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Gas Membrane Sensor Technique for Long Term Gas Measurements in Deep Boreholes

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The direct determination of the gas composition in subsurface brines in deep boreholes is necessary for the characterization of existing fluids and the monitoring of changes of reservoir gases during industrial use. The conventional methods used for this purpose were mostly expensive and sophisticated techniques and typically involve the collection of discrete samples that are transported to a laboratory for analyses.
Alternatively, the presented new gas membrane sensor technique allows for a permanent collection of gas in the subsurface and the continuous conduction of the gathered gas through a special borehole cable with subsequent real time analyses at the surface. The system is easy to handle, avoids complex mechanical components and therefore reduces costs.
The main component of the gas sensor is a tube-shaped membrane, together with a piezoresistive pressure and temperature transmitter and two stainless steel capillaries embedded in a borehole cable for the gas transport to the surface. A filler material prevents the membrane from collapsing inwardly under pressures exceeding 200 bars.

The practicability of our method was tested by comprehensive laboratory experiments at different pressures, temperatures and salt concentrations and by comparing the results with literature data on gas permeation coefficients and activation energies gained by the conventional “time-lag” method.
By taking into account the permeability coefficient for carbon dioxide in the used polydimethylsiloxan membrane, the Henry-law coefficient and the salting out effect the quantification of dissolved carbon dioxide in deep borehole brines is possible.

The described method was successful applied at the scientific carbon dioxide storage test site in Ketzin, Germany. Changes in the reservoir gas composition were monitored and the breakthrough of injected carbon dioxide and krypton gas tracer into the observation well were recorded.