

ABSTRAK

Black urea adalah modifikasi pupuk urea yang dilapisi asam humat dari batubara berkualitas rendah jenis lignit guna meningkatkan efisiensi pemupukan sebesar 25% dan meningkatkan kadar Nitrogen sebesar 10%. Pabrik *Black Urea* saat ini belum ada sehingga menjadi potensi besar untuk mendirikan pabrik tersebut. Pabrik ini dirancang pada kapasitas 183.000 ton/tahun. Produksi *black urea* membutuhkan urea sebanyak 170.000 ton/tahun dan batubara lignit sebanyak 31.309,84 ton/tahun.

Proses produksi dimulai dengan mengecilkan batubara hingga 0,175 mm dan dioksidasi dengan larutan H_2O_2 30% pada suhu 60°C dan tekanan 1 atm. Batubara teroksidasi kemudian diekstraksi dengan larutan KOH 0,5 M pada suhu 70°C dan tekanan 1 atm sehingga menghasilkan filtrat yang kaya kalium humat. Batubara residu dimanfaatkan untuk bahan bakar di *boiler*, sedangkan filtrat diteruskan ke Reaktor Presipitasi. Presipitasi asam humat dilakukan dengan menambahkan larutan HCl 6 M pada suhu 35°C dan tekanan 1 atm. Asam humat yang tidak dapat larut dalam kondisi asam akan mengendap dan dikirim ke unit *coating*. Proses *coating* urea dimulai dengan pemanasan urea hingga suhu 75°C kemudian dilapisi dengan *neem oil*, Ca-lignosulfonat, dan terakhir dengan asam humat. Produk *black urea* kemudian didinginkan hingga 35°C sebelum disimpan di tangki penyimpanan.

Kebutuhan air diperoleh dari Sungai Sangatta sebanyak 30.740,99 kg/jam. Kebutuhan *steam* sebanyak 1.072,96 kg/jam. *Steam* dibangkitkan dari hasil pembakaran batubara residu hasil oksidasi+ekstraksi sebanyak 210,27 kg/jam dan udara sebanyak 1.670,803 kg/jam. Jumlah udara instrumen sebanyak 775,99 kg/jam. Kebutuhan listrik total pabrik yaitu 1540,27 kVA yang dipasok oleh PLN ULP Sangatta. Pabrik didirikan di Kabupaten Kutai Timur, Provinsi Kalimantan Timur dengan luas area pabrik yaitu 2 ha. Pabrik beroperasi 24 jam dalam sehari selama 330 hari/tahun. Jumlah total pegawai yaitu 187 orang dengan 60 orang operator.

Modal yang dibutuhkan untuk mendirikan Pabrik *Black Urea* yaitu *fixed capital investment* sebesar \$24.553.215,83 atau Rp393.505.796.414,09 dan *working capital* sebesar \$46.010.250,68 atau Rp737.390.184.024,80. Hasil analisis kelayakan yang dilakukan adalah nilai *pay out time* (POT) *before tax* sebesar 1,59 tahun dan POT *after tax* sebesar 2,01 tahun. *Return of investment* (ROI) *before tax* yaitu 52,89% dan ROI *after tax* yaitu 39,66%. Nilai *discounted cash flow rate of return* (DCFRR) yaitu 22,74%, *breakeven point* (BEP) sebesar 55,06%, dan *shutdown point* (SDP) sebesar 44,86%. Sebagai *high risk chemical industry*, Pabrik *Black Urea* telah memenuhi standard parameter yang ada sehingga menarik dan layak untuk dikaji lebih lanjut.

Kata Kunci: asam humat, batubara, *black urea*, lignit, pupuk, urea

ABSTRACT

Black urea is a modification of urea fertilizer coated with humic acid from low-quality coal to increase fertilizer efficiency by 25% and increase Nitrogen content in urea by 10%. There is currently no existing black urea plant in Indonesia, so it is a great potential to establish the plant. This Black Urea Plant is designed to produce 183.000 tons/year of black urea. The raw material needed are 170.000 tons/year of urea and 31.309,84 tons/year lignite coal.

The process starts with the comminution of coal to 0,175 mm which is then oxidized using 30% H₂O₂ solution at 60°C and 1 atm. The oxidized coal is then extracted with 0,5 M KOH solution at 70°C and 1 atm to produce a potassium humate-rich filtrate. The residual coal is then utilised as the main source of fuel for the boiler, whereas the filtrate is sent to Precipitation Unit. The precipitation of humic acid is done by adding 6 M HCl solution at 35°C and 1 atm. Humic acid is not soluble in an acidic medium, hence the humic acid will turn into a solid sediment and will be sent to the coating unit. The coating starts by heating the urea to 75°C which is then coated with neem oil, ca-lignosulfonate, and humic acid. The black urea product is then cooled to 35°C before stored in the storage tank.

The amount of water needed for the Black Urea Plant is 30.740,99 kg/jam and collected from Sangat River. The steam needed for the process is 1.072,96 kg/jam. Steam is generated from the combustion of 210,27 kg/jam residual coal from oxidation+extraction process with 1.670,803 kg/jam air. The amount of instrument air needed is 775,99 kg/jam. The amount of electricity to power the plant is 1.540,27 kVA which is supplied by PLN ULP Sangatta. The Black Urea Plant is planned to be built at Kabupaten Kutai Timur, Provinsi Kalimantan Timur with the area of 2 ha. The plant operates for 24 hours a day fro 330 days a year. The plant needs 187 workers with 60 operators.

Based on the economic and feasibility analysis that has been carried out, the capital required to establish the Black Urea Plant is a fixed capital investment of \$24.553.215,83 or Rp393.505.796.414,09 and working capital of \$46.010.250,68 or Rp737.390.184.024,80. The results of the feasibility analysis carried out are the value of pay out time (POT) before tax of 1.59 years and POT after tax of 2.01 years. Return of investment (ROI) before tax is 52,89% and ROI after tax is 39,66%. The discounted cash flow rate of return (DCFRR) is 22.74%, the breakeven point (BEP) is 55,06%, and the shutdown point (SDP) is 44,86%. As a high-risk chemical industry, the Black Urea Plant has met the existing standard parameters so that it is interesting and worthy of further study.

Keywords: black urea, coal, fertilizer, humic acid, lignite, urea.