**BOROL™ SOLUTION**

**Description**

BOROL SOLUTION is a proprietary mixture containing sodium borohydride (NaBH₄) and sodium hydroxide.

**Typical Properties**

These properties are typical but do not constitute specifications.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>1.4 (11.5 lb/gal)</td>
</tr>
<tr>
<td>Appearance</td>
<td>Off-white liquid</td>
</tr>
<tr>
<td>Viscosity</td>
<td>60.4 mPa.s @ 20°C</td>
</tr>
<tr>
<td>Solubility</td>
<td>Can be diluted with water</td>
</tr>
<tr>
<td>Stability</td>
<td>&lt;0.01% decomposition per year</td>
</tr>
</tbody>
</table>

**Application**

Rohm and Haas offers a family of Sodium Borohydride-based brightening technologies for many bleaching applications.

A BOROL Bleach generating unit allows a mechanical pulp mill to generate its own Sodium Hydrosulfite bleach on-site at substantially reduced cost relative to merchant Hydrosulfite bleach. Our premix technology involves addition of BOROL and sodium bisulfite solution to the pulp. BOROL SOLUTION is the preferred approach to achieve an 8–10 point brightness gain. With refiner bleaching, 11–14 brightness points are obtainable. Brightness gains above 14 points can be achieved with a 2-stage bleaching process of hydrogen peroxide followed by BOROL-Generated Hydrosulfite.

**Chemistry**

Sodium Hydrosulfite bleach (Na₂S₂O₄) is produced by adding BOROL SOLUTION to a mixture of aqueous NaOH and liquid/aqueous sulfur dioxide (SO₂). As an alternative, BOROL can be added to an aqueous solution of Sodium Bisulfite (NaHSO₃).

\[
\text{NaBH}_4 + \text{NaOH} + \text{SO}_2 \rightarrow \text{Na}_2\text{S}_2\text{O}_4 \\
\text{NaBH}_4 + \text{NaHSO}_3 \rightarrow \text{Na}_2\text{S}_2\text{O}_4
\]

As a side-reaction, some of the sodium borohydride is hydrolyzed thereby generating hydrogen gas. The small amount of H₂ produced is safely discharged outside the mill with a vent.

**Application Recommendations**

The conditions generally required to achieve maximum bleaching performance are as follows:

- Bleach preparation temperature: 60–100°F/16–38°C.
- Sodium Hydrosulfite usage rate: 0.7–1% of 100% active Sodium Hydrosulfite bleach for 8–10 brightness points.
- Premix technology involves a typical dosage of 0.1–0.5% BOROL SOLUTION and 0.4–2.0% sodium bisulfite.
Bleaching conditions and temperature: 1 hour of bleaching at a 3–12% consistency above 120°F/49°C.

pH: 4.5–7.0

Chelating agents: 0.05–0.2% of 100% active chelant can significantly improve brightness response in pulps with a high concentration of metals.

Availability and Shipping

BOROL SOLUTION is available in 2,920 lb/1325 kg non-returnable totes, 40,000 lb/18,000 kg and 70,000 lb/32,000 kg tank trucks, (Canada only) or 120,000 lb/55,000 kg or 190,000 lb/86,000 kg railcars.

Toxicity and First Aid

1. BOROL SOLUTION has dermal LD$_{50}$ of 100–500 mg/kg and, like 50% caustic soda, (NaOH) solutions can cause skin burns and irritations. The acute oral LD$_{50}$ of BOROL SOLUTION is 500–1000 mg/kg.

2. BOROL SOLUTION is very corrosive to the eye and should be handled according to generally accepted procedures for corrosive chemicals. In case of accidental contact, flush eyes with water and seek immediate medical attention.

3. Precautions should be taken to avoid direct skin contact or ingestion. In case of accidental contact, flood the affected area with copious amounts of water and then wash skin with soap and water.

Product Handling

1. **Personal Protection**: Protective rubber gloves, clothing, face shield, and safety goggles should always be worn when handling BOROL SOLUTION.

2. **Handling**: In general, BOROL SOLUTION should be handled in the same manner as 50% caustic soda. It is classified as a non-flammable, corrosive liquid, and it is stable to shock. Due to the presence of NaOH, BOROL SOLUTION absorbs CO$_2$ forming insoluble carbonates. Consequently, it should not be unnecessarily exposed to air for extended periods.

BOROL SOLUTION will decompose and evolve hydrogen if overheated, subjected to neutral or acidic pH conditions, or brought into contact with oxidizing agents, metal salts or fine metallic precipitates of Ni, Co, Cu or Fe. BOROL SOLUTION should be stored and reacted in vented vessels to prevent hydrogen buildup.

3. **Product Decomposition**: Under normal storage conditions, the decomposition of BOROL SOLUTION is less than 0.01% per year. During extended storage under adverse conditions, H$_2$ pressure may develop over the solution. All closed containers should have at least 10% free volume and be checked periodically.

4. **Sampling**: Samples should be kept in plastic bottles. Under no condition should samples be stored in glass containers.

Storage

Accepted storage procedures for BOROL SOLUTION are the same as those for 50% liquid caustic soda.

BOROL SOLUTION can be stored in stainless steel, mild steel, or approved fiberglass vessels. Stainless steel (316 SS or 304 SS) is recommended for piping, valves, pumps, etc. BOROL SOLUTION must NOT be stored in vessels which react with caustic soda, such as aluminum. Storage tanks should be adequately vented to minimize hydrogen gas buildup.

BOROL SOLUTION should be stored at temperatures above 65°F (18°C) to improve handling. The solution becomes viscous below 60°F (16°C) and can crystallize at temperatures below 55°F (13°C). To liquefy, warm slowly to 70–90°F (21–32°C), making sure the container is vented; do not use live steam. The warmed material should then be recirculated with a pump until a homogeneous solution is obtained.
If piping used to transfer BOROL SOLUTION is exposed to temperatures below 55°F (13°C), it should be heat traced to improve handling. However, precautions should be taken to avoid excessively high temperature since BOROL SOLUTION may decompose, resulting in the evolution of hydrogen gas and possible excessive line pressure.

**Waste Disposal**

BOROL SOLUTION has been classed as a ‘corrosive liquid’ under DOT regulations.

1. BOROL SOLUTION is a corrosive material (EPA hazardous waste #D002) and must be disposed of accordingly. BOROL SOLUTION can be disposed of (hydrolyzed) by initial dilution with a large excess of water, followed by slow addition of a dilute solution of acetic acid or acetone to the mixture. This procedure should be performed in a well ventilated area.

   Provisions should be made to safely vent hydrogen gas given off during neutralization. BOROL SOLUTION should not be flushed to the sewer.

2. In case of accidental spillage, absorb the BOROL SOLUTION with an inert material such as sand or dolomite. Absorbed material should be hydrolyzed as described above.

3. Any vessels which have been used for reactions or storage of BOROL SOLUTION should be carefully vented, drained, washed, and adequately flushed with nitrogen and air before any repair operations are undertaken. Exposure to an open flame (e.g., welding torch) should be avoided.

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To the best of our knowledge the information contained herein is correct. All products may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of suitability of the product is the sole responsibility of the user. Users of the product should satisfy themselves that the conditions and methods of use assure that the product is used safely. No representations or warranties, either express or implied, of merchantability, fitness for a particular purpose or any other nature are made hereunder with respect to the information contained herein or the product to which the information refers. Nothing herein is intended as a recommendation to use our products so as to infringe any patent. We assume no liability for customer’s violation of patent or other rights. The customer should make his own patent investigation relative to his proposed use.