

Appendix I
MV Tillikum – Operational Details

To: Paul Brodeur, Director of Maintenance
From: Scott Calhoun, Staff Chief, MV Tillikum
Date: February 18, 2009
Subject: Biodiesel Final Report – MV Tillikum
Attachments: #1 – Biodiesel Timeline Chart
 #2 – Injector Problem Report

Paul,

I will address your questions with my comments below. Please note that I've submitted a couple of attachments which address some of your questions.

- 1) Feedstock used during the testing?
 - a) Canola

- 2) Identify any issues that you experienced and at what percentage those issues appeared, e.g. 5%, 10%, or 20%?
 - a) We experienced in September, 2008, while at B10 concentration, bugs in the purifier causing heavy sludge buildup. Humbug tests of samples taken from both main fuel tanks and day tank were negative. We applied maintenance dosages of Biobor at each fueling during the month of September, which cleared up the bugs. We have had no reoccurrence and have not used Biobor since.
 - b) We experienced severe sticking and stuck injectors. We first noticed the problem at B10 concentration levels. We are currently on the third complete set of injectors since the start of biodiesel testing. See Attachment #2 which details injector change-out intervals back to year 2005.

- 3) What did you find was an adequate cleaning frequency for your fuel purifier? How does that frequency differ from normal operations—e.g. 100% petroleum fuel?
 - a) Cleaning frequency has been twice weekly throughout biodiesel testing and going back to when we first stopped using high sulfur fuels. Cleaning once per week was the norm prior to alternative and low sulfur fuels.

- 4) What did you find was the average filter life? How does that life differ from normal operations—e.g. 100% petroleum fuel?
 - a) Filter life was not an issue with the canola product at any concentration level.

- 5) In your opinion, was fuel tank cleaning necessary at the start of the project?
 - a) During the Tillikum's previous test periods on soy feedstock we found thick slime on internals of fuel tanks at the end of testing. I feel it was a good idea to clean the tanks as we had never tried the canola before. We will be opening the tanks for inspection during our Eagle Harbor layup, which is currently scheduled for late March or early April, 2009. We will be able to compare with what we have seen in the past.

- 6) Did you experience any leaking / weeping seals or gaskets on any fuel related components?
 - a) We had to replace o-ring seals on the purifier on two occasions due to swelling and material breakdown.

Appendix I MV Tillikum – Operational Details

- 7) Did you notice any differences in the exhaust gas stack emissions?
 - a) No.
- 8) Did you notice any differences in the exhaust gas stack temperatures?
 - a) No.
- 9) Did you notice any loss of power or did you burn more fuel due to the less energy content of biodiesel? If yes, can you estimate how much, e.g. 1%, 2%?
 - a) No, not a noticeable amount. We do not have fuel monitoring equipment like some other vessels which would show burn rates at comparable load levels.
- 10) Do you have any other observations / recommendations looking back / going forward?

Observations:

Canola Feedstock

- 1) The Tillikum's experience with this product has been favorable as far as filter life is concerned. The purifier is doing the job as filter life is comparable to pre-alternative fuel days.
- 2) The injector problems encountered on the Tillikum is a big issue. We sent out three injectors a couple months ago to VDDA for teardown and analysis. The report I finally received today states that what they saw was normal wear, however, this is not anything close to normal wear based on my 30+ years of experience. This past weekend I sent three more injectors with Chevron representatives Tom Kiernes and Peter VanSlyke, who will also do teardowns. One theory is that fuel residue is oxidizing on the barrel and plunger when engines are secured and hot.

High Cloud Point Feedstock

- 1) According to the Staff Chief of the Klahowya, they are changing racor filters on a weekly basis at 10 psi differential pressures. In the past on the Tillikum while testing soy feedstock, we changed racor filters frequently at 5 psi differential. I also know that the Klahowya has had boiler flame failures much the same as the Tillikum did during prior test periods on soy. Racor filters are not installed on Tillikum/Klahowya boiler fuel supplies. The filter plugging material is getting by the purifier and plugging filters.
- 2) The Klahowya does maintenance dosages of biobor at all fuelings, which is and has been vessel policy for a long time. I feel it would have been a good opportunity to know if this is necessary with this product.

