MPL Technology Hopper Applied Top of Rail Lubrication Test

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Prepared for MPL Technology, Inc.
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...a subsidiary of the Association of American Railroads
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1.0 INTRODUCTION

MPL Technology, Inc. (MPL) contracted Transportation Technology Center, Inc. (TTCI), located in Pueblo Colorado, to perform a vehicle-mounted top of rail (TOR) lubrication system.

The test was performed to quantify and document if there was any reduction in energy required for train movement. The test was conducted using two locomotives and 30 cars traveling around a 3.4-mile loop. Energy readings were recorded and documented on a completed lap-by-lap basis. The readings were then compared between dry (no lubrication) baseline readings to lubricated readings. To assist in the energy readings recorded onboard the locomotive, a hand-operated tribometer was used to measure friction conditions of the contact between the wheels and the rail. The tribometers were used to help determine when the rail was considered “lubricated” by MPL personnel and their representatives.

TTCI supplied two SD70MAC locomotives (BNSF 9679 and BNSF 8878) equipped with MPL flange lubrication systems, a 100-ton hopper car, and 29 loaded 125-ton capacity hopper cars. The lubrication system was mounted on the first truck of the 100-ton hopper.

2.0 OBJECTIVES

The objectives of the test were to quantify the energy savings that could be achieved between dry and lubricated rail conditions. The test was also to document the residual effects (positive or negative) of a rail vehicle-mounted TOR system for subsequent trains.

3.0 TEST MATERIALS

3.1 Track Used

Testing was performed at TTCI’s facility, on the Wheel Rail Mechanism (WRM) Loop. The WRM loop consists of 3- to 12-degree curves and is 3.4 miles long (Figure 1).

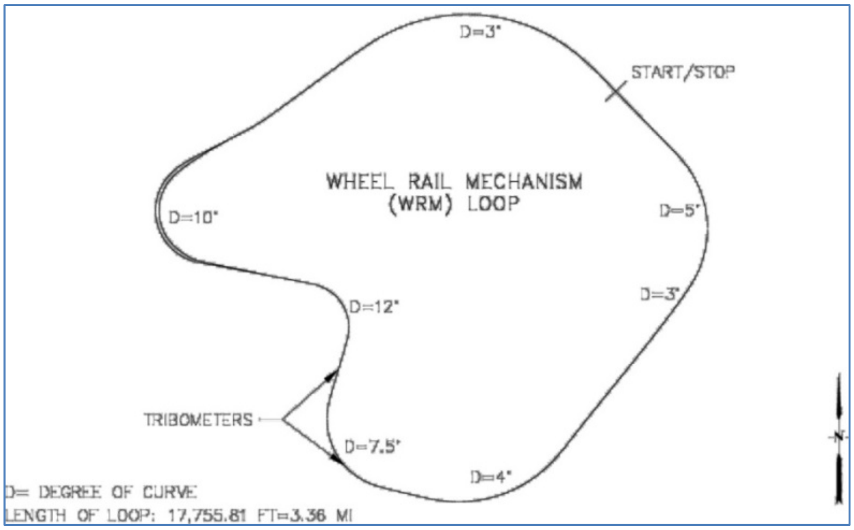

Figure 1. Wheel/Rail Mechanisms Loop

3.2 Equipment Used

The test consist was made up of two SD70MAC locomotives, a 100-ton hopper car, and 29 125-ton capacity hopper cars. The lead truck of the 100-ton hopper, which was the first car of the train, was equipped with the MPL truck-mounted solid stick TOR lubrication applicator. The 100-ton hopper also had an instrumented coupler on the front of the car.

3.3 Test Consist Setup

The test consist was made up of two SD70MAC locomotives, a 100-ton capacity coal hopper car equipped with the MPL TOR lubrication system and an instrumented coupler, and 29 loaded 125-ton capacity coal hopper cars. The total consist weight was 5,128 tons, and trailing tonnage (behind the lubrication hopper) was 4,696 tons.

4.0 TEST PROCEDURE

All testing was performed at a target speed of 30 mph. As with any piece of large equipment, this exact speed could not be strictly maintained because of grade and curvature. Train handling and consistent speed lap to lap was maintained to minimize lap-to-lap variation. No air brakes were used during testing to control train speed on downgrades, and the train was consistently handled using dynamic braking only. Dynamic brakes only were also used to stop the train.

