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The TecEco Times *Printed in cyberspace on recycled electrons*
Keeping you informed about TecEco sustainability projects. Issue 90, 22 June 10

What it takes for Commercialisation of a Carbonating Magnesium Cement

With Comments on the Latest Developments

There are a wide range of magnesium cements yet few have been marketed successfully. Most are poorly understood the building fraternity, by their inventors and in particular by patent examiners who seem unable to distinguish between what is new and what is not. Evidence of this is the lack of commercial product on the market and a lot of dubious intellectual property. Yet given the need to sequester CO2, magnesium binders hold great promise.

Renewed interest in magnesium cements has been driven in recent times partly by the success of a deliberate Chinese strategy to add value to magnesium oxide with the wide scale production and export of "MgO boards" made using magnesium oxy chloride or sulfate composites that are usually coated in a magnesium phosphate cement for waterproofing and the publicity achieved by TecEco for the invention of carbonating magnesium cements and the concept of a built environment that absorbs CO2 and thereby sequesters massive amounts of carbon. What little research there is however remains poorly directed because the magnesium compounds industry has no association to provide direction or fund essential basic research and inventors appear to invent without a clear understanding of the requirements for successful commercialisation of a "green" magnesium cement.

A technical solution to global warming:

- Must not have any legacies attached for future generations to have to deal with and
- Must be profitable

For a new carbonating cement:

- The raw materials for the cement must be widespread and in abundant supply and be able to be utilised without releases or other environmental downsides.

- The cement must have utility. It is no good to just carbonate calcium or magnesium oxide or hydroxide and claim a cement. The cement must have properties such as strength that it imparts to a composite made with it.
- The cement must result in profit for those involved in its production and marketing. As the market price is set by Portland cement the cost base must be relatively low for there to be profit.
- The cement in the composite made with it must carbonate reasonably rapidly. For there to also be profit this means without special carbonation rooms etc.

The only invention so far that meets these common sense criteria in most situations is our own Eco-Cement with the exception perhaps of supply chain issues which is something serious funding can remedy. In some situations such as a strong need to utilise fine wastes like fly ash Why and how follows.

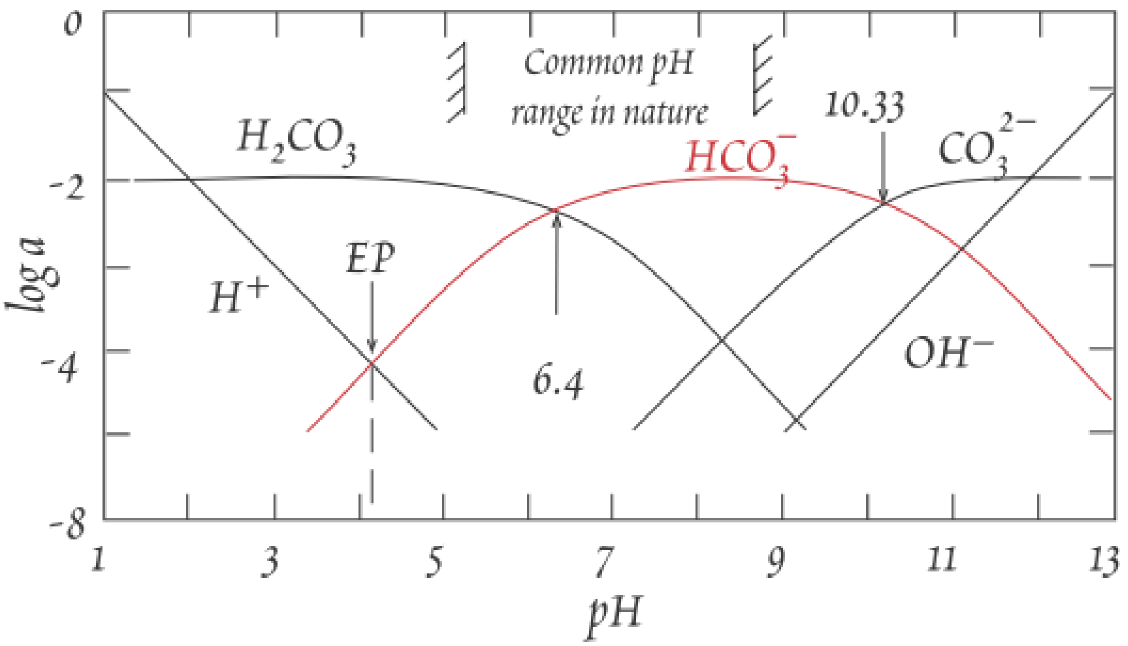
We alerted the world to the sequestration potential of carbonating concretes and there has been considerable interest the result of which has been the invention of a number of "me too" technologies that unfortunately just do not stack up. Unfortunately most of these new calcium and magnesium carbonate cements that have emerged will never have the properties required to be of commercial value. Some also require expensive processes such as carbonation rooms. Many are backed by large reputable universities and the public has provided money without the knowledge to predict that most of them are not new at all or will never be a commercial success. None of the new players including Calera, Novacem and Calix appear to understand the requirements for a good mineral binder, how good Portland cements are, that they too can be made without releases [1] and what it takes to be competitive with them or in our case supplement them.

