



## Scav-Ox<sup>®</sup> II Catalyzed 35% Hydrazine Solution for Corrosion Protection in Industrial Boilers

Most corrosion in boilers and related equipment is due to dissolved oxygen carried into the steam generating system with the feedwater. Elimination of dissolved oxygen is usually accomplished by a combination of deaeration equipment and chemical treatment with oxygen scavengers. The scavengers most commonly used are sodium sulfite and hydrazine.

Scav-Ox<sup>®</sup> \* II is a catalyzed hydrazine: Its reaction speed with oxygen is much faster than that of plain hydrazine and more or less equal to that of catalyzed sodium sulfite (depending upon temperature, pH and concentration). It provides better corrosion resistance than either.

Scav-Ox II is recommended for control of oxygen corrosion in those feedwater systems where the slower reaction time of uncatalyzed hydrazine results in unsatisfactory protection, or where the dissolved solids introduced by sodium sulfite cannot be tolerated.

Since Scav-Ox II contains no inorganic solids, it is well suited for the treatment of steam, steam condensate and deionized feedwater, even when the feedwater is used to desuperheat steam. It may also be used for wet lay-up of boilers.

### Characteristics of Oxygen Scavengers

The ideal oxygen scavenger must have two primary capabilities. First, it should react with oxygen as quickly as possible. Second, it must also build and maintain a uniform magnetite barrier on internal surfaces.

In addition, the ideal oxygen scavenger should not decompose to form corrosive products. It should not affect water purity by contributing potentially harmful dissolved solids. It should also be compatible with other boiler treatment chemicals.

Catalyzed sodium sulfite reacts rapidly with dissolved oxygen, even at comparatively low water temperatures. For this reason, it is frequently used in systems with poor mechanical deaerators and low feedwater temperatures. However, such use leads to other problems.

Sodium sulfite contributes dissolved solids (sodium sulfate) to the boiler water. It decomposes into corrosive products above 282 °C (540 °F), which corresponds to about 950 psig of saturated steam. Comparatively large residuals of sodium sulfite are required to form and maintain the magnetite barrier which protects steel surfaces.

Plain hydrazine removes oxygen more slowly than sodium sulfite at low water temperatures. However, it contributes no dissolved solids to the boiler water (its reaction products are water and nitrogen). It does not form acidic decomposition products which are corrosive to boiler steel. Only a small residual of hydrazine is required to maintain passivation of internal steel surfaces.

Scav-Ox II combines all the inherent advantages of plain hydrazine with the fast reaction speed formerly found only in sodium sulfite. It thus provides all the attributes of the ideal oxygen scavenger.

### Scav-Ox II Catalyzed Hydrazine

Scav-Ox II is a 35% aqueous solution of hydrazine (N<sub>2</sub>H<sub>4</sub>) containing a small amount of an organic catalyst. The catalyst accelerates oxygen removal to rates more or less comparable to sodium sulfite (depending on temperature, pH and concentration).

**Table 1**  
**Typical Properties**

Form	Aqueous solution
Hydrazine (min % by weight)	35.0
Catalyst (% by weight)	0.2
pH, 1% solution	10.4
Density @ 25°C (77°F) (g/ml)	1.02
(lb/gal)	8.51
Viscosity @ 25°C (77°F) (cp)	1.403
Boiling Point @ approx. 760 mm Hg	
(°C)	109.4
(°F)	229
Flash Point	None
Solubility in Water	Completely miscible
Color	Light pink to light orange <sup>a</sup>

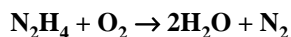
The level of dissolved solids resulting from the use of Scav-Ox II is relatively insignificant. The organic catalyst in a typical dosage of 0.2 ppm of Scav-Ox II introduces less than 1 ppb of organic solids.

<sup>a</sup> The color of Scav-Ox II may darken in time. This color change does not affect its performance.



