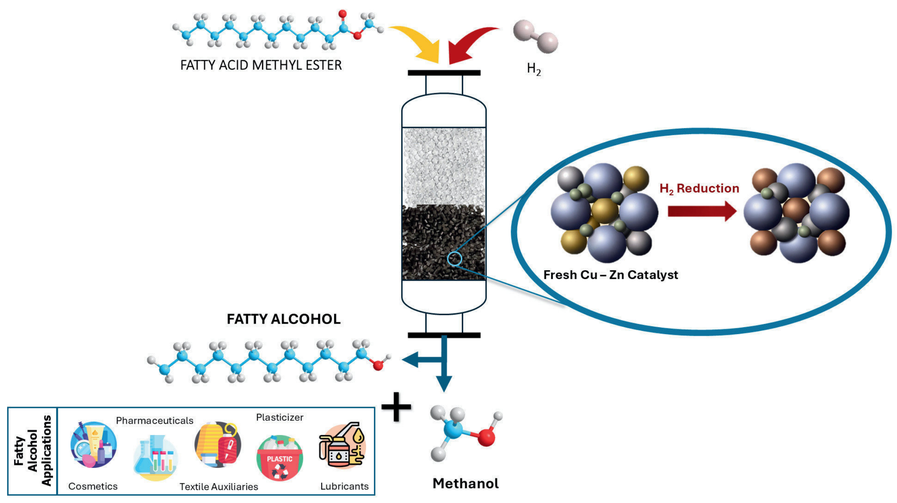
Comparative Investigation of Cu-Zn Catalyst Performance for Hydrogenation of FAME to Fatty Alcohols under Low-Pressure Condition

Zaqiyah Addarojah[1], Melia L. Gunawan[1,2], Carolus B. Rasrendra[1,2], I Dewa Gede Arsa Putrawan[1], Nur Afni Agustina[2], Budiningtyas Puspito[2], Rezky Oktaviandy Anggaswara[2]

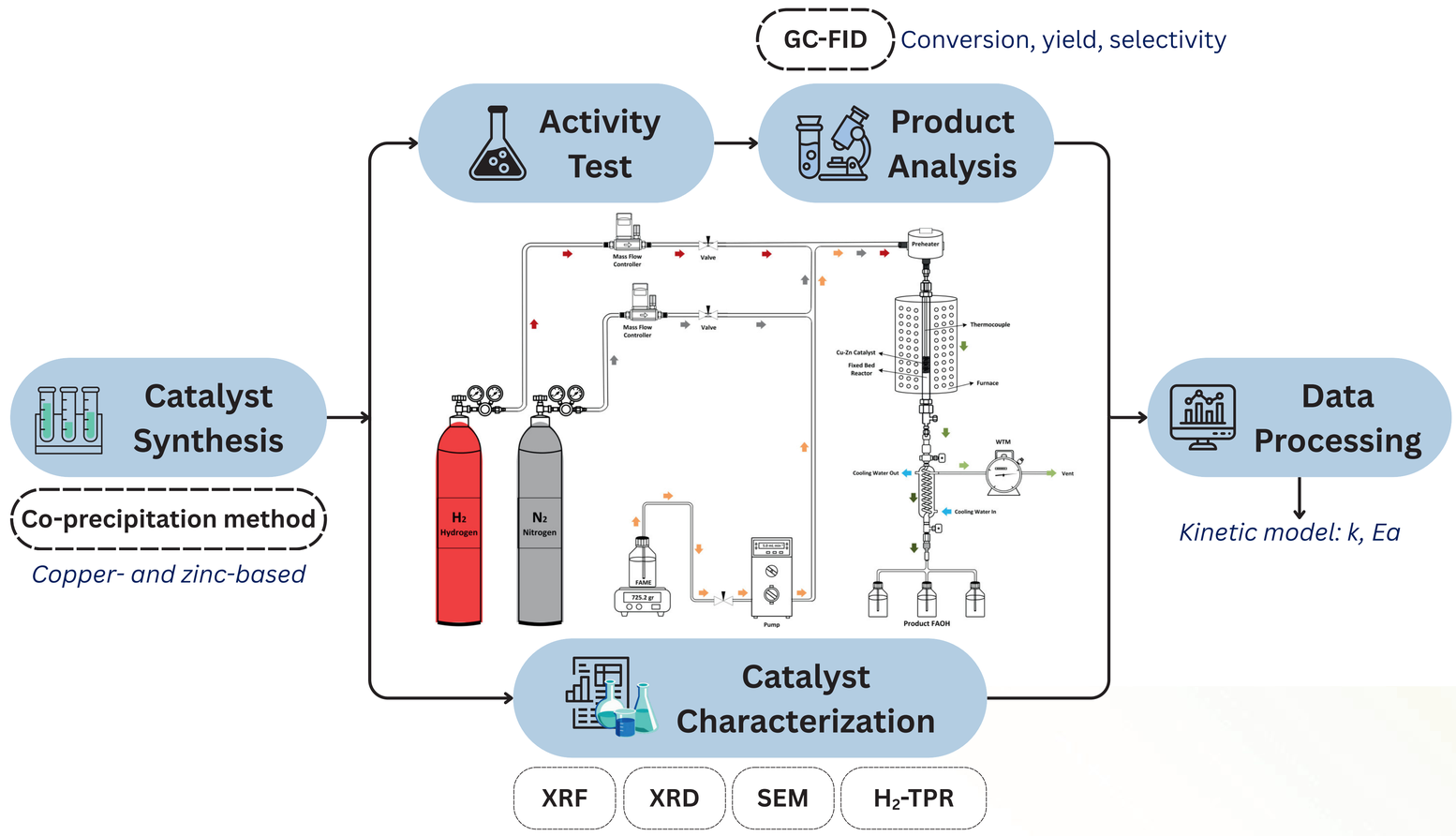
[1]Department of Chemical Engineering, Faculty of Industrial Technology, Institut Teknologi Bandung
[2]Center for Catalysis and Reaction Engineering, Institut Teknologi Bandung