Although calcium and magnesium are both widespread and in abundant supply, the method of production of a viable carbonating cement must be clean and green. By this we mean the use of non fossil fuels and no releases to the atmosphere. Our Tec-Kiln achieves these criteria and we are not aware of any other technology that does. Carbonation on its own does not make a viable cement. Utility as a binder is essential and not addressed by the new players. A fundamental and important property relevant to utility is strength. As none of the magnesium carbonates have particular strength according to their hardness, good micro-structure is essential as it delivers strength and related properties. Nesquehonite (a tri-hydrated magnesium carbonate) in its acicular form is one of the few carbonates that can develop the micro-structure necessary for a strong viable concrete. (Authors opinion supported by [2]). Carbonation of our Eco-Cements in gas permeable substrates results in the formation of nesquehonite whereas none of the other new players have cements that develop significant strength as other carbonates form.

We question the methods and economics of the methods used by Cambridge Univeristy, Novacem, Calera and now Calix to achieve reasonable carbonation kinetics. Carbonation rooms (Cambridge University and others) involve additional process steps but may make possible the use of finer wastes as gas permeability is not so important. The need to produce significant amounts of carbonate to make carbonate (Novacem and Calera) just does not make sense. We again think our approach the only profitable way forward.

Our strategy for carbonation is simple:

- High Ca++ through the release of Ca(OH)2 during the hydration of Portland cement clinker. Ca++ is a catalyst for dissolution of MgO and Mg(OH)2. That Ca++ is a catalyst has been confirmed. [3]
- High pH, provided by the production of Ca(OH)2 from the setting of Portland cement in our mix. High pH's favour the CO3-- ion as demonstrated in the speciation diagram that follows. The carbonation reaction is through solution and requires abundant CO3-- ion for good kinetics.



Speciation of Carbon Dioxide in Water

- Permeability, essential for good gas transport to reaction site. Gas transport is much fast than transport through solution.
- Nucleation, provided by CSH and some pozzolans with high internal surface area in our Eco-Cements.
- Alternating wet dry curing conditions. Dry for gas transport, wet for through solution reaction.

It has always intrigued me as to how we achieve both dissolution of MgO and rapid carbonation in permeable substrates and many of the conditions are not optimal for dissolution such as high rather than low pH as low pH favours dissolution of MgO and Mg(OH)2, whereas higher pH favours carbonation through the production of CO3-- species as in the above speciation plot. The factors are numerous and complex and include temperature, pH, activity of ions etc. and the answer probably lies in the fact that dissolution is controlled by surface chemistry not transport and "highly defective surfaces and powders convert readily to brucite" [4].

As should be expected gas permeability and alternating wet dry conditions as my be found in many climates are ideal for rapid carbonation of our Eco-Cement concretes. We do not need carbonation rooms etc. etc. and think the idea not commercially realistic.

