TEMPERATURE COMPENSATED MEASUREMENT METHOD AND SYSTEM

Field of Invention

The present invention relates generally to temperature compensated measure methods and apparatus. More specifically, the present invention relates to a self-powered apparatus for continuous monitoring of fuel consumption system.

Background

Fuel, for example diesel fuel, is typically supplied to an engine from a fuel tank either by suction pressure of a fuel pump or by pressure from a low-pressure electrical fuel transfer pump inter-coupling the engine and fuel tank. The fuel supplied to the engine is typically more than the amount required for consumption by the engine. Excess fuel is channeled for cooling the engine's fuel system before being returned to the fuel tank to be cooled. The volume of returned fuel is higher than the actual fuel consumed by the engine. Its temperature is also increased due to heat exchanged via convection with the combusting engine. It is known in the art that the volume of a given amount of fuel varies in response to changes in temperature. Consequently, the density of the fuel varies in response to changes in its temperature.

Due to lack of precise information provided by onboard instrumentations for fleet management to ensure proper maintenance and monitoring fuel consumption of diesel engines mounted on vehicles or heavy equipment, there is little awareness on whether the metered diesel fuel filled into the fuel tank of a vehicle tallies with the fuel consumed by the engine.

Known fuel-monitoring systems for retrofitting to old vehicle are bulky, and therefore, onerous to install on vehicles. These systems utilize either pre-calibrated volumetric container with temperature control as prover means or thermal heat exchanger-based devices and components to determine the volume and temperature passing through gauged passages for processing by a microcomputer to effect temperature compensation-based measurement and monitoring for diesel or gasoline. These conventional methods

requires two variables, dynamic quantity and temperature, to be measured and determined at operating conditions for use as reference conditions when conducting fuel monitoring. After both the two variables have been determined, the actual volume is then determined as a function thereof.

In tropical countries, fuels are dispensed at an average of 31°C (87.8°F) at gas stations. However, most existing fuel monitoring systems perform temperature compensation at a reference temperature of 15°C or 60°F for hydrocarbon measurements. The difference in temperature of 27.8°F would result to an error of 1.9 % in gasoline and 1.3 % in diesel due to it coefficient of expansion. Petroleum companies do not indicate the density of their product specifically but were given in a range of 820 ~ 860@15°C kg/m^3 for ultra low sulfur diesel or automotive diesel. At 31°C, the density of diesel is 809.2 kg/m^3 and 848.7 kg/m^3 of equilibrium density at 820@15°C kg/m^3 and 860@15°C kg/m^3 respectively. Taking 809.2@31°C kg/m^3 of equilibrium density at 820@15°C kg/m^3 as a reference base condition for temperature compensations would err in net fuel consumption monitoring as consumers are getting 98.7% per unit volume of diesel fuel purchased.

Therefore, there is a need for an improved temperature compensated monitoring system and method.

Summary

In accordance with a first aspect of the invention, there is disclosed a temperature compensated measurement method. The method comprises measuring a first flow quantity and a first flow temperature of supply fluid travelling along a first path with the supply fluid being providable to a fluid consuming system, and adjusting the measured first flow quantity based on the first flow temperature to thereby obtain a first compensated quantity of the supply fluid substantially at a reference temperature. The method further comprises measuring a second flow quantity and a second flow temperature of return fluid travelling along a second path with the return fluid being receivable from the fluid consuming system, and adjusting the measured second flow quantity based on the second flow temperature to thereby obtain a second compensated

quantity of the return fluid substantially at the reference temperature. Consumption quantity of the supply fluid consumed by the fluid consuming system is subsequently determinable from the first compensated quantity and the second compensated quantity, the consumption quantity being substantially associated with the reference temperature.

In accordance with a second aspect of the invention, there is disclosed a temperature compensated measurement system comprising a controller, a first temperature sensor and a first flow meter. The first temperature sensor is for measuring a first flow temperature and the first flow meter is for measuring a first flow quantity of supply fluid being providable to a fluid consuming system. Each of the first temperature sensor and the first flow meter being in signal communication with the processor for providing corresponding one of the first flow temperature and the first flow quantity thereto. The controller is for adjusting the measured first flow quantity based on the first flow temperature to thereby obtain a first compensated quantity of the supply fluid substantially at a reference temperature. Consumption quantity of the supply fluid consumed by the fluid consuming system is subsequently determinable from the first compensated quantity, the consumption quantity being substantially associated with the reference temperature.

