

## Selective synthesis of MIBK via acetone hydrogenation over hydrotalcite based Cu-Al mixed oxide catalyst

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### Highlights

- Inexpensive Cu-Al mixed oxides was prepared from cheap precursors.
- Vapour phase acetone hydrogenation was conducted over the prepared mixed oxides catalyst.
- Acetone conversion increases with copper content.
- Metal as well as acid sites affect MIBK selectivity.

### 1. Introduction

Acetone is a low value by-product of the phenol production process via cumene peroxidation route. The expansion of market for phenolic resins is driving the production of phenol. Acetone is produced in equimolar amount in this process. As such, production of acetone exceeds its demand. Therefore, it is essential to upgrade acetone to valuable products. The present work is concerned with the synthesis of methyl isobutyl ketone (MIBK) via vapour phase hydrogenation of acetone. MIBK finds wide application as a solvent in paints, coatings and resins. Industrially, MIBK is synthesized from acetone over a noble metal based acidic catalyst. In this work, an inexpensive non noble metal based Cu-Al mixed oxide catalyst was prepared from hydrotalcite precursors and tested in a continuous packed bed reactor for its activity towards acetone hydrogenation with high selectivity for MIBK.

### 2. Methods

A series of hydrotalcite based Cu-Al catalysts were synthesised via co-precipitation technique. The Cu:Al mole ratio was varied from 0.1 to 0.75. Copper nitrate tri-hydrate and aluminium nitrate nona-hydrate were used as precursors. Sodium carbonate was used as a precipitating agent. The pH was maintained by addition of sodium hydroxide. The catalysts were characterised by different techniques such as XRD, FESEM coupled with EDS, BET, H<sub>2</sub>-TPR and NH<sub>3</sub>-TPD. The activity of all the catalysts was tested in a continuous packed bed reactor at atmospheric pressure. The catalysts were reduced under hydrogen atmosphere prior to hydrogenation reaction. The experiments were conducted by varying the temperature from 200 to 300 °C, H<sub>2</sub>/CH<sub>3</sub>COCH<sub>3</sub> mole ratio from 0.5 to 1.25 and space-time from 13.2 to 21.3 kg cat h/kmol acetone. The product stream was analysed by gas chromatograph for its composition.

### 3. Results and discussion

In order to find the influence of copper content on hydrogenation activity, experiments were conducted at 250 °C, 1 H<sub>2</sub>/CH<sub>3</sub>COCH<sub>3</sub> mole ratio and 16.88 kg cat h/kmol acetone space-time. The catalysts exhibited significant hydrogenation activity. The conversion was found to increase with copper content (Figure 1). As copper is the active site for hydrogenation reaction, the rate of reaction increased with copper content. The highest selectivity of MIBK was found to be 70 % for CuAl<sub>0.25</sub> (Figure 1). The selectivity decreased at higher copper loadings. The condensation and dehydration reaction leading to mesityl oxide require acid sites. Mesityl oxide is hydrogenated to MIBK over copper. At higher copper loading, the concentration of acid sites decreases, thereby decreasing the production of mesityl oxide. Hence, MIBK selectivity reduces at higher copper contents.

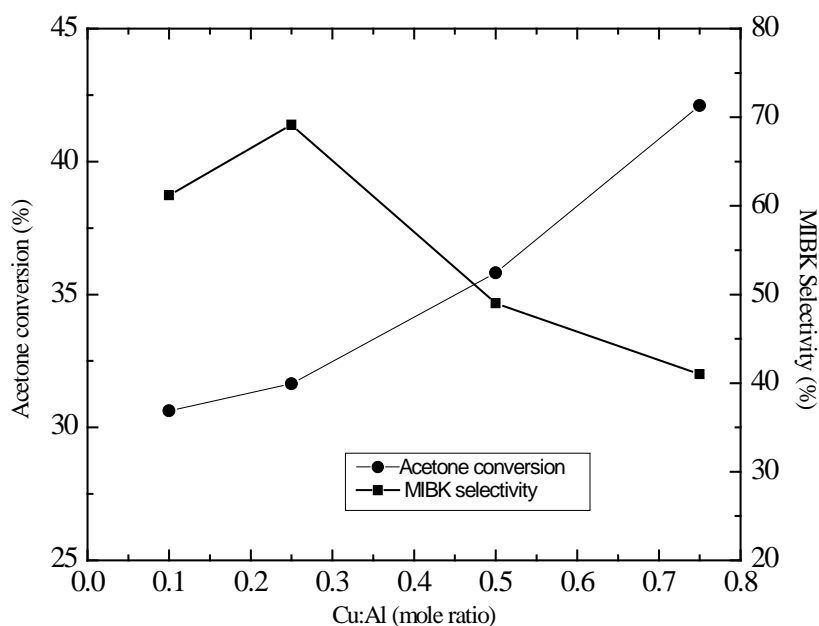


Figure 1. Effect of copper content on acetone conversion and MIBK selectivity.

#### 4. Conclusions

Cu-Al mixed oxide catalyst showed significant acetone hydrogenation activity. Both the functionalities present in catalyst, metal as well as acid influenced MIBK selectivity. The catalyst having Cu:Al molar ratio of 0.25 showed highest selectivity (70%) to MIBK at 250 °C. The conversion of acetone was found to increase with Cu:Al mole ratio of the catalysts.

#### References

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#### Keywords

Acetone; hydrogenation; MIBK; Cu-Al mixed oxide.