Cement industry: environmental changes

Cement Industry

Summary

This report details the way in which the cement industry currently produces cement and outlines the reasons why it needs to be changed in order for it to have a lower less damaging effect on the environment as possible.

This can be achieved by implementing new procedures in the process of manufacturing cement and also by using different materials in this process, all of these ideas and more are currently being implemented or are being developed for implementation in the near future by the cement industry and associated partners.

Terms of reference

This report is on an area of the UK construction industry that has a negative impact on the environment. This report was undertaken and focuses on the environmental impact that the production process of cement has on the environment in the UK and how the process in manufacturing cement is changing/developing for the future.

The report show’s how the process of cement production was under taken and what steps have or are waiting to be implemented in the production of cement that will be less damaging to the UK environment.

This report was created in November of 2007 for Phil Harris, lecturer at Wolverhampton University for Environmental Science in construction.

What is Cement?

Cement is the second most consumed substance in the world, and is second only to water consumption. A brief history of Portland cement sees that it was invented and produced in the UK in 1824 by an English bricklayer named Joseph Aspdin. He found that by Burning limestone and clay together at incredible heat (approx than 2700 degrees Fahrenheit) it made the two minerals fuse together. Once this newly created material was cool enough it was then ground down into a fine ash, this newly created substance could then be mixed with water and the resulting substance that when allowed to set, would be as hard as the Portland stone that gave it its name.

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What do we use Cement for?

Cement is one of the single most important materials relied upon in the world, without cement we would not be able to build houses, roads, bridges and other public structures that cement products help to build. We need cement to produce concrete; concrete is basically a mixture of two components: aggregates and paste. The paste is usually composed of Portland cement and water, and when mixed together it binds the fine and coarse aggregates together.

A typical mix is about 10 to 15% cement, 60 to 75% sand/aggregate, 10 to 20% water and 5 to 8% air.

The production process of cement.

The manufacturing of cement is still one of the most energy consuming processes that is under taken in the world today. But a lot of development has and still is taking place within the cement manufacturing industry with a view to meeting the government targets of reducing the amount of greenhouse gases produced per tonne of cement manufactured.

“ Cement is said to be one of the most environmentally hazardous materials in the world, adding more carbon dioxide to the atmosphere than the entire weight of the global airline industry” – quote from the Guardian Newspaper.

Most of the stages in the manufacturing of cement have a negative impact on the environment, and this report highlights those direct and indirect effects, and how the future of cement manufacturing will continue to implement new methods of manufacturing to reduce the negative effects on the environment.

The first stage in manufacturing cement is to obtain the raw materials from a quarry; the raw materials are then crushed usually 2 or 3 times to approx 3” or less and then fed into a kiln in a dry state. The raw materials are then heated up to approx 2700 degrees F in large steel rotary cylinder, which is lined with a special heat resistant brick. Kilns are usually at least 12 feet in diameter and mounted on a slight incline. The finely ground raw material is then fed into the higher end of the kiln and at the lower end you have a roaring flame being applied and controlled very precisely, usually produced by coal, oil or gas with a controlled amount of forced draft.

As the process flow continues through the kiln gas elements are burned off and the remaining elements form a new substance called a “ clinker” these are in the form of small marble type shapes.

Clinkers are discharged from the lower end of the kiln and brought down to a manageable temperature by means of various types of coolers. The coolers do however at this stage help towards reducing Co2 emissions by saving fuel by returning the hot air emitted from the cooling clinkers back into the cylindrical kiln as part of the controlled air used to sustain the flame used.

Co2 emissions and cement production

What is Co2?

“ Carbon dioxide is a colourless gas that makes up a minor part of the earth’s atmosphere – approximately three parts in 10, 000. It is formed in the decay of materials, the respiration of plant and animal life, and the natural and human-induced combustion of carbon-based materials and fuels.” Quote from Ecosmartconcrete. com

What is the role of Co2 in the Earth’s atmosphere?

Carbon dioxide is one of a number of naturally occurring greenhouse gases (others include water vapour, methane, and nitrous oxide) that keep the Earth warm enough to support life. These gas molecules absorb much of the sun’s energy that is re-radiated by the Earth’s surface, and reflect this energy back to the Earth as heat. The gas molecules function like an insulating blanket, or like glass panes of a greenhouse, transmitting sunlight but holding in heat – hence the term “ greenhouse gases.” Quote from Ecosmartconcrete. com

The link between cement production and Co2 production is quite apparent as studies have been carried out by scientists who have concluded that there are a variety of human activities that are producing greenhouse gases such as Co2.