Finally in relation to supply chain issues we have been having we wish to announce a breakthrough. There is a method of making magnesium oxide from waste bitterns and brines. If CO2 is bubbled through pH adjusted magnesium chloride solution, nesquehonite forms as a precipitate and we intend to collaborate with other researchers to improve the method. The nesquehonite can be pyro processed in our Tec-Kiln to produce magnesium oxide without releases and magnesium oxide is a major component of our formulations. Magnesium chloride is an abundant waste.

Both Novacem and Calera are offshoots from universities and our conclusion is that academics are generally not good inventors and as a result of misguided government policy that connects funding to the acquisition of ip end up usually copying prior art by adding a highly technical verbal twist to blind examiners with "science" The flip side is that essential fundamental research remains neglected such as conditions favouring the formation of the various carbonates. TecEco are not alone in calling for a less commercial approach to academic funding as only in this way can the all important fundamental research be achieved.

TecEco's objective was to improve, not replace Portland cements, and our patents contemplate blending with them and other hydraulic cements to create better cements including our Tec, Eco and Enviro Cements as we have called them. The few modifications we advocate resolve many outstanding issues such as durability, shrinkage and cracking in an environmentally friendly way and the result is excellent concretes that in gas permeable substrates carbonate their hydroxide phases resulting in sequestration.

TecEco deliberately decided to lodge a strategy patent that does not go into the chemistry more than necessary to explain the reason for each addition and does not speculate about process or mechanisms. We merely point out that for blending with Portland and other hydraulic cements it is essential to use highly reactive magnesia. Although we have of course dramatically improved our understanding of our own cements and since developed better formulation strategies we were fortunate in that our original patent applcations were fundamentally correct in relation to this.

The broad scope and simplicity of our patents is the foundation of their brilliance and should not be underestimated. Our inventive step is that we demonstrate that highly reactive magnesia [4] can be blended with other hydraulic cements and optionally pozzolans in virtually any proportion.

Because it is so simply stated there is a huge range of possible formulations covered by our patents. In Tec-Cements magnesia forms brucite which acts as a pH regulator, rheology modifier and anti shrinkage additive. In permeable Eco-Cements, magnesia is allowed to first hydrate then carbonate given access to CO2. The normal reactions that would occur with magnesia in aqueous or atmospheric conditions depending on engineered permeability are allowed to proceed within mineral based hydraulic binder systems. Highly reactive magnesia does not interfere deleteriously with the hydration reactions of other hydraulic cementitious components such as Portland cement or pozzolans. Neither does it cause physical problems such as dimensional distress in concretes as was previously thought. The standards are wrong and the reason was simple to understand. Dimensional distress is caused by delayed hydration and reactive magnesia hydrates in the same rate order as other components.

In TecEco cements magnesia that is much more reactive than the magnesia that would be used in virtually all the other magnesium cements is used so it dissolves quickly. Such reactive magnesia can only be made using low temperature calcination. This teaching is in contrast with the present view of many manufacturers which is that reactivity can be achieved by fine grinding. We point out that the temperature of calcination is more important as what is required is magnesia that has low lattice energy to be overcome for hydration to occur within the same time frame as other constituents and only low temperature calcination will result in low lattice energy [5].

I also accept that I should be more specific by what I mean by low lattice energy which I used to define MgO[5]. The dissolution rate of MgO is surface not transport controlled and "highly defective surfaces and powders convert readily to brucite"[4]. The atoms on the outside of any group of Mg and O atoms have structure but less lattice energy as they are not completely in the lattice and are thus available to be wrenched away from the lattice by protons for example as is thought to be the mechanism by some for the dissolution of MgO [6] [7]. The lower the temperature of calcination the greater the surface defects and greater the surface area. The greater the surface area then the more atoms are on the outside of MgO for reaction. It follows that surface area is a good proxy for lattice energy, the greater the surface area the lower the total lattice energy.

The MgO bond is more co-valent than the CaO bond so dissolution is not as rapid, hence the need for highly reactive low total lattice energy magnesia. The dissolution of metal oxides like MgO takes place through metal for proton exchange reactions at the surface. The original metal oxygen bonds are broken and new proton oxygen bonds formed [7]. The lower the lattice energy the more dissorded the structure of MgO the more reaction sites for this proton exchange.

