GREEN PREPARATION OF ACETAMINOPHEN FROM THE CLAY-CATALYSED REACTION OF 4-AMINOPHENOL AND ACETIC ANHYDRIDE

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Introduction

Acetanilide, phenacetin, and acetaminophen are *N*-acetylated aromatic amines that are important in over-the-counter pain-relieving (analgesic) and fever-reducing (antipyretic) remedies (Bertolini *et al.*, 2006). Today acetaminophen has replaced phenacetin and acetanilide as pain-killers, and acetaminophen is marketed under the tradenames, Panadol, Paracetamol, Paracetol, Tylenol and Datril (Chiniwalla *et al.*, 1990).

Acetaminophen is customarily prepared by *N*-acetylating 4-aminophenol with acetic anhydride or acetic acid in the presence or absence of a mineral acid such as concentrated phosphoric acid at atmospheric pressure and temperatures ranging from room temperature to 130 °C. An unsatisfactory product is generally obtained due to the readily oxidizable nature of 4-aminophenol and the consequent formation of coloured impurities which are carried over to the acetylated product. Removal of colored impurities requires additional steps in the commercial production of acetaminophen. Phosphoric acid, which serves as a Brønsted acid catalyst in this reaction is a corrosive chemical.

Cation-exchanged montmorillonite clays can function as environmental-friendly solid acid catalysts in organic reactions (Lazlo and Balogh, 1993). Montmorillonite clay belongs to semectite family and has an expandable layer structure of aluminosilicate. The layered structure facilitates the uptake of cations such as Zn^{2+}, Al^{3+}, Fe^{3+} and ZrO^{2+}. Cation-exchanged clays show high Brønsted and Lewis acidity. We report here a green preparation of acetaminophen, in pure form as a colorless product, and other *N*-acetylated aromatic amines in high yield using ZrO^{2+}-exchanged montmorillonite (ZrO^{2+}-MMT) clay as a Brønsted/Lewis acid catalyst under mild conditions.

Materials and Methods

Preparation of catalyst

Na^{+}-Montmrillonite clay (5 g) was stirred overnight with a 0.5 M solution of zirconyl chloride (200 ml) to obtain ZrO^{2+}-MMT clay catalyst. The clay was then centrifuged and washed with distilled water repeatedly until washings showed negative test for chloride ions. The clay sample was then dried under ambient air for a week and ground to pass through a mesh of size 100. The clay sample was characterized using X-ray diffraction analysis (XRD), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) and Fourier-