Nickel Alloys Solve Corrosion Problems in Wet Limestone FGD Systems

Lew Shoemaker
Huntington Alloys / Special Metals Corporation

McIlvaine Hot Topic Hour
Corrosion Issues and Materials for APC Systems
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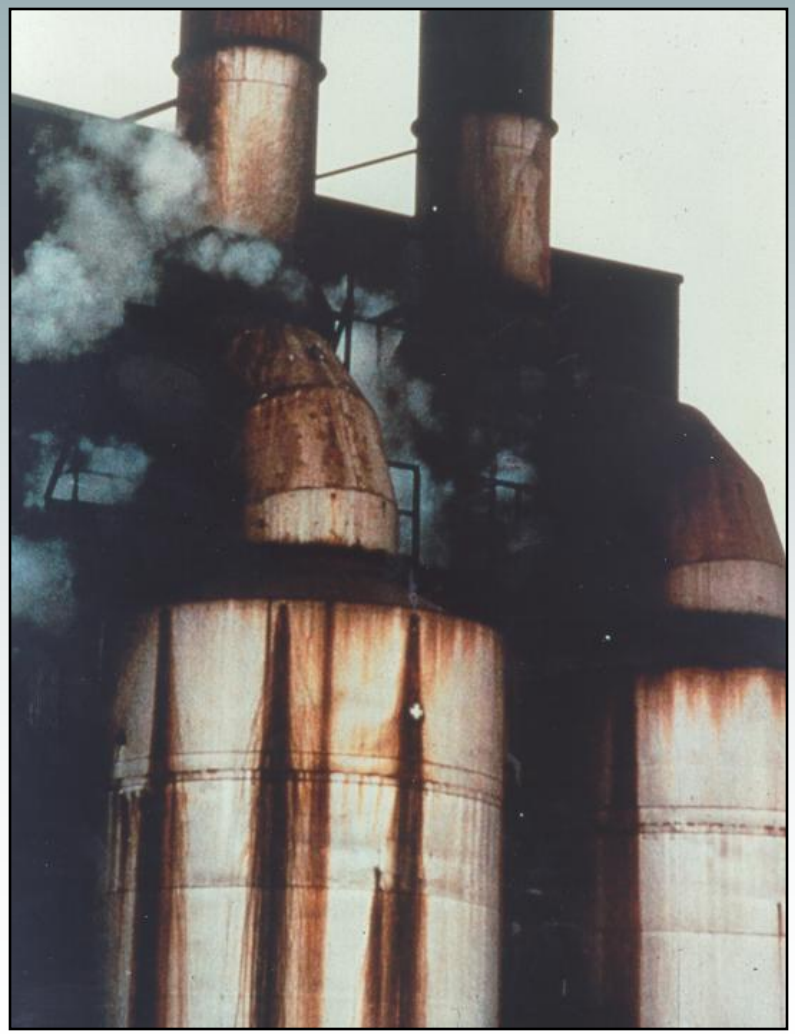
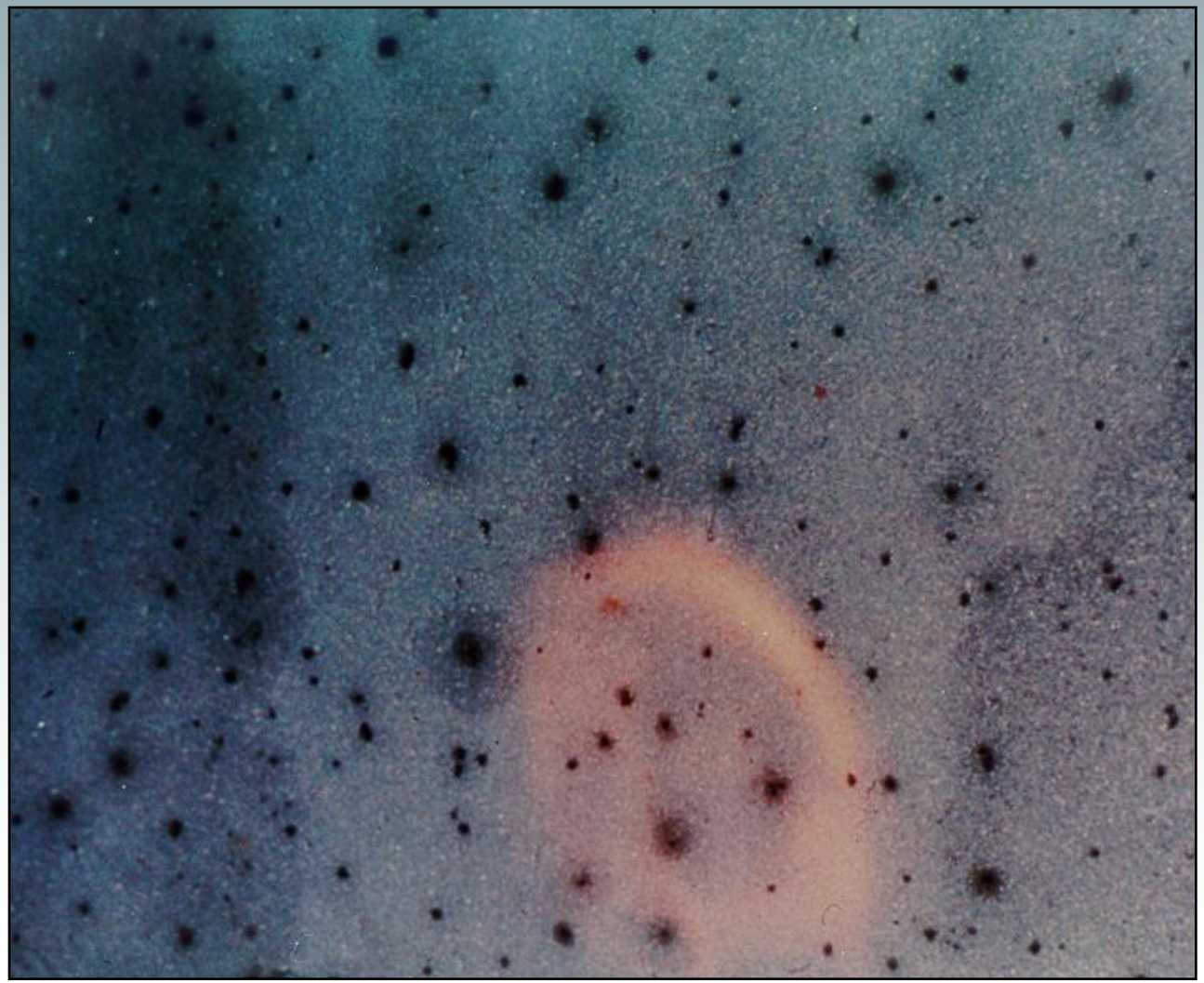
Premature Failure of Absorber Vessels due to Corrosion



