Truck Operation at Constant Reduced Tire Pressure

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The U.S. Forest Service, in cooperation with log truck operators and tire manufacturers, has been operating loaded trucks with tire pressures down to 65 psi. This pressure is significantly lower than the 90- to 110-psi tire pressures normally used by the trucking industry. The tires remain at this constant but reduced pressure and the pressure is not increased when the truck is operated on paved roads at highway speeds. The pressure selected is the lowest allowable pressure considering the maximum load and speed the vehicle will encounter during its operation. In this study, 65-psi tire pressures were used and maximum speed on paved highways was restricted to 55 mph. Operation at constant reduced tire pressure can accomplish many of the benefits obtained with central tire inflation (CTI) systems, but without the need for expensive hardware. No detrimental effects were observed in the tire casings, nor was there an increase in fuel consumption. Benefits include reduced road damage to roads with weak structural sections. Ride quality and traction also improved. Limitations do apply to the length of the loaded travel at highway speeds. Vehicles must be equipped with radial tires. This study at constant reduced tire pressure is an outgrowth of CTI studies that vary tire pressure to suit the load, road surface, and speed of the vehicle.

The USDA Forest Service, in cooperation with log truck operators and tire manufacturers, has been operating log trucks with tire pressures significantly lower than the pressures normally used by the trucking industry. In 1984, the Forest Service began testing the use of lower tire pressures in conjunction with central tire inflation (CTI) studies. The basic principle of CTI is to vary tire pressures to select the optimum tire pressure for each phase of a particular vehicle operation.

This tire operation at constant reduced low pressures differs from CTI in that the pressure in the tires is not varied. It is set at a constant pressure, on the basis of the maximum speed and load for the specific hauling operation. The pressures selected are within the tire manufacturers' recommended practices, but are significantly lower than the pressures customarily used by truckers. The tire pressure selected is based on the condition of the road surface and the maximum speed and load the tires will encounter. In this study, 65-psi tire pressures were used and maximum speeds on the paved highways were restricted to 55 mph.

BACKGROUND

It was documented in the 1987 Low-Volume Road Proceedings, that reduced tire pressures are beneficial both to paved and unpaved roads (*1*). Vehicle mobility, ride, fuel economy, and road surface conditions all improved when low tire pressures were used on unpaved roads. Tire pressures were then increased for vehicle operation on paved highways at higher speeds. Loaded log trucks have historically operated with tire pressures between 90 and 110 psi.

Heavy vehicles cause a disproportionate amount of damage to the structural sections of roads. Damage may occur regardless of whether the road has native, gravel, or asphalt surfacing. A reduction in tire pressure distributes the tire load to a larger area of the road's structural section, thus reducing unit loadings.

Many truck haul operations involve a portion of travel on unpaved roads and the remainder on paved highways. CTI systems are ideal for adjusting tire pressure to match the load and speed requirements for tires. However, the cost and limited availability of the hardware needed to change tire pressures from the truck cab are disadvantages. Stationary airing stations may be used to vary the pressure in tires, but they also require expensive hardware and create costly delays for the trucker.

A simpler method was needed to achieve many of the benefits that reduced tire pressures create for weak or unpaved roadbeds and still permit the flexibility to operate on paved highways at higher speeds.

Rationale for Selecting Tire Pressures

The limiting factor for this study was the selection of a reduced tire pressure that would benefit unpaved roads and would still permit loaded haul at highway speeds. Sixty-five pounds per square inch for the drive and trailer tire pressures was selected for the following reasons:

- A CTI demonstration project on the Mendocino National Forest near Ukiah, California, used air compressors to vary tire pressures. Loaded trucks operating with 45-psi tires produced beneficial results to the unpaved road. In another project, Foglio Trucking, on the Siuslaw National Forest in western Oregon, operated CTI-equipped trucks with 60-psi tires. By visual observation, the aggregate surfaced roads in both projects experienced similar beneficial results with 45- and 60-psi tires.
- A drawbar pull test in Auburn, Alabama, studied tractive effort as related to tire pressure (*2*). Loaded trucks were tested with tires inflated to 30, 65, and 100 psi. Test results showed a 34 percent increase in pull on a sandy soil and a 17 percent increase on wet clay for tires at 65 psi over tires at 100 psi.

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There was not a significant increase in drawbar pull on either road surface when tire pressures were decreased from 65 to 30 psi.

- These findings suggested that tire pressures near 60 psi would provide significant benefits to unpaved roads. The pressure of 65 psi was selected for the test project because it was the lowest pressure that would still permit 55-mph haul on highways according to tire manufacturers' requirements (see Table 1).

