The TecEco project: the factors of cement and climate change.

Summary
TecEco Pty Ltd is currently developing an environmentally friendly cement system, which emits less greenhouse gases GHG in comparison to conventional Portland cements. This project has attracted considerable interest around the world and caught the attention of the world's leading cement scientists.

Up to 10 lds anthropogenic GHG emissions are attributed to the use and manufacture of Portland cement. World wide, it is estimated that annually 1.7 billion tones of Portland cement are produced. For each tonne of Portland cement over a tonne of carbon dioxide CO2 can be emitted to the atmosphere. Reducing CO2 emissions will result in reducing the effects of global warming.

TecEco's technology is based on magnesium oxide, that:

- requires less energy to produce,
- ultimatly can reabsorb (sequester) carbon dioxide, and,
- is recyclable.

The raw materials for this technology are abundant and following correct manufacture and design, a product of equal or enhance physical properties to those exhibited by products made from Portland cement is produced. These properties combine to make TecEco's technology an exciting, sustainable building product.

Introduction

TecEco was established in Tasmania, Australia in November 1999 by John Harrison. The mission was to develop sustainable technologies for the manufacturing and construction industries.

Focusing on reducing the environmental impacts associated with products used in the construction industry, it was identified that the reduction of carbon dioxide emissions associated with Portland cement was of fundamental importance.

Portland cement is one of the most widely used products in the building and construction indusry, its use and manufacture accounts for approximately 10 % of anthropogenic greenhouse gases emitted to the atmosphere[1]. Investigation into the use of reactive magnesium oxides has identified that the use of this technology may reduce the detrimental impacts on the environment associated with conventional cement use, by dramtically reducing the amount of greenhouse gas emmisions.

Since the Kyoto Protocol has been ratified by many nations, materials scientists around the world are examining alternatives to sequester carbon and reducing the impact of potential CO_2 taxes as well as for encapsulating industrial wastes.

Subsequently TecEco has filed a series of international patents covering this technology[2].

Technology

Conventional Portland cement is structured around calcium mineral technology[3]. The reaction associated with limestone is paramount, calcium oxide and carbon dioxide (CO_2) are formed when calcium carbonate (limestone) is processed through a kiln. Portland cement is produced at temporatures of around 1400 – 1500 ^oC. The firing process, associated mechanical operation and the release of CO_2 from the chemical process can account for between 1 to 1.3 tonnes of CO_2 emssions to the atmosphere for every tonne of Portland cement manufactured[4]. When the emissions per tonne of Portland cement are considered

[1] The built environment offers tremendous opportunities for improving sustainability. The manufacture of Portland cement accounts for around 23% of global CO2 emissions and about 10% of anthropogenic greenhouse gases (See http://www.propubs.com/climate/).
[2] TecEco's PCT application has been examined and all 17 claims found novel, inventive and conforming. At this stage there is therefore a very high probability that world wide protection can be achieved.
[3] In combination with other minerals present as a result of the constitution of the raw materials, Silica, aluminium, iron.
[4] Limestone CaCO3 converts to CaO plus CO2 when heated to a sufficient temperature. The value of .81 tonnes CO2 per tonne cementisius product (pyroprocessing only) was arrived at by Hendriks C.A., Worrell E, de Jager D., Blok K., and Riemer P. Emission Reductions of Greenhouse Gases from the Cement Industry. International Energy Agency Conference Paper. Other emissions of CO2 relate to operational use of fossil fuels to heat the kiln and power the poress and has a range s indicted.

with the annual production of Portland cement world wide, which is estimated to be around 1.7 billion tonnes,[5] then the scale of the issue can be comprehended.

The technology being developed by TecEco is based on the use of highly reactive magnesium oxide and related forms of this mineral. In comparison to the manufacture of Portland cement, the process to manufacture reactive magnesium oxide results in a significant reduction in greenhouse gas emissions. The chemical reaction to allow the process of converting magnesium ore (magnisite) to magnesium oxide requires a temperature of approximately 600 ^{o}C. Lower process temperatures results in lower energy requirements and less associated energy losses resulting in reduced emissions of carbon dioxide. The plant required to produce reactive magnesia is significantly smaller than the plant required to manufacture conventional Portland cement. This results in less energy required to produce the magnesia-based cement and allows for the capture of emitted CO_2 at source.

Magnesia based cements have the ability to re-absorb carbon dioxide in a sequestration process.

In some applications, by substituting TecEco technology cement for Portland cement, it is possible to reduce the amount of carbon dioxide emitted to the atmosphere by over 80%.

The products made by using TecEco technology can be recycled into useful reactive forms after the their use as a building/structure. Traditional Portland cements are not reusable in this manner. Additionally magnisium ore(s), in particular magnisite, are common and are estimated to be the worlds eighth most abundant element.

When used in the manufacture of concrete, the technology has been established to work well in combination with supplementary cementicious (pozzolanic) materials, such as fly ash. These materials are waste products from other industries and using them in the manufacture of concrete is an effective manner to reduce the burden on the environment.

The company's approach to placing the technology into the market place is based around the introduction of non-structural building products, applications in the waste incapsulasation field, and following research, then the premixed concrete industry.

Building products
Initial research has been carried out to investigate different mixes of TecEco cement combined with fly ash to produce a suitable brick mix. The results have shown that the required strength is reached from bricks made by using a commercial brick machine. Using bricks in construction that have a significantly reduced environmental impact has the potential to be of significant importance. Other properties include potential fire extinguishing properties for example.

