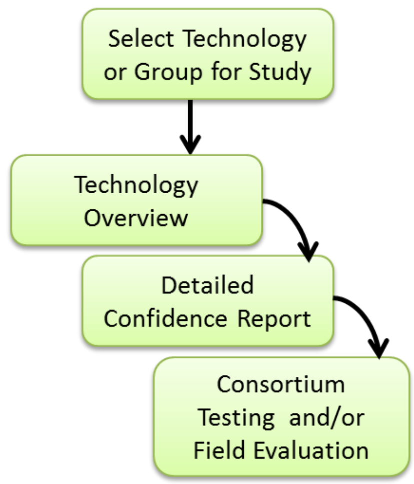
Technology Overview: Engine Parameters

Introduction

Trucking Efficiency is a joint effort between the North American Council for Freight Efficiency and the Carbon War Room to double the efficiency of North American goods movement through the elimination of market barriers to information, demand and supply.

The Operation is gathering and centralizing the many existing sources of data about the performance results of different technology options and working with the industry to share previously unpublished data, when employed in a variety of vehicle models and duty cycles, and making all of that data openly accessible and more cross-comparable. In order to generate confidence on the performance claims of efficiency technologies, *Trucking Efficiency* is conducting a series of studies, known as Confidence Reports. Confidence Reports have been published on tire pressure systems (Aug 13), 6x2 axles (Jan 14), and idle reduction solutions and a fourth coming this fall on automated transmissions.



Technology Overviews are the first step in the Confidence Report process and share readily available information on a particular technology or complementary set of technologies. Their intention is to supply a general overview on the topic and to solicit assistance and study sponsorships, to enable Trucking Efficiency to dedicate the resources for a complete Confidence Report, if it is needed. This overview discusses the opportunity to improve efficiency through the setting of Engine Parameters for Class 8 tractor trailers in North America. The team is considering completing a deep dive Confidence Report on this topic, if sufficient interest exists in the industry and sponsorship funds are obtained.

Summary Statement

Electronic diesel engines gained prominence in the mid-1990s. Tightening emissions regulations resulted in the use of electronics to manage the combustion process and forced the mandatory adoption of electronic engines. In the ensuing years, engine, truck and component manufacturers have continued to optimize the systems to take advantage of the abilities of electronics to improve the performance of heavy-duty trucks.

The benefits of lower fuel consumption associated with thorough and disciplined management of electronic engine parameters can be achieved across many different vocations, however this report focuses solely on long and regional haul tractor-trailer operations.

Technical Summary

Truck and engine manufacturers offer electronic engine parameters on new trucks and allow customers to select their own settings for each parameter. For instance, if a fleet owner asks to have the road speed governor set at 62 mph, during the manufacturing process the engine and truck will be configured with that setting. This is true for all of the available electronic engine parameters. And while the parameters are set during the manufacturing process, they can be changed at a later date as vehicle-operating conditions warrant.

Common Electronic Engine Parameters

While there are a wide variety of electronic engine parameters, this technology overview will focus on five: road speed governor, cruise control droops, gear down protection, load based speed control and extended idle shutdown. Note there are some parameters — such as reserve speed, which allows a drive to exceed the pre-set maximum road speed in order to pass; and engine brake service brake lock, which allows the driver to coast when decelerating before the engine brake engages — they have a more minor effect on fuel economy and are not covered in this Technology Overview. In addition, the driver is a key element in the fuel economy equation and his efforts to drive the vehicle in the most fuel-efficient manner should not be discounted.

The following terminology is that used by one engine manufacturer to describe its engine parameters. Each engine manufacturer has its own terminology to describe the programmable engine parameters on its engines. It was outside the scope of this Technology Overview to include terminology from all truck engine manufacturers

A **road speed governor** is designed to limit the maximum vehicle speed to help reduce fuel consumption. When vehicle speed reaches the pre-set limit, the engine reduces fueling to control maximum speed. On average, a truck traveling 65 mph instead of 75 mph will experience up to a 27% improvement in fuel consumption. As a rule, for every one mile per hour decrease in speed there is a 0.1 mpg fuel economy improvement. Road speed governors also provide some droop. The lower droop allows the vehicle speed to increase at light loads. This can be used to build momentum as the vehicle comes down one hill and goes into the next one. Upper droop reduces torque and thus fuel at full loads. Droop limits are also programmable.

Cruise control manages vehicle speed to an operator-adjusted value. It saves fuel because it controls the vehicle speed to a more precise value than what an operator can. This eliminates unnecessary overshoots and undershoots in vehicle speed. When active the cruise control always operates on one of three curves: upper droop, isochronous or lower droop. Each droop may be programmed between 0 and 3 mph. Higher values improve fuel economy, lower values improve speed control.

When the cruise control is operating on the upper droop curve and torque is at maximum, ECM-selected vehicle speed equals operator-selected vehicle speed minus the cruise control upper droop parameter. As torque output decreases, ECM-selected vehicle speed gradually approaches the operator-selected vehicle speed.

