American Mineralogist, Volume 89, pages 1240–1246, 2004

Investigation of jet breakup and droplet size distribution of liquid CO_2 and water systems—implications for CO_2 hydrate formation for ocean carbon sequestration

DAVID RIESTENBERG, ELIZABETH CHIU, MONSURU GBORIGI, LIYUAN LIANG, OLIVIA R. WEST, AND COSTAS TSOURIS*

Oak Ridge National Laboratory, P. O. Box 2008, Oak Ridge, Tennessee 37831-6181, U.S.A.

ABSTRACT

An experimental investigation has been conducted into the effect of fluid velocity and orifice size on the breakup patterns of liquid CO_2 in water, as well as those for water in CO_2. Under high-pressure and low-temperature conditions, the jet breakup patterns follow distinct Rayleigh, transitional, and spray modes. Droplet size distribution was determined in the different modes, with the spray mode producing the smallest droplets and the most uniform size distribution. The system appears to progress from transitional to spray mode when the Ohnesorge number is approximately 18 Re^{-1}. Using this relationship, it is possible to predict the minimum injection rate necessary for spray mode at any injector diameter. Under hydrate-forming conditions, the jet breakup did not appear to be affected because breakup occurred faster than hydrate formation. However, injection into a confined space could promote droplet coalescence, resulting in a larger average drop size. These results can be used to control hydrate conversion in an ocean CO_2 injection system and to ensure a large dispersion of injected CO_2 during its sequestration in the ocean.