Alkaline digestion of waste glass

Key features

- Simple process developed for the extraction of sodium silicate from soda-lime glass, characterised by a high utilisation of the raw materials and energy embodied in glass
- Suitable for the low-value fraction of waste glass which is too small to be optically sorted (by colour) and remade into glass products
- Significant commercial (reduced capex and opex) and social benefits (reduce landfill and consumption of virgin materials) when compared to conventional production routes of sodium silicate.

Background

1. **Glass**: In theory, glass is infinitely recyclable. However, the reality is that recycling glass from solid waste streams is complicated by the variable chemical compositions of different glass types and the fact that a particle size >10 mm is required to optically sort different glass types (**Figure 1**). Of ~1.2 million tonnes of container glass consumed in Australia in 2013, only 45.3% was recycled; leaving 657,000 tonnes of glass to be stockpiled, landfilled or used in low-value end markets such as road-base.

2. **Sodium silicate**: with a global market size estimated at USD 8.9 billion and production capacity of 10 million tonnes, it is one of the most widely used chemicals in both commercial and domestic settings. A combination of having no known ecologically problematic properties and usefulness as a cost-effective binder, pH adjustor, cleaning agent and feedstock for precipitated silica has seen sodium silicate become an integral part of many products, including detergents, concrete hardeners, zeolites, geopolymer concrete, tyres, ceramics, paper and cardboard.

Figure 1. (Top) Piles of recycled glass, (Bottom) glass particles to be optically sorted.

The Technology

There is a narrow range of reaction conditions under which the alkaline digestion of soda-lime glass and separation of resultant products is able to proceed in a commercially relevant way.

Research has optimised digestion conditions and product processing. The average purity of final alkali-silicate samples taken from 20 individual digestions and measured by ICP-OES was 99.41% with a 95% CI of +/-0.14%. Glass can now be used to produce a range of high-value products including:

1. Liquid alkali-silicates in all commercially relevant concentrations and ratios;
2. High purity silica gel; and
3. Calcium Silicate Hydrate (CSH).

Key advantages

- estimated costs of sodium silicate production (capex and opex) >50% lower than conventional production routes
- reduction in material going to landfill and associated economic and environmental costs
- reduced virgin raw material consumption and greenhouse gas emissions (via reduced energy and calcining requirements)
- the process is easily scalable and has a large stock of inputs available.

Figure 2. Raw glass pre-process (**left**) and dried high-purity silica gel produced from digestion products (**right**).

Intellectual Property

The reaction conditions and steps for processing reaction products are the subject of an Australian Provisional Patent Application.

Commercialisation Opportunities

UniQuest is seeking licensing, collaborative or investment partners to commercialise the technology.

Research leaders

Professor Damien Batstone and UQ PhD student **Rhys Pirie** developed the technology following discussions on how to produce a low-cost, highly-available silicon source for use in agricultural fertilisers.

Damien is a chemical engineer with over 20 years' experience in wastewater process modelling, design, and environmental biotechnology.

Rhys comes from an agricultural background and has a particular interest in developing technologies which enable circular nutrient economies.

About UniQuest

UniQuest is Australia's leading technology transfer company and manages the intellectual property of The University of Queensland (UQ). Established in 1984, our innovation portfolio has seen the creation of more than 100 startup companies, and includes Australia's first blockbuster vaccine Gardasil®, the internationally acclaimed Triple P-Positive Parenting Program and superconductor technology used in most of the world's MRI machines. In 2015, our spinout company Spinifex Pharmaceuticals secured Australia's largest ever biotechnology acquisition.

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