### How *Scav-Ox II* Combats Corrosion

*Oxygen Removal:* Hydrazine reacts with oxygen according to the following equation:



The reaction products are water and inert nitrogen which is carried over with the steam. Because it is catalyzed, *Scav-Ox II* overcomes the conventional objection to the use of plain hydrazine: slow reaction rate at lower temperatures.

*Magnetite Formation:* Magnetite forms gradually as an adherent, protective, black iron oxide coating ( $\text{Fe}_3\text{O}_4$ ) on feedwater and boiler surfaces exposed to low levels of hydrazine (plain or catalyzed) over extended periods. This reaction can occur below the normal boiling point of water.

Hydrazine also forms magnetite by reducing red iron oxide ( $\text{Fe}_2\text{O}_3$ ):



The process of magnetite formation, both as an adherent coating on the metal and in the conversion of loose rust, continues as long as a hydrazine residual is maintained in the feedwater and in the boilers.

This process also keeps surges of oxygen caused by temporary operational upsets under control. These surges oxidize the magnetite to ferric oxide (rust). But residuals of oxygen scavenger maintained in the water will repair the magnetite by reduction of rust back to magnetite. Loose rust is also reduced to dense particles of magnetite which separate and can be removed easily in the blowdown or in the bottom header.

Hydrazine begins to reduce rust above about 138°C (280°F) and is not affected by elevated temperatures. Sodium sulfite reduces rust only in the narrow range from about 221°C to 282°C (430°F to 540°F). Above this, sodium sulfite decomposes into corrosive sodium sulfide and sulfur dioxide.

### Corrosion Inhibition Test Results

Tests were performed on mild steel and copper to measure corrosion rates for *Scav-Ox II*, plain hydrazine and catalyzed sodium sulfite. Test specimens were placed in the feedwater system of an industrial steam boiler operating at 300 to 400 psig and generating steam at a rate of 2-3 million pounds per day.

The oxygen scavengers were fed to the storage sections of two Cochrane spray deaerator heaters. A bleedline supplied

treated feedwater to the test arrangement at a temperature of 107°C (225°F).

Clearly, *Scav-Ox II* functioned as a superior control agent on both metals. Compared with sodium sulfite treatment, the corrosion rate of mild steel was reduced by approximately 31% and the corrosion rate of copper was reduced by about 60%. Plain hydrazine also performed better than sodium sulfite, though not as well as *Scav-Ox II*.

### Areas of Application

*Feedwater Systems:* *Scav-Ox II* is recommended as the oxygen scavenger for treatment of high-purity feedwaters. These include feedwater used in the desuperheating of steam and feedwater for high pressure steam generating systems. Such feedwaters may require a reactive oxygen scavenger because of oxygen corrosion problems in the preboiler systems, but may be able to tolerate only very small amounts of dissolved solids.

Feedwater, lines, preheaters and economizers can be protected by the addition of *Scav-Ox II* to the feedwater storage tank or to the storage sections of deaerator heaters. A typical dosage of 0.2 ppm of  $\text{N}_2\text{H}_4$  (0.57 ppm *Scav-Ox II*) contributes only a little over 1 ppb of dissolved catalyst to the system.

*Condensate Systems:* Leakage of air into condensate systems may require treatment of the condensate with an oxygen scavenger. Because of the comparatively low temperatures of condensates, plain hydrazine would react too slowly. Because the condensate is returned to the boiler feedwater in most systems, dissolved solids must be kept to a minimum - thus ruling out sodium sulfite. *Scav-Ox II* solves both problems.

*Other Areas:* *Scav-Ox II* may be used in direct application to the boiler water, especially in low pressure boilers or in closed hot water heating systems.

*Scav-Ox II* is also suitable for the wet lay-up of boilers, especially when reactivity with oxygen and control of dissolved solids are desired.

*Note:* Steam from the boilers treated with *Scav-Ox II* must not contact food or human drug products.