In accordance with a third aspect of the invention, there is disclosed a machine-readable medium having stored therein a plurality of programming instructions, which when executed, the instructions cause the machine to measure a first flow quantity and a first flow temperature of supply fluid travelling along a supply path with the supply fluid being providable to a fluid consuming system, and adjust the measured first flow quantity based on the first flow temperature to thereby obtain a first compensated quantity of the supply fluid substantially at a reference temperature. Consumption quantity of the supply fluid consumed by the fluid consuming system is subsequently determinable from the first compensated quantity, the consumption quantity being substantially associated with the reference temperature.

In accordance with a fourth aspect of the invention, there is disclosed a temperature compensated measurement method comprising measuring a flow quantity and a first flow temperature of supply fluid travelling along a supply path with the supply fluid being providable to a fluid consuming system, and adjusting the measured first flow quantity based on the flow temperature and a reference temperature to thereby obtain a first compensated quantity of the supply fluid substantially at the reference temperature. Fluid consumption quantity of the fluid consuming system is determinable from the compensated quantity.

Brief Description of the Drawings

Fig. 1 shows a schematic diagram of a temperature compensated measuring system incorporated with a diesel engine fuel system of a vehicle according to an embodiment of the invention;

Fig. 2 shows a first reference table for use by a microcomputer of the temperature compensated measuring system of Fig. 1;

Fig. 3 shows a second reference table for use by a microcomputer of the temperature compensated measuring system of Fig. 1;

Fig. 4 shows a partial isometric view of a filter head whereto a filter is couplable and which is utilizable with the temperature compensated measurement system of Fig. 1;

Fig. 5 shows a flowchart of a temperature compensated measurement method for application by the temperature compensated measurement system of Fig. 1; and

Fig. 6 shows show a process of monitoring (or measuring) the net fuel consumption for a diesel engine with a return fuel system using the temperature compensated measurement system of Fig. 1 and applying the temperature compensated measurement method of Fig. 5.

Detailed Description

An exemplary embodiment of the present invention, a temperature compensated measurement method 100 (the method 100) and a temperature compensated measurement system 20 (the system 20), is described hereinafter with reference to Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5 and Fig. 6.

The system 20 is preferably encased and configured for retrofitting onto a vehicle (not shown). The vehicle comprises an engine 22 and an engine fuel pump 24 for drawing fuel from a fuel tank 26 of the vehicle for supply as supply fuel 28 to the engine 22. The supply fuel 28 is drawn through the supply line 30 and passages through a fuel filter water separator 32 (the FFWS 32) installed along the supply line 30. Preferably, the FFWS 32 comprises a pressure sensor 34. The system 20 comprises a first flow meter 36, a first temperature sensor 38, a second flow meter 40 and a second temperature sensor 42. Each of the first flow meter 36 and the second flow meter 40 is preferably a positive displacement flow meter calibratable for measuring fluid volume in terms of pulse signals.

Preferably, the first flow meter 36 and the first temperature sensor 38 are disposed at a downstream portion along the supply line 30. Excess fuel from the engine 22 travels back to the fuel tank 26 via a return line 44 as return fuel 46. Preferably, the second flow meter 40 and the second temperature sensor 42 are disposed along the return line 44. The system further comprises a microcomputer 48. It is known in the art that mircoprocessors are also commonly referred to as microcomputers. Preferably, each of the first flow meter 36, the first temperature sensor 38, the second flow meter 40 and the second temperature sensor 42 is in signal communication with the microcomputer 48. The first flow meter 36 and the first temperature sensor function to measure respectively first flow quantity and first flow temperature of the supply fuel 28 for signal transmission to the microcomputer 48. The second flow meter 40 and the second temperature sensor 42 function to measure respectively second flow quantity and second flow temperature of the return fuel 46 for signal transmission to the microcomputer 48. It is apparent to a person skilled in the art in light of the above disclosure that one or more of the first flow

meter 36, the first temperature sensor 38, the second flow meter 40 and the second temperature sensor 42 may be used in the system 20.

