

CLEANING LABORATORY EVALUATION SUMMARY

SCL #: 1996
 DateRun: 02/20/1996
 Experimenters: Jay Jankauskas, Sutherland Ramesh
 ClientType: Coatings Manufacturer
 ProjectNumber: Project #1
 Substrates: Stainless Steel
 PartType: Coupon
 Contaminants: Adhesive, Coatings
 Cleaning Methods: Immersion/Soak
 Analytical Methods: Gravimetric
 Purpose: To test the soil loading characteristics

Experimental Procedure: The purpose of this trial is to test the soil loading characteristics of the EP-921 and HTF 85B as compared to NMP. By observing how efficient the chemicals are at various levels of dissolved urethanes, the best performing terpene can be picked out. Three 400ml beakers were filled with 350 ml of each chemical. The initial plan of this experiment is to clean 5 coupons in each chemistry at each percentage of soil loading. The soil loading will be done as a weight percentage of basecoat #51144 to the total weight of contaminated cleaning solution. Soil loadings will be increased in increments of 10% from 0% to 30%. So a total of 30 coupons will be cleaned for each chemical. Cleaning will be performed at 160F for 30 minutes with stir-bar agitation. Rinsing will start with a one minute tap water rinse at 130F followed by a brief acetone rinse (so the gravimetric results do not pick up residual cleaner). The coupons will then be dried under a UV light for 10 minutes and then allowed to cool down overnight. Since it was determined that the Basecoat #51144 was tougher to remove, we just experimented with this to expedite the soil loading tests. All coupons were contaminated in an identical fashion to the phase 1 testing. To determine the amount of Basecoat #51144 needed to achieve a particular percentage, the specific gravity of the cleaning solutions was obtained from the MSDS sheets (NMP=1.025, EP-921=.9800, HTF85B=.9932). The below chart shows the grams of basecoat #51144 that needs to be added to each chemistry to achieve a specified loading

| Product | 10% | 20% | 30% |
|---------|-------|-------|--------|
| NMP | 40.00 | 89.69 | 153.75 |
| EP-921 | 38.11 | 85.75 | 147.00 |
| HTF85B | 38.86 | 86.91 | 148.98 |

The amount of urethane removed during cleaning was taken into consideration when increasing the soil loading. All urethane added to increase soil loading was uncured to reduce the time taken to dissolve. A note of some of the assumptions made with respect to chemical volume. It was assumed that there were no evaporative and drag-out losses. So for all soil loading calculations made, a solvent volume of 350 ml was used.

SUBSTRATE MATERIAL: 304 Stainless Steel Coupons
 CONTAMINANTS: Durane Base Coatings #51144
 CONTAMINATING PROCESS USED: Rubbed on with swab and allowed to cure overnight

Results: GRAVIMETRIC RESULTS

NMP- No soil loading.

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 1 | 60.4200 | 61.2718 | 60.4887 | 0.7831 | 91.93% |
| 2 | 59.7665 | 60.4789 | 59.8633 | 0.6156 | 86.41% |
| 3 | 60.4839 | 61.3083 | 60.6515 | 0.6568 | 79.67% |
| 4 | 59.9056 | 60.6630 | 59.9399 | 0.7231 | 95.47% |
| 5 | 60.0143 | 60.9037 | 60.1513 | 0.7524 | 84.60% |
| | | | | 3.531 | 87.62% |
| | | | | | 6.21% |

Inland Tech-EP-921 no soil loading

CLEANING LABORATORY EVALUATION SUMMARY

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 1 | 60.6562 | 61.3097 | 60.6566 | 0.6531 | 99.94% |
| 2 | 60.7081 | 61.3835 | 60.7082 | 0.6753 | 99.99% |
| 3 | 60.3344 | 61.3955 | 60.3350 | 1.0605 | 99.94% |
| 4 | 60.7016 | 61.6404 | 60.7170 | 0.9234 | 98.36% |
| 5 | 60.3590 | 61.2314 | 60.3592 | 0.8722 | 99.98% |
| | | | | 4.1845 | 99.64% |
| | | | | | 0.72% |

Terpene Tech HTF85B-No soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 1 | 59.9047 | 60.8014 | 59.9049 | 0.8965 | 99.98% |
| 2 | 60.2195 | 60.8220 | 60.2197 | 0.6023 | 99.97% |
| 3 | 60.4770 | 61.1145 | 60.4773 | 0.6372 | 99.95% |
| 4 | 60.2211 | 60.8589 | 60.2211 | 0.6378 | 100.00% |
| 5 | 60.0083 | 60.7290 | 60.0090 | 0.7200 | 99.90% |
| | | | | 3.4938 | 99.96% |
| | | | | | 0.04% |

NMP-10% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 6 | 60.4197 | 61.2909 | 60.5188 | 0.7721 | 88.62% |
| 7 | 59.7668 | 60.5674 | 59.8698 | 0.6976 | 87.13% |
| 8 | 60.4838 | 61.4613 | 60.6831 | 0.7782 | 79.61% |
| 9 | 59.9053 | 60.9938 | 60.0204 | 0.9734 | 89.43% |
| 10 | 60.1101 | 60.9607 | 60.3303 | 0.6304 | 74.11% |
| | | | | 3.8517 | 83.78% |
| | | | | | 6.66% |

Inland Tech EP-921-10% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 6 | 60.6562 | 61.3019 | 60.6708 | 0.6311 | 97.74% |
| 7 | 60.0137 | 60.6603 | 60.0164 | 0.6439 | 99.58% |
| 8 | 60.7082 | 61.6846 | 60.7346 | 0.9500 | 97.30% |
| 9 | 60.2780 | 61.0849 | 60.2823 | 0.8026 | 99.47% |
| 10 | 60.3344 | 61.4548 | 60.4056 | 1.0492 | 93.65% |
| | | | | 4.0768 | 97.55% |
| | | | | | 2.41% |

Terpene Tech HTF85B-10% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 6 | 60.539 | 61.4090 | 60.5428 | 0.8662 | 99.56% |
| 7 | 60.7019 | 61.8941 | 60.7044 | 1.1897 | 99.79% |
| 8 | 60.5755 | 61.2914 | 60.5788 | 0.7126 | 99.54% |
| 9 | 60.3591 | 61.2216 | 60.3643 | 0.8573 | 99.40% |
| 10 | 59.3007 | 60.1078 | 59.3208 | 0.787 | 97.51% |
| | | | | 4.4128 | 99.16% |
| | | | | | 0.93% |

CLEANING LABORATORY EVALUATION SUMMARY

NMP-20% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 11 | 60.6562 | 61.4064 | 60.6783 | 0.7281 | 97.05% |
| 12 | 60.0137 | 60.7303 | 60.0804 | 0.6499 | 90.69% |
| 13 | 60.7082 | 61.2288 | 60.7426 | 0.4862 | 93.39% |
| 14 | 60.2780 | 60.9753 | 60.4015 | 0.5738 | 82.29% |
| 15 | 60.3344 | 61.1885 | 60.4885 | 0.7000 | 81.96% |
| | | | | 3.138 | 89.08% |
| | | | | | 6.74% |

Inland Tech EP-921-20% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 11 | 60.1058 | 60.6858 | 60.1275 | 0.5583 | 96.26% |
| 12 | 60.2287 | 61.0412 | 60.2767 | 0.7645 | 94.09% |
| 13 | 60.5201 | 61.2172 | 60.5646 | 0.6526 | 93.62% |
| 14 | 60.2423 | 60.9690 | 60.3341 | 0.6349 | 87.37% |
| 15 | 59.9511 | 60.6721 | 60.0110 | 0.6611 | 91.69% |
| | | | | 3.2714 | 92.61% |
| | | | | | 3.35% |

Terpene Tech HTF85B-20% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 11 | 59.9047 | 60.7873 | 59.9083 | 0.8790 | 99.59% |
| 12 | 60.2195 | 60.9210 | 60.2228 | 0.6982 | 99.53% |
| 13 | 60.4770 | 61.0192 | 60.4990 | 0.5202 | 95.94% |
| 14 | 60.2211 | 61.0052 | 60.2619 | 0.7433 | 94.80% |
| 15 | 60.0083 | 60.7387 | 60.0424 | 0.6963 | 95.33% |
| | | | | 3.5370 | 97.04% |
| | | | | | 2.34% |

NMP-30% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 16 | 60.5386 | 61.7741 | 60.7543 | 1.0198 | 82.54% |
| 17 | 60.7016 | 61.9505 | 61.2649 | 0.6856 | 54.90% |
| 18 | 60.5752 | 61.7028 | 60.9753 | 0.7275 | 64.52% |
| 19 | 60.3590 | 61.2255 | 60.7621 | 0.4634 | 53.48% |
| 20 | 59.9047 | 60.9930 | 60.4955 | 0.4975 | 45.71% |
| | | | | 3.3938 | 60.23% |
| | | | | | 14.15% |

Inland Tech EP-921-30% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 16 | 60.6562 | 61.6654 | 60.8742 | 0.7912 | 78.40% |
| 17 | 60.0137 | 61.1050 | 60.2685 | 0.8365 | 76.65% |
| 18 | 60.7082 | 61.8099 | 60.9082 | 0.9017 | 81.85% |
| 19 | 60.2780 | 61.4399 | 60.5666 | 0.8733 | 75.16% |
| 20 | 60.3344 | 61.2438 | 60.5804 | 0.6634 | 72.95% |
| | | | | 4.0661 | 77.00% |

CLEANING LABORATORY EVALUATION SUMMARY

| | | | | | |
|--|--|--|--|--|-------|
| | | | | | 3.37% |
|--|--|--|--|--|-------|

Terpene Tech HTF85B-30% soil loading

| sample # | clean mass (g) | mass with contamination (g) | mass after cleaning (g) | contaminant removed (g) | Percent Removal |
|----------|----------------|-----------------------------|-------------------------|-------------------------|-----------------|
| 16 | 60.4197 | 61.4393 | 60.5603 | 0.8790 | 86.21% |
| 17 | 59.7668 | 60.6630 | 59.9172 | 0.7458 | 83.22% |
| 18 | 60.4839 | 61.5339 | 60.5702 | 0.9637 | 91.78% |
| 19 | 60.1101 | 61.3927 | 60.4882 | 0.9045 | 70.52% |
| 20 | | | | | |
| | | | | 3.493 | 82.93% |
| | | | | | 9.00% |

Summary:

| | | | | | | |
|-------------------------|--|----------------------|---------------|--------------------|-------------------------------------|----------------------|
| Substrates: | | Stainless Steel | | | | |
| Contaminants: | | Adhesive, Coatings | | | | |
| Company Name: | | Product Name: | Conc.: | Efficiency: | Effective: | Observations: |
| ISP Technologies | | N Methyl Pyrrolidone | 100 | 87.62 | <input checked="" type="checkbox"/> | |
| Inland Technologies Inc | | EP 921 | 100 | 99.64 | <input type="checkbox"/> | |
| Tarksol Inc | | Tarksol HTF 85 B | 100 | 99.96 | <input checked="" type="checkbox"/> | |

Conclusion:

All data obtained shows that the HTF85B is the best solvent tested for Coatings Manufacturer and should be tested on a pilot scale level. Phase III testing will focus on determining the most effective aqueous cleaner (U.S. Polychem & General chemical products).