Fuel flow measurement

Re-Sol's solutions optimize the low-flow accuracy of fuel flow measurements on returnless engines

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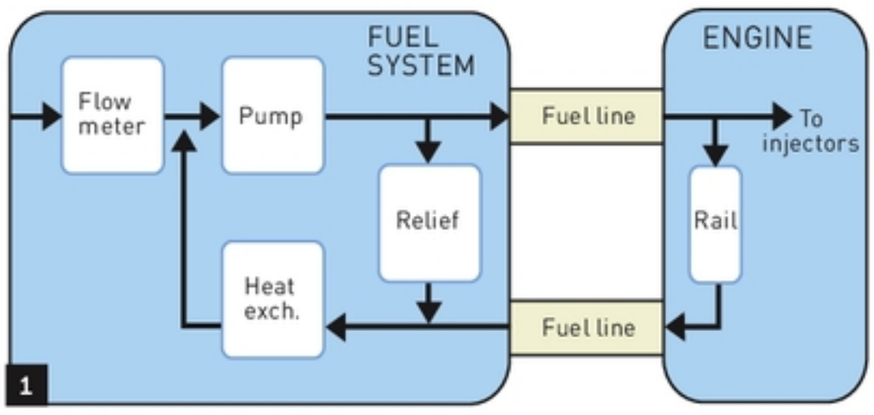
Increased targets in fuel economy require constant research in testing technologies. Returnless engines provide a new opportunity to measure transients at low flow rates. Engines with returns have to allow for compromises when trying to qualify idle flow measurements after a step down from higher flow rates. The reason for this issue is that the flow meter is measuring any thermal effect downstream as well as the actual consumed fuel flow.

For testing engines with return, components such as pumps and heat exchangers have to be added, which have fuel enclosed (Figure 1). This fuel is subject to expansion or contraction depending on the change in temperature. Fuel lines, including the engine supply and return, add to this volume, while the upstream flow meter reads this effect as positive or negative consumption. The amplitude of the flow rate is a function of the volume and the temperature gradient. These two factors can only be minimized to a certain extent. Temperature controllers might even contribute in a negative way.

The curve in Figure 2 shows a typical stabilization time after a load change. This stabilization can take minutes, or even hours. The magnitude of this thermal effect has been discussed in a number of past articles, and further information on the subject can be requested from Re-Sol.

Testing engines without return enables the flow meter to be installed as the last element in the engine supply line and, therefore, minimizes



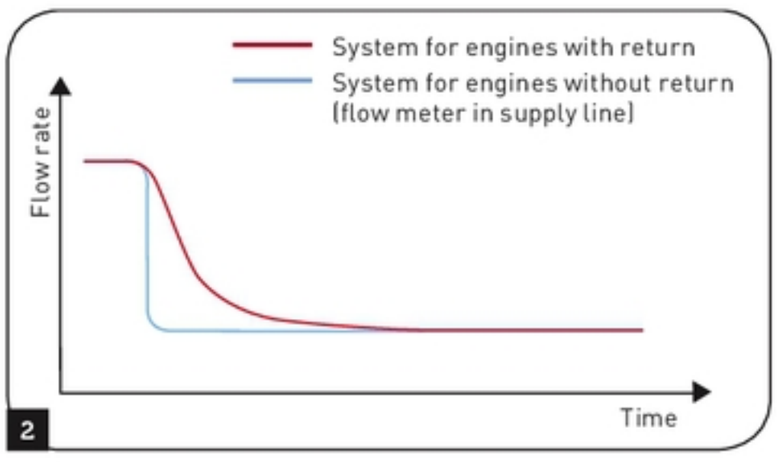
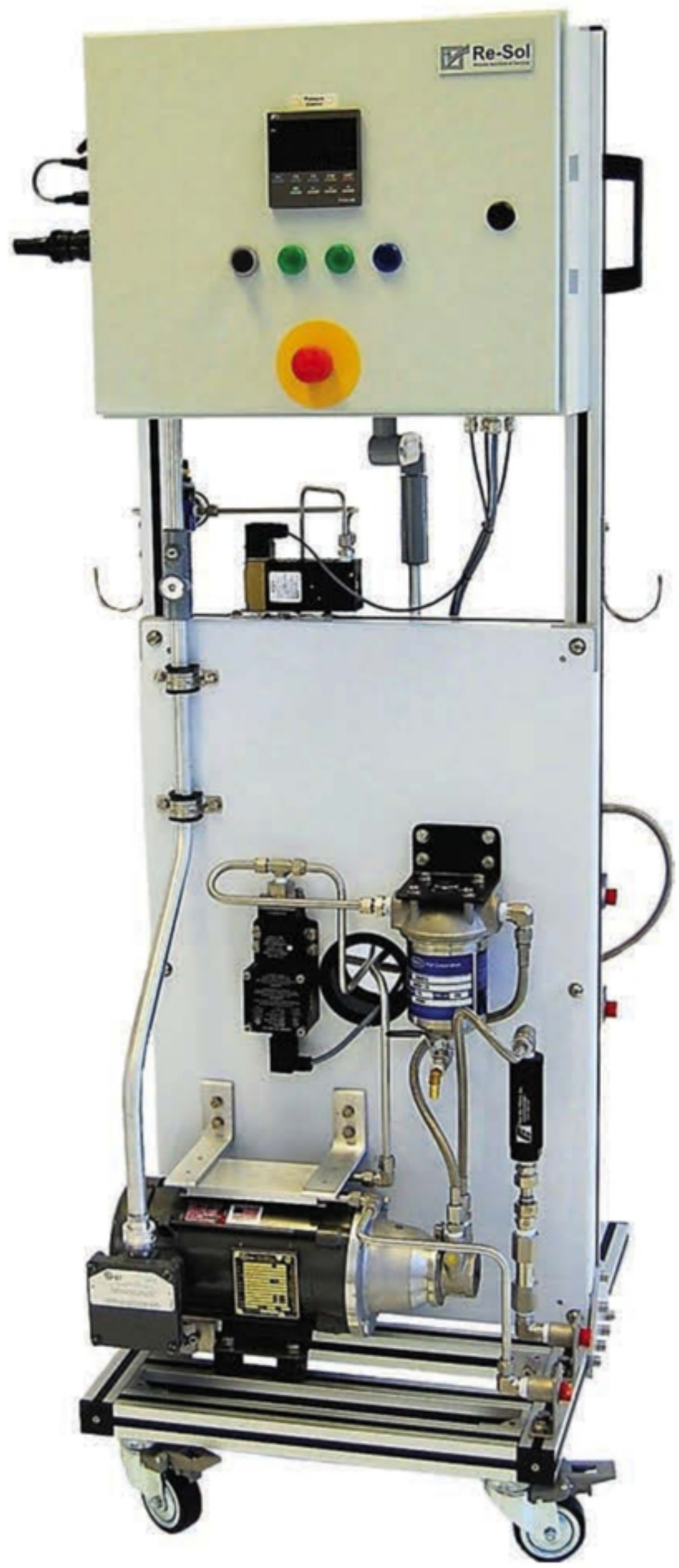