Introduction

Fatty alcohols are valuable products for personal care, pharmaceutical, and industrial applications, driving demand for sustainable production from renewable feedstocks. FAME hydrogenation over Cu-based catalysts offers high selectivity, with Cu–Zn catalysts as promising candidates because of their enhanced Cu dispersion and stability. Their catalytic performance and reaction kinetics under low pressure remain insufficiently understood, motivating further investigation for sustainable fatty alcohol production.



Research Method



Keywords: FAME hydrogenation; Fatty alcohol; Low-pressure hydrogenation; Cu-based catalyst; Reaction kinetics; Kinetic modeling.

Result & Discussion

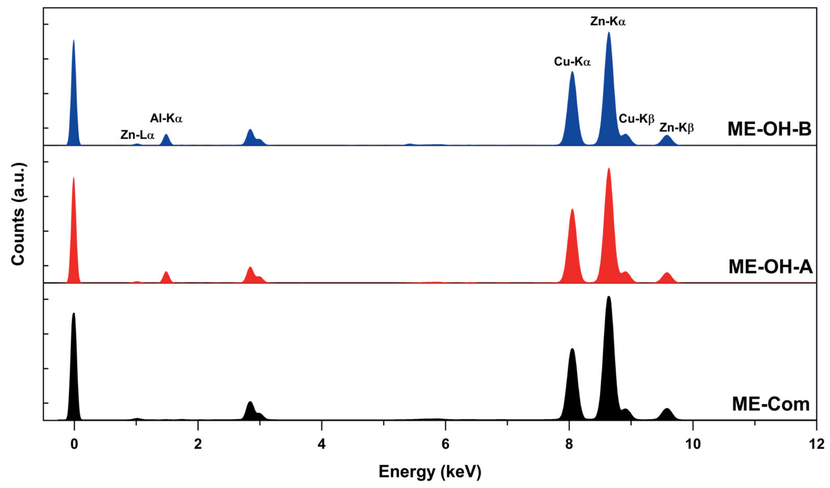
A Catalyst



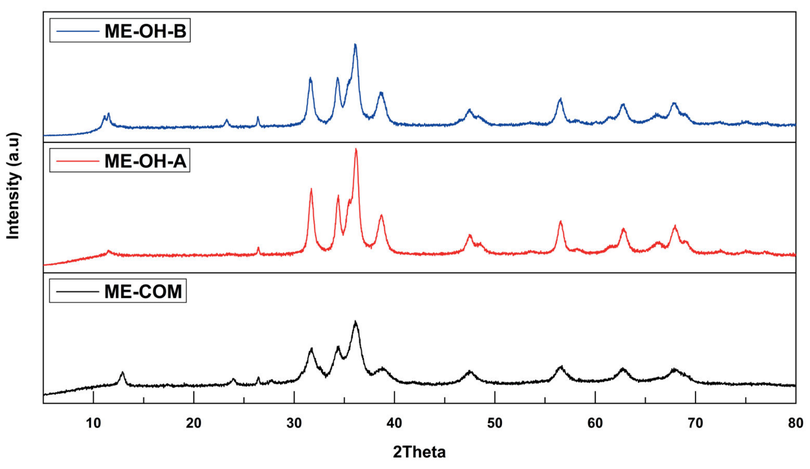
B Feed & Product



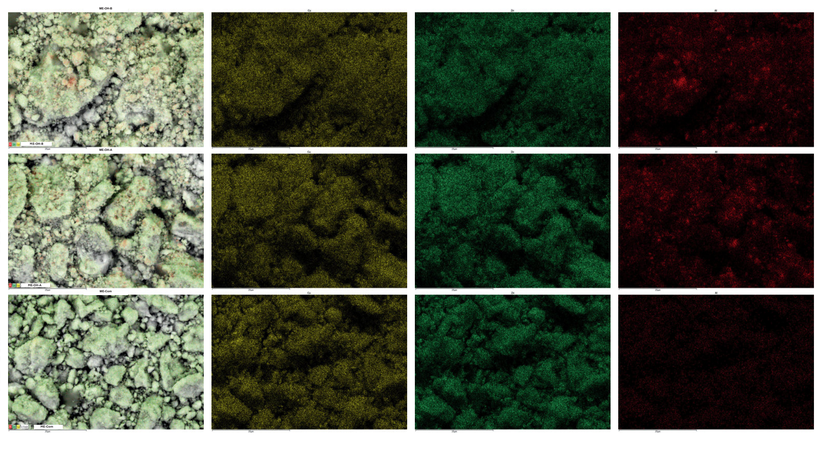
C XRF: Catalyst Composition



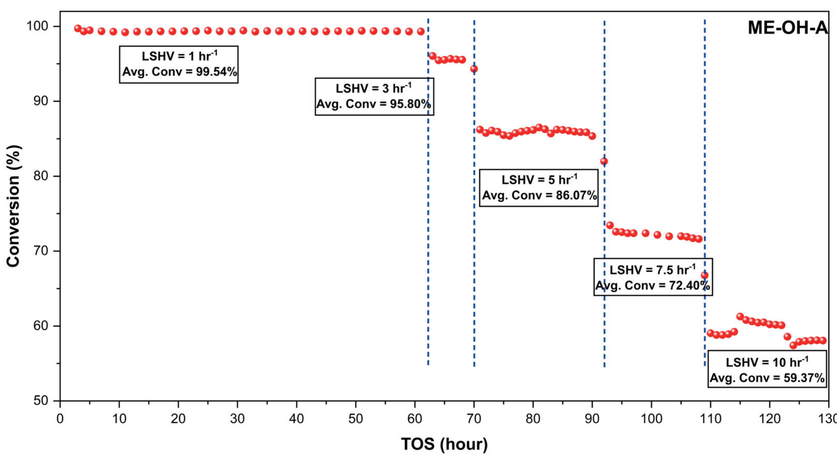
D XRD: Crystal Structure



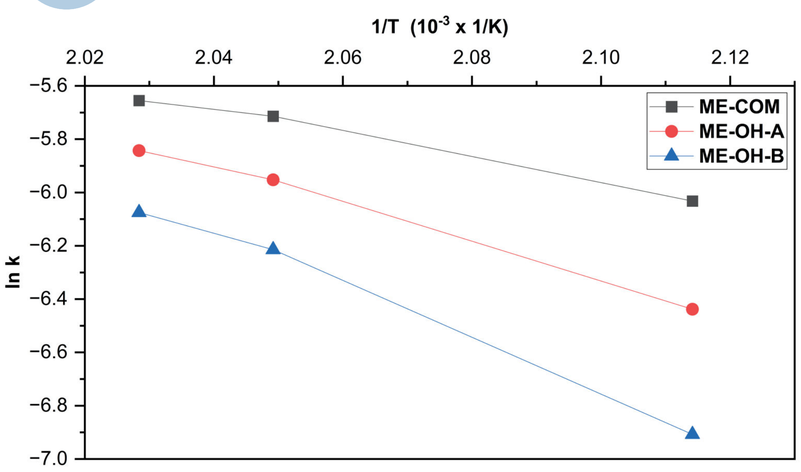
E SEM: Morphology



F Catalytic Activity (Stability)



G Kinetic Arrhenius Plot



- Reference catalyst (ME-Com) and synthesized catalysts (ME-OH-A & ME-OH-B) were investigated, showing high FAME conversion of over 99.5% at 215°C and LHSV 1 h^{-1}.
- ME-OH-A demonstrated the best stability for hydrogenation conversion over 60 h with an average of 99.54%.
- Increasing temperature significantly enhanced the reaction rate, whereas hydrogen pressure exerted only a modest influence.
- Kinetic model for ME-OH-A:

$$-r_{FAME} = 4.91 \times 10^{3} exp\left(\frac{-58,720}{8.314 \times T}\right) \times C_{FAME}$$

Conclusion

FAME hydrogenation over Cu–Zn catalysts showed increased conversion with temperature and reduced conversion at higher LHSV. Catalyst performance depended on Cu active-site accessibility and reducibility. ME-OH-A achieved 99.54% average conversion over 60 h at 215°C and 1 h^{-1}. Power-law kinetic analysis revealed higher apparent rate constants and lower activation energies for catalysts with improved Cu dispersion and reducibility.