WALLCOLMONOY
HI TEMP BRAZING ALLOYS

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Nicrobraz 33®: The New Filler Metal of Choice for EGRS

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In recent years, the number of diesel engines sold has increased due to their fuel economy, high torque and smoother running engine characteristics compared to earlier diesel engines. This makes them particularly attractive to private and commercial users.

To meet the requirements of present and future emission laws such as Euro 5 & 6, EGRs are commonly deployed in diesel engines to reduce the concentration of NOx. EGRs are usually brazed under high vacuum conditions using nickel-based filler metals to achieve good metallurgical bonding. During the brazing process, these BFMs provide good wetting properties on the base metal, typically stainless steels and nickel-based alloys, good high temperature properties and corrosion resistance under service conditions.

However, the varying fuel qualities in different regions of the global market make it necessary to modify the components and joining methods. As a result, further demands are required from brazing filler materials, such as enhanced corrosion resistance when deploying the parts in regions of lower fuel purity.

To save cost and improve efficiency, thinner wall structures are desirable. In these cases, boron containing filler metals have significant disadvantages because of high base metal erosion and burn through caused by lowering the localised melting point of the substrate.

The Ni-Cr-Si-P brazing filler metal range avoids this problem and improves the life-span under more arduous service conditions.

Boron Free Ni-Cr-Si-P Nicrobraz® Material Characteristics

The chemical composition, melting properties and recommended brazing range of boron free Ni-Cr-Si-P materials are presented in

Ni-Cr-Si-P brazing filler metal alloy nominal chemical compositions.

Brazing Filler Metal	Ni wt%	Cr wt%	Si wt %	P wt %
Nicrobraz® 31	Bal	22.0	6.5	4-4.5
Nicrobraz® 33	Bal	29.0	6.5	6.0
Nicrobraz® 152	Bal	30.0	4.0	6.0

DTA analysis from Ni- Cr-Si-P brazing filler metal powders showing the solidus and liquidus estimations.

	Solidus (heating/ cooling)	Liquidus (heating/ cooling)	Solidus (heating/ cooling)	Liquidus (heating/ cooling)
	°F		°C	
Nicrobraz® 31	1805°/1783°	1976°/1972°	985°/973°	1080°/1078°
Nicrobraz® 33	1815°/1779°	1879°/1862°	991°/971°	1026°/1017°
Nicrobraz® 152	1805°/1792°	1933°/1944°	985°/978°	1056°/1062°

Recommended brazing temperature for the Ni- Cr-Si-P brazing filler metal powders.

Alloy	Recommended brazing range	
	°F	°C
Nicrobraz® 31	2000 - 2200	1093 - 1204
Nicrobraz® 33	1950 - 2150	1066 – 1177
Nicrobraz® 152	1950 - 2100	1066 - 1149

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Boron Free Ni-Cr-Si-P Nicrobraz® BFM's for Automotive Application

European manufacturers of EGRs have selected as the new filler metal of choice for EGRs.

In internal test programs, demonstrated exceptional wetting characteristics and gap filling properties. The corrosion resistance was evaluated using a dip and dry test program to simulate the aggressive automotive exhaust gas environment and service conditions. The testing program produced life times in excess of the specified 1000 hour target.

Nicrobraz® alloys, including **Nicrobraz® 33**, can be tailored to customer specific application methods such as screen printing, syringe and spray deposition. This is essential to optimise brazing process efficiency. An example of a brazed 316L T-piece specimen using **Nicrobraz® 33** is presented in **Figure 1**.

