CHEM-BAC *Laboratories, Inc.*

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Certificate of Analysis

Client: Greensorb
200 S. Wacker Drive, Suite 1500
Chicago, IL 60606
Attn: Tom Uskup

Client Number: 9999
Work Order: 1750-11
Sample Date: 06-20-11
Report Date: 07-12-11

GreenSorb Product Study – Sulfuric Acid Study

Chem-Bac Laboratories was requested by Mr. Tom Uskup to perform a product study on "GreenSorb". The product study would encompass the absorbent properties of the product when subjected to common acids used in commercial industry. The acid covered in this report will be Sulfuric Acid. The report will detail the ratio of GreenSorb to Sulfuric Acid for complete encapsulation. The report will also reveal data for the neutralization of the encapsulated acid waste product. The neutralization data will include the selection of a neutralizing agent and pH measurements of the waste product with varying concentrations of the neutralizing agent.

Sulfuric Acid Data

Sulfuric Acid was selected as one of the test liquids based on its wide commercial use. Principal uses include lead-acid batteries for cars and other vehicles, ore processing, fertilizer manufacturing, oil refining and wastewater processing. The majority of commercial applications do not use concentrated Sulfuric Acid, but rather a diluted concentration. Chem-Bac Laboratories selected the use of 30% (W/W) concentration of Sulfuric Acid as the test liquid. This is the concentration of the Sulfuric Acid found in lead-acid batteries for cars and will provide the best test data pertaining to the majority of the commercial applications. The 30% mass concentration will be referred to as "Sulfuric Acid" in the remainder of the report.

Determination of Encapsulation Ratio: The encapsulation ratio outlined in this section of the report will be considered the ratio of "GreenSorb" to Sulfuric Acid required to pass the EPA paint filter test (Method 9095B). The ratio will initially be reported on a weight basis for both the "GreenSorb" and the Sulfuric Acid. Using the density of the Sulfuric Acid a volume conversion is also included in the report.

Encapsulation Data – Sulfuric Acid

Weight of GreenSorb (lb)	Weight of Sulfuric Acid (lb)	Weight Ratio	Time Required for Complete Absorption	Surface Condition Following Absorption
2 lb	1 lb	2:1	2.5 min.	Clean and Dry

Based on an average density of Sulfuric Acid of 10.4 lb/usgal – It would require 20.8 lbs of "GreenSorb" to absorb 1 gallon of Sulfuric Acid.

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It should be noted that the GreenSorb did not react violently when subjected to the Sulfuric Acid. No reaction byproducts such as heat or noxious fumes were noted upon contact with the GreenSorb. The GreenSorb encapsulated the Sulfuric Acid in a safe and controlled manner.

The encapsulated mixture was subjected to an EPA Paint Filter test. The results are as follows.

Paint Filter Liquid Test Results – Method 9095B

Analysis	Result	Reporting Limit	Qual	Units	Batch	Dilution Factor	Date Analyzed
Free Liquid	Negative	0	--	ml	Sulfuric	--	7/05/11

Discussion of Results: No free liquid was observed at a ratio of 2.0 parts "GreenSorb" to 1 part Sulfuric Acid.

Following the Paint Filter Test, distilled water was added to the encapsulated waste mixture. Upon the contact with water, the encapsulated mixture experienced an exothermic reaction. The reaction, commonly known as the "heat of dilution", increased the temperature of the waste product by over 80° C. This change in temperature will vary according to the amount of water added, the temperature of the water added, and the volume of the initial waste mixture. Care should be taken when adding water to the encapsulated Sulfuric Acid/GreenSorb mixture. If possible, the acid waste mixture should be neutralized before adding water to eliminate the dangers associated with the rapid and intense heat change.

Neutralizing Agent Selection and pH Data
Chem-Bac Laboratories evaluated several chemicals to determine the most suitable neutralizing agent for the waste product. The most common types of chemicals used to neutralize acids are hydroxides, carbonates and bicarbonates.

Hydroxides tend to be more caustic than carbonates and bicarbonates and can cause severe burns upon contact with skin or eyes. If inhaled, hydroxides can possibly damage the lungs. Hydroxides will produce much more heat when subjected to Sulfuric Acid than carbonates or bicarbonates. This increase in temperature may be large and instantaneous which may prove to be a hazard. Hydroxides can also be corrosive.

