Predictive Modeling of Gas Diffusion and Solubility in Polymers for Offshore Application

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The transport of carbon dioxide (CO_2) between the capture and storage point is matter of great importance for the oil and gas industry, although it is not as often debated. NOV (National Oilwell Varco) manufacture flexible pipelines for offshore transport of fluids in deep water conditions. Flexible pipelines become a good alternative to the rigid ones, mainly because of the following advantages: easier storage and transport, lower operating costs, simpler maintenance and higher chemical and mechanical resistance. A flexible pipeline consists in several layers, where the so-called inner polymer liner provides the barrier to the egress of the gas being transported. Inside the pipeline the gas is transported at extreme conditions of temperature and pressure, within the range of the supercritical stage (e.g. 90 ˚C and 650 bar). The study and optimization of these pipelines systems is an experimental challenge that requires the acquisition of some thermodynamics and transport properties of supercritical gases: solubility and permeability of the polymer/gas system at as function of pressure and temperature. In this work, two different apparatus systems are used to test determine the key properties of the gas/polymer system: a Magnetic Suspension Balance (MSB), to determine the solubility, and a 2-D permeation cell, to measure the permeability. The measurements were performed with three different polymers, PVDF, XLPE and PA11, while using pure CO_2 and its mixture with methane (90/10) at different conditions of pressure and temperature. These results, obtained under collaboration with NOV as industrial partner, have direct impact in the safety and operating conditions of gas transport in flexible pipelines.