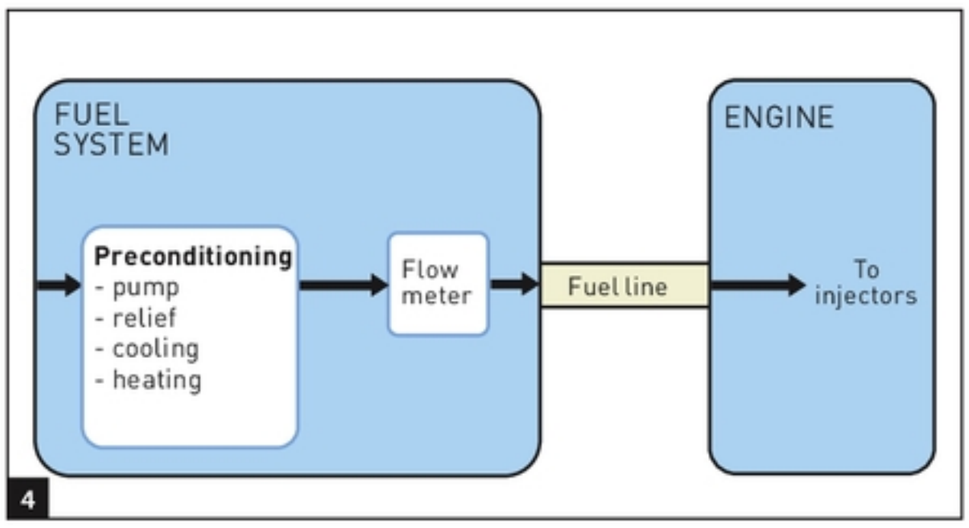
FIGURE 1: Simplified fuel system with return

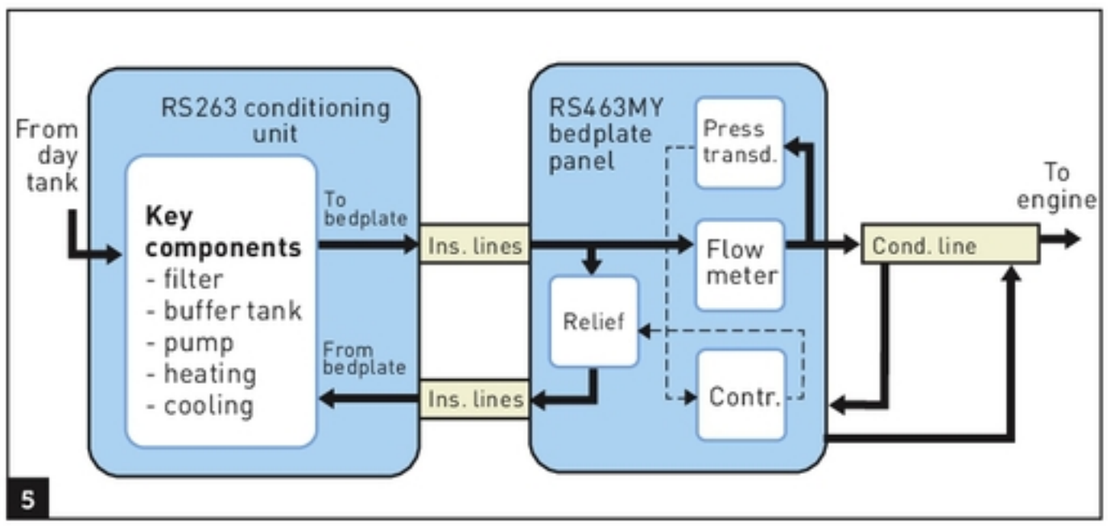
FIGURE 2: Engine load change to idle flow