Each of the first flow meter 36 and the second flow meter 40 is preferably calibrated for measuring the corresponding one of the first flow quantity and the second flow quantity based on a meter "K" factor. The first temperature sensor 38 and the second temperature sensor 42 have substantially identical beta (β) parameters. The first flow quantity and the second flow quantity are specifically volume measures of the supply fuel and the return fuel respectively. However, the first flow quantity and the second flow quantity cannot be used as actual volumes as they are not temperature normalized. Specifically, the first flow temperature and the second flow temperature are quantitatively different when the engine is at transient operating conditions, and quantitatively higher than temperature of fuel in the fuel tank 26. Preferably, interval of temperature signals sent by the first temperature sensor 38 and the second temperature sensor 42 is set at the maximum flow rate of the first flow meter 36 and the second flow meter 40.

Diesel has a low true vapor pressure at 0.0065psia@60°F. The working pressure of the fuel pump 24 and pressure drop in the supply line 30 is insufficient to cause any vaporization in resulting vapor lock in the fuel pump 24. Installing the system 20 to the supply line 30 will not disrupt fuel supply to the engine 20.

Figure 2 shows a first reference table 50 with reference point values 52 set within temperature extremities of the return fuel 46, the supply fuel 28, dispensing fuels fuel data based on specific gravity provided by petroleum companies. As the first reference table 50 is provided in the microcomputer 48, the limiting of the reference point values 52 to within the temperature extremities is to reduce time taken required by the microcomputer 48 when matching a value against the first reference table 50 and to ensure better accuracy for in temperature compensation tasks. Reference signal pulses 54 and reference sequence numbers 56 are also provided in the first reference table 50 and correspond with the reference point values 52. The meter "K" factors of the first flow meter 36 and the second flow meter 40 are assigned with a reference temperature value

58 of "0". The reference sequence numbers 56 comprise the reference temperature value 58. Therefore, one or more of the first reference table 50 may be used for providing respectively a common or dedicated table to the first flow meter 36 and the second flow meter 40.

Upon the microcomputer 48 receiving either of the first flow temperature or the second flow temperature from the first flow meter 36 and the second flow meter 40 respectively, the corresponding one of the reference signal pulses 54 is obtained from the first reference table 50 for use as the equivalent meter "k" factor of the corresponding one of the first flow meter 36 and the second flow meter 40. Specifically, the meter "k" factor is the number of pulse signals for indicating the equivalent of one (1) liter of fuel, or the like fluid, corrected to the coefficient of expansion of the fuel based on the temperature of the fuel. The gradient linear setting of the temperature for matching in the temperature table set in the microcomputer can modified to required accuracy and in accordance with the required measure, for example Celsius or Fahrenheit, in conformation with its coefficient of expansion.

Additionally or alternatively, a second reference table 60 of Fig. 3 is utilizable by the microcomputer 48. The second reference table 60 uses an exemplary nominal meter "k" value of 2345 signal pulses for each of the first flow meter 36 and the second flow meter 40. The reference point value 62 of 26°C (F3-7) is used as the reference temperature value 64 as its corresponding reference signal pulses 66 (or reference meter "k" factor) of 2366 signal pulses is the nearest to the nominal meter "k" value of 2345 signal pulses for per unit volume of 1 liter of diesel at a density at 845@15°C kg/m^3.

Although the expanded volume of diesel at 26°C is 1.0091 liter (F3-7), taking 2,345 pulses as the nominal value per unit volume allows an actual volume of 0.9909 liter (~ 1 liter) to be metered. To meter the correct first compensated volume (also known as first compensated quantity) and the second compensated temperature (also known as the second compensated quantity) from the first flow quantity of the first flow meter 36 and the second flow quantity of the second flow meter 40 respectively, the microcomputer 48

matches the corresponding one of the first flow temperature and the second flow temperature to obtain the corresponding one of the reference signal pulses 66 indicative of per unit volume, for example 1 liter, of fuel. For example, if a temperature of 14°C (F3-19) is registered by the microcomputer 48, it takes 2,343 pulses as the nominal value per unit volume. Once the first compensated volume of the of the supply fuel 28 is obtained, it is stored by the microcomputer 48 for subsequent subtraction from the second compensated volume of the return fuel 46 for obtaining actual volume of fuel consumed by the engine 22 for display or for storage to a remote data storage system (not shown). It is apparent to a person skilled in the art from the foregoing description each of the first reference table 50 and the second reference table 60 is representable with a chart graph or a series of functions.

