

Borates for pH control in nylon carpet dyeing

1. Introduction

Aqueous borax decahydrate or *Neobor*® borax pentahydrate solutions are known to exhibit relatively stable pH values at various concentrations and temperatures. For this reason, borax decahydrate is an excellent buffer and is recommended for pH control in the dyeing of nylon carpeting. Borax decahydrate offers the following advantages:

- pH remains relatively constant: Monitoring and periodic bath adjustments are reduced significantly
- Precludes initial high starting pH which minimizes change in pink and cerise shades, thereby allowing better shade matching
- Prevents staining by the jute backing

In the dyeing process, a mildly alkaline condition (pH = 8.5-9.0) is necessary to optimize the color level and dye penetration, as well as to keep the fiber clean. Sufficient alkalinity is required to prevent the deposition of fugitive stains from the jute. Of more importance is pH control during the dyeing cycle. A steady pH minimizes the problem of shade matching due to the susceptibility of certain dyes to pH fluctuations.

2. Effect of trisodium phosphate (TSP), tetrasodium pyrophosphate (TSPP) and soda ash on pH

Laboratory work has been performed on the effect of various compounds as buffers or the ability of these materials to provide a uniform pH during the dyeing operation. It was found that the two most commonly used compounds, TSP (trisodium phosphate) and

TSPP (tetrasodium pyrophosphate), while able to provide sufficient alkalinity (high pH) during the initial stages of the dyeing process, failed to maintain a sufficiently high enough pH throughout the dyeing operation. Both compounds underwent a severe drop in pH in the presence of jute, indicating that the jute probably neutralized some of the alkalinity.

The pH values of both solutions (at the three concentrations tested) drops rapidly to a low level by the end of the two hour tests. Of equal significance is the drop in pH during the warm-up period to 205°F (96°C). Although the addition of sufficient alkali would ensure the final desirable pH, this would result in a starting pH of 10-11 which would not be satisfactory since, as noted above, certain dyes are sensitive to high pH values.

Soda ash systems also show a considerable pH drop during the initial warm up. While such systems display a leveling of pH after the initial warm up a starting pH of 10-11 is again required to ensure a safe pH level during the dyeing operation.

3. Effect of borax on pH

The effect of borax decahydrate on pH shows very little decrease in pH during the test cycle. Completion of a two hour dyeing test indicates that at concentrations of 3-4% (based on total dry weight of carpet), the drop in pH is very slight or on the order of 0.4 pH units. Borax is an excellent buffer for such systems providing a minimum of 3% borax is used.

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The use of borax decahydrate or *Neobor* borax pentahydrate, obviously, offers advantages over phosphates:

- pH remains constant, significantly reducing monitoring and periodic adjustments
- Eliminates the need for alkali additions, thus avoiding the danger of pH fluctuations with resulting shade variations

Borate solutions can be prepared from either borax decahydrate or *Neobor* borax pentahydrate. Use of *Neobor* borax pentahydrate would result in a savings because of lower freight costs, storage, and handling requirements, since 0.76 units of *Neobor* borax pentahydrate is equivalent to one unit of borax.

About U.S. Borax

U.S. Borax, part of Rio Tinto, is a global leader in the supply and science of borates—naturally-occurring minerals containing boron and other elements. We are 1,000 people serving 500 customers with more than 1,700 delivery locations globally. We supply 30% of the world's need for refined borates from our world-class mine in Boron, California, about 100 miles northeast of Los Angeles. We pioneer the elements of modern living, including:

- **Minerals that make a difference:** Consistent product quality secured by ISO 9001:2015 registration of its integrated quality management systems
- **People who make a difference:** Experts in borate chemistry, technical support, and customer service
- **Solutions that make a difference:** Strategic inventory placement and long-term contracts with shippers to ensure supply reliability

4. Alternative systems

Buffered mixtures can also be used to control pH fluctuations. It was found that a starting pH approximating 9.0 dropping to about 8.5 during the dyeing operation (at 205°F), can be obtained by using 1% borax decahydrate with 0.11% sodium hydroxide. This system, while suitable, might not be desirable, in that extra storage and mixing of two materials are required. The use of a single material such as borax, would be more conventional and leaves little room for error by the operator.

About 20 Mule Team® products

20 Mule Team borates are produced from naturally occurring minerals and have an excellent reputation for safety when used as directed. Borates are essential nutrients for plants and key ingredients in fiberglass, glass, ceramics, detergents, fertilizers, wood preservatives, flame retardants, and personal care products.



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