Pitting Corrosion



Crevice Corrosion

Recent Absorber Vessel Construction in the USA

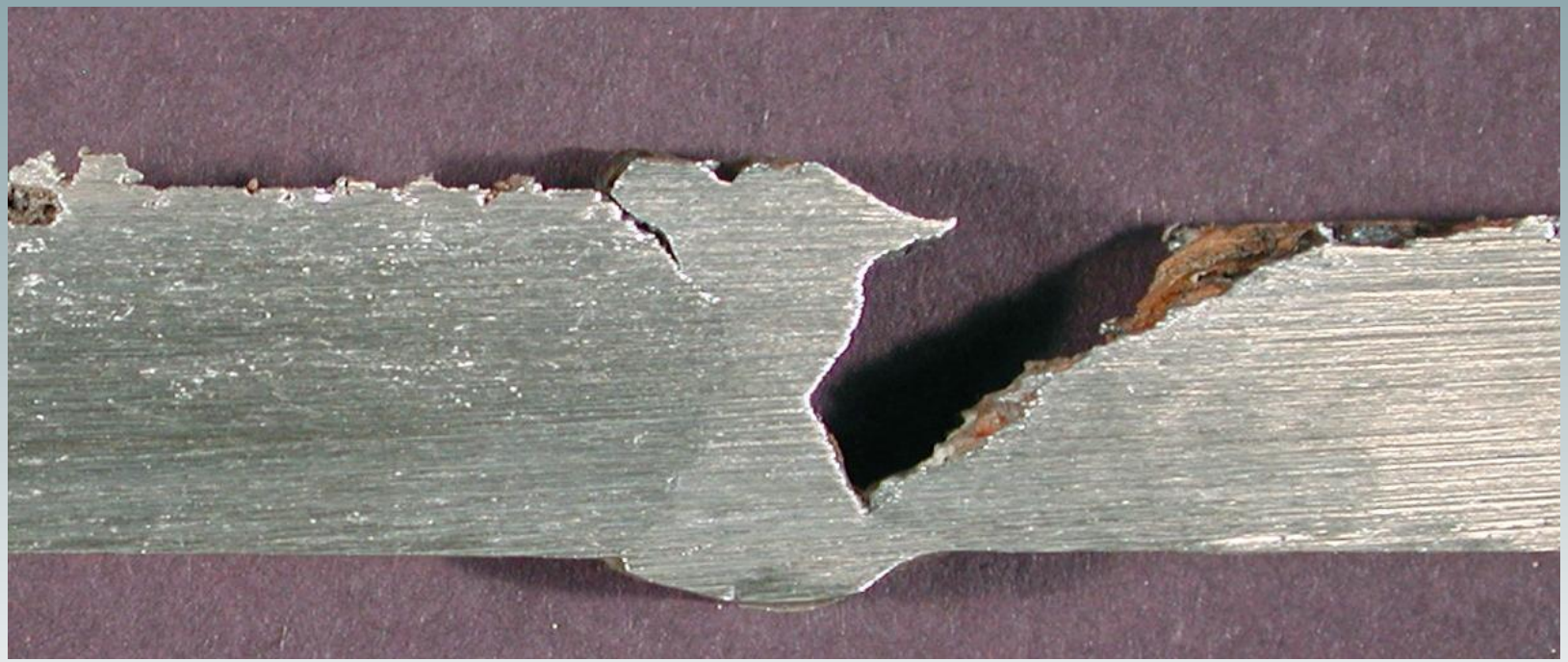
In the early 2000's the costs of nickel and molybdenum metals skyrocketed resulting in greatly increased prices for the FeNiCrMo and NiCrMo alloys and stainless steels that were then commonly used for FGD construction. As a result, approximately 85 FGD absorber vessels in the USA were fabricated from grade 2205 duplex steel plate. These vessels have suffered severe corrosion, often being perforated after one or two years of operation. Crevice corrosion has been cited as the cause of this rapid failure.

Field Experience

- **Two wet limestone FGD absorber vessels constructed of duplex steel plate were found to be severely corroded after only 7 months of operation.**
- **Severe attack was found adjacent to welds as well as away from them. Crevice corrosion was believed to be the mode of attack.**
- **One scrubber was shut down for repair. The inside of the vessel was inspected and test samples were installed.**

Crevice corrosion under the seal of 2205 duplex steel (S31803) entry cover of a wet limestone FGD absorber vessel after less than one year of operation

Crevice corrosion of duplex steel absorber wall adjacent to weld



Corroded duplex stainless steel absorber wall joined with NiCrMo 625 welding product. The weld is not attacked but the base metal is nearly penetrated.

Crevice corrosion of duplex steel absorber vessel wall located well away from weldment

Crevice corrosion of a section of the duplex steel absorber wall that appears to be weld-related, perhaps due to mineral deposit build-up by “proud” welds? The nickel-alloy welds were not attacked.

Field Testing

One foot square test specimens of were attached to the absorber walls by welding.

Materials tested were:

- **Nickel-base alloys: N10276, N06686**
- **Super-austenitic stainless steel: S31277**
- **Duplex steel (as a control sample) - S31803**

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

Duplex Steel (S31803)

Super-Austenitic Steel (S31277)

Test panels exposed 7 months on the absorber vessel wall. Mineral buildup is believed to have induced crevice condition. Note adherent black film.

Duplex steel test panel after cleaning.
Attack is evident, especially near the weld.

Super-austenitic steel (S31277) test panel after cleaning. No attack was found.

