

CLEANING LABORATORY EVALUATION SUMMARY

SCL #: 2022
 DateRun: 06/10/2022
 Experimenters: Zoe Lawson, Tatyanna Moreland Junior
 ClientType: Adhesive Manufacturer
 ProjectNumber: Project #3
 Substrates: Stainless Steel
 PartType: Coupon
 Contaminants: Adhesive
 Cleaning Methods: Manual Wipe
 Analytical Methods: Gravimetric, Visual, Wipe

Purpose: To test the effectiveness of the removal of adhesives using HSPiP chemistries.

Experimental Procedure: Pre-weighed stainless steel coupons, six for each chemical (three being tested with unheated and three being tested with heated), were soiled with the Phenolics adhesive soil. Approximately 0.25 g of the soil was applied using a hand held swab. Each set of coupons were manually wiped with a cloth of the same material, one set dipped into unheated and another set dipped into the heated chemical. During this process, any noticeable soil removal was observed and recorded. Coupons were allowed were wiped with a paper towel to ensure no residue of the cleaner, and afterwards final weights were recorded. The efficiency of removal was calculated for each coupon cleaned.

Results: Heated Treatment Results

| Cleaner | Treatment | Initial wt of cont. | Final wt of cont. | %Cont Removed | Average % Removal |
|-----------------------------------|-----------------|---------------------|-------------------|---------------|-------------------|
| Sec-butyl acetate | Heated (60-70F) | 0.5784 | 0.0656 | 88.66 | 88.76 |
| | | 0.5171 | 0.0764 | 85.23 | |
| | | 0.6567 | 0.0500 | 92.39 | |
| 2-propanol | | 0.4138 | 0.4029 | 2.63 | 2.09 |
| | | 0.3467 | 0.3435 | 0.92 | |
| | | 0.3373 | 0.3282 | 2.70 | |
| di-isobutyl ketone | | 0.5938 | 0.0907 | 84.73 | 77.76 |
| | | 0.5272 | 0.1751 | 66.79 | |
| | | 0.4301 | 0.0784 | 81.77 | |
| 2-phenoxy ethanol | | 0.3791 | 0.3688 | 2.72 | 4.00 |
| | | 0.4380 | 0.4006 | 8.54 | |
| | | 0.2870 | 0.2849 | 0.73 | |
| t-butyl acetate | | 0.2700 | 0.1159 | 57.07 | 46.05 |
| | | 0.2710 | 0.1391 | 48.67 | |
| | | 0.2973 | 0.2010 | 32.39 | |
| d-limonene | | 0.3751 | 0.0497 | 86.75 | 85.36 |
| | | 0.3391 | 0.0504 | 85.14 | |
| | | 0.4025 | 0.0636 | 84.20 | |
| ektapro EEP | | 0.4124 | 0.0347 | 91.59 | 94.15 |
| | | 0.2423 | 0.0072 | 97.03 | |
| | | 0.2510 | 0.0155 | 93.82 | |
| n-amyl acetate | | 0.3232 | 0.1351 | 58.20 | 51.73 |
| | | 0.3006 | 0.1332 | 55.69 | |
| | | 0.3046 | 0.1788 | 41.30 | |
| dimethyl glutarate | | 0.3134 | 0.3016 | 3.77 | 42.47 |
| | | 0.2018 | 0.1348 | 33.20 | |
| | | 0.9639 | 0.0921 | 90.45 | |
| diethylene glycol monobutyl ether | | 0.1727 | 0.1716 | 0.64 | 35.88 |
| | | 0.5009 | 0.2581 | 48.47 | |
| | | 0.4221 | 0.1751 | 58.52 | |
| n-butyl acetate | | 0.3183 | 0.1138 | 64.25 | 58.14 |

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|------------|--|--------|--------|-------|-------|
| | | 0.3310 | 0.1281 | 61.30 | |
| | | 0.3508 | 0.1793 | 48.89 | |
| 1-propanol | | 0.3743 | 0.3708 | 0.94 | 1.04 |
| | | 0.2696 | 0.2667 | 1.08 | |
| | | 0.3435 | 0.3397 | 1.11 | |
| FAME | | 0.3678 | 0.3043 | 17.26 | 17.37 |
| | | 0.4766 | 0.4438 | 6.88 | |
| | | 0.3515 | 0.2532 | 27.97 | |

Unheated Treatment Results

| Cleaner | Treatment | Initial wt of cont. | Final wt of cont. | %Cont Removed | Average % Removal |
|-----------------------------------|-----------|---------------------|-------------------|---------------|-------------------|
| Sec-butyl acetate | Unheated | 0.7258 | 0.0589 | 91.88 | 88.93 |
| | | 0.5425 | 0.0725 | 86.64 | |
| | | 0.4250 | 0.0499 | 88.26 | |
| 2-propanol | | 0.2266 | 0.2235 | 1.37 | 2.14 |
| | | 0.2082 | 0.1985 | 4.66 | |
| | | 0.2999 | 0.2987 | 0.40 | |
| di-isobutyl ketone | | 0.2930 | 0.0867 | 70.41 | 76.09 |
| | | 0.3587 | 0.1134 | 68.39 | |
| | | 0.2443 | 0.0257 | 89.48 | |
| 2-phenoxy ethanol | | 0.6850 | 0.6632 | 3.18 | 3.16 |
| | | 0.7704 | 0.7253 | 5.85 | |
| | | 0.4024 | 0.4006 | 0.45 | |
| t-butyl acetate | | 0.1787 | 0.0450 | 74.82 | 68.51 |
| | | 0.1700 | 0.0821 | 51.71 | |
| | | 0.1353 | 0.0284 | 79.01 | |
| d-limonene | | 0.5954 | 0.0733 | 87.69 | 77.47 |
| | | 0.3109 | 0.0660 | 78.77 | |
| | | 0.3004 | 0.1023 | 65.95 | |
| ektapro EEP | | 0.1711 | 0.0054 | 96.84 | 95.67 |
| | | 0.2421 | 0.0182 | 92.48 | |
| | | 0.2627 | 0.0061 | 97.68 | |
| n-amyl acetate | | 0.2469 | 0.0892 | 63.87 | 69.86 |
| | | 0.1964 | 0.0338 | 82.79 | |
| | | 0.2402 | 0.0891 | 62.91 | |
| dimethyl glutarate | | 0.4656 | 0.4376 | 6.01 | 5.88 |
| | | 0.4333 | 0.4066 | 6.16 | |
| | | 0.3385 | 0.3200 | 5.47 | |
| diethylene glycol monobutyl ether | | 0.2791 | 0.2695 | 3.44 | 4.45 |
| | | 0.3072 | 0.2950 | 3.97 | |
| | | 0.3798 | 0.3573 | 5.92 | |
| n-butyl acetate | | 0.2175 | 0.0765 | 64.83 | 53.39 |
| | | 0.1949 | 0.0560 | 71.27 | |
| | | 0.6194 | 0.4702 | 24.09 | |
| 1-propanol | | 0.3754 | 0.3694 | 1.60 | 1.08 |
| | | 0.3848 | 0.3798 | 1.30 | |
| | | 0.2827 | 0.2817 | 0.35 | |
| FAME | | 0.4618 | 0.3827 | 17.13 | 16.91 |
| | | 0.3756 | 0.3553 | 5.40 | |
| | | 0.3010 | 0.2161 | 28.21 | |

Overall Average % Removals

| Cleaner | Average % Removal - Unheated | Average % Removal - Heated | Overall Average % Removal for Cleaner |
|-------------------|------------------------------|----------------------------|---------------------------------------|
| Sec-butyl acetate | 88.93 | 88.76 | 88.84 |

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| | | | |
|-----------------------------------|-------|-------|-------|
| 2-propanol | 2.14 | 2.09 | 2.11 |
| di-isobutyl ketone | 76.09 | 77.76 | 76.93 |
| 2-phenoxy ethanol | 3.16 | 4.00 | 3.58 |
| t-butyl acetate | 68.51 | 46.05 | 57.28 |
| d-limonene | 77.47 | 85.36 | 81.42 |
| ektapro EEP | 95.67 | 94.15 | 94.91 |
| n-amyl acetate | 69.86 | 51.73 | 60.79 |
| dimethyl glutarate | 5.88 | 42.47 | 24.18 |
| diethylene glycol monobutyl ether | 4.45 | 35.88 | 20.16 |
| n-butyl acetate | 53.39 | 58.14 | 55.77 |
| 1-propanol | 1.08 | 1.04 | 1.06 |
| FAME | 16.91 | 17.37 | 17.14 |

Looking between the average % removal for unheated vs. heated there appears to be little difference in the effectiveness of the cleaner. The two exceptions to this are dimethyl glutarate (36.59% improvement) and diethylene glycol monobutyl ether (31.45% improvement) as they both were far more effective at removing the adhesive when heated. Overall the majority of the chemicals tested were found to be ineffective. The most promising cleaners to proceed with for testing include sec-butyl acetate (88.84%), d-limonene (81.42%), and ektapro EEP (94.91%). Di-isobutyl ketone (76.93%) may also be worth testing in the next trials.

Summary:

Conclusion:

Further testing is needed to determine the efficiency of the chemicals on other types of adhesives. So far, the most promising cleaners to proceed with for testing include sec-butyl acetate (88.84% overall average removal), d-limonene (81.42% overall average removal), and ektapro EEP (94.91% overall average removal). Di-isobutyl ketone (76.93% overall average removal) may also be worth testing in the future.