

RINGKASAN

Lapangan RS merupakan lapangan minyak baru yang sedang berada dalam tahapan pengembangan dengan reservoir *carbonate* sebagai zona produksi. Zona A merupakan salah satu lapisan reservoir dengan estimasi jumlah cadangan minyak terbesar yang telah diproduksi sejak bulan Oktober tahun 2019. Injeksi air mulai dilakukan melalui satu sumur injeksi pada bulan November tahun 2020. Sampai dengan bulan Desember tahun 2022, terdapat 8 sumur produksi (6 sumur aktif dan 2 sumur *inactive*) dengan kumulatif produksi minyak sebesar 3.64 MMSTB. Dari data produksi yg diperoleh, diketahui bahwa terjadinya penurunan tekanan reservoir inisial sebesar 3,400 psig menjadi 2,647 psig pada bulan Desember tahun 2022. Penurunan tekanan yang cukup signifikan tersebut merupakan indikasi bahwa injeksi air belum optimal dalam mempertahankan tekanan reservoir. Analisis lebih lanjut dan lebih detail mengenai evaluasi kinerja injeksi air sebagai *pressure maintenance* dengan metode *monitoring surveillance* dan karakterisasi reservoir menjadi bagian penting sebagai referensi pengembangan lapangan jangka panjang agar Lapangan RS dapat mempertahankan tekanan reservoir dan memberikan perolehan produksi minyak yang optimal.

Penelitian dibagi menjadi tiga tahap analisis yaitu evaluasi injeksi air (*pressure maintenance*) *surveillance*; evaluasi karakteristik reservoir; dan optimasi menggunakan simulasi reservoir. Analisis *surveillance* meliputi analisis performa produksi dan injeksi; analisis performa tekanan; analisis *voidage replacement ratio* (VRR); analisis *Hall's Plot* dan *Chan's Diagnostic Plot*. Evaluasi karakteristik reservoir meliputi analisis terhadap jumlah cadangan sisa; jenis *drive mechanism* yang bekerja; profil fasa pendesakan dalam reservoir berdasarkan analisis *fractional flow* (Buckley-Leverett); profil kualitas reservoir dan heterogenitas reservoir; serta kondisi tekanan reservoir Lapangan RS. Pemodelan *material balance* digunakan sebagai simulasi awal untuk optimasi sumur injeksi dan prediksi performa produksi.

Berdasarkan tahapan analisis *surveillance*, injeksi air pada reservoir Zona A Lapangan RS belum optimal dalam mempertahankan tekanan reservoir dan meningkatkan perolehan minyak. Berdasarkan evaluasi karakteristik reservoir, Zona A pada Lapangan RS *compatible* untuk dilakukan optimasi *injeksi air* dengan memperhatikan heterogenitas reservoir dan kualitas air injeksi. Optimasi injeksi air dapat dilakukan untuk mempertahankan nilai *voidage replacement ratio* pada kondisi setimbang (VRR=1). Berdasarkan *production prediction* model *material balance*, reservoir Zona A mampu memproduksi minyak dengan laju alir sebesar 3038.36 BOPD; mampu mempertahankan tekanan reservoir sampai dengan 1679.28 psig; nilai *water cut* reservoir mencapai 77.82%; dan nilai *cumulative oil production* sebesar 31.14MMSTB atau setara dengan 12.50% *recovery factor*. Pemodelan reservoir 3 Dimensi perlu dilakukan untuk mensimulasikan skenario lanjutan optimasi injeksi air sebagai *pressure maintenance* di lapangan RS.

Kata kunci: reservoir, injeksi air, *pressure maintenance*, karakterisasi reservoir, model *material balance*

ABSTRACT

The RS field is a green oil field that is in development stage with a carbonate reservoir as the interest zone. A zone is one of the reservoir zones of the field with the highest oil reserve and has been produced since October 2019. A water injection program has been applied through one injection well since November 2020. Until December 2022, there are 8 production wells (6 active producers and 2 shut-in wells) with 2.64 MMSTB of oil cumulative production. Based on production data, the reservoir pressure is decreased from 3,400 psig to 2,647 psig at cut-off date (December 2020). The significant pressure decline is an indicator that the injection program in A zone is not optimum yet in maintaining the reservoir pressure. Therefore, a further detail and comprehensive analysis to evaluate and optimize the pressure maintenance program through monitoring surveillance and reservoir characterization is required. The objective is to optimize the pressure maintenance program and to increase the oil recovery of A zone in RS field.

This study consists of three steps of analysis: the evaluation of existing water injection (pressure maintenance) surveillance; reservoir characterization evaluation; and reservoir simulation study. Surveillance analysis includes production and injection performance analysis; pressure performance analysis; voidage replacement ratio (VRR) analysis; Hall's Plot analysis and Chan's Diagnostic Plot analysis. Reservoir characterization evaluation includes remaining reserve evaluation; drive mechanism analysis; reservoir displacement profile phase based on fractional flow analysis (Buckley-Leverett); quality and reservoir heterogeneity; and reservoir pressure condition analysis. Material balance modeling is used as an initial simulation for optimization of injection wells and production performance prediction.

Based on surveillance analysis, water injection in the Zone A reservoir of the RS Field, it is not yet optimal in maintaining reservoir pressure and increasing oil recovery. Based on the evaluation of reservoir characteristics, Zone A in the RS Field is compatible for optimization of water injection taking into account reservoir heterogeneity and injection water quality. Water injection optimization can be done to maintain the value of voidage replacement ratio at equilibrium conditions ($VRR=1$). Based on production prediction model material balance, if produced with $VRR = 1$, until the end of the contract (October 2039), the Zone A reservoir is capable of producing oil with a flow rate of 3038.36 BOPD; capable of maintaining reservoir pressure up to 1679.28 psig; water cut reservoir reached 77.82%; and cumulative oil production is 31.14MMSTB or equivalent to 12.50% of recovery factor. 3-D reservoir modelling is required to determine advanced scenarios of water injection for pressure maintenance in RS field.

Keywords: *reservoir, water injection, pressure maintenance, reservoir characterization, reservoir simulation*