NiCrMo alloy N10276

NiCrMo alloy N06686

Alloy test panels after cleaning. No attack was found.

Laboratory Testing
Corrosion of Alloys & Stainless Steels
in a Simulated FGD Solution at 70°C (158°F)*

Alloy	2205	2507	316L	25-6MO	27-7MO	C-276
Rate (mpy)	1864	1999	37	2	5	5

*** 60% H_2SO_4 + 0.5% HCl + 0.2% HF + 0.1% HNO_3**

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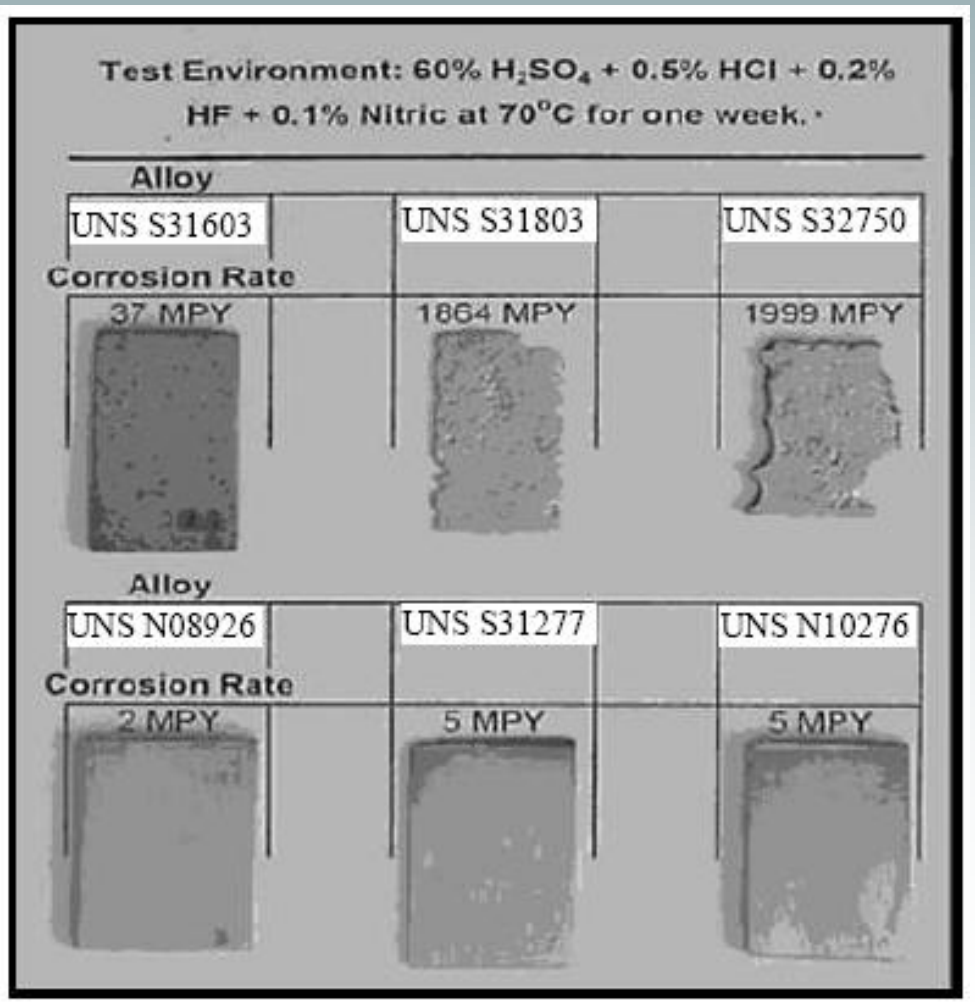


