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# Fuel Tank Capacity and Gas Pump Accuracy

*By Juana Williams*

Often when fuel prices rise as they have during 2005, weights and measures officials see an increase in the number of complaints related to the accuracy of gasoline pumps (retail motor-fuel dispensers). Frequently, weights and measures jurisdictions report receiving consumer complaints from motorists who believe they filled their vehicle's fuel tank with more gasoline than the tank is specified to hold. The possibility that the pump may be inaccurate exists, but typically complaints arise because the vehicle tank capacity rating is only an approximate volume. In this article we will examine some possible reasons why a motorist might see variations in tank capacity indications.

**Rated vs. Actual Fuel Tank Capacity**

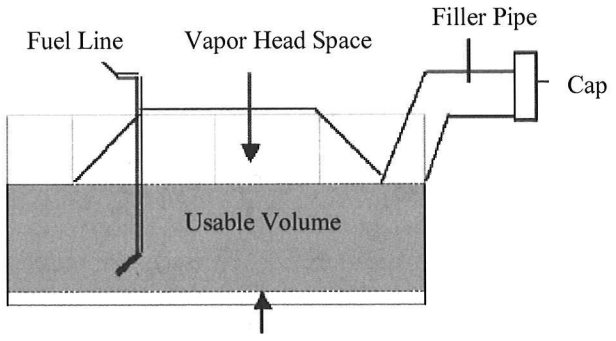
The vehicle's fuel tank capacity rating is a reasonable approximation given variables such as differences in design practices, test procedures, and other influence factors on the fuel system. Some manufacturers estimate that fuel tank capacity can vary by as much as 3 % from the actual tank capacity as a result of normal variations in design characteristics, the manufacturing process, and other inherent factors such as the physics associated with components and the electronics in the fuel system and fuel level indications. Knowing the vehicle's fuel tank capacity provides the driver with information needed to plan driving distance, refueling stops, fuel costs, etc., associated with highway travel. Tank capacity is also a factor used by vehicle components that monitor emissions and other on-board diagnostic equipment that affect fuel level indications. Typically, the owner's manual provides a reasonable estimate of the vehicle's fuel tank capacity. Some owners' manuals list fuel tank capacity in SI (metric) units, equivalent U.S. customary units, as well as other international units of measurement such as the British Imperial gallon, for example, 70 L (18.5 gal, 15.4 Imp gal). The tank capacity's numerical value is reported in tenth of whole figures rounded to the nearest value and, therefore, represents an *approximate* volume.

Various related terms are used by auto manufacturers and associated agencies to describe the actual (liquid- and vapor-space) and advertised fuel tank capacity and fuel levels important to drivers. In March 2005 the Society of Automotive Engineers (SAE) Refueling Interface Subcommittee published SAE J398, a guide that clarifies terminology as well as a procedure for establishing fuel tank capacity for passenger vehicles. In SAE J398, the vehicle's fuel tank capacity rating is reported as an average volume based on test data gathered on the capacity of multiple tanks. Representative samples of a particular type of fuel tank are filled to a prescribed number of automatic shut-offs by the pump nozzle to determine fuel tank capacity. Attempts by drivers to fill the fuel tank beyond the pump's automatic shut-off point can result in fuel being drawn into the pump's or vehicle's vapor recovery systems. Auto manufacturers choose the test conditions and may vary the test mode based on the intended use of the vehicle.

Drivers might find that a vehicle's fuel tank capacity rating includes only the usable portion of the tank's liquid capacity shown in the diagram below or both the usable and *un*usable portion of the tank's liquid capacity.

The *un*usable volume is the portion of the fuel tank's liquid capacity that lies at the bottom of the tank out of reach of the fuel pump. The usable volume is the portion of the fuel tank's liquid capacity that can be delivered through the filler pipe into the tank when the vehicle is level (and when the *un*usable volume is also in the tank). The vehicle's fuel tank capacity does not include the vapor headspace (that portion of the tank compartment at a level above the filler pipe neck) or the volume of the filler pipe. Sometimes drivers ignore the pump nozzle's automatic shut-off and continue to hold the nozzle operating the lever open in an attempt to deliver additional fuel. When this happens, the additional fuel begins to fill the vapor headspace and the filler pipe that are not considered part of the tank's rated capacity, thus resulting in a delivery of fuel greater than the fuel tank capacity rating stated in the owner's manual. Similarly, the lanes that surround the service station pumps may not be level and fuel may shift into the vapor space thus allowing more fuel to be delivered into the tank.

