Chemical Technology: An Indian Journal

Opinion | Vol 16 Iss 4

Techniques for Separating Hydrogen Using a Membrane

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Received: July 03, 2021; **Accepted:** July 13,2021; **Published:** July 23,2021

Abstract

Fossil fuels provide for over 80% of current global energy needs. Using hydrogen as an energy source produces only water as a byproduct, unlike using fossil fuels. The use of hydrogen as an energy source could assist to address concerns such as global climate change and local air pollution, which are both linked to energy security. Furthermore, hydrogen is widely available across the universe and has the highest energy content per unit of weight of any known fuel. As a result, the need for hydrogen energy and production has increased in recent years. When compared to established technologies such as pressure swing adsorption and cryogenic distillation, the membrane separation technique is an appealing option. This study discusses the various types of membranes used to separate hydrogen from hydrogen-rich mixtures. Much of the present research has been concentrated on nonpolymeric materials such metal, molecular sieving charcoal, zeolites, and ceramics, according to the study. Thin membranes would not only save money on materials, but they would also boost hydrogen flux. For hydrogen purification, metal alloys or composite metal membranes have been utilised. Metallic membranes, on the other hand, are susceptible to gases like carbon monoxide and hydrogen sulphide. As a result, ceramic barriers that are impervious to harmful gases are desirable.

Introduction

Thin-film palladium membranes provide a number of benefits over inorganic microporous membranes. More crucially, the flux in microporous membranes is proportional to the pressure directly, whereas the flux in palladium membranes is proportional to the square root of the pressure. The advantages and disadvantages of various hydrogen separation membranes are also discussed in the article. The paper also discusses the performance of several membranes in terms of hydrogen selectivity and permeability. The use of hydrogen as a source of energy could help to solve global climate change, energy security, and local air pollution. In recent years, there has been an increase in demand for hydrogen, which has prompted research into bettering methods of hydrogen production, separation, and purification. There are many byproducts associated with the production of hydrogen, especially when thermochemical means are used. Therefore, separation of hydrogen from other gases is an important step in the hydrogen production process. Several methods for purifying hydrogen exist, including Pressure Swing Adsorption (PSA), cryogenic distillation, and membrane separation. Separation techniques such as PSA and cryogenic distillation are commercially available. They do, however, consume a lot of energy. Membrane-based procedures are thought to be one of the most promising methods for producing high-purity hydrogen. Depending on the purity and size of production, it may be a viable alternative to PSA and cryogenic distillation. Furthermore, membrane separation methods use less energy because they can run continuously. Membrane separation techniques are essential because catalytic reforming might be imbedded in the membrane, causing the reversible reforming reaction to shift to the right, resulting in higher hydrogen conversion. The cryogenic distillation process is still a popular approach for separating fluid mixtures. It does, however, take a significant amount of energy. The cryogenic process is a low-temperature separation method that works by separating feed components based on their boiling temperatures. Membrane separation techniques have sparked the most interest, other from PSA and cryogenic distillation. Membranes are physical barriers that enable only certain materials to pass through them. The most significant impediment to the preparation of Pd membranes is the cost.Thin metallic membranes have been the subject of recent research. Thin membranes would cut material costs while also increasing hydrogen flux. On supports, thin membranes are created. Porous glass, such as porous Vycor, was one of the most commonly utilised supports. Because of their smooth surface, porous ceramic and glass supports can be employed. Fitting ceramics to metal, on the other hand, lacks mechanical stability. Because of its mechanical durability, thermal expansion coefficient similar to Pd, and simplicity of gas sealing, stainless steel might be employed as a support material in this case. Based on the transport mechanisms, there are two types of carbon membranes: molecular sieving and surface diffusion membranes. Molecular sieving membranes are promise in terms of separation qualities as well as reasonable flux and stabilities, however they are not yet commercially available in large enough quantities.

Carbon Molecular Sieving CMS membranes can be made in two ways: (i) unsupported CMS membranes like flat membranes, capillary tubes, or hollow fibres, or (ii) supported CMS membranes on a macroporous material. Carbon membranes are fragile and difficult to package if the membrane surface area grows too high. 8 Carbon membranes are also still prohibitively expensive. If the feed streams contain organic traces or other strongly adsorbing vapours like H_2S, NH_3, or chlorofluorocarbons, the membranes' performance will suffer significantly . Inorganic membranes are currently attracting more attention than organic membranes. Organic membranes are more susceptible to damage than inorganic membranes. Pd and its alloys are the most commonly researched metallic membranes. Ceramic membranes are growing more appealing as Pd becomes more pricey. Membranes made using microfabrication techniques had the best permeance, while metallic membranes made using electrodeposition had superior H_2 selectivity over N_2. In the case of ceramic membranes, sol-gel gives good hydrogen permeability and selectivity. Comparing various reports to find the best membranes, however, is difficult due to differences in the factors employed, such as temperature, pressure, and membrane thickness.