Evaluation of NatureBlend™ Biodegradable Flange Lubrication from MPL Technology, Inc.

Testing Conducted at Transportation Technology Center, Inc.

TTCI Test Controller: Scott Gage

Report generated by MPL Technology with data provided by TTCI

November, 2014

EXECUTIVE SUMMARY

MPL Technology, Inc. has developed a new patent pending formulation of solid lubrication using environmentally friendly materials called NatureBlend™. This material is made up of a combination of biodegradable and renewable polymers, a high performance vegetable oil, and a combination of proven extreme pressure additives designed to provide railroads with a 'green' alternative for flange lubrication.

Testing of the lubrication benefits of NatureBlend was conducted on November 1st, 2014 at the Transportation Test Center in Pueblo, CO to determine effectiveness and longevity. The test was conducted on the Transit Loop using two EMD locomotives with steerable trucks and recently turned wheels. Testing was conducted and recorded by TTCI personnel using the TTCI data acquisition system attached directly to the locomotives. Tribometer readings were taken by TTCI staff and recorded.

The results of this testing indicate that within a short time period of application, energy savings provided by the NatureBlend lubricant were between 2% and 4.5% for both mechanical and electrical energy and the material was able to immediately reduce the outside rail gage face CoF from 0.44 down to 0.26 on the electrical energy measurements.

It is important to note due to the wide range of factors impacting this type of testing, we are attempting to identify trends and indicators within the data. The testing clearly indicates NatureBlend's ability to provide lubrication and reduce gage face coefficient of friction (CoF). The testing also illustrates when the CoF is reduced on the rail, energy consumption is also reduced. Data is included as Appendix A.

INTRODUCTION

MPL Technology has been the industry leader in providing SolidStick flange lubrication for over a decade. In an effort to keep up with today's increasing environmental awareness MPL began researching the possibility of developing a solid lubrication formulation that was both biodegradable and renewable. The result of this research is the patent pending NatureBlend formulation which uses a combination of biodegradable and renewable polymers in combination with a vegetable oil and traditional extreme pressure additives to provide the rail industry with an environmentally conscious flange lubrication alternative without compromising performance or benefits of traditional flange lubrication. Unlike other solid lubricants claiming to be 'bio' they still utilize non-biodegradeable hydrocarbons as their primary polymer binder.

In order to document the performance of the NatureBlend formulation, MPL contracted with TTCI to perform testing of the material under actual field conditions. This report documents the testing protocol, equipment used and results of the analysis.

TEST OBJECTIVE

The objective of the testing is to quantify the energy between dry and lubricated conditions and determine the residual effects of a locomotive flange lubrication system for subsequent trains. In order to accomplish these objectives, the amount of energy required to transport a heavy haul train under dry conditions is established, and then compared with energy requirements subsequent to the lubrication system being activated.

PROCEDURES

Testing was conducted on the 9.1 mile transit test loop which incorporates four (4) 1.5 degree curves and the remainder being tangent track. The track was noted to be in excellent condition.

Two EMD locomotives (UP 3886 & CSX 4762) were used in this test, an SD 70AC and a SD 70 M **(both equipped with steerable trucks)**. All wheels on both locomotives had been turned the previous week which provides the closest match wheel profile for minimal flanging with steerable trucks. The trailing tonnage was comprised of 30 (125 ton) coal cars. The target speed for laps during operation was 50 mph.

TTCI selected the two locomotives and installed main generator shunts on both locomotives in addition to an instrumented coupler in the first car of a loaded thirty car consist to measure mechanical forces. Electrical data from the locomotives and force data from the instrumented coupler was collected using a single data collection system located in the first locomotive.

The test procedure called for undetermined number of conditioning laps to run in order to warm up bearings and clean the rail. These conditioning laps would be run until such time a minimum of three steady state laps with similar energy consumption are able to be identified. The average of these laps would be used as the "dry" baseline measurement for comparison purposes. The test coordinator (Scott Gage) would make the decision on when these steady state laps have been reached and the application of the lubricant should begin.