One such activity is the production of cement which is one of the main contributors to the greenhouse effect due to the high amount of Co2 being produced during manufacturing. The traditional Portland cement based concrete is the UK's backbone of the built environment and production of this cement is needed to keep up with the rapid population growth which in turn then lead's to an increase in production of cement. This is due partly to an increase in the housing requirements of the public and associated buildings that are required by the general public to sustain a comfortable life style.

Conclusion

What is required within the cement manufacturing industry are some lower energy consuming cements that give of less carbon emissions during manufacturing to be developed and take over where the traditional cements left off. If this cannot be done then the negative effects that are currently damaging the environment will only continue to develop and have greater detrimental effect on the planet.

There are a number of developing technologies coming through at the moment and these are produced using various different materials for use in the building industry. One of these new product's is called Ceramicrete which is a lighter foam-based concrete which according to there makers is twice as

strong as the concrete’s we currently use so builders use less of it hence the better it is for the environment! The only negatives known about this new product is that it is more expensive than traditional concrete and it needs to be subjected to further testing to establish it’s long-term structural suitability and environmental performance before it can be promoted on a wider scale.

There are a number of other cements currently in production that are also worth exploring as they are less energy dependant during manufacturing and emit less carbon dioxide than traditional Portland cement these are…

- Magnesium oxide-based cements
- CSA-belite cements
- Eco-cements based on municipal solid waste incinerator ash.

Magnesium oxide-based cements

Magnesium oxide based cements are quite a recent development in such that they haven’t been mass produced and have only had small commercial quantities made to produce non structural products such as concrete bricks, blocks and pavers.

The magnesium oxide is produced by heating magnesium carbonate as a mineral magnesite, to a temperature of around 650 °C. A quantity of CO2 is given off during this process.

In comparison, Portland cement which is based on calcium oxide and has to be produced by firstly heating calcium carbonate (limestone) to approx 900 °C, again with CO2 as a by product.

At this stage in the process, the quantity of CO2 released is less than that from an equivalent mass of magnesium carbonate but the calcium oxide, plus other ingredients then has to be heated to 1450 °C to produce the final product a “ clinker”. This other process is accompanied by more CO2 being emitted during the whole process, with the resulting CO2 being much greater than that emitted during the production of the same quantity of magnesite.

So at first glance magnesium oxide-based cements look like a better solution than continuing with Portland cement manufacturing in the UK but in practice manufacture is dependent on the availability of the basic raw material and its proximity to a production facility but regrettably the raw material found in abundance in mainland Australia and Tasmania, is very rare in the UK where there are no significant deposits in UK suitable.

Therefore, as a minimum, there would be a significant increase in traffic movements required to transport the raw material to existing kilns, with consequent environmental impacts.

CSA-belite cements

This type of cement has been successfully used on industrial scale throughout china for about 20 years; it is made by heating/sintering industrial wastes such as coal fly ash, gypsum and limestone at 1200 – 1250°C in rotary kilns

Compared with Portland cement the energy savings are quoted as being approx as high as 25%, along with limestone reductions of 60 % together with a reduction in CO2 emissions of approx 20%.

At first glance, CSA-belite cements could be manufactured in the UK, as there is no technical process or supply issues to be dealt with in regards of their production. However, much applied research and many pilot studies would be needed to verify that local materials and existing plant could produce consistent high quality product before manufacturers in the UK would take it on.

Eco-cements based on municipal solid waste incinerator ash

Eco-cements are currently being manufactured in Japan, they are based on the traditional Portland cement in as such that they are processed in much the same way as traditional Portland cement but approx 50% of the content has been replaced by municipal solid waste incinerator ash (MSWIA), and the fossil-fuels used for heating purposes have been replaced by waste products such as oil and non recyclable plastics.

MSWIA eco-cement use less energy as well as ‘ clinkering’ takes place at 1350°C as apposed to 1450°C.

But for a few exceptions eco-cements are virtually indistinguishable from Portland cement and consequently have very much the same properties, performance.

There would seem to be no obvious technical barriers to production in the UK. However, manufacture would be dependent on the availability of MSWIA and its location to existing cement works. Currently, this is in short and irregular supply in the UK but even if this were not to be the case, ‘ public perception’ issues might arise about the process of manufacturing, so the

likelihood of producing a familiar Portland cement by this process is at present very unlikely.

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