Sharif university of technology

Chemical & Petroleum Engineering Department

Synthesis and evaluation of zeolite-based catalysts for selective catalytic reduction of NO_X with ammonia

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Introduction

Nitrogen oxides(NOx),generated from combustion of fossil fuel in power plants, industries and vehicles, are a core component of air pollutants. Considered the dominant source of acid rain, photochemical smog, ozone depletion and global warming, NOx is harmful to human health, thus the reduction of emissions is a critical issue

The key SCR catalyst reactions are:

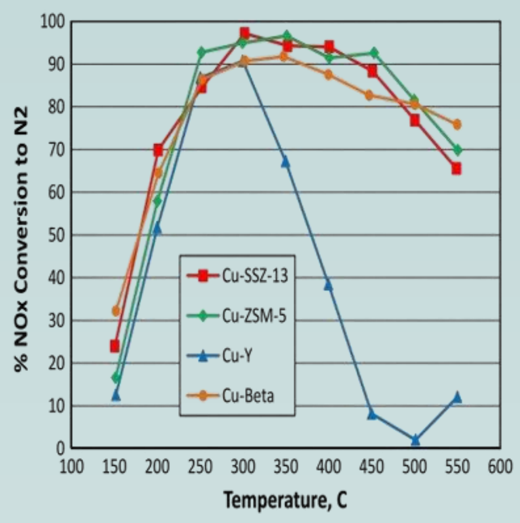
standard SCR reaction: $4NH_3+4NO+O_2 \rightarrow 4N_2+6H_2O$

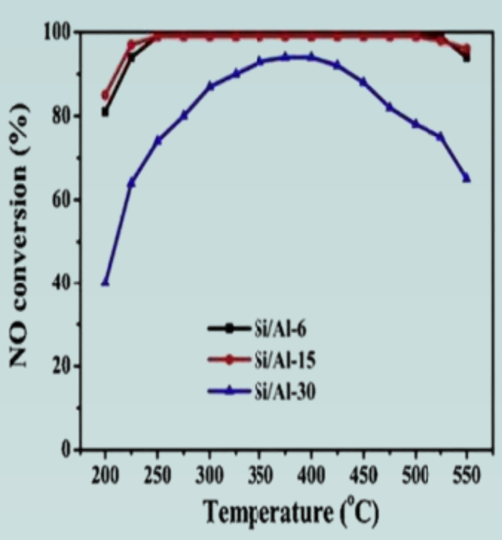
fast SCR reaction: $8NH_3+6NO_2 \rightarrow 7N_2+12H_2O$

