CLEANING LABORATORY EVALUATION SUMMARY

SCL #:	1996
DateRun:	09/18/1996
Experimenters:	Jay Jankauskas
ClientType:	Recycling
ProjectNumber:	Project #1
Substrates:	Aluminum, Copper
PartType:	Part
Contaminants:	Tar, Asphalt
Cleaning Methods:	
Analytical Methods:	Visual
Purpose:	Testing on the asphalt coated core windings

Experimental Procedure:

I just finished up some testing on the asphalt coated core windings that you sent me last week. I am glad to say it looks like I found two semi-aqueous chemicals that could possibly be effective for your cleaning operations. The two chemistries are AG Environmental Soy Gold 2000 and Calgon Corporation Geo-Guard 5210.
Soy Gold 2000 is a soy-derived Methyl Ester that is coupled with a surfactant to form an emulsion in water. The flash point is over 300 F and from the testing performed, it looks like one gallon of full-strength Soy Gold 2000 will dissolve 2 lbs. of asphalt.
Calgon Geo-Guard 5210 is a pine derived terpene that is also coupled with a surfactant to form an emulsion in water. The flash point is 210 F and the Geo-Guard 5210 will also dissolve 2 lbs. of asphalt per gallon of solution (but it needs to be heated up to 160 F).
The testing performed and the actual data is shown on the following test report. I also included MSDS's of both the Geo-Guard 5210 and the Soy Gold 2000 for your perusal.

Testing plan for evaluation of cleaning chemical used for asphalt removal. I just wrote up a testing plan to evaluate several different cleaning chemicals in removing hardened asphalt off of the aluminum/copper core windings.
I am planning to break up the testing into three phases. Each phase will build upon the other, so changes in the testing plan may take place due to results obtained in the previous phase.

Phase 1-Preliminary test - Place a small piece of asphalt in a sample of each cleaning chemical. Let the sample sit for an hour and observe any solvency or softening of the asphalt. Chemicals that are ineffective will not be tested further.
Phase 2-Solvency Test -Using 10 ml samples of each chemical that passed test #1, determine the maximum solvency (mg/ml) of each chemical at four temperatures (Ambient, 100 F 130 F and 160 F). For each chemical make a plot of solvency verses temperature and fit this graph with a curve. Obtain the same solvency curve for a chemical that is readily known to dissolve asphalt and compare.

Phase 3-Recycling- Spent cleaning fluid will need to be disposed of as a hazardous waste. From my preliminary observations it appears that the asphalt will foul up the cleaning solution pretty fast. This will lead to high chemical and hazardous waste disposal costs. After Phase 2 is complete, a recycling issues will be more closely thought out.

If there is anything further you would like me to take a look at, don't hesitate to call. I'll send you weekly summaries as to the progress of the testing.

Results:

DATE: September 18th, 1996
EXPERIMENTER: Jay Jankauskas
CLIENT: Recycling Company
SUBSTRATE MATERIAL: Copper Aluminum core windings
CONTAMINANTS: Owens-Corning Petroleum Asphalt
CONTAMINATING PROCESS USED: As received from Recycling Company.

The purpose of this trial is to find a cleaning chemical for Recycling Company that will meet the following requirements.

1) Must be able to effectively remove hardened asphalt from aluminum-copper core windings.
2) Must be able to be used effectively in a Graymills Tempest TL-2 Jet Spray Parts cleaner. This will involve having a flashpoint below 200 F and being compatible with the seals and gaskets used by Graymills.

In order to meet the above requirements, the testing was split up into two phases. The first phase involved a visual examination of twelve chemicals that were deemed to be successful in asphalt removal. The second phase tested the good performing chemicals of the first phase further by evaluating their solvency as related to temperature.

Phase I testing:
Twelve different chemicals were tested to a visual determination as to how well they dissolved the hardened asphalt. 20 ml of each chemistry was placed in a vial along with 2 grams of asphalt. The vials were allowed to sit for an hour and then shaken. The chemicals were based on a visual amount of how well

they dissolved the asphalt. If the resulting solution was black, this showed that the chemical was effective and was tested further. Solutions that were colored brown or clear, were considered ineffective and were not tested further. The results from the first phase of testing are shown in Table 1.

Phase II testing:
The five successful chemistries in phase 1 were tested further by evaluating their solvency of asphalt at different temperatures. 40 ml of each of the five chemicals were placed in a vial with five grams of asphalt. The vials were allowed to sit for one hour and then shaken up and 5 ml of resulting solution was pipetted and placed in an aluminum weighing dish. The weighing dish was then placed on a hot plate where all of the chemical was evaporated out. After evaporation, the resulting asphalt was allowed to cool down for 15 minutes. The solvency was determined by equation 1:

Solubility(g/l) = {1000 * (W sub 3 - W sub-1)} over {(W sub 2 - W sub-3)/SG sub {solvent}}

Where W1 = Mass of empty weigh dish (grams)
W2 = Mass of weigh dish and solvent before evaporation (grams)
W3 = Mass of weigh dish after evaporation (grams)
SG = Specific gravity of the cleaning chemical (taken from MSDS sheets)

The above procedure was performed for four different temperatures (70F, 100F, 130F, 160F). After plotting, each data series was fitted with a linear regression to get a straight line fit. The results from phase II are shown in Table II.