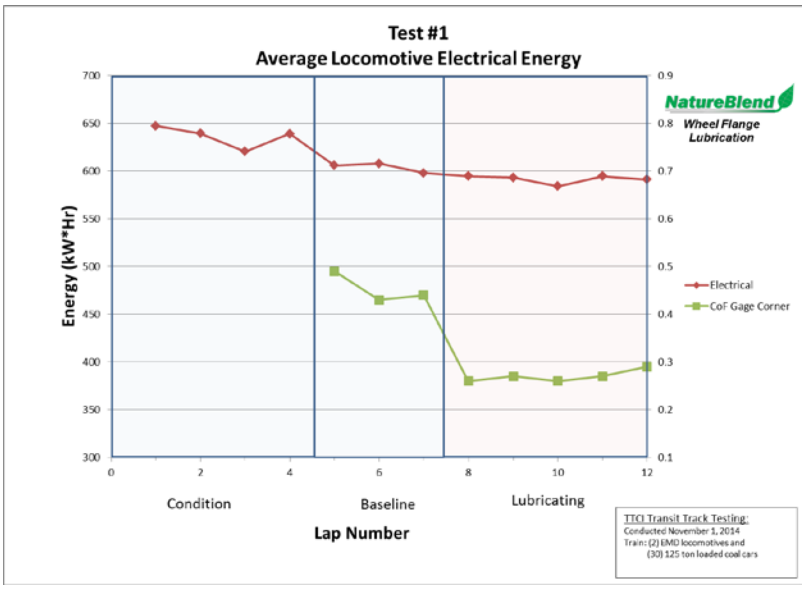
Once a dry baseline or steady state was established the flange lubrication sticks would be installed in the applicators already mounted on the locomotives. The applicators would apply the NatureBlend formulation to the #3 and #4 axles on both of the locomotives. Once installed, the train would resume laps and monitor electrical and mechanical energy on a per lap basis to determine any reduction in energy consumption. Coefficient of friction readings of the gage corner were to be taken after each lap of baseline to monitor the materials ability to transfer from the wheel to the rail as well as the residual benefits.

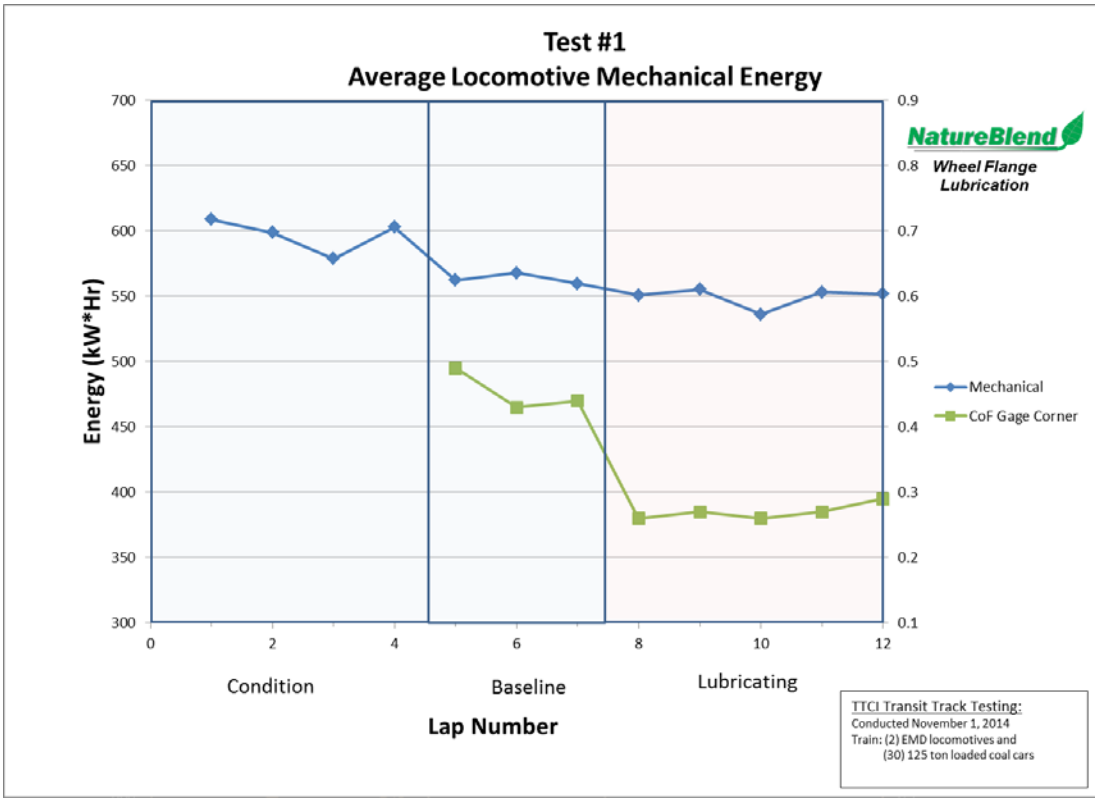
TEST RESULTS

The NatureBlend testing was conducted Saturday morning, November 1st, 2014 at the TTCI testing facility located in Pueblo, CO. The weather conditions on that day were sunny with light winds and an early morning low temperature of 46F and a high of 72F.