slow SCR reaction: $2NH_3+NO+NO_2 \rightarrow 2N_2+3H_2O$

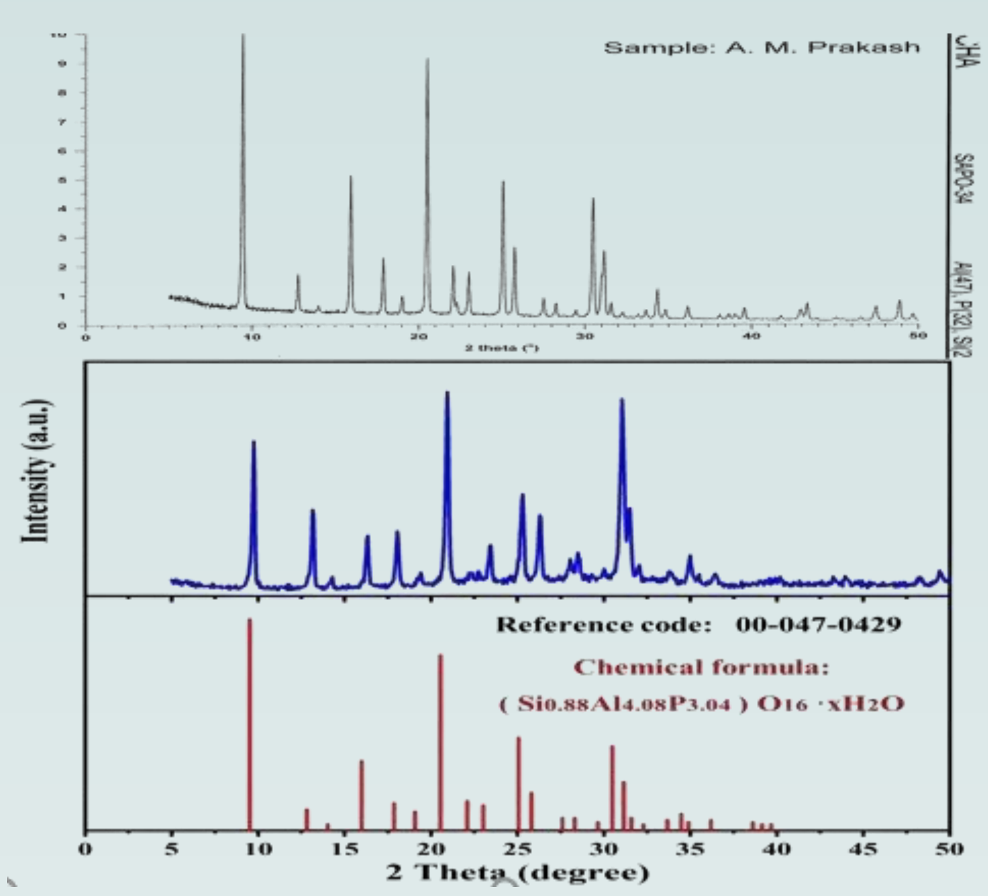
Literature review

Zeolite catalysts, particularly metal-exchanged zeolites, have recent drawn much discussion, as they present high activity on converting NO_x to N_2, a broad temperature window, high thermos stability, and chemical durability



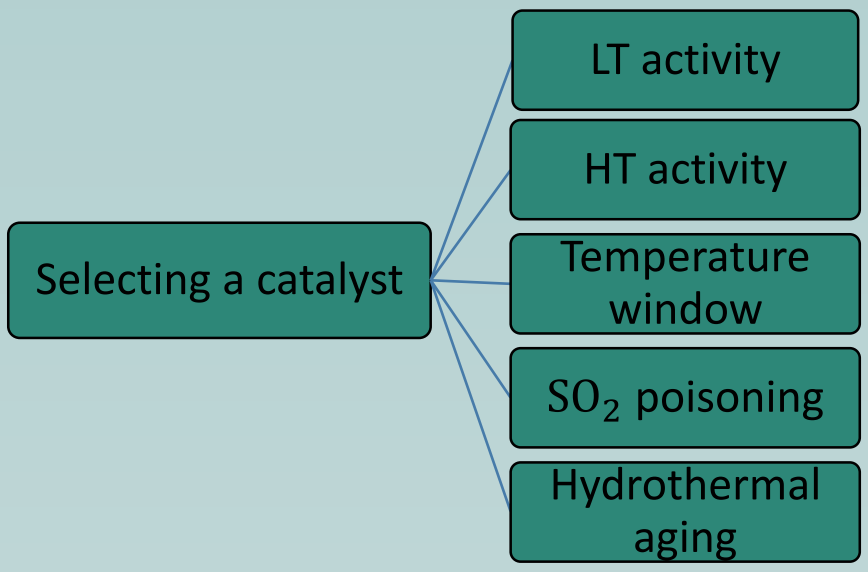


Synthesis of Zeolite and XRD analysis



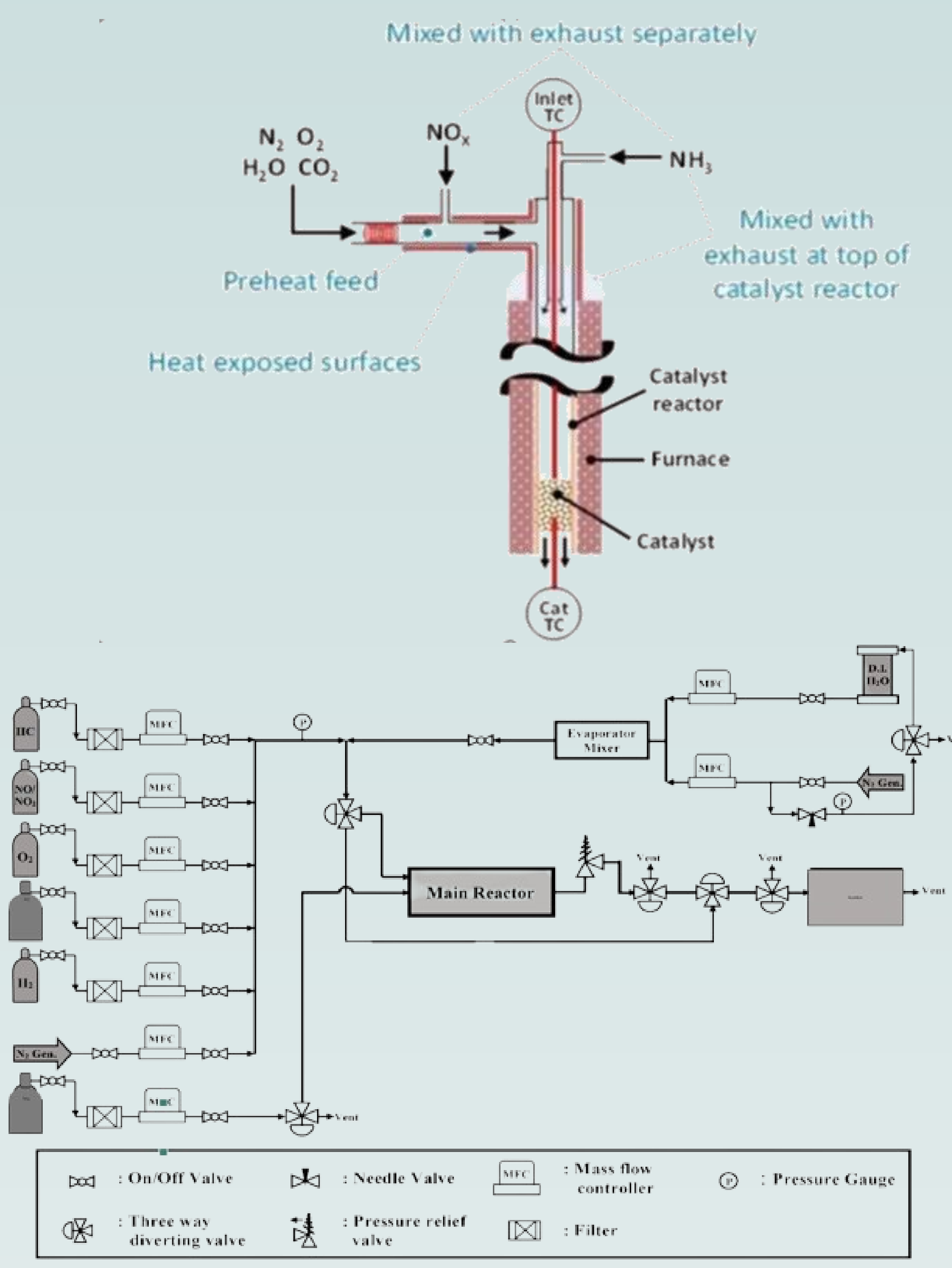
After treatment system Incudes :diesel particulate filter , diesel oxidation catalyst ,lean NO_x trap and selective catalytic reduction