Soy Feedstock

- 1) I haven't had any conversations with the Staff Chief of the Issaquah. I did have one conversation with an Oiler who stated that they had some bug infestation issues in the main fuel tanks. He also stated that the material that plugs filters is getting by the purifier, which is what the Tillikum experienced with the soy product in the past. I read in the Operations Log a few weeks back that an auxiliary engine shutdown due

Appendix I
MV Tillikum – Operational Details

to a plugged fuel filter. As with the Tillikum/Klahowya boilers and the Issaquah engines, there is no Racor primary filtration in the supply lines.

Recommendations looking back / going forward

- 1) Looking back I feel that this was a valuable endeavor. We have gathered a lot of data that can be used in the future. Unfortunately there are still a lot of unknowns out there, both short term and especially long term.
- 2) Going forward I think the idea of a long term test of five years on a single vessel would be a good idea. I do not feel that we have enough information and data to commit the whole fleet to biodiesel. If the lawmakers stick to their mandate and the entire fleet has to switch to biofuel I strongly recommend that two micron filtration with differential psi alarm and monitoring be installed in the fuel supply to all critical machinery. There is potential for engine shutdown do to filter plugging, which needs to be avoided at any cost.

It has been a pleasure working with “The Team.” Thanks for all the support provided. Let me know if I can be of further assistance.

Scott Calhoun
Staff Chief, MV Tillikum

Appendix I
MV Tillikum – Operational Details

BIODIESEL TIMELINE CHART – MV TILLIKUM

Date	Primary Racor Filters Changed		Secondary Spin-on Filters Changed		Purifier Cleaned	Comments
	#1 M/E	#2 M/E	#1 M/E	#2 M/E		
3/3/08			X	X		Normal Maintenance
3/31/08	X	X				Start of biodiesel testing
4/1/08 thru 7/30/08					Twice Weekly	B5 Canola / ULSD Blend
4/24/08		X				5 PSI Differential
4/28/08 thru 5/16/08						Dry-Dock @ Todd's
5/22/08	X					5 PSI Differential
5/23/08			X	X		Normal Maintenance
7/25/08		X				5 PSI Differential
8/1/08 thru 8/31/08					Twice Weekly	B10 Canola / ULSD Blend
8/9/08						Changed o-ring, purifier bowl hood due to swelling
9/1/08 thru 9/30/08					Twice Weekly	B10 Canola / ULSD Blend, Maintenance dosage of biobor at each fueling due to heavy sludge buildup in purifier (BUGS)
9/6/08						Changed 1 ea. stuck injector on #2 main engine
9/13/08			X	X		Normal Maintenance
9/27/08	X					5 PSI Differential

Appendix I
MV Tillikum – Operational Details

10/1/08 thru 1/31/09					Twice Weekly	B20 Canola / ULSD Blend
11/8/08						Changed all injectors, both main engines due to sticking
12/6/08		X				5 PSI Differential
1/3/09	X					5 PSI Differential
1/7/09						Changed o-ring, purifier bowl hood due to swelling
1/17/09						15 of 24 injectors found to be stuck at shutdown.
1/30/09						Changed all injectors, both main engines due to sticking

Appendix I
MV Tillikum – Operational Details

To: Paul Brodeur, Director of Vessel Maintenance
 From: Scott Calhoun, Staff Chief, MV Tillikum
 Date: February 18, 2009
 Subject: MV Tillikum M/E Injector Problem Report

