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Improved Technique of Dispersing Carbon Nano-Tubes May Help To Revolutionize Concrete

On 2 November 2011, Eden Energy Ltd announced that its wholly owned US subsidiary, Hythane Company, has for several months been undertaking research involving concrete reinforced with carbon nano-fibres (CNF) and carbon nano-tubes (CNT) using carbon produced at its laboratory in Colorado, USA. Preliminary concrete test results in certain concrete formulations had shown a very encouraging increase in flexural strength ranging from 15-30% at 7 days of age.

New Dispersion Technique Developed

Since then Hythane Company has been refining its techniques to evenly disperse the carbon and has now developed a greatly improved technique which enhances the even dispersion of carbon nano-materials in concrete and/or mortar composites. As previously announced, even dispersion of the carbon is perhaps the major obstacle in the quest to develop bulk commercial applications for the unique properties of great strength and thermal and electrical conductivity that nano-carbon materials provide.

Sufficiently dispersed carbon nano-fibres (CNF) and carbon nano-tubes (CNT) have been shown to be highly beneficial when added to concrete/mortar. Nano-carbon can increase various orientations of concrete strength by bridging the gaps across micro-cracks which occur from initial set of cement. These micro-cracks gradually grow to form much larger macro-cracks, which expose reinforcement and allow severe damage to the integrity of a structure or structural member.

Even and adequate dispersion of the carbon nano-materials is difficult. The Vander Waals forces holding the fibres/tubes together are incredibly strong, requiring a form of mechanical disturbance to achieve dispersion. Further investigation into the method of dispersing the nano-carbon has yielded an improved technique, which is anticipated, will help to significantly increase strength when incorporated into the mixing methodology of concrete and/or mortar.

The Results

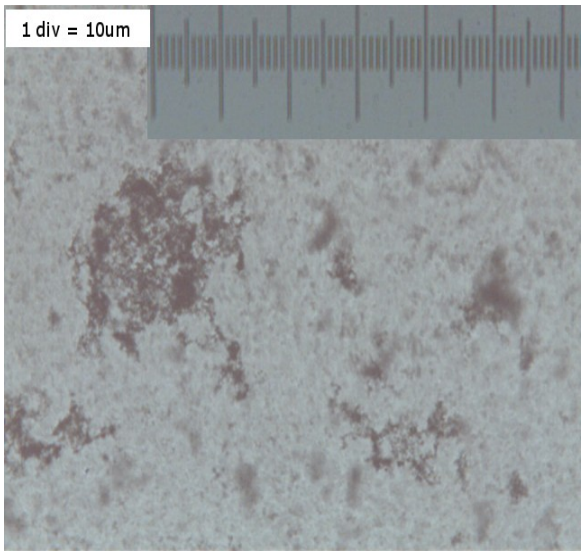
Immediately following mixing, two CNT solutions, the first produced with the original method and the second produced using the new technique, were each run through a separate filter. The picture below on the left, shows the remaining carbon agglomerations filtered from a mixture from the original mixing method caught by the first filter, including large chunks of carbon that were not dispersed. The picture on the right which is of the second filter after filtration of the mixture produced using the new mixing technique shows the second filter that is free of agglomerations and/or chunks of carbon.

Level 40, Exchange Plaza, 2 The Esplanade, Perth, Western Australia 6000
Telephone: (08) 9282 5889 Facsimile: (08) 9282 5866
www.edenenergy.com.au

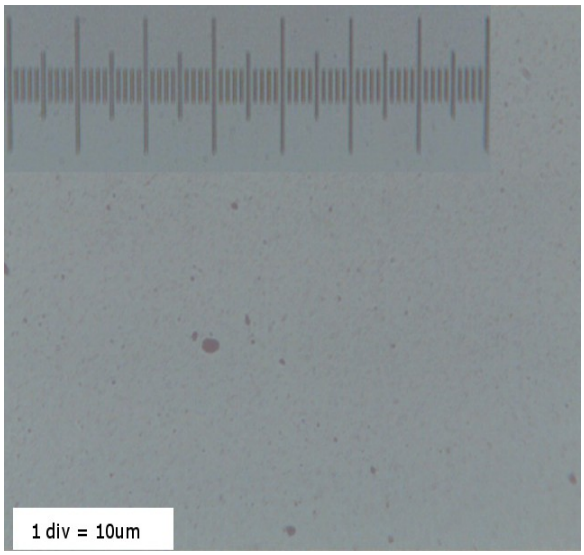
Filter showing Trapped Carbon Using Original Mixing Method

