RINGKASAN

Lapangan Batang telah diproduksikan selama 46 tahun namun *recovery factor* (RF) hanya sekitar 14.73% pada 31 Mar 2020. Minyak yang dihasilkan berupa minyak berat dengan 22,1^o API. Selama ini produksi minyak dilakukan menggunakan injeksi uap secara *huff & puff* dengan kualitas 70-80% pada temperatur 400-500 ^{o}F dan tekanan ~300 psig. Produksi secara *huff & puff* kurang optimum dan untuk meningkatkan RF diperlukan metode injeksi uap. Dalam perencanaan injeksi uap diketahui akan terjadi *steam breakthrough* disumur produksi. *Steam breakthrough* terproduksi perlu ditangani untuk diubah menjadi kondensat air dan minyak terikut tidak mencemari lingkungan.

Permasalahan *steam breakthrough* dapat ditangani dengan memanfaatkan panasnya untuk menaikkan panas fluida kerja air umpan *Boiler*. Sistem tersebut terdiri dari pipa *steam breakthrough* dari sumur ke *heat exchanger*, *Heat exchanger* sebagai media transfer panas kedua fluida, pipa fluida kerja dari *heat exchanger* ke *Boiler*. *Steam breakthrough* berasal dari Sumur P3 dan P4 dengan total laju alir volumetrik 3520 BCWEPD, laju alir massa 51304,25 lb/hr, tekanan dan temperatur rata – rata 184,0 psig dan 44,25,8 ^{o}F. Laju alir volumetrik fluida kerja 3500 BCWEPD, laju alir massa 51012,7 lb/hr, tekanan 300 psig dan temperatur 89,6^{o}F. Jarak dari sumur *breakthrough* ke *heat exchanger* dengan panjang 3510 ft. Jarak dari *heat exchanger* ke *Boiler* sepanjang 100 m.

Fasilitas pemanfaatan *steam breakthrough* terdiri dari pipa dari sumur ke *heat exchanger* memiliki *inside diameter* 6,065 in dengan *pressure drop* 7,6 psi dan hilang panas 5 ^{o}F. *Heat exchanger* tipe *plate* dengan luas transfer panas 900 ft^2 dan efisiensi 94,88%, pipa fluida kerja dari *heat exchanger* ke *Boiler* dengan *inside diameter* 4,026 in dengan *pressure drop* 0,9 psi dan hilang panas 0,1 ^{o}F. *Boiler* dengan temperatur fluida kerja masuk 89,6 ^{o}F memerlukan panas pembakaran sebesar 1.476 MMBtu/hari dan biaya produksi Rp 214 juta/hari. *Boiler* dengan tambahan *heat exchanger* memiliki temperatur fluida kerja masuk *Boiler* 349 ^{o}F dan memerlukan panas pembakaran sebesar 1.035 MMBtu/hari serta *biaya produksi* Rp 150 juta/hari. Pada analisa keekonomian didapatkan biaya investasi *heat exchanger* sebesar Rp 4,70 milyar, biaya investasi Pipa sebesar Rp 5,09 milyar, total biaya investasi sebesar Rp 36,3 milyar, keuntungan sebesar Rp 64.07 milyar per hari maka didapatkan POT selama 1,5 tahun, NPV senilai Rp 20,90 milyar, IRR sebesar 40% dan ROI sebesar 0,93.

Kata Kunci: *Steam breakthrough*, *Heat exchanger*, *Boiler*, pemanfaatan panas.

ABSTRACT

The Batang field has been in production for 46 years but the recovery factor (RF) is only around 14.73% as of 31 Mar 2020. The oil produced is heavy oil with 22.1o API. So far, oil production has been carried out using huff & puff steam injection with a quality of 70-80% at a temperature of 400-500 oF and a pressure of ~300 psig. Production of huff & puff is less than optimal and to increase RF steam injection method is needed. In planning for steam injection, it is known that steam breakthrough will occur during production. Breakthrough steam produced which needs to be handled for conversion to air and oil condensate is also not an environmental issue.

The steam breakthrough problem can be handled by utilizing its heat to increase the heat of the Boiler feed water working fluid. The system consists of a breakthrough steam pipe from the well to the heat exchanger, a heat exchanger as a heat transfer medium for the two fluids, a working fluid pipe from the heat exchanger to the boiler. Breakthrough steam from Wells P3 and P4 with a total volumetric flow rate of 3520 BCWEPD, mass flow rate of 11339.4 lb/hr, pressure and average temperature of 184,0 psig and 44,25.8 oF. The volumetric flow rate of the working fluid is 3500 BCWEPD, the mass flow rate is 51012.7 lb/hr, the pressure is 300 psig and the temperature is 89.6oF. The distance from the breakthrough well to the heat exchanger is 3510 ft. The distance from the heat exchanger to the boiler is 100 m.

The breakthrough steam utilization facility consists of a well pipe to a heat exchanger having an inside diameter of 6,065 in with a pressure drop of 12.2 psi and heat loss of 7.5 oF. Plate type heat exchanger with a heat transfer area of 900 ft2 and an efficiency of 94.88%, working fluid pipe from the heat exchanger to the boiler with an inner diameter of 4,026 in with a pressure drop of 0.9 psi and heat loss of 0.1 oF. A boiler with an inlet working fluid temperature of 89.6 oF requires a heat of combustion of 1,476 MMBtu/day and a production cost of Rp. 214 million/day. Boilers with additional heat exchangers have a working fluid temperature that enters the Boiler at 349 oF and requires heat of 1,035 MMBtu/day and a production cost of Rp. 150 million/day. In the economic analysis, the investment cost of heat exchanger is Rp. 4.70 billion, Pipe investment cost is Rp. 5.09 billion, total investment cost is Rp. 36.3 billion, profit is Rp. 64.07 billion per day, so POT is obtained for 1, 5 years, NPV of Rp 20.90 billion, IRR of 40% and ROI of 0.93.

Keywords: Steam breakthrough, heat exchanger, Boiler, heat utilization.