DATE	MAIN ENGINE #	MAIN ENGINE HOURS	COMMENTS
06/18/05	#1	55,700	Changed all injectors after two years service – normal change-out interval, fuel racks all free.
06/21/05	#2	55,700	Changed all injectors after two years service – normal change-out interval, fuel racks all free.
06/11/07	#1	66,074	Changed all injectors after two years service – normal change-out interval, fuel racks all free after 10,374 running hours.
06/12/07	#2	66,074	Changed all injectors after two years service – normal change-out interval, fuel racks all free after 10,374 running hours.
04/01/08	Both	70,726	First load of B5 Canola / ULSD.
08/01/08	Both	72,375	First load of B10 Canola / ULSD.
10/06/08	Both	73,552	Found several stuck injector racks when engines are secured. The fuel racks free up after engines are started.
10/07/08	Both	73,576	First load of B20 Canola / ULSD.
11/08/08	Both	74,129	Changed all injectors (24 total) on both main engines due to most racks being stuck, engines are hard to start. 17 months & 8,055 hrs. of service from this set of injectors.
12/20/08	Both	74,774	Top deck inspections of both main engines. Checked one bank of injectors (6 total), none of the checked injector racks were stuck.
01/17/09	Both	75,247	Found that 15 out of 24 injectors are sticking when engines are secured, the racks free up once the engines are running. 1,118 total engine hours on these injectors. Very abnormal!

Appendix I
MV Tillikum – Operational Details

1/30/09	Both	75,480	Changed all injectors (24 total) on both main engines due to most racks being stuck, engines are hard to start. Less than 3 months & 1,351 hrs. of service from this set of injectors.
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At this point the above data indicates that the problem is tied to the use of the canola feed stock product. This problem was not observed when the vessel was running on soy feed stock during the two previous test periods or at any time while running on low and ultra low sulfur fuels.

Scott Calhoun
Staff Chief, MV Tillikum

Appendix H

MV Tillikum – Fuel Injector Report

Feb 2, 2009

Valley Power Systems

P/N 40079006 (05J20286, 05C22300, 06B22243)

Ref. Biofuel (Canola base) B20 blend ULSF injector failure analysis

(Injectors have been in operation from 11-06-07 until 11-08-08 with 8,055 hours)

All units were tested for the following:

Performance

Rack Freeness

One unit had a smooth operating rack and the other two had sluggish racks. There was evidence of corrosion and carbon contaminants in the gear and rack teeth.

Atomization

All units displayed good atomization of the test oil during both fast and slow stroking of the plunger regardless of rack position. (Tested at full fuel through idle rack position)

Leakage Rate

All units were tested and found to be well within specification for leakage. (Specification used for leakage is identical to that of a newly remanufactured injector.)

Calibration

The three units were calibrated at standard conditions and delivery was at the midpoint of the calibration specification for newly remanufactured injectors.

Physical condition of major components

Plunger & Bushing assembly

Plungers are in good condition, no visible signs of seizure (intermittent or full). Helices are in good condition with no indication of chipping or erosion. Short and slight scratches above the helices indicate occasional hard contaminants entering through the bushing port holes and rapidly diminishing in size. Any visible marks observed on the plunger and bushing are minor in nature and do not appear to be different from those found on units tested previously with straight ULSF.

Nozzle assembly

Nozzle bodies are in good condition; seating areas are free from chipping, erosion, or abrasion. Needles are likewise in good condition and show no signs of scuffing or scoring on the quill bearing surfaces. Spray holes do not exhibit any uneven or excessive wear patterns.

Conclusions

Internal components all indicate normal wear patterns. No evidence of a manufacturing defect was found which would cause the complaint that the injectors would stick at cold start. Excessively high viscosity of the fuel or lube oil during cold start can cause a “sticking” (plunger no-follow) condition.

EL/JAJ 2-2-09

Appendix I
MV Tillikum – Operational Details

To: Paul Brodeur, Director of Maintenance
From: Scott L. Calhoun, SCE, MV Tillikum
Date: April 5, 2009
Subject: Condition Report, Fuel Oil Day Tank

The following will describe what you are looking at on the following pictures.

