NEW WASTE CONCEPTS, INC.

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R&D Test Report (Ref. JWC-2-128)

Improving the Water Resistance Properties of *ConCover 180* using *HydraGuard 42*

Overview

ConCover 180 is designed for use in landfills, high erosion environments, and remediation projects that require a durable, longer-term cover material that can suppress VOC's, dust and odors. ConCover 180 can be applied in wet or moist conditions and, once cured, provides a relatively impermeable barrier with excellent water run-off properties during rainstorm events, thus controlling erosion and minimizing subsurface contamination.

ConCover 180 is *not* normally intended to be used in applications in which the applied material could be exposed to longer-term immersions under water. Being able to use ConCover 180 in such environments would add considerably to its versatility as a premier cover material. One potential application is usage as a cost-effective spray-applied liner for temporary water-collection basins. Another use could be in remediation projects along riparian zones that are subject to flash-flooding that could normally erode away contaminated soils and redeposit them downstream.

Adding high quality, yet cost effective polymers to ConCover 180 can add significantly to the water resistance properties of the cured system. SuperSeal 40, a vinyl acetate co-polymer in powder form, has long been used to impart additional properties (including adhesion, water resistance, and longer-term durability) to ConCover 180. It is, however, a relatively expensive product. This report will investigate the usage of a liquid co-polymer blend, HydraGuard 42, and its effectiveness in imparting additional water resistance properties to ConCover 180.

HydraGuard 42

HydraGuard 42 is a stabilized blend of vinyl acetate and acrylic polymers dispersed in a waterborne emulsion. When used as is or in conjunction with ConCover 180, HydraGuard 42 begins to cure as water evaporates from the system during drying, ultimately forming an irreversibly bound polymer network which becomes highly resistant to resolubilization in water. When added to ConCover 180, HydraGuard 42 will also add considerably to overall physical properties (including tensile and compressive strengths), as well as improve adhesion to various substrates (plastics, metals, aggregates, soils, concrete, etc.).

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Two test methods were chosen to characterize the water resistance properties of this system:

1. Hydraulic Conductivity Measurements (ASTM D 5084-03)
2. Water Immersion Testing – 3 months (percent moisture absorption, durability)

I. Hydraulic Conductivity Testing (Overview)

Hydraulic conductivity testing is commonly used to define the rate of movement of water through a porous medium such as a type of soil, rock or aquifer. It can also be used to characterize water movement through materials such as concrete and polymeric materials like ConCover 180/HydraGuard 42. Hydraulic conductivity, symbolically represented as *K*, is defined as the flow volume of water per unit cross-sectional area of the porous medium (test specimen) under the influence of a unit hydraulic gradient (water pressure).

As indicated by the following table, the smaller the value of *K,* the more "impervious" the material is to the flow of water:

TABLE ONE:

K (cm/sec.)	10^2	10^1	$10^0=1$	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}
Relative Permeability	Pervious				Semi-Pervious				Impervious				

A polymer-based material that can maintain its degree of imperviousness over a period of time can be considered to be water resistant. Materials that are less water resistant will start to deteriorate due to hydrolytic and/or resolubilization effects, with a corresponding increase in its hydraulic conductivity value.

TEST METHOD: ASTM D 5084-03 "Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter" (Method C – Falling Head)

Preparation of Test Specimens

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Five (5) separate laboratory mixes of ConCover 180 were prepared using increasing amounts of HydraGuard 42. The values listed below (Table Two) have been adjusted to represent the equivalent of ONE UNIT of ConCover 180, as would be used in the field:

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TABLE TWO:

Material	1	2	3	4	5
ConCover 180 Pt. A	150 lbs.	150 lbs.	150 lbs.	150 lbs.	150 lbs.
Pt. B Paper Mixture	35 lbs.	35 lbs.	35 lbs.	35 lbs.	35 lbs.
Water	50 gals.	45 gals.	40 gals.	35 gals.	25 gals.
HydraGuard 42	0 gals.	5 gals.	10 gals.	15 gals.	25 gals.
HydraGuard 42 as % of mix liquid volume	NONE (CONTROL)	10 %` by volume	20 % by volume	30 % by volume	50 % by volume

Materials were cast into open right cylinder steel molds, each measuring approximately 2.8 inches in height and 2.8 inches in depth. After two days drying time, each specimen was removed from its mold and allowed to further dry under ambient conditions (about 21 °C), for a total of seven (7) days drying time.

