

# Zerust® ReCAST - PSB

CORROSION MANAGEMENT FOR ABOVEGROUND STORAGE TANKS

## NTIC'S OIL & GAS CLIENTS

Over 17 years of providing various solutions to Oil & Gas clients that include:

- Petrobras, Brazil
- Emirates Petroleum Products Company (EPPCO), UAE
- Conoco-Philips, USA
- Shell, Malaysia
- Shell, Philippines
- Exxon-Mobil, USA
- Baker-Hughes, USA
- Halliburton, USA

## CREDENTIALS

- 30+ years of experience in corrosion prevention
- Client support in 50+ countries
- Member of API
- Chair key task group at NACE International



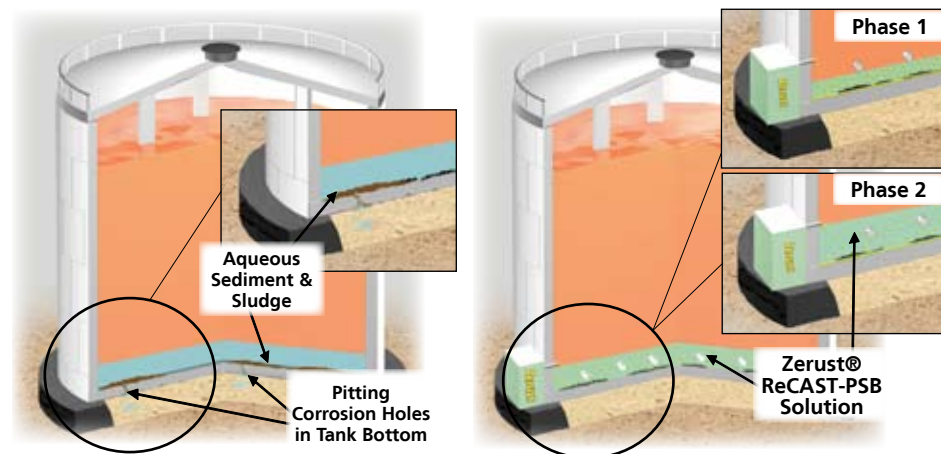
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## PREVENTION OF PRODUCT SIDE BOTTOM CORROSION IN ABOVEGROUND STORAGE TANKS (ASTs)

### THE PROBLEM

Aqueous solution sediments (e.g. water and sludge mixed with different salts and sulphur compounds) accumulating at the bottom of Aboveground Storage Tanks (ASTs) used for petroleum products cause significant corrosion damage.

Epoxy coatings currently used to protect ASTs from this corrosion problem are very expensive and these linings are known to fail when there are even tiny imperfections of the epoxy layer. Furthermore, these epoxy coatings are only designed to have a service life of 10 years, while ASTs are expected to operate for 30 to 40 years. This means that AST operators must repeatedly incur significant maintenance costs each time these epoxies are stripped off and reapplied. ASTs may also have cathodic protection (CP) systems installed internally to provide additional corrosion protection. However, since these CP systems are electro-chemical circuits that are designed to use the sediment water at the bottom of the tank to act as a conductive electrolyte, this corrosion defense is neutralized when the bulk of the sediment water is drained. At the same time, the sludge and pockets of water that remain cause localized areas of pitting and general corrosion.



### IMPACT TO TANK OPERATORS

Tank operators have to periodically stop tank operations in order to complete patchwork repairs or to replace entire bottoms. The stoppage time can come within the first few years of a tank's life (2 to 4 years), or at scheduled inspection intervals (6 to 10 years as per relevant API 650 guidelines).

