Recent Experience with Stainless Steels in FGD Air Pollution Control Service

Lewis Shoemaker,

Dr. Deba Maitra,

Jim Crum

Special Metals Corporation, Huntington, WV

Overview

- Some recently constructed flue gas desulfurization (FGD) air pollution control systems have experienced severe corrosion problems after short term operation, in some cases in less than one year.

- To better understand the corrosive attack and the conditions under which various materials may be used, operating systems were examined and both laboratory and field tests were conducted.

Overview

Materials used for components of wet limestone flue gas desulfurization (FGD) air pollution control systems

- Non-metallic Material (Coatings)- disbonding
- Ceramic Materials (Acid Brick)- installation inadequate
- Austenitic Stainless steel (316L, 317L, 904L)- pitting and crevice corrosion
- Titanium Alloys- Fluoride attack
- Ni Alloys (Alloy 400, 825 and and Alloy 20)- inadequate
- NiCrMo Alloys (C-276)- Expensive
- Duplex (Grade 2205) and super-duplex (Grade 2507) stainless steel- severe corrosion
- Super Austenitic stainless steel (Alloy 27-7Mo)- improved performance, Lower cost than C-276

FGD chimney flues fabricated from solid NiCrMoNb alloy 625 plate

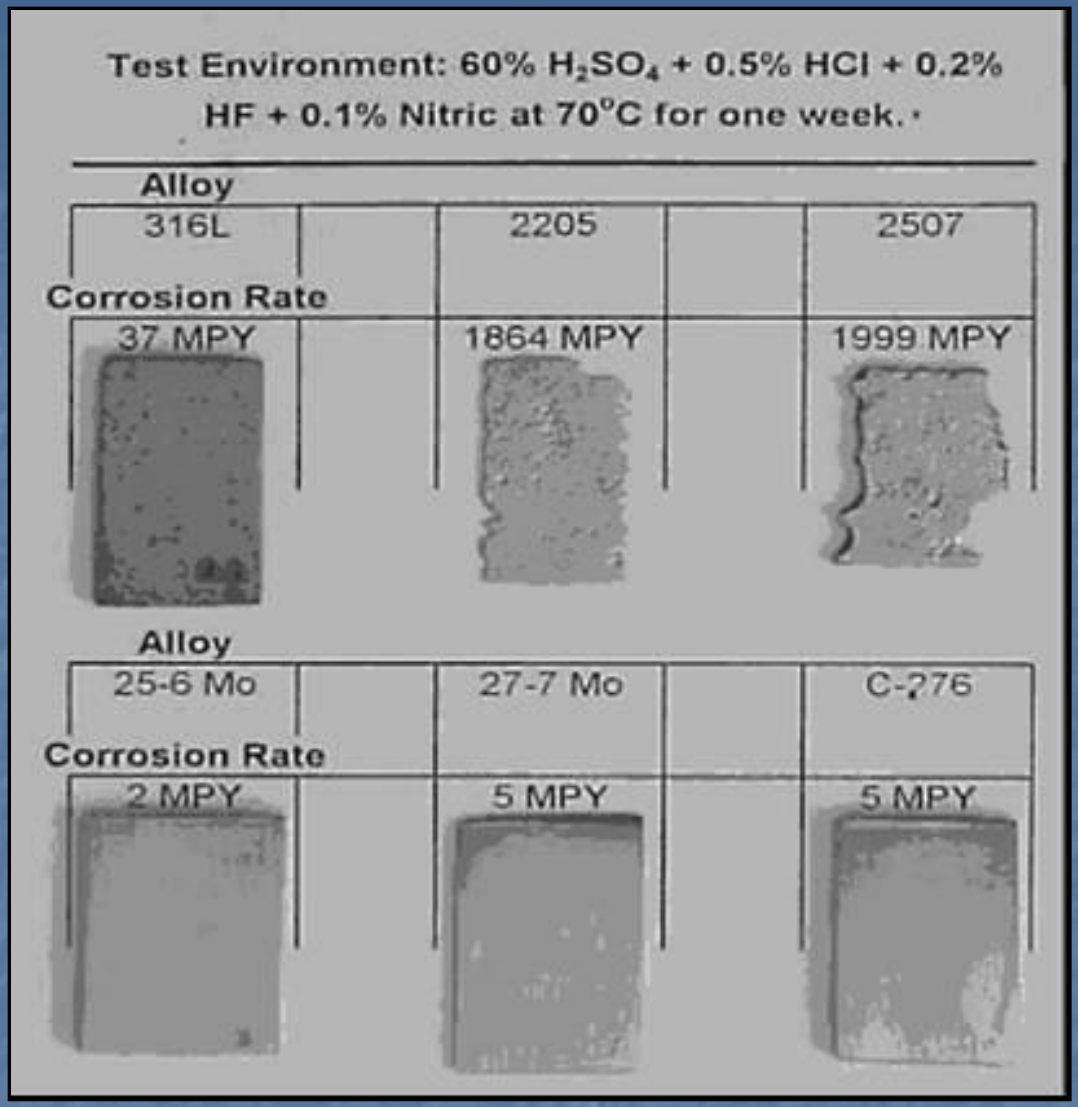
Laboratory Testing

Duplex, super-duplex, super-austenitic steels and a nickel-base alloy were tested in a simulated aggressive FGD environment

- Solution 1 – 60% H_2SO_4 + 0.5% HCl + 0.1% HF + 0.1% HNO_3 @ 70°C
- Solution 2 – 60% H_2SO_4 + 2.5% HCl + 0.2% HF @ 60°C

Corrosion Rates of Alloys in Laboratory-Simulated FGD Conditions

Alloy	Corrosion Rate mpy (mm/a)	
	Test No. 1	Test No. 2
NiCrMoW alloy C-276 (N10276)	5 (0.13)	3 (0.08)
Super-Austenitic 27-7MO (S31277)	2 (0.05)	7 (0.18)
Super-Austenitic 25-6MO (N08926)	5 (0.13)	8 (0.20)
Super-Duplex 2507 (S32750)	1999 (50.77)	64 (1.63)
Duplex 2205 (S31803)	1864 (47.35)	129 (3.28)
