

INTISARI

ANALISIS PERAMBATAN GELOMBANG SEISMIC ELASTIK 2D DENGAN METODE *FINITE DIFFERENCE* ORDE SPASIAL-8,-12, DAN-16 PADA MODEL SINTETIK RESERVOAR HIDROKARBON

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Penelitian ini menganalisis perambatan gelombang seismik elastik 2D menggunakan metode *finite difference* dengan variasi orde spasial-8,-12, dan -16 pada model sintetik reservoir hidrokarbon berstruktur antiklin. Simulasi dilakukan menggunakan skema beda hingga orde kedua pada domain waktu dan orde tinggi pada domain spasial. Evaluasi dilakukan melalui *shot gather*, *wiggle plot*, serta parameter *time-frequency misfit* (TFM) dan *goodness-of-fit* (TFG) pada berbagai *zero-offset*, *near-offset*, *mid-offset*, dan *far-offset*.

Hasil menunjukkan bahwa peningkatan orde spasial mengurangi dispersi numerik dan menghasilkan gelombang yang lebih halus. Orde-8 menunjukkan osilasi ekor (*ringing*) pada *far-offset* yang mengaburkan refleksi dan fenomena AVO. Orde-12 dan -16 berhasil menekan artefak tersebut, menghasilkan citra seismik yang lebih tajam. Dengan TFG orde-12 vs orde-16 tetap "*very good*" hingga "*excellent*" ($GOF > 9,3$) bahkan pada *far-offset*, sementara orde-8 mengalami degradasi signifikan ke kategori "*good*" ($GOF \approx 7,9$). Waktu komputasi meningkat seiring orde ($14.560 \rightarrow 17.990 \rightarrow 20.353$ detik), namun efisiensi CPU tetap tinggi (97–99%) dan penggunaan memori yang relatif stabil. Secara keseluruhan, Orde-12 memberikan keseimbangan optimal antara akurasi dan efisiensi komputasi.

Kata kunci: gelombang elastik, *finite difference*, orde tinggi, dispersi numerik, *time-frequency misfit*, *time-frequency goodness of fit*, efisiensi komputasi, hidrokarbon

ABSTRACT

ANALYSIS OF 2D ELASTIC SEISMIC WAVE PROPAGATION USING FINITE DIFFERENCE METHOD WITH 8TH-, 12TH-, 16TH-ORDER SPATIAL SCHEMES ON A SYNTHETIC HYDROCARBON RESERVOIR MODEL

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This study analyzes the propagation of 2D elastic seismic waves using the finite difference method with spatial orders of 8, 12, and 16 on a synthetic hydrocarbon reservoir model with an anticline structure. The simulations were carried out using a second-order finite difference scheme in the time domain and higher-order schemes in the spatial domain. Evaluation was conducted through shot gathers, wiggle plots, as well as time-frequency misfit (TFM) and goodness-of-fit (TFG) parameters at various zero-offset, near-offset, mid-offset, and far-offset positions.

The results indicate that increasing the spatial order reduces numerical dispersion and produces smoother wavefields. The 8th-order scheme exhibits tail oscillations (ringing) at far-offsets, obscuring reflections and AVO phenomena. The 12th- and 16th-order schemes successfully suppress these artifacts, yielding sharper seismic images. With TFG values for the 12th- and 16th-order schemes remaining in the “very good” to “excellent” range ($GOF > 9.3$) even at far-offsets, the 8th-order scheme shows significant degradation to the “good” category ($GOF \approx 7.9$). Computational time increases with order ($14,560 \rightarrow 17,990 \rightarrow 20,353$ seconds), yet CPU efficiency remains high (97–99%) with relatively stable memory usage. Overall, the 12th-order scheme provides the optimal balance between accuracy and computational efficiency.

Keywords: *elastic wave, finite difference, high-order scheme, numerical dispersion, time-frequency misfit, time-frequency goodness of fit, computational efficiency, hydrocarbon*