#### • Hard Dollar Losses

- Labor and management resources expended for maintenance and replacement
- Cost of cleaning and certifying a tank bottom for cutting and maintenance
- High cost of reapplying epoxies
- Capital required to replace a tank bottom

#### • Intangible Costs

- Opportunity cost when tank is out of operation
- Significant loss of tank service life
- Risk of environmental impact due to leakage of stored product
- Risk of explosion and fire

## OPERATING CONDITIONS

Each AST tends to have a unique and unpredictable internal environment due to vast variations in the quality of the stored product, the ambient temperature ranges, the temperature of the stored product, the method of construction/design of the tank, and any additional systems that might be in place (e.g. agitators and/or heaters inside the tanks, coatings, CP systems, etc.). The Zerust® ReCAST-PSB system has been developed to operate in such aggressive internal corrosion environments as illustrated by the key parameters below:

Critical Corrosion Environment	Range of Values
Temperature, °C	Up to 55
pH, S.U.	4-8
Inorganic Salts, g/L	4-250*
H <sub>2</sub> S, and CO <sub>2</sub> , ppm	Up to 1000
O <sub>2</sub> , %	Up to 10

\*Summary concentration of NaCl, MgCl<sub>2</sub>, CaCl<sub>2</sub>, NaHCO<sub>3</sub>, Na<sub>2</sub>SO<sub>4</sub>

## COST IMPACT

The sedimentation of aqueous solutions (that contain a wide variety and concentration of inorganic, acidic components like hydrogen sulphide and sulphur dioxide) and sludge to the bottom of tanks causes significant general and pitting corrosion of the inside tank bottoms. The problem is further exacerbated when puddles of corrosive liquid are trapped in the sludge. Draining most of the water from the bottom doesn't mitigate the problem either, as this only raises the concentration of corrosive contaminants in the water that remains during operation and thereby accelerates corrosion damage. The resulting combination of surface and pitting corrosion is often beyond patchwork repairs, forcing the replacement of the entire bottom.

Cost Elements	US Dollars
Purging/cleaning/inspections	\$180,000
Cutting/removal of bottom and replacement	\$770,000
Application of high build glass flake polyester epoxy	\$1,500,000
Miscellaneous additional costs	\$100,000
Opportunity cost of idle tank	\$150,000
<b>TOTAL</b>	<b>\$2,700,000</b>

*Illustrative data developed for 50m diameter tank*

The high rate of corrosion means that such tanks can expect to have their bottoms replaced – or undergo significant downtime for patchwork maintenance due to pitting corrosion holes – every 10-12 years. Assuming 12 years of tank bottom life, the cost is over US\$200,000 per year per tank to tank operators.

## THE NTIC SOLUTION

NTIC has developed a comprehensive corrosion protection solution that leverages a proprietary combination of chemical inhibitors and cathodic protection (CP) systems. Standard cathodic protection systems are only effective in ASTs when the electro-chemical CP circuits are closed by the conductive electrolyte provided by the water/sludge found at the bottom of the tank. Therefore, the efficacy of a standard CP system declines dramatically when the level of electrolyte at the bottom of the tank is low. NTIC, however, has surmounted this weakness by using chemical inhibitors that work best when low volumes of water/sludge maximize their concentration.

NTIC has a proprietary inhibitor dosing system that pumps Zerust® ReCAST-PSB chemical inhibitors into the tank via a portable delivery pump when the tank is initially filled. After that, a specifically designed dose of chemical inhibitors is added to the product each time the water is drained from the tank bottom. The inhibitors do not mix with the stored product, but rather settle to the bottom of the tank where they remain until they come into contact with water. They then dissolve into the water and mitigate corrosion of the metal surface. The second part of the system is a specifically optimized sacrificial anode CP system that is installed on the product side of the bottom of the tank.