It is true that most reactions that are useful in mineral cementitious binders occur in an aqueous medium and so water is of course present in most other magnesium cements. This does not however make such other formulations "hydraulic" in the context of the industry standard definition cited in our patent and is where the similarities usually end. In most other magnesium cements magnesia is required to react or interact with some other chemical or substance in some other way than in does with our technology which does not require the presence of any other additives other than a hydraulic cement as defined and optionally a pozzolan. There are many categories that describe the wide range of cements that rely on all sorts of chemistry from simple reaction to the formation of a huge range of nano or mechano composites that rely on inter layer polar bonding and we have put a classification of the wide range of possible cements on our web site in the technical section which is reproduced below in this newsletter. See **A Classification of Magnesium Cements**

As mentioned - there have been a number of new cements over the last 20 years or so based on magnesium that have resulted in money being raised and yet at this point in time there are few successful products on the market other than those based on magnesium oxychloride or sulfate family of compounds and phosphates such as the Chinese MgO boards being made in large quantity mentioned above and self levelling or rapid set cements. What this means is that .

Patent offices have been all to eager to issue patents many of which are not new ip at all but elaborate attempts to get over existing ip and the classification system referred to above is a first attempt to apply some rigor to the vast and confusing array of patents, some of which are worthwhile and many of which are not as they merely mimic those that are. As a consequence a large number of investors have lost their money on magnesium cements and we have noticed the after effects in our own attempts to raise capital to introduce our blended Mg - hydraulic cements.

The TecEco technology is simple, easy to understand and works very well in spite of the early criticism of it from Cambridge University, Imperial College and the British Research Establishment. We are still not sure whether their early criticisms were merely the result of a failure to understand basic issues such as particle packing or a deliberate attempt to kneecap our commercialisation. See **3rd Party Research and Development**. We suspect the latter as both universities have moved on to develop their own magnesium cements. Cambridge university has since started doing some useful work on magnesium carbonates in relation to block making which interestingly contradicts the claims by "Novacem" an offshoot of Imperial college whom they used to work with and whose patent claims that seeding by a "special" carbonate is required.

Consider first the recent Cambridge work. They have been making blocks in which magnesia alone has been used. They demonstrate that some results were better than that of Portland cement controls and this is not unexpected as we have found likewise in our formulations. Although they do not speculate why this is so, we point out that much more magnesium carbonate is produced than the MgO added and that this is a simple function of molar stoichimetry. Their process is not as commercial as ours as for effective carbonation they need special rooms with greater than normal concentrations of $CO2$ in order to develop sufficient strength rapidly.

The work of Novacem, an offshoot of Imperial college is of less commercial interest as we do not believe that they can ever effectively commercialise as they are not only producing the wrong carbonates but need to produce carbonate to produce brucite which then carbonates. They appear to also need carbonation rooms and add chloride to achieve any strength.

Their formulations always contain what is referred to as a special carbonate which has to be made first. This carbonate could be one of many or even a mixture thereof although it their patent specification clearly favours hydromagnesite for its "rosette" morphology. The role of the special carbonate is claimed to be to provide nucleation sites which we have no doubt it does. The issue is that this is a common well known phenomena often referred to in the literature and not something special to the Novacem cements or that Novacem invented. The so called special carbonates are similar to those in a wide range of other patents and we suspect they are described as special as a ruse to fool examiners to enable the use of a wide range of other carbonates without infringement. Nucleating crystal growth is well understood as a catalysis mechanism and continues to be referred to today by many authors in the field of mineral carbonation such as Siegfried, Lackner, Wendt and others **[8]**. Crystalisation is a precipitative process and crystals are well known to catalyse their own growth without here going into the reasons why this occurs. For a comprehensive summary of the nucleation/precipitation process see Luigi Marini's excellent book "Geological Sequestration of Carbon Dioxide"**[7]** at page 181. In most patents the process is fundamental and assumed and definitely not considered anything special. In our own system for example we are aware that calcium silicate hydrate and some pozzolans do the same thing. (See earlier)

A more disturbing feature of the Novacem patent is the addition of common salt (sodium chloride) in many of the formulations. Even though described as present because common salt is deliquescent, it is only marginally so and it should be made known that the result will be the formation of magnesium oxychloride. We suspect of course that as for the use of carbonate this is just another ruse to get over existing intellectual property as in the table in which we have included the Novacem patent (WO 2009/156740 Al) as well as similar patents. See **A Classification of Magnesium Cements.** Not only is the use of common salt an issue in relation to steel reinforcing but there is no thought out strategy for pH control as in our concretes where brucite is the regulator in conjunction with CSH. "Gouging salts" like NaCl also increase the rate of dissolution and reaction.

