

Technologies for the identification and separation of chemical substances

Separation technologies using hydrates

Today, every year about 10,000 tons of additional fluorochemical waste which contributes to global warming is disposed of in the form of styrofoam waste. Since these fluorochemicals are becoming increasingly absorbed into the atmosphere, to recycle and reuse these waste materials we must separate and refine them first. Here we will describe technologies which use hydrates to separate global warming agents.

Hydrates are a type of inclusion compound which display a unique structure in which gas molecules are enclosed within a container formed by water molecules. The molecules enclosed in this container are called 'guest molecules', and compounds consisting of water and carbon dioxide, nitrous oxide, methane, chloro-fluorocarbon (CFC), hydrochlorofluorocarbons (HCFC), or hydrofluorocarbons (HFC) and other global warming agents all form hydrates when under the necessary temperatures and pressures.

While advances have been made in recent years in terms of separation technologies using functional materials which can be used to perform molecular recognition, in addition to being able to be used in the same way as crown ethers, cyclodextrins, and other functional extractants to perform molecular recognition based on molecular diameters, hydrates have the property of being able to be used to perform molecular recognition to a greater precision using methods based on differences in the potentials of guest molecules and water molecules. In addition, the pressures required to generate hydrates are lower than the saturated vapor pressures of global warming agents, thus reducing the amount of energy required for extraction and making this a superior method in terms of cost.

Figure 1 shows the conditions required for the generation of hydrates from HFC134a, a representative global warming agent. Hydrates may be generated from HFC134a at normal atmospheric pressure if it is cooled to a temperature of about 4°C.

The conditions under which hydrates like these may be generated differs for different global warming agents.

Figure 2 shows the results obtained when hydrates are used to separate HFC134a from a gas mixture of HFC134a and nitrogen. For instance, in a case where the exchange with air is proceeding at a rate of about 40 percent and the system is operated at a temperature of 5°C and a pressure of 2 atmospheres, it is possible to refine up to about 97% of the HFC134a shown in the first row.

In addition to this, we are also hard at work performing the measurements needed in order to obtain the basic data which will be needed in order to design a global warming agent separation system like this which use hydrates to perform separation, and with the aim of developing actual working systems, we are performing research and development work on high-efficiency separation systems using static mixers, continuous separation systems using porous materials, and other similar systems. Figure 3 illustrates the principles underlying the working of such systems. The gas mixture from the intake which has been separated by passing it through the porous material and the water from the transmission layer are fed in, the water and gas come into contact within the porous material, and the pressure of the intake is set to the pressure needed in order to generate hydrates to cause hydrates to be formed at the gas-liquid phase boundary. By setting the pressure of the transmission layer to the pressure required for hydrate decomposition, it becomes possible to decompose the hydrates and continuously extract the separated gas.

Separation and identification of microorganisms

It is important to be able to identify not only chemical substances, but also microorganisms found in the environment. Microorganisms play a major role in determining the behavior of chemicals released into the environment. The actual degradability of biodegradable plastics and similar materials

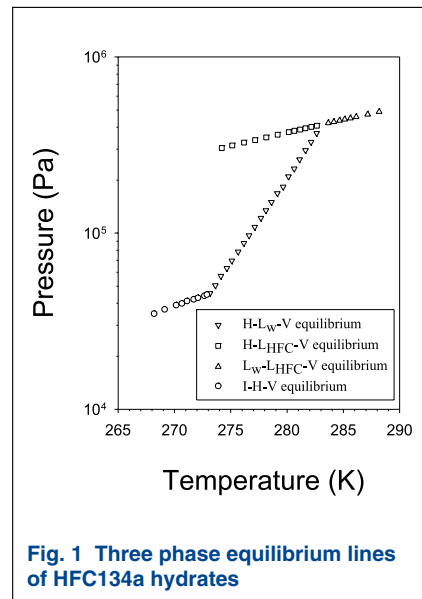


Fig. 1 Three phase equilibrium lines of HFC134a hydrates

varies depending on the types of microorganisms present. It is necessary to have an understanding of both chemicals as materials and the environment as a place for reactions to take place, and we are accordingly performing the research needed in order to rapidly separate and identify different types of microorganisms. Electrophoresis is a well-known method for use in separating different chemical substances, but we have discovered that it can also be used with microorganisms and that it is possible to separate microorganisms over short separation times by adding certain polymers to the electrophoresis solution. We are also developing a method of identification which uses the soft ionization mass spectrometry method (MALDI-TOF-MS) to measure the concentrations of proteins and lipids found in microorganisms. (See Figure 4.) It has been found that this method makes it possible to easily distinguish between different types of microorganisms even when they consist of microorganisms which are extremely similar to each other at the genetic level.

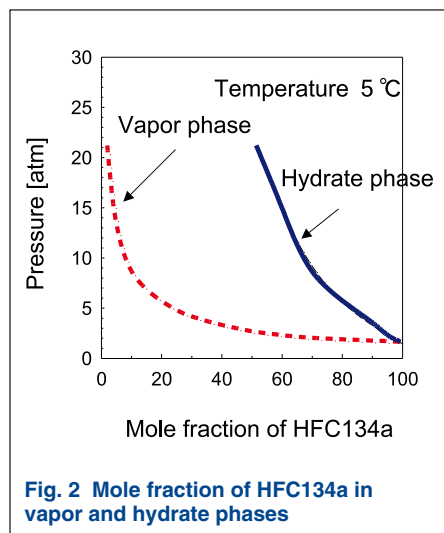


Fig. 2 Mole fraction of HFC134a in vapor and hydrate phases

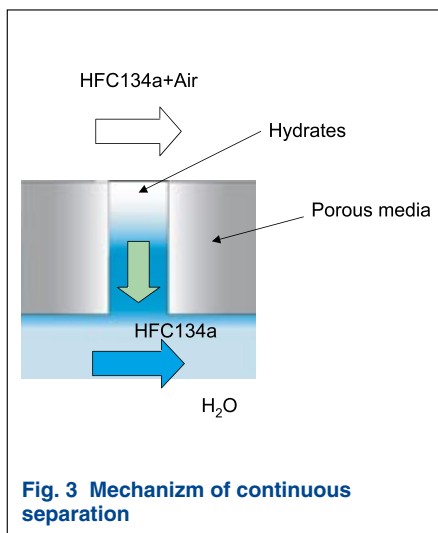


Fig. 3 Mechanism of continuous separation

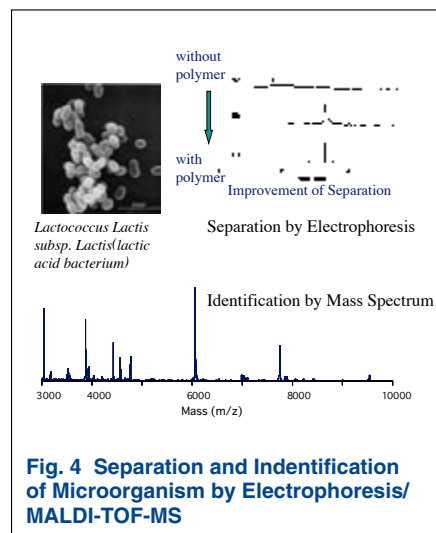


Fig. 4 Separation and Identification of Microorganism by Electrophoresis/MALDI-TOF-MS