Butanol or Isobutanol as a Value-added Fuel Additive to Inhibit Microbial Degradation of Stored Gasoline

Background

- A known problem with bulk (bio)fuels in both storage and vehicle tanks is microbial growth causing: biocorrosion, biofouling and biodeterioration. This occurs in >80% of inspected tanks. The presence of a small water phase provides conditions for microbial growth. Expensive biocides and corrosion inhibitors are often now added.
- Iso-butanol has been approved up to 16% (v/v) and n-butanol proposed as renewable fuel oxygenate additives to gasoline. n-Butanol and iso-butanol are inhibitory to microbial growth, esp. if >20 g/L in an aqueous phase.

Approach.

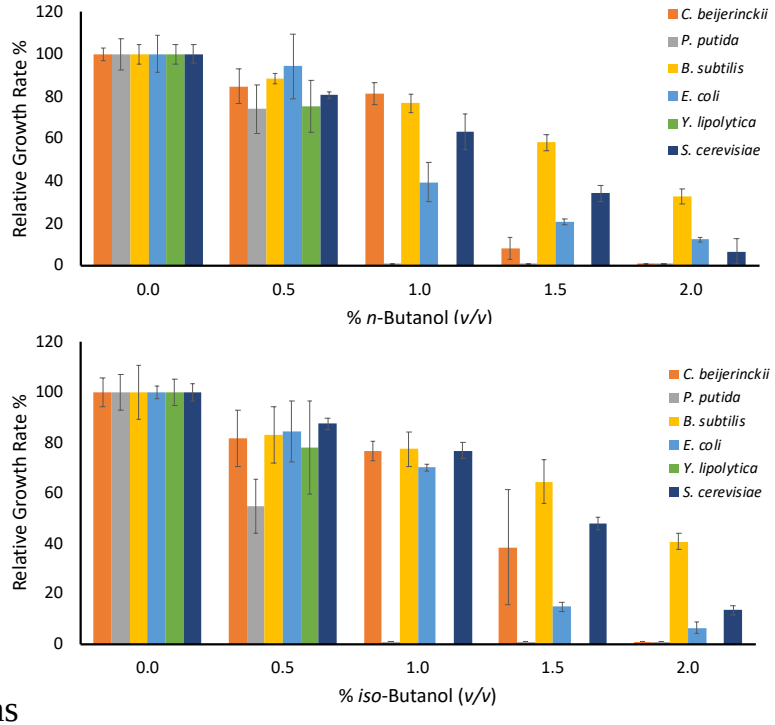
- We performed equilibrium partition tests to show that n-butanol partitions into the aqueous phase of a model gasoline/water system reaching concentrations of 42 g/L and up to 48 g/L from gasoline blends at 10% and 24% (v/v), respectively. Likewise, isobutanol blended in gasoline at 10% and 24% (v/v) partitioned into an aqueous phase at 45 g/L and 53 g/L, respectively.
- This was demonstrated by collecting growth inhibition data for a range of microbes including strains considered to be solvent-tolerant or model biofuel production strains, as well as fuel storage tank isolates.

Results

- We found that n-butanol and iso-butanol partition into the aqueous phase of water/fuel mixtures at concentrations sufficient to inhibit the growth of microorganisms -- reducing growth by 40-100% for C_4 alcohol concentrations of 1.5 and 2.0% (v/v). No growth was observed at 3% levels.

Significance

- In this proof-of-concept study, we have demonstrated that the amphiphilic solvents n-butanol and isobutanol, when added to gasoline in the expected concentrations, will partition into an added aqueous phase at sufficient concentrations that inhibit the growth of several microorganisms. These solvents may also be produced from renewable feedstocks as biofuels and could serve not only as suitable blending oxygenate agents but also as effective value-added inhibitors to microbial fouling, deterioration, and corrosion during fuel storage.



Relative growth rates in increasing levels of (A) n-butanol and (B) isobutanol. The organisms used: Bacillus subtilis 168, Escherichia coli DH5a, Pseudomonas putida KT2440 (aromatic degrader), Saccharomyces cerevisiae D5A, (fermentation standard, high ethanol tolerance), Yarrowia lipolytica (lipogenic yeast), Byssochlamys spectabilis (fungal isolate from fuel tanks)), and Clostridium beijerinckii BA101 (butanol hyperproducer).

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