Hydraulic conductivity testing was conducted by an independent testing laboratory, TTL Associates Inc. (Toledo, OH). Initial specimen dimensions and weights were measured, and then each specimen placed into a flexible wall permeameter apparatus. Deaired tap water was used to saturate the samples over a period of about 5 days, with permeameter pressures being adjusted to promote the flow of water through each specimen. After complete saturation was attained, permeability measurements were determined by taking a total of five (5) readings per test specimen over an eight hour period. This data was then averaged to yield an “Average Hydraulic Conductivity” (*K*) value for each test specimen. The specimens were then left in the permeameters for an additional five (5) days and permeability measurements were noted once again, in an attempt to see if any material deterioration (with a subsequent increase in permeability) was occurring over this time period.

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TEST RESULTS: Average Hydraulic Conductivity (*K*) Values

Specimen (Mix) No.	**1**	**2**	**3**	**4**	**5**
HydraGuard 42 (% of mix liquid volume)	NONE (CONTROL)	10 %` by volume	20 % by volume	30 % by volume	50 % by volume
K *(cm/sec.)* Initial	1.20E-06	7.61E-07	6.27E-07	5.13E-07	4.16E-07
K *(cm/sec.)* Additional 5 days	1.42E-06	8.96E-07	6.95E-07	5.13E-07	4.16E-07

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The data clearly shows that adding HydraGuard 42 to ConCover 180 has a pronounced effect in lowering the Hydraulic Conductivity value *K*, correlating to an increase in the impermeability of the system to water. The ConCover 180 "control' mixture (no HydraGuard 42), was at the lower end of the "Impervious" range (10^{-6}) of the Relative Permeability scale depicted in Table One. Adding increasing amounts of HydraGuard 42 shifted *K* further into the "Impervious" range (10^{-7}), as indicated in the graph below. Samples with no or lower levels of HydraGuard 42 did show a slight reduction in water permeability after an additional five days of testing, but this phenomenon becomes negligible with increasing amounts of HydraGuard 42.

GRAPH ONE:

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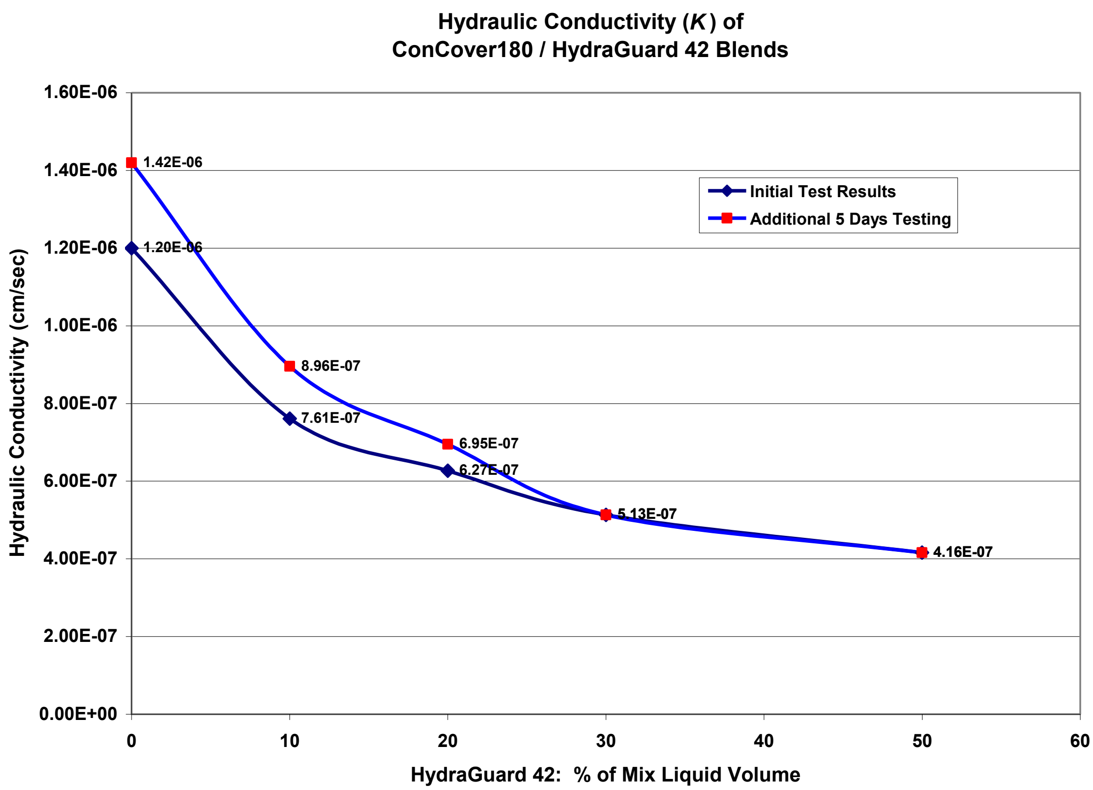

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II. Water Immersion Testing (3 Months Exposure Time)

Materials remaining from the ConCover 180 and HydraGuard 42 mixes described above (Table Two) were used to prepare testing specimens for water immersion testing. Each specimen was allowed to dry at ambient or higher temperatures for a specified period of time, weighed, and then placed under water for up to three (3) months total immersion time. An assessment of the physical durability and the percentage of moisture absorption were then made for each sample.

