

LIST OF SUITABLE SOLVENTS FOR HIGH IEC AEMION+® POLYMER AP3-HNN9-00-X

Solvent Type	Comments	Recommended Solubility wt%
Ethanol / Acetone	50:50 (v/v) mixture. Recommended low-boiling solvent	1% – 7%
Methanol / MEK	50:50 (v/v) mixture	1% - 6%
NMP, DMF	High boiling point solvents, can cause complications with gas permeability	1% - 10%

EtOH g	Acetone g	AP3 solubility 7 wt%	Viscosity approx cP*
9	1	No	NA
8	2	No	NA
7	3	No	NA
6	4	Dissolved	192
5	5	Dissolved	114
4	6	Dissolved	90
3	7	Dissolved	61

*Viscosity calculated by Ionomr internal falling ball viscometer method

Note: Achieving solubility at mid to high wt% range, may require appropriate heating and stirring for up to 48 hours. Sonication may speed-up this process but is not recommended beyond ~30 minutes in a sonication bath

ANION EXCHANGE IONOMERS: DISPERSION AND INK FORMULATION

DISPERSION AND INK FORMULATION

The following is a starting point for preparing catalyst inks based on an ink formulation designed for fuel cell catalyst layers. Please note that different ionomer content may be required depending on the application. Similarly, depending on the application and performance requirements, further optimization may be required, such as solvent composition and weight percent of solids in solution.

1. Calculate the mass of polymer, catalyst powder, and solvents required for electrode composition. As a guideline, the final ionomer to catalyst ratio should be around 10 to 25 wt%. This is heavily application dependent. Adapting existing ink formulation based on polymers of other densities based on vol% is suggested for an initial approximation. The density of Aemion+® is ~1.2 g/mL, so an ink based on 30 wt% of a ~2.0 g/mL polymer would be approximately equivalent to 18 wt% Aemion+®. It is recommended that the solvent ratio is 1:1 organic solvent or solvent mix to water, e.g. 1:1 MeOH:water. The primary alcohol can be adjusted after the polymer is dissolved in step 2. The volume of solvents required should be dictated by a final weight percent of total solids (catalyst powder + ionomer), with 1-2 wt% suggested for electrode application by spray-coating. One method of controlling drying characteristics (e.g. membrane swelling causing wrinkled catalyst layers, catalyst layer porosity, etc.) is to alter the alcohol ratio; it is strongly inadvisable to increase this ratio above 3:1

2. On a stir plate (with magnetic stirring capabilities), prepare a 3-5 wt% solution of Aemion+ and suitable low-boiling alcohol mixture from below (e.g. methanol/MEK) to dissolve the polymer. If particles are noted, pass the ionomer through a glass fiber filter to eliminate any contaminants. Reserve about 5 mL of the chosen alcohol to capture concentrated ionomer coating the glassware after dropwise addition (mentioned later).

3. Preferably in a narrow-necked glass bottle and on a stir plate capable of magnetic stirring, add the catalyst (such as Pt/C) powder followed by a stir bar and all the calculated water. Stir gently (e.g. 100 RPM) until catalyst powder is fully wetted and dispersed. Increase stir rate until a vortex begins to form but before cavitation (e.g. 400-600 RPM, heavily dependent on ink volume and stir bar size)

4. Slowly pour in the calculated alcohol, apart from the 5 mL reserve and that contained in the ionomer solution. Maintain vigorous stirring and add the alcohol/ionomer solution dropwise, visually ensuring surface accumulation of polymer is kept to a minimum. Occasionally swish to integrate catalyst particles that accumulate at the ink-bottle interface. Use the remaining 5 mL of alcohol to rinse the ionomer glassware (i.e. capture the residual polymer so calculated values for ionomer are realized) and dislodge any remaining catalyst powder from the sides of the ink bottle. Stir at moderate rate (e.g. 300 RPM) until use; a minimum of four hours is recommended. Treatment in a low-power sonication bath for 15-30 minutes after an initial 30-60 minutes of stirring may help homogeneity.

Disclaimer

Ionomr Innovations Inc. is not responsible for any damages or loss of materials when preparing catalyst inks. Always use caution when mixing any finely divided metal catalyst particles with flammable solvents as spontaneous combustion may occur. Use proper containment procedures and wear personal protective equipment at all times.

