INTISARI

Serat alami selulosa berasal dari sumber daya terbarukan seperti kayu dan non kayu dapat diproses lebih lanjut menjadi selulosa berukuran nano yang memiliki diameter kurang dari 100 nm. Salah satu bentuk utamanya adalah *Cellulose Nanocrystal* (CNC) yang merupakan bahan nano yang kuat berbentuk batang. CNC dapat diproduksi dari biomassa selulosa seperti kayu dan bahan berbasis non-kayu menjadi bentuk bubuk, cair atau gel dengan metode seperti hidrolisis asam. Karena sifat fisik, mekanik dan fisikokimia dari CNC yang unik, penggabungan sejumlah kecil CNC ke matriks material (polimer, keramik ataupun logam) dapat merubah sifat permukaan material tersebut. CNC juga berasal dari sumber alam yang tidak memberikan dampak buruk terhadap lingkungan, sehingga layak untuk dikembangkan dan diterapkan pada berbagai macam industri. Fokus pada penelitian ini adalah mencari metode yang efektif dalam preparasi CNC dari jerami padi, mempelajari kinetikanya serta pemanfaatannya sebagai *reductant* pada pelindian pasir yang mengandung mangan. Penelitian ini menyoroti proses penyiapan dan karakterisasi CNC meliputi isolasi selulosa dari jerami padi menggunakan proses Kraft, *bleaching*, pengujian kadar selulosa hasil *pulping*, hidrolisis selulosa pulp menggunakan asam campuran diikuti dengan sonikasi kemudian pemisahan produk dari cairan asam dengan sentrifugasi dan pemurnian produk menggunakan sonikasi, dialisis dan pengeringan beku. Produk akhir CNC dikarakterisasi dengan analisis distribusi ukuran partikel, analisis kristalinitas dan analisis sifat permukaannya serta dipelajari kinetika pembentukan produk CNC dan kristalnya kemudian dipelajari pengaruh dosisnya sebagai reduktan pada pelindian pasir mengandung mangan. Hasil pengujian distribusi ukuran menggunakan *Particle Size Analyzer* menunjukkan produk nanoselulosa dengan ukuran terkecil diperoleh pada kondisi proses hidrolisis asam campuran menggunakan asam sulfat 64 % dan asam klorida 37 % dengan perbandingan asam sulfat dan asam klorida 1:1 selama 80 menit pada suhu 26ºC, yaitu 99,3 % partikel berukuran dibawah 22,54 nm. Hasil pengujian index kristalinitas tertinggi menggunakan analisis *X-Ray Diffraction* diperoleh pada kondisi proses hidrolisis asam campuran asam sulfat 64 % dan asam klorida 37 % dengan perbandingan asam sulfat dan asam klorida 1:1 selama 80 menit pada suhu 26ºC sebesar 83,90%. Data laju reaksi pembentukan produk CNC dicari dengan metode *fitting data* menggunakan program Matlab dan diperoleh SSE akhir sebesar 9,9169e-07, konstanta laju reaksi ks sebesar 0,0017 $(gram/ltr)^{0,5}$.mnt, order reaksi degradasi selulosa α sebesar 2,0464 dan order reaksi pembentukan solut n sebesar -1,485. Sedangkan data laju reaksi pembentukan produk kristal dicari dengan metode *fitting data* menggunakan program Matlab dan diperoleh SSE akhir sebesar 8,6928e-07, konstanta laju reaksi kc sebesar 0,0027 mnt^{-1}, order reaksi pembentukan kristal γ sebesar 0,4888 dan order reaksi pembentukan solut-amorf β sebesar 0,4929. Penambahan CNC sebanyak 1 gram pada pelindian pasir mengandung mangan dengan asam asetat 15% pada suhu 60ºC dianalisis hasilnya menggunakan *X-Ray Fluoresence,* hasil uji unsur menunjukkan 59,9625 % mangan terlindi yang mana hampir 1,5 kali lipat dari pelindian tanpa CNC pada kondisi operasi yang sama yaitu sebesar 43,75 % mangan yang terlindi.

Kata kunci : Hidrolisis asam, kinetika, nanoselulosa, nanokristal, pelindian, mangan

ABSTRACT

Natural cellulose fibers derived from renewable resources such as wood and non-wood can be processed into nano-sized cellulose which has a diameter of less than 100 nm. One of its main forms is Cellulose Nanocrystal (CNC) which is a strong nano material in a rod shape. CNC can be produced from cellulosic biomass such as wood and non-wood materials into powder, liquid or gel form by methods such as acid hydrolysis. Because of its unique physical, mechanical and physicochemical properties, the addition of a small amount of CNC into the matrix materials (polymers, ceramics or metals) can change the surface properties of the materials. CNC also comes from natural sources that don't have negative impact on the environment, so it is feasible to be developed and applied to a wide variety of industries. The focus of this research is to search on effective methods in the preparation of CNC from rice straw, study its kinetics and use it as reductant in sand containing manganese leaching. This research highlights the process of preparing and characterizing CNC including isolation of cellulose from rice straw using the Kraft process, bleaching, cellulose content testing, hydrolysis of cellulose pulp using mixed acids followed by sonication then separation of the product from acidic solvent by centrifugation also product purification using sonication, dialysis and freeze dryer. The resulting CNC product was characterized by particle size distribution analysis, crystallinity analysis and surface properties analysis. The kinetics of product and crystal formation were studied. Also, the effect of doses as reductant on manganese leaching was studied. The results of size distribution test using Particle Size Analyzer showed that the smallest size nanocellulose product was obtained under the conditions of hydrolysis process with 64% sulfuric acid and 37% hydrochloric acid with ratio of sulfuric acid and hydrochloric acid was 1:1 for 80 minutes at 26^{o}C, which was 99.3% of particles were under 22.54 nm in size. The results of crystallinity index test using X-Ray Diffraction showed that the highest crystallinity index was obtained under the conditions of hydrolysis process with 64% sulfuric acid and 37% hydrochloric acid with ratio of sulfuric acid and hydrochloric acid was 1:1 for 80 minutes at 26^{o}C, which was 83.90%. The reaction rate of the supernatant product formation was calculated by using data fitting method in the Matlab program and the results were: final SSE was 9.9169e-07; the reaction rate constant ks was 0.0017 (gram/ltr)^{0,5}.mnt; the order of cellulose degradation reaction α was 2.0464 and the reaction order for the formation of solutes n was -1.485. Meanwhile, the reaction rate of the crystalline product calculation results were: final SSE was 8.6982-07; the reaction rate constant kc was 0.0027 mnt^{-1}; the order of cellulose crystalline production γ was 0.4888 and the reaction order for the formation of solutes-amorf β was 0.4929. Addition of CNC as much as 1 gram to the sand containing manganese leaching with 15% acetic acid at 60^{o}C was analyzed using X-Ray Fluoresence, the elemental test results showed 59.9625% of manganese leached which was almost 1.5 times than the sand containing manganese leaching without CNC in the same operating conditions which was 43.75% of manganese leached.

Keywords: Acid hydrolysis, kinetics, nanocellulose, nanocrystal, kinetics, leaching, manganese