



Guide for repair of a deep eroded wear on martensitic stainless steel CA-6NM or X5CrNi 13 4									
Base metal Martensitic stainless steel		Filler alloys Castolin 33700 stick electrode (E309L) CaviTec SMA stick electrode				Filler Classification: AWS A5.9 Class ER309L and CaviTec SMA			
Welding Process MMA		Shielding Gas		Feed Rolls		Welding Position All Positions except vertical down			
Complete penetration		NDT: Liquid Penetrant		Preheating min: 50°C ER309L – 100°C CaviTec Maximum and interpass temperature: 200°C					
Joint Preparation					Layers sequence				
Filler	No of Layers	Wire Ø mm	Current (A)	Polarity	Wire Speed lpm m/min	Weld Speed mm/s	Stickout mm	Linear energy J/cm	Torch angle (degrees)
Castolin 33700	1 to 4	2,5	55-75	+					0 to 15
Castolin 33700	1 to 4	3,2	70-95	+					0 to 15
Cavitec SMA	5,6,7	3,2	100-140	+ For PE AC(~) Or (-)					0 to 15

Notes :

Cushion Layer of Castolin 33700 (309L)

In order to reduce the porosity, do not put more than 2 layers of CaviTec. The more the layers, the more the porosities and the bigger they are. Fill up with 309L and keep 6 mm to add 2 layers of CaviTec;

It is important to determine whether there are cracks or porosities:

Porosities in reasonable quantities with Cavitec is rather normal and usual;

Post Weld Heat Treatment:

No post weld heat treatment has been performed on turbines repaired on site. Experiment of heat treatment (590-620°C) on coupons of Cavitec welded on CA6NM showed no reduction of cavitations'

resistance, but a reduction of the bending angle to 15° in comparison to 20° to 40° on non heat treated samples have been observed.

Repair of a deep eroded wear (> 10mm) on a martensitic stainless steel CA-6NM / or 13/4

1) Identify the area to be repaired;

2) Gouging;

- A) Remove all spongy or pitted metal by arc air gouging with a flat carbon electrode or with plasma gouging torch
- B) Gouged zone must exceed around 25mm the eroded zone to prolong the service life
- C) As illustrated on the sketch of the surface preparation, the gouging of the edges must be done to provide 60° angle minimum;
- D) Grind to white metal all gouged areas to remove splatters, oxidized or carburized layer and all copper traces;

3) Preheat

A preheat of the zone to repair of 100°C is mandatory for the following reasons:

Eliminates moisture and related hydrogen embrittlement of base metal

Reduce risk of porosities

Reduce residual stress

Improve MMA welding

A preheat before gouging is also recommended

Keep interpass temperature between 100 and 200°C

4) Filler material

On the surface where erosion wear is deep (>10mm) on the martensitic steel CA-6NM or 13/4 a cushion layer of Castolin 33700 (E309L) thick enough but allowing a Cavitec layer thicker than 6 mm (two passes). No peening is necessary on both 33700 and Cavitec SMA.

5) Grinding

On large surface to repair, use a template to retrieve the original profile. Use Zirconium grinding disc

6) Quality control

A) Visual inspection on the whole repair and verify the regularity of the profile

B) Perform a liquid penetrant test on zones where cracks are anticipated

C) The forman provide a brief report with the following details:

Repair duration

Gouging, welding and grinding duration

Quantity of filler alloy required

Quality Control results

Castolin Eutectic disclaim all subsequent life of this piece of given in good faith to assist the



responsibility for welding and equipment. This information is customer in his undertaking.

Guide for repair of shallow erroded wear (< 10mm) on a martensitic stainless steel CA-6NM or X5CrNi 13 4										
Base metal Martensitic stainless steel		Filler alloys CaviTec SMA stick electrode				Filler Classification: AWS A5.9 Class ER309L and CaviTec SMA				
Welding Process MMA		Shielding Gas		Feed Rolls		Welding Position All Positions except vertical down				
Complete penetration		NDT: Liquid Penetrant		Preheating min: 100°C CaviTec Maximum and interpass temperature: 200 °C						
<p style="text-align: center;">Joint Preparation</p>					<p style="text-align: center;">Layers sequence</p>					
Filler	No of Layers	Wire Ø mm	Current (A)	Polarity	Wire Speed lpm m/min	Weld Speed mm/s	Stickout mm	Linear energy J/cm	Torch angle (degrees)	
Cavitec SMA	1,2	3,2	110-140	+ For PE AC(~) or (-)					0 to 15	

Notes :

It is important to determine whether there are cracks or porosities:

Porosities in reasonable quantities with Cavitec is rather normal and usual;

Post Weld Heat Treatment:

No post weld heat treatment has been performed on turbines repaired on site. Experiment of heat treatment (590-620°C) on coupons of Cavitec welded on CA6NM showed no reduction of cavitations' resistance, but a reduction of the bending angle to 15° in comparison to 20° to 40° on non heat treated samples have been observed.

