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Technical Bulletin #4

Study of the Effect of Fitch Fuel Catalyst on Microbial Contaminated Diesel Fuel

This document is one in a series of Technical Bulletins designed to describe the effect of the permanent fuel treatment Fuel Catalyst manufactured by Advanced Power Systems International, Inc. (commercially sold as the Fitch Fuel Catalyst) has on fuels and on the combustion process. May 2005

TREATMENT OF BIO CONTAMINATED DIESEL FUEL WITH METAL ALLOY FUEL CATALYST

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OBJECTIVE

To study the effect of an In-Line metallic alloy fuel catalyst device on microbial growth in diesel fuel (DF-2).

EXPERIMENTAL PROCEDURES AND METHODS

A re-circulating system designed to simulate a diesel engine fuel system was constructed consisting of a fuel reservoir (tank), a variable rate fuel pump, an In Line catalyst system , a flow meter, and draw off taps for removal of fluid samples. The specific In Line catalyst system employed for this analysis was a Fitch Fuel Catalyst - Model F 750 catalyst formula C supplied by Advanced Power Systems

FUEL PREPARTION

Two liters of commercially available DF-2 was inoculated with *Pseudomonas Oleovorans* strain grown in a 50:50 organic: inorganic growth medium. The inoculated diesel fuel was allowed to incubate for approximately two months. The diesel slowly turned visibly turbid over the two-month incubation period.

Pseudomonas Oleovorans PO is representative of the psychotropic bacteria, those with the preference for lower temperatures and commonly found in fuels. The particular *Ps. oleovorans* was obtained from the American Type Culture Collection (ATCC) had been previously isolated from machine shop cutting oils and demonstrated to be capable of utilizing alkanes. The species has also been isolated in petroleum contaminated Arctic soils.

The treatment or exposure of contaminated spoiled diesel to the Fuel Catalyst was performed by incorporating the In Line FFC device into a re circulating system shown in Figure 1.

Figure 1.

Circulating the fuel through the In Line FFC device treated the contaminated diesel. The initial exposure and treatment was for a two day period, 12 hours on followed by 12 hours off, simulating intermittent use such as a vehicle or generation equipment experiences in normal use. During operation the diesel fuel flow rate was maintained at 500 cc/min. The flow meter was calibrated manually. The contaminated diesel was subjected to continuous circulation and exposure to the In Line FFC device starting day 3 for an additional period of 4 days. The quality of the diesel was inspected by UV-Visible spectroscopy, by drawing from the return line. Fuel samples were drawn and inspected at 12-hour intervals during 96 hours of continuous operation.

RESULTS

The spoiled diesel # 2 was very dirty and turbid. The Figures 2 and 3 show the appearance of the spoiled diesel after the 2-month incubation period before initiation of exposure to the fuel catalyst. The treated diesel appeared as in Figures 4 and 5

