

Island Explorer 3 Field Demonstration of Technologies to Reduce Fuel Consumption and Exhaust Emissions – 07.18.2013 Rev.

Project Overview

Comparison of engine performance(EGT), exhaust emissions and fuel consumption with and without Fitch Fuel Catalysts on the *m/v Island Explorer 3* used for whale watching excursion trips from Anacortes and Everett, WA. Vessel is owned and operated by **Island Adventure Cruises** and is a converted 100-ft Gulf of Mexico crew boat with a passenger capacity of 149 and is powered by three Detroit 1271 engines.



Near Capacity trip on Island Explorer 3

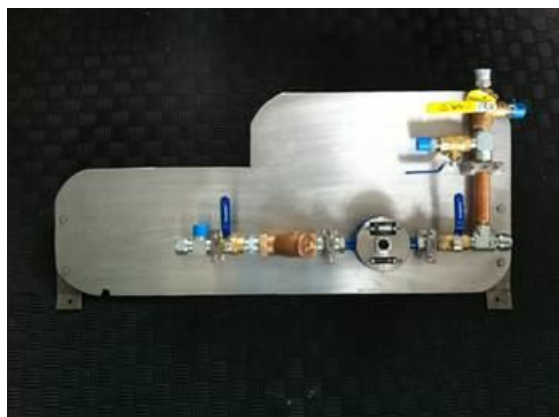
Instantaneous fuel consumption on the center engine was measured to the nearest one-tenth of a gallon per hour with an AIC precision fuel meter supplied by Reicon, U.S. A torque sensor, supplied by Datum Electronics, was mounted on the center shaft to provide shaft speed and kilowatt power output. A computerized data logging system supplied by BlueFlow Americas was employed to capture horsepower and torque from the shaft and merge it with the fuel measurements and GPS position data to provide a platform for accessing and analyzing the data measured with and without the Fitch Fuel Catalyst(model F150HDG) engaged on the center engine.

Emissions (CO, CO₂ and O₂) levels and temperature readings inside the exhaust stack were captured using an e-Instruments portable gas analyzer provided courtesy of Tri Marine Fishing Management.

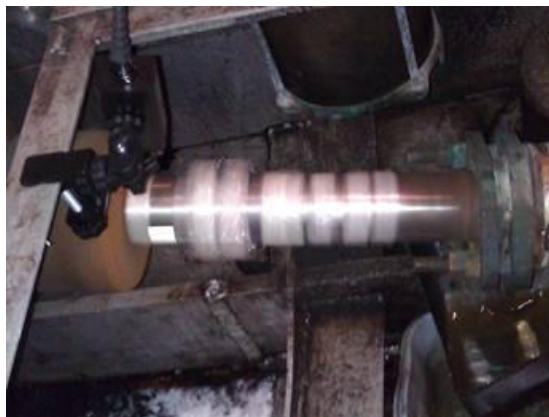
Island Explorer 3 Field Demonstration of Technologies to Reduce Fuel Consumption and Exhaust Emissions – 07.18.2013 Rev.

Equipment Setup

The torque sensor was attached to the shaft and the transmitter and battery pack were secured with tape. The shaft speed send-receive unit was clipped to frame to measure shaft rotation(rpm). Data is transmitted to BlueFlow real-time client display screen. All data is recorded and saved for subsequent uploading via Wi-Fi or 3g connection to the BlueFlow server which processes and makes available data shown in following screenshots. Both the AIC meter and Fitch Fuel Catalyst have bypass valves installed to control when each is in or out of loop.



AIC Precision Fuel Meter



Datum Shaft Torque Sensor



Fitch Fuel Catalyst



BlueFlow Client Display

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Integrated Data Presentation



This is a screenshot taken from a 1-hour section of data (12:45 to 13:45) recorded on March 2nd during a 3-hour excursion from Everett. The Fitch Fuel Catalysts were dis-engaged from the fuel supply on all 3 engines in order to collect baseline data under full or nearly full conditions. Approximately 100 passengers were on-board for this trip. The gray bar in the middle section at the bottom provides for navigating a 1-hour viewing pane (narrow white strip in the right part of color-coded graphs). The date selector is shown above the navigation bar and indicates we are looking at data from 2013-03-02.

In the detail 1-hour viewing pane, one sees the graphs for the user-selected parameters. In this case fuel consumption in gal/hr (red), shaft torque in ft-lbsX100 (green), shaft speed x 10(blue), shaft power in Kilowatts x 10(yellow) and break specific fuel consumption in gal/per 100 kilowatts (turquoise). The red vertical line can be moved with the cursor to select any specific data point with an interval of 1 second. The legend in the upper left hand corner of the viewing pane shows the time position and values at that precise moment(13:15:04), where fuel consumption was 17.7 gal/hr., torque was 1876 ft-lbs, shaft speed was 714 rpms, power output at the shaft was 190kw and the break-specific fuel consumption was 9.32 gal/100kw.

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As more and more data is accumulated, it will be possible to build a reference set of data at various speeds such as this 35 minute section where shaft speed was relatively steady around 715 rpm and make comparisons under similar conditions with and without the Fitch Fuel Catalysts employed.

