**Miracon Special Testing Overview**

* **During 2007 thru 2009, Miracon participated in a Fly Ash study** that was partially funded by the D.O.E. . Active participants included: 1)ADA-ES, a major player in the carbon sequestration process designed for use at coal utility power plants; 2) WI Energies, Wisconsin Energies; 3) Miracon Technologies. The D.O.E. funded purchasing of a license from Miracon, so that testing could be performed at the R&D facility of ADA-ES, in Denver, Colorado. No other funding was available, so Miracon offered its resources at no cost to support the testing program – which lasted approximately 2 years.

The D.O.E., by the start of this study, had determined that that ADA-ES had developed an effective (cost and performance) carbon sequestration process .The good news: The process insured the sequestration of mercury as it exited the coal burning/furnace and traveled through the flue gas chamber – importantly, before it exited the flue chamber as emissions into the atmosphere. The bad news : carbon, in any form, sequestered in fly ash, was well known to cause problems with air entraining. So the D.O.E. wanted to know if the man-made carbon and process developed by ADA-ES was commercially adopted by the Utility Industry, would there be a problem with the industry not being able to sell /dispose of its significant volume of fly ash causing a disposal issue.

Miracon made numerous trips to Denver over the course of the testing program. Miracon also conducted testing in its own lab to assist ADA-ES prior to attempting critical testing work in ADA-ES lab. Miracon also delivered and supported on site testing work completed in Wisconsin at WI energies coal utility facility. All of the costs for travel and manpower provided by Miracon were at Miracon’s expense.

Results and conclusions of this 2 year study/work were compiled in a paper entitled : **Concrete Applications Using High-Carbon Fly Ash From The Toxicon Baghouse** . The paper documented how Miracon was effective in addressing air entraining concrete when any level of activated (man-made) carbon was present in fly ash. Virtually no other type of air entrainer chemistry was able to consistently produce a favorable result. In fact, at high (30% by weight of the fly ash) levels of activated carbon, Miracon was the only air entrainer that could entrain air at all.

This paper was presented at numerous conferences in the several years following the conclusion of the study, including (by invitation) presentation at the world’s largest energy conference – The EUEC.

Many utilities have converted to use of natural gas for clean emissions in the last few years as opposed to using the higher cost carbon-injection process. At the time the study began, natural gas was not a readily available lower cost alternative. Miracon was certainly able to show its robust performance capability as compared to any other air entraining product, which certainly had at least general marketing value.

* **In 2007 and in 2008, Miracon funded and performed research programs that resulted in Papers for publication**, and further resulted in invitations for presentations to The Concrete Technology Conference in each of those years.

The largest concrete industry organization is the NRMCA ( National ready Mix Concrete Association). Each year, the Association sponsors a Technology Forum, and there is a call for papers. Approximately 25 papers (out of hundreds submitted) are selected for formal presentation at the conference. In 2007 our research and paper entitled “Precision Air Entrainment For High-Performance Concrete” was selected for presentation at this 3 day conference. In 2008, our research and paper entitled “Advances In Cost Effective Cement Reduction” was selected for presentation at that year’s conference. Note the research work and paper documented the improved rheological properties unique to Miracon’s air entraining product, which in turn led to lower cement usage ( due to less water required to mix/place the concrete).

* During a three year time frame,2007 through 2009, Miracon worked directly with a prominent engineering firm, KSF, to determine **How To Efficiently Extend The Life Of Concrete Bridges .** KSF is the leading engineering firm involved with design of bridges throughout all of the Hawaiian islands. KSF approached Miracon with the problem: concrete bridge life was limited to maximum 25 years in Hawaii. During three years of research work, performed in Miracon’s lab as then certified at CTL Laboratories in Skokie, IL, and in CMT Laboratories, Salt Lake City, UT, Miracon by virtue of its air entrainer ( with special rheological / flow properties and cement reduction potential) established a concrete mix formulation which was highly successful, and still in practice today. The new mix design, with approval from the D.O.T. for Hawaii, with Miracon air entrainment product, allowed for a cement reduction of 23%, calculations made from early test data, strength gain of over 50%, and based upon data collected, the bridge life expectancy extended to over 100 years.

