

# **Efficacious Mitigation and Removal of Corrosion Through Non-destructive Chemical Reactions Based on Time, Temperature, Dynamics, and Concentration**

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## **MEGA WASH SOLUTIONS™**

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# White Paper on Rust Removal: Efficacious Mitigation and Removal of Corrosion Through Non-destructive Chemical Reactions Based on Time, Temperature, Dynamics, and Concentration

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## Abstract

Rust removal is a critical process in maintaining the integrity and functionality of metal components across various industries, including defense. This white paper explores the inefficiencies of traditional rust removal methods and advocates for the superior efficacy of a combined chemical dipped process enhanced with specialized ultrasonics using varying frequencies and secondary wash to alleviate environmental waste. Emphasizing this approach's advantages in efficiency, thoroughness, and preservation of the base material, this paper also integrates insights from advanced industrial systems like American Cleanforce Defense and MEGA WASH Solutions™, highlighting their transformative impact on corrosion mitigation.

## Introduction

Corrosion poses significant threats to metal components, particularly in critical sectors such as defense and manufacturing. Effective mitigation strategies are essential to maintain structural integrity, operational efficiency, and safety. The U.S. Department of Defense (DoD) incurs around \$22 billion annually on corrosion-related maintenance, underscoring the critical need for advanced rust removal techniques.

## Causes and Challenges of Corrosion

### Corrosion Causes

Corrosion results from the chemical reaction of metals with environmental factors, including:

- Moisture and water exposure
- Environmental pollutants and particulate matter
- Mechanical damage and fatigue
- Saline aerosols and sulfates

These elements accelerate the formation of rust, an electrochemical degradation process where iron reacts with oxygen and water to form iron oxides. Surface rust is commonly flaky and friable, and provides no passivational protection to the underlying iron, unlike the formation of patina on copper surfaces.

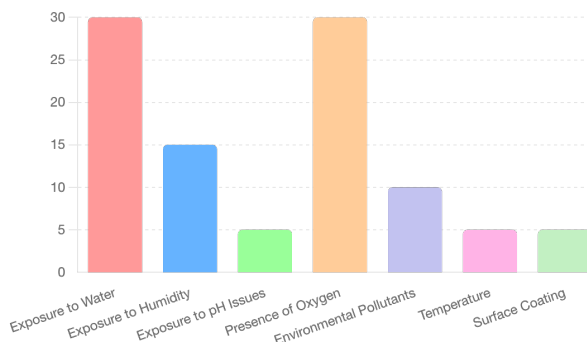
### Challenges of Rusty Parts

Rusty parts suffer from:

- Reduced structural integrity and mechanical performance
- Compromised electrical conductivity
- Spread of corrosion leading to further damage
- Increased maintenance costs and safety hazards

### TOP REASONS METALS RUST

1. **\*\*Exposure to Water\*\***: 30%
2. **\*\*Exposure to Humidity\*\***: 15%
3. **\*\*Exposure to pH Issues\*\***: 5%
4. **\*\*Presence of Oxygen\*\***: 30%
5. **\*\*Environmental Pollutants\*\***: 10%
6. **\*\*Temperature\*\***: 5%
7. **\*\*Surface Coating\*\***: 5%



## Impact on the U.S. Military

The DoD faces substantial corrosion-related challenges across its fleet of ground vehicles, aircraft, ships, and submarines, significantly impacting operational readiness and safety. Annual expenditures on corrosion-related maintenance highlight the need for more effective rust mitigation strategies.



## Inefficiencies of Traditional Rust Removal Methods

### Mechanical Methods

- **Sandblasting, Wire Brushing, and Grinding:** Effective but labor-intensive and extremely damaging to delicate parts. Observed process degrade threads, splines, and part size integrity.

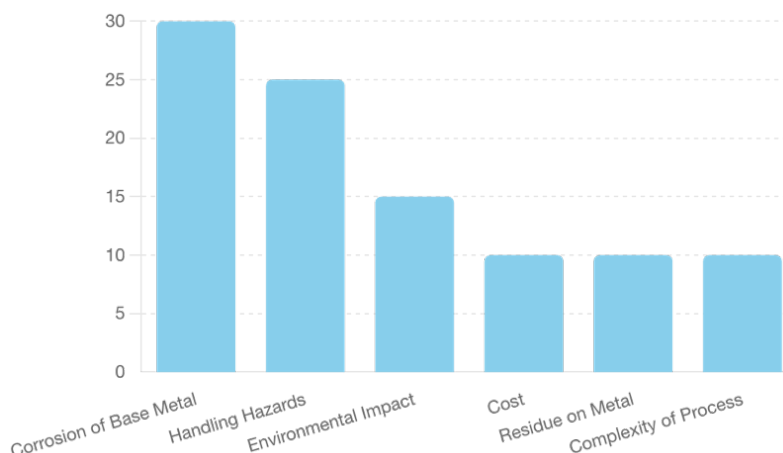
### Chemical Methods

- **Traditional Rust Converters and Removers:** Efficient but can be slow and require careful handling due to their corrosive nature. Chemicals like acid can deteriorate original metals and cause unneeded scrap when either performed incorrectly or not treated promptly and properly.