- D001.jpg Tank Overhead
- D002.jpg Tank Bulkhead, Frame-0
- D003.jpg Tank Bulkhead, Inboard
- D004.jpg Tank Bulkhead, Frame-2
- D006.jpg Tank Bottom

The Fuel Oil Day Tank was very clean. There is no real buildup on any surface in the tank. This is consistent with what we were seeing in operation while testing the B20 Canola product. With this product the purifier does the job of separating the solids from the fuel which keeps the Primary 2 Micron Racor Filters from plugging up.

Scott Calhoun
Staff Chief, MV Tillikum



Day Tank Overhead (D001.jpg)



Day Tank Bulkhead, Frame-0 (D002.jpg)

Appendix I
MV Tillikum – Operational Details



Day Tank Bulkhead, Inboard (D003.jpg)



Day Tank Bulkhead, Frame-2 (D004.jpg)



Day Tank Bottom (D006.jpg)

To: Paul Brodeur, Director of Maintenance

Appendix I
MV Tillikum – Operational Details

From: Scott L. Calhoun, SCE, MV Tillikum
Date: April 5, 2009
Subject: Condition Report, Starboard Main Fuel Tank

The following will describe what you are looking at on the following pictures.

S002.jpg	Tank Overhead
S003.jpg	Tank Bulkhead, #2 End, Frame-6, Top
S004.jpg	Tank Bulkhead, #2 End, Frame-6, Bottom
S005.jpg	Tank Bulkhead, Inboard, Top
S006.jpg	Tank Bulkhead, Inboard, Bottom
S009.jpg	Tank Bottom, Lower
S010.jpg	Tank Bottom, Longitudinal Divider
S011.jpg	Tank Overhead, Rub-rail, and Bottom, Outboard At Top Of Tank
S012.jpg	Tank Bottom Above Suction Line
S013.jpg	Tank Bottom Above Suction Line

Overall the tank internals are quite clean. There is no buildup on the top or sides of the tank. On the tank bottom there is a small amount of buildup (black in color) which is mostly in the bottom portion of the tank. Pictures S009.jpg, S012.jpg, and S013.jpg show black and brown colored streaking. The brown color is the skin of the tank and the black is the small amount of buildup. We did not go into the tank or get the remaining fuel out of the tank to expose the vee at the bottom.

We received our last load of B20 Canola January 27, 2009. To date the Tillikum has taken approximately 94,700 gallons of Ultra Low Sulfur Diesel. I don't know if the buildup was worse at the end of the biodiesel test period.

Scott Calhoun
Staff Chief, MV Tillikum

Appendix I
MV Tillikum – Operational Details



Storage Tank Overhead (S002.jpg)



Storage Tank Bulkhead, #2 End
Frame-6, Top (S003.jpg)



Storage Tank Bulkhead, #2 End
Frame-6, Bottom (S004.jpg)



Storage Tank, Inboard, Top (S005.jpg)

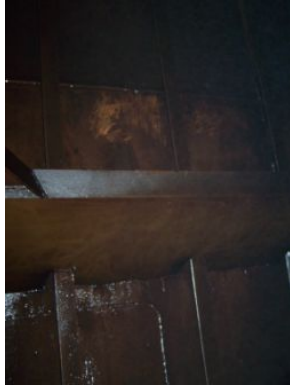


Storage Tank, Inboard, Bottom (S006.jpg)



Storage Tank Bottom, Lower (S009.jpg)

Appendix I
MV Tillikum – Operational Details



Storage Tank Bottom
Longitudinal Divider (S010.jpg)



Storage Tank Overhead, Rub-rail
and Bottom, Outboard At Top (S011.jpg)



Storage Tank Bottom Above Suction Line
(S012.jpg)



Storage Tank Bottom Above Suction Line
(S013.jpg)