



Fusing Colmonoy® 52 SA onto B.O.P. Ram.

Colmonoy® 52SA, 52M 52C, 53F, 52-H, 52-P

Nickel-Based
Hard-Surfacing Alloys With
Increased Ductility, Better
Impact Resistance, and
Moderate Hardness

Description:

Colmonoy® 52 & 53 are nickel-based, hard-surfacing alloys for use on new parts to resist against wear, corrosion, heat and galling. The alloys are also used for repair of worn or out of tolerance parts. The benefit of these alloys are their combined effects of moderate hardness, increased ductility but slightly less resistance to abrasion and corrosion when compared to Colmonoy® 62 & 63 alloys. These alloys are non-sparking, non-magnetic, non-galling and have low coefficient of friction.

Colmonoy® 52 & 53 alloys are not generally used to protect against corrosion alone. The alloys are not resistant to ferric chloride and hot or concentrated nitric acid and should not be used in sodium sulphite liquor or lactic acid (milk products).

Colmonoy® 52 & 53 alloys are versatile in terms of its applications by successfully being applied with equipment such as Fusewelder™, Spraywelder™, High Velocity Oxy-Fuel (HVOF), Plasma Transferred Arc (PTA) and Laser Cladding systems. Fully fused deposits can achieve a hardness range between **Rockwell C 45-53**. However, hardness levels may differ dependant on equipment type, parameter settings, fusing temperature and substrate material.

Colmonoy® 52 & 53 alloys have been successfully applied throughout the petroleum industry. Applications include pump shafts, centrifugal pump parts, gates and seats, B.O.P. rams, sleeves and wear rings. Additional applications outside of the petroleum industry include camshaft lobes, glass

plungers, cement industry gate and globe valve components, mining crusher shafts, dragline rollers and metalworking dies used for forming and drawing.

Specification Equivalents:

UNS N99645 and AWS A5.21 Classification ERNiCr-B (applicable to chemistry only).

Nominal Composition - % by Weight:

B	C	Cr	Fe	Si	Ni
2.3	0.5	12.0	4.5	3.3	Bal

Forms Available:

Colmonoy® 52 & 53 alloys are supplied as atomised powder via several routes dependant on application requirements and equipment.

Alloy	Micron Size	Application
Colmonoy® 52SA	-106+38 µm	Spray & Fuse
Colmonoy® 52M	-125+45 µm	
Colmonoy® 52C	-90+45 µm	
Colmonoy® 53F	-106+20 µm	
Colmonoy® 52-H1	-63+20 µm	HVOF
Colmonoy® 52-P1	-180+63 µm	PTA
Colmonoy® 52-P2	-150+53 µm	PTA / Laser
Colmonoy® 52-P3	-125+45 µm	

Colmonoy® 52SA, 52M, 52C, 53F:

Colmonoy® 52SA, 52M, 52C, and 53F are designed for spray and fuse applications, using combustion thermal spray systems such as the Fusewelder™ and J-3 Spraywelder™.

Fused coatings via methods such as torch, induction or vacuum and controlled atmosphere, form a metallurgical bond with the substrate providing inter-particle cohesive strength and substrate-to-coating adhesive strength with very low porosity. The coatings show good resistance to wear and impact and their hot hardness is excellent. (Table 3)

Colmonoy® 52M is designed for use with thermal spray systems that are more oxidising, thereby requiring a coarser material to achieve a quality coating.

Colmonoy® 52-H1:

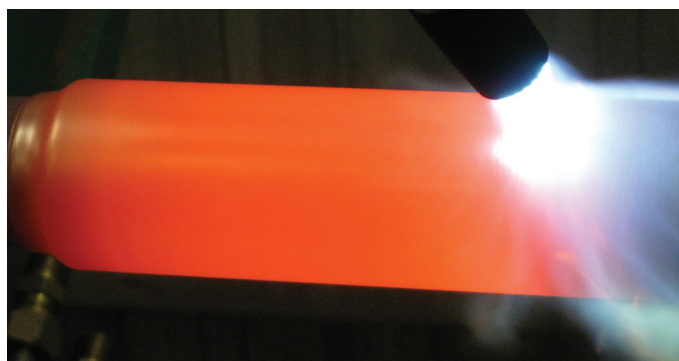
Colmonoy® 52-H1 is designed for use in High Velocity Oxy-Fuel (HVOF) Systems and do not require fusing. (Table 4)

Colmonoy® 52-H1 powder is used for centrifugal pump parts, heat exchanger tubes and other non-point loading applications. The coating is well suited for applications requiring abrasion and corrosion resistance, particularly in the as-sprayed condition when fusing is not possible. The coatings are also used to protect against particle erosion up to 815°C.

