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Technical Report

Investigation of the Need for In-Use Dispensing Rate Limits and Fuel Nozzle Geometry Standardization

May 1987

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Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Sources
Office of Air and Radiation
U. S. Environmental Protection Agency

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I. Introduction

As a part of the technical information received during the development of EPA's draft refueling emissions test procedure, one auto manufacturer suggested that the in-use dispensing rate of gasoline would have to be controlled and gasoline nozzle geometries standardized in order to assure the proper in-use operation of onboard vapor recovery systems (onboard systems).[1] In response to this suggestion, the effects that these two parameters (dispensing rate and nozzle geometry) may have on refueling emissions control were studied. As is discussed below, this study led to the conclusion that a dispensing rate limit of 10 gallons per minute (gpm) would be complementary to the operation of an onboard system and the control of spillage-related refueling emissions since the maximum in-use dispensing rate and the dispensing rate for vehicle refueling emission certification testing would be the same. However, with regard to the second parameter, additional information and public comment is needed on the effects of nozzle geometries on refueling emissions control before it can be concluded that action is needed.

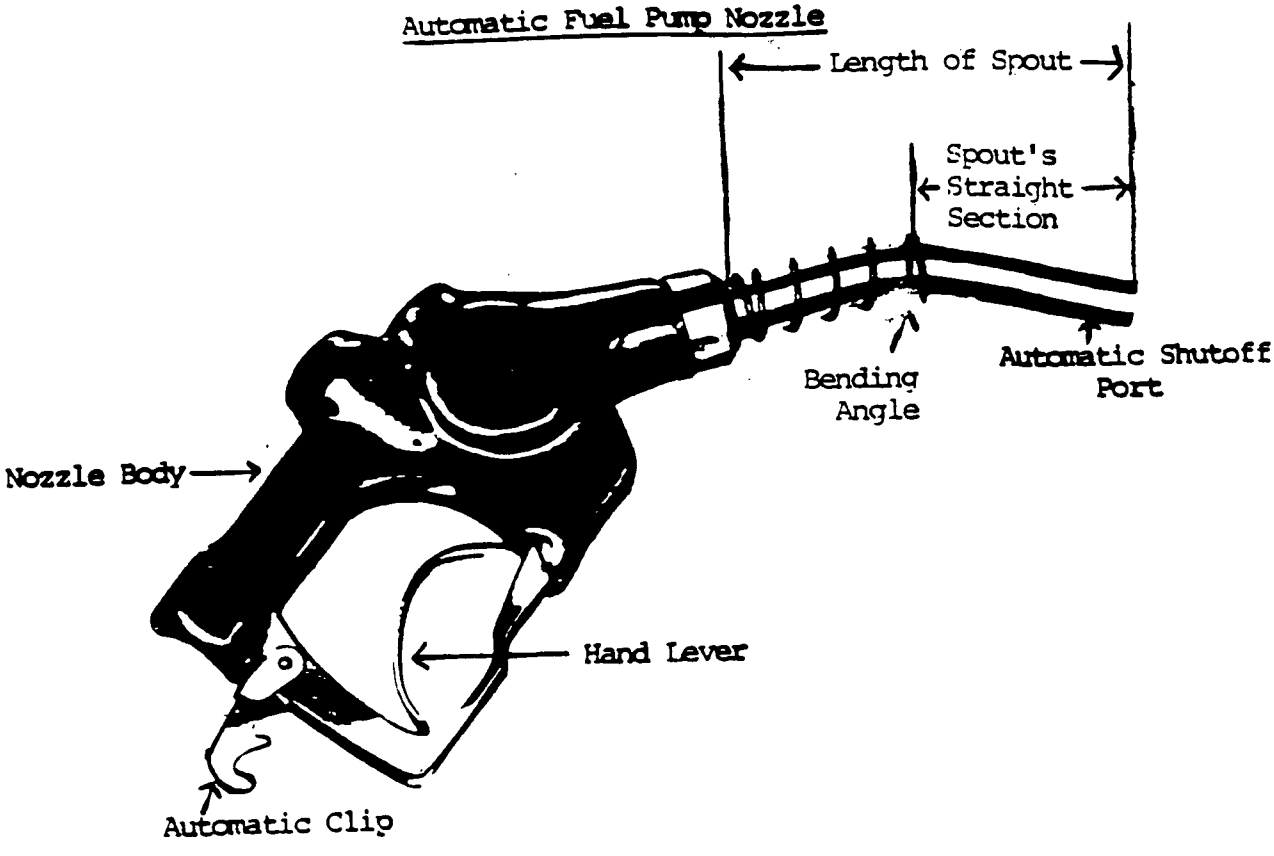
As a result of the conclusions from this study, the Agency pursued the development of a voluntary in-use dispensing rate standard with the American Petroleum Institute (API), which represents petroleum industry interests. As summarized in their statement of August 6, 1986,[2] API concluded that it is not feasible to develop a voluntary standard. API also concluded that it should be the motor vehicle manufacturers' responsibility to develop refueling control systems which cause nozzle shut-off without spitback if design flow limits are exceeded.