Several carbonates and bicarbonates were evaluated based on neutralization ability, reaction byproducts, cost, and availability.

Sodium Bicarbonate was selected as the best neutralizing agent for the encapsulated Sulfuric Acid waste product. The reaction with the encapsulated Sulfuric Acid has a very low heat of reaction and only gives of carbon dioxide as a byproduct. The Sodium Bicarbonate is readily available as "Baking Soda" and is very cost effective.

Sodium Bicarbonate was placed into contact with the Sulfuric Acid waste product at different concentrations. The pH of the waste product was measured. A table showing the pH of the waste product and different concentrations of the Sodium Bicarbonate is shown below. The addition of the Sodium Carbonate was stopped when a pH of 7.00 was achieved.

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The following table will show the weight of Sodium Bicarbonate added to an encapsulated waste mixture containing 10 lbs of GreenSorb to 5 lbs of Sulfuric Acid (2:1ratio) and the resulting pH values.

Neutralization Data Table (Sodium Bicarbonate)

Weight of Sodium Bicarbonate added to 15 lb Encapsulated Mixture of GreenSorb and Sulfuric Acid (lb)	Resulting Waste pH
1	1.62
1.5	1.72
2.0	1.89
2.5	2.26
3.0	5.20
3.25	6.10
3.5	6.43
3.75	6.66
4.0	6.82
4.25	6.94
4.30	7.00

If 4.3 pounds of Sodium Bicarbonate are added to 15 pounds of encapsulated waste, the resulting pH will be 7.00. A more simplified ratio would be 1 part Sodium Bicarbonate to 3.5 parts encapsulated GreenSorb waste.

A noticeable pH jump occurs at the 1 part Sodium Bicarbonate to 5 parts GreenSorb waste ratio. Depending on the pH requirements of the waste, the ratio selection of the Sodium Bicarbonate can be made from the table above.

In conclusion the GreenSorb effectively and safely encapsulated the Sulfuric Acid solution. Once encapsulated, the Sulfuric Acid waste can be safely neutralized by the addition of Sodium Bicarbonate. The encapsulated waste product does not produce a high heat of reaction or demonstrate any of the violent carbon dioxide release that may be seen if the GreenSorb is not used. The ability of the GreenSorb to encapsulate the Sulfuric Acid makes the neutralization process cleaner and safer.

Chem-Bac Laboratories used a 30% solution of Sulfuric Acid as the test liquid. GreenSorb will also encapsulate different concentrations of Sulfuric Acid other than the 30% solution. The encapsulation ratio may vary slightly, and adjustments to the neutralizer must be made based on the strength of the acid. The same advantages seen with the 30% solution are expected to occur with other concentrations of Sulfuric Acid. The neutralization process will be safer and cleaner because of the encapsulating ability of GreenSorb. The versatility of GreenSorb to encapsulate varying concentrations of Sulfuric Acid allows for broad based application use throughout the commercial marketplace.

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It should be noted that standard personal protection equipment and ventilation should be used when cleaning up acid spills with GreenSorb. Although the GreenSorb reduces the reactivity of the acid, all of the dangers experienced with the handling and contact with acids still exist.

Crushed Clay Comparison
A sample of crushed clay was also subjected to the Sulfuric Acid encapsulation testing for comparison purposes. The crushed clay absorbed the Sulfuric Acid. A high heat of reaction (+80° C) was noted during the absorption process. Following the absorption and reaction, the physical integrity of the crushed clay granules was greatly compromised. The crushed clay had a "paste like" consistency and was not able to demonstrate the same absorption properties as it did prior to the contact with Sulfuric Acid.

The ceramic nature of GreenSorb allows for the product to withstand the higher temperatures associated in the reaction with Sulfuric Acid and water. The crushed clay looses the majority of its physical integrity following the contact with Sulfuric Acid. The "pastelike" consistency of the crushed clay following the Sulfuric Acid reaction differs greatly from the GreenSorb product.

It should be noted that the dry, hard granules of the GreenSorb product are easier to clean up and handle following encapsulation than the crushed clay product.

Respectfully Submitted,
Chem-Bac Laboratories, Inc.
James T. Ward
Supervising Chemist