Effects of Temperature and Gas Mixing on Formation Pressure, CO_2 Sequestration and Methane Production in Underground Coalbeds*

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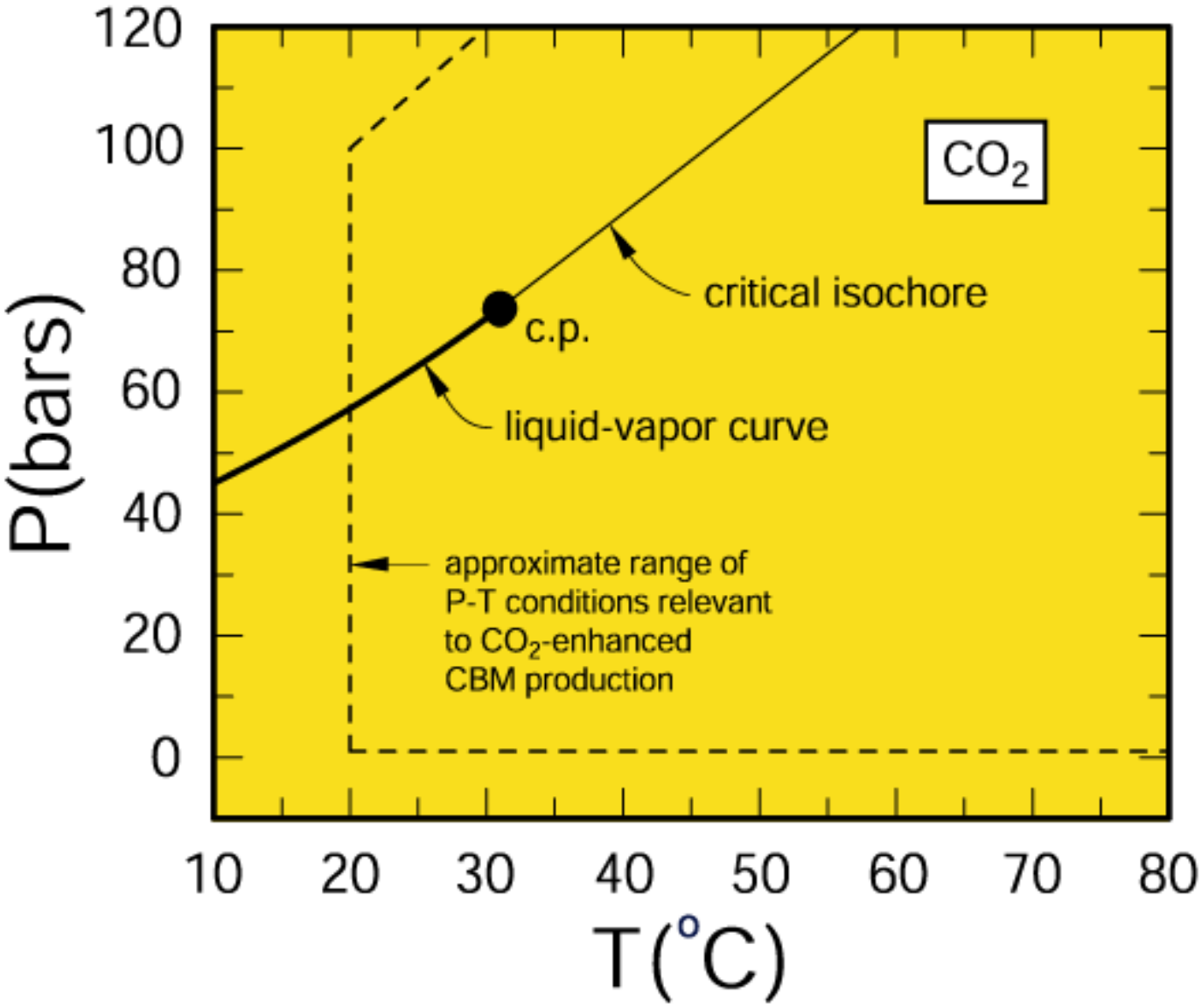
Key Issues

At the elevated temperatures and pressures encountered in deep, unmineable coalbeds:

- The densities and viscosities of binary and ternary CO_2-CH_4-N_2 gas mixtures*
- Rates and magnitudes of gas (CO_2-CH_4 ± N_2) sorption/desorption onto/from “dry” and “moist” coal samples
- Coal swelling/shrinkage in mixed-gas (CO_2-CH_4 ± N_2) pressure media