One of the unique features of Miracon’s “enabling” product as documented in this study, has to do with how air entraining products perform in concrete bridges. Typically, all concrete bridges have a significant amount of steel (rebar) reinforcement. Additionally, all other air entrainers have a natural affinity to adsorb onto solid surfaces such as steel – especially on the underside of the steel. When these air entrainer become an air void as a result of the concrete curing, there is now a space between the concrete and the steel ( so, lack of bond). This void, especially on bridges, is problematic, because as traffic moves over a bridge, it concrete structure flexes and causes the steel to vibrate...which, because of the void, causes the concrete to loose bond further and deteriorate (pop/break apart). However, as part of the research, it was documented that the Miracon product did not adsorb on to the steel, which translated into superior bonding.

The results of this Miracon-enhanced concrete mix design research, and actual application, were presented in a paper at the North American Bridge Conference which was consequently available to all concrete producers .

* **Miracon Maintains Industry Certifications** which allow us to represent that our air entraining product meets ACI (American Concrete Institute) standards. There is only one standard for air entrainment which is set forth in **ASTM C-260/AASHTO-M154**. When Miracon first entered the structural concrete market in 2004 it did not have a certification indicating that it met the industry standard. SP (Staker Parson/JB Parson) agreed to fund the direct cost of testing to insure that its product would qualify and meet that standard. In turn, Miracon supplied the equipment and support for the testing completed (in 2004) at CMT laboratories in Salt lake City, UT. Miracon’s product met and significantly surpassed all requirements in this series of testing.

Since 2004, Miracon has maintained its ASTM C-260/AASHTO M154 certification, as required, by completing and passing all the tests involved with this certification. Certifications were completed and paid for by Miracon in 2008 ( by CMT labs.) and in 2013 ( by Wiss, Janney, Elstner Associates, Inc., Austin,TX) .

Note that other ASTM standards apply to air/gas as used in concrete for other applications (such as Cellular Concrete,etc.). However, an air/gas product supplier does not have to have product tested and certified with these types of concrete – the air/gas product supplier must simply represent that their product meets these (other) standards.

* In 2005, Miracon with the assistance of SP, set out to perform a test to determine if concrete paving with Miracon’s air entrainer performed any differently (better/worse) in terms of curling, a common problem with highway paving. Miracon and SP met with **Utah State D.O.T. who Designed and Approved a Curling Test** for our intended purpose.

The Curling test was performed in Salt Lake City, with concrete furnished by SP from the California Ave plant. Two concrete mixes were placed into a large scale testing form to replicate a highway paving section. The only difference between the mixes was the brand of air entrainer – one was Miracon’s product; the other was SP’s typical air entrainer product. The test had electronic devices to accurately monitor and measure curling. The test was scheduled to last a minimum of 6 months, however, at approximately 4 months, vandalism ( on SP property) destroyed the testing device, and so interrupted the testing report.

While the testing did not last the scheduled minimum 6 months, the daily /weekly/monthly reports from the testing had shown significant performance difference between the two specimens. The concrete with Miracon product had 38% less curling than the concrete with the SP’s typical air entrainer product.

We (Miracon) were especially anxious to continue, and as such re-do the test, but unfortunately SP indicated that they did not want to repeat the test.

* One of the (many) issues with using(conventional) air entrainment in concrete has to do with the **Coalescing of Entrained Air - When a Concrete Mix is Re-tempered**. Typically in the sequence of making concrete, any concrete, pre cast or Ready Mix/Transit Mix, water is the first ingredient to go into the mix, all other materials then added. In 2005, Kozikowski, Vollmer and Taylor, prominent researchers at The Portland Cement Association published extensive test findings which showed the Extremely high predictability of air entrainment/air void clustering when concrete is re tempered with non-Vinsol resin (the standard for all air) entrainers . This was/is significant in its finding since most concrete is re tempered just before discharge from the mixing drum or chamber.

In 2007, Miracon performed a series of tests to demonstrate the effect of re-tempering any concrete mix when Miracon air entraining product is used. Testing procedures followed those of Kozikowski, Vollmer and Taylor. Test results showed literally no tendency for Miracon product to cluster. This test was widely publicized by Miracon – through our web site as well as customer presentations.