Preferably, the system 20 uses a filter head 70, as shown in Fig. 4, for enabling coupling of a spin-on full flow filter or fuel filter water separator (FFWS) or installation of a protruding threaded pipe (80) as a primary fuel filter for retention of solids and to filter out "free" and "emulsified" water and other contaminants in the diesel. It is preferred that the system 20 utilises a strainer or filter in the upstream with filtration porosity smaller than the tolerance gap between the moving parts and wall of the flow meter, for example the first flow meter 36 and the second flow meter 40. As a precaution, a strainer mesh of smaller aperture compare to the tolerance gap of the moving parts in the flow meter is place inside the protruding threaded pipe to ensure that no solids larger than the tolerance gap of the moving parts in the flow meters can enter during replacement of filter. This is to ensure continuous operation of the system and better measurement accuracy for measuring engine net fuel consumption.

The deciding factor to perform periodical maintenance of engine for replacement of filters is by the usage or mileage shown on the tachometer or hour meter reading on the vehicle. In this gadget, a pressure sensor with vacuum pressure and positive pressure sensing capability is install to monitor the suction pressure from the fuel pump or positive pressure from fuel transfer pump. This is to monitor the fuel restriction in the filter on the gadget. When the filter plugged up, it can create differential pressure across the filter.

The fuel pump's suction pressure will suck entrained air in the fuel causing vapor lock in the fuel pump and fuel starvation of the engine 22. To prevent the fuel pump from sucking entrained air from the fuel and causing error for net fuel consumption monitoring, the pre-restriction pressure are set in the microcomputer and shown on the LCD screen on the gadget to inform consumers to replace the filter before the filter is fully restricted.

The supply fuel 28 en route the system 20 through the filter of the filter head 70 to the engine 22. The first flow temperature of the supply fuel 28 is measured by the first temperature sensor 38 for capture by the microcomputer 48. The pressure of the supply fuel is measured by the pressure sensor 34. The second flow temperature of the excess return fuel 46 is measured by the second temperature sensor 42 prior to the return fuel 46 flowing back to the fuel tank 26.

As shown in Fig. 5, the method 100 applied by the system 20 comprises measuring of the first flow quantity and the first flow temperature of the supply fuel 28 to the engine 22 by the first flow meter 36 and the first temperature sensor 38 in a step 102. Next, the microcomputer 38 matches the first flow temperature to the first reference table 50 or the second reference table 60 for obtaining the first compensated volume in a step 104. The second flow quantity and the second flow temperature of the return fuel 46 are then measured by the second flow meter 40 and the second temperature sensor 42 respectively in a step 106. Next, the microcomputer 38 matches the second flow temperature to the first reference table 50 or the second reference table 60 for obtaining the second compensated volume in a step 108. The volume of fuel consumed by the engine is obtained in a step 110 by subtracting the second compensated volume from the first compensated volume.

The steps 102-110 of the method 100 are preferably coded for execution by the microcomputer 48. Alternative, the steps 102-110 of the method 100 are executable by the microcomputer 48 as instruction codes of a program stored in a memory module (not

shown) in data communication with the microcomputer 48. Alternatively, the memory module is a storage medium decouplable from the microcomputer 48.

In general, Fig. 6 shows show a process 200 of monitoring (or measuring) the net fuel consumption system for engine with return fuel system. The process 200 incorporates at least a portion of the method 100 therewith. For engine with non-return fuel system, only a flow meter and a temperature sensor are required to monitor the net fuel consumption of the engine. If the system is use on gasoline engine, coefficient of thermal expansion of gasoline is use in the temperature table program in the microcomputer, the method of obtaining temperature compensation remains the same.

Preferably, the described embodiment of this invention preferably validates the net fuel consumption of the engine to prevent fuel siphoning by operators. The invention is design as a plug and play gadget and integrating flow meters with a filter head for a spin-on filter for installing on the fuel lines in between the fuel tank and the diesel engine. The system can utilize on gasoline engine deploying the same principle with some changes to its programs and components.

