

Causes and Remedies for Titanium Corrosion in Chemical Processes

DETRIMENTAL CONDITION	POSSIBLE MODE OF CORROSION	EFFECTIVE COUNTER MEASURES
Hot, uninhibited reducing acids (HCl, HBr, H ₂ SO ₄ , H ₃ PO ₄)	General corrosion	Observe temp/conc. limits
		Add oxidizing species as inhibitors
		Select a more resistant Ti alloy (Gr. 7, 11, 16, 17, 18, 19, 20, 26, 27, 28, 29)
Metal-metal, gasket-metal, and deposit-metal crevices in hot ($\geq 75^{\circ}\text{C}$) chlorides or other halide salts	Crevice corrosion	Observe pH/temp limits
		Select a more resistant Ti alloy (Gr. 7, 11, 12, 16, 17, 18, 19, 20, 26, 27, 28, 29)
		Ennoble crevices with localized surface treatments
Hot, acidic, hydrolyzable salt solns (MgCl ₂ , CaCl ₂ , ZnCl ₂ , FeCl ₃)	Pitting, crevice corrosion	Select a more resistant Ti alloy (Gr. 7, 11, 16, 17, 18, 26, 27, 28, 29)
Smeared-in surface iron in hot brines ($>75^{\circ}\text{C}$)	Pitting	HNO ₃ /HF pickle to remove embedded iron
Hot, strongly alkaline media	Excessive hydrogen absorption and eventual embrittlement	Observe pH/temp limits
		Thermal oxidation
		Add oxidizing species
High temp oxidizing bromide media	Pitting	Select low-Fe, unalloyed Ti
		HNO ₃ /HF pickle
		Thermal oxidation
Totally anhydrous organic streams	Pitting (stress cracking in dry methanol)	Add traces of water (add >2 wt.% water for methanol)
Excessive impressed cathodic potentials	Hydrogen absorption/embrittlement	Observe potential limits, use potentiostatic control and stay noble to -0.85V in seawater or near-neutral brines
		Electrically isolate Ti component
		Protect Ti surface with polymeric coating or lining/sheathing
		Thermal oxidation
Galvanic couples with active metals in hot electrolytes	Hydrogen absorption/embrittlement	Use electrically-isolating joints/connections
		Coat the Ti (cathode) surface with a polymer
		Use compatible resistant alloys
		All Ti alloy design
Stray AC/DC currents	Anodic pitting	Ground or insulate equipment properly
Dry Cl ₂ /enriched O ₂ gas	Ignition/burning	Add moisture to chlorine (moist, wet gas)
		Observe oxygen pressure/vol.% limits
		Avoid surface damage

Ref: Table and Data developed by and reprinted with the permission of R. W. Schutz, Tel: (330) 544-7846, RMI Titanium Company, 1000 Warren Avenue, Niles, Ohio, October 26, 1998