The train began running the first conditioning laps at 9:13 am with light winds and a temperature of 46 degrees F. A total of seven (7) laps were completed with the last three (3) serving as steady state laps with average mechanical energy of 563.26 KWH, electrical average of 603.93 KWH and a beginning gage face corner coefficient of friction of 0.44.

The train was then stopped so the NatureBlend lubrication sticks could be installed in the applicators at the recommendation of the test controller. The sticks were installed in the locomotives on the number 3 and 4 axels. Subsequent laps were then conducted and the following chart represents the documented energy measurements from watt meters and coupler forces as well as gage face CoF:



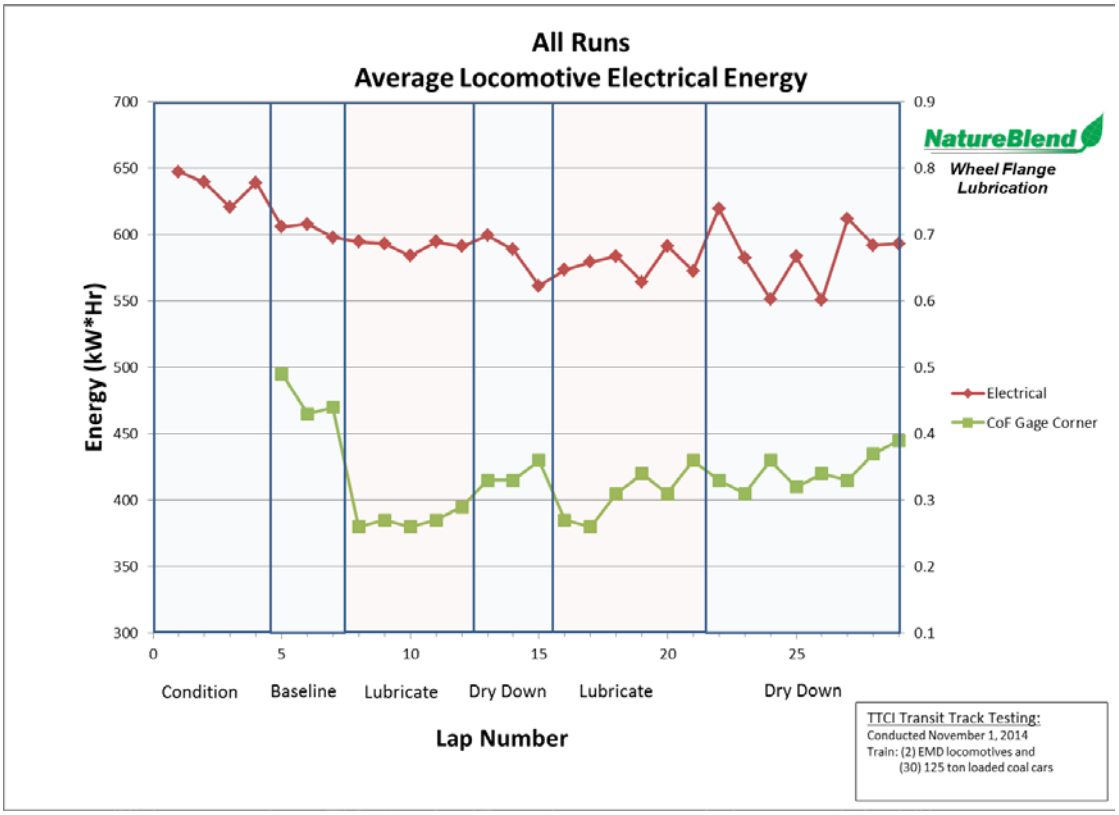


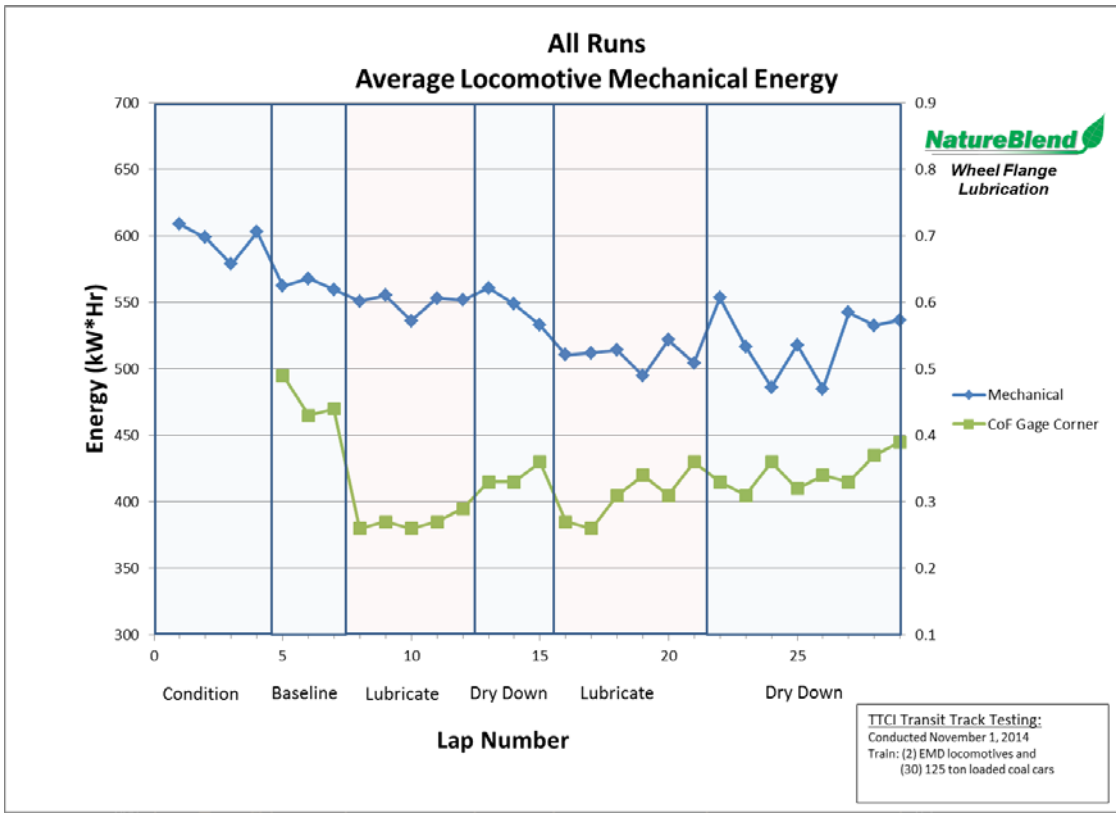
After 5 laps had been completed the sticks were removed from the applicator and the track was sanded in attempt to remove the lubricant from the rail and conduct subsequent (repeated) testing. After the sanding lap, energy measurements were again taken and it was noted that energy measurements continued dropping as the CoF of the gage face slowly began to rise. Based on this reading, test coordinator, Scott Gage, indicated we most likely stopped lubricating the rail too soon to determine maximum energy savings and had we not stopped, energy would have continued to drop. The train was stopped and the lubrication sticks were reinstalled to continue monitoring energy reduction.

Once the sticks had been reinstalled (lap 16) the power supply to the data acquisition system malfunctioned (melted) and an auxiliary generator had to be installed on the locomotive. As a result of the loss of power, the mechanical coupler had to be recalibrated. We believe the drop (shift) in the mechanical energy at the beginning of the second round of lubricating was as a result of this recalibration.

In an attempt to dry down the rail, locomotive sanders and car brakes were dragged in an effort to remove the lubricant from the rail. The train maximum speed during operation of the sanders was 13 mph. The 3 mid-test dry laps and subsequent 8 laps required to raise the CoF clearly demonstrate the retentiveness of the NatureBlend formulation and its ability to transfer and provide residual benefit.