This report presents the results of the investigation of the effects of dispensing rates and fuel nozzle geometries on refueling emissions and supports EPA's proposal to regulate in-use dispensing rates and further study the need for some form of nozzle standardization. The first portion of the report is devoted to background. After defining a few key terms, the report begins with a discussion of the issues. This is followed by a presentation of EPA's statutory authority to regulate fuel dispensing rates. After this background information is presented, the benefits, implementation approach, and economic impact of a dispensing rate limit are discussed. The report closes with a brief summary and conclusions.

II. Definition of Terms

Defined below are some key terms related to fuel dispensing, fuel dispensing units, and related hardware. Items related to the fuel nozzle itself are identified in Figure 1.

Figure 1


Automatic Fuel Pump Nozzle
Length of Spout
Spout's Straight Section
Bending Angle
Automatic Shutoff Port
Nozzle Body
Hand Lever
Automatic Clip

"Spills" - loss of gasoline during the refueling event due to one or more of four causes: pre-fill drip, spitback, overflow, and post-fill drip.[3]

"Spitback" - discharge of gasoline from the fillpipe resulting from pressure build-up in the vapor space during an automatic fill.[3]

"Overflow" - loss of fuel from the fillpipe when the amount of gasoline dispensed exceeds the tank capacity; often caused by topping off.[3]

"Dispensing unit" - the entire refueling hardware that exists above ground.

"Pump" - the refueling hardware that exists beneath the ground or within the dispenser which drives the dispensing unit.

"Nozzle" - the hand-held portion of the dispensing unit which consists of the nozzle body, stem, and spout.

"Spout" - the terminal end of the fuel nozzle which fits into the vehicle's fillpipe when refueling.

"Automatic Shut-off Port" - the hole near the tip of the spout which activates the nozzle automatic shut-off when covered with liquid.

With these basic term definitions, it is now possible to discuss the issues involved in this study.

III. Discussion of the Issues

A limited amount of information available in the literature suggests that both the fuel dispensing rate and nozzle geometry can affect the amount of emissions generated in a refueling event. This relationship exists because both the dispensing rate and nozzle geometry can affect the amount of turbulent mixing which occurs in the fillpipe, and experience shows that refueling emissions vary directly with the amount of turbulent mixing.[4] Thus these parameters may have a small effect on both the uncontrolled refueling emission rate and the refueling emissions load to the canister in an onboard vapor recovery system. Further, in a related area, one source suggests that gasoline spills during refueling are also directly affected by the nozzle configuration and dispensing rate.[3]

The effect of dispensing rates and nozzle geometries on the control of refueling emissions and gasoline spillage is discussed below, together with the rationale for any potential regulatory controls. Dispensing rates are considered first and nozzle geometries follows.

A. In-use Dispensing Rates

The fuel dispensing rate is important because of its effect on the design and performance of an onboard vapor recovery system. As mentioned above, the fuel dispensing rate slightly affects the refueling emission rate which is one of the factors impacting canister size. In addition, since the fuel dispensing rate determines the rate at which fuel vapor is displaced from the tank during a refueling event, it also impacts the design of an onboard system. The major effects are on the vapor line diameter needed to optimize system backpressure characteristics, and the size and shape of the canister needed to capture the refueling emissions.

The dispensing rate also has some effect on the potential for gasoline spillage (spitback) during a refueling event. If the fuel is dispensed at a rate greater than vapors can be displaced from the system, backpressure within the system can increase and cause a premature shut-off of the fuel nozzle and the possibility of a fuel spitback.

Since the fuel dispensing rate is one of the key factors affecting the design of an onboard system, EPA had to establish a dispensing rate value for use in refueling emissions testing. Rather than arbitrarily choosing a value, it was important that the values specified in the certification test procedure be representative of the dispensing rates expected in-use.