NTIC uses the complimentary characteristics of these two systems to form a highly effective solution that is patent-protected and works in the following three scenarios:

**Phase 1:**

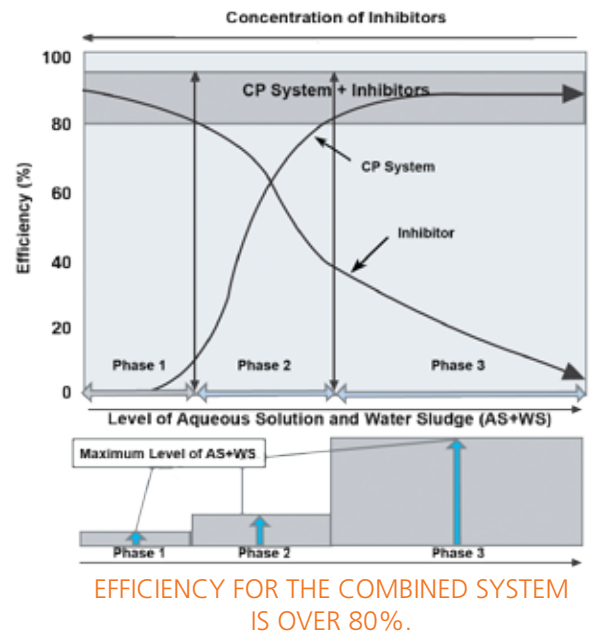
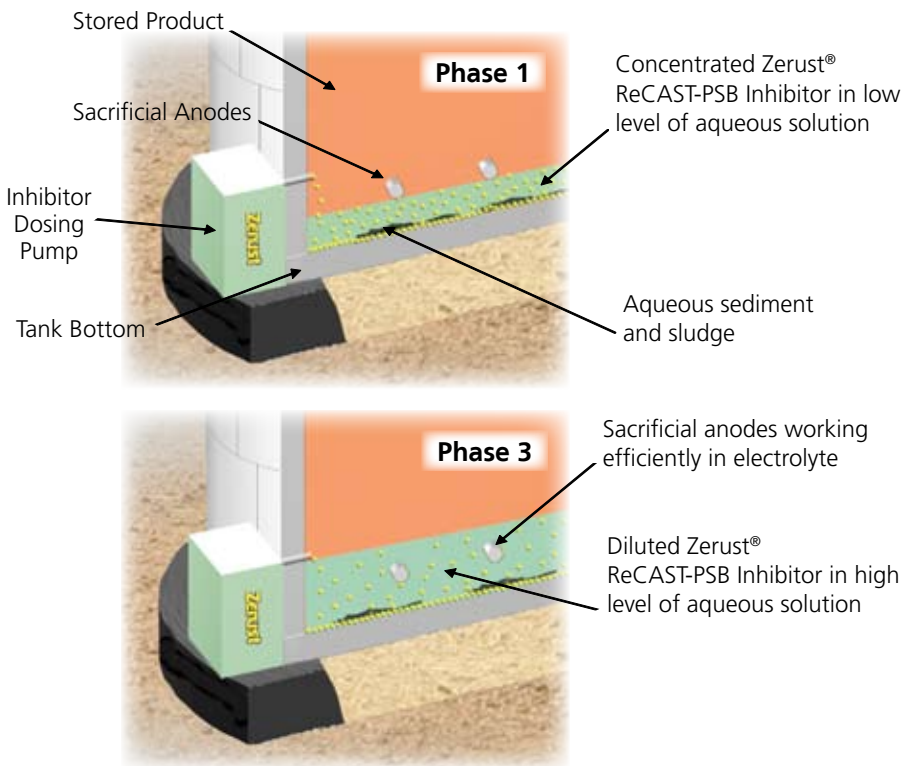
- The aqueous solution sediments and dissolves the chemical inhibitors.
- The bulk of the initial aqueous solution is drained from the tank, and the cathodic protection system can no longer provide significant corrosion protection.
- The primary corrosion protection is now being provided by the high concentration of inhibitors settled at the bottom of the tank.

**Phase 2:**

- The level of aqueous solution is increased in the tank, thereby lowering the concentration and the efficacy of the chemical inhibitors.
- The cathodic protection system can function again.
- Effective corrosion protection is provided by the combined action of the chemical inhibitors and the CP system.