When cruise control is operating on the isochronous curve, the ECM-selected vehicle speed is the same as the operator-selected vehicle speed.

When the cruise control is operating on the lower droop curve and torque output is at minimum, ECM-selected vehicle speed equals operator-selected vehicle speed plus the cruise control lower droop parameter. As torque output increases, actual vehicle speed gradually approaches the ECM-selected vehicle speed.

Gear down protection encourages drivers to stay in the top gear. When the vehicle is in a gear other than top gear, the maximum road speed will be set lower than the allowed top speed. This encourages the driver to operate in top gear allowing the engine to run at its most efficient operating range. The engine also can detect the vehicle load and will allow higher road speeds with heavy loads in lower gears to prevent vehicles from slowing down too fast in top gear. For gear down protection to work properly, transmission setup and vehicle speed sensor features must be tuned correctly. In general, gear down protection delivers up to a 2% fuel economy improvement depending on driver skill and duty cycle.

Load based speed control senses the power demand and limits engine speed in gears below the top two gears, assuming full power is not being demanded. Load based speed control restricts engine speed to encourage early up shifting. A vehicle mass estimation algorithm detects heavily loaded vehicles that may require higher engine speed (more power) on hills, and automatically allows higher speed when needed. Load based speed control can deliver a 2% to 5% fuel economy improvement depending on driver skill and duty cycle.

Extended idle shutdown restricts the amount of time an engine can idle by automatically shutting off the engine after a predetermined time limit. A timer counts down when the engine is running but the vehicle is not moving and there is no operator interaction with the clutch, brake or accelerator. When the timer expires, the ECM shuts down the engine. An optional ambient air temperature sensor can be used to prevent engine shutdown in cold weather. Idle shutdown can be used with power take-offs to allow PTO operation above a minimum load level. Depending on the actual amount of idle time that is reduced, fuel economy improvements can be in the 7% range.

Fleet Experience

The electronic engine parameters are set when the vehicle is being manufactured, but can be changed in the field if there are changes to the fleet's operation such as truck routes in states with different speed limits or more mountains or hotter climates. Fleets can adjust the parameter settings to balance all the requirements of operating their trucks to achieve better fuel efficiency overall.

Unlike other fuel saving options — chassis side skirts, aerodynamic bumpers etc. — electronic engine parameters are invisible on the truck. Fleets, engine manufacturers and truck OEMs have systems in place to ensure that trucks are delivered as specified, but changes can be made to the electronic engine parameter settings throughout the truck delivery process. This can occur at repair areas at the end of the assembly line, in truck modification centers, at body builders or dealers and even at the fleet's delivery inspection. Changes can be unintentional, but will affect the truck's operation.

Benchmark fleets have systems in place to continuously monitor each truck and to ensure engine parameter settings are not altered, and they take action when they discover that a change has been made.

Regulation

There are no known obstacles in the U.S. federal operating territories or states that would prohibit the adoption or use of electronic engine parameters. U.S. EPA and NHTSA federal regulations that took effect in 2014 include controls on changes that can be made to trucks after initial production. This includes not allowing changes to the road speed governor that would affect the fuel consumption and therefore the exhaust emissions for trucks as they age.

Economics

Fuel consumption improvements can be achieved with each of these parameters. For a vehicle driving 125,000 miles per year, averaging 6 mpg with an average fuel cost of $4 a gallon, the money saved for each 1% fuel consumption improvement is $8,400 per year. Fleets have said they've seen a 5% to 15% improvement through adoption of various combinations of these five parameters. With limited initial capital investment, the adoption and maintenance of these features is common and crucial to continuing to keep fuel costs in check.

References

Garthwaite, Josie, "Smarter Trucking Saves Fuel Over the Long Haul," inboundlogistics.com, January 2012

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Help us transform the entire industry. Fuel-efficiency technologies abound, but the claims providers make about their technology's efficiency-improving values are equally numerous, and fleet owners need proof of the validity of performance data before adopting. *Trucking Efficiency* has been created as a trusted, unbiased source of information on fuel-saving technologies, their applications and potential solutions for financing their adoption. The NACFE and the CWR are developing a two-pronged strategy, addressing both informational and financial barriers, that will build credibility and fast-track the adoption of fuel-saving technology by class 8 commercial vehicles in the United States. This effort is driven by the fleets included in the NACFE technical advisory group, shown to the right. They along with every tractor and trailer end user are the primary customers of these confidence reports.

Project sponsorship is needed to complete the confidence report. Sponsorships are available as shown below. Contact either Mike Roeth, NACFE Executive Director at mike.roeth@nacfe.org or Ann Davlin, CWR Director, Development at adavlin@cabonwarroom.com.

The Carbon War Room

The Carbon War Room, founded by Sir Richard Branson, accelerates the adoption of business solutions that reduce carbon emissions at gigaton scale and advance the low-carbon economy. Learn more at www.carbonwarroom.com.

North American Council for Freight Efficiency

The North American Council for Freight Efficiency (NACFE) is a nonprofit organization dedicated to doubling the freight efficiency of North American goods movement. Learn more at www.nacfe.org.