The use of partially calcined magnesium carbonate or double carbonate such as dolomite or huntite will result in CO2 trapped within the particles that is useful for later re carbonation. This phenomena is well known and described for example in the Periclase patents (e.g. O 97/20784 and US6200381131) which themselves lean heavily on GB 1160029 (Mayer) and most importantly JP8198803. EP 0650940 A1, US4003752, JP57188439, US1456667, AU 55715/73 and US4003752 have a similar internal carbonation theme. Given the detail in the table on our web site under technical (See **A Classification of Magnesium Cements**) also published in this newsletter and the comprehensive cross referenced in house data base we have on magnesium patents it is difficult to understand why Novacem were granted a patent at all. Unchallenged patents are not necessarily strong patents and may not stand up to a court challenge. We tried similar mixtures to that Novacem have patented in the late 90's and discarded them as we were not impressed with the rate of strength development. We also eliminated the use of sodium chloride because of the obvious effect on steel corrosion of mobile sodium salts and strong efflorescence of minerals like thenardite and halite. Novacem may never become truly commercial just as none of the significant prior art has never been successful. This is an outcome we do not want to see as it will only add to the bad name magnesium cements already have in the world of investors. Having said this the patent is well written and the science somewhat highbrow, so we conclude it may have blinded patent examiners and investors with science that is not wrong but not new and has gone nowhere in the past our conclusion is that nothing much has changed.

We have been asked to comment by large companies on another new technology start up going under the name of the Calix. Their patents are about calcining using steam in a manner that minimised reverse reactions. As of the date of writing (May 2010) they are in the process of raising money in what appears to be a float and have also thrown in a similar technology to Novacem which they do not appear to have patented, probably because they can't.

Given that many of the patents covering much of the earlier art mentioned above and in the table below (**A Classification of Magnesium Cements**) relating to Novacem have run out Calix can use a dolime as they call it however will do no better that the prior art in spite of the claims that the use of steam will further increase reactivity of the MgO and efficiency of the special carbonates produced. Although superheated steam will bind to the surfaces of magnesium containing compounds and assist breaking them apart, probably via intermediates, it needs to be demonstrated that the enthalpy costs of heating water to make steam and heating calcium carbonate which has no other role to play other than perhaps providing internally trapped and perhaps to some extent polar bound CO2 and possibly nucleation sites as well.

In relation to Calera, Calix and Novacem, although inventive competition should be healthy at the same time it can be dangerous. Take for example geopolymers, a potentially wonderful technology. There are so many flags on this intellectual property ground it is difficult to commercialise without infringement. As a part consequence, over 60 years on, we still do not have successful businesses making significant quantities of geopolymer. In the magnesium compounds industry, in spite of the common sense and wide range of our patent, there is a chance, given the failure by patent offices to understand the complex mineralogy of magnesium cements generally, that a plethora of new patents such as that lodged by Calera and Novacem will choke off and thus hinder the commercialisation of our wonderfully simple technology.

We therefore implore academics not to try and outdo as you will not succeed. Please co-operate with us.

A Classification of Magnesium Cements

Just as describing a game as requiring a ball and something to hit it with would inadequately describe cricket, golf, hockey, polo and a large array of other sports and it would be necessary to consider the type of hitting device, how it is used, what is hit, who does the hitting, when, how and why to identify the game uniquely, it is necessary for a clear understanding of the teaching of a magnesium cement patent and to distinguish intellectual property to consider the role of various ingredients; how they will interact and the outcomes from that interaction. A reasonable way to understand and distinguishing our technology is therefore to consider the form, purpose, importance and role of the magnesia added in other patents as doing so highlights our uniquely simple yet brilliant strategy so we have developed the following classification.

