Introduction

- Due to the growing importance of renewable feedstocks and use of heterogeneous catalysts the interest in hydrotalcite-derived mixed oxides to perform the Guerbet reaction increased.
- The Compound Annual Growth Rate (CAGR) of Guerbet alcohols in 2016-2024 is 5.6%.
- Ni/Cu hydrotalcite derived mixed oxides are employed as highly selective, stable and active catalysts in combination with KOH.
- The Ni/Cu catalysts are tested in the self and cross condensation on a broad variety of starting alcohols.

Hydrotalcite-derived mixed oxides

Hydrotalcite-like material

Calcination: T = 500°C

Mixed Oxides

e.g. NiCuMgAl(OH)_{3}·(CO_2·xH_2O)

Hydrotalcite-like material

NiCuMgAl(OH)_{3}·(CO_2·xH_2O)

NiCuMgAl(OH)_{3}·(CO_2·xH_2O)

NiCuMgAl(OH)_{3}·(CO_2·xH_2O)

Materials Characterization

(a) XRD patterns obtained for:
Calcined mixed oxides

(b) H_2-TPR profiles obtained for:
Calcined mixed oxides

Combining Cu & Ni leads to:
- Increased stability of Copper
- Increased reducibility of Nickel

Self condensation

Catalyst: Ni9Cu1HT

Starting alcohol | T_{max}(°C) | Wt % | Wt %
--- | --- | --- | ---
1-Octanol | 225 | 4 | 2
2-Octanol | 280 | 4 | 3
2-Methyl-1-pentanol | 240 | 0.5 | 1.33
2-Methyl-2-pentanol | 200 | 0.5 | 1.25

Conclusions:
- Excellent kinetics for citronellol, but limited conversion
- High selectivity for all feedstocks
- Ni9Cu1HT is very versatile catalyst

Cross condensation

Catalyst: Ni9Cu1HT

Starting alcohol | T_{max}(°C) | Wt % | Wt %
--- | --- | --- | ---
1-Octanol | 225 | 4 | 2
2-Octanol | 280 | 4 | 3
2-Methyl-1-pentanol | 240 | 0.5 | 1.33
2-Methyl-2-pentanol | 200 | 0.5 | 1.25

Conclusions:
- All reactions obtain distributions close to the theoretical distribution.
- Very high selectivity reactions

Products

Properties Guerbet alcohols

- Lower melting point
- Changed viscosity and polarity
- Excellent oxidative and colour stability
- Biodegradable

Appearance

- As liquid, solid gel...
- Dependent on chain length and branching

Use

- Wide variety of products suitable for various applications.
  - Cosmetics and personal care: as solvents or emulsifiers
  - Detergents & cleaners: as surfactants
  - Metal processing: as cooling liquids or lubricants
  - Others

Conclusions

The combination of Nickel and Copper leads to a higher stability of the copper, a better reducibility of the nickel and an improved performance in terms of selectivity to the required Guerbet alcohols. Ni9Cu1HT is a very versatile and robust catalyst to convert a broad variety of starting alcohols via self and cross condensation to a large variety of end products suitable for various applications dependent on the physicochemical properties of the Guerbet products.