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Sintesis dan karakterisasi Fe-BDC Metal Organic Frameworks (MOFs) sebagai Adsorben zat warna Methylene Blue dan Rhodamine B = Synthesis and characterization of Fe-BDC Metal Organic Frameworks (MOFs) as adsorbent for Methylene Blue and Rhodamine B dyes

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Abstrak

Pencemaran limbah cair industri zat warna di Indonesia telah menjadi permasalahan lingkungan yang serius. Beberapa metode yang digunakan untuk mengatasi limbah zat warna diantaranya filtrasi membran, ozonisasi, klorinasi, proses elektrokimia, fotodegradasi, koagulasi flokulasi, oksidasi kimia, oksidasi biologi, dan adsorpsi. Adsorpsi memilki kelebihan yaitu berbagai macam bahan adsorben, preparasi dan operasi mudah, nilai ekonomis tinggi, efisiensi tinggi, reusabilitas baik, cocok untuk beragam zat warna ramah lingkungan dan dapat digunakan untuk menghilangkan pewarna organik dalam perairan dengan skala besar. Beragam adsorben dengan struktur pori dan luas permukaan spesifik telah dipelajari, salah satunya MOFs. MOFs memiliki keunggulan seperti luas permukaan spesifik yang tinggi, porositas yang baik, dan ukuran pori terkontrol. Dalam penelitian ini MOFs jenis MIL-101 (Fe) disintesis menggunakan logam Fe yang ramah lingkungan dan ligan BDC dengan metode solvothermal. Variasi suhu 100oC dan 120oC, jumlah prekursor FeCl3.6H2O 2,45 mmol, 4,9 mmol, dan 9,81 mmol dan jenis pelarut yaitu DMF dan campuran pelarut DMF : Aquades dengan perbandingan 2 : 3 dipelajari pengaruhnya terhadap sintesis MOF, MOF hasil sintesis kemudian diaplikasikan sebagai adsorben zat warna Methylene Blue dan Rhodamine B dalam air. Hasil sintesis dikarakterisasi menggunakan FTIR, XRD, TGA, BET, dan SEM untuk mengetahui ikatan kimia, topologi kerangka, kristanilitas, luas permukaan, dan stabilitas termal. Hasil karakterisasi menunjukan variasi suhu dan prekusor dihasilkan MOF dengan struktur polimorfik MIL-88B. Aplikasi adsorpsi zat warna Methylene Blue dan Rhodamine mencapai kapasitas absorpsi optimum pada pH 9 dan waktu kontak 180 menit adsorpsi Fe-BDC MOF pada Methylene Blue dan Rhodamine B mengikuti pemodelam isoterm adsorpsi Langmuir dengan kapasitas adsorpsi maksimum berturut-turut sebesar 162,82 mg/g dan144,65 mg/g.

Kata Kunci: Fe-Metal Organic Frameworks, Methylene Blue, Rhodamine B, Adsorpsi, Ligan BDC (Asam 1,4-benzena dikarboksilat), metode solvothermal.<hr />The industrial dye-wastewater has been a tremendous environmental problem in Indonesia. Several techniques have been used to eliminate dye-waste water, such as membrane filtration, chlorinaton, ozonation, coagulation-floculation, chemical oxidation, biology oxidation, and adsorption. Adsorption technique is extensively used for removal of the dye-wastewater due the excellent properties of its method, having various of adsorbent material, simple preparation and operation, low cost, high efficiency, good reusability and capable of reducing the organic dyes widely. In this case, many adsorbents, having tunable pore and specific surface area, have been studied. MOFs have some advantages as adsorbents in that their large surface area, tunable pore size, and adjustable porosity. In this work, MOFs type MIL-101 (Fe) was synthesized assisted solvothermal reactions at 100 oC and 120 oC, and various amount of FeCl3.6H2O precursor of 2.45 mmol, 4.9 mmol, and 9.81 mmol. The effect of solvents in the synthesis was studied by using DMF and mixture of DMF: distilled water 3 : 2. Briefly, MIL-101 was synthesized with environmental friendly metal precursor, FeCl3.6H2O,

and 1,4 benzenedicarboxylate (BDC) ligands. The material characteristics of the as-synthesized Fe-BDC MOF such as structure and topology of MOFs, surface area, and thermal stability were studied using XRD, FTIR, BET, TGA, and SEM. The XRD patterns show that the crystals of MIL101 was successfully formed with some impurities of MIL-88B. The application of Fe-BDC MOF as adsorbent for Methylene Blue (MB) and Rhodamine B (RhB) in aqueous solution is learned. The optimum adsorption condition showed when 5 mg Fe-BDC MOF is applied to the dyes after 180 minutes at pH 9. It was found that the isotherm data for Methylene Blue and Rhodamine B had a good correlation with the Langmuir isotherm. The maximum adsorption capacity of MOF was able to reach 162,82 mg/g for Methylene Blue and 144,65 mg/g for Rhodamine B.
Keyword(s): Fe-Metal Organic Frameworks, Methylene Blue, Rhodamine B, adsorption, 1,4 benzenedicarboxylate (BDC), and solvothermal method.