To be granted a patent in most competent jursidictions it is necessary to have an invention step which for the edification of one or two players (and examiners) is not just a description in another way of something that in other patents happens anyway. The following classification of magnesium cements is provided in the hope that it helps eliminate some of the confusion and as an aid to patent examiners in relation to so called new inventions.

Level	Description of Category	Patent Examples
1	Cements that rely on the chemical reaction of magnesia with another component.	

1.1	Reactions causing the formation of magnesium oxychloride, magnesium oxysulfate or derivatives. (Excluded in TecEco claim 1)	EP 352096A, JP59105882, JP7069706A
1.1.1	As a base with chlorides or sulfates. E.g Aluminum, magnesium, calcium, zinc or copper chloride or sulfate.	JP 52-138522a, PN SU881044-B, GA 1982-76384E, EP 352096A, US4760039, US3202520, US4572862, RU2102349 A, AU 55715/73, US 4838941, WO90/11976, GB938853, US5180429, CN1247177, RU2158718 C1, GB1160029, DE908837 C, JP57188439, US1456667, US6200381, WO9854107, RU2089525 C1, RU 2028335 C1, WO0024688, JP 57056364, WO 2009/156740 A1
1.1.2	As a base with acids. E.g. Sulfuric or hydrochloric acids	CN 1071154, EP 352096A, PCT/AU96/00774, WO97/20784, US4003752, AU 55715/73, WO90/11976, GB938853, CN1247177, US1456667
1.1.3	As a base with partially substituted acids or salts containing chloride or sulfates. e.g. Reaction with calcium aluminate trisulphate, a double salt, delivering sulphate for the formation of magnesium oxy sulfate	PCT/AU96/00774, WO97/20784
1.2	Chemical reaction with substances that cause carbonation.	PCT/AU96/00774, WO97/20784
1.2.1	As a base with organic substances delivering CO3--. E.g Carbonic acid. (See also 1.3.1)	EP 0650940 A1, US5897703, US6200381, US5669968
1.2.2	As a base with inorganic substances delivering CO3--. E.g. Sodium carbonate and calcium carbonate	EP 0650940 A1, AU 55715/73, GB1160029, US6200381, WO9854107, RU2089525 C1, WO 2009/156740 A1
	Carbonic acid, CO2 or a chemical that releases CO2. The CO2 which then dissolves in water forming carbonic acid. Carbonic acid will force rapid carbonation of magnesia whereby various magnesium carbonates are formed in situ.	
1.3	Chemical reaction with acidifying agents	PCT/AU96/00774, WO97/20784
1.3.1	Organic acidifying agents. E.g. Citric acid, acetic acid and other carboxylic or polycarboxylic acids (such organic acidifying agents may also deliver carbonate (CO3--.) and thus fall into the category 1.2.1 above.)	US 7070647B2
1.3.2	Inorganic acidifying agents. Acidifying acids may assist the dissolution and reformation of carbonate or act as accelerators or retardants depending on the mix.	

1.3.3	Neutralization of acids e.g low molecular weight organic acids from the breakdown of pectin and lignin in wood prior to use of an ingredient such as in this case wood	
1.4	Cements that include an soluble or acid phosphate and result in chemical precipitation of insoluble magnesium phosphates.	US3202520, WO90/11976, US4734133, WO9206048, US 7070647B2
1.5	Chemical reaction in the form of ion exchange. The use of magnesia for ion replacement in a more soluble substance rendering the substance less soluble	EP 352096A, US5194087
1.5.1	The replacement of Na+ or K+ is waterglass. E.g the replacement of Na+ or K+ in sodium or potassium silicates resulting in an insoluble precipitate of magnesium silicate.	US5194087, JP 57056364
1.6	Chemical reaction as a so called "activator" or "accelerator" Note that Mg is not a network former in geopolymeric binders as claimed rather arbitrarily by many.	US6231664
1.7	Cements that rely on prior addition of magnesia to another substance resulting in chemical and physical interaction sequentially prior to the addition of other binder components	JP59-083970A
1.7.1	The interaction of magnesia with schist or the waste from coal washings prior to the addition of other binders such as Portland cement	WO00/05178
1.7.2	The reaction of magnesia with low molecular weight compounds e.g. wood acids prior to further additions.	JP59-083970A
1.8	The reaction of substances in a binder prior to addition of the reactants to magnesia	
1.9	Chemical interaction with other salts (e.g. borax)	EP 352096A, GB1160029
1.10	Interaction with some other substance	US 4620947, US5897703, US6231664
2	Cements in which the main role of magnesia is in electrostatic bonding reactions. Cements that rely on the strong non-ionic, non covalent bonding of Mg++ to a negative region of a molecule. E.g. Mg++ to oxygen - similar to hydrogen bonding.	
2.1	Bonding of Mg++ to oxygen in cellullosic compounds and oxygen in water.	US4011094