Colmonoy® 52-H1 powder cannot be hardened by fusing. A Metallurgical bond can be achieved, and coating integrity can be increased by torch, induction or furnace fusing. The fusing temperature is approximately 1045°C.

Coatings of Colmonoy® 52-H1 powder can be ground with silicon carbide or machined with CBN or carbide tooling.

Additionally, Colmonoy® 52-H1 can be used as a chromium plating replacement. Though not as hard (45-50 HRC), the coating is more dense (≥98%) and far less prone to cracking.



Colmonoy® 52 being fused onto a downhole pump plunger.

Properties:

Table 1: Physical Properties (approximate):

Density	8.14g/cm ³
Specific Gravity	8.14
Melting Point	1045°C
Specific Heat	0.4605 kJ/kg/°C (25-100°C)
Thermal Coef. of Expansion	8.4 x 10 ⁻⁶ (50-600°C)
Thermal Conductivity	15 W / m-K
Coefficient of Friction (6 - micro surface finish)	0.1
Magnetic Permeability	1.005 N/A ²
Modulus of Elasticity (Tension or Compression)	32 x 10 ⁶ psi

Table 2: Room Temp. Mechanical Properties:

Deposits produced by Spray & Fuse

Compressive strength, (ave.)	1,896.06 Mpa
	275,000 psi
Tensile strength, (ave.)	413.69 Mpa
	60,000 psi
Charpy impact*, (ave.)	4.0 N-m
	3.0 ft-lb
*Specimens having 12.7mm (1/2-inch) radius notch and polished to remove all possibility of stress concentrations	

Table 3: Room & Elevated Temp. Hardness:

Deposits produced by Spray & Fuse

Test Temp (°C / °F)	Rockwell C Hardness
21 / 70	45-53
316 / 600	46
425 / 800	45
540 / 1000	42
650 / 1200	38

Application Methods:

Colmonoy® 52 & 53 alloys are easily applied to all steels having less than .25% carbon, grey cast iron; Meehanite, malleable, ingot and wrought iron; nickel, Monel^a alloy 400, Inconel^a alloy 600, Nichrome, Chromel^b. Most high-temperature alloys can be overlaid without special precautions.

Steel having more than .25% carbon can also be overlaid, but requires controlled slow cooling after fusion, in suitable insulation such as Sil-O-Cel, mica, etc. Do not apply to ferrous metals that require subsequent hardening and tempering, because the dimensional change associated with the formation of martensite will crack the deposits of Colmonoy® 52 & 53 alloys. Hardenable base metals may be overlaid, but must be annealed isothermally after uniform austenitising to prevent cracking of the deposits of Colmonoy® 52 & 53 alloys. (Consult [Technical Services](#) for further details).

Application by Spraywelder™:

Colmonoy® 52 alloys are applied by use of the Spraywelder™, which is the recommended thermal spray system designed by Wall Colmonoy to produce dense coatings. The powder is sprayed on the part to be hard surfaced as in ordinary metal spraying procedure, and the overlay is then fused to the base metal by torch, induction or furnace. This is ideal when deposits of uniform thickness are being applied over a large area. Reference Spraywelder™ Brochure and Manual for more information.

Application by Fusewelder™:

Colmonoy® 53F powder is applied by Fusewelder™ or similar torch. The Fuseweld™ Process is a coating application method to apply metallurgically bonded coatings to the edges and corners of molds and blanks. Small shafts, the leading edge of flights for augers and centrifuge scrolls, keyways, splines, and cams can all be efficiently coated or rebuilt with this process. Reference Fusewelder™ Brochure and Manual for more information.

Application by High Velocity Oxygen Fuel (HVOF) Thermal Spray Processes:

Table 4: JP 5000 / 8000 Parameters for Spraying Colmonoy® 52-H1 Powder*

Gun barrel:	102mm (4")
Spray distance:	365mm (14")
Coating thickness:	>1.5mm (>0.060")
Spray rate:	4.5 - 5.4 kg/hr (10-12 lb./hr.)