An investigation of the current in-use dispensing rates by API revealed that values generally range from 6-12 gpm, with values normally lying between 8-10 gpm. The in-use dispensing rates of gasoline varies depending on a number of different factors. Older and smaller service stations use a suction pump which is located inside the individual dispenser. These suction pump dispensers normally operate at 8 to 9 gpm.[5] Newer, higher volume facilities use submersible turbine pumps which are located away from the dispensers and are either on or in the underground storage tank. They serve all the dispensers and nozzles drawing product from the tank, thus the actual flow rate varies depending on the number of nozzles being operated from one pump. These submersible pumps are of a higher horsepower, and deliver gasoline at rates of 10 to 12 gpm (presumably when only one or two nozzles are in operation) with a few newer facilities capable of operating at levels as high as 15 gpm under the same conditions.[2,5] One in-use survey reported full serve dispensing rates of 6.5 to 8 gpm with self service rates slightly higher at 9 to 11 gpm.[5] These rates were observed at various dispensers and from nozzles of different manufacturers. All of the available information indicates that most in-use dispensing rates fall in the range of 8 to 10 gpm with evidence of a trend toward higher rates in new stations using higher horsepower pumps.

Based on this information, the maximum dispensing rate in EPA's draft refueling emissions test procedure was set at 10 gpm to correspond to values near the higher end of the current in-use dispensing rate range.[6] The automobiles being certified will then be designed for and tested at conditions most comparable to those presented in-use. EPA's draft refueling test procedure would also essentially require that no fuel spillage occur during the refueling test, since any spilled fuel which evaporates during the test is included in the overall emission results. Thus, the implementation of onboard controls could also result in a reduction in fuel spillage (spitback) which now occurs when the fuel nozzle automatic shut-off is activated.

However, if the in-use dispensing rates increase as API predicts, the dispensing rate used for certification testing of onboard vehicles will no longer be comparable to those in-use.[2] Vehicles equipped with onboard systems will not be refueled in-use at the dispensing rates they were designed for in certification. Furthermore, many vehicles will not be designed to accept such high refueling rates and premature shut-offs and fuel spillage related to spitbacks may increase. Consequently, the expected reductions in emissions due to spitback spillage could be decreased or lost totally, and some of the benefits of controlling refueling emissions may be offset if spillage increases.

There are basically two options available to prevent an incompatibility between the certification and in-use dispensing rates. The first option is to set the dispensing rate used for certification testing equal to the maximum rate reasonably expected in-use in the future, rather than 10 gpm. This would ensure that the in-use dispensing rates do not exceed the rate used for certification, but it could increase the cost of onboard systems because they would have to be designed to handle much higher flow rates. This option also allows in-use dispensing rates to increase even further in the future since the vehicles would be able to accept these higher rates. Thus incompatibility between certification and in-use dispensing rates could reappear in the future, and the problem would not be solved.

The second option is to implement an in-use dispensing rate limit which is equal to the maximum rate used in the certification testing of onboard-equipped vehicles. As discussed above, this value would be 10 gpm. Under this option, retail gasoline marketers and wholesale purchaser-consumers would be required to limit the dispensing rate of their gasolines to 10 gpm. The maximum dispensing rate chosen for certification testing (10 gpm) is based on values found near the high end of the current in-use range, so most service stations would not be affected except to restrict any

future changes. This option would ensure that the certification and in-use dispensing rates remain comparable in the future. This compatibility would enhance the overall effectiveness of the onboard refueling controls and achieve additional control of refueling emissions by reducing the amount of in-use spillage.

Based on the discussion above, the second option is more favorable in assuring that the maximum certification and in-use dispensing rates remain equivalent. Establishing an in-use dispensing rate limit equal to the maximum certification rate (10 gpm) would guarantee that the rate used in the design of the onboard system for certification testing is comparable to that in-use. This would complement the performance of onboard controls and reduce in-use spitback spillage. In addition, an in-use dispensing rate limit will prevent increasing dispensing rates as vehicles that are designed to handle higher flow rates enter the fleet, as may have occurred under the first option considered. As will be discussed further below, this option could also provide additional environmental benefits by decreasing the amount of gasoline spillage which occurs during the refueling of vehicles without onboard controls.