2.2	Bonding and complexing with water. In solution Mg++ complexes with water more readily than Ca++ forming ions of the general form [Mg(H2O)N]2+. Mg++ can also hydroxylate forming H3O+ and Mg+OH and hydrated forms of Mg+OH. These complexes greatly affect the rheology of water particularly in the presence of substances displaying strong hydrogen bonding, wherein Mg++ displays strongly kosmotrphic behaviour and is attracted to the net negative charge on oxygen.	US4011094
2.3	Electrostatic and sorption bonding to activated carbon.	US 4257815
3	Cements that use dead burned rather than reactive magnesia.	US 2880101, JP57095858, US 5565026, US 5228913, US 2511725
3.1	Cements that use dead burned rather than reactive magnesia to deliberately induce expansion.	US 2880101, US4002483, US4797159, US5942031, US3960580, SU104719
4	Cements that rely on the physical properties of magnesia rather than reaction. E.g. Cements that use dead burned rather than reactive magnesia to increase fire retarding properties	UK871428A,
5	Cements that have a high proportion of calcium carbonate in them. (May also fall into 1.2.2 above) When the atomic ratio of calcium to magnesium approaches one as in dolomite (or greater) As there are a large number of patents relying on partial calcination to deliver CO2 the TecEco patent excludes reactive magnesium oxide sourced from dolomite with significant remaining carbonate component.	PCT/AU96/00774, WO97/20784, RU2102349 A, AU 55715/73, KR9508585, US6200381, WO9854107, RU2089525 C1, RU 2028335 C1, US 2511725, WO 2009/156740 A1
5.1	Cements that include magnesia sourced from dolomite (as in our claim 1 exclusion (specific) or	
5.2	Cements that have been blended to include calcium carbonate. (excluded as we teach this is obviously not desirable)	GB1160029
	Cements that may include magnesia but do not include a hydraulic cement like Portland cement. To compare TecEco technology with others purely on the constituents is misleading to say the least. It assumes that it is only necessary to	

6	know what is present in a mix and not why what is present is essential or how components react or interact with each other. To say magnesia and Portland cement are present and therefore our technology is defeated assumes a certain lack of understanding of chemistry which is insulting. What else is present matters as such other constituents will react with magnesia in a way not required for the operation of TecEco technology.	FR890325A, EP 0650940 A1, PCT/AU96/00774, WO97/20784, US4760039, US3202520, AU 55715/73, WO90/11976, US4734133, US5897703, US5180429, GB1160029, US1456667, US6200381, WO9854107, RU2089525 C1, RU 2028335 C1, US5669968
7	Citations in which the use of magnesia is incidental and unnecessary	US3260675, US4620947, US5897703, US 5565026, US 5228913
8	Citations that are often quoted that are not magnesium cements!	PN JP55032782-A, JP83025058-B, GA 1980-28374CER, US 4115138
9	Mechano or nano composites in part or completely	JP 52-138522a, CN 1071154, US4620947, PN SU881044-B, GA 1982-76384E, EP 352096A, EP 0650940 A1, PCT/AU96/00774, WO97/20784, US4760039, US3202520, JP59-083970A(?), JP59105882, JP7069706A, US4572862, RU2102349 A, AU 55715/73, WO00/05178(?), US 4838941, WO90/11976, GB938853, US5897703, US5180429, CN1247177, RU2158718 C1, KR9508585, GB1160029, DE908837 C, JP57188439, US1456667. US6200381, WO9854107, RU2089525 C1, RU 2028335 C1, WO0024688, US5669968, US6231664, US 2511725, JP 57056364, WO 2009/156740 A1