Spray Parameters	Supply Pressure	Flow	System Pressure **
Oxygen	210 psi	1925 scfh	140+/-10 psi
Fuel (K1 kerosene)	170 psi	6.0 gph	121+/-10 psi
Powder (nitrogen carrier)	50 psi	19-20 scfh	not applicable
Combustion	N/A	not applicable	103+/-5 psi
Water Temperature: incoming - outgoing -	21°C 50°C +/-5°C		

* Some modifications to the parameters may be needed to compensate for longer hoses.

** System pressures are based on supply pressure and flow settings and are present for the purpose of monitoring the condition system consumables; located at the bottom of the control console.

Table 5: Typical Unfused Coating Characteristics:

Process	JP 5000 / 8000
Macro Hardness HRC	45-50
Porosity	<2%
Bond Strength	>90 MPa
	>13,000 psi
Surface Finish (as sprayed) (ground)	240-300Ra <10Ra
Coefficient of Friction (6-micro-inch surface finish)	0.1

Table 6: Hybrid Diamond Jet Parameters with methane (CH₄) for spraying Colmonoy® 52-H1 Powder*

DJ8-9 Powder Injector
 DJ2701 Extended Air Cap (1/4" throat) 9MP-DJ
 Powder Feeder set at 6.0 lb / hr

Spray Parameters	Pressure (psi)	Flow (SCFH)
Air	110	42
Oxygen	150	30
Fuel	110	68

* Some modifications to the parameters may be needed to compensate for longer hoses.

Application by Plasma Transferred Arc Welding (PTA):

There are numerous Plasma Transferred Arc Welding systems on the market and a wide range of welding parameters which can be used to produce excellent weld overlays of Colmonoy® 52-P1, 52-P2 & 52-P3 alloys.

Wall Colmonoy recommends that a pure argon plasma gas be used in combination with an argon-hydrogen shielding gas and an argon carrier gas.

Welding parameter settings will depend on the base metal, its thickness, geometry and metallurgical condition as well as the desired properties/geometry of the weld overlay and the type of PTA equipment being used.

Preheat and weld inter-pass temperature can affect the quality of the weld deposit and its wear properties.

Preheat Temperature by Class for steels					
Class	Description	up to 1/2"	1/2" to 1"	1" to 2"	Interpass
10xx	C steels	100 – 600	100 – 700	100 – 800	200 – 700
13xx	Mn steels	350 – 500	400 – 600	450 – 700	450 – 600
23xx	Ni steels	200 – 400	200 – 500	300 – 700	300 – 600
31xx	Ni – Cr steels	200 – 600	300 – 700	400 – 900	>400
32xx	Ni – Cr steels	300 – 900	400 – 1000	500 – 1100	500 – 900
33xx	Ni – Cr steels	500 – 900	600 – 1000	700 – 1100	700 – 900
34xx	Ni – Cr steels	900 – 1100	900 – 1100	900 – 1100	900 – 1100
4140	Cr – Mo steel	600	700	800	600 – 800
4340		600	800	900	700 – 900
46xx		400 – 600	500 – 700	600 – 800	≅ 600
4820		600	700	800	600 – 800
5120		100 min	200 – 300	250 – 350	≅ 300
5145		400 – 500	450 – 550	500 – 600	≅ 500
86xx		100 – 400	200 – 500	300 – 600	≅ 400
High strength alloy steels (quenched and tempered)					
A533, B		50 – 200	100 – 350	200 – 450	100 – 350
A542		150 – 300	200 – 350	250 – 450	200 – 350
HY-130		75 – 225	75 – 275	200 – 375	200 – 350

Application by Laser Cladding:

Colmonoy® 52-P2 & 52-P3 alloys produce an excellent weld overlay using various direct laser deposition instruments.

Laser cladding utilises a laser beam as a heat source to weld a surfacing material to a substrate. Surface cladding powder is delivered to the weld zone through a powder feeder with an inert gas carrier. The power level of the laser, the powder feed rate, pre-heat of the base metal, and 3-dimensional movement speeds must be balanced to produce a metallurgically bonded, low dilution, crack free, porosity free clad overlay.

Properly applied laser clad overlays can have significantly higher hardness than a corresponding thermal spray applied coating of the same material. Alloy selection for the laser cladding process should take this into consideration.

Laser cladding can be conducted in a sealed, inert environment, or in an open shop environment. In the latter case, the use of argon or helium carrier gases with argon and/or helium shielding gases are recommended. Nitrogen is not an inert gas and it is not recommended for general use in laser cladding.