**Phase 3:**

- The volume of aqueous solution increases to a level that severely reduces the concentration and efficacy of the chemical inhibitors.
- The primary corrosion protection is now being provided by the CP system.



**RISK SHARING**



NTIC monitors the effectiveness of this solution, at agreed upon inspection intervals, by measuring current leakage via sensors installed along the bottom of the tank. Tank operations do NOT need to be stopped during inspection and/or maintenance of the Zerust® ReCAST-PSB solution. The required efficacy of corrosion protection will be achieved by continually maintaining the required level of chemical corrosion inhibitors in the tank and by optimizing the electric potential of the CP system. Payments to NTIC are based on the demonstrated corrosion inhibiting results of the solution. This risk-sharing approach minimizes any upfront capital outlays by the client and ensures continued long-term support from NTIC.

## NTIC DELIVERS

NTIC, a pioneer in corrosion management, offers an innovative and unique new method to protect AST bottoms. This system addresses the limitations of alternate approaches currently being deployed and minimizes the risk of tank bottom failure. NTIC offers pay-for-performance programs with a long-term contractual relationship that minimize client risk in deploying the solution. The NTIC team can be positioned in over 50 countries across the globe to analyze corrosion issues on a case-by-case basis and optimize the solution to client-specific needs.



## FREQUENTLY ASKED QUESTIONS

### 1. How is the inhibitor introduced into an AST?

The inhibitor is pumped into the tank via a portable delivery pump when the tank is initially filled. After that, a specifically designed dose of inhibitor is added to the tank after each time the water is drained from the tank bottom. NTIC has alternate delivery systems that can be adapted to suit individual client operations requirements.

### 2. Does the inhibitor contaminate the stored product?

The inhibitor is water soluble, and typically does not mix or react with the stored product. Hence there should be no contamination issues. NTIC will work with clients on a case-by-case basis to re-evaluate this issue based on the specific tank, stored product and client contamination allowances.

### 3. How quickly does the inhibitor get depleted?

Inhibitor depletion depends on the volume of aqueous solution and/or sludge/sediment in the product stored in the tank. Typically a new inhibitor load is needed each time the water – with the old inhibitor load mixed in it – is drained. Depending on the frequency of water drainage, inhibitor can be reintroduced easily via the NTIC portable inhibitor pump or through a constant dosing station.

### 4. Can the solution be applied to old tanks or only new tanks/bottoms?

The solution can be applied to both new and old tanks – however it can only be implemented after the tank has been emptied, purged, cleaned and a new CP system has been installed on the inside tank bottom.

*Note: Other pieces of capital equipment with similar internal operating conditions (e.g. separators, underground storage tanks, etc.) can also be fitted with the Zerust® ReCAST PSB solution.*

### 5. What is the service life of the solution?

The service life depends on client requirements – but the system can be designed to last 50+ years. The frequency of inhibitor replenishment will depend on client requirements (6 months, 12 months, etc.) and shall be managed by NTIC throughout the life of the solution contract.

### 6. My current epoxy or internal cathodic protection system works just fine. Why do I need this?

Overwhelming client feedback has been that epoxy coatings work very well for 8-12 years – after that pitting corrosion starts quickly, creating holes, and the coating must be reapplied. For internal CP systems, small leaks also start within 6-10 years. These could be patched for short term fixes – but eventually bottom replacement will be required. To effect an operational life of 30-40 years, the tank operator must allow for several stoppages (some may be unscheduled) and high repair costs. The Zerust® ReCAST PSB solution comprehensively addresses all the limitations of the other systems and is the best available long-term choice.

### 7. What is the cost to deploy this solution?

The system pricing depends on multiple factors. The inhibitor formulation and the CP design need to address the corrosive nature of the product, aqueous solution sediment, and other factors generated by the application conditions and the operating environment. The service life required by the client, the size of the tank, the material of the tank bottom, etc. are all considerations that affect the price. Clients can expect significant savings on their lifetime cost to maintain/replace tank bottoms.

