Automotive

# CASE STUDY - Methyl Ethyl Ketone (MEK) Replacement with AEROGREEN® 4110 for GE TRANSPORTATION

**Project Profile:**
GE Transportation is a global technology leader and supplier to the railroad, marine, drilling, wind and mining industries. GE provides freight and passenger locomotives, railway signalling and communications systems, information technology solutions, marine engines, motorized drive systems for mining trucks and drills, high quality replacement parts and value added services. GE Transportation will produce 43 high value locomotive kits in its facilities in Erie and Grove City, Penn for Transnet Rail Engineering (TRE) who will assemble the locomotives in South Africa. These locomotives will save approximately 600,000 liters of fuel each year and significantly reduce emissions. Orders totalling 143 new locomotives will contribute to job creation in the U.S and provide infrastructure growth in South Africa.

**Problem**

Methyl Ethyl Ketone (MEK) is currently being used in plant manufacturing operations. MEK is a highly flammable chemical that also poses significant risk of short-term and/or long-term exposure health problems via inhalation. Several alternative cleaning agents were tested to find a suitable substitute for MEK, which cleans as well or better, but is not as hazardous.

**Solution**

AEROGREEN® 4110 cleaner has performed as well as or better than MEK in a series of cleaning tests measured by the coefficient of friction, additionally; AEROGREEN® 4110 is a non-hazardous cleaner that is readily biodegradable and non-flammable. AEROGREEN® 4110 cleaner is a proposed alternative to MEK, based on testing

**Testing Procedure**
1. Type S ground finish steel Q-panels (20 – 50 microinch finish) were contaminated with commons soils found on the surfaces that need to be cleaned with MEK. Two different sizes of Q-panels were used to determine coefficient of friction on the prepped surfaces. A large 4" x 12" panel was paired with a 3"x 6" panel for testing. All of the 3" x 6" were bent 1" from the end before being contaminated. Fifty of each type of panel were contaminated with the following soils:

- Dykem Hi-Spot Blue 107
- Ferrocote 5815 LVO rust preventative
- Used gear oil

The panels contaminated with the rust preventative and the gear oil were hung vertically overnight. This ensured a constant film thickness with these heavy contaminants. The bluing compound was applied with Kleenex lint free towels and wiped down until only a thin bluish tint could be seen on the metal. The ground finish sides of the plates were used for testing since that side resembles the finish of the parts more closely. The panel had a 20 – 50 microinch finish, and the typical parts used have a finish between 15 – 32 microinches. This was the closest approximation with standardized test panels.

2. Next, the panels were cleaned with MEK, CRC Brakleen Non-Chlorinated Cleaner, LPS No Flash Electro Contact Cleaner,
70% VM&P Naphtha/ 20% Mineral Spirits/ 10% SP3ABB Solvent, SP3ABB Solvent, DK Solvent, AEROGREEN® 4110 Cleaner, Simple Green Cleaner, Magnaflux Spotcheck and Leksol. All of the panels were cleaned in the same manner using Kleenex towels with the cleaners applied to the surface.

3. Nalco PST solution was then applied to each cleaned surface. The PST was applied by wetting a Kleenex towel with the solution and then wiping it onto the metal substrate.

4. The plates were then set-up on the Instron machine, with the frictionized surfaces pressed together and the smaller panel on top of the larger. A 533.8g weight was placed on the back of the small panel and then was pulled 6" per minute by the machine. As soon as the panel moved, the machine was stopped and the force recorded.

5. All of the small panels were then weighed and all analysis of the data was done using Excel and Minitab. An average coefficient of friction for each of the sets of five samples was calculated and then a 2-sample t-test comparison of means was used to determine statistical difference or similarity.

