Molten Salt Cleaning of Titanium and Its Alloys: From Primary Metal Manufacturing to Finished Products

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What Are Cleaning Salts?

- Composed of inorganic compounds
- Become liquid due to operating temperature (400-1200°F)
- Continues to produce repeatable, consistent results even when supersaturated with reaction byproducts
- Removal of byproducts and addition of fresh chemicals allow for perpetual bath life

May be composed of any of the following:
- Alkali hydroxides
- Nitrates
- Chlorates
- Sulfates
- Halides (Cl-, F-)
Application Types

- Cleaning
  - Organic
    - Paint Removal
  - Inorganic
    - Lubricant Removal
    - Scale Conditioning/Descaling
    - Glass removal

Chemistry used is application specific
Equipment Consideration

- Custom-engineered to meet production throughput
- Robust, rugged designs provides a long service life
- Fully hooded and ventilated
- Energy efficient – compares favorably with conventional hot soak processes
- Integrated handling systems – manual or automated
- Requires minimal maintenance
Equipment Consideration

- Process lines can contain one or more salt baths
- Often contain auxiliary process under a common hood
  - Water quench
  - Hot water rinse
  - Acid neutralization/etch (H₂SO₄, HF/HNO₃, ...)
- May require waste water treatment depending on alloys processed and local water discharge requirements
Equipment - Strip Lines
Equipment - Batch Operations
Batch Animation

Integrated Work Handling System

Water Quench & Rinse Tanks

Salt Bath & Sludge Removal Zone
Ti64 As Annealed

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Ti64 Conditioned Surface

SEM

XRD

EDS
Descaling

Salt conditions hot mill scale to create a surface that is easier to clean and generates better surfaces
Descaling

The salt bath has a work zone of about 3 ft wide by 30 ft long to process the Ti helicopter blades at about 400° F.

Once clean, the blades are sent to final fabrication.
Dimensionally Stable Anodes

- Used as counter electrodes for various electrolytic processes
- Surface eventually becomes compromised and needs to be cleaned and recoated
Cleaning Forged Products

- Glass lubricant is used to protect the part during the forging process.
- Molten salt readily dissolves the glass left on the surface.
Thermal Coating Removal

Molten salts quickly dissolve the coatings for remanufacturing, forming alkali tungstates and chromates.

Examples of flame spray coating application - tungsten carbide and chromium carbide.
Molten salts quickly remove graphite or MoS$_2$ dry lubricants used in drawing and heading operations.
Paint Stripping

- Paint lines that use electrostatics to improve transfer efficiency require clean racks on each pass to maintain grounding
- Molten salts are capable of removing any paint or polymer coating.
- Typical cycle times are 10 second up to a few minutes
MRO Operations

- Provide quick cleaning for maintenance, repair, and overhaul operations
- Capable of removing grease, grime, carbon deposits, or oxide formations that results from in field service
Conclusions

- Salt bath cleaning can be used to remove a variety of surface contaminants
- Continue to produce repeatable, consistent results even when saturated with reaction byproducts
- Salt bath cleaning provides efficient and economical processing of Titanium and Titanium parts
Thank You!

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