

**PENINGKATAN ADSORPSI ZAT WARNA KRISTAL VIOLET
MENGGUNAKAN ABU LAYANG BATUBARA MELALUI
PERLAKUAN H₂SO₄ DAN PERLAKUAN HNO₃**

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ABSTRAK

Penelitian tentang penggunaan abu layang hasil pembakaran batubara PT Semen Holcim Indonesia, Tbk. Pabrik Cilacap, Jawa Tengah sebagai adsorben zat warna kristal violet (tris (4-(dimetilamino)fenil)metilium klorida) telah dilakukan. Abu layang batubara masing-masing dilakukan refluks menggunakan dua larutan asam berbeda, meliputi larutan H₂SO₄ 6 M dan larutan HNO₃ 6 M, kemudian dicuci hingga pH netral dan dikeringkan dalam oven. Abu layang yang diperoleh dikarakterisasi dengan FTIR dan XRD. Kajian adsorpsi zat warna kristal violet meliputi pengaruh pH larutan, massa adsorben, waktu kontak, dan konsentrasi awal zat warna.

Hasil penelitian menunjukkan bahwa abu layang batubara mempunyai komponen utama berupa kuarsa dan *mullite* (-Si/-Al). Perlakuan kimia menggunakan larutan H₂SO₄ dan larutan HNO₃ mampu menghilangkan mineral-mineral pengotor tanpa merusak situs aktif pada permukaan abu layang batubara. Adsorpsi zat warna kristal violet berlangsung optimum pada pH 8, massa adsorben 0,2 gram, waktu kontak selama 75 menit, dan konsentrasi awal sebesar 125 ppm. Kinetika adsorpsi kristal violet mengikuti model kinetika orde kedua semu dengan nilai konstanta laju reaksi (k_2) sebesar 0,0434; 0,0368 dan 0,1050 g mg⁻¹ menit⁻¹ masing-masing untuk proses adsorpsi dengan abu layang tanpa perlakuan asam, dengan perlakuan H₂SO₄ dan dengan perlakuan HNO₃. Isoterm adsorpsi kristal violet mengikuti model isoterm Langmuir. Nilai energi adsorpsi sebesar 25,26; 25,81 dan 26,20 kJ mol⁻¹ dan kapasitas adsorpsi maksimum sebesar $5,14 \times 10^{-5}$; $5,33 \times 10^{-5}$ dan $5,66 \times 10^{-5}$ mol g⁻¹ diperoleh masing-masing untuk proses adsorpsi dengan abu layang tanpa perlakuan asam, dengan perlakuan H₂SO₄ dan dengan perlakuan HNO₃.

Kata kunci: abu layang batubara, adsorpsi, kristal violet

**ADSORPTION ENHANCEMENT OF CRYSTAL VIOLET DYE
USING COAL FLY ASH THROUGH H₂SO₄ TREATMENT
AND HNO₃ TREATMENT**

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ABSTRACT

Research on application of fly ash of coal combustion from PT Semen Holcim Indonesia, Tbk. Cilacap Plant, Central Java as an adsorbent of crystal violet dye (tris (4-(dimethylamino)phenyl)methylmethyl chloride) has been performed. Research was performed by refluxing coal fly ash using two different acid solutions, which are H₂SO₄ 6 M solution and HNO₃ 6 M solution. The fly ash was washed until neutral and dried in the oven. The resulted adsorbent was characterized by Fourier Transform Infrared (FTIR) and X-Ray Diffraction (XRD). In the adsorption study of crystal violet dye, effect of pH, mass of adsorbent, interaction time and initial concentration on the effectiveness of adsorption was examined.

The experimental result showed that the main components of coal fly ash are quartz and mullite (–Si/–Al). Chemical treatment using H₂SO₄ solution and HNO₃ solution is able to remove the impurities without damaging the active sites on the fly ash surface. The optimum condition for removal of crystal violet dye by coal fly ash was obtained at pH of 8, adsorbent mass of 0.2 g, contact time at 75 min, and at initial concentration of 125 ppm. The kinetics of adsorption process was better described with pseudo-second-order kinetic model. The reaction rate constants (k_2) for original fly ash, H₂SO₄-treatment fly ash, and HNO₃-treatment fly ash are 0.0434; 0.0368 and 0.1050 g mg⁻¹ min⁻¹, respectively. The isotherm data of adsorption process fit well with Langmuir isotherm model. The values of adsorption energy are 25.26; 25.81 and 26.20 kJ mol⁻¹ and the maximum adsorption capacity are 5.14×10⁻⁵; 5.33×10⁻⁵ dan 5.66×10⁻⁵ mol g⁻¹, respectively for the adsorption process using original fly ash, H₂SO₄-treatment fly ash, and HNO₃-treatment fly ash.

Keywords: adsorption, coal fly ash, crystal violet