Paebbl

Paebbl transforms CO_2 into valuable construction materials through its innovative mineralisation technology. Founded in 2021 and operating across London, Rotterdam, Helsinki, and Stockholm, they accelerate natural mineralisation processes by a factor of a million, achieving in one hour what nature takes centuries to complete. Their materials perform like traditional construction products but instead of releasing carbon dioxide, they permanently store it. With backing from leading climate technology investors such as Amazon's Climate Pledge Fund, Capnamic, 2050, The Grantham Foundation and Pale Blue Dot, they're working to turn the construction industry from one of the world's largest carbon emitters into part of the climate solution.

What we do

At Paebbl, we leverage nature's own mechanism of rock formation to lock carbon away, but at vastly accelerated rates. In doing so, the same carbon dioxide that was once an industrial by-product becomes the cornerstone of future-proof building materials.

Our mineralisation process represents a significant advancement in carbon capture and utilisation technology. The process begins with captured CO_2, which can come from various sources, including direct air capture or industrial emissions. This CO_2 is combined with abundant minerals, primarily olivine today, to form cement.   However, Paebbl is small and new, employing less than sixty people. We are therefore looking for additional support to help us understand and model our processes so that we can speed up the development of our technology and start making a difference.

The Problem

Paebbl uses a novel mineralisation process in a reactor developed specifically for this particular purpose. However, there are several key issues that need to be overcome to make sure that the process delivers a sustainable product.

One of these issues is that the reactor contains a slurry of ground minerals and water which is pumped around the main reactor and pipework to allow the reactor to work. However, slurry is a complex material, it does not necessarily flow well and the particulate matter within the liquid can build up in the pipework and build up at the bottom of the reactor. This leads to problems requiring the reactor to be flushed and cleaned regularly, increasing the cost of production both in terms of overall price and environmental impact.

This build-up of particulate matter is dependent on many factors. The particle size distribution of the solid, the solid to liquid ratio, the size of the pipework, the speed and direction of the flow and the geometry of the pipework are only the start of the potential inputs. It is possible to simply 'over-engineer' the problem, making the flow fast, the solid to liquid ratio small and the pipe-diameter large. However, every time we 'over-engineer', we are adding to the CO_2 footprint. We would therefore like to minimise the footprint while also minimising the buildup. To do this we need a mathematical model of what is happening within the pipes.

Ideally, we would like to have a model of the particulate flow, fall out and buildup so that we can optimise the system to minimise buildup and resultant maintenance. This would mean that in the future we can design our reactor to limit build-up while still minimising our carbon footprint.

Key areas of focus

Key issues to be addressed include the way the particulate builds up in pipes, the potential for ‘clumping’ of the material and what changes the rate and type of build-up.

Areas of focus could include:

- Modelling the flow in a straight smooth pipe and developing a method for predicting build up given a set of input parameters
- Modelling the flow in a more complex geometry of pipe, when flow goes round a bend in the pipe or is pumped upwards within the system
- Modelling the impact of slurry in the reactor itself where temperature and pressure also play a part

Paebbl can provide reference particle size distributions and physical parameters of the mineral particles, potential pipe and reactor geometries, reference flow rates, temperatures and pressures. We can also provide some photographic evidence of the types of build-ups seen in the pipework for a small set of input parameters as well as details of the current flushing and cleaning requirements to help validate any modelling.

Outcomes

Ideally Paebbl would like to have access to models for understanding the fall out and build-up of particulate matter, with the desired extension that we can predict these parameters for new systems to minimise the maintenance requirements. However, any information on change points, or guidelines would be useful in future planning.

Challenges

There is only a minimal set of potential validation data within Paebbl due to the innovative nature of our work so other potential validation data sets may need to be sourced. It is also a highly complex problem with materials in two different states and potentially infinite potential geometries. Therefore, it is likely that some base assumptions will need to be developed. Finally, whatever is developed should use only the minimum amount of compute necessary. Paebbl is committed to reducing our carbon footprint and large, computationally expensive models should only be used where we really need them.