Generally, the operating conditions and environment or field conditions of the diesel engine determined the referred base condition for temperature compensations, average ambient and dispensing temperature of fuel in each country or territory and within the range of specific gravity specified by the petroleum companies. This referred base condition with corresponding indicative temperatures and temperature threshold limit are employ in a temperature table, which is defined in the microcomputer for temperature compensations. The entry point in temperature degree on the temperature table for processing is relevant to field operating conditions of the engine and to facilitate the processing time or matching time between registered temperature by the temperature sensors and the temperature table in the microcomputer. The flow meters meter "K" factors is set to the entry point conjunction to the referred base condition in floating manners and the meter "K" factors adjust according to the temperature of the fluids registered by the temperature sensors in the flows. The microcomputer record the

temperatures from the sensors of corresponding flows and peg to a accumulating set of pulses from both flow meters separately, equilibrium to the nominal number of pulses per unit volume according to the temperature table. The set of pulses are convert to volume by the microcomputer and supply fuel volumes subtract returned fuel volumes to obtain net fuel consumption and display on a LCD screen on the gadget or transmit to a remote computer.

In the foregoing manner, a temperature compensated measurement method and an temperature compensated measurement system for application thereof are described according to one exemplary embodiments of the present invention. Although only one exemplary embodiment of the present invention is disclosed, it will be apparent to a person skilled in the art in view of this disclosure that numerous changes and/or modifications can be made without departing from the scope and spirit of the present invention.

Claims

1. A temperature compensated measurement method comprising:

measuring a first flow quantity and a first flow temperature of supply fluid travelling along a supply path, the supply fluid being providable to a fluid consuming system;

adjusting the measured first flow quantity based on the first flow temperature to thereby obtain a first compensated quantity of the supply fluid substantially at a reference temperature;

measuring a second flow quantity and a second flow temperature of return fluid travelling along a return path, the return fluid being receivable from the fluid consuming system; and

adjusting the measured second flow quantity based on the second flow temperature to thereby obtain a second compensated quantity of the return fluid substantially at the reference temperature,

wherein consumption quantity of the supply fluid consumed by the fluid consuming system is subsequently determinable from the first compensated quantity and the second compensated quantity, the consumption quantity being substantially associated with the reference temperature.

2. The method as in claim 1, further comprising:

determining the consumption quantity of the supply fluid consumed by the fluid consuming system from the first compensated quantity and the second compensated quantity.

3. The method as in claim 2, the consumption quantity being the difference between the first compensated quantity and the second compensated quantity,

wherein the return fluid is a portion of the supply fluid.

4. The method as in claim 1, the first compensated quantity being a function of the first flow quantity and the first flow temperature, the second compensated

quantity being a function of the second flow quantity and the second flow temperature.

5. The method as in claim 1, adjusting the measured first flow quantity based on the first flow temperature comprising:

matching the first flow temperature against at least one of a reference table and a reference chart to obtain a first compensation factor corresponding substantially with the first flow temperature,

wherein the first compensated quantity is a function of the first flow quantity and the first compensation factor.

6. The method as in claim 5, adjusting the measured second flow quantity based on the second flow temperature comprising:

matching the second flow temperature against at least one of the reference table and the reference chart to obtain a second compensation factor corresponding substantially with the second flow temperature,

wherein the second compensated quantity is a function of the second flow quantity and the second compensation factor.

7. The method as in claim 1, the first flow quantity being pulse count measured from pulse signals transduced from a first flow meter disposed along the supply path, and the second flow quantity being pulse count measured from pulse signals transduced from a second flow meter disposed along the return path.

8. The method as in claim 1, the first flow quantity being flow volume of the supply fluid travelling along the supply path, and the second flow quantity being flow volume of the return fluid travelling along the return path.

9. The method as in claim 1, each of the first flow temperature and the second flow temperature being an average of temperatures measured within a sampling window, the sampling window having a fixed duration.

10. The method as in claim 1, each of the supply fluid and the return fluid being hydrocarbon fuel with the fluid consuming system comprising an engine wherethrough the hydrocarbon fuel is consumable.