Tables for Tire Pressure, Load, and Speed

The National Tire and Rim Association and individual tire manufacturers publish information regarding minimum and maximum tire pressures for various tire loads and speeds. This test of operation at constant reduced tire pressure met manufacturers' recommended pressures for the specific tire used. Table 1 was developed from Michelin's truck tire data book for 11R24.5 highway tires (*3*).

For this test, Michelin authorized a 4 percent increase in load with a speed restriction of 55 mph. Each dual tire with 65 psi carried 4,250 lb. Additional increases in load are permitted with each 5-mph reduction speed.

CASE STUDIES

Three separate studies using constant reduced tire pressures were conducted: the Quincy, Soper-Wheeler, and Sonora tests. The Quincy test consisted of six log trucks equipped with new Michelin 11R24.5 radial truck tires on all 18 wheels. Tire inflation pressure was set at 65 psi in the eight drive tires and in the eight trailer tires. The steering tires were set 10 psi higher, at 75 psi, to provide better steering response. When loaded, the trucks carried up to 80,000 GVW. These reduced tire pressures still permitted operation on highways at speeds up to 55 mph when loaded.

Figure 1 displays the axle configuration and tire pressures for the Quincy and Sonora tests. The Soper-Wheeler test used pressures 5 psi higher.

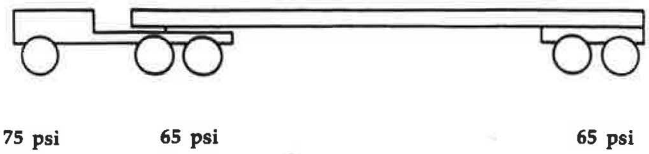

FIGURE 1 Axle configuration and tire pressures for the Quincy and Sonora tests.

The Quincy test began in the spring of 1988 and has operated for three 8-month logging seasons. Clover Logging's trucks hauled logs from over a dozen different locations on the Plumas National Forest to the lumber mill in Quincy, California. The haul route typically included a native or gravel surfaced forest road, a paved or chip sealed county road, and a paved state highway. The duration of haul on the paved highways was less than 1 hr. Speeds were restricted to a maximum of 55 mph. The typical round-trip haul was 50 mi and consisted of approximately equal distance on paved roads and on gravel or native-surfaced roads.

The Soper-Wheeler test was conducted in the spring and summer of 1990. Soper-Wheeler, Inc., a timber company near Oroville, California, operated four trucks at constant reduced pressures. Trucks used existing 11R24.5 radial tires manufactured by Dunlop. Pressures were deflated from their customary 100+ to 70 psi. Steering axle tires were again 10 psi higher, at 80 psi. The haul route consisted of approximately 20 mi of unpaved forest roads, 25 mi of paved county roads, and 60 mi of straight, level state highway. The determination of the effects of lower tire pressures on fuel consumption was a primary objective of the test because the travel was mostly at higher speeds on paved highways.

The Sonora test was the only test to operate during the winter. The haul route included 15 mi of aggregate and native surfaced forest and county roads and 25 mi of paved county and state highways near Sonora, California. Six log trucks, owned by Lone Pine Logging, were operated at the tire pressures shown in Figure 1. The road typically experienced morning freezing of snow or rain water and roadbed thawing in the afternoon. The test was operated partly because of the unacceptable condition of this road the previous winter while using high tire pressures.

RESULTS

Road Surface

The unpaved roads in the Quincy test required significantly less maintenance blading than they did before the use of reduced tire pressure operations. One gravel road, for example, required only one spot blading instead of the customary three complete bladings for the same volume of traffic. The benefits to the unpaved road were similar to those experienced in other variable tire pressure operations in which tire pressures were

TABLE 1 RECOMMENDED TIRE PRESSURES FOR VARIOUS TIRE LOADS AND SPEEDS (*3*)

	Speeds up to 65 mph							
psi	65	70	75	80	85	90	95	100
Single tire	4,465	4,705	4,960	5,235	5,513	5,780	6,105	6,430
Dual tires	4,079	4,285	4,534	4,740	4,976	5,200	5,495	5,790
Speeds restricted to 55 mph								
Single tire	4,559	4,799	5,059	5,340	5,623	5,896	6,227	6,559
Dual tires	4,160	4,371	4,625	4,834	5,076	5,304	5,605	6,690

varied with the use of air compressor stations or with CTI systems (*3*).

The Soper-Wheeler test also experienced a noticeable reduction in washboarding of the unpaved roads.

The Sonora test created a marked improvement in the condition of the unpaved county road. This road had become almost impassable during the previous winter log haul operation using high tire pressures. Local residents living along the road had complained of difficulty in driving the road because of segments of deeply rutted road. There was a significant improvement in the surface condition of the road the winter in which reduced tire pressures were operated. The deep rutting of the road experienced with the high tire pressures the previous year did not occur. There were similar amounts of rainfall both winters. It was the consensus of road users that the road surface remained in good condition during the entire winter season of haul.