Filter showing Very Little Trapped Carbon Using New Mixing Method

The study also included measurement of particle size in both mixtures after specific durations. Solutions containing an identical amount of CNTs were mixed for specific durations, and samples taken and placed on slides. The slides were then photographed using a suitably equipped optical microscope. On the black scale visible in each of the pictures below, each division is equal to 0.01mm, or 10microns.



Agglomeration of Carbon Using Original Mixing Method



Greatly Reduced Aggolmeration of Carbon Using New Mixing Method

The pictures above show the remaining CNT agglomerations in the two mixtures after each had had been mixed for the same time. The picture on the left is of the mixture using the original procedure, and the picture on the right is of the remaining agglomerations in the mixture using the new procedure.

After mixing using the new procedure the remaining carbon particle size is a small fraction of the remaining particle size in the mixture from the original procedure.

Eden's improved dispersion and non-agglomeration technique is a further important step towards

understanding how to best incorporate nano-carbon into concrete more effectively. Bridging micro-cracks more effectively increases the strength of concrete/cement composites, requiring more energy to propagate micro-cracks into larger macro-cracks.

The properties of concrete that presently appear to be likely to be most benefited will be flexural and tensile strength. Slab depths and column diameters can be reduced due to increased tensile/flexural strength. Ultimately, once fully tested and proven, these benefits could significantly reduce construction budgets, extend the service-life, and reduce life-costs of concrete structures.

Increased flexural strength is desirable in concrete design because it allows for reduced concrete beam dimensions which can reduce overall building heights due to thinner floor depths. Also, the increase in flexural strength can reduce the amount of steel reinforcement necessary to adequately support the same structural load. This can also reduce project material costs substantially.

Evenly Dispersed Carbon Nanotubes May Enable Stress Testing of Concrete

Preliminary tests of Eden's proprietary nano-carbon dispersion techniques have resulted in CNT loaded concrete (2% by weight of cementatious materials) exhibiting an increase in conductivity of a magnitude of 40x. CNTs are highly conductive along their surface area and respond to changes in stress with a change in resistance.

Increasing the conductivity of concrete using CNTs is a developing technology geared towards revolutionizing concrete. CNTs embedded in concrete could ultimately become a stress indicator, as their resistance changes due to changing loading conditions. The possibilities of how this could change the concrete industry are yet to be discovered.

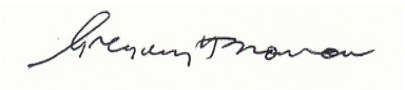
Re-testing of Earlier Trials Underway

Hythane Company is now undertaking re-testing of some of its earlier trials to measure the effect of its new mixing procedure on the flexural strength of mortar beams made from nano-carbon enriched mixtures made with this new technique. If as expected these produce improved results, this could significantly extend the ability of Eden's carbon to positively benefit the properties of concrete/mortar. The first preliminary re-testing of mortar beam flexural strength has begun, with initial results analysis expected to begin within 30 days.

Conclusion

These are very encouraging new developments in Eden's quest to find suitable large scale commercial applications for its carbon nano-tubes and carbon nano-fibres. Concrete is the world's most widely used construction material, and significant interest has already been shown by one of the world's largest cement and concrete manufacturers, which is currently testing Eden's nano-carbon in various concrete mixtures .

Better and more cost effective concrete products, with significantly reduced carbon dioxide footprints, are anticipated, after all necessary testing, to lead to new, large scale commercial applications for Eden's nano-carbon and would open the way for the full scale commercial rollout not only of its carbon products but also of its Hythane® and hydrogen products that can utilise the hydrogen that is produced as the only direct by-product of Eden's nano-carbon production process.



Gregory H Solomon

Executive Chairman

For further information please contact Greg Solomon (+618 9282 5889) or visit our website (www.edenenergy.com.au)