Machining, Grinding and Lapping:

There are several techniques used for material removal that produce high quality finished products. Machining can be done, using cubic boron nitride tooling. Use GE's BZN compacts (such as BRNG-43T) or Kennametal's CNMA 433KC-210. Use a negative rake tool, with a 15-degree lead angle. It should have a 1.2mm (3/64-in) radius and T-land edge preparation. Set tool at centreline of work. Feed at 0.005-0.010 IPR, with depth of cut up to 3.18mm (0.125-in), at 200-300 SFM or higher.

The coatings can be machined with difficulty by carbide-tipped tools, such as Kennametal K6, Carboloy 883 or equivalent. For roughing, grind the tool with a slight lead and rake angle, and a slight radius (approx. 0.79mm (1/32")). Use a fine feed, about 0.076mm (0.003") per revolution, with a depth of cut about 0.38mm (0.015") at 15 SFPM. Set tool about 0.79mm (1/32") below centre. For finishing, grind the tool with the same slight lead and rake angles and with about a 1.6mm (1/16") radius. Use a fine feed, about 0.076mm (0.003") per revolution, with a maximum cut of 0.13mm (0.005") at approximately 45 SFPM.

Grinding is used after machining to remove the last 0.13 - 0.15mm (0.005-0.006") of material. Actually, the entire finishing is most commonly done by grinding, which eliminates machining. Grinding produces a near-frictionless mirror finish. Such smooth surfaces usually wear better, because they generate less heat and friction. Whereas a diamond wheel is preferred, green silicon carbide wheels (hardness H to K) can be used. Use 24 to 36 grit for roughing and 60 grit or finer for finishing. Grind wet when possible; do not let the wheel get loaded; dress frequently. Take light, fast cuts. (Manufacturer can provide full details for grinding.)

Dry lapping can be used to give the alloy an excellent finish. Silicon carbide, boron carbide and diamond dust are all capable of cutting the Colmonoy coating, but they must be embedded in a cast iron or steel wheel to properly lap fused deposits of Colmonoy® 52 alloys. Apply with a steady pressure and avoid overheating. If the lapping compounds are used loose, they will cut the nickel matrix before the chromium carbides, giving the surface an etched appearance.

Safety:

When handling powders do so in such a way to avoid creating a dust cloud; avoid inhalation or contact with skin or eyes. Conduct coating operations in a properly ventilated area. For more information, consult 11.8 (Ventilation), *AWS Thermal Spraying: Practice, Theory, and Application* available from American Welding Society, OSHA Safety and Health Standards available from U.S. Government Printing Office, and the manufacturer's Safety Data Sheet (SDS).

Warning: Thermal spray torches and heating torches used for application of this product utilize compressed gasses or liquid fuels including oxygen, air, flammable fuel gas, or flammable liquid fuel. Follow your employer's safety procedures when using and handling these gases and equipment. Infrared and ultraviolet radiation (light) emitted from flame and hot metal can injure eyes and burn skin. HVOF and HVAF systems can produce noise levels that can damage hearing. Use appropriate personal protective equipment.

Danger: Plasma transferred arc (PTA) welding is a welding process used for application of this product. Follow your employer's safety procedures and the equipment manufacturers instructions when PTA welding. Electric shock can kill. Properly install and ground electrical equipment prior to use. Infrared and ultraviolet radiation emitted from the hot metal or welding arc can injure eyes and burn skin. Use appropriate personal protective equipment.

Warning: Laser cladding processes may use high power levels when applying this product. Follow your employers safety procedures and the equipment manufacturer's instructions when laser cladding. Refer to AISI Z136.1 "Safe use of Lasers" and consult your employer's Laser Safety Officer regarding the proper use of personal protective equipment.

Storage Requirements:

Keep thermal spray powders in a closed container and protect against moisture pick-up. The containers should be tumbled before using the powder. If moisture is absorbed from the atmosphere, it can be removed and flowability can be restored by drying the powder, with the seal removed and lid loosened, at 66-93°C (150-200°F) for two hours prior to use.

The information provided herein is given as a guideline to follow. It is the responsibility of the end user to establish the process information most suitable for their specific application(s). Wall Colmonoy Limited (UK) assumes no responsibility for failure due to misuse or improper application of this product, or for any incidental damages arising out of the use of this material.

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b Registered trademark of Concept Alloys.*

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