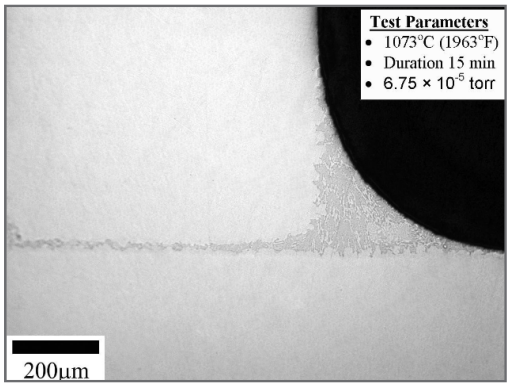

Figure 1: 316L stainless steel brazed T-piece cross section; (x100 magnification)

Nicrobraz® filler materials such as **Nicrobraz® 33** are typically used to braze stainless steel and nickel based components in a vacuum environment. However, in order to improve productivity, brazing filler metals such as **Nicrobraz® 33** have been successfully used in continuous belt-furnaces under protective atmospheres. The melting range of these alloys makes them particularly suitable to form leak-free braze joints at lower brazing temperatures.

Independent tests using **Nicrobraz® 33** produced very consistent results demonstrating good wetting, gap filling, strength and corrosion resistance properties confirming results from Wall Colmonoy's development [1]. It has been established that even under wide gap conditions (0.011" (~0.28mm)) (**Figure 2**), good wetting, gap filling and microstructural properties were observed with low levels of continuous brittle intermetallic phases.

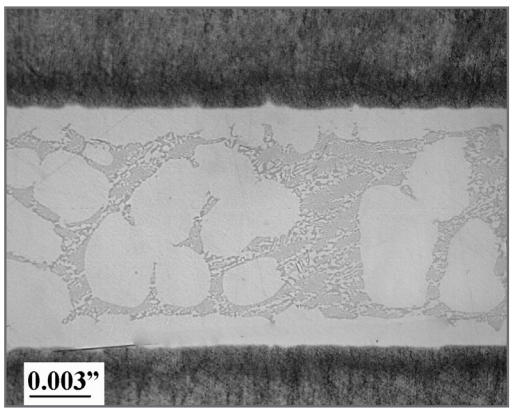

Figure 2: Nicrobraz® 33 section from variable clearance test showing brazed joint of approximately 0.011" (~0.28mm).

Spreading ratios may also be used [2] as an indication of wettability. **Nicrobraz® 33** produced a spreading ratio in excess of 40% (**Figure 3**) which shows excellent wettability characteristics that correspond to the gap filling performance outlined in **Figure 2**.

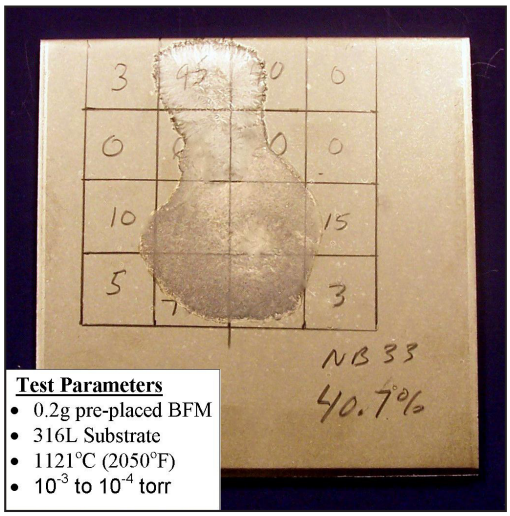

Figure 3: Nicrobraz® 33 Wetting Test Result

Ultimate tensile strength testing of **Nicrobraz® 33** in both butt and lap joint configurations produced strengths in excess of 36 and 44 thousand PSI (248MPa and 303MPa) respectively (**Figure 4**).