Phase II-
TABLE 2: Solvency Results from Phase II testing (grams/l).

Temperature (F)	Resineater	Soy Gold 2000	Soy Gold 1000	Citra-Safe	Geo-Guard 5210
70	11.87			54.52	51.29
100	19.68	266.39	334.12	98.69	77.3
130	32.74	277.58	275.34	149.1	172.78
160	63.16	242.54	411.6	145.65	292.55

Summary:
The first part of this test was the same as phase two testing in the first test. All of the new chemistries were tested by estimating the maximum solvency of each chemical at various temperatures. One of the problems with the last bunch of tests was that the solvency was the main method used for determining the effectiveness of each chemical, in all actuality, this will just measure how long the chemicals will work for and not take into consideration the time for cleaning.
This time a Milton Roy Spectrophotometer (Model 21) was used to measure concentration at a wavelength of 540 nm. This method was chosen over the evaporation method since it was believed that non-volatiles in the solvents were increasing concentration readings. Calibration curves were made up for the five solvents tested by taking % transmittance readings on several known concentrations. This data was then fit to a straight line and an equation was obtained to relate concentration to % transmittance. Highly concentrated samples had to be diluted with pure solvent to obtain a readable sample (highly concentrated samples are so thick that light will not pass through). When this was the case, the concentration obtained was multiplied by the dilution factor (volume of pure solvent plus one divided by the volume of asphalt/solvent mixture).
The above procedure was performed for four different temperatures (70 F, 100 F, 130 F). For an ideal solvent, the plot of the natural log of the concentration verses the inverse of the absolute temperature should yield a straight line. With this straight line fit an equation can be obtained to relate the maximum solvency verses the temperature. maximum concentration readings are shown in Table 1 and Figure 1. The resulting solvency equations are shown in equations 1 through 5.

Maximum Solvency Results (grams/l)					
Temp (F)	AG Env. Soy	Brulin Corp.	A.W. Chest	U.S. Polychem	Rochester Midland
	Gold 1000	Nature Sol 100	Supersolv 278	Solvent 86B	Neugenic 4176
70	24.201	66.299	39.336	111.032	79.003
100	28.488	79.93	54.445	119.532	83.679
130	39.274	74.842	67.613	121.03	83.483
160	51.998	91.52	67.802	123.071	85.635

Vant'Hoff Solubility Curves

Solvency Equations and linear fit errors (R2):
Soy Gold 1000 ln(C) = -1578.1 + 8.5018 R2 = 0.973 (1)
T
278 Super Solv ln(C) =-1141.6 + 7.6148 R2 = 0.8952 (2)
T

Nature-Sol ln(C) =-545.9 + 6.0685 R2 = 0.7468 (3)
T
Neugenic4176 ln(C) =-147.25 + 4.8808 R2 = 0.839 (4)

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T
Solvent 87RB ln(C) =-198.39 + 5.3994 R2 =0.973 (5)
T
* C= Saturation Concentration (g/l)
T= Absolute Temperature (R or K)

Conclusions:
From the solubility tests, it appears that the U.S. Polychem Solvent 87RB has the best solvency. Basically, the higher the solvency, the less solvent would be consumed. By using the above equations at the desired temperature of operation and estimating the amount of asphalt that will be removed in a given time period, the total amount of solvent used can be estimated, and taking the cost of each solvent into account, the economic optimum can also be determined.

Solvency Rate Testing:
Although the maximum solvency will give an idea into the amount of chemical needed it still does not take into account the rate of chemical attack on the solvent. The rate of solvency is dictated by a variable called the diffusion rate. Although these diffusion rates are very difficult to estimate for a solid liquid system, a relative comparison can be obtained.
Asphalt from the customer's parts was melted and evenly spread on 1" x 2" sample coupons. These coupons were immersed in a 100 ml sample of the chemical at ambient temperature. Every ten minutes, the sample coupon was removed from the chemical bath, the solution was stirred, and a sample was taken and tested for the concentration. The sample coupon was then immersed into the chemical bath and the above process was repeated. Concentration reading were taken for ten-minute intervals up to 50 minutes. The results for the solvency rate testing is shown in Table 2 and Figure 2.

Table 2 Solvency Rates

Time	AG Env.	A.W. Chest	Brulin Corp.	Rochester Midland	U.S. Polychem
min	Soy Gold 1000	Supersolv 278	Nature Sol 100	Neugenic 4176	Solvent 86B
10	69.42	140.92	6877.3	135.41	10085
20	107.99	207.13	4649.8	200.88	17147
30	147.66	280.12	6534.6	263.23	19007
40	176.31	365.15	6571.3	318.57	19007
50	228.65	481.02	6602.7	387.94	19007

Conclusion: From the above testing it appears that both the Nature-Sol 100 and the Solvent 87RB were the fastest acting chemicals by far. One thing to note is that both the Solvent 87RB and the Nature Sol 100 dissolved all of the asphalt off the sample coupon (about 1/8" thick).

Summary: From the above testing, it looks like the customer has two possible options:
Figure 2: Solvency Rates
*Note: Nature-Sol 100 and Solvent 87RB results were divided by ten so that all chemicals could be viewed on the same graph.
1) If just a single cleaning stage is desired, the 278 Supersolv and the Neugenic 4176 has a greater solvency and are faster acting than the AG Environmental Soy Gold 1000, so they can be safely used. The Supersolv 278 has a flashpoint of 225 F while the Neugenic 4176 has a flashpoint of 235 F.
2) If just the spray washer may not be effective, an ambient presoak with a more aggressive chemical would definitely increase the cleaning efficiency. Both the Brulin Nature-Sol 100 and the U.S. Polychem Solvent 87RB would make excellent soak cleaners. These solutions could not be heated up that much due to their flashpoints (Nature-Sol 100 = 140 F and Solvent 87RB = 100 F). U.S. Polychem also has a chemical similar to the Solvent 87RB that has a flash point around 140 F.
Both Brulin and U.S. Polychem supplied a spray wash chemical to be used in conjunction with their pre-soak solvents. Brulin's Chemistry was the 1990 GD, which was not that effective in the spray stage. U.S. Polychem's Hydropurge 007 spray cleaner definitely is more effective than the 1990 GD but will not outperform Soy Gold 1000, Neugenic 4176 or 278 Super Solv on a one-on-one basis. But the two chemical packages supplied by U.S. Polychem was the most effective tested out in the lab.

Table 3: Contact Names and Numbers
Company Name-Contact Name--Phone Number
AG Environmental-Tony Tompson--1-800-599-9209
AW Chesterton-Sandra Pomer--1-508-469-6698
Rochester Midland-Jim Hayden--1-508-520-1070
US Polychem-Mark Paull---800-431-2072
Brulin Corp.-Joe Titus--1-800-776-7149 x4990 Mailbox #1022

Summary:

Substrates:	Aluminum, Copper				
Contaminants:	Tar, Asphalt				
Company Name:	**Product Name:**	**Conc.:**	**Efficiency:**	**Effective:**	**Observations:**
CSA Inc	Bio Safe 1025	100	0.00	☐	
Calgon Corporation	Geo Guard 5210	100	0.00	☑	
	Ecobrite Cleaner AK	100	0.00	☐	

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Eastern Color and Chemical Company					
Inland Technologies Inc	Citrasafe	100	0.00	☐	
Finger Lakes Chemical	FLSC-12 Resineater Sample	100	0.00	☐	
Finger Lakes Chemical	1-1-02	100	0.00	☐	
EcoLink	Safe Strip	100	0.00	☐	
Loctite Corporation	7360	100	0.00	☐	
Tarksol Inc	Tarksol HTF 85 B	100	0.00	☐	
AG Environmental Products	Soy Gold 1000	100	0.00	☐	
AG Environmental Products	Soy Gold 2000	100	0.00	☐	
Tarksol Inc	Asphalt Release	100	0.00	☐	

Conclusion:

Based on the performance of the above tested chemistries, it looks like the two that are most likely to be effective for Recycling Company would be either the Soy Gold 2000 or the Calgon Geo-Guard 5210.
Although the Soy Gold 1000 had better solvency than any other chemical tested, it is not water soluble, so two rinses would be needed. The first would contain a slight amount of detergent, the second would be water. This would involve unnecessarily creating twice as much wastewater.
The Soy Gold 2000 has the advantage of having a high solvency at low temperatures. One potential problem I see coming from the Soy Gold 2000 is that it has a high viscosity (4.5 centipoise at 25 F). The high viscosity will definitely result in a loss of outlet pressure from the spray nozzle heads (to reduce this, you might want to run at a higher temperature).
The Calgon Geo-Guard 5210 had good solvency, but only when heated at high temperatures (you would probably want to go to at least 150 F). The Geo-Guard 5210 also has a lower flashpoint (210 F) which may be a problem at the elevated temperatures.
Although both of these chemicals are water emulsifiable, I would not recommend dilution. Usually when a solvent is emulsified, its solubility decreases exponentially.