Austenitic 316L (S31603)	37 (0.94)	1465 (37.21)



Relative corrosion of samples exposed in a simulated FGD environment

Field Experience

- Two wet limestone FGD absorber vessels constructed of grade 2205 duplex steel were found to be severely corroded after only 7 months of operation.
- Appears to be result of crevice corrosion both near and away from weldments.
- One scrubber was shut down for repair

Crevice corrosion under the seal of a duplex steel entry cover of a wet limestone FGD absorber vessel after less than one year of operation

Field Testing

- one foot square test specimens of various alloys were attached to the absorber walls.

- Materials tested were
  - Nickel Base alloys:-
    Alloy C-276, Alloy 686
  - Super-austenitic stainless steels:-
    Alloy 25-6MO and alloy 27-7MO
  - Duplex stainless steel as control sample
    Grade 2205

- Prior to installation, a weld was deposited on each sample to evaluate the effect of welding

Field Testing

Duplex steel 2205

Alloy 27-7MO

Test panels exposed 7 months on the absorber vessel wall.
Mineral buildup might have resulted in crevice conditions

Field Testing

Cleaned Duplex stainless steel 2205 test panel exposed 7 months on the absorber vessel wall

Super-austenitic steel (Alloy 27-7Mo) test panel after cleaning.
No attack was found.

Alloy C-276

INCONEL Alloy 686

NiCrMo alloys test panel after cleaning. No attack was found.

Summary

- While the cost of duplex stainless steels is attractive for FGD construction, severe crevice corrosion has occurred in some absorber vessels after less than a year of operation.
- Environments similar to simulated test solutions can form under crevices or in condensing areas and are expected to have caused the recent duplex failures.
- Super-austenitic stainless steels and nickel-base alloys were resistant to the conditions that caused corrosion of the duplex steel.