

INTISARI

Starch nitrate atau *nitrostarch* adalah senyawa turunan pati yang mengandung gugus nitrat dengan rumus kimia $(C_6H_7O_2(ONO_2)_3)$. *Starch nitrate* memiliki sifat oksidator kuat dan eksplosif yang memungkinkannya digunakan sebagai bahan baku dalam formulasi bahan peledak. Kebutuhan impor bahan peledak di Indonesia terus meningkat setiap tahunnya dan diprediksi akan mencapai 42.940 ton pada tahun 2029. Pabrik bahan peledak emulsi berbasis *starch nitrate* ini dirancang dengan kapasitas produksi sebesar 4.400 ton/tahun dan beroperasi secara *batch*. Untuk memenuhi kapasitas produksi pabrik, dibutuhkan bahan baku berupa *corn starch* sebesar 495,8182 ton/tahun dan asam nitrat 98% sebesar 1.472,7273 ton/tahun. Sementara itu, untuk bahan pendukung, diperlukan amonium nitrat sebesar 2.692,5696 ton/tahun, natrium nitrat sebesar 450,4455 ton/tahun, *fuel oil* sebesar 155.928,4870 L/tahun, PIBSA sebesar 37,0800 ton/tahun, dan *microballoons* sebesar 36,0000 ton/tahun. Pabrik ini juga menghasilkan produk samping berupa asam nitrat 50% sebesar 1.741,0909 ton/tahun.

Produksi *emulsion explosives starch nitrate* pada pabrik ini terdiri dari beberapa tahap, yaitu proses nitrasi, pengenceran asam nitrat, filtrasi, dan emulsifikasi. Pada proses nitrasi, bahan baku berupa *corn starch* dinitrasi dalam reaktor menggunakan asam nitrat 98% dengan rasio 1:3, reaksi bersifat eksotermis dan dikendalikan pada tekanan 1 atm dan suhu 20°C dengan *chilled water* dalam jaket pendingin. Proses dilanjutkan dengan pengenceran asam nitrat hingga 50% menggunakan *mixer* dan pengurangan kadar air pada *starch nitrate* hingga 14% melalui proses filtrasi di *Nutsche Filter*. *Starch nitrate cake* yang dihasilkan lalu dicampur dengan amonium nitrat dan natrium nitrat kemudian diemulsifikasi dalam *Ribbon Blender* menggunakan *Polyisobutylene Succinic Anhydride* (PIBSA), *fuel oil*, dan *glass microballoons* untuk menghasilkan *emulsion explosive* yang homogen dan dikemas dalam selongsong.

Pabrik bahan peledak emulsi *starch nitrate* direncanakan berdiri di daerah Cikampek, Kabupaten Karawang, Jawa Barat dengan luas area sebesar 4,1104 hektar dan karyawan sebanyak 169 orang. Kebutuhan pabrik meliputi kebutuhan air sebanyak 5.953,8934 kg/jam yang diperoleh dari Sungai Citarum, kebutuhan listrik pabrik sebesar 386,5708 kW, kebutuhan udara sebesar 1.133,5671 kg/jam, dan kebutuhan steam sebesar 143,6727 kg/jam.

Pabrik ini membutuhkan *fix capital* sebesar \$6.016.530,44 + Rp168.386.048.727,44 dan *working capital* sebesar \$4.823.728,91 + Rp12.085.727.901,95 untuk menjalankan produksi. Pabrik bahan peledak emulsi *starch nitrate* tergolong *high risk* dengan ROI *before tax* 44,17% dan *after tax* 22,09%, POT *before tax* 1,8 tahun dan *after tax* 3,1 tahun, BEP 41,17%, SDP 25,18%, dan DCFRR 22,71%. Hasil analisis ekonomi menunjukkan bahwa pabrik ini dinilai menarik dan layak untuk dikaji lebih lanjut.

Kata kunci: nitrat pati, bahan peledak emulsi, nitrasi, asam nitrat, pati jagung

ABSTRACT

Starch nitrate or nitrostarch is a starch derivative compound containing nitrate group with the chemical formula $(C_6H_7O_2(ONO_2)_3)$. Starch nitrate has strong oxidizing and explosive properties that allow it to be used as a raw material in the formulation of explosives. The need for explosive imports in Indonesia continues to increase every year and is predicted to reach 42,940 tons in 2029. This starch nitrate based emulsion explosives factory is designed with production capacity of 4,400 tons/year and operates in batches. To meet the factory's production capacity, raw materials are needed in the form of corn starch of 495.8182 tons/year and 98% nitric acid of 1,472.7273 tons/year. Meanwhile, for supporting materials, ammonium nitrate is needed of 2,692.5696 tons/year, sodium nitrate of 450.4455 tons/year, fuel oil of 155,928.4870 L/year, PIBSA of 37.0800 tons/year, and microballoons of 36.0000 tons/year. This factory also produces by-products in the form of 50% nitric acid of 1,741.0909 tons/year.

The production of emulsion explosives starch nitrate in this factory consists of several stages, namely the nitration process, nitric acid dilution, filtration, and emulsification. In the nitration process, the raw material in the form of corn starch is nitrated in reactor using 98% nitric acid with a ratio of 1:3, the reaction is exothermic and controlled at pressure of 1 atm and temperature of 20°C with chilled water in a cooling jacket. The process is continued by diluting nitric acid to 50% using mixer and reducing the water content in starch nitrate to 14% through filtration process in the Nutsche Filter. The starch nitrate cake produced is then mixed with ammonium nitrate and sodium nitrate and then emulsified in Ribbon Blender using Polyisobutylene Succinic Anhydride (PIBSA), fuel oil, and glass microballoons to produce homogeneous emulsion explosive and packaged in cartridge.

The starch nitrate emulsion explosives factory is planned to be built in Cikampek, Karawang, West Java with an area of 4.1104 hectares and 169 employees. The factory's supporting needs include water supply of 5,953.8934 kg/hour obtained from the Citarum River, factory electricity supply of 386.5708 kW, air supply of 1,133.5671 kg/hour, and steam supply of 143.6727 kg/hour.

This factory requires fixed capital of \$6,016,530.44 + Rp168,386,048,727.44 and working capital of \$4,823,728.91 + Rp12,085,727,901.95 to run production. The starch nitrate emulsion explosives factory is classified as high risk with ROI before tax of 44.17% and after tax of 22.03%, POT before tax of 1.8 years and after tax of 3.1 years, BEP of 41.17%, SDP of 25.18%, and DCFRR of 22.71%. The results of the economic analysis show that this factory is considered attractive and worthy of further study.

Keywords: starch nitrate, emulsion explosives, nitration, nitric acid, corn starch