Figure 2. Microbial spoiled diesel #2

Figure 3. Close view of the microbial spoiled diesel

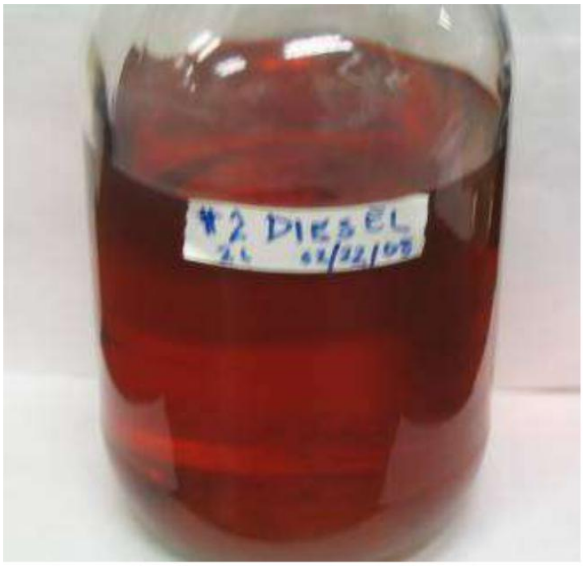
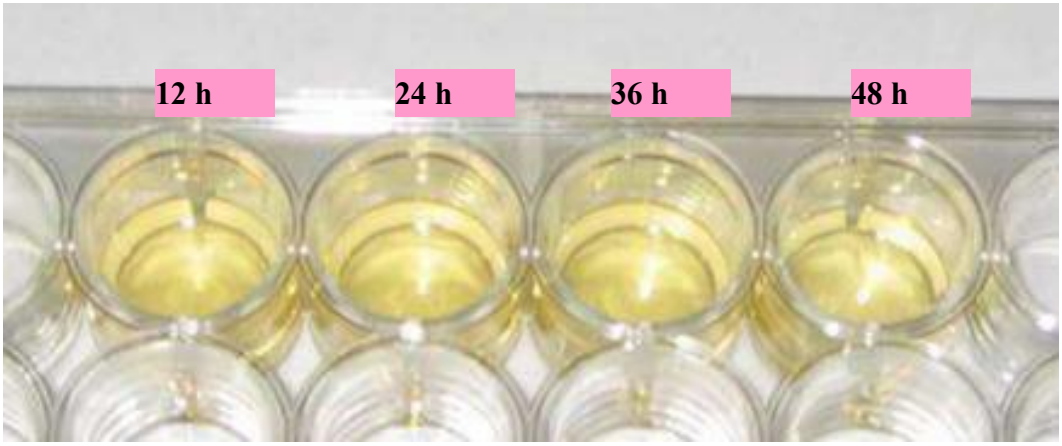


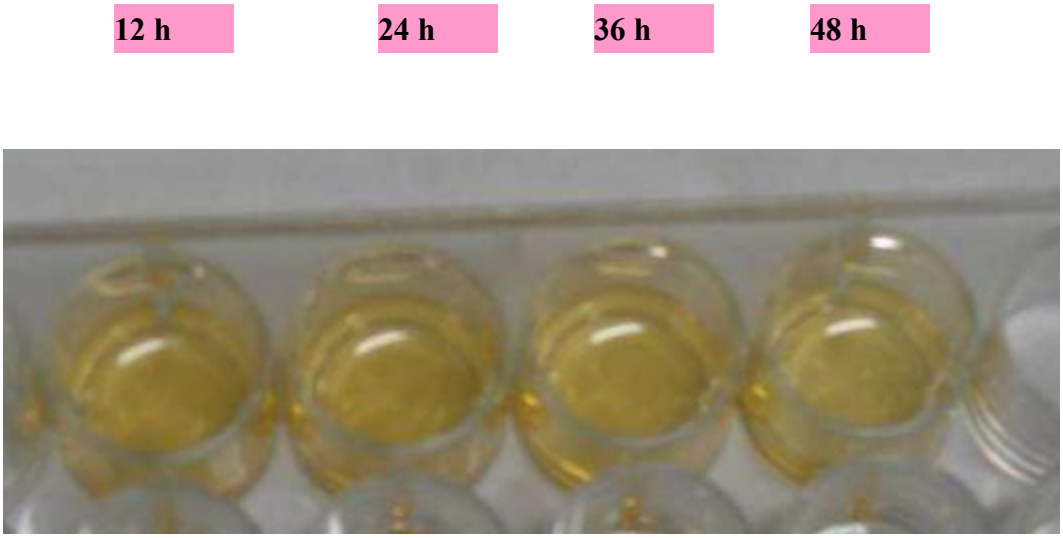
Figure 4.Close view of microbial spoiled diesel DF2 after treatment

Figure 5. Microbial spoiled diesel DF2 after treatment

The color of the diesel changed gradually in direct proportion to hours of treatment. Figures 6 and 7 show the color variation. The left most shows the color at the beginning of treatment while the right most shows at the end of treatment.



Figures 6(top) and 7(bottom). Color variation in diesel fuel after undergoing continuous treatment in the fuel circulatory system with the In Line FFC device. Figure 6 is taken with extra lighting, figure 7 is with normal room lighting. The numbers denote the hours of exposure, after which the diesel was drawn for analysis.



UV-VIS Analysis

The diesel was further analyzed by UV-VIS spectroscopy. The fresh diesel DF- 2 was taken as the blank for the UV-VIS. The UV-VIS spectroscopy from wavelength 380 nm to 820 nm shows only the extra peaks in spoiled diesel in relation to blank of fresh diesel DF 2. The results are shown in Figures 8 and 9. The peak at ~ 400 nm shows the spoiled diesel compared to the fresh diesel.