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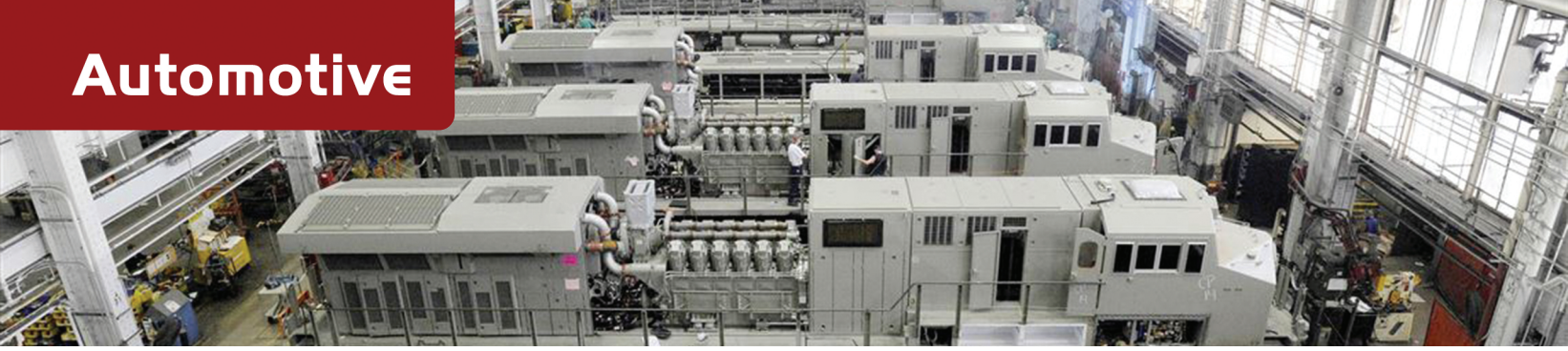

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**Results**

| | Cleaner Name | Method of Cleaner Application | Bluing Results | Rust Preventative Results | Gear Oil Results | Cromac Results |
|---|---|---|---|---|---|---|
| BASELINE: | MEK | Rag damp w/ cleaner | 0.992 | 0.675 | 0.397 | 0.658 |
| | DK solvent | Rag damp w/ cleaner | 0.568 | 0.633 | 0.423 | 0.621 |
| | Brakleen | Aerosol spray on surface | 1.036 | 0.466 | 0.520 | 0.636 |
| | Contact Cleaner | Aerosol spray on surface | 0.864 | 0.481 | 0.446 | 0.515 |
| | Leksol | Rag damp w/ cleaner | 1.086 | 0.532 | 0.466 | 0.643 |
| | Magnaflux | Aerosol spray w/ cleaner | 0.977 | 0.513 | 0.455 | 0.792 |
| | SP3ABB | Rag damp w/ cleaner | 1.240 | 0.539 | 0.411 | 0.897 |
| | Simple Green | Trigger spray on surface | 0.890 | 0.688 | 0.454 | 0.904 |
| | Aero-Green | Trigger spray on surface | 1.018 | 0.954 | 0.888 | 1.079 |
| | 70/20/10 Solvent Mixture | Rag damp w/ cleaner | 1.406 | 0.548 | 0.425 | 1.029 |

**Table 1.** *Average coefficient of friction values obtained*

Listed in the above table are the average values for the coefficient of friction from the set of five samples tested. Below are the comparative results of the 2-sample t-test. In each case, the alternative cleaner was compared with MEK. The higher average was compared with the lower average in each case to see if it was statistically higher at a 95% confidence interval. Here the cleaners are rated comparatively better or worse than the value given for MEK. The results listed as "close" in the table are values that would be accepted as definitely better or worse with a 90% confidence interval.

| | Cleaner Name | Method of Cleaner Application | Bluing Results | Rust Preventative Results | Gear Oil Results | Cromac Results |
|---|---|---|---|---|---|---|
| BASELINE: | MEK | Rag damp w/ cleaner | 0.992 | 0.675 | 0.397 | 0.658 |
| | DK solvent | Rag damp w/ cleaner | worse | same | same | same |
| | Brakleen | Aerosol spray on surface | same | worse | better | same |
| | Contact Cleaner | Aerosol spray on surface | worse | worse | same (close to better) | worse |
| | Leksol | Rag damp w/ cleaner | same | same (close to worse) | better | same |
| | Magnaflux | Aerosol spray w/ cleaner | same | same (close to worse) | better | same |
| | SP3ABB | Rag damp w/ cleaner | better | same (close to worse) | same | better |
| | Simple Green | Trigger spray on surface | same | same | better | better |
| | Aero-Green | Trigger spray on surface | same | better | better | better |
| | 70/20/10 Solvent Mixture | Rag damp w/ cleaner | better | same (close to worse) | same | better |

**Table 2.** *Comparative t-test results*

**Conclusions/Recommendations**

As seen in the tables, Aero-Green cleaner produced the best average coefficient of friction for both the rust preventative and the gear oil. Most cleaners performed well enough at removing the bluing compound, however, the rust preventative and gear oil produced generally lower and varying results. While AEROGREEN® 4410 cleaner has performed well over these selected contaminants, the effectiveness against other common contaminants cannot be predicted. As seen through the experiment, similar solvents and contaminants can produce very different results for this process through the different solubilities of the cleaners, and residues left after cleaning.