The two SD70MAC locomotives were equipped with instrumentation to measure electrical energy, and the instrumented coupler was used to obtain mechanical energy. A typical energy test was conducted to quantify energy differences between dry and lubricated conditions, and the test was carried out using the procedure outlined below:

1. **Establish dry baseline energy readings**

   Dry baseline readings are established when a minimum of three consecutive laps at test speed (30 mph) are conducted and the electrical and mechanical readings are consistent, as determined by TTCI personnel.

2. **Apply lubricator sticks**

   Once dry baseline conditions are established, the train is stopped and the lubricators are engaged. The train then runs laps until a lubricated condition is reached, as defined by consistent energy readings **and** tribometer readings. The lubrication call is up to the vendor or determined by the tribometer readings. Energy readings and tribometers readings are recorded for all laps at test speed.

3. **Remove lubricator sticks**

   Once lubricated conditions are established, the train is stopped and the lubrication system is disengaged. The train then runs laps until dry baseline energy readings are reestablished and tribometer measurements indicate dry track.

4. **Repeat steps 1-3**

   Once dry baseline conditions are reestablished, the lubrication and dry-down cycles (Steps 1 through 3) are repeated. If lubricated energy readings are consistent for each cycle, the test is complete. If readings are inconsistent, a third lubrication cycle needs to be performed.

4.1 Equipment

Friction measurements were taken at two locations (Figure 1) using hand-operated tribometers. MPL personnel and/or their representatives determined when the rails were properly lubricated and the train could be stopped and the lubricator sticks removed.

5.0 TEST LOG

Table 1 shows the test runs and observations for the lubrication test.

Table 1. MPL Test Summary

Lap #	Time	Condition	Avg Speed	Notes
0	11.11	Dry/Baseline		
1	11:21		29.2	
2	11:29		28.3	
3	11:36		29.7	
4	11:43			Slow down lap so no energy and speed.
	11:52			Stopping at Summit to re-install TOR sticks. Test #1 with TOR sticks installed
0	11:58	TOR lube on		
1	12:06		30.2	
2	12:12		29.9	
3	12:19		30	
4	12:26	Slow down lap		
				Stopping at summit to remove TOR sticks. Post stick length (right 16 5/8 in) & left (14 7/8 in)
0	12:41	Dry/Baseline		
1	12:49		30	
2	12:55		30.3	
3	13:02		30	
4	13:09		30	
5	13:23		28.6	
6	13:30		29.6	
7	13:37		29.4	
8	13:43		30.1	
9	14:00			Stopping to install TOR sticks for test #2. New baseline established at lower level than desired.
				Tribo measurements indicate a dry track.
				Pre stick length for lube test #2(right 16 5/8 in) & left (14 7/8 in)
0	14:07	TOR lube on		
1	14:15		30	
2	14:22		29.9	
3	14:29	Slow down lap		
	14:38			Stopping at summit to remove TOR sticks. Post stick length for test #2 (right = 15 in) & (left = 12 3/4 in)
0	15:24	Started drydown	Sanders on	
1		No energy data called in		
2	16:02		26.7	
3	16:09		29.5	
4	16:19	Slow down lap to stop		
	16:26	**END of TEST**		

6.0 INSTRUMENTATION AND DATA COLLECTION

The electrical power for the two locomotives was measured by installing an Ohio Semitronics 10,000 amp current loop transducer on the current-carrying conductors leading to the traction motors. Also, an Ohio Semitronics 2,500 volt transducer was placed on the current loop transducer to measure the main generator voltage. A data collection system provided by TTCI was used to acquire the main generator volts and amps. From the volts and amps recorded, electrical and mechanical energy were computed and converted into kilowatt hours. For signal conditioning, Instrum signal conditioner buckets were used, and a Panasonic Toughbook computer configured with a 12-bit analog to digital converter was used to record the data. Train speed and GPS location information were obtained using a Garmin 12-channel receiver.

The mechanical power was obtained by recording the output from a 1-million-pound capacity instrumented coupler that was installed in a 100-ton capacity loaded hopper car positioned directly behind the trailing locomotive. (It should be noted that most of the recorded data was less than 150,000 pounds, resulting in a non-ideal signal-to-noise ratio. The minor differences in the measured mechanical power are related to some error in the coupler force measurements.) The mechanical power was then converted to force and then to kilowatt hours. This was done by multiplying the coupler force by the train speed and a conversion constant (1.986), then summed over time to compute kilowatt hours. The GPS signal was used in the computing of the kilowatt hour numbers.

7.0 RESULTS

Table 2 and Figure 2 show the results of the first run of testing with the lubricator sticks. The lubricator system was not working properly on the outside rail so the test was halted.