Energy measurements for both electrical and mechanical as well as gage face CoF can be found in the charts below:


All Runs
Average Locomotive Electrical Energy
Energy (kW*Hr)
Lap Number
Condition
Baseline
Lubricate
Dry Down
Lubricate
Dry Down
NatureBlend
Wheel Flange Lubrication
Electrical
CoF Gage Corner
TTCI Transit Track Testing:
Conducted November 1, 2014
Train: (2) EMD locomotives and
(30) 125 ton loaded coal cars


All Runs
Average Locomotive Mechanical Energy
Energy (kW*Hr)
Lap Number
Condition
Baseline
Lubricate
Dry Down
Lubricate
Dry Down
NatureBlend
Wheel Flange Lubrication
Mechanical
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Of note in the charts above is NatureBlend's ability to immediately reduce the gage face CoF with each application of the product. Due to the limited time available for testing, we were not able to return the track to the original 0.44 CoF; however the chart demonstrates with a reduced gage face CoF, the energy measurements were consistently lower than with a dry rail.

The dry down laps at the end of the charts were conducted the following morning Sunday, November 2nd, 2014. The initial spike in energy consumption can be attributed to conditioning of the track and warming of the oil in the car gear boxes. The dry down laps illustrate a trend of the increasing CoF without lubricant being applied and the electrical and mechanical energies returning to near baseline levels.

The dry average was determined by averaging the 3 baseline laps. Once lubrication was initiated the results indicate an immediate reduction in CoF and energy requirements after a single lap. Subsequent laps continue to reduce energy requirements and average energy savings for both sets of lubricating tests can be found in the chart below:

NatureBlend Analysis Results (% Reduction in Energy Requirements)		
	Mechanical Energy (KWH)	Electrical Energy (KWH)
Dry Average	563.26	603.93
Test 1 Average	549.57	591.60
Test 2 Average	509.60	577.59
Test 1 Reduction	**2.49%**	**2.08%**
Test 2 Reduction	**- ***	**4.56%**

resulted after coupler recalibration due to power failure

CONCLUSION

Upon completion of test operations, test controller confirmed NatureBlend clearly reduced mechanical, electrical, and gage face friction in very stringent conditions proving steerable trucks can realize benefit from effective flange lubrication.

The biodegradable and renewable materials used in the NatureBlend formulation have proven to provide a quantifiable benefit to railroad operations. The formulation ensures the material can be quickly applied to the rail and provide residual benefit.

Appendix A

Lap	Condition	Mechanical Energy (KW)	Electrical Energy(KW)	CoF	Temperature	Wind	Time
1	Conditioning	608.87	647.39		46	0	9:13
2	Conditioning	598.81	639.58		46	0	9:26
3	Conditioning	578.78	620.54	0.49	46	2	9:38
4	Conditioning	602.87	639.1		47	2	9:50
5	Dry	562.3	606	0.49	48	4	10:07
6	Dry	567.91	607.97	0.43	49	4	10:19
7	Dry	559.57	597.83	0.44	50	5	10:31
8	Lube	551.010	594.820	0.26	54	6	11:48
9	Lube	555.430	593.200	0.27	54	6	12:00
10	Lube	536.260	584.140	0.26	56	5	12:12
11	Lube	553.350	594.700	0.27	56	11	12:24
12	Lube	551.810	591.160	0.29	56	10	12:36
13	Dry-Down	560.770	599.550	0.33	69	5	2:21
14	Dry-Down	548.680	588.700	0.33	70	5	2:32
15	Dry-Down	532.800	561.420	0.36	72	4	2:53
16	Lube	510.720	573.660	0.27	70	4	4:30
17	Lube	512.130	579.540	0.26	69	4	4:42
18	Lube	514.000	583.740	0.31	69	4	4:54
19	Lube	494.550	564.310	0.34	68	4	5:06
20	Lube	521.720	591.560	0.31	67	4	5:18
21	Lube	504.478	572.750	0.36	65	4	5:30
22	Dry-Down	553.590	619.860	0.33	64	4	8:43
23	Dry-Down	516.690	582.300	0.31	65	4	8:55
24	Dry-Down	486.160	551.490	0.36	66	4	9:07
25	Dry-Down	517.880	583.630	0.32	67	4	9:19
26	Dry-Down	484.880	550.950	0.34	68	5	9:31
27	Dry-Down	542.480	612.080	0.33	67	7	10:16
28	Dry-Down	532.670	592.150	0.37	66	8	10:28
29	Dry-Down	536.680	593.400	0.39	67	8	10:40