Ride quality for the truck operator, especially in the loaded truck, improved in all three tests. The increase in vehicle traction was especially apparent to drivers on the slippery road in the Sonora test. Other CTI studies (*4*) have indicated benefits to paved structural section in addition to unpaved road surfaces.

Fuel Consumption

During the second season of the Quincy test, four trucks were operated for 2 weeks at reduced tire pressure, then a week at high tire pressure of 90 psi. Fuel consumption and mileage traveled were recorded daily. Loaded truck weights were not recorded. Drivers used load scales on the log bunks to achieve as near as possible a maximum legal load for each trip. Three trucks obtained a 3 percent increase in fuel economy with high-pressure tires. One truck had a 4 percent increase with the reduced-pressure tires. Fuel consumption for all the trucks was in the range of 3.5 mi/gal. Considering variables of load and driver differences, no significant change in fuel consumption was noted.

One truck and driver in the Soper-Wheeler test was used to study the effects of fuel consumption. Logs were hauled from the Plumas National Forest to a saw mill in Paskenta, California. The log trailer was piggy-backed on the return trip. Seven round-trip loads were hauled a total of 1,462 mi with 90 psi in the tires. Fuel consumption was 4.75 mi/gal. Eight loads were hauled to the same destination using the same truck and driver, but with 70 psi in the tires. The lower tire pressure haul covered 1,711 mi and averaged 4.80 mi/gal. Fuel consumption with lower tire pressures showed a slight improvement of 0.05 mi/gal even though the haul was predominately on the highway at 55 mph.

Tire Wear

Specific tire tread life data were not a part of the study. The tires in the Quincy test have begun to be recapped. Recapping is generally occurring between 25,000 and 30,000 mi. The subjective evaluation of the truck owner is that tire wear is unchanged from the previous high tire pressure operations. Four tires were damaged during the test, but none of the damage was attributed to reduced tire pressure operation. The tires will continue to be operated at 65 psi for the life of the casing.

Tread Type

Michelin's XDHT tread pattern was used in the Quincy test. This is a cross-tread pattern creating individual blocks of tread. Drivers complained of a squirmish feel on the paved highway with the reduced tire pressures. Once the tread was half-worn, drivers reported a better feel to the tire. The XZY rib tread was used in another CTI test without this complaint. Rib treads are inherently more rigid and better suited for operation on paved roads at reduced pressures. Figure 2 shows the differences between the two tread patterns.

LIMITATIONS

Drive tires with 65 psi still constitute a relatively high tire pressure when the truck is empty. Drivers of empty trucks did experience some rough ride. With the trailer piggy-backed, the load per drive tire is less than 3,000 lb/tire. In the Quincy test, empty trucks did create some road washboarding on steep switchback curves on one of the haul roads. However, the washboarding was significantly less than occurred in previous years when 90 psi was the standard tire pressure. Previous CTI studies have shown that when the air pressure in the drive tires of the empty trucks is reduced to 25 psi, washboarding does not occur (*1,2*).

Trucks must be equipped with tubeless radial tires for operation at lower pressures. Travel at highway speeds may need to be limited because tire casing heat buildup could be detrimental on a sustained high-speed haul.

The length and maximum speed of the loaded haul on the highway affects the selection of the lowest permitted air pressure. Most tire manufacturers publish load tables for tire pressures down to 65 or 70 psi. These tables should be used in the selection of a specific tire pressure.

NEED FOR FUTURE TESTING

Additional testing is needed to determine if there is a quantifiable difference in the condition of a gravel road surface

FIGURE 2 Tread patterns of the XDHT cross rib tread (*left*) and the XZY rib tread (*right*).

when 65- and 70-psi tires are operated. The test should ideally study the effects of tire pressures between 45 and 90 psi. Additional testing is also needed to test road performance with unloaded trucks with a range of tire pressures down to 25 psi.

CONCLUSIONS

Operation at constant reduced tire pressure promises significant benefits for many truckers. It is simple and inexpensive to implement. When truck tire pressures were decreased from 90 psi to either 65 or 70 psi, the following conditions were noted:

- Unpaved road surfaces benefited significantly,
- Truck traction and ride improved,
- Fuel consumption was unchanged, and
- No detrimental effects were noted on tires.

This concept is applicable to log trucks, garbage trucks, ready-mix trucks, or buses. Any vehicle involved in haul situations involving unpaved roads or with a mix of paved and unpaved roads may benefit from operations at constant reduced tire pressure.

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