FIGURE 3: An example of an RS463 system



"The requirement to become even more accurate at idle flow rates and to reduce the settling time after a load change demanded the next steps in system development"





the fuel volume downstream. Figure 4 shows a typical system layout, where all the conditioning (temperature and pressure) can be done upstream. In this configuration a load change will have a minimum impact. This impact also can be reduced by using conditioned fuel lines between the flow meter and the engine. Pressure drops across the flow meter can be compensated for by a feedback control.

In environmental applications, where a wide engine temperature is required (for example -10°C to +50°C or more), the whole conditioning can be done upstream and all components, such as the flow meter and regulators, can be brought to the same temperature.

For a number of years Re-Sol has supplied a variety of solutions for returnless test applications. The mobile RS463 system was built for a wide range of flow rates and a larger number of options. Figure 3 shows one example of an RS463 system.

The requirement to become even more accurate at idle flow rates and to reduce the settling time after a load change demanded the next steps in system development. New low-flow meters were developed and the system packaging had to be reviewed. Customers were also asking for the required floor space close to the engine to be reduced, as it conflicted with bringing the fuel flow measurement system even closer to the engine. The solution was to split the flow measurement system into a bedplate panel with minimized components and a preconditioning unit at the test cell wall. Figure 5 shows a simplified diagram.

A small bedplate unit contains only a relief regulator, the flow meter, a pressure transducer and pressure control components. To minimize any temperature losses in the fuel line between the fuel panel and the engine, a conditioned fuel line can be added.

The RS463MY fuel flow measurement bedplate panel is a typical example for a variety of fuel flow measurement solutions (Figure 6). This system is designed as a bedplate panel with a minimized number of components required to be

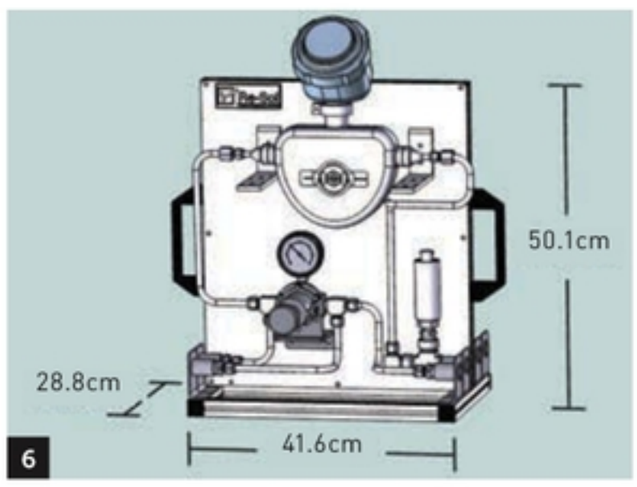


FIGURE 4: Simplified fuel system without return

FIGURE 5: Simplified system diagram

FIGURE 6: Fuel flow measurement bedplate

close to the engine. The RS263 wall-mounted preconditioning unit houses a buffer tank, an explosion-proof boost pump with relief, a heat exchanger and an optional electrical heater. These components can be sized based on the maximum fuel consumption, required temperature range and pressure range. Typical maximum flow rates are 50kg/h, 125kg/h and 250kg/h. The integrated Coriolis mass flow meters give accuracies of ±0.1% of reading. A variety of interface options are available to communicate to almost every test cell computer system, including AK interface and Modbus/TCP communication via Ethernet.

The RS463MYE mobile system was designed as an add-on to existing fuel flow measurement systems. In these cases, the existing system will be used as a preconditioning unit, while the flow meter on the mobile system provides the fuel flow information. The pressure controller and the flow interface are installed on the mobile system. This way the mobile system can be moved to the test cells, where extra idle flow accuracies are needed.

Re-Sol was formed in 2003 to provide reliable fuel flow measurement solutions and services that redefine value in the automotive test sector with an eye toward future technologies. The company focuses on delivering reliable test hardware, software, calibration services and documentation to address an automotive industry need for value-driven solutions. ‹