Table 2. MPL TOR Lubrication Results

		Energy (kWh)		Tribometer (COF)	
		Mechanical	Electrical	Inside Top	Outside Top
Run 1	Dry (Baseline) Average	240.71	319.16	0.48	0.47
	Lap 0	---	---	0.50	0.39
	Lap 1	220.44	296.28	0.50	0.47
	Lap 2	224.15	299.40	0.50	0.47
	Lap 3	224.15	302.64	0.50	0.50
	Lap 4	---	---	0.32	0.50
	Run 1 Average	222.91	299.44	0.46	0.47
	Savings (%)	7.39	6.18	---	---

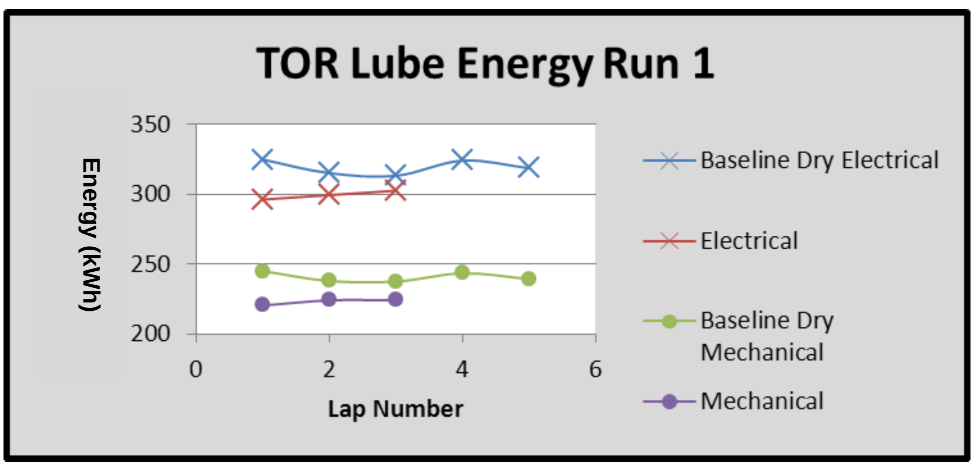

Figure 2. Results of Run 1 Plotted

Dry baseline conditions were established at an average energy value of 240 mechanical kilowatt hours and 319 electrical kilowatt hours for the six laps that were run with the lubricator sticks disengaged. After four laps around the WRM loop (13.6 miles) with the TOR lubricators engaged, the average energy for the four laps was 222 mechanical kilowatt hours and 299 electrical kilowatt hours. The energy savings from the lubricator sticks for the first run is 7.39 percent mechanical kilowatt hours and 6.18 percent electrical kilowatt hours.

Four laps with the TOR lubricators disengaged were required to reestablish a dry baseline condition for lubrication cycle 2. During these passes, tribometer measurements were taken to ensure that the rails were back to dry conditions, as well as monitoring the energy of the locomotives. After four laps, TTCI was satisfied that the conditions had returned back to dry. Average dry baseline conditions for lubrication cycle 2 were established at 235 mechanical kilowatt hours and 319 electrical kilowatt hours, as Table 3 and Figure 3 show.

Table 3. Data from Second Run

		Energy (kWh)		Tribometer (COF)	
		Mechanical	Electrical	Inside Top	Outside Top
Run 2	Dry (Baseline) Average	235.02	319.34	0.44	0.50
	Lap 0	---	---	0.37	0.50
	Lap 1	220.44	296.28	0.47	0.50
	Lap 2	224.15	299.40	0.35	0.37
	Lap 3	224.15	302.64	0.35	0.30
	Lap 4	---	---	0.33	0.32
	Run 2 Average	222.91	299.44	0.37	0.40
	Savings (%)	5.15	6.23	---	---

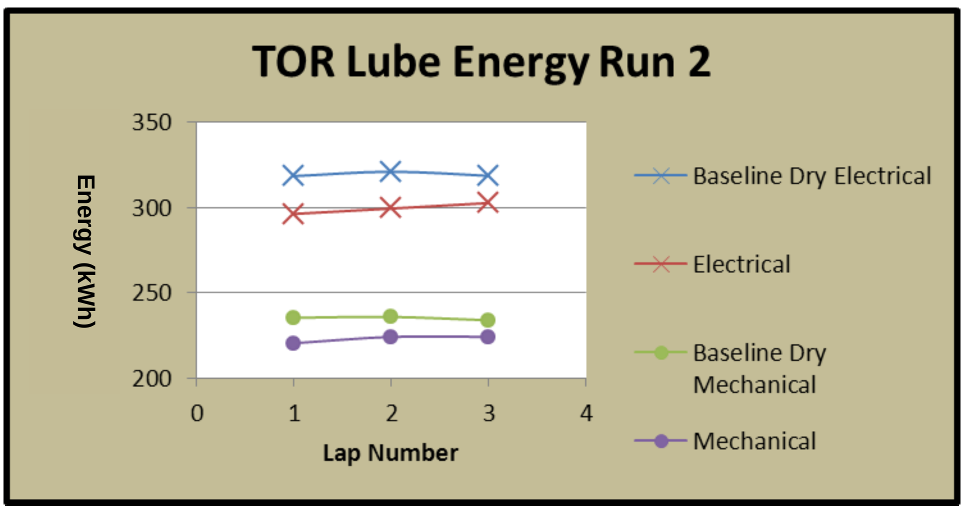

Figure 3. Results of Run 2 Plotted

After three laps (10.2 miles) with the TOR lubricators engaged, the average energy for the three laps was 222 mechanical kilowatt hours and 299 electrical kilowatt hours. The energy savings from the lubricator sticks for run two is 5.15 percent mechanical kilowatt hours and 6.23 percent electrical kilowatt hours.

Ten laps with the TOR lubricators disengaged were required to reestablish a dry baseline condition for lubrication cycle 2, showing that the lubrication has some residual effects if applied to both rails. As with Run 1, tribometer measurements were taken to ensure that the rails were back to dry conditions, as well as monitoring the energy of the locomotives. It was determined that after 10 laps the rail had returned back to dry. Average dry baseline conditions were established at 229 mechanical kilowatt hours and 318 electrical kilowatt hours for Run 3, as Table 4 and Figure 4 show.

Table 4. Data from Third Run

		Energy (kWh)		Tribometer (COF)	
		Mechanical	Electrical	Inside Top	Outside Top
Run 3	Dry (Baseline) Average	229.91	318.92	0.44	0.44
	Lap 0	---	---	0.48	0.33
	Lap 1	218.49	306.87	0.38	0.37
	Lap 2	216.58	303.37	0.37	0.37
	Lap 3	---	---	0.37	0.34
	Run 2 Average	217.54	305.12	0.40	0.35
	Savings (%)	5.38	4.33	---	---

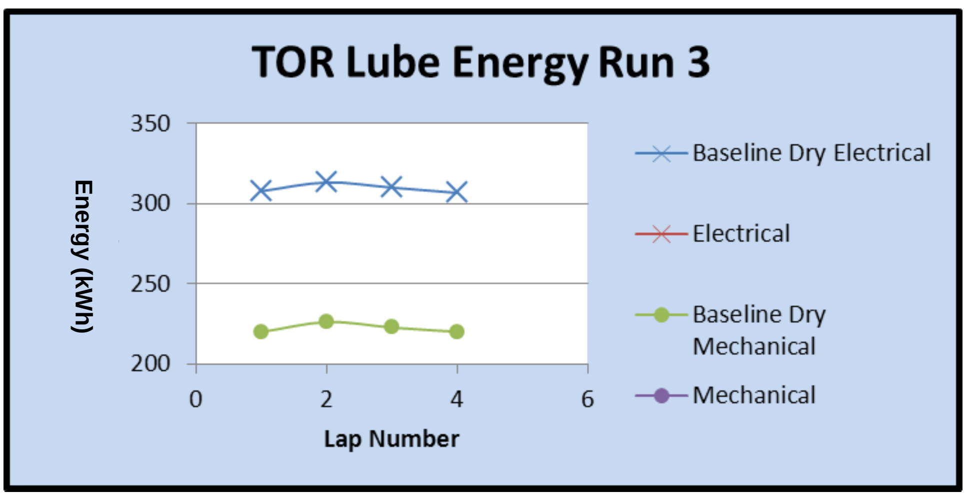

Figure 4. Results of Run 3 Plotted

After three laps (10.2 miles) with the TOR lubricators engaged, the average energy for the three laps was 217 mechanical kilowatt hours and 305 electrical kilowatt hours. The energy savings from the lubricator sticks for run three is 5.38 percent mechanical kilowatt hours and 4.33 percent electrical kilowatt hours.

At MPL's request, no data runs were made to reestablish a dry baseline condition in order to document residual effects for lubrication cycle 2.

8.0 CONCLUSION

Based on the data collected and the results of the data, it shows the TOR lubricator sticks reduce energy consumption. More testing will be required to fully document the correct operating procedure, application, and results of the TOR lubricators.

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