M.SC Semester III

Core Course XII

Environmental Chemistry

TOPIC:-Unit IV, GREEN SOLVENTS EFFECT

Department of Chemistry
L.S COLLEGE MUZAFFARPUR
B. R. A. BIHAR UNIVERSITY
Dr. Priyanka

SOLVENT EFFECTS & GREEN CHEMISTRY

In order to study the solvent effect we need an help of conceptual basis such as:-

- Theories of molecular structures.
- Concept of polarity.
- Bulk properties

a) Dielectric constant

b) Density

Green solvents & its definition

- GOALS OF GREEN CHEMISTRY:-

i. To reduce hazards associated with product & process, this is to maintain not only quality of life but also technical achievements.

ii. Reduction of risk:

RISK= HAZARD × EXPOSURE.

Solvents define a major part of the environmental performance of processes in chemical industry and also impact on cost, safety and health issues.
The idea of "**green**" solvents expresses the goal to minimize the environmental impact resulting from the use of solvents in chemical production.

CONTI.....

- An ideal green solvent must possess following criteria:

i. Must have human safety.
ii. Reduced hazard.
iii. Easily degradable.
iv. Provide high product yield.

- Criteria for solvent selection:

i. Must have less human & environmental absorption.
ii. Its environmental toxicity should be understood.
iii. Environmental fate should be understood.

Green Solvents in Green Chemistry:-

- Water
- Methanol
- Nitromethane
- Acetone
- Ethanol
- DMF
- DMSO
- HMPA
- Acetonitrile
- Pyridine
- Ammonia

Water as a reaction medium

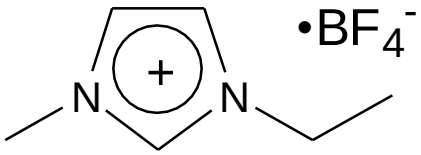
- One of the most obvious alternatives to VOCs.
- Cheap, readily available, and plentiful (in the UK!)
- Useful for certain types of reaction but limited because of:
  - Low solubility of organic substrates
  - Compatibility with reagents
- Clean up of aqueous waste difficult
- Useful in biphasic processes in conjunction with other solvents

Carbon Dioxide

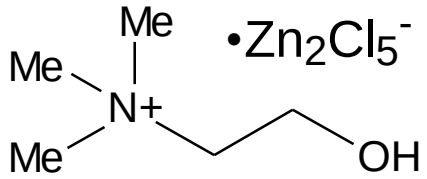
- Similar advantages to water
  - Natural, cheap, plentiful (too much of it!)
  - Available in >99.9% pure form, £70/$110 per 25kg.
  - By-product of brewing, ammonia synthesis, combustion
- Already being adopted in a variety of commercial processes (see later)
- Non-toxic and properties well understood
  - asphyxiant at high concentrations
- Easily removed and recycled, and can be disposed of with no net increase in global CO_2
  - Simple product isolation by evaporation, to 100% dryness.
- No solvent effluent
- Potential for product processing (extraction, particle formation, chromatography etc.)

Ionic liquids (IL's)

- Typically consist of organic cation (often ammonium or phosphonium salt) and inorganic anion



1. Ethylmethylimidazolium tetrafluoroborate, [emim][BF_4]



2.Choline chloride/Zinc chloride ionic liquid

- Usually only consider IL's which are liquid at room temperature
- Great variety of structures possible
- Very low vapour pressure – attractive alternative to VOCs.

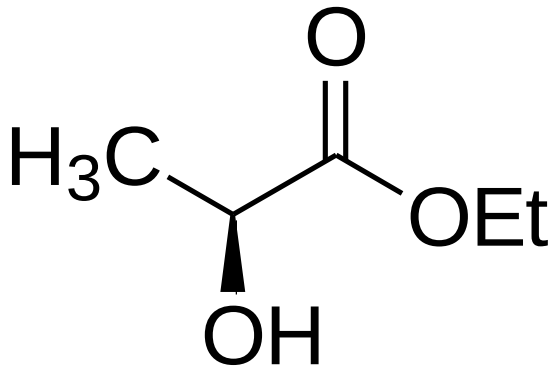
Ionic Liquids as Reaction Media

- Diels-Alder reactions
- Alkylation reactions
- Hydroformylation reactions
- Friedel Crafts reactions
- Pd-mediated C-C bond formation
- Alkene polymerisation
- Biotransformations

T. Welton, *Chem. Rev.*, **1999**, *99*, 2071.

Ethyl lactate – a renewable solvent

- Derived from processing corn
- Variety of lactate esters possible
- Renewable source (non-petrochemical)
- Attractive solvent properties
  - Biodegradable,
  - Easy to recycle,
  - Non-corrosive,
  - Non-carcinogenic
  - Non-ozone depleting
  - Good solvent for variety of processes



- Commonly used in the paint and coatings industry
  - Potentially has many other applications.

http://www.cargilldow.com