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Preparation of Test Specimens

Materials were cast into 3-inch nominal size aluminum weighing dishes. After an overnight curing period, each sample was then removed from its aluminum dish, yielding a round "hockey puck" like test specimen approximately 9/16 inches in depth x 2-7/8 inches top diameter x 2-3/4 inches bottom diameter.

Materials were then cured for an additional two (2) days at one of two curing temperatures:

1. Ambient temperature (laboratory counter): approx. 70 °F (21 °C)
2. Higher temperature (laboratory oven): 140 °F (60 °C)

Curing specimens at the higher (140 °F) temperature can accelerate the development of cure properties of the ConCover 180/HydraGuard 42 mixture, whereas ambient cured samples may require a longer period of time to develop their full cure. Caution must be used when comparing data obtain under these two temperature extremes, realizing that materials applied in most real field environments do not have the benefit of such higher curing temperatures.

Testing Procedure

After three (3) days cure time, each specimen was labeled with water-resistant ink, weighed, and then immersed in clean tap water (pH 7.4) for a period of three (3) additional days. After this time, each specimen was then removed from the water and the surface quickly "blotted-dry" with an absorbent paper towel, taking care to not to over-dry the exposed surfaces thus pulling additional moisture out of the interior of the sample. Observations were made as to the physical appearance of each sample, after which it was then re-weighed and percent moisture absorption determined.

The test samples were then immersed again into water and left submerged for a total of 90 days (3 months) time. The samples were then re-dried and re-weighed for percent moisture determinations, and another assessment made of the overall physical durability of each specimen.

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TEST RESULTS: Percent Moisture Absorption after 3 Days, 90 Days Water Immersions

Specimen (Mix) No.	1	2	3	4	5
HydraGuard 42 (% of mix liquid volume)	NONE (CONTROL)	10 %` by volume	20 % by volume	30 % by volume	50 % by volume

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AMBIENT CURED SAMPLES (70 °F)					
3 Days H_2O					
Initial Weight (grams)	28.92	28.64	30.22	30.92	31.82
Weight (3 days H_2O)	(Disintegrated)	71.60	70.27	68.86	57.30
H_2O Increase (grams)	n/a	42.96	40.55	37.94	25.48
% wt. H_2O Increase	n/a	+ 150 %	+ 133 %	+ 123 %	+ 80 %
Appearance	(Disintegrated)	Soft, rubbery (still intact) ➔ ➔ ➔ ➔ Firmer, slightly pliable			
90 Days H_2O					
Weight (90 days H_2O)	n/a	Crumbled	73.09	72.24	64.10
H_2O Increase (grams)	n/a	n/a	42.87	41.32	32.28
% wt. H_2O Increase	n/a	n/a	+ 142 %	+ 134 %	+ 101 %
Appearance	(Disintegrated)	Crumbled	Rubbery ➔ ➔ firmer, pliable		
HEAT CURED SAMPLES (140 °F)					
3 Days H_2O					
Initial Weight (grams)	26.26	28.58	29.97	30.21	31.35
Weight (3 days H_2O)	(Disintegrated)	73.47	71.04	68.48	61.65
H_2O Increase (grams)	n/a	44.89	41.07	38.27	30.30
% wt. H_2O Increase	n/a	+ 157 %	+ 137 %	+ 127 %	+ 97 %
Appearance	(Disintegrated)	Soft, rubbery (still intact) ➔ Firmer, slightly pliable (harder than corresponding ambient cured samples)			
90 Days H_2O					
Weight (90 days H_2O)	n/a	72.69	73.84	72.10	65.53
H_2O Increase (grams)	n/a	44.11	43.87	41.89	34.18
% wt. H_2O Increase	n/a	+ 154 %	+ 146 %	+ 139 %	+ 109 %
Appearance	(Disintegrated)	Soft, rubbery (still intact) ➔ ➔ ➔ ➔ Firmer, slightly pliable			

(Continued: R&D Test Report JWC-2-128)

Discussion (Water Immersion Test Data) **[See PHOTOGRAPHS]**

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As expected, the ConCover 180 control sample (containing no HydraGuard 42) did not perform well under longer-term complete water immersion conditions, with both ambient and heat cured samples resolubilizing in water and losing their physical integrity. However, once ConCover 180 was modified with HydraGuard 42, all specimens maintained their physical properties after three (3) days of water immersion and, except for the mixture containing the lowest amount of HydraGuard 42 (Specimen 2), all were intact after 90 days total immersion time in water. The overall appearance of the physical durability of these specimens did not change appreciably between 3 day and 90 day immersion periods.

