld will appear. These cracks (known as checking or check cracks) are not detrimental because they do not penetrate into the tougher base metal or buildup alloy. They are, in fact, helpful in relieving stress buildup which would cause eventual longitudinal cracking in the fusion zone, leading to spalling of the hard facing material. On heavy weldments where heat buildup is great, check cracks may not appear. They should be induced by a light water spray or by an occasional hammer blow on the weld surface.

Nickel Base Alloys - The nickel base alloys contain 70-80% nickel, 11-17% Chromium, 2.50-3.70% boron, and 0.30-4.50% Silicon.

It is used as excellent resistance to low temperature abrasion, and makes these the best alloys for metal-to-metal wear. These alloys also have good heat and corrosion resistance. They retain their hardness and temperatures up to1200°F. The nickel base alloys lend themselves to flame spray and plasma arc applications, and are available largely in powder form. The cost of nickel base alloys is approximately five to six times that of the iron base alloys.

Cobalt Base Alloys - The cobalt base alloys consist of 45-63% cobalt, 24-29% Chromium, 5.50-13.5% tungsten and 1.10-3.20% carbon.

They are probably the most versatile of the hard facing alloys because they resist heat, corrosion, abrasion, moderate impacts, galling, and metal-to-metal wear. Some alloys in this group remain substantially hard at temperatures up to 1500°F.

Applications would include hot work equipment such as hot punches, valve parts, shear blades, etc.

Tungsten Base Alloys - The tungsten base alloys produce the most wear resistant deposits of the hard surfacing materials.

This is not used for metal-to-metal applications, but ideal for applications such as rock drill bits and other mining, quarrying and digging applications.

Despite their excellent abrasion resistance, tungsten carbide alloys can only withstand impacts that do not produce compressive stress above their yield strength.
Tungsten carbide alloys have low resistance to oxidation and low resistance to corrosion,

METHODS OF HARDFACING

S**hielded Metal Arc Surfacing** - The Hard facing electrode has a flux coating to assure weld Clean. The equipment is the same as for SMAW and consists of a power source both Ac or DC

Use recommended current and Weaving bead instead of a stringer bead and keeping the electrode in the puddle rather than on the base metal.

Gas Tungsten Arc Surfacing - Deposition rate is low, but deposits are of high quality as long as efforts are made to keep dilution to a minimum. Although argon, helium or mixtures of these gases may be used, dilution is the lowest when using pure argon. Gas Tungsten Arc Surfacing is used for many of the same type of applications as the oxyacetylene process.
These are usually small wear surfaces which require a smooth high quality deposit.

Flux Cored Arc Surfacing - Two types of continuous tubular electrodes are available for hard sufracing; Self-shielded and those which require a gas shield.

The self-shielded type are by far the more popular, and in the hard facing field, are known as “open arc wires”.

Dilution is higher than that of coated electrodes, but lower than that of submerged arc welding.

The gas shielded cored wires are used to a lesser extent. The shielding gases are used to reduce oxidation and minimize alloy loss. The use of CO_2 as a shielding gas has a tendency to increase penetration and thereby, increase dilution.

Submerged Arc Surfacing - The deposition rate and travel speeds are high, and the penetration is deep. Weld beads are smooth and of good quality.

Heat input is high and for this reason, this process is not recommended for use on austenitic Manganese steels. The deep penetration causes the highest dilution (up to 50%) of all of the processes, which makes it necessary to deposit three or more layers to attain the full properties of the surfacing material.

Gas Metal Arc Surfacing - Gas metal arc surfacing is not widely used for Hard facing since most of the iron based alloys can be deposited more economically by other methods. It is used somewhat for out-of-position surfacing where the low penetration of the short circuiting transfer mode produces low dilution. It is also used for depositing non-ferrous alloys, such as aluminum-bronze, which cannot be applied by other methods.

GENERAL RULES FOR HARDFACING

Some general rules and precautions which will help to assure sound hard facing deposits are listed below:

Base Metal Identification - The base metal must be properly identified so that the proper buildup and/or hard facing alloy can be selected. Also, base metal type will help determine the proper preheat and inter pass temperature.
A magnet will help to identify austenitic manganese steel since it is non-magnetic. The magnet should be tried at several locations on the part because work hardened areas will be slightly magnetic.

Base Metal Preparation - The base metal must be cleaned with a grinding wheel and be free of rust, oil, grease, or other foreign matter. Cracks, tears, or gouges must be repaired using the proper filler metal or buildup alloy.

Metal Removal - Rolled over and fatigued metal must removed. Work hardened surfaces of austenitic manganese steel should be ground away before buildup or surfacing.

Buildup - Buildup of badly worn parts to within approximately ¼” of their finalsize with an appropriate buildup alloy prior to hard facing is necessary.

Preheat and Inter Pass Temperature - The importance of observing preheat and

Inter pass temperatures cannot be overstressed. Problems, such as spalling, Cracking and distortion can be minimized by proper preheating, inter pass temperature and slow or retarded cooling.

Dilution - Dilution of the hard facing deposits is expected in all cases where the Hard facing alloy is fused to the base metal and should be kept to a minimum. Excessive dilution with the base metal will alter the hardness of the deposit and in part, is a result of the heat input

Dilution will be greater in stringer beads (straight) than in a weaving bead. A weaving bead is recommended.

Electrical Stick out must be kept relatively constant to control penetration in open arc welding.

Long Stick out decreases penetration and thereby, the amount of dilution. Short Stick out can drastically increase penetration and dilution.

Hard facing Thickness - Too much hard facing can cause more problems than too little. The hard facing deposit should consist of no more than two layers and the total thickness should not exceed ¼” in most cases.

BSRM HARD FACING ELECTRODES

HARDFACING ALLOY SELECTION FACTORS

In order to select the proper electrode, Hardness of an overlay deposit is frequently considered as the prime objective in the selection of a hard surfacing alloy.

Hardness - While constant hardness for various hard surfacing alloys is maintained, the particular hardness of any one alloy is a property resulting from the amount of alloying elements, including carbon, used to create the carbide formations necessary to attain a desired amount of wear resistance

Abrasion & Impact - When abrasion is combined with heavy impact, the alloy best suited to render the ultimate in wear resistance must have the proper balance of carbide forming elements in relation to matrix.