Vapor Degreaser Replacement Case Study
Aerospace Industry

Background
A major OEM and MRO provider of turbine and jet engine blades and vanes needed to replace a soon to be obsolete vapor degreaser, due to local regulations. They contacted Magnus to come up with a solution. The soils were EDM oils, machining oils and NDT dye penetrant oils. They also had a requirement to have 100% dry parts due to secondary operations where any residual moisture would be detrimental.

The vapor degreaser was effective and simple to operate. However, it required a dedicated operator on every shift to keep up with the cleaning demands. So, the shear number of parts was also a major factor when specifying the proper aqueous cleaning equipment.

Plan of Action
The first plan of action was to determine the best method of aqueous cleaning and the best cleaning chemistry. Due to the variety of parts, the complex part configurations and the internal cavities, it was determined that immersion agitation would be the most effective. Magnus worked closely with an aerospace approved chemical supplier to develop the process times, recommended chemistry and chemical concentration.

Parts were sent to Magnus' lab and run through eighty five individual cleaning tests in Magnus' full scale production sized cleaning equipment laboratory. FTIR analyses were performed on the full spectrum of parts with the complete range of soils. It became apparent that some soils, particularity the dye penetrant oils, were most effectively cleaned from the small crevices with a combination of immersion agitation and ultrasonics. It was also apparent that for these parts and these soils, ultrasonics also added in the rinsing. The FTIR results shown below clearly show that the aqueous cleaned parts are actually as clean as or cleaner than the existing vapor degreased parts!

Technical Services Laboratory Report

Purpose
The purpose of this project is to evaluate cleanability of the sample parts submitted.

Background
A new cleaning methodology is being tested to replace vapor degreasing of specialty parts in the aerospace industry and the testing herein is being used to compare an aqueous technology against the current one in place.

Conclusions
A summary of the results may be seen in Table 1 and Figures 1 and 2.
The results obtained by the FTIR cleanability study indicate that the alternative cleaning methods of EMD 5 and FPI 5 performed better than the currently used technology of vapor degreasing.

Procedure
The submitted parts were washed in a 10 ml volume of tetrahydrofuran (THF, inhibitor-free solvent). A 50 μL aliquot of the extract was then placed on a zinc selenide attenuated reflectance cell (ATR), the solvent allowed to evaporate and analyzed by FTIR. The soil from a dirty part was used as a reference sample(28 mg in 20ml THF). Quantification of the residue cast on the ATR cell was done by comparing the intensity of the carbon - hydrogen stretching frequencies in the 2800 to 3050 cm^{-1} region of the mid-IR. The absorbances of peak height of each cleaned part was ratioed to the reference standard and micrograms soil per part calculated as in Table 1.

Results

A summary of the results may be seen in the Table1 below and in Figure 1.

Table 1

Summary of Lubricant Residue Found.

Sample	***Soil*** *(mg/part)*
Vapor Degreased	1.38
EDM 5	1.02
FPI 5	0.80

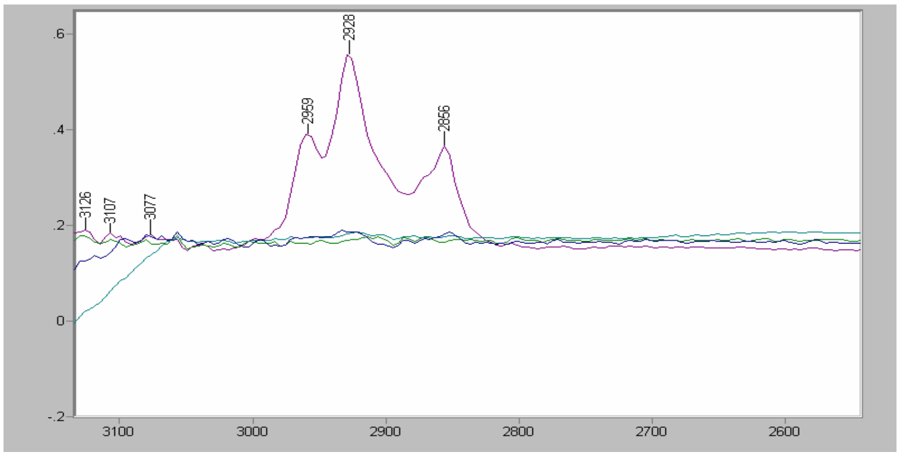

Figure 1 shows an overlay of the dirty sample (large spectrum) compared to the three cleaned samples: vapor degreased, EDM 5 and FPI 5.

