

## NAFION™ Hydrogen-Form Membrane Expansion

### Technical Information Bulletin 93-01

Many NAFION™ perfluorinated membranes\* are produced in the hydrogen ionic form (H<sup>+</sup>) to meet specific customer needs.

Prior to using these membranes, it is necessary to expand them before installation so that during operation, the membranes will shrink slightly and remain wrinkle-free. Because there are many different applications and electrolyzers that these membranes are used in, we recommend that membrane expansion be discussed with your equipment supplier or your representative.

#### Special Expansion Considerations

- Membranes expand more in deionized (DI) water when they are in the hydrogen ionic form (H<sup>+</sup>) than they do when they are in the sodium ionic form (Na<sup>+</sup>) or potassium ionic form (K<sup>+</sup>). Consequently, many applications processing dilute electrolytes require that membranes be pre-expanded in DI water.
- Membranes expand more when the expansion bath is heated. Consequently, some applications may require elevated bath temperatures to prevent wrinkling during USC.
- The hydrogen-form membranes are relatively free of other cations. In special cases where purity is essential, such as fuel cell applications, the membrane is typically expanded in high purity HNO<sub>3</sub> or HCl followed by a DI water rinse.
- Hydrogen-form membranes expanded in DI water will be slightly acidic (pH 2 to 7). This may cause corrosion of certain types of electrodes before start-up. Corrosion of some electrodes (activated nickel, for example) could result in nickel absorption in the membranes and subsequent high voltage during normal operation. If this is the case, alkaline expansion is recommended as detailed next. If in doubt about possible corrosion of your electrodes, contact your hardware supplier for specific recommendations.
- If alkalinity is required to protect the electrodes, or if there is uncertainty about your electrodes, we recommend that the membrane be converted to the sodium form, except that only NaOH should be used for the conversion. If NaHCO<sub>3</sub> were used, CO<sub>2</sub> gas would be generated and the bubbles would coat the membrane and inhibit wetting.
- Some electrode types are not affected by slight acidity, and water expansion is a convenient way to expand membranes. When expanding the hydrogen-form membranes in DI water, follow the guidelines presented below.

\*NAFION™ 117 perfluorinated membrane (abbreviated N-117), NE-112, NE-115, N-417, N-450, N-120, N-324, and N-350 are some of the hydrogen-form membranes available.

## Procedure: Expanding Hydrogen-Form Membranes in DI Water

1. Use only DI water to prevent contamination of the membrane with undesirable elements or compounds that can affect performance later.
2. Because DI water pH is usually 6 to 7 and the treatment bath will probably turn slightly acidic (pH 6 or less), the construction materials of the bath must be carefully chosen. PVC is commonly used.
3. For expansion, membrane sheets may be suspended vertically or laid horizontally with or without mesh separators.
4. Completely cover the membranes with DI water and change the bath periodically to remove any impurities and debris that may have accumulated. Arbitrarily, we recommend changing the bath after treating 1 m<sup>2</sup> per 5 liters of water.
5. Soak the membranes in DI water a minimum of 4 hours at a temperature of 18°C to 30°C.
6. Mesh separators between sheets are not required in horizontal DI water treatment. However, we recommend the following:
  - Do not treat more than 100 membranes at a time.
  - Increase treatment time from 14 hours to 12 hours.
  - Insert the membranes into the bath one at a time to minimize air bubbles adhering to the membrane and reducing expansion.
7. Only enough DI water to completely cover the membranes is required; however, the bath should be replenished frequently to prevent buildup of impurities and debris. We recommend an arbitrary bath replacement after treating 1 square meter of membrane per 5 liters of water.
8. Avoid folding or wrinkling membranes while moving them in and out of the solution. If possible, membranes should be unrolled from the shipping core directly into the water.
9. After each membrane is inserted into the tank, smooth out any wrinkles before adding the next sheet. This prevents the weight of subsequently inserted membranes from creasing and damaging membranes on the bottom of the stack.

## Procedure: Expanding Hydrogen-Form Membranes in Warm DI Water

Additional 0.5% to 1.0% expansion can be obtained by increasing the DI water bath temperature from room temperature to 80°C. The equipment supplier or a Chemours representative will recommend the best procedure for your application; occasionally expansion temperatures to 90°C have been utilized.

## Procedure: Expanding Hydrogen-Form Membranes in Dilute Acid

The procedure for using acid is similar to that of DI water except that:

- The solution is 0.2% to 0.5% HNO<sub>3</sub> or HCl and must be very pure to prevent membrane contamination. Occasionally, higher concentrations (5%) are used.
- The recommended temperature is 18°C to 60°C, depending on application and experience.
- Adequate ventilation must be provided.
- The membrane should be bathed several times with DI water before installation.

