ABSTRAK

ANALISA PENYIMPANAN CO_2 DI *SALINE AQUIFER* DENGAN PENDEKATAN *FULLY IMPLICIT INTEGRATED NETWORK MODELING* PADA LAPANGAN "AZ"

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Peningkatan emisi karbon dioksida (CO_2) akibat aktivitas industri dan energi mendorong pengembangan teknologi *Carbon Capture and Storage* (CCS) sebagai salah satu solusi mitigasi perubahan iklim. Di antara berbagai opsi geologis, *saline aquifer* memiliki keunggulan dalam penyimpanan CO_2 karena kapasitasnya yang besar, distribusinya yang luas, tidak bergantung pada nilai ekonomis hidrokarbon, serta kestabilan geologi dan geokimia yang tinggi. Lapangan "AZ", yang terletak berdekatan dengan salah satu pembangkit listrik beremisi 2,2 juta ton CO_2 per tahun, dipilih sebagai lokasi studi penyimpanan.

Penelitian ini bertujuan untuk menganalisis mekanisme pemerangkapan (*trapping mechanism*) dan mengoptimalkan kapasitas penyimpanan (*storativity*) CO_2 menggunakan pendekatan pemodelan terintegrasi secara *fully implicit*. Pemodelan dilakukan dengan membangun model statik dan dinamik *saline aquifer* formasi Johansen, serta integrasi dengan sumur dan fasilitas permukaan melalui fitur *well designer* dan *network designer* di tNavigator. Simulasi dijalankan selama 140 tahun, meliputi 40 tahun masa injeksi dan 100 tahun pasca-injeksi.

Hasil simulasi menunjukkan bahwa Lapangan "AZ" mampu menyimpan CO_2 sebesar 1,58372 TSCF dengan dominasi mekanisme *solubility trapping*/*residual trapping*, selain dari *structural trapping*. Tidak ditemukan indikasi kebocoran ke permukaan, yang menunjukkan bahwa integritas *caprock* tetap terjaga sepanjang periode simulasi. Pemodelan terintegrasi secara *fully implicit* terbukti efektif dalam merepresentasikan interaksi dinamis antara *reservoir*, sumur, dan fasilitas permukaan, sehingga mendukung Lapangan "AZ" sebagai lokasi penyimpanan CO_2 yang aman dan berkelanjutan.

Kata kunci: *deep saline aquifer, carbon capture and storage* (CCS), *trapping mechanism, storativity, integrated network modeling*

ABSTRACT

ANALYSIS OF CO_2 STORAGE IN A SALINE AQUIFER USING A FULLY IMPLICIT INTEGRATED NETWORK MODELING APPROACH IN THE 'AZ' FIELD

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The increasing carbon dioxide (CO_2) emissions from industrial and energy activities have driven the development of Carbon Capture and Storage (CCS) technology as a key solution for climate change mitigation. Among various geological storage options, saline aquifers offer significant advantages due to their large storage capacity, wide distribution, independence from hydrocarbon value, and stable geological and geochemical conditions. The "AZ" Field, located near a power plant emitting 2.2 million tons of CO_2 annually, was selected as the study site for CO_2 storage.

This study aims to analyze the trapping mechanisms and optimize the CO_2 storage capacity (storativity) using a fully implicit integrated modeling approach. The methodology involves building a static and dynamic model of the Johansen Formation saline aquifer, and integrating well and surface facility models using the well designer and network designer features in tNavigator. A 140-year simulation was conducted, comprising 40 years of injection and 100 years of post-injection period.

Simulation results show that the "AZ" Field can store up to 1.58372 TSCF of CO_2, predominantly through solubility/residual trapping mechanisms, in addition to structural trapping. No leakage was observed to the surface, indicating that caprock integrity remained intact throughout the simulation period. The fully implicit integrated modeling approach effectively captured the dynamic interactions between the reservoir, wells, and surface facilities, supporting the feasibility of the "AZ" Field as a safe and sustainable CO_2 storage site.

Keywords: deep saline aquifer, carbon capture and storage (CCS), *trapping mechanism, storativity, integrated network modeling*