Waste encapsulation
Large producers of waste are beginning to experience stricter waste related legislation and associated non-compliance. This together with potential carbon taxes is prompting waste companies to find methods to embrace these requirements. The waste industry is one of the fasting growing sectors in the world, indicating a growing need for the immobilisation of wastes, including toxic and hazardous wastes and related technology. The low permeability and high stability of the matrixes produced by TecEco technology makes this a logical area for future development.

Concrete
Portland cement is used in the majority of concrete mixes as a binder, often with the addition of pozzalanic materials, such as fly ash. The potential for using TecEco's technology in a pre-mixed concrete application is promising. Considering durability issues: magnesium based cements offer a potential enhancement of durability due to the low solubility property of the cement matrix structure. Chloride ion attack associated with marine and de-icing environments relates to the concentration of surface Cl^- ions and the rate ion of diffusion.

[5] USGS figure extrapolated

Diffusion rate is related to the porosity of concrete, TecEco cements can enhance the porosity properties advantageously. Repairing damaged concrete structures in these environment accounts for much expenditure each year worldwide. Increasing the durability properties of concrete may also open opportunities to manufacture thin section architectural panels, being lightweight, thin panels could be used in more building applications.[6]

The rheology of concrete can be improved by incorporating TecEco technology.[7] Use of TecEco technology can increase workability without losing strength or other properties of concrete. An improved 'stick' ability has advantages in applications such as drill well muds and gunnite or shotcrete.

Current Situation
TecEco is currently at an exciting time in its development. Research is being carried out into the technology locally and internationally.

Each month the company issues a newsletter electronically to over 2000 readers, which has led to numerous enquiries and communication. TecEco cement technology has received publicity and attention worldwide and managing director, John Harrison, has appeared on TV and radio stations in Australia. Articles have appeared in a diverse range of publications including New Scientist[8], Westminster diary, and the Toronto Star[9]. A film about block making using the technology has been shown by Discovery Channel Canada and more recently in the USA. The technology won the Tasmanian Innovation of the Year Award in 2002 and is now the subject matter of a £ 165,350 R & D program with the BRE in the UK and research in universities all over the world.

Immediate benefits to arise from the BRE and other research will include the application of the TecEco cement and the tech tendon[10] method of prestressing and reinforcing to concretes resulting in increased durability of steel and much lighter structures. Longer-term benefits will include a lowering of CO_2 emission through the use of less concrete for the same purpose[11] and through structures having to be replaced less often as a result of dramatically improved durability.

The project will facilitate the acceptance of the new technologies and lead the world in sustainable building methods and materials, offering huge opportunities for sequestration[12]. The technology will also form the basis of a new industry based on magnesite, an ore available in abundance all over the world[13] and a new market for steel strapping utilising spare capacity in the steel industry.

Future Direction
TecEco will earn revenue from its technologies by:

Licensing: - License fees based on the global production of cement utilising TecEco technology and from products made utilising TecEco cements.

Production and Sale of Cements and Reactive Magnesia: - The sale of TecEco cements and reactive magnesia locally and to countries that do not have magnesite resources (such as Japan).

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[6] In TecEco cements lime is replaced by magnesium hydroxide (brucite) which is some three or four hundred times less soluble. Resistance to acids is similar to Portland cement but resistance to salts greatly increased. Brucite also has an open layered structure and is capable of absorbing many extraneous cations of similar size and charge to magnesium during hydration. Combined with suitable pozzolans such as clinoptilolite the theoretical possibilities for waste fixing are colossal

[7] A concretes rheology, describes the workability properties of fresh 'plastic' concrete
[8] New Scientist- Pearce, F., "The Concrete Jungle Overheats" &, vol 175 issue 2351, 19 July 2002, page 39 and Tam Dalyell & vol 176 issue 2368, 09 November 2002, page 55
[9] , National Report, Saturday, July 27, 2002, p. F05
[10] an earlier invention of Mr Harrison's, that could not progress without much more durable cements
[11] For example by using Tech Tendons hollow panels could provide walling with 70% less concrete.
[12] preliminary calculations indicate that over 2 billion tonnes could be sequestered
[13] Magnesium is the eighth most abundant element in the crust

Manufacture of Application Products: - TecEco will become directly involved when necessary to catalyse the entry of a product utilising its technology into the market place.

Kiln Sales: - The Company plans to manufacture and sell new technology kilns designed to make highly reactive magnesia suitable for it's cements. These kilns will have the advantage of being decentralised and reduce the environmental impacts associated with transportation. The Company is developing a production facility (including a prototype kiln) that will allow for decentralised production of cements based on the technology.

Conclusion

Probably the most important outcome of the project will be a way forward for the Kyoto Protocol process. Scientists around the world are recognizing that a multifaceted approach is necessary to reduce or even halt, global warming. The advantages of the new technologies embraced by the project are that they involve only our built environment, not the environment on a wider scale. Adoption by third world countries is likely to be rapid because project technologies involve the utilisation of hazardous wastes such as fly ash and because given economies of scale they are likely to improve their economic welfare.

References

Reports and documents that support and validate the new technology are available on the TecEco website at www.tececo.com. (Link to the documentation page and use the pass word "Aberdeen" and /or "Lyne" to access the documentation required.)

Notes

The science of TecEco binders is continuously changing. Since this paper was written and published we have determined that the carbonates formed are an amorphous phase, lansfordite and nesquehonite.

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