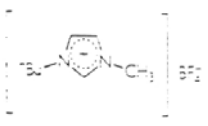
hydrocarbon. The reaction is carried out by shaking and heating the two liquids together. Once the shaking is stopped and the mixture cooled, though, they quickly separate like oil from water and the ionic liquid sinks below the other layer. This means the catalyst in the ionic liquid can be decanted off and used again once the reaction is over. Solid catalysts can be filtered off but they are not as efficient as dissolved catalysts so this approach could be much more effective in industry.

... to Brazil

Jairton Dupont and his team at the Federal University of Rio Grande do Sul, Brazil, are using ionic liquids to dissolve metal catalysts that have been used for years in solid form, such as palladium catalysts. This will allow various standard industrial reactions to be carried out in a more environmentally acceptable manner. Last year, his team used the ionic liquid 1-*n*-butyl-3-methyl-imidazolium tetrafluoroborate to dissolve a palladium catalyst and to carry out the hydrodimerisation of 1,3-butadiene to make octa-2,7-dien-1-ol, which is used in drug and dye manufacture. They have to warm the reaction to 70 °C to make it work, but this is much cooler than most industrial reactions. The catalyst and ionic liquid can again be decanted off once the reaction is over, and recycled.



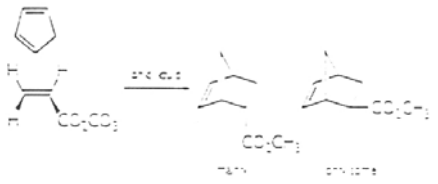
1-*n*-butyl-3-methyl-imidazolium tetrafluoroborate

... and back to the UK

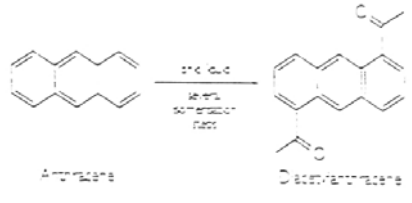
In the UK, Tom Welton of Imperial College, London and York University's Paul Dyson are also using ionic liquids to dissolve catalysts. They can dissolve catalysts in the ionic liquid 1-butyl-3-methyl-imidazolium chloride–aluminium chloride, and use it to hydrogenate aromatic compounds, such as benzene and phenanthrene, found in oil-derived fuels, like petrol and diesel. By hydrogenating a fuel it will burn leaner and cleaner.

Welton's team is also working on carrying out the Diels–Alder reaction in ionic liquids. This reaction makes rings of carbon atoms in a molecule. It is

A typical Diels–Alder reaction.



A typical Friedel–Crafts reaction.



used to make precursors for pharmaceuticals and polyester resins as well as agrochemicals. The reaction works just as well in an ionic liquid as it does in its normal solvent, water. So why not use water as the solvent? Welton points out that by using an ionic liquid he and his colleagues can use starting materials that are moisture-sensitive, thus exploiting the Diels–Alder reaction further.

Kenneth Seddon of Queen's University Belfast is carrying out another very important industrial reaction in the ionic liquid 1-methyl-3-ethyl-imidazolium chloride–aluminium chloride. The Friedel–Crafts reaction is used to add alkyl (C_nH_{2n+1}) or acyl ($C_nH_{2n+1}CO$) groups to aromatic compounds, such as benzene, to make new hydrocarbons and ketones, which are useful precursors in many industrial reactions, such as perfume manufacture. The researchers can make many compounds, such as musky fragrance molecules, in this way. They have also discovered that ionic liquids can help them add alkyl groups to aromatic amines and alcohols, another important industrial process for making precursor molecules for the drug, fragrance and flavourings industries. Many of their reactions work at room temperature and atmospheric pressure, unlike equivalent industrial reactions that have to be heated strongly and squeezed to 350 times atmospheric pressure.

Chemists are finding new ionic liquids all the time by combining different ions of organic and inorganic salts. One day there could be an ionic liquid for almost any reaction that would normally use a noxious organic solvent. With many research groups working on the problem ionic liquids could provide an ideal solution to cleaning up the chemical industry.