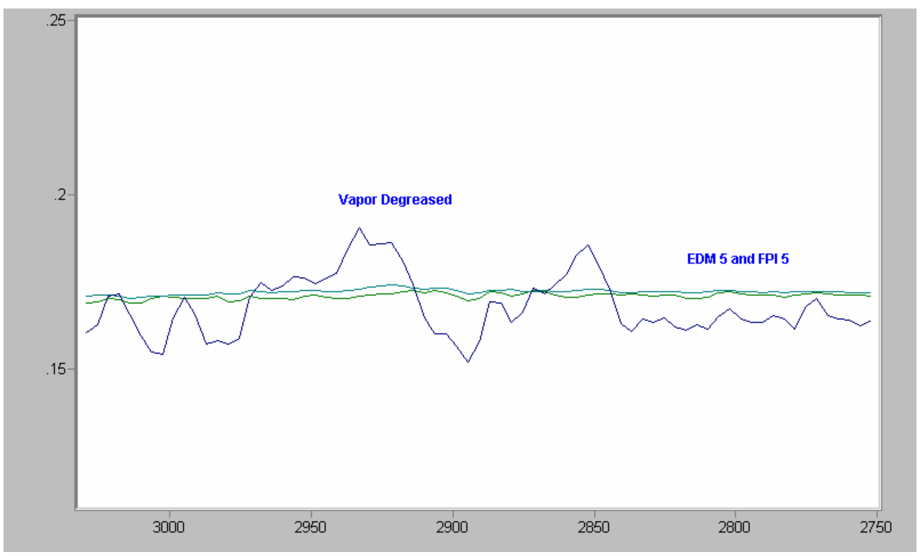

Figure 2 is a FTIR scan of the three cleaned parts (blow up of the above region without the spectrum of the dirty part). Note how the vapor degreased sample has a slight signal (blue trace), while the EDM 5 and FPI 5 exhibit even less sign of remaining lubricant contamination.

After the cleaning process and parameters were determined and the equipment specified, drying tests were performed. Some parts had the potential to accumulate and pool the cleaner and the rinse water. For this reason, drying was sure to take significantly more time than the wet processing. So as not to bottleneck the flow of parts with the lengthy drying times, a multiple stage variable speed belt dryer was proposed. With an average washing and rinsing cycle time of five minutes, a four stage dryer would provide twenty minutes of drying while a load would still exit the dryer every five minutes and would keep up with the production.

The system was provided with many features to reduce rinse water usage, reduce chemical consumption and to ensure rinse water purity. Some of these features included:

- Multiple counterflowing rinses to reduce rinse water usage.
- Multiple wash stages, with a dedicated ultrasonic stage, to provide a robust process.
- Automated level controls and liquid counterflows flows to reduce water consumption and to ensure that the final rinse is the purist rinse.
- A conductivity meter and controller on the final rinse to monitor and automatically maintain the rinse water purity in the final rinse. This is critical, as the parts will only be as clean as the final rinse stage.
- Particulate filtration down to 20 microns.
- Coalescing of oils in the wash stage to remove floating oils and to extend the life of the cleaners.

Current Cleaning Line Status

- With the above system features, the cleaning line can run for up to six months without having to change the cleaning solution.
- The rinse water purity in the final rinse is maintained below 20 micro siemens with just make up water from dragout and evaporation.
- One operator can process the same number of parts in three hours versus the eight hours required with the vapor degreaser.
- The system has been in full production since 2002 without one part being rejected!
- This customer has purchased a second system for another plant location!