Data Collection-Phase 1 Demo

On Wednesday, February 27, 2013 we and our guests departed Anacortes at about 11:00am (1 hour behind schedule). About 3 hours of data was recorded using all the technologies and presentations discussed above. We had approximately 1:15 of break-in time when the Fitch Fuel Catalyst (FFC) was engaged in the fuel supply to pre-circulate fuel through the device before commencing measurements. Because of the time delay at the start, we were not able to get a full 3 hours of fuel consumption data with the FFC for comparison purposes.

A portable handheld emission tester was used to gather flue temperature and emission data inside the exhaust stack with and without the Fitch Fuel catalyst installed. Data is provided in the tables below. Data shows increasing improvement over time at similar engine speeds which is indicative of the engine responding to improved quality of fuel treated with the FFC. The post-Fitch data shown was acquired approximately 1 hour and 45 minutes after switching the 3-way valve on the FFC(see photo above) to the position to pass fuel through the catalyst. Because the return fuel, which would normally be routed back to the supply tank, was sent back to the engine via the closed loop through the AIC meter, additional fuel treatment was afforded to the fuel.

Flue Temperature Measurements						
Average	Baseline RPM	with FFC RPM	Baseline Deg. F	with FFC Deg. F	Decrease Deg. F	Percent Change
2 readings	723	720	544.5	538.1	6.4	1.18%
2 readings	705	705	564.4	507.4	57.0	10.09%
3 readings	700	700	524.4	459.8	64.6	12.32%
4 readings	645	633	517.1	451.3	65.8	12.72%

Carbon Monoxide(CO) concentration measured in exhaust stack						
Average	Baseline RPM	with FFC RPM	Baseline ppm	with FFC Ppm	Decrease Ppm	Percent Change
2 readings	723	720	107.5	95.0	12.5	11.63%
2 readings	705	705	121.5	82.5	39.0	32.10%
3 readings	700	700	96.0	74.3	21.7	22.57%
5 readings	644	627	95.8	76.8	19.0	19.83%

Carbon Dioxide(CO2) percent measured in exhaust stack						
Average	Baseline RPM	with FFC RPM	Baseline vol %	with FFC vol %	Decrease vol %	Percent Change
2 readings	723	720	4.1	4.1	0.0	0.00%
2 readings	705	705	4.2	3.7	0.5	12.05%
3 readings	700	700	4.1	3.3	0.8	20.33%
4 readings	645	633	3.8	3.0	0.9	22.37%

Island Explorer 3 Field Demonstration of Technologies to Reduce Fuel Consumption and Exhaust Emissions – 07.18.2013 Rev.

Data Collection-Phase 2

All the test equipment described above remained on the vessel through the end of March. One trip was made with a nearly full boat without FFC connected to any of the 3 engines. This set of data would serve as a baseline for comparing future trips with the FFC engaged on all 3 engines. Please note that in high return engines such as the 2-stroke Detroit 71 series, the majority of fuel pumped through the injectors is returned to the fuel tank. In this way depending on how many hours per day the engines are run (in this case about 3 hours per day), a portion of the fuel in the supply tank has received exposure to the Fitch catalyst and is partially treated. The residual benefit of passing through the catalyst tends to last for 24 to 48 hours.

Despite some data transfer problems where some potentially useful data was lost, sufficient comparison points to the baseline data set were captured in the BlueFlow database to determine that fuel savings expressed in gallons consumed per kilowatt-hour of power produced declined 10% +/-5% with the FFC verses the baseline.

In addition a new set of emissions data was collected on 3/22 and shows the presence of the FFC on all 3 engines has further reduced the temperatures and emissions as per the following summary:

	T			
Max>>	Flue	CO	CO2	Tot Eff
BL 2/27	566.1	125	4.2	69.8
FFC 2/27	556.2	108	4.1	69.4
FFC 3/22	524.5	103	3.8	69.9
Change	41.6	22.0	0.4	0.1
Pct	7.35%	17.60%	9.52%	0.14%

All measurements were taken at high RPM-Maximum readings.

Data Collection-Phase 3

After all the test equipment was removed on March 31st, the *m/v Island Explorer 3* continued to conduct daily 3-hour whale watching tours out of its temporary base in the Port of Everett. The three Fitch Fuel Catalysts remained connected and engaged. On May 7th, the vessel relocated to its home base in Anacortes, WA. Since that time, she has been taking passengers on daily trips with duration of 6 to 7 hours per trip instead of the 3-hour trips conducted out of Everett.

Discussion of Results

Applying a methodology that incorporates power generated at the propeller shaft verses fuel consumed at various comparison shaft speeds to analyze the wealth of data provided by the **BlueFlow** system we are able to identify an improvement in a measure of overall efficiency related to the presence of the fuel catalyst. As supported by the comparative improvement in emission levels and EGT referenced above, there is an improvement, particularly towards the end of our data collection period with the FFC, of 10 percent +/-5%.

In addition, after approximately 2 months operating the vessel on 6-7 hour excursions from Anacortes, both of the vessel's captains report observing substantial fuel savings, cleaner exhaust emissions and longer lasting fuel filters.