### **How to Use Scav-Ox II**

The ideal place to add *Scav-Ox II* is at the deaerator discharge. This provides maximum protection for the feedwater system.

*Application Rate:* The amount of *Scav-Ox II* added to the feedwater depends initially on the dissolved oxygen level in the water, with an excess provided to react with ferric oxide and to form a magnetite film on the steel surface. The dose will vary, therefore, depending on the efficiency of deaeration and the cleanliness of the system.

*Scav-Ox II* should be fed at a rate sufficient to maintain a residual of from 0.01 to 0.10 ppm of hydrazine in the boiler. The rate may be higher at first, when rust is being reduced to loose, heavy magnetite and the adherent magnetite film is being established. After this initial period, the desired residual can be maintained with a much lower feed rate.

*Dilution:* *Scav-Ox II* is a 35% solution and only small volumes are required. Therefore, it is best to dilute this solution for ease in pumping and metering. Dilution to a hydrazine content of 1-5% is generally adequate. The degree of dilution is not critical, and depends mainly on the precision of the available feed equipment.

Either batch or continuous dilution of *Scav-Ox II* is possible. A batch is prepared by simply adding a measured amount of *Scav-Ox II* to a measured amount of condensate in the feed tank.

Since *Scav-Ox II* is compatible with most treating chemicals, it may also be added as a combined feed.

*Equipment:* If *Scav-Ox II* is replacing sodium sulfite or plain hydrazine, the same equipment will generally be satisfactory, as is. If a new system is required, mild steel or polyolefins are suitable materials for construction.

### **Hydrazine Methods of Analysis**

Hydrazine residuals in feed and boiler water can be determined by standard analytical methods with no interference from the catalyst in *Scav-Ox II*.

The most common method is a simple colorimetric analysis based on p-dimethylaminobenzaldehyde. Several versions of this method are in use. Instruments of varying degrees of sophistication are available, ranging from inexpensive color comparators to spectrophotometers and automatic analyzers/recorders. If the boiler water itself is colored

(e.g., from lignosulfonates) the interference can generally be cancelled out.

Residuals of hydrazine may also be analyzed by direct titration with reagent in a pH 7 buffer.

### **Storage and Handling**

*Scav-Ox II* has no flash point and does not constitute a fire hazard. However, hydrazine is a strong reducing agent, as well as a base. Therefore, it should not be stored near oxidizing agents or acids. Exposure to direct sunlight or to high temperatures should be avoided.

Dilute aqueous solutions of hydrazine are capable of releasing hydrazine vapors to the surrounding atmosphere. Because of the toxicity of hydrazine vapors, care should be taken to assure adequate ventilation whenever *Scav-Ox II* is handled in open containers.

### **Shipping Information**

*Scav-Ox II* is available in 6 gallon (50 lbs net) pails, and in 30 gallon (250 lbs net) and 55 gallon (450 lb. net.) polyethylene drums.

### **For More Information**

#### **Technical Service**

Technical Service is available to facilitate use of *Scav-Ox II* 35% catalyzed hydrazine solution. If you have a specific question or need further information, please write or call Hydrazine Technical Service, Arch Chemicals, Inc., 350 Knotter Drive, Cheshire, CT 06410; (203) 271-4225.

#### **How to Order**

To place an order for delivery in the U.S. or Canada and to get fast answers on order status or product availability, call our toll-free number: 1- (800) 654-6018.

Or visit our web site [www.hydrazine.com](http://www.hydrazine.com)

After your first order, you will be assigned your own personal Arch Chemicals Customer Service Representative. When you call back, simply ask for your Customer Service Representative by name. If you call evenings (after 4:30 p.m. eastern time) or on weekends or holidays, your message will be recorded and your Representative will contact you at the beginning of the next business day.

For written inquiries about orders, and to place confirmations, we have set up a special box number for you. Just address your envelope to the address at the end of the document.



**Technical  
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