All of the ConCover 180/HydraGuard 42 specimens absorbed appreciable amounts of water, with weight gain percentages ranging from about 100% (higher levels of HydraGuard 42) up to about 150% or so (lower levels of HydraGuard 42). Interestingly, the data for both ambient as well as heat cured samples showed very close correlation for each level of HydraGuard 42 addition. The degree of water absorption seen in this testing is inherently characteristic of the ConCover 180 system for several reasons. ConCover 180 was originally designed as a “foaming” type cover material that promotes a controlled degree of air entrainment during mixing, resulting in a lighter-weight overlayment that is saturated with numerous closed-cell air voids in its interior. For cost economics, the system also contains paper mulch and wood fibers which also tend to absorb water. Although ConCover 180 can absorb additional water under total immersion conditions, it is still relatively impervious to the movement of water through its structure, as verified by the hydraulic conductivity data discussed above.

Once the ConCover 180/HydraGuard 42 samples were removed from water at the end of the 90-day immersion period, all were allowed to “dry-out” for several days under ambient laboratory conditions. Although surface hardness measurements could not be quantified as a Shore durometer was not available, all of these samples appeared (visually and palpably) to be very similar to their original cured state prior to their initial immersion into water.

CONCLUSIONS

The addition of HydraGuard 42 to ConCover 180 can significantly upgrade the overall water resistance properties of this cover material, allowing it to be used in areas where longer-term exposure to water immersions might occur. This system can, in many applications, be a very cost-effective functional offset to more expensive containment liners, geomembranes, bentonite capping, etc. Additional labor cost savings can also be realized with the added versatility of this easy-to-mix and spray-applied system. Finally, the ConCover 180/HydraGuard 42 system is biodegradable and will have not have any negative impact on the environment if left in place or, ultimately, removed and landfilled.

PHOTOGRAPH ONE:

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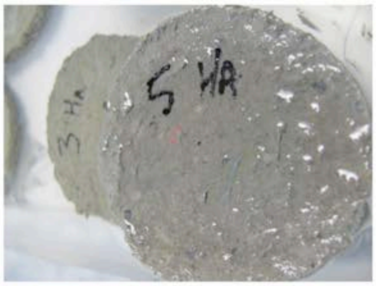
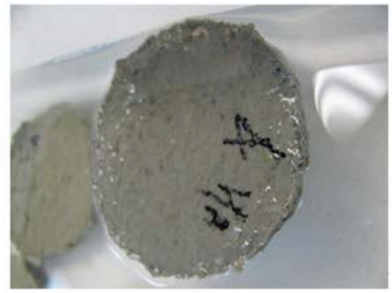


Initial CC180 w/ HydraGuard 42 immersion in Water on February 12, 2009



1. CC 180 w/HydraGuard 42: INITIAL Immersion into Water (February 12, 2009)

After 3 days initial cure time at ambient room temperature (T_A) or oven heat aging (H_A), specimens are placed into container of tap water. Specimens that had higher levels of HydraGuard 42 tended to float longer on the surface of the water, until they finally absorbed enough water to lose their buoyancy.

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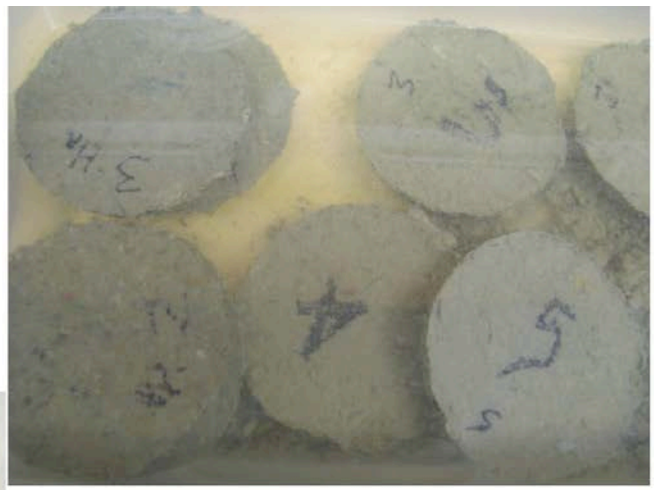
PHOTOGRAPH TWO:

CC 180 w/HydraGuard 42: AFTER 90 Days Immersion in Water (May 13, 2009)



CC180 control specimens (without HydraGuard 42) have disintegrated while specimens with HydraGuard 42 have maintained their original shapes and physical integrities.

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PHOTOGRAPH THREE: