Experimental study of catalysts and process designs for chemical synthesis using H_2 and CO_2

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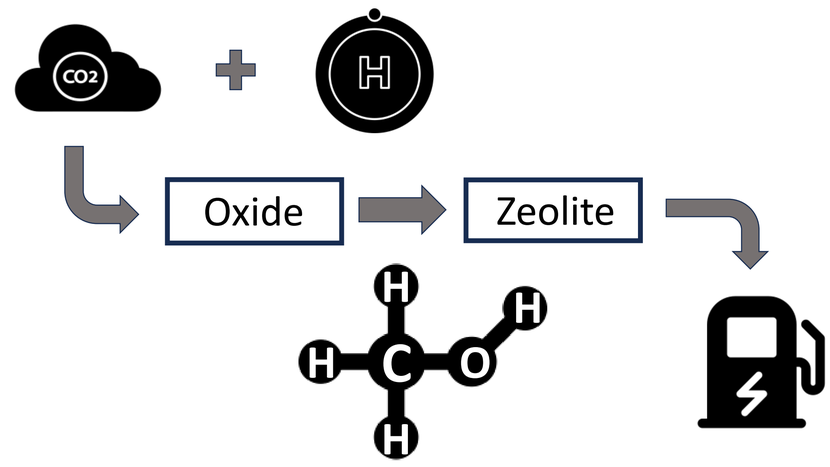
INTRODUCTION

Carbon neutral fuels are getting more and more attractive due to the global warming and energy crisis. The main goal of this project is to produce green added-value fuels (e.g. jet, higher length hydrocarbons) directly from CO_2 and H_2 in a **one-step reaction**.

Until today this process has been studied mainly using syngas (CO/H_2) as a feed and producing hydrocarbons through the Fischer-Tropsch Synthesis route, especially for certain ranges of hydrocarbon numbers.

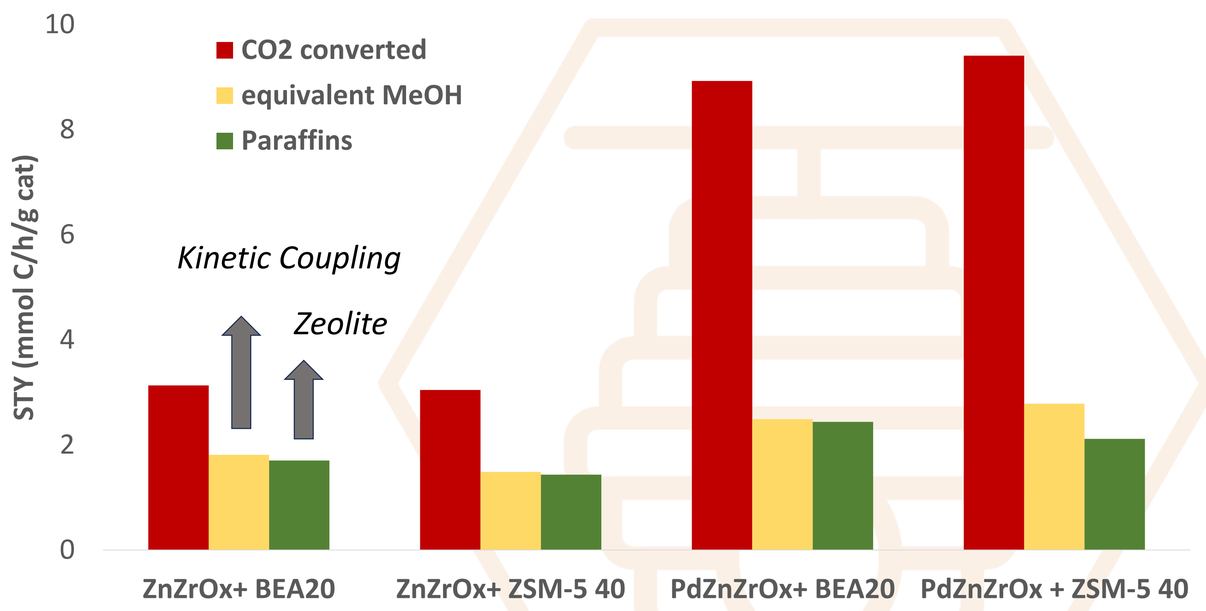
The idea is to use **CO_2 and H_2 feeds** via methanol as intermediate by combining the CO_2 to methanol process on reducible oxide catalysts with the well-known **Methanol to Hydrocarbons** chemistry. The latter will be modified through new catalyst development to selectively produce gasoline-range hydrocarbons.



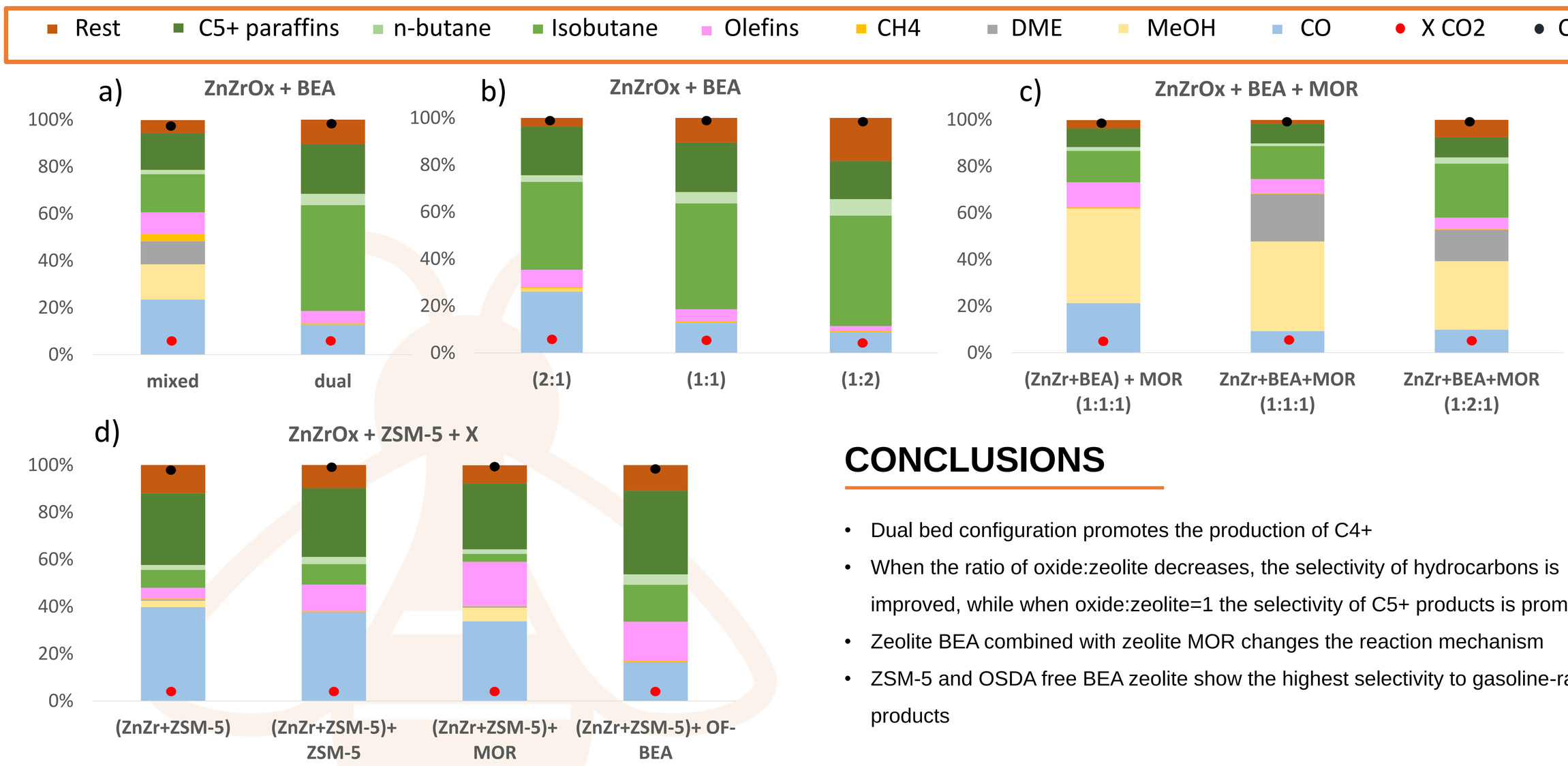
EXPERIMENTAL RESULTS

TARGETS

- Screening of pure ZnZr oxide as well as doping it with Pd
- Testing different zeolites (topologies of BEA and ZSM-5) as methanol to hydrocarbons catalysts
- Studying different bed configurations that affect the proximity between the oxide and the zeolites
- Study different ratios of oxide:zeolite
- Altering the system by the addition of a 2nd zeolite to enhance the gasoline production



Space Time Conversion and Space Time Yield of equivalent methanol and paraffins on synthesized ZnZr oxide and PdZnZr oxide combined with 2 different topologies (zeolites BEA and ZSM-5), Fixed bed reactor, Conditions, T = 300°C, P = 40 bar, GHSV = 8500 ml g_{cat}^{-1} h^{-1}



Product distribution, CO_2 conversion and carbon balance in CO_2 to hydrocarbons reaction on ZnZr oxide and (a) BEA zeolite in different proximities, (b) BEA zeolite in different oxide:zeolite ratios, (c) BEA and MOR zeolites, (d) ZSM-5 mixed and 2nd layer of zeolite

Fixed bed reactor, Conditions, T = 300°C, P = 40 bar, $GHSV_{(a,b,d)}$ = 8500 ml g_{cat}^{-1} h^{-1} , $GHSV_{(c)}$ = 5670, 8500 and 6375 ml g_{cat}^{-1} h^{-1}

CONCLUSIONS

- Dual bed configuration promotes the production of C4+
- When the ratio of oxide:zeolite decreases, the selectivity of hydrocarbons is improved, while when oxide:zeolite=1 the selectivity of C5+ products is promoted
- Zeolite BEA combined with zeolite MOR changes the reaction mechanism
- ZSM-5 and OSDA free BEA zeolite show the highest selectivity to gasoline-range products

FUTURE PLANS

- Target in high C4+ selectivity (at high C balances)
- Scale up for best materials in semi-pilot scale reactor
- Study and optimize process conditions

AKNOWLEDGEMENTS

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