When the contaminated diesel was undergoing exposure to the In-Line FFC device during Day 1 and 2 of intermittent operations (12 h of circulation followed by 12 h of standby), the three UV-VIS samples depicted in Figure 8 were drawn at 12-hour intervals. The characteristic peak at ~ 400 nm decreased. The characteristic peak at 400 nm is the tool for measuring amount of diesel spoilage and bacterial contamination.

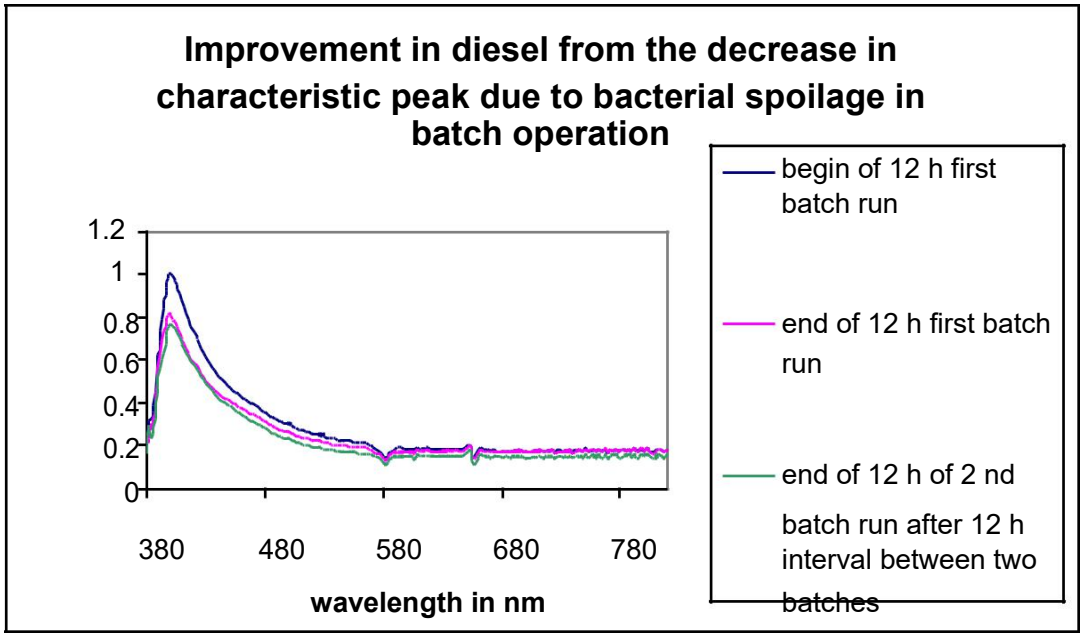


Figure 8. UV-VIS spectroscopy of treated diesel under intermittent operation.

The contaminated fuel was subjected to continuous operation (circulation) for 96 h period. The UV-VIS results of diesel treatment under continuous circulation are shown in Figure 9. Fuel was withdrawn every 12 h and analyzed under UV-VIS spectroscopy.

Figure 9 reveals that the observable peak at 400 nm gradually decreased with time when diesel underwent the continuous circulation with the In Line FFC catalyst device. The peak at 400 nm decreased drastically over time. The improved diesel demonstrated no peak at all in the UV-VIS spectroscopy compared to the fresh diesel blank.