1) Identify the area to be repaired;

2) Gouging;

A) Remove all spongy or pitted metal by arc air gouging with a flat carbon electrode or with plasma gouging nozzle; grinding can be used as well

B) Gouged zone must exceed around 25mm the eroded zone to prolong the service life

Moreover, it has to be deep enough to allow a build up thicker than 6mm (\approx two passes).

C) As illustrated on the sketch of the surface preparation, the gouging of the edges must be done to provide a 60° angle minimum;

D) Grind to white metal all gouged areas to remove splatters, oxidised or carburized layer and all copper traces;

3) Preheat

A preheat of the zone to be repaired of 100°C is mandatory for the following reasons:

Eliminates moisture and related hydrogen embrittlement of base metal

Reduce risk of porosities

Reduce residual stress

A preheat before gouging is also recommended

Keep interpass temperature between 100 and 200°C

4) Filler material

On the surface where erosion wear is shallow ($>$ 10mm) on the martensitic stainless steel CA-6NM, apply Cavitec layer thicker than 6mm (\approx two passes). No peening is necessary on CaviTec.

5) Grinding

On large surface to be repaired, use a template to retrieve the original profile. Use Zirconium grinding disc.

6) Quality control

A) Visual inspection on the whole repair and verify the regularity of the profile

B) Perform a liquid penetrant test on zones where cracks are anticipated

C) The forman provide a brief report with the following details:

Repair duration

Gouging, welding and grinding duration

Quantity of filler alloy required

Quality Control results

Castolin Eutectic disclaims all responsibility for welding and subsequent life of this piece of equipment.

This information is given in good faith to assist the customer in his undertaking.

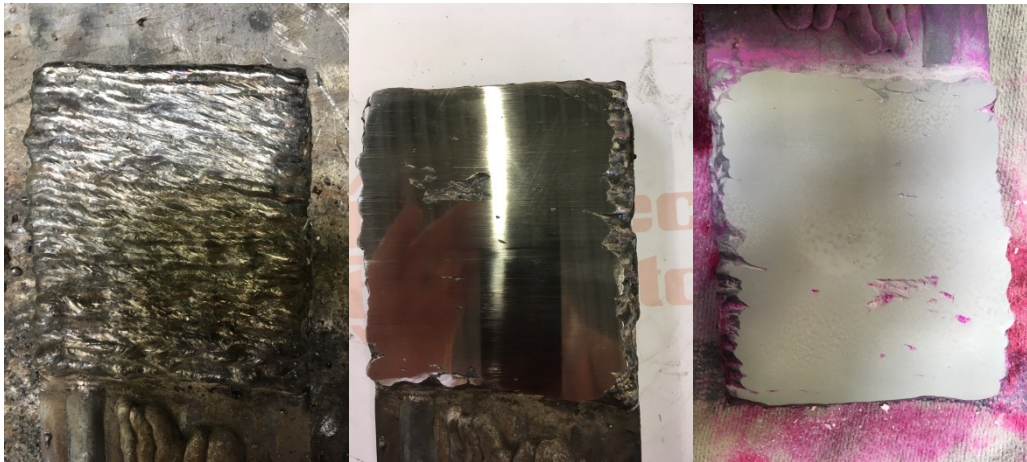
Cavitec layer with low porosity

Welding test with Cavitec SMA 3,2mm done 09.11.2016 in Austria

Mild steel plate was buffered with E309L stick rod, 2 layers, both with 100 A, DC(+), welding position PA.

On this cushion layer another 2 layers with Cavitec SMA 3,2mm welded in PF. Best result achieved with AC current (CastoTig in MMA mode used) Electrodes dried overnight in oven at 350 °C. Every layer tested for porosity with penetration test.

1st layer Cavitec SMA



2ns layer Cavitec SMA



So welding with old transformator power source with AC current or with CastoTig with MMA AC setting is giving good result without porosity for Cavitec SMA instead DC (+).