Welding Production Selection

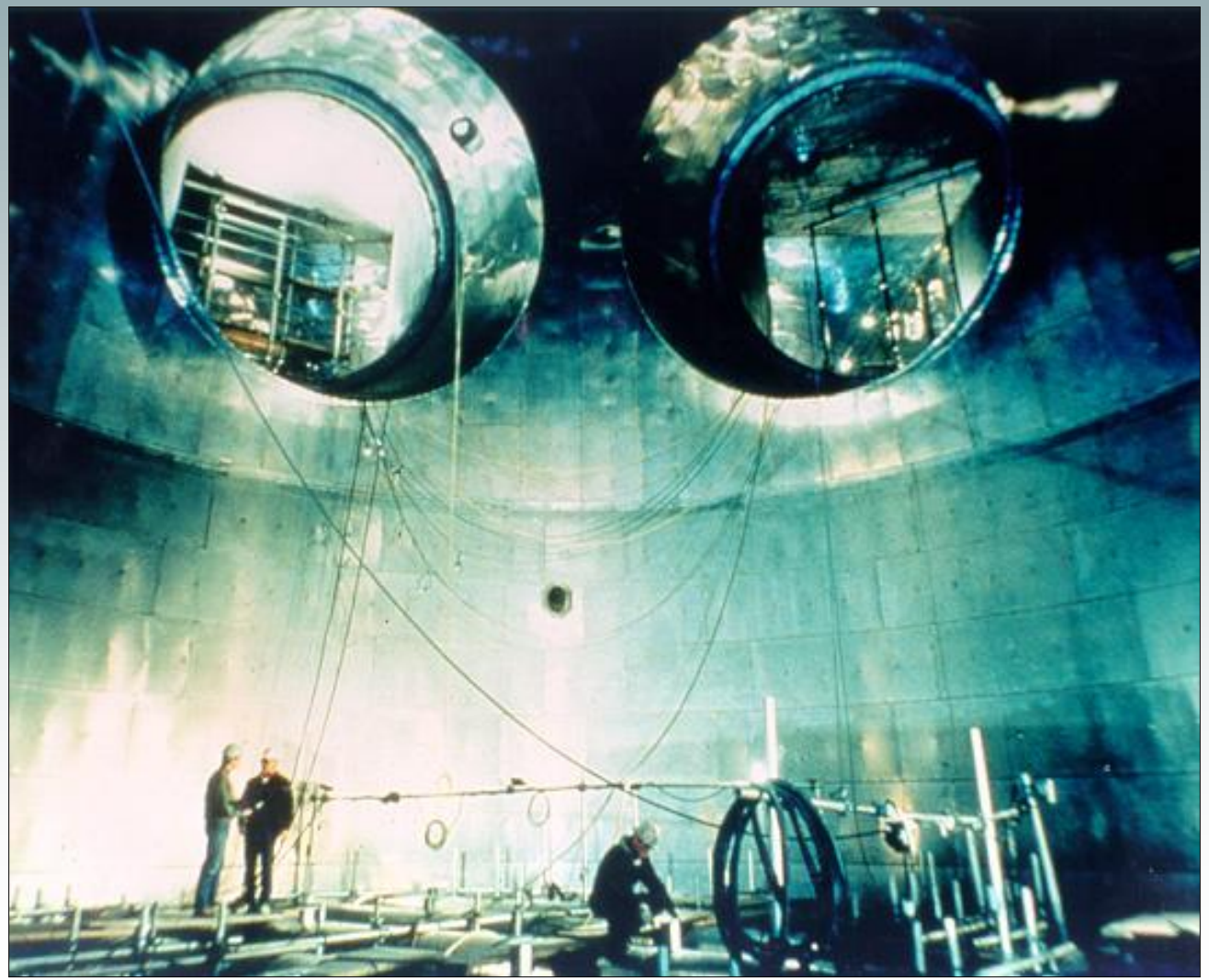
Use overmatching composition welding products to offset iron dilution & elemental segregation in NiCrMo & FeNiCrMo corrosion-resistant alloys & stainless steels.

Preferential attack of NiCrMo C-276 filler metal welds in FGD outlet duct

Overmatched NiCrMo 686 filler metal welds after six months FGD service

Super-Austenitic Steel 27-7MO (S31277) Chimney Flue at APS-Cholla Station

Nickel-Alloy, Wallpaper-Lined FGD Absorber Vessel



In Summary

Super-austenitic stainless steels offer an economical alternative to more costly nickel alloys for FGD vessel repair.

Wallpaper cladding is a viable repair scenario for corroded duplex steel absorber vessels.

Overmatching composition welding products are required to produce fully resistant welds.

Clean Air & Clear Skies