**Passenger Vehicle Fuel Tank Capacity**




Note: The diagram illustrates the parts of a fuel tank that relate to tank capacity. The dimensions do not represent the exact scale of each tank component.

***Indicated Volume***

Another scenario that can prompt consumer complaints involves the fuel tank capacity and the fuel gauge indication. When the fuel tank indicates a particular level, the customer frequently assumes that this represents a corresponding fraction of the fuel tank capacity. For example, on a fuel tank with an 18-gallon rating in the owner's manual, the consumer assumes that a "half-full" fuel gauge indication means that 9 gallons of fuel remains in the tank. When the consumer is able to dispense more than 9 gallons of fuel into that "half-full" tank, the consumer assumes that there is a total of more than 18-gallons of fuel in the tank, thus exceeding the fuel tank rating listed in the owner's

manual. The consumer then concludes that the gasoline dispenser must be in error and lodges a complaint.

In addition to considering the factors discussed earlier regarding fuel tank capacity, it is important to understand that manufacturers also take into account a number of factors when designing the fuel indications. Many variables have an affect on a vehicle's analog and/or digital fuel level indications. Auto manufacturers design fuel systems with gauges, lights, audible signals, and/or other indications to provide advance warning to the driver when fuel levels are low and warrant attention. Motorists would find it inconvenient if the fuel gauge needle pointed to "Empty" or the low fuel indicator light was designed to illuminate at the very moment the tank runs out of gas, not to mention the possible adverse affects to the vehicle's fuel system. In fact, some owner's manuals recommend maintaining a minimum level of fuel.

A shift in fuel levels may occur when the vehicle is not on level ground, for example, when parked on a hill or traveling around a curve. A temporary change in the position of fuel can cause the fuel gauge needle to shift and/or cause the low fuel warning light to flicker or give the appearance of more or less fuel in the tank than is indicated by the fuel gauge. Drivers should also keep in mind that the indicated fuel level could vary based on the position of the driver's eye when reading the fuel gauge needle on the instrument panel.

A reserve amount of fuel is present in the tank if the manufacturer elects to set the fuel gauge to indicate "Full" at a level just below the tank's actual liquid capacity. Similarly, reserve fuel may be present in the tank if the manufacturer designs the fuel gauge to indicate "Empty" at a level above the actual point where the tank runs out of fuel.

Some vehicles are also equipped with trip computers to assist the driver in planning travel based on the fuel that remains in the tank and mechanisms that estimate remaining mileage. These indications are also often used by the driver to determine the "quantity" of fuel in the tank prior to purchasing fuel. The vehicle's mileage for each gallon of fuel depends on a number of conditions such as vehicle-maintenance, age, cargo/passenger load, use of extra accessories such as air conditioning, or the motorist's driving habits, terrain, traffic, weather and even fuel composition. Any of these factors can increase fuel consumption if the end result is the engine must work harder. Consequently, increased fuel consumption will affect how soon the low fuel warning indicator lights up on the instrument panel. Trip computers may calculate the estimated miles that can be traveled on the fuel remaining in your tank based on the vehicle's fuel economy during a specific driving period. The estimated miles that can be traveled may vary since the calculated distance might be based on the worse or best case driving conditions that existed when the fuel economy was last determined by the vehicle's diagnostic equipment.

The points outlined in this article may be helpful in addressing complaints in which the consumer questions pump accuracy based on the rated capacity of the vehicle's fuel tank or the fuel tank indications. However, it is important to recognize that in some such instances there may actually be a problem with pump accuracy or its manner of use.

Consequently, it is prudent to thoroughly investigate all complaints in an attempt to determine the cause of the discrepancy.

If you have any questions about this information, please contact Juana Williams at 301-975-3989 or at juana.williams@nist.gov.