Developing a Novel Water Vapor Selective Composite Membrane by Adding a Thin Polymeric Layer

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Polymer-based membranes in gas separation processes have become a prevailing technology in the field of material science, especially in industrial capacities. These membranes can remove water vapor efficiently while blocking the passage of other gases or particles to reduce the amount of energy consumed in industrial and domestic settings. These include natural gas dehydration and air conditioning, the latter consuming about 70% of Saudi Arabia's total electricity usage. However, it is challenging to identify a suitable polymer and maintain a minimum thickness, thereby reducing cost and increasing productivity. This study develops thin composite membranes made up of three layers with the third layer acting as the selective layer. Cellulose, TPX, Nafion, Nexar, Teflon, Polyactive, and Pebax 2533 were the polymers chosen to test as the selective layer in the composite membrane. The base material of the composite membrane was pre-prepared in the laboratory and was coated with a third thin layer of the selected polymers with varying concentrations. Using the cup method to measure the permeance of water vapor and the constant pressure-variable volume method to measure the permeance of nitrogen, the composite membrane's selectivity was calculated to identify the most promising membrane. Results show that Cellulose, with a selectivity of 1320 GPU and a thickness of 0.40 μm, is the most promising polymer with the highest selectivity for water vapor over other gases. Therefore, it can act as the selective layer in the composite membrane. These membranes can be further be used in future beneficial water filtration research.