### Advanced Methods

- **Laser Cleaning:** Limited to specific areas of parts (process cannot reach into holes, around threads, in cavity areas, etc.) and is costly. Process requires specialized equipment, subject matter expertise, and constant set-up challenges.
- **Molten Salt Baths:** Molten salt baths can result in several challenges:
  - Material Compatibility Issues: Potential adverse reactions with certain metals, hostile to mixed metal parts.
  - Environmental and Safety Hazards: Toxic fumes and difficult disposal of hazardous waste.
  - Uniformity Issues: Inconsistent rust removal leading to uneven surfaces.
  - High Energy Consumption: Temperature requirement and constant 'ON' state leads to utilization uptime inefficiency and high costs for continuous operation even without parts present.
  - Complex Equipment Maintenance: Frequent maintenance needs due to harsh operating conditions.
  - Potential Over-Removal: Risk of over-removing material, compromising part integrity.

**Molten Salt Bath  
Graph of Issues**



## Best Practices for Rust Removal

### Ultrasonic Cleaning

Utilizing high-frequency sound waves (20-400 kHz) in a liquid solution to create cavitation bubbles, which produce shock waves that dislodge rust and contaminants. This method is effective for:

- **Complex Geometries:** Reaches intricate parts and small crevices.
- **Environmental Benefits:** Utilizes a specialized clean chemical solution.
- **Surface Integrity:** Gentle yet thorough, minimizing the risk of damaging underlying metals. The chemical targets only the oxidized metal on the surface, eliminating setup and timing issues common in other processes.

### Chemical Concentration and Temperature

Maintaining optimal chemical concentration and temperature ensures:

- **Reaction Rates:** Efficient chemical reactions.
- **Solubility and Stability:** Maximized effectiveness of cleaning agents.
- **Evaporation Control:** Maintains chemical availability and effectiveness.
- **Safety:** Minimizes risks associated with over-concentration or under-concentration.

### Industrial Filtration

Filtering wash solutions improves:

- **Cleaning Efficiency:** Enhanced effectiveness of the cleaning process.
- **Equipment Protection:** Prevents clogging and wear, extending equipment lifespan.
- **Quality Control:** Ensures consistent cleaning results.
- **Environmental:** Reduces hazardous waste generation by creating concentrated by-product.
- **Cost Efficiency:** Lowers operational costs and minimizes the need for re-cleaning.

## Integrated System Solution

### American Cleanforce Defense and MEGA WASH Solutions™

These advanced systems offer a comprehensive solution for rust removal:

- **Durable Construction:** Robust stainless steel and modular design for scalability.
- **Advanced Filtration:** State-of-the-art technology for maintaining solution purity. Filtration of wash fluids throughout the system creates optimal access of chemicals to metal surfaces.
- **Multi-Frequency Ultrasonics:** Alternating frequencies target both surface and intricate areas. This unique process transcends the normal ultrasonic process to simultaneously attack large, flat surfaces and holes, threads, and splines that require unique cavitation consideration.
- **Controlled Thermal Management:** Ensures optimal decontamination efficacy using heat as an enhancement while maintaining temperature range specific to the chemical solution.
- **Environmental Sustainability:** Closed-loop systems promote water reuse and minimal waste generation. The requirements of a proactive environmental impact to lessen unwanted industrial by-product can be integrated with system modularity.
- **Cleaned and Protected:** Multi-staged wash system post-ultrasonic submersion processing to remove surface chemical adhesion from parts, with added benefit to integrate a rust preventative chemical to support both time and environmental attacks while providing re-painting capabilities beyond normal expectation from other non-optimal processes.

These systems enhance maintenance efficiency, operational readiness, and safety, meeting DoD standards for hazard-free operations.

## Conclusion

Addressing corrosion is critical for maintaining the integrity and performance of metal components across various industries. The combined chemical submersed process enhanced with specialized cavitation manipulation through alternating frequencies offers a superior, non-destructive, and environmentally friendly solution. Implementing such advanced systems and best practices ensures the reliability and durability of critical assets, ultimately supporting operational readiness and safety.