B. Nozzle Geometries

As was mentioned previously in the introduction, at least one automobile manufacturer has expressed concern to EPA that without uniform nozzle geometries mechanical fillpipe seals may not be feasible. They feel such design standards should include at minimum an in-use dispensing rate limit, as well as specifications on length, diameter, position and angle of nozzle bends, position of latching mechanisms and control on burrs and protrusions that could potentially damage the seal mechanism and harm the onboard control efficiency.[1] In a broader context, the SAE Fuel Supply Systems Subcommittee has also expressed similar concerns regarding standard nozzle spout specifications. At a recent meeting of this Subcommittee, several auto manufacturers conveyed a belief that such nozzle standards are needed to ensure proper interface between the nozzle spout and auto fillpipe.[7]

In response to these concerns, EPA investigated the effects of fuel nozzle geometries. During this investigation, it was learned that nozzle geometries may have an effect on spillage. First, according to a study by Scott Research Laboratories, the nozzle bending angle and spout length are two factors affecting spitback spillage.[3] These can cause increased splashing against the fillpipe wall and greater turbulence.[4] This splashing and turbulence could cause more frequent premature nozzle shut-offs. The greater number of premature nozzle shut-offs results in an increase in the amount of spitback spillage which occurs during refueling operations.

Second, the bending angle of the spout affects the fuel flow to the vehicle tank within the fillpipe. The increased splashing against the fillpipe walls and greater turbulence created by some bending angles prevent optimum fuel flow.[4] Due to this variance in angles, some fillpipes may not be able to achieve their design fill rate without premature shut-offs. Therefore, standardized nozzle geometries could ease the automobile manufacturers' design of fillpipes which ensure optimum fuel flow to the vehicle tank and minimize premature shut-offs.

Third, since nozzle geometries also affect the location of the automatic shut-off port within the fillpipe, varying nozzle and fillpipe designs can impact the potential for fuel spitback when the automatic shut-off device is activated at the end of a refill. The closer the shut-off port is to the fillpipe outlet, the higher the fuel must rise in the fillpipe to activate the shut-off, and thus the greater the chance for a fuel spitback to occur.

In addition, this investigation studied the currently available fuel nozzles. As is discussed in more detail below, current nozzle configurations and geometries were investigated and found to be relatively similar. This similarity in configurations is sought primarily for marketing reasons. Underwriters Laboratories examines the compatibility of different manufacturers' nozzles with listed power-operated dispensing units and labels the nozzles as "interchangeable" if compatible.[8] All "interchangeable" nozzles can be used on any listed dispensing unit. Therefore, in order to be "interchangeable" and more marketable, the design of the spout and handle location of most nozzles are comparable, but not necessarily identical.

Furthermore, EPA regulation and some voluntary standards for nozzle designs also contribute to the similarity of current nozzle geometries. These regulations and standards include the following:

- Federal Register - 40 CFR 80.22
  This ruling regulates the outside diameter for both leaded and unleaded nozzles spouts. It also specifies a minimum straight section length and position of the retaining spring for unleaded nozzle spouts.[9]

- UL 842 - "Valves for Flammable Fluids"
  This standard of Underwriters Laboratories specifies the strength and endurance of the nozzle material. It also gives a maximum nozzle length.[10]

- NFPA No. 30 - "Flammable and Combustible Liquids" This standard of the National Fire Protection Association specifies that any nozzle dispensing Class I liquids such as gasoline must be automatic closing and listed by Underwriters Laboratories (and therefore conform to UL 842).[11]

Compliance with the EPA regulation ruling is mandatory for all nozzle manufacturers, whereas most manufacturers choose to adopt the other voluntary standards presented above solely for insurance/liability purposes. It is important to emphasize, however, that to date no real limits on the flow rates or configuration, besides diameters and a straight section length, have been made. The manufacturers have total freedom in their nozzle designs, except for market and insurance constraints.

The International Standards Organization (ISO) is currently evaluating possible design standards for all fuel nozzles in order to reduce fire risks. These draft standards include specifications on the dimensions and geometries for nozzle spouts as well as a maximum dispensing rate.[12] Response to these proposed ISO standards by SAE and other American concerns has not been positive. They believe that these standards specify too many parameters and are therefore too restrictive. Consequently, the U.S. voted to disapprove the proposed ISO standards.[13]

As part of this investigation of fuel nozzle geometries, some key dimensions of nozzle spouts from the two largest nozzle manufacturers were compared.[14,15] The designs of these two nozzles are followed closely by other manufacturers and these nozzles are often rebuilt. Thus they are quite representative of the majority of in-use nozzles. These fuel nozzle design characteristics of the two manufacturers are presented in Table 1. This table shows that in general the two nozzle spouts are similar with slight differences in the straight section length and dispensing rate characteristics. Since the nozzle configurations are quite similar, nozzle standardization may not be necessary. It is not clear that minor differences such as these would impact the operation of an onboard system, although there is some evidence that nozzle geometries could very slightly affect the refueling emission rate due to varying amounts of turbulent mixing and droplet entrainment.

However, even if nozzle geometries are standardized, it is not clear than the desired effect would be achieved. The nozzle spout position within the fillpipe is also affected by the angle at which the individual refueler inserts the nozzle itself during each refueling event. The variability in nozzle position caused by this effect alone could be enough to negate any potential emission or control system operation benefits which arise from nozzle standardization.

Table 1

Fuel Nozzle Design Characteristics

Dimension	OPW 11-A	EMCO Wheaton A2000
Total Spout Length	7"	7.25"
Spout Straight Sec. Length	3.9"	2.9"
Spout Bending Angle	24-25°	27°
Automatic Shut-off Location*	0.73"	0.67"
Nozzle Outside Diameter	.81"	.81"
Dispensing Rate @ 5 psi ΔP	4gpm	7.5gpm
@ 10 psi ΔP	10gpm	13.5gpm

* Distance from nozzle tip.
** Maximum.

Given this effect and the relative uncertainty regarding the impact of nozzle geometries on refueling emissions and their control, it is not clear that nozzle geometries need to be standardized to control refueling emissions. If further information becomes available which demonstrates that the impacts of varying nozzle geometries on refueling emissions and effects on onboard control designs are significant and that the costs of nozzle standardization are reasonable, then such standardization will be considered.

Based on the rationale presented above, it appears that in-use dispensing rate limits would enhance the effectiveness of onboard controls and reduce spitback spillage. Standardized nozzle designs may be considered in the future, but further study and information is required. The remainder of this report provides further background information and analysis pertaining to a dispensing rate limit requirement.

IV. CAA Authority

The Clean Air Act (CAA) gives EPA authority to regulate the in-use dispensing rate. EPA's authority in this area stems from Section 211 (c) of the Act. This section allows EPA to control or prohibit the introduction into commerce or offering for sale of any fuel for use in a motor vehicle or motor vehicle engine if the emission products of the fuel contribute to air pollution which endangers public health or welfare or the emission products of such fuel will impair to a significant degree the performance of any emission control system. In this case, the emission products of the fuel are the refueling vapors and evaporated spilled fuel associated with the dispensing of gasoline. These vapors are photochemically reactive hydrocarbons which contribute to the formation of ozone, an NAAQS criteria pollutant. The emission control system of interest in this case is an onboard vapor recovery system. As discussed previously, dispensing rate limits could enhance the efficient performance of an onboard system and avoid significant impairment in the control of refueling emissions by onboard controls through a reduction in spillage.

Section 211 (c)(2)(B) further requires EPA to consider all available scientific and economic data on possible alternatives, including a cost benefit analysis comparing emission control systems, when regulating a fuel in order to protect the effectiveness of emission controls. The alternative to onboard refueling controls is Stage II vapor recovery systems. This alternative has been thoroughly analyzed by EPA. Although Stage II is a technically feasible alternative, EPA believes that vehicle-based vapor recovery, or onboard systems, is the preferred control approach. Regardless, Stage II systems would most likely also require

flow rate limits to ensure proper performance as is now required in California.[16] Thus, a limit on in-use dispensing rates appear consistent with the requirements of Section 211(c) of the CAA.

V. Benefits

A number of benefits can be achieved by limiting in-use dispensing rates. These include enhanced control of refueling emissions, gasoline savings, plus health and safety benefits. Each of these is discussed below.

First, as previously mentioned, a dispensing rate requirement would complement the efficient operation of an onboard refueling control system. With a dispensing rate limit, the dispensing rate used for the design of an onboard system would be compatible with the rates observed in-use.

Second, a dispensing rate limit would provide both refueling emission reductions and gasoline savings by reducing in-use spillage. A dispensing rate limit would reduce or practically eliminate premature nozzle shut-offs and spitback from onboard-equipped vehicles and reduce the spitback from current in-use vehicles without onboard controls. The onboard vehicles would be designed to accommodate 10 gpm dispensing rates without spitback. For in-use vehicles without onboard controls, a dispensing rate limit would reduce spillage for those vehicles which can handle a flow rate of 10 gpm, but not higher values which could occur if in-use dispensing rates were allowed to increase. However, some in-use vehicles cannot handle even a 10 gpm dispensing rate; a dispensing rate limit would not have any effect on the spitback from these vehicles.

The current average emission factor associated with spitback spillage is 0.15 g/gallon of dispensed fuel.[3] Using this emission factor and EPA's fuel consumption projection for 1995, spitback spillage is estimated to cause about 11,000 tons of refueling emissions in that year.[17] This spitback spillage amounts to 3.7 million gallons of gasoline spilled in 1995. In 1995, the vehicles without onboard controls will comprise about 50 percent of the total vehicle fleet, if onboard controls are implemented for 1990 model year vehicles.[18] Assuming that a dispensing rate limit would eliminate spitback from all vehicles with onboard systems and one-half of non-onboard equipped vehicles, and a gasoline price of $1 per gallon, such a dispensing rate limit could provide a savings of approximately $2.8 million for gasoline consumers in 1995. This provides an emission reduction of 8,250 tons per year. In addition to these emission reductions and gasoline savings, a dispensing rate limit would provide additional convenience to the general public by reducing spillage of gasoline on automobiles or persons.

It is important to note that the current spitback spillage emission factor of 0.15 g/gallon of dispensed fuel is probably conservative. This emission factor originated from a 1972 study done by Scott Research Laboratories. Since most stations in 1972 used suction pump dispensers, which have lower dispensing rates than the current stations using submersible turbine pumps, it would be reasonable to assume that the in-use dispensing rates at that time were lower than present rates.[2] Since the study found a higher probability for spitback spillage at faster dispensing rates, today's spillage emission factor may be greater. Furthermore, at the time of the study, most stations were full service and only gasoline attendants, people with greater experience dispensing gasoline than today's self-service customers, were used in this analysis. Hence, it is reasonable to believe that today's self-serve customers may spill gasoline more frequently and in larger amounts than the gasoline attendants used in the 1972 study. Another important factor in this Scott study is the presence of a person monitoring the gasoline attendants. With a monitor present, the attendants could have been more careful and less likely to spill gasoline. For these reasons, the 0.15 g/gallon emission factor used in this report for spitback spillage may be conservative.

Third, establishing an in-use dispensing rate limit will provide some health benefits for the general public. A dispensing rate limit will help reduce the ozone concentration in the lower atmosphere by enhancing control of refueling emissions. In addition, repeated or prolonged dermal contact with liquid gasoline due to spillage can cause irritation and dermatitis for some individuals.[19] Thus, there are some health benefits gained from limiting the in-use dispensing rates.

In addition to the health benefits, a dispensing rate limit provides some additional safety benefits for refueling operations. The refueling operation would be inherently more safe because of reduction in spitback and spillage. An in-use dispensing rate limit would help to reduce spillage during refueling, and would thus contribute to a reduction in the potential for fires caused by inadvertent ignition of spilled gasoline.

VI. Implementation

Any regulation to control dispensing rates should be implemented with minimal impact on service station operations. With this in mind, the possible approaches for limiting in-use dispensing rates were evaluated. The implementation approaches are discussed below including the necessary liability and enforcement aspects. However, one of the key factors affecting how dispensing rate limits could be regulated is the nature and structure of the nozzle industry. This is discussed first.

Since an in-use dispensing rate limit and/or nozzle geometry standards would have some impact on the nozzle industry, it is important to highlight its structure. The fuel nozzle industry consists of both primary manufacturers and rebuilders. The primary nozzle manufacturers produce equipment from all new materials whereas rebuilders reuse the original nozzle body castings and replace all the old and worn operating parts. According to the Petroleum Equipment Institute, approximately 70 percent of the entire market consists of originally manufactured nozzles.[20] Moreover, the nozzle market structure consists primarily of a few large original manufacturers, a few mid-size original manufacturers who also rebuild nozzles, and several small rebuilders.

The rebuilders, or remanufacturers, range greatly in size.[20] Some rebuilders operate from their trucks and travel to service stations replacing worn-out nozzle parts. Other rebuilders are larger companies who rebuild and test the nozzles they rebuild to meet given specifications. Recently, primary manufacturers have become more concerned about the liability of rebuilt nozzles since they could be held responsible for a failure of a rebuilt nozzle with their original casting.[20] Because of this concern, one original manufacturer has quit rebuilding nozzles and has tried to prevent others from rebuilding their original nozzles.

With respect to the implementation of an in-use dispensing rate limit, it is important to characterize what causes the variation in dispensing rates. The flow rate from the nozzle spout is dependent on two factors: the pressure supplied to the nozzle by the pump and the pressure at the orifice created by the hand lever position on the nozzle. These combine to form a pressure drop which governs the flow rate through the nozzle. The same nozzle can produce a variety of flow rates depending on this pressure drop. For any given nozzle configuration, the maximum pressure drop is controlled by the supplied pump pressure since the nozzle characteristics are fixed. The maximum dispensing rates of different manufacturers' nozzles vary with the supplied pump pressure due to different nozzle characteristics. Thus, to control the maximum flow rate through the nozzle, the resulting pressure drop created by the pump and the lever position must be controlled. This could be done by controlling the pressure contribution of both the pump and the lever position. A better solution, however, is using a variable flow limiting orifice or flow restrictor to limit the flow rate. This would control the wide variance in dispensing rates that could occur with different combinations of pump pressures and nozzle configurations.

As mentioned above, in order to limit the dispensing rate a flow restrictor or limiting orifice would have to be incorporated somewhere in the dispensing system. This flow restrictor could be located in the dispensing unit, the hose, or the nozzle itself. The in-use effectiveness of the dispensing limit regulation may depend to some degree on the restrictor location. The best location would be one where the restrictor provides effective dispensing rate control, easy installation and resistance to tampering. Inserting the restrictor or limiting orifice internal to the nozzle body appears to be the best way to achieve these requirements and thus may be the best approach to control dispensing rates.

There are basically two implementation approaches for an in-use dispensing rate limit requirement. First, all gasoline retailers and wholesale purchaser-consumers could be required to limit dispensing rates at the nozzle to no greater than 10 gpm. It places responsibility for compliance with the dispensing rate limit on the gasoline retailers and wholesale purchaser-consumers, those who own and maintain the in-use fuel nozzles. This option allows that no action be taken if the dispensing rate limit requirement is being met without any modifications and also provides flexibility on how compliance is achieved when measures are needed (i.e., nozzle, pump, or hose restrictor).

The second implementation method considered would be to require that nozzle manufacturers design their nozzles so that the maximum dispensing rate would not exceed 10 gpm. Under this approach, nozzle manufacturers would probably have to verify compliance with the dispensing rate regulation through an EPA certification program. The gasoline retailers and wholesale purchaser-consumers could then purchase certified nozzles for dispensing gasoline at their facilities. This alternative would guarantee that the flow regulator was part of the internal nozzle design and also would insure the availability of a product which conforms to the 10 gpm dispensing rate limit. However, this implementation approach has several drawbacks. First, it puts at least part of the liability for controlling in-use dispensing rates on the nozzle manufacturers, who are not responsible for the maintenance or condition of the nozzles in use. Second, this option would force EPA to regulate a new industry, the nozzle manufacturers, which could have some economic implications on small business. Third, under this approach it would be necessary to provide a phase-in period for the effective date of a dispensing rate limit to prevent a massive turnover of fuel nozzles at the service stations. Finally, this option would make rebuilders, which are for the most part small businesses, use a different approach in order to stay in the market. They would have to certify each type of nozzle they rebuild. This could substantially alter their business and marketing operations.

Based on the discussion above, the most straightforward approach is the first option which requires that gasoline retailers and wholesale purchaser-consumers dispense gasoline at a maximum flow rate no greater than 10 gpm. This approach has several advantages. First, this option minimizes compliance costs since most service stations would already be in compliance and would not have to take any action. If the maximum flow rate for a nozzle exceeds 10 gpm, however, the restrictor or limiting orifice discussed above would need to be placed in the system to limit flow.

Second, this option will not force EPA to regulate a new industry or have any negative impacts on small business. For marketing reasons, however, both original nozzle manufacturers and rebuilders could choose to modify their product designs to fulfill this in-use dispensing rate limit requirement. Original manufacturers could either modify the poppet in their current nozzles to act as a limiting orifice or insert a flow regulator (variable orifice) in the nozzle. Rebuilders, which use the original nozzle bodies, could add a fixed or variable flow regulator if the original nozzle was not already designed to comply with the dispensing rate limit.

Third, this option is preferable from an enforcement perspective. Existing enforcement programs at both the state and federal levels could easily be expanded to include a maximum dispensing rate measurement. The test procedure used to determine the flow rate would consist of either an in-line flow meter or a volume/time measurement.

Finally, the liability for compliance with the 10 gpm maximum dispensing rate requirement would lie with the gasoline retailers and wholesale purchaser-consumers. The liability provisions could be similar to those applied to the current nozzle spout diameter regulations for leaded and unleaded fuels (40 CFR 80.23).

