The Trouble With Presets

By Tim Mayson, International Sales Engineer (BE Mech)

A detailed look at the difficulties of dispensing exact amounts of CNG

As the NGV industry continues to develop, the number of stations and accessibility to CNG refuelling grows.

Traditionally CNG vehicle tanks are completely filled but now some drivers may lack the funds for a complete fill, and Station Owners may prefer to deal only in whole denominations of currency. This has created the demand for pre-selection of a set amount of fuel to be dispensed, as opposed to a full fill of CNG in a vehicle. While this feature has been available for some time for liquid fuels, such as petrol and diesel, its application to the NGV industry is still relatively new and presents its own challenges.

In a traditional complete fill (non – preset), as the pressure in the vehicle cylinder reaches the maximum fill pressure, the flow rate through the dispenser decreases steadily to a point where there is no further gas flow. The pressures inside the dispenser and inside the vehicle are equal. As there is no pressure difference between the dispenser and the vehicle, there is no additional flow of gas following the control valve termination of the fill. Therefore the gas delivered can be controlled accurately.

As a gas, CNG is highly compressible which means its volume increases significantly when it is released from a compressed state. This characteristic makes delivering exact predetermined quantities of gas very difficult. Once a dispenser control valve closes, the gas contained in the downstream portion of the system of hoses, pipes and valves will continue to flow until the gas pressures equalize.

Putting this in the context of filling a vehicle with CNG using a dispenser's preset facility; let us take the example of a vehicle arriving to be filled, with its tanks at a pressure of 30 bar. The driver of the vehicle requests 50 Rs of gas, this value is entered to the dispenser preset control and the start button is pushed. The control valve inside the dispenser opens and the dispenser's hose is fully charged to maximum fill pressure. The dispenser fill hose is connected to the vehicle and refuelling begins. When the value of the fill reaches 50 Rs the dispenser valve closes.

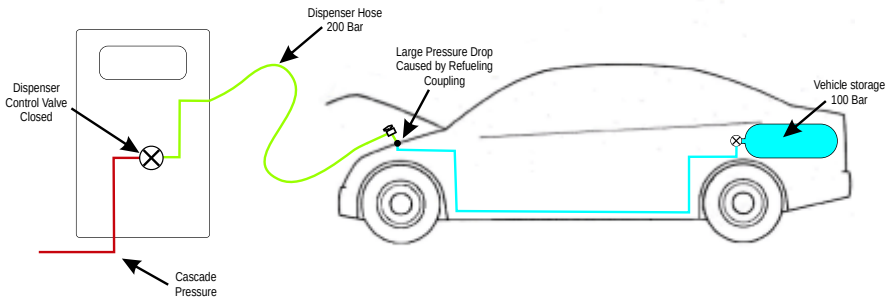

Figure 1 : Pressure Distribution Following Closure of Control valve on preset fill

At this point, everything downstream of the control valve, but upstream of the vehicle refuelling coupling (shown in green Figure 1), is likely to still be at a higher pressure than the vehicles storage. This is because the vehicle storage was not completely filled, and the refuelling coupling between the dispenser and the car is almost always the most restrictive point to the flow of gas.

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Gas contained downstream of control valve will continue to flow into the vehicle until the pressures have equalised (see Figure 2).

As CNG is so compressible, the amount of gas that continues to flow following the closure of this valve can be significant. The actual amount is dependent on a number of factors including; the dispenser inlet pressure, flow rate at the time of closure, the vehicle storage pressure, restriction of the coupling and CNG conversion kit/installation. All of these variables are present and are different with each fill, making them extremely difficult to predict and compensate for.

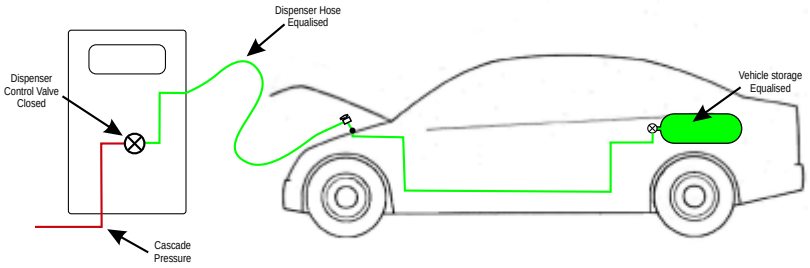

Figure 2 : Vehicle Storage and Dispenser hose has equalised

The dispenser equipment must deal with this vast range of variables. Transaction guidelines indicate that it is important to ensure that the customer is not disadvantaged, and it is also important to meet customers' expectations of an actuate fill to avoid dispute and loss of reputation with the Station Owner. This means that any variation in the preset cut off must be in the customers favour.

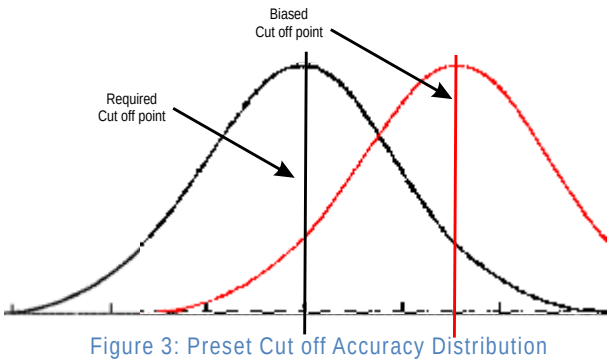

Figure 3: Preset Cut off Accuracy Distribution

Obviously it is important that the dispenser reaches the preset amount the majority of the time, otherwise its purpose of dispensing round numbers is effectively defeated. Statistically, after compensating for the additional gas flow, the accuracy of shutting off the gas has a normal distribution spread i.e. some under-fills, some over-fills, but most fills are the correct amount. To compensate for any possible under-fills a further factor must be added to the timing of the control valve closure so that it is biased in the customers favour to not only reach the desired preset value, but also more likely to “over-deliver” (see figure 3). This ensures that the dispensed gas value is reached the majority of the time and the number of under fills is minimised

While it is important for Station Owners to offer the preset facility, the “late shut-off” biasing of the control valve closure puts them at risk of “giving away” significant amounts of gas. Masking the amount of the “over delivery” to the customer (and also the Station Owner) by modifying the dispenser software is a simple process for dispenser manufacturers. By changing the displayed amount so that it reads exactly what was requested on the preset, it is easy to think that the filling has stopped at the exact amount. However, if the displayed value on the dispenser is compared to that of an independent “Master Meter”, a significant “over delivery” may be found. In fact, some vehicle customers become wise to this inconsistency and use it to their advantage, repeatedly requesting small preset fills to obtain over-deliveries that they will not be charged for. Ultimately cheating the Station Owner of potential profits.

In the interests of providing quality solutions and maintaining a good reputation, manufacturers providing preset capable dispensers should take every possible step to minimise the over delivered amount, while avoiding under delivery to the customer. To achieve this, dispenser software can “tune” the timing of control valve closures relative to flow rates and fast acting control valves can be used. Using these techniques there is no reason why a well engineered solution could not limit gas overruns to a maximum of around 20 grams. On a 2 kg fill this would equal a 1% inaccuracy, well inside the 1.5% total dispenser accuracy required by OIML. As the preset quantity increases, the percentage of 'inaccuracy' reduces, as the inaccuracy of the fill shut off is independent of fill size.

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