Analisis Tekno-ekonomi Sistem Pengering Biomassa Berbasis Panas Limbah Boiler pada Pembangkit Listrik Tenaga Co-firing Batubara = Techno-economic Analysis of Boiler Waste Heat-based Biomass Drying System of a Coal Co-firing Power Plant

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Abstrak

Langkah konservasi energi penelitian ini mengupayakan peningkatan efisiensi pada teknik co-firing yang sudah umum dilakukan di Indonesia melalui sistem pengering biomassa. Percobaan dilakukan melalui pengujian salah satu pembangkit PLTU di area Jawa Barat dengan daya terpasang 3 x 350 MW yang sudah menerapkan co-firing sejak tahun 2021. Sistem pengering dipilih menggunakan jenis Rotary Drum Dryer dengan media pemanas berupa limbah panas gas buang exit boiler yang diambil setelah IDF #1 dengan tekanan ± 20 pa dan temperature 150 oC. Tekanan keluaran IDF #1 sangat rendah membutuhkan energi tambahan besar centrifugal fan dalam menyalurkan flue gas melalui pipa sepanjang ± 500 m sampai menuju lokasi dryer di area coal yard, dekat penyimpanan biomassa dan conveyor batu bara penyuplai bahan bakar ke sistem pembangkit. Biomassa disupplai dari pengusaha lokal sekitar lokasi pembangkit antara lain terdiri dari 90% sawdust dan 10% sekam padi. Memiliki kandungan rata-rata moisture campuran (44,57% dan rata-rata calorific value campuran (2.673,72 Kcal/Kg. Kapasitas pengering disesuaikan dengan kemampuan supplai biomassa sebesar 200 t/day. Pengujian dilakukan menggunakan simulasi pengering rotary dryer pada Aspen Plus dengan memvariasikan flow inlet biomass 8, 9 dan 10 t/h, flue gas flow 70, 80 dan 90 t/h serta residence time 15, 20 dan 25 menit. Moisture produk dry biomass terendah diperoleh 6,54% pada pengujian flow inlet biomass 8 t/h, flue gas flow 90 t/h dan residence time 25 menit. Hasil simulasi Aspen kemudian dibandingkan pada 5 kriteria penilaian kelayakan investasi yaitu NPV, IRR, Payback Period (PBP), Benefit and Cost (B/C) Ratio dan ROI. Hasilnya walaupun moisture produk dry biomass diperoleh lebih besar 10,9%, namun nilai NPV, IRR dan PBP, masing-masing sebesar Rp. 116.445.284.041,63, 150,32% dan 0,67 tahun, diperoleh sebagai yang terbaik pada pengujian flow inlet biomass 10 t/h, flue gas flow 90 t/h dan residence time 25 menit. Hal ini karena flow rate produk dry biomass lebih besar sehingga mampu membangkitkan selisih energy output yang lebih besar pula pada generator pembangkit. Sedangkan hasil terbaik B/C Ratio dan ROI, masing-masing sebesar 4,14 dan 314,12%, didapatkan saat pengujian flow inlet biomass 10 t/h, flue gas flow 80 t/h dan residence time 25 menit, hal ini karena energi tambahan untuk mendorong flue gas lebih kecil sehingga mempengaruhi B/C Ratio dan ROI. Penurunan energy output dan operational duration harus sedapat mungkin dihindari karena dampaknya sangat significant dalam menurunkan nilai 5 kriteria penilaian investasi. Validasi desain sistem pengering pada Aspen juga dilakukan untuk mengetahui akurasi.

.....This energy-conservation research aims to improve the efficiency of the cofiring process, which is widely utilized in Indonesia, using a biomass drying system. The experiment was conducted on a steam-coal power station in the West Java area with an installed power of 3 x 350 MW, which has been using cofiring since 2021. The drying method was selected utilizing a Rotary Drum Dryer type with a heating medium from waste heat of exhaust boiler flue gas obtained after IDF # 1, with pressure ± 20 pa and temperature 150 oC. The output pressure of IDF #1 is very low, requiring large additional energy from the centrifugal fan to

flow the flue gas through a pipe measuring ± 500 m long to the dryer location in the coal yard area, near the biomass storage and coal conveyor that supplies fuel to the boiler system. Biomass is supplied from local suppliers around power plant location, consisting of 90% sawdust and 10% rice husks. It has an average mixed moisture content 44.57% and an average mixed calorific value 2,673.72 Kcal/Kg. The dryer capacity is adjusted to the biomass supply capability of 200 t/day. Experiments were carried out using a rotary dryer simulation on Aspen Plus by varying biomass inlet flow of 8, 9 and 10 t/h, flue gas flow of 70, 80 and 90 t/h and residence time of 15, 20 and 25 minutes. The lowest dry biomass product moisture was obtained at 6.54% in the biomass inlet flow test of 8 t/h, flue gas flow of 90 t/h and residence time of 25 minutes. The results from Aspen simulation then compared with 5 investment assessment criteria: NPV, IRR, Payback Period (PBP), Benefit and Cost (B/C) Ratio and ROI. Even though the moisture content of the dry biomass product was 10.9%, which was higher than the smallest value, the biomass inlet flow test yielded the best NPV, IRR, and PBP values, including Rp. 116,445,284,041.63 for NPV, 150.32% for IRR, and 0.67 years for PBP, with a biomass inlet flow test of 10 t/h, a flue gas flow of 90 t/h, and a residence time of 25 minutes. This is because the flow rate of the dry biomass product is greater, so it can generate a larger energy output in the power plant generator. Meanwhile, the best B/C Ratio and ROI findings, including 4.14 and 314.12%, were obtained by testing the biomass inlet flow of 10 t/h, flue gas flow of 80 t/h, and residence period of 25 minutes, this is because the additional energy to push the flue gas is smaller, thus affecting the B/C Ratio and ROI. Decreasing energy output and operational duration must be avoided wherever possible because the impact is very significant in reducing the value of the 5 investment assessment criteria. Validation of the drying system design for Aspen was also carried out to determine accuracy.