VII. Economic Analysis

The economic impact of an in-use dispensing rate limit requirement is expected to be minimal. Since the 10 gpm value was chosen from values near the high end of the current dispensing rate range, most stations are now in compliance without any additional modifications and will incur no costs. Therefore, the primary effect of an in-use dispensing rate limit would be on current service stations which are dispensing at rates higher than 10 gpm, new service stations, and service stations which will replace their current underground pumps and dispensing hardware in the future.

For those current service stations/nozzles which are dispensing at rates higher than 10 gpm, some modifications would be necessary to attain compliance. They could retrofit their dispensing hardware to satisfy the dispensing rate limit by inserting a flow regulator in the hose, dispenser, or nozzle. In the future they could purchase new or rebuilt fuel nozzles which have a fixed or variable flow regulator and can effectively regulate dispensing rates.

For new service stations and those stations which will replace their current underground pumps and dispensing hardware in the future, equipment they install will have to comply to the 10 gpm dispensing rate requirement. If their equipment exceeds the 10 gpm requirement, they could either insert flow regulators in their equipment (i.e., dispenser or hose) or purchase nozzles which are designed specifically to control the maximum dispensing rate to 10 gpm. Furthermore, these stations would not need to install underground pumps of higher horsepower than those currently used since the dispensing rate would be regulated and the increased horsepower would provide little or no additional benefits. Thus both capital and operating costs related to the pump could be saved.

Based on the discussion above, it appears that the simplest and most effective way to regulate the dispensing rates for for current and future stations would be through nozzle modifications. The costs associated with these nozzle modifications are discussed below.

As was mentioned previously, there are two ways to effectively regulate fuel flow in the nozzle: 1) modify the existing poppet in most current nozzles to serve as a limiting orifice, or 2) insert a flow regulator in the nozzle. Modifying the existing nozzle design would require only minor tooling changes in the production of the nozzles. These tooling changes would cost approximately $1 per nozzle to amortize the necessary fixed costs needed for these changes. These tooling change costs are only short-term and would be eliminated after a few years. Inserting a flow regulator, however, would provide better control of dispensing rates over a wider pressure range. Based on discussions with nozzle manufacturers, the flow regulator and necessary tooling changes are estimated to cost between $1 and $5 per nozzle.[21,22] Therefore, the hardware and tooling costs for original manufacturers to incorporate an in-use dispensing rate limit into their nozzle designs will range from $1 to $5 per nozzle depending on the type of control the manufacturer chooses to implement.

Rebuilders have only one alternative to effectively regulate dispensing rates in the nozzle. This alternative is to insert a fixed or variable flow regulator in the internal design of the nozzle. As stated above, the hardware costs necessary to incorporate this flow regulator into the nozzle design ranges between $1 and $5 per nozzle.

Based on this discussion, the economic burden of a dispensing rate limit requirement would be expected to be very low. Since the flow rate limit was selected from near the high end of the current in-use dispensing rate range, most stations would already meet this requirement and therefore incur no associated cost. In addition, it is worth noting that any additional costs to the consumer related to limiting dispensing rates could be substantially offset by the reduction in spitback spillage which may result.

VIII. Summary and Conclusions

From the discussion of the issues studied in this investigation, an in-use dispensing rate limit would enhance the onboard effectiveness and reduce spitback caused by premature nozzle shut-offs. Such a limit would ensure that the maximum in-use dispensing rates are equivalent to the dispensing rates used in the design and certification of the vehicle's refueling control system. It may also be beneficial to specify nozzle geometries to assist in controlling refueling emissions and prevent spillage. Further information regarding the impacts of nozzle geometries on refueling emissions and onboard system designs, however, is needed before such standardization is considered.

Section 211 (c) of the Clean Air Act gives EPA the authority to regulate the dispensing rates and geometries of fuel nozzles. A dispensing rate limit requirement would enhance the performance and efficiency of onboard controls as well as provide additional refueling emission reductions and gasoline savings by reducing spillage. In addition, the reduction in gasoline spillage will provide several health and safety improvements for refueling operations. A recommended approach for a dispensing rate limit would require that all commercial gasoline retailers and wholesale purchaser-consumers use nozzles with a maximum dispensing rate of 10 gpm. Federal and state surveillance teams would have to expand their enforcement programs to measure the maximum dispensing rate at service stations. Furthermore, such regulations should have very small economic impact since most stations would already be in compliance with the dispensing rate limit.

In conclusion, it appears that development of an in-use dispensing rate limit is in order to ensure proper functioning of onboard control systems and reduce in-use gasoline spillage. The benefits received from such a regulation outweigh any costs which may result. In addition, further investigation of the effects of nozzle geometry standardization should be further studied for the same reasons.

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