The classification is not set in concrete and constructive criticism is welcomed. Hopefully once established the system of classification will then act as a guide for patent offices and investors and there is more certainty and order and less "snake oil" in the route forward for commercialisation, particularly as magnesium carbonates have a role to play in sequestration. Please communicate any constructive criticism to TecEco and if we think you are right we will change the table.

Learning from Nature

Study nature and what you will find is that in nature carbon is important and goes round and round. We breath it out and trees, snails and shellfish build with it.

We oxidise O2 to make CO2. Just enough used to be released between us and other animals as well as occasional bushfires and volcanic eruptions to maintain a remarkably stable quasi homeostatic balance that has not changed much for at least the holocene. It is likely that we have been the moderating factor contributing to this recent stability [9].

Then we invented machines. Like us they get their energy as a result of oxidation processes. Unlike us and all other animals they oxidise orders of magnitude more than we do. So much so that we have had to turn to fossil fuels to feed them and as a consequence the CO2 level in the atmosphere is steadily and now quite rapidly increasing.

We must unwind this problem in the exact opposite way to which we created it. We must invent industrial processes that use instead of producing carbon. I put my mind to this some ten years ago and invented Eco-Cement. Since then I have invented all the means required for this new technology paradigm.

There is an infinite supply of calcium and magnesium ions on the planet that according to my inventions can be used to build man made carbonate that can be utilised for building and construction. By adopting this paradigm we can profitably, without legacies for future generations change the flow of materials and energy and as a consequence reverse the flow of CO2. We can steadily unwind the problem of too much in the air in a manner opposite to the way we created it. The solution is politically acceptable because it is potentially very profitable and there are no downsides thereby removing the risk of making decisions.

Why the current direction of "emissions reduction" will not succeed quickly enough is quite simply because the use of fossil fuels is 100% correlated to the world industrial product.

Our politicians and to some extent our scientists have confused cause and effect and so half the world's population don't even believe CO2 causes global warming. TecEco's technology makes it easy to take the safer decision and reduce the CO2 level in the atmosphere without negative political consequences. It represents a direction with no downsides that business will pay for because of the profits that can be made.

References

[1] The manufacture of Portland cement can be split into two sub-processes, the endothermic production of CaO (in which CO2 could be captured) and an exothermic reaction between CaO and a source of silica and alumina (+- iron) to produce Portland cement clinker which is a mixture of di and tri calcium silicates, tri calcium aluminates and tetra calcium alumino ferrites.

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[3] Pokrovsky, O. S., J. Schott, et al. (2005). "Kinetics of Brucite Dissolution at 25°C in the Presence of Organic and Inorganic Ligands and Divalent Metals." Geochimica et Cosmochimica Acta 69(4): 905 - 918.

[4] Mejias, J. A. B., Andrew J. Refson, Keith and D. G. Fraser (1999). "The kinetics and mechanism of MgO dissolution." Chemical Physics Letters 314: 558–563.

[5] Reactive magnesia is also variously known as caustic calcined magnesia, caustic magnesia or CCM. The temperature of firing has a greater influence on reactivity than grind size as excess energy goes into lattice energy. The more disordered the structure the more reactive. Technical information about reactive magnesia is available in the technical area of our web site.

[6] Stumm, W. (1992). Chemistry of the Solid - Water Interface. New York, Wiley - Interscience.

[7] Marini, L. (2007). Geological Sequestration of Carbon Dioxide. Amsterdam, Elsevier.

[8] Just googling the names of the authors and the word seeding will show numerous results!

[9] Ruddiman, W. F. (2007). Plows, Plagues, and Petroleum: How Humans Took Control of Climate Princeton, Princeton University Press.