11. A temperature compensated measurement system comprising:

a controller;

a first temperature sensor; and

a first flow meter, the first temperature sensor for measuring a first flow temperature and the first flow meter for measuring a first flow quantity of supply fluid being providable to a fluid consuming system, each of the first temperature sensor and the first flow meter being in signal communication with the processor for providing corresponding one of the first flow temperature and the first flow quantity thereto, the controller for adjusting the measured first flow quantity based on the first flow temperature to thereby obtain a first compensated quantity of the supply fluid substantially at a reference temperature;

wherein consumption quantity of the supply fluid consumed by the fluid consuming system is subsequently determinable from the first compensated quantity, the consumption quantity being substantially associated with the reference temperature.

12. The system as in claim 11, further comprising:

a second temperature sensor; and

a second flow meter, the second temperature sensor for measuring a second flow temperature and the second flow meter for measuring a second flow quantity of return fluid being receivable from the fluid consuming system, each of the second temperature sensor and the second flow meter being in signal communication with the processor for providing corresponding one of the second flow temperature and the second flow quantity thereto, the controller for adjusting the measured second flow quantity based on the second flow

temperature to thereby obtain a second compensated quantity of the return fluid substantially at a reference temperature;

wherein the consumption quantity of the supply fluid consumed by the fluid consuming system is subsequently further determinable from the second compensated quantity.

13. The system as in claim 12, further comprising:

a fluid source wherefrom the supply fluid is obtainable; and

a filter fluid inter-communicating the fluid source and at least one of the first temperature sensor and the first flow meter.

14. The system as in claim 12, at least one of the first flow meter and the second flow meter being a positive displacement flow meter.

15. The system as in claim 11, further comprising at least one of:

a display for displaying the consumption quantity of the supply fluid consumed by the fluid consuming system; and

a data storage means for storing the consumption quantity of the supply fluid consumed by the fluid consuming system.

16. The system as in claim 11, the controller comprising:

at least one of a reference table and a reference chart whereagainst the first flow temperature is matchable to obtain a first compensation factor corresponding substantially with the first flow temperature,

wherein the first compensated quantity is a function of the first flow quantity and the first compensation factor.

17. The system as in claim 12, the controller comprising:

at least one of a reference table and a reference chart whereagainst the first flow temperature and the second flow temperature is matchable to obtain respectively a first compensation factor corresponding substantially with the first

flow temperature and a second compensation factor corresponding substantially with the second flow temperature,

wherein the first compensated quantity is a function of the first flow quantity and the first compensation factor and the second compensated quantity is a function of the second flow quantity and the second compensation factor.

18. The system as in claim 12, the first compensated quantity being a function of the first flow quantity and the first flow temperature, the second compensated quantity being a function of the second flow quantity and the second flow temperature.

19. The system as in claim 12, the first flow quantity being pulse count measured from pulse signals transduced from the first flow meter disposed along the supply path, and the second flow quantity being pulse count measured from pulse signals transduced from the second flow meter disposed along the return path.

20. The system as in claim 12, the first flow quantity being flow volume of the supply fluid travelling along the supply path, and the second flow quantity being flow volume of the return fluid travelling along the return path.

21. The system as in claim 12, each of the first flow temperature and the second flow temperature being an average of temperatures measured within a sampling window, the sampling window having a fixed duration.

22. The system as in claim 12, each of the supply fluid and the return fluid being hydrocarbon fuel with the fluid consuming system comprising an engine wherethrough the hydrocarbon fuel is consumable.

23. A machine-readable medium having stored therein a plurality of programming instructions, which when executed, the instructions cause the machine to:

measure a first flow quantity and a first flow temperature of supply fluid travelling along a supply path, the supply fluid being providable to a fluid consuming system; and

adjust the measured first flow quantity based on the first flow temperature to thereby obtain a first compensated quantity of the supply fluid substantially at a reference temperature,

wherein consumption quantity of the supply fluid consumed by the fluid consuming system is subsequently determinable from the first compensated quantity, the consumption quantity being substantially associated with the reference temperature.

24. The machine-readable medium as in claim 23, the instructions further cause the machine to:

measure a second flow quantity and a second flow temperature of return fluid travelling along a return path, the return fluid being receivable from the fluid consuming system; and

adjust the measured second flow quantity based on the second flow temperature to thereby obtain a second compensated quantity of the return fluid substantially at the reference temperature,

wherein the consumption quantity of the supply fluid consumed by the fluid consuming system is subsequently further determinable from the second compensated quