

CLEANING LABORATORY EVALUATION SUMMARY

SCL #: 2021
DateRun: 01/22/2021
Experimenters: Justin Kiander
ClientType: Metal Working
ProjectNumber: Project #1
Substrates: Stainless Steel
PartType: Part
Contaminants: Lubricating/Lapping Oils
Cleaning Methods: Immersion/Soak
Analytical Methods: Gravimetric, Visual

Purpose: This is a final report summarizing all of TURI testing.

Experimental Procedure: Unheated immersion, heated immersion at 100°F, heated immersion at 120°F, and heated immersion at 120°F with agitation were all conducted throughout trial testing. The following are the ideal cleaners and their suggested method: Metalnox 6386 100% concentration unheated immersion for 15 minutes. Dimethyl Glutarate 100% concentration heated immersion with a stir bar for agitation at 120°F for 30 minutes. SC Aircraft & Metal 20% concentration heated immersion with a stir bar for agitation at 120°F for 30 minutes followed by a 30 second deionized water rinse at 120°F. All parts are dried with a heat gun.

Results: The following is a summary of all TURI testing results:

Trial 0 Unheated Immersion 15 min

| Cleaner | Initial wt of Cont | Final wt of Cont | %Cont Removed | %AVG |
|-----------------------|--------------------|------------------|---------------|---------|
| Metalnox 6386 | 0.0375 | 0.0016 | 95.73 | 96.56% |
| | 0.0390 | 0.0009 | 97.69 | |
| | 0.0775 | 0.0029 | 96.26 | |
| Dimethyl Glutarate | 0.0432 | 0.0664 | -53.70 | 15.53% |
| | 0.1002 | 0.0511 | 49.00 | |
| | 0.0854 | 0.0416 | 51.29 | |
| Smart Solve 605 | 0.1169 | 0.1168 | 0.09 | -10.50% |
| | 0.0918 | 0.1088 | -18.52 | |
| | 0.1239 | 0.1401 | -13.08 | |
| SC Aircraft and Metal | 0.1096 | 0.0435 | 60.31 | 68.25% |
| | 0.1480 | 0.0338 | 77.16 | |
| | 0.1076 | 0.0352 | 67.29 | |
| SC Supersolve | 0.1115 | 0.0502 | 54.98 | 60.96% |
| | 0.0633 | 0.0356 | 43.76 | |
| | 0.1382 | 0.0219 | 84.15 | |
| Crystal Simple Green | 0.1266 | 0.0349 | 72.43 | 71.30% |
| | 0.1875 | 0.0430 | 77.07 | |
| | 0.1475 | 0.0525 | 64.41 | |

Trial 1 Heated Immersion at 100°F 15 min

| Cleaner | Initial wt of cont | Final wt of cont | %Cont Removed | %AVG |
|---------------------|--------------------|------------------|---------------|--------|
| Dimethyl glutarate | 0.0192 | 0.0064 | 66.67 | 68.02% |
| | 0.0438 | 0.0118 | 73.06 | |
| | 0.0387 | 0.0138 | 64.34 | |
| Smart Solve 605 | 0.0250 | 0.0076 | 69.60 | 74.31% |
| | 0.0344 | 0.0086 | 75.00 | |
| | 0.0226 | 0.0049 | 78.32 | |
| SC Aircraft & Metal | 0.0301 | 0.0048 | 84.05 | 79.55% |
| | 0.0272 | 0.0045 | 83.46 | |
| | 0.0239 | 0.0069 | 71.13 | |

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|----------------------------|--------|--------|-------|--------|
| SC Supersolve | 0.0692 | 0.0177 | 74.42 | 74.35% |
| | 0.0579 | 0.0202 | 65.11 | |
| | 0.1123 | 0.0185 | 83.53 | |
| Crystal Simple Green | 0.0926 | 0.0026 | 97.19 | 82.87% |
| | 0.0731 | 0.0081 | 88.92 | |
| | 0.0408 | 0.0153 | 62.50 | |

Trial 2 Heated Immersion at 120°F 15 min

| Cleaner | Initial wt of cont | Final wt of cont | %Cont Removed | %AVG |
|----------------------------|--------------------------|---------------------|------------------|--------|
| Dimethyl Glutarate | 0.0325 | 0.0064 | 80.31 | 84.51% |
| | 0.0224 | 0.0032 | 85.71 | |
| | 0.0168 | 0.0021 | 87.50 | |
| Smart Solve 605 | 0.0162 | 0.0007 | 95.68 | 93.98% |
| | 0.0132 | 0.0011 | 91.67 | |
| | 0.0166 | 0.0009 | 94.58 | |
| SC Aircraft & Metal | 0.0282 | 0.0060 | 78.72 | 71.32% |
| | 0.0224 | 0.0054 | 75.89 | |
| | 0.0214 | 0.0087 | 59.35 | |
| SC Supersolve | 0.0473 | 0.0097 | 79.49 | 64.71% |
| | 0.0214 | 0.0104 | 51.40 | |
| | 0.0155 | 0.0057 | 63.23 | |
| Crystal Simple Green | 0.0135 | -0.0021 | 115.56 | 95.21% |
| | 0.0192 | 0.0045 | 76.56 | |
| | 0.0154 | 0.0010 | 93.51 | |

Trial 3 Unheated Immersion 30 min

| Cleaner | Initial wt of cont | Final wt of cont | %Cont Removed | %AVG |
|----------------------------|--------------------------|---------------------|------------------|--------|
| Metalnox 6386 | 0.0273 | -0.0011 | 104.03 | 104.7% |
| | 0.0211 | -0.0012 | 105.69 | |
| | 0.0205 | -0.0009 | 104.39 | |
| Dimethyl glutarate | 0.0228 | 0.0088 | 61.40 | 57.80% |
| | 0.0199 | 0.0081 | 59.29 | |
| | 0.0148 | 0.0070 | 52.70 | |
| Smart Solve 605 | 0.0165 | 0.0014 | 91.52 | 91.24% |
| | 0.0159 | 0.0001 | 99.37 | |
| | 0.0134 | 0.0023 | 82.83 | |
| SC Aircraft & Metal | 0.0147 | 0.0075 | 48.98 | 39.31% |
| | 0.0128 | 0.0052 | 59.38 | |
| | 0.0094 | 0.0085 | 9.57 | |
| SC Supersolve | 0.0121 | 0.0047 | 61.16 | 72.90% |
| | 0.0127 | 0.0031 | 75.59 | |
| | 0.0133 | 0.0024 | 81.95 | |
| Crystal Simple Green | 0.0115 | 0.0088 | 23.48 | 6.80% |
| | 0.0086 | 0.0121 | -40.70 | |
| | 0.0109 | 0.0068 | 37.61 | |

Trial 4 Heated Immersion 100°F 30 min

| Cleaner | Initial wt of cont | Final wt of cont | %Cont Removed | %AVG |
|------------------------|--------------------------|---------------------|------------------|--------|
| Dimethyl glutarate | 0.0314 | 0.0062 | 80.25 | 80.80% |
| | 0.0231 | 0.0051 | 77.92 | |
| | 0.0203 | 0.0032 | 84.24 | |
| SC Aircraft & Metal | 0.0205 | 0.0048 | 76.58 | 88.43% |
| | 0.0200 | 0.0052 | 74.00 | |
| | 0.0163 | -0.0024 | 114.72 | |
| SC Supersolve | 0.0153 | 0.0080 | 47.71 | 72.59% |

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|----------------------|--------|---------|--------|--------|
| | 0.0173 | 0.0070 | 59.54 | |
| | 0.0152 | -0.0016 | 110.53 | |
| Crystal Simple Green | 0.0140 | 0.0072 | 48.57 | 34.91% |
| | 0.0138 | 0.0135 | 2.17 | |
| | 0.0150 | 0.0069 | 54.00 | |

Trial 5 Heated Immersion 120°F 30 min

| Cleaner | Initial wt of Cont | Final wt of Cont | %Cont Removed | %AVG |
|----------------------|--------------------|------------------|---------------|--------|
| Dimethyl glutarate | 0.0220 | 0.0034 | 84.54 | 86.89% |
| | 0.0290 | 0.0033 | 88.62 | |
| | 0.0240 | 0.0030 | 87.50 | |
| SC Aircraft & Metal | 0.0215 | 0.0056 | 73.95 | 84.62% |
| | 0.0184 | 0.0036 | 80.43 | |
| | 0.0196 | 0.0001 | 99.49 | |
| SC Supersolve | 0.0160 | 0.0068 | 57.50 | 59.36% |
| | 0.0147 | 0.0057 | 61.22 | |
| | 0.0028 | -0.0237 | 946.43 | |
| Crystal Simple Green | 0.0062 | -0.0027 | 143.55 | 83.31% |
| | 0.0123 | 0.0031 | 74.80 | |
| | 0.0159 | 0.0013 | 91.82 | |

Bold numbers excluded from average calculations; too little soil was applied to these coupons, and do not represent cleaner performance. Soil was most likely removed quickly then the substrate was damaged due to overexposure to solvent.

Trial 6 Heated Immersion 120°F 30 min with stir bar for agitation

| Cleaners | Initial wt of cont | Final wt of cont | %Cont Removed | %AVG |
|---------------------|--------------------|------------------|---------------|---------|
| Dimethyl glutarate | 0.0214 | -0.0004 | 101.87 | 101.27% |
| | 0.0200 | -0.0003 | 101.50 | |
| | 0.0224 | -0.0001 | 100.45 | |
| SC Aircraft & Metal | 0.0169 | 0.0005 | 97.04 | 85.02% |
| | 0.0171 | 0.0009 | 94.74 | |
| | 0.0177 | 0.0065 | 63.28 | |
| SC Supersolve | 0.0176 | 0.0048 | 72.73 | 83.36% |
| | 0.0141 | 0.0029 | 79.43 | |
| | 0.0144 | 0.0003 | 97.92 | |

Trial 7 Parts Testing

| Cleaner | Observations |
|---------------------|--|
| Metalnox 6386 | Post Clean & Dry: Appears to be effective, no oil residue visible |
| Smart Solve 605 | May not have had enough solution for accurate testing. Post Clean: Appeared to be a residue which disappeared with drying. |
| Dimethyl Glutarate | Post Clean & Dry: Appears to be effective, no oil residue visible |
| SC Aircraft & Metal | During the cleaning process: oil droplets forming and falling into solution. Solution became foggy, indicating removal of soil occurring. Post Clean: Appeared to be a residue that disappeared with drying. |

Smart Solve 605 was removed from the recommendation list due to difficulties trying to contact the vendor for several months

Summary:

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|----------------------|--------------------------|
| Substrates: | Stainless Steel |
| Contaminants: | Lubricating/Lapping Oils |

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| Company Name: | Product Name: | Conc.: | Efficiency: | Effective: | Observations: |
|-------------------|---|--------|-------------|-------------------------------------|---|
| Kyzen Corporation | Metalnox M6386 | 100% | | <input checked="" type="checkbox"/> | 15 minutes of unheated immersion, dried with a heat gun |
| Fisher Scientific | Dimethyl glutarate (CAS: 1119-40-0) | 100% | | <input checked="" type="checkbox"/> | Heated Immersion for 30 minutes at 120°F with a stir bar for agitation, dried with a heat gun |
| Gemtek Products | SC Aircraft & Metal Cleaner Super Concentrate | 20% | | <input checked="" type="checkbox"/> | Heated Immersion at 120°F for 30 minutes with a stir bar for agitation, rinsed in a deionized water bath at 120°F for 30 seconds, dried with a heat gun |

Conclusion:

Unheated immersion for 15 minutes with Metalnox 6386 at 100% concentration, Heated Immersion at 120°F with a stir bar for agitation for 30 minutes with Dimethyl Glutarate at 100% concentration, or Heated Immersion at 120°F with a stir bar for agitation for 30 minutes with SC Aircraft & Metal at 20% concentration, followed by a 30 second deionized water rinse at 120°F, are all effective potential alternative cleaning methods.