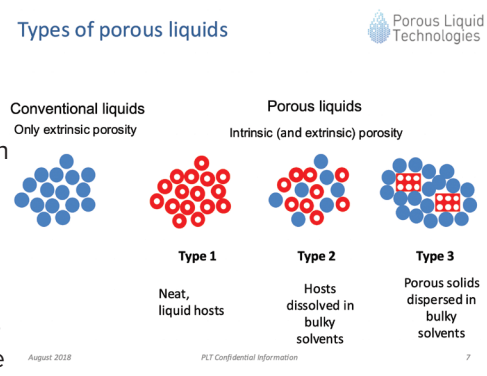
New materials offering New Platform Technology

On first consideration, a porous liquid, a liquid with CO2 gas filled holes is nothing new; champagne is a great example.

However, if the gas capture capacity of a liquid can be enhanced by addition of a porous solid, while retaining the liquid advantages of a mobile, cyclable material, a porous liquid, then the possibilities for gas capture on an industrial scale are extensive. If the gas can be released from the porous liquid simply and sustainably, by physical means of recycling through a recovery and return loop, then the economic and environmental advantages over solid fixed-bed systems become extremely exciting. If that gas capture capacity is greater than existing industrial systems and the solid can be designed as shape and size selective, then we have a technology that will have remarkable advantages over existing technologies. We have a Type 3 Porous Liquid. Of course, it is difficult to put the gas back in champagne and there probably would not be much point, but with new porous liquid technology, the ability to charge and discharge gas simply by pressure and temperature swing is remarkable and easy.



The idea was the brainchild of Stuart James, Professor of Inorganic Chemistry at the Queen's University Belfast who together with David Rooney, Professor of Chemical Engineering discussed the potential for gas capture by suspending a stable, inert, porous solid in a carrier solvent that could not enter the pores, to form a porous liquid. The concept was generalised and published in a paper in 2007[1], then followed up by demonstration of actual materials in 2015, in an article in Nature[2]. This latter work was a collaboration between Queen's and Andy Cooper, Professor of Chemistry at University of Liverpool and research groups in Argentina, France and Germany. Porous Liquid Technologies Ltd was formed in 2017 to exploit the industrial potential of these novel materials.

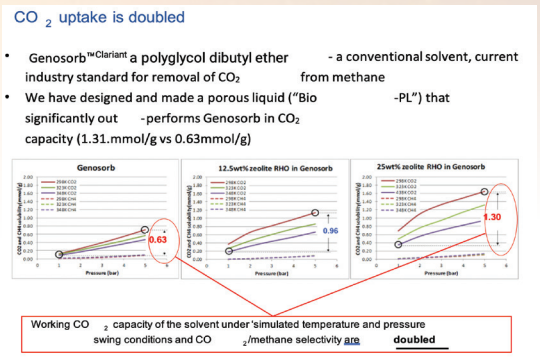
Porous Liquids offer a tailorable new platform technology with many applications:

- Have up to 20% porosity
- Have much higher gas solubilities than non-porous solvents
- Flow – can be circulated
- Can be made at scale without expensive synthesis
- Have excellent selectivity
- We can design PLs for purpose using a wide range of porous solids and benign, readily available solvents - even water!

The full potential of porous liquids cannot be reviewed in a short article, so only the most remarkable properties are discussed below.

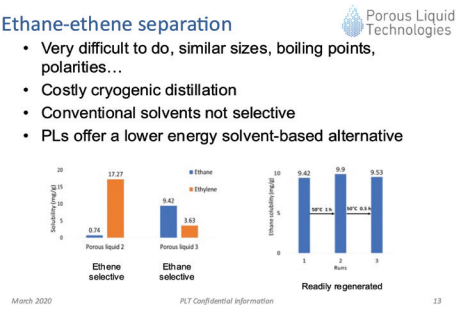
CO2 Capture

The CO2 uptake of current industrial solvents can be doubled using porous liquids, leading to overall operational cost saving of 23% confirmed by independent technoeconomic analysis, due in large part to the lower methane loss. We believe that with further work, this performance could be considerably enhanced.



Gas Separation and Recovery Ethane/Ethene

Other gases can be separated, for example ethane and ethene mixtures. Separation of these gases is usually achieved by expensive, energy-intensive, cryogenic distillation. Porous liquids can be designed to be selective to either ethane or ethene and the ethane/ethene can easily be recovered to regenerate the porous liquid.



Other Potential Uses

Over 500 porous liquids have been made so far from diverse components including zeolites, organic cages and hypercrosslinked polymers dispersed in a range of solvents including liquid polymers, water, non-volatile organic solvents and even edible natural liquids such as olive oil.

They can be designed to be size- and shape-specific to capture volatile organic compounds (VOCs, e.g. solvent emissions from chemical processes) and perform liquid/liquid extractions such as MEG/Water separations.

For further information, our business and technical team can arrange individual presentations, contact Dr Tony Bastock at tony.bastock@porousliquidtechnologies.com

[1] N. O'Reilly, N. Giri and S.L. James Chem. Eur. J. 2007, 13, 3020.
[2] N.Giri, M. G. Del Popolo, G. Melaugh, R. L. Greenaway, K. Rätzke, T. Koschine, L. Pison, M. F. C. Gomes, A. I. Cooper and S. L. James, Nature, 2015, 527, 216.