

Fundamental research about the development of monitoring technique of inorganic composition of concentrated-seawater by near infrared spectroscopy

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There are various methods for salt-manufacturing, for example, traditional method utilizing wind power and solar heat and ion-exchange membrane electro-dialysis method. Even if any method is adopted for salt-manufacturing, monitoring of inorganic composition of concentrated-seawater in real-time is an important and an indispensable to make good salt products.

Near infrared (NIR) spectroscopy is a simple technique. Because it is fast, nondestructive and it requires little or no sample preparation, many industries use it. If determining inorganic component using near infrared spectroscopy is possible, a superior contribution of NIR techniques to salt-manufacturing process can be anticipated.

In order to develop of monitoring technique of the inorganic composition of concentrated-seawater by near infrared spectroscopy, we first examined the relationship between the near infrared spectra and inorganic components, and then investigated the potential of near infrared spectroscopy to measure the main inorganic components of concentrated-seawater as a basic research.

First, the characteristics of the near infrared spectra of the aqueous solutions of various standard salt reagents were investigated. At 1,100-1,850 nm wavelength range, the perturbations of the water absorption band by NaCl were very clear. When the concentration of NaCl increased, the intensity (absorbance) of the water band decreased, the band became narrower and shifted to short wavelength. These changes are caused by decrease in water concentration in NaCl solutions and hydrations of ions. The different electrolytes perturb the water bands to form different patterns and to different degrees. KCl had spectra similar to that of NaCl, whereas Na₂SO₄, CaCl₂, MgCl₂ and MgSO₄ have significantly different spectra from that of NaCl. These difference s of near infrared spectra of the aqueous solution by different salt reagent could be also clarified from the difference spectrum.

Then the PLS regression analysis were performed based on the inorganic composition of concentrated-seawater and the original near infrared spectra (1,100-1,850 nm) of the calibration and validation sample sets. As results, the near infrared spectra could be related to the inorganic composition of concentrated-seawater, and could be used to predict the inorganic ion component composition of concentrated-seawater with good accuracy.