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CS2000-TREATED CONCRETE INTERNAL RELATIVE HUMIDITY TECHNICAL BULLETIN

Over 20 years ago, CS2000 was introduced as an industry-changing solution that represented the first truly effective moisture control system that was not a costly, environmentally-challenging epoxy-based solution. At the time of CS2000's introduction, customers relied almost exclusively on epoxy surface coatings to prevent moisture migration/intrusion which sometimes led to resilient flooring failures. Over the lifespan of the CS2000, it has been tested and refined to provide industry-leading moisture vapor emission control (MVEC) performance. OBEX purchased the brand and intellectual property rights of CS2000 in 2016 and is proud to offer it as a leading moisture vapor emission control product solution. CS2000 provides a value-engineered and competitively-priced MVEC day of pour solution. With CS2000, owners and contractors can drastically reduce the cost of MVEC systems on their projects.

CS2000 has curative properties, which means CS2000 densifies and hardens the upper surface of the concrete slab, allowing the concrete to retain moisture during the early curing and hydration period. Relative to concrete hydration and curing, carefully calculated and incorporated moisture is beneficial. Concrete requires water that will be utilized during hydration to develop compressive strength. A typical water to cementitious ratio for a commercial slab on grade, or slab on deck, is around a .45 to .50 water to cementitious (w/c) which provides enough water for hydration (water of necessity), and effective finishing (water of convenience). In order to maximize hydration, curing methods are utilized in order to maintain moisture in the slab following concrete placement. In ordinary environmental conditions, 50% of the cement would be hydrated after 7 days, and 90% of the cement would be hydrated after 28 days of curing.[1] "The strength development of concrete is directly related to the degree of hydration of the cement, which is related to the amount and length of moist curing."[2] CS2000 supports the curing process by chemically retaining water in the slab during the early hydration period. Comparing Tables 1 and 2, where Table 1 is a .50 w/c 4-inch slab cast on Day 1, untreated, with no curing methods utilized, and Table 2 is a .50 w/c 4-inch slab cast on Day 1, treated with CS2000. Climate conditions were maintained at 65 to 70 F and 50% ambient relative humidity, and ASTM F2170 was utilized to evaluate internal relative humidity (RH) values in the concrete slabs.

Table 1. Reference Slab

Test Date	RH (%)	Temp (F)
Day 7	98%	68
Day 26	93%	70

Table 2. Slab Treated with CS2000

Test Date	RH (%)	Temp (F)
Day 7	98%	69
Day 26	98%	70

During the early hydration process, the untreated slab internal RH drops to 93%, while the CS2000-treated slab retains moisture at 98% RH which helps support proper concrete hydration. While internal moisture is beneficial relative to hydration and curing, negative-side moisture vapor emissions (MVE) and slab moisture, sometimes precipitated by expedited construction schedules, can influence flooring failures resulting in extremely costly repairs.

The advantage of a CS2000-treated slab is that while the slab retains moisture to facilitate hydration in the early stages of that process, as the moisture is utilized during hydration, there is no appreciable impact on internal moisture results when the slab is completely cured. More importantly, CS2000 helps densify the surface of the concrete slab, reducing capillary size and avenues for moisture to migrate, reducing MVE in compliance with floor placement requirements. Compare Table 3 (untreated reference) to Table 4 (CS2000-treated) later in the hydration process.

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Table 3. Reference Slab

Test Date	RH (%)	Temp (F)
Day 47	94%	69
Day 75	90%	68
Day 109	86%	65
Day 141	84%	71
Day 172	79%	69

Table 4. Slab Treated with CS2000

Test Date	RH (%)	Temp (F)
Day 47	92%	69
Day 75	88%	68
Day 109	84%	66
Day 141	81%	70
Day 172	80%	70

Almost six (6) months after initial placement, there is no appreciable difference in internal relative humidity values between the Reference slab and the CS2000-treated concrete slab. **What this means for construction projects is that employing CS2000 *WILL NOT* hinder or detract from passing or failing ASTM F2170 RH testing performed per specifications, or in compliance with flooring manufacturer requirements. CS2000 *WILL* limit MVE that might otherwise migrate out of the concrete slab and potentially damage the resilient flooring system.**

It should be noted that internal slab RH values, as measured by ASTM F2170, are largely dependent on 1) w/c ratio, 2) curing times, and 3) climatic conditions including rainfall, ambient RH and temperatures at which the concrete slab completes the curing/hydration process. The industry standard is one (1) month of curing time for each inch of concrete thickness.[3] There is an increasing emphasis by flooring manufacturers, and specifiers, with respect to ASTM F2170 testing, instead of, or in conjunction with, ASTM F1869 calcium chloride (moisture vapor emission rate) testing. Regardless, a typical 4-6 inch concrete slab will necessitate 4-6 months of curing prior to flooring placement. Typical and prevalent construction timelines—compressed to comply with demands for rapid development and turnover—do not permit a slab to fully cure in accordance with manufacturer specifications prior to flooring placement. For example, a slab placed in November in most areas of the United States with a turnover date in January, defies the expectation of a fully cured slab at 75-80% RH. As a result of basic chemical reactions and processes, it is virtually impossible for a slab to achieve that internal RH—especially if the slab is subject to measurable rainfall/snow conditions. In instances of compressed, expedited construction timelines, to *absolutely* ensure appropriate moisture control, installation of an ASTM F3010 system such as Creteseal MAX may be more applicable.

OBEX advocates following manufacturer specifications with respect to moisture testing prior to the installation of flooring. The reason is simple—over the millions of square feet poured and treated, a lot of learning has taken place in every segment of the value chain. The manufacturer specifications are not just an attempt to limit liability; they are intended to represent minimization of risk (failure) for project owners and contractors. OBEX strongly encourages customers to avoid the headaches and hassles of failures by testing all treated slabs in accordance with manufacture specifications and industry standards. In the event moisture testing represents a potentially high level of risk, risk that defies typical warranty considerations, OBEX's policy is to credit customers for the full-value of the CS2000 MVEC system installation toward the Creteseal MAX system which requires no subsequent testing after installation. Considered in that manner, applying CS2000 virtually eliminates any risk of flooring failure and provides owners with enhanced peace of mind in the event testing levels are inconsistent with warrantable levels of MVE.

[1] Kanare, Howard, *Concrete Floors and Moisture*, EB119, Portland Cement Association, Skokie, Illinois, and National Ready Mixed Concrete Association, Silver Spring, Maryland, USA, 2008, page 31.
[2] *Id*. pages 35-36.
[3] Harriman, L, "Drying Concrete," *Construction Specifier*, Vol. 48, No. 3, March 1995, pages 55-64.