WALLCOLMONOY

PRODUCT NEWS

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The Properties of Colmonoy 88 Fused Thermal Spray Coatings

Over the past 21 years, Colmonoy® 88 has become one of Wall Colmonoy's most widely used alloys. It is now our most versatile product, available in more forms than any other single product:

- Bare rod (Gas and GTAW)
- Metal Cored Mig Wire (0.045" and 0.062")
- Plasma Transferred Arc Powder (88PTA)
- High Velocity Oxy/Fuel Powder (88HV and 88DJ)
- Spray-n-Fuse Powder (88 and 88M)
- Ingot

Recently we have heard from a couple of sources that statements are being made refuting the need for a high level of Tungsten in this product. There are very specific reasons why the Tungsten, Chromium and Carbon composition ranges were set. These are illustrated in the following commentary.

Colmonoy 88 is an alloy coating material developed by Wall Colmonoy and protected under US Patent 5,141,571. This alloy was developed to provide extended service life at elevated temperatures to parts exposed to:

A. Abrasion
B. Erosion
C. Corrosion
D. Fretting
E. Galling

To achieve better properties than Colmonoy 6 or 62 the traditional Nickel, Chromium, Boron, Silicon and Carbon composition was modified, and Tungsten was introduced at a relatively high percentage (16%). The effects of these changes are relatively simple:

A. Hot hardness up to 1000°F is improved.
1. HRC 56 for Colmonoy 88
2. HRC 49 for Colmonoy 62

B. Abrasive wear resistance is improved. ASTM G-65 schedule A:
1. Colmonoy 62 volume loss = 30 mm^3
2. Colmonoy 88 volume loss = 18 mm^3

C. Hot gas corrosion and aqueous corrosion resistance is enhanced.

D. Parts coated with Colmonoy 88 last longer in service.

From a scientific perspective the metallurgy of this alloy system is slightly less simple. Each of the elements in the Nickel based alloy imparts certain properties and in combination yield the desirable properties outlined above.

Boron and Silicon lower the melting range and provide fluxing properties needed to allow the coating to be fused into a dense metallurgically bonded coating. These elements, particularly Boron are also primary hardening ingredients. Hard Boride phases can be formed with both Chromium and Tungsten.

Iron and to a degree Carbon improve the wetting properties of the alloy above its solidus temperature.

Chromium helps to widen the range between solidus and liquidus temperatures and alters the atomic structure so that a face centered cubic (austenitic type, non-magnetic) structure is achieved. It also provides for the formation of a protective chrome-oxide surface layer to form which protects the coating from many forms of corrosive media. In combination with Carbon, wear resistance is also enhanced by formation of Chromium carbides.

Tungsten plays a multi-purpose role in this alloy. In solid solution with Nickel it increases the coatings high temperature strength and provides resistance to localized corrosion (known as pitting). Like Chromium it is also a carbide former. In its role as a carbide former it serves two basic purposes:

1. To increase wear resistance due to the higher hardness of tungsten carbide versus chrome carbide.

2. To tie up some of the Carbon that would otherwise form chrome carbide so that more Chromium is left in the solid solution to enhance the corrosion resistance of the coating.

During production the alloy powder undergoes fairly rapid solidification, which retains some of the Carbon in solid solution and the balance as very finely dispersed carbides. During the spraying, and primarily the fusing process, the carbides present as meta- stable phases have time to grow and precipitate into desirable wear-resistant forms.

The carbide formation and precipitation process is governed by not only by thermodynamics - but by kinetics. That is to say that the reaction most favored by thermodynamics will not be the only one to occur. Thus Colmonoy 88 coatings contain several types of carbides which can comprise up to 50% by volume of the coating:

A. Bi-metallic carbides of Chromium and Tungsten with typical Vickers hardness of 2050.
B. Chromium carbides with typical Vickers hardness of 1600.
C. Tungsten carbides with typical Vickers hardness of 2400.

This happens because the kinetics is actually a function of both reaction and diffusion controlled mechanisms. Thermodynamics indicates that Chromium carbides are the most favored phase. Practice shows us that many other phases are also formed. For this reason we do not want Molybdenum in the alloy. Molybdenum is a strong carbide former, stronger in fact, than Tungsten. Molybdenum carbide is also softer than either Tungsten or Chromium carbide and would reduce the coatings resistance to wear.

Tungsten in solid solution with Nickel enhances both aqueous and high temperature corrosion resistance very similarly to Molybdenum. According to the ASM Metals Handbook it takes about twice the weight percentage of Tungsten to give the same corrosion resistance as Molybdenum. For this wear and corrosion resistant product the high level of Tungsten is what makes it so effective in service.

Statements made to the effect that 15 to 17% Tungsten is not needed in Colmonoy 88 are entirely false. Statements made that a lower Tungsten alloy gives the same coating longevity as Colmonoy 88 could be true for a particular application. Alloys with less Tungsten will have a greater amount of softer Chromium carbide. Unless the Chromium is significantly higher there will also be less Chromium in solid solution to form an effective barrier to corrosion.

We have seen Colmonoy 88 outperform other alloys on boiler tube sections in side by side testing. We expect Colmonoy 88 to excel in environments where hot oxidation, sulfidation and erosion are present.