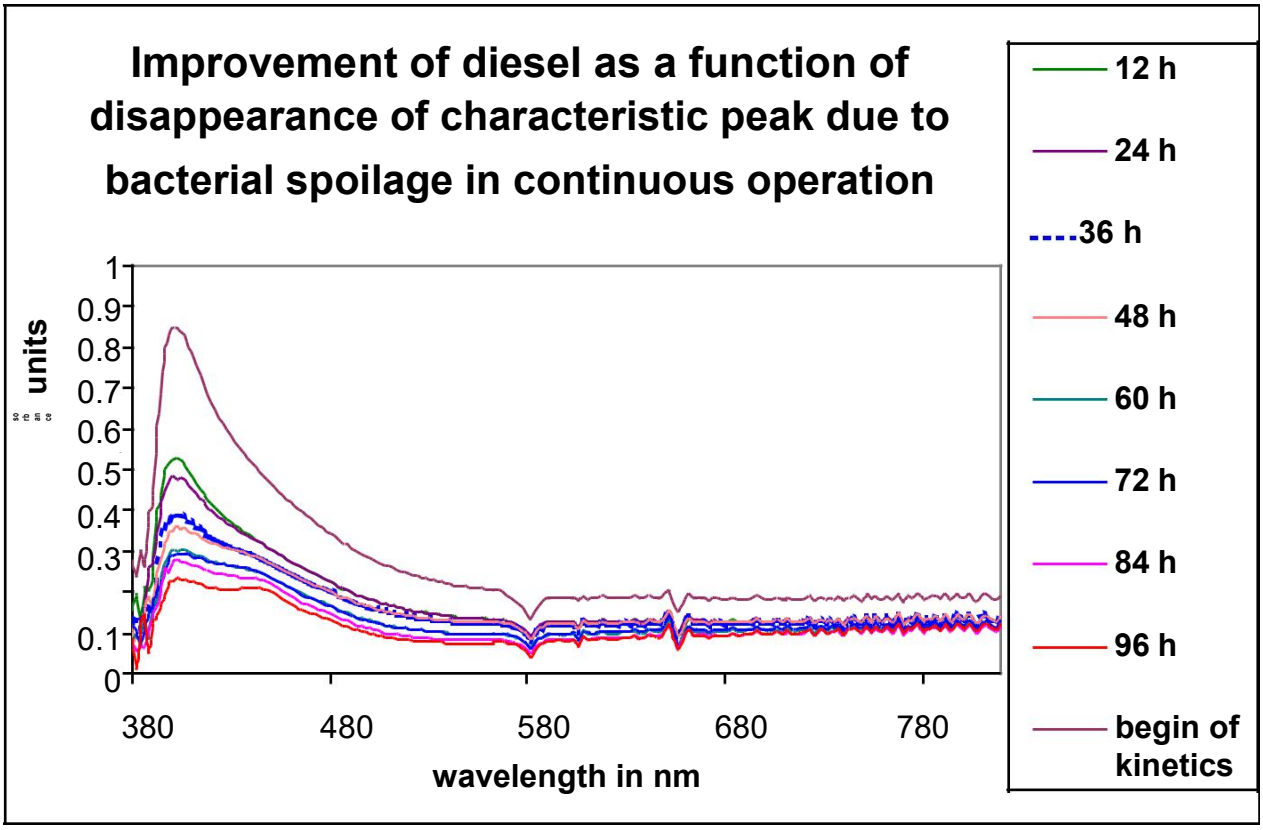


Figure 9. Kinetic study of the diesel treatment by UV-VIS spectroscopy under continuous operation.

DISCUSSION

One observation based on both visual inspection and UV-VIS spectroscopy is that the diesel that turned turbid (over the 2 month incubation period), became transparent after treatment and exposure to the In Line fuel catalyst system. The appearance of the peak at 400 nm may be attributed to the presence of bacteria or exogenous by products of bacterial metabolic pathway. Whatever the reason for the appearance of the peak, the decrease in it is a good indication of suppression of bacterial growth and improvement in the quality of the diesel fuel.

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References:

Defense Logistics Organisation Land Equipment Technical Bulletins
Volume 6 No 9 September 2002
Volume 7 No 3 March 2003

Engine Manufacturers Association, Chicago
Illinois Recommended Guidelines on Diesel Fuel

In this text the EMA notes that “Microbial Growth can cause operational problems, corrosion and sediment build-up in diesel engine fuel systems. The growth of microbes in fuel storage tanks and vehicle/equipment fuel tanks is believed to be related to pipeline and storage techniques and times and cannot be sufficiently addressed in a fuel specification.”

