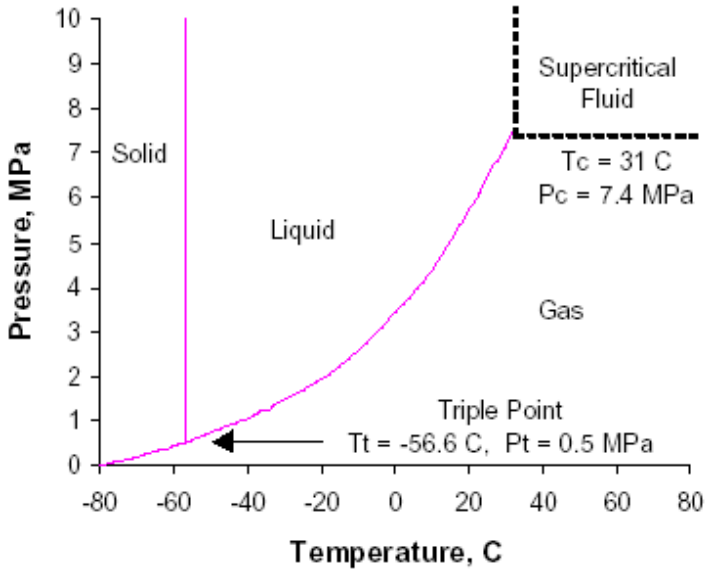
AAPG/SEG/SPE HEDBERG CONFERENCE
"GEOLOGICAL CARBON SEQUESTRATION: PREDICTION AND VERIFICATION"
AUGUST 16-19, 2009 – VANCOUVER, BC, CANADA

Estimation of Storage Capacity of Carbon Dioxide in Subsurface Geological Reservoirs

Dr. Anuj Gupta
Texas A&M University at Qatar, Doha, Qatar

Geological sequestration of Carbon dioxide has gained popular support in recent years. However, engineering and design of the process for depends upon the characteristics of the candidate geological formation. Storage capacity of a formation, per acre-ft, depends upon the properties of Carbon dioxide at the pressure and temperature anticipated in the formation as well as the porosity and fluid saturations of the formation. Carbon dioxide exists as a supercritical fluid at the high pressure and temperature conditions found in a typical oil or gas well. At supercritical fluid conditions, CO2 has a density similar to that of water and low viscosity and diffusivity of a gas.

Above 304.2 K (31.2 ^{o}C) and 7.4 MPa (1074 psi) carbon dioxide behaves as a supercritical fluid and shows properties of both a liquid and a gas. The **phase diagram** of carbon dioxide[1] is shown below.



The Peng Robinson Equation of state was used to obtain the pressure-density data. This is a good choice because it predicts densities fairly accurately in the super critical region. However, experimental data on density of CO2 is not available at very high temperature and pressure conditions and the predictions are subject to experimental validation. The Peng Robinson equation is solved to get one real root that gives the molar volume from which the density is obtained. The calculated density can be used along with porosity measurements to estimate the storage capacity of CO2 in a formation. Such estimates for a range of geological conditions will be presented.

In addition to density, viscosity of Co2 is needed to estimate the rate at which it can be injected into the formation. Two methods were used and compared. The two methods are:

1) Lucas et al method3

Lucas method is one of the widely used equations to find dense gas viscosities. This method takes the temperature and pressure as the input. The calculation procedure is as follows:

For the reduced temperature of interest, parameter Z1 is calculated where

Z1=(0.807(Tr)0.618–0.357exp(-0.449Tr)+0.340exp(-0.449Tr)+
0.340exp(-4.058Tr)+0.018)Fp.Fq

2) Chung et al method3

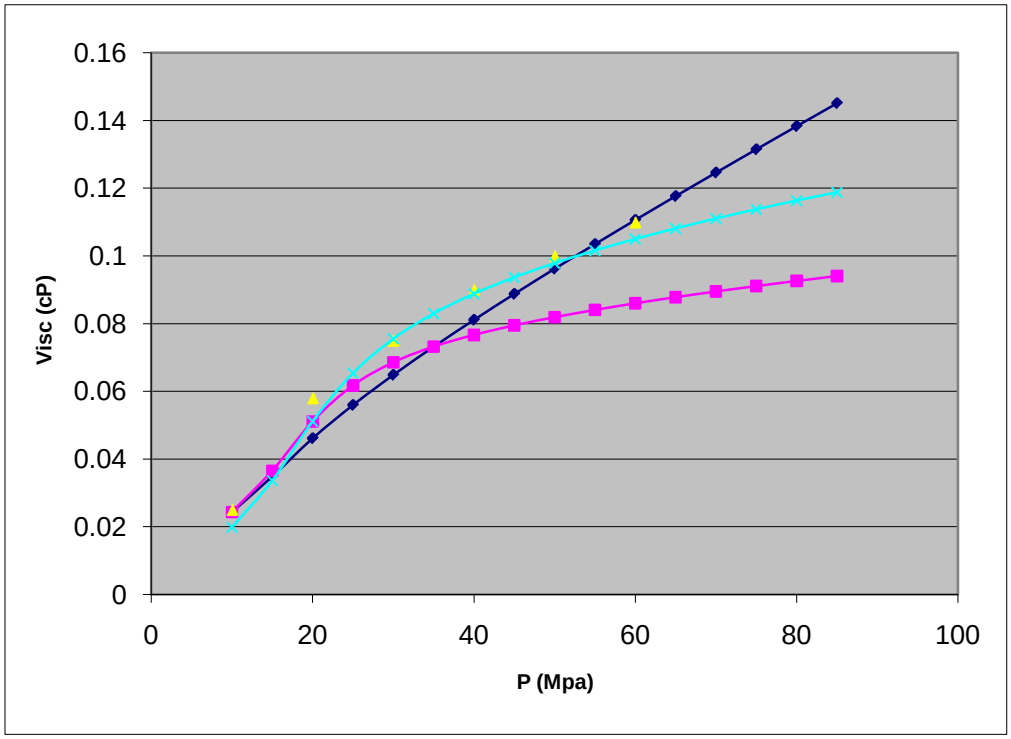
Lucas method is another one of the widely used equations to find dense gas viscosities. This method takes density as the input in addition to temperature and pressure.

The equations involved are:

$$\eta = \frac{\eta 1.(36.344) * \sqrt{MTc}}{Vc^{2/3}}$$

η= viscosity, μP
M= molecular weight, g/mol
Tc=critical temperature, K
Vc=critical volume, cc/mol
η1=parameter involving acentric factor, density, critical volume

Comparison of results:



Conclusions:

- Peng Robinson equation of state gives fairly accurate values of densities when compared to the data in literature
- Chung method gives results closer to the values reported in the literature as compared to the Lucas method though deviations are seen at lower pressures.

References:

1. Colina, C.M., et al; "Thermal Properties of Supercritical Carbon Dioxide by Monte Carlo Simulations", Molecular Simulation, Vol 29 (6-7), pp 405-412, June 2003
2. McHugh, V. Kukronis; Supercritical Fluid Extraction, 2nd ed. Butterworth-Heinemann, Boston, MA
3. Poling, B.E., et al; " Properties of gases and liquids", 5th Ed, McGraw Hill, 2002