Technical Brief

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Cost-effective process for manufacturing γ-Valerolactone from Levulinic Acid

Technology Summary

CSIR-CSMCRI has developed an improved selective process for the preparation of γ-valerolactone (Gvl) by catalytic hydrogenation of biomass-derived levulinic acid (LA). The disclosed process renders excellent yield (100%) under mild reaction conditions within a short reaction time.

Background

Levulinic acid (LA) is a sustainable platform molecule that can be converted to many valuable chemicals and fuel additives, such as gamma valerolactone (Gvl) through hydrogenation. However, till date no catalytic hydrogenation process has been reported to be effective near ambient conditions in shorter time with high yields.

Technology description

CSIR-CSMCRI has developed an improved selective process for the preparation of γ-valerolactone (Gvl) by catalytic hydrogenation of biomass-derived levulinic acid (LA). This process renders excellent yield (100%) under mild reaction conditions within a short reaction time in aqueous medium (at high LA concentrations) using in situ generated recyclable Ru-based heterogeneous catalysts (hydrous ruthenium oxide), or it's supported forms and with a lesser amount of Ru (with respect to LA), using nearly stoichiometric amounts of H2. In addition to the batch reaction, a continuous flow hydrogenation process for Gvl from LA is also successfully demonstrated adding further opportunity for commercial exploration.

Market Potential

Gvl finds the most promising application as a green, high-boiling solvent for high temperature reactions (>100 C), with the green and bio-solvents global market valued at ~$7 billion. Gvl also finds application as a gasoline additive in green fuels and as an advanced biofuel with clean burning characteristics. The global biofuel market is valued at $150 billion. For value-added product from LA, the global market is estimated at $30 million.

Value Proposition

- Reaction under mild conditions (50-100 C, 5-15 atm H2)
- 100% conversion of LA
- Excellent selectivity of GVL even at high LA concentration
- Lesser reaction time
- Using lesser quantity of precious metal catalyst
- In situ generated catalyst (no prior reduction step)
- Recyclable active catalyst; catalyst can be supported on inexpensive supports
- Reaction in aqueous medium
- Stoichiometric quantity of hydrogen used ⇒ avoids recycling operations
- Continuous flow hydrogenation process also shown

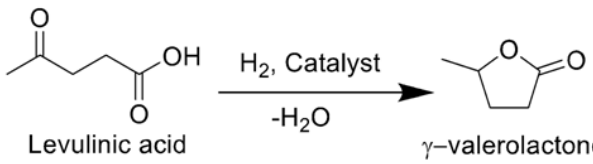
Applications

Gamma valerolactone (Gvl) finds extensive application as a high-boiling “green” solvent, food additive/ flavoring agent, and a fuel additive and bio-fuel of the future.

Technology status

- Demonstrated at 1 Liter scale (lab)
- Techno-economic viability analysis done – Viable at > 2 tons/ day scale and 2 shifts
- This invented process is protected by IP IN 2866DEL (08th October 2014), WO 056030 Al (14th April 2016), EP 3204366 A1 (19th August 2017), US 10221149 B2 (5th March 2019).

Min 2 tons/day cap



Levulinic acid — γ–valerolactone

Cost: Rs X/kg
Cost: USD Y/kg

Cost: Rs (X+200) /kg
Cost: USD (Y+3)/ kg

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