Chemical Engineering Journal 218 (2013) 425–432

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

A rapid synthesis route for Sn-Beta zeolites by steam-assisted conversion and their catalytic performance in Baeyer–Villiger oxidation

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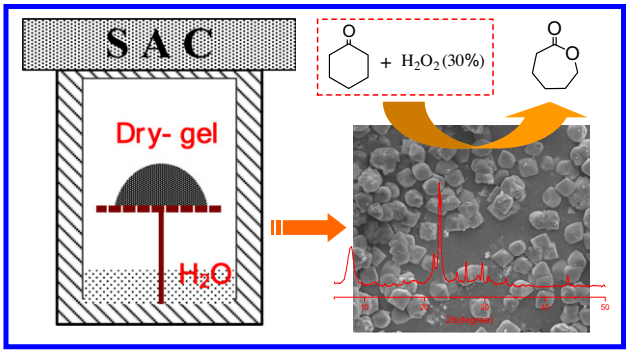
HIGHLIGHTS

- A steam-assisted conversion (SAC) method is used to rapidly synthesize Sn-Beta zeolites.
- Sn-Beta zeolites with high crystallinity and BEA topology could successfully be synthesized by SAC method.
- The Sn-Beta by SAC method can demonstrate good catalytic activity for cyclohexanone oxidation with 30% H_2O_2.

GRAPHICAL ABSTRACT

A steam-assisted conversion (SAC) method was used to rapidly synthesize Sn-Beta zeolites with high crystallinity and yield. The Sn-Beta zeolites could exhibit good catalytic activity for Baeyer–Villiger (B–V) oxidation reaction of cyclohexanone to ε-caprolactone using aqueous H_2O_2 (30%) as oxidant.



ARTICLE INFO

Article history:
Received 26 July 2012
Received in revised form 20 November 2012
Accepted 4 December 2012
Available online 12 December 2012

Keywords:
Zeolite
Sn-Beta
Steam-assisted conversion
B–V oxidation
Cyclohexanone

ABSTRACT

Sn-Beta zeolites were prepared by a rapid and clean steam-assisted conversion (SAC) method from dry stannosilicate gel. The amorphous gel was converted to highly crystalline Sn-Beta within 5 h at mild reaction temperature of 453 K. The properties of the as-prepared samples were characterized by XRD, SEM, FT-IR, UV–Vis, UV-Raman, ICP and N_2 adsorption. A high gel conversion to BEA can be obtained with Sn^{4+} inserted in the zeolite framework. The SAC method was successfully used to produce pure silica Beta zeolite (Si/Sn = ∞) to Sn-Beta zeolite with 3.8 wt.% SnO_2 (i.e., Si/Sn = 83). The Sn-Beta prepared by SAC method is an efficient catalyst for Baeyer–Villiger (B–V) reaction of cyclohexanone to ε-caprolactone.

1. Introduction

Tin-containing zeolites are of considerable interest due to their unique chemistry and applications [1–4]. The Sn-Beta zeolite having large 3D pore structure is shown to be very active and chemoselective catalyst for many important organic reactions [5], such as Baeyer–Villiger (B–V) oxidation [6], Meerwein–Ponndorf–Verley (MPV) reduction [7], Oppenauer oxidations [8] as well as sugar conversion to lactic acid derivatives [9], isomerization of glucose to fructose [10] and conversion of carbohydrates to 5-(hydroxymethyl)-furfural (HMF) [11]. The conventional

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http://dx.doi.org/10.1016/j.cej.2012.12.019