CO₂ LEAKAGE DETECTION AND LOCATION IDENTIFICATION IN CCS PIPELINES THROUGH ACOUSTIC SENSING

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Abstract:
Carbon Capture and Storage (CCS) is a technology to reduce greenhouse gas emissions from power generation and other industrial processes. Pipelines are the most economic and environmentally friendly way of transporting the captured CO₂ to permanent storage sites such as depleted oil and gas reservoirs. CO₂ transportation is a very important part of the CCS chain, so CO₂ leakage from the pipelines can cause direct economic loss and environmental pollution. Serious CO₂ leakage poses a threat to the safety and health of local residents in the vicinity of the pipelines. Therefore, it is imperative to detect and locate the CO₂ leakage throughout the transportation pipelines.

This paper presents a technique for the CO₂ leakage detection and location identification through acoustic sensing. The technique uses a pair of acoustic sensors, which are installed on two points of a pipeline. When a CO₂ leakage occurs from the pipeline, the pressure at the leaking point will drop suddenly and the leakage source can produce fierce vortex flow with acoustic emission. The acoustic wave propagates along the pipe wall and can be detected by the sensors. The peak amplitude and dominant frequency of the acoustic signal from each sensor are mainly dependent on the size of the leakage hole and the CO₂ pressure condition in the pipeline. The speed of the acoustic wave can be determined by incorporating the pipe material and experimental statistics. The time lag between the two sensors is calculated by cross correlating the acoustic signals. The location of the leakage source is then determined from the acoustic wave speed and the time lag between the two sensors. Since the speed of the acoustic wave changes with its frequency in the propagation process, mode decomposition is taken into account in order to precisely locate the point of leakage. Experimental work was carried out on a pipeline under laboratory conditions. A range of controlled leakage conditions were created and detected using the acoustic sensors. Results obtained are presented and discussed.

Keywords: CCS, leakage, detection, acoustic emissions, acoustic sensors.

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