A Laboratory Procedure of Measuring Ultrasonic Properties of CO_2 Saturated Fluids

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Abstract

CO_2 storage opportunities into geological structures aiming to reduce their emissions into atmosphere have led to many different studies related to seismic monitoring by qualitatively tracking the movement of CO_2 plume in reservoir and quantitatively measure the amount of CO_2 in place with other fluids (oil and/or brine). Recent ultrasonic measurements for CO_2 saturated samples shows the effects of CO_2's vapor-liquid-supercritical phase transitions on the overall rock seismic response. We have also recently observed influence of the rate of cooling and heating on CO_2 condensation and evaporation in a saturated synthetic rock sample. Acoustic properties of end member CO_2 and CO_2 saturated fluids at various temperatures and pressures, therefore, would be useful studies in order to develop theoretical modeling of these observed responses using theories that will include the CO_2 properties more fully. An adapted version of the traditional double reflectors pulse echo method is built to make the measurements of speed of sound in fluids affected by temperature and pressure in order to aid in the interpretation of field seismic observations. As of calibration purposes the speeds of sound of pure water are measured in a temperature range of 10° C to 70° C and at pressures up to 60 MPa. The uncertainty of these measurements is around 0.1% comparing with the formulation of International Association for the Properties of Water and Steam (IAPWS-95). Further measurements in water with 105 ppm salinity show the speeds of sound lie between 0.02% and 0.04% within Wilson's empirical formulations of sound speeds in seawater. However the experimental set-up is now in the process of being modified to take measurements in CO_2 saturated fluids at temperatures and pressures up to 100° C and 80 MPa, respectively, using the pulse-echo double reflectors method and later the results will be compared with observations from CO_2 saturated rock samples.

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