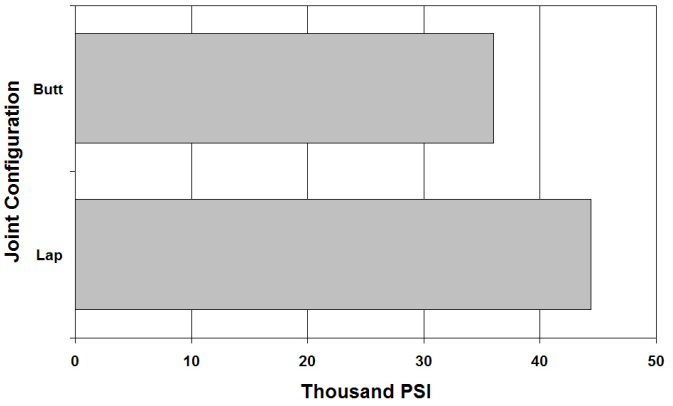

Figure 4: Nicrobraz® 33 Ultimate Tensile Strength Performance.

Compared to two other boron-free nickel-based filler metals, **Nicrobraz® 33** demonstrated the best corrosion resistance attributable to its relatively high Silicon and Chromium content (both of which have been identified as improving corrosion and oxidation resistance [3]). The results are presented in **Figure 5**.

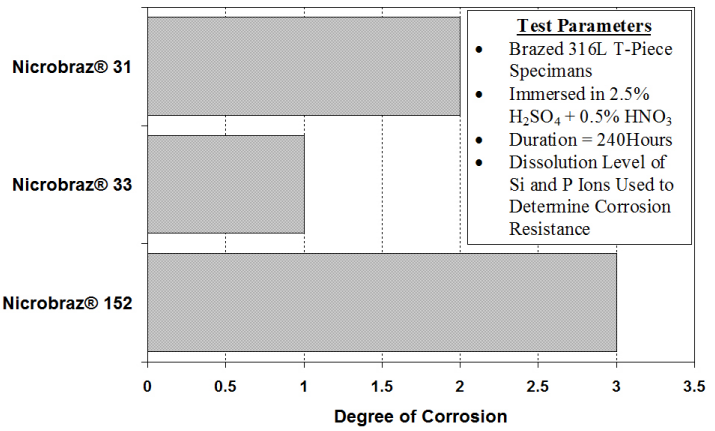

Figure 5: Ni-P-Cr-Si Brazing Filler Metal Corrosion Performance.

References

1. Evolution of High Temperature Nickel Brazing: New Filler Metals for The 21st Century, G.C. Stratford, A.J. Battenbough, L. Lee, M. Weinstein, Wall Colmonoy Corporation.

2. Characteristics of a newly developed nickel brazing filler metal, Tanaka, Hidake, & Nagai presented at 2000 Powder Metallurgy World Congress, November 2000.

3. "Development of Nickel-Chromium-Silicon Base Filler Metals" E. Lugscheider, O. Knotek and K. Klohn, Weld-ing Research Supplement, October 1978, pp 319-323

About Wall Colmonoy

Wall Colmonoy joins parts for high-temperature and corrosion applications using **Nicrobraz®**, **Niferobraz®**, and **Cubraz®** brazing filler metals and brazing aids.

Wall Colmonoy is the pioneer of high-temperature brazing. In 1950, their expert brazing engineer, Bob Peaslee, invented a new brazing technology involving nickel-based filler metals and hydrogen atmosphere furnaces. They named this new filler metal, **Nicrobraz®**.

Today, **Nicrobraz®** and the family of **Nicrobraz** (**Niferobraz®** and **Cubraz®**) brazing filler metals are used in a variety of industries including aerospace, oil & gas, steel, energy, food, auto, rail and defense industries meeting AWS, AMS, G.E., Honeywell, Pratt & Whitney and Rolls-Royce specifications. Available as powder, rods, paste, transfer tape and sheets, binders and pastes and in a full range of sizes and specifications. Wall Colmonoy also custom formulates brazing filler metals to meet customer requirements.

Aerobraze Engineered Technologies is a division of Wall Colmonoy that manufactures aerospace engineered components. Providing collaboration with customers taking concept to design to prototype to production. Specializing in applications for aerospace using the processes of brazing, surfacing, welding, thermal processing, fabricating, machining and overhaul.

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