Large scale reactor details and results for the formation and decomposition of methane hydrates via thermal stimulation dissociation

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1. Introduction

Current estimates forecast that world oil production will peak between 2010 and 2030 (Aleklett et al., 2010), which translates into continued oil use for the foreseeable future. During this time new domestic and distributed sources of energy can be developed to ensure that society’s demands are met while transitioning away from oil. The best carbon-based energy source is natural gas, because of its high hydrogen to carbon ratio, thus yielding the greatest energy per unit carbon. Worldwide efforts increasing compressed natural gas shipments provide further evidence to a shift to methane based fuel.

The largest sources of methane worldwide are trapped in the permafrost and marine sediments in the form of gas hydrates and are estimated to be as large as all oil, coal and conventional gas combined (Moridis et al., 2009). Methane hydrates have the potential to provide the needed energy in a sustainable manner because their extraction can possibly be coupled to a system that allows for the permanent and stable sequestration of carbon dioxide. Interest in methane hydrates as a potential source for clean hydrocarbon energy has been increasing. Natural gas, or methane hydrates are solid, non-stoichiometric compounds of small guest molecules and water (Sloan, 2003). Hydrates form when methane originating from biogenic or thermogenic sources combines with water at sufficiently low temperatures and high pressures where the guest molecule becomes trapped within atomic scale crystalline cages of H2O. Natural forming hydrates have been found as lenses, nodules, and pore infillings on and beneath the sea floor at shallow depths within the ocean sediment around the world, particularly along continental shelves (Alexi and Sassen, 2002). The most promising regions containing natural gas hydrates are located in polar continental sedimentary rock and in the permafrost areas of the Arctic. In comparison with other important carbon deposits, gas hydrates store an extremely large quantity of organic carbon. There are some uncertainties with regard to the global budget, yet it is believed that gas hydrate formations contain approximately 0.2 × 1015 to 120 × 1015 m3 of methane at STP (Sloan and Koh, 2008). USGS surveys have produced estimates of hydrate deposits off the coast of North and South Carolina in the range of 3.6 × 1013 m3, a deposit of this size could supply the US with gas for 55 years at 2010 consumption rates (Demirbas, 2010). Gas hydrates could therefore represent a potentially significant alternative source of energy in the future, replacing or supplementing conventional fossil fuel sources.

There has been a tremendous amount of research done on locating and quantifying gas hydrate resources (Trofimuk and...