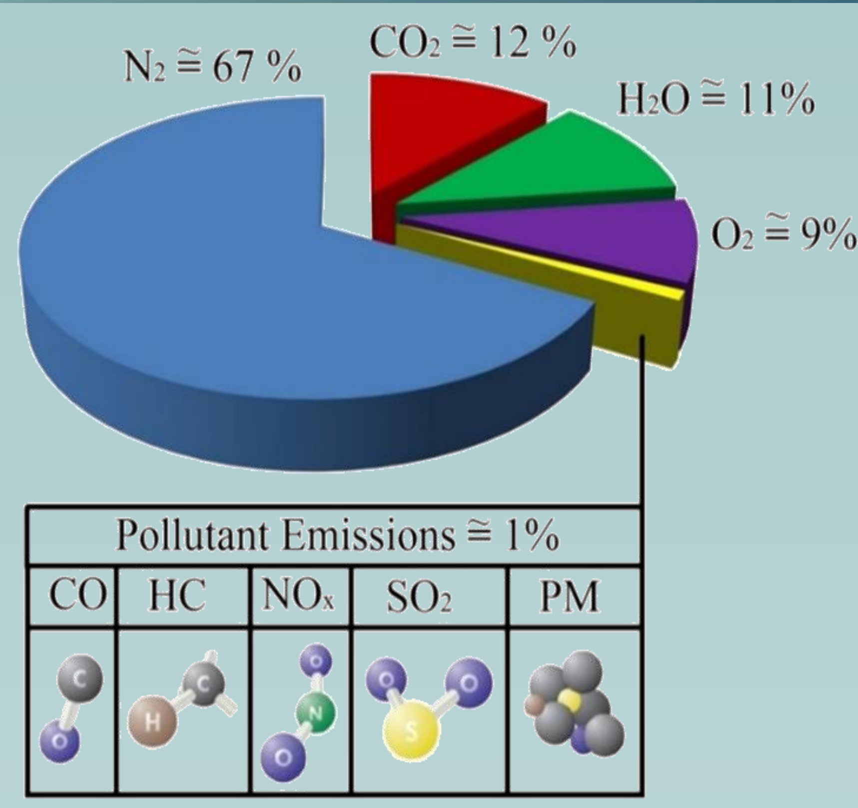
Objectives



Fan et al found that the ratio of Si/Al had influence on the hydrothermal stability, and prepared the Cu-SSZ- 13 catalysts with the ratios of Si/Al were 6, 15, 30, which had the same Cu loadings. The results showed that the Cu-SSZ-13 with the Si/Al of 15 could maintain the highest NO conversion among others after the hydrothermal treatment at 850 ◦C, while the Si/Al was 30 had lowest NO conversion

Reactor test protocols





Fan et al investigated the deactivation mechanism of the CuSAPO-34 catalyst after hydrothermal aging treatment at 950 ◦C for 3 h, 6 h and 12 h. The NO conversion and N_2 selectivity decreased with the increase of hydrothermal treatment time, and the activity decreased significantly after 12 h treatment

Standard SCR activity testing

Test mode	Action	Temperature time	Exhaust make-up (balance N_2)
Pretreatment	Hold	600 ˚C, 20 min	$[O_2]$ $[CO_2]$ $[H_2O]$
Option #1—Preferred test strategy: ramp down and ramp up			
–	Cool	550 ˚ C, 5 min	$[O_2]$ $[CO_2]$ $[H_2O]$
STD SCR test	Hold	550 ˚ C, 5–20 min	$[O_2]$ $[CO_2]$ $[H_2O]$ [NO] $[NH_3]$
STD SCR test	Ramp down	550-100 ˚C @ 2˚C/min	$[O_2]$ $[CO_2]$ $[H_2O]$ [NO] $[NH_3]$
STD SCR test	Ramp up	100-550 ˚C @ 2 ˚C/min	$[O_2]$ $[CO_2]$ $[H_2O]$ [NO] $[NH_3]$
Option #2—Alternative test strategy: ramp up only			
–	Cool	100 ˚ C, 5 min	$[O_2]$ $[CO_2]$ $[H_2O]$
STD SCR test	Ramp up	100-550 ˚C @ 5 ˚C/min	$[O_2]$ $[CO_2]$ $[H_2O]$ [NO] $[NH_3]$

fast SCR activity testing

Test mode	Action	Temperature time	Exhaust make-up (balance N_2)
Pretreatment	Hold	600 ˚C, 20 min	$[O_2]$ $[CO_2]$ $[H_2O]$
Option #1—Preferred test strategy: ramp down and ramp up			
–	Cool	600–550 ˚ C	$[O_2]$ $[CO_2]$ $[H_2O]$
Fast SCR test	Hold	550 ˚ C, 5–20 min	$[O_2]$ $[CO_2]$ $[H_2O]$ [NO] $[NO_2]$ $[NH_3]$
Fast SCR test	Ramp down	550-100 ˚C @ 2˚C/min	$[O_2]$ $[CO_2]$ $[H_2O]$ [NO] $[NO_2]$ $[NH_3]$
Fast SCR test	Ramp up	100-550 ˚C @ 2 ˚C/min	$[O_2]$ $[CO_2]$ $[H_2O]$ [NO] $[NO_2]$ $[NH_3]$
Option #2—Alternative test strategy: ramp up only			
–	Cool	600–100 ˚ C	$[O_2]$ $[CO_2]$ $[H_2O]$
Fast SCR test	Ramp up	100-550 ˚C @ 5 ˚C/min	$[O_2]$ $[CO_2]$ $[H_2O]$ [NO] $[NO_2]$ $[NH_3]$

summary

1-litreture review to select preferred catalysts
2-synthesis of proffered catalyst include :
SSZ-13 has been purchased commercially , sapo-34 has synthesized hydrothermally and metal will be loaded on zeolites.