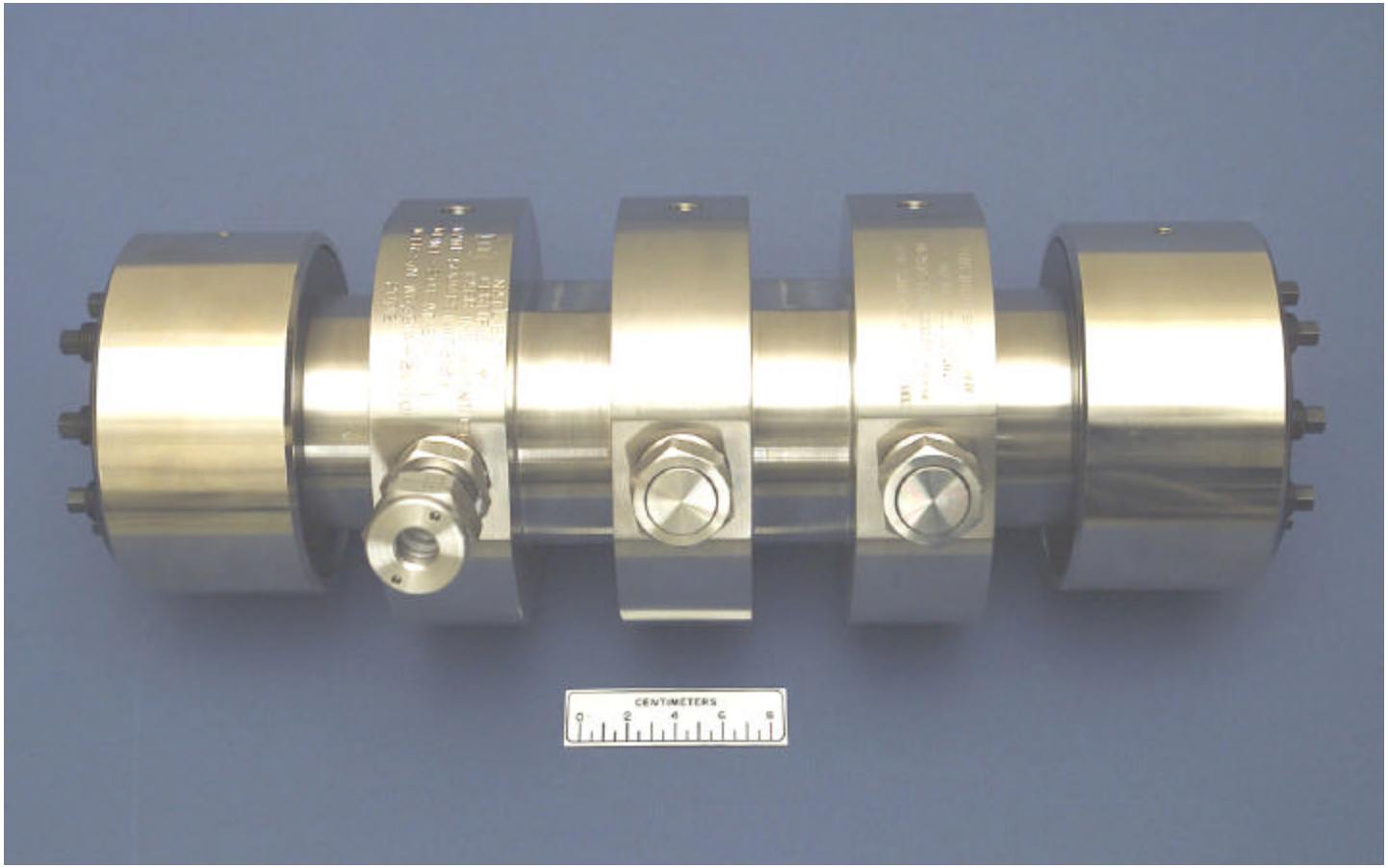
*Principal focus of the new research


120
100
80
60
40
20
0
P(bars)
10
20
30
40
50
60
70
80
T(°C)
CO2
critical isochore
c.p.
liquid-vapor curve
approximate range of
P-T conditions relevant
to CO2-enhanced
CBM production

Approach

- Experiments will be performed at 30-70°C, 10-200 bars, using a custom-designed rocking autoclave apparatus with a 1.2 liter internal volume.
- Discrete masses of pure CO_2, CH_4 and N_2 are loaded into—and aliquots of mixed CO_2-CH_4 ± N_2 gas are extracted from—the autoclave through two injection/ sampling ports during experimentation.
- The density data obtained for binary and ternary CO_2-CH_4-N_2 gases will be used to develop semi-empirical, pressure-explicit equations of state for the mixtures.

Multi-Purpose Autoclave



Justification

- The densities of CO_2-CH_4-N_2 gas mixtures at elevated temperatures and pressures are not accurately predicted by commercial computer codes.
- The viscosities of CO_2-CH_4-N_2 gases have not been measured at temperatures and pressures relevant to CO_2-enhanced CBM production.
- CO_2-CH_4-N_2 mixing is highly nonideal at *P-T* conditions near the critical point of CO_2. Therefore, depending on ambient temperature and pressure, gas mixing could produce strong pressure surges during injection of CO_2 into deep unmineable coalbeds.

Justification (Cont'd)

- Nonideal CO_2-CH_4-N_2 mixing will have significant effects on measured, mixed-gas sorption isotherms for coal, because CO_2-CH_4-N_2 sorption/desorption on coal surfaces depends partly on the fugacities of the gas species, rather than their "ideal" partial pressures.

  [Note: the fugacity of a gas species (component) is its "real pressure" in a thermodynamic system.]

- It may be possible to accurately predict mixed-gas sorption isotherms from: (1) the sorption isotherms for the pure (end-member) gases, and (2) the fugacities of the gas species in the mixed gas.