LAND EQUIPMENT

TECHNICAL

BULLETIN

Produced by DLO (Chertsey) at the direction of DG ES (L)

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This Bulletin must not be quoted as an authority.
All articles contained within should be considered time expired 12 months from the date of publication

However, within the document, most paragraphs contain a reference under the subject heading within the context. These references which quote an authoritative document or body are in themselves the authority to comply with the instruction and are to be implemented. The document is issued primarily to enable ***all ranks to do the "right thing right" first time.***

6. **WARRIOR (ALL VARIANTS) - FUEL STARVATION**

References:

A. AESP 2350-T-200-512, Para 30.
B. AESP 2350-T-200-201, Chap 2-2.

a. Although not well reported, Warrior has long suffered from fungal growth (Microbes) that thrive in water contained within the diesel fuel. The microbes can grow in the presence of free water (a distinct water layer), which tends to settle on tank surfaces and at the inter-face between the fuel and any water that might be present on the tank bottom. Warm temper-atures aid their proliferation.

b. The resulting sludge collects in the bottom of the main and collector fuel Tanks but may be re-suspended into the overlaying fuel by agitation during cross country driving, or the addition of fresh fuel. The Microbial contamination suspended in the fuel quickly results in fuel starvation, due to clogged fuel filters, invariably with fuel lift pump failure as secondary damage.

c. The contamination is not unique to Warrior, being recognised world-wide and normally treatable by the addition of additives. Unfortunately, because of the toxicological hazard associated with additives, they present handling and disposal problems have prevented authorisation of their use by Defence Fuels Group.

d. Units experiencing recurring fuel starvation problems as a result of fungal growth, which is recognisable as a brown/black slimy or stringy sludge, are advised to arrange for completion of the following actions:

(1) Drain and thoroughly clean both main and collector fuel tanks.

(2) Renew in-line disposable fuel filter element, the NSN for which is as follows:

(a) 9MCV 2910-99-968-3005.

Note: Do not renew complete canister.

(3) Remove and clean/renew collector tank pick-up filter, NSN 9MCV 2910-99-789-9221d.

(4) Renew both canister filters at power pack, NSN 7RR 2910-99-767-2989.

(5) Confirm serviceability of both lift pumps in accordance with EMER Power P 424/1-429/1.

(6) Confirm fuel system pressure in accordance with Reference A.

e. To minimise occurrences of fuel starvation, pending possible improvements to the fuel filtration system the following interim servicing changes are recommended at Mission Maintenance:

(1) Monitor condition of the in-line filter, renewing if required.

(2) If in-line filter renewed, remove and clean/ renew collector tank pick-up filter (Level 2).

(3) Drain water/debris from collector and main tanks (3 drains) as described within Reference B.f. During periods when equipments are out of use, ensure that fuel tanks remain full and are regularly drained of water.

f. To support a case for improving the fuel filtration system, Units are reminded that 100% EFR action is required in all cases of fuel starvation and lift pump failure, quoting as much historical information as possible.

LAND EQUIPMENT

TECHNICAL BULLETIN

Produced by Tech 1a Comms, DLO Andover, at the direction of
Director General Equipment Support (Land)

This Bulletin is published monthly by ES(Land) to draw attention to urgent equipment care, maintenance and management issues and to inform the ES community of good practice.

Volume 7 No 3 Mar 03

8. **WARRIOR - ALL VARIANTS - FUEL STARVATION**

References:

A. Land Equipment Technical Bulletin, Vol 6, No 9 (Sep 02), Sect VII, Para 6.
B. Routine Signal HQ LAND HPH 311545 Z Jan 03.
C. AESP 2350-T-200-711, Chap 2-4-1, Fig 5, Item 2.
D. AESP 2350-T-204-711, Chap 2-5, Fig 4, item 3 and Fig 6, item 3.

a. Reference A, discussed the long standing problem of fuel starvation suffered by all Warrior Variants due to fungal growth blocking fuel strainers and filters, with subsequent failure of fuel lift pumps.

b. Pending long term resolution of this problem, the following actions are recommended, as stated at Reference B.

1) All Variants, less REME Repair and Recovery. Permanently remove fuel collector tank strainer (NSN 9MCV 2910-99-789-9221), see Reference C.

2) REME Repair and Recovery. Permanently remove both fuel collector and main tank strainers, (NSN 9MCV 2910-99-789-9221), see Reference D.

3) All Warrior Variants committed to Op TELIC. Increase replacement frequency, to 'Mission Maintenance', of the in-line fuel filter element, NSN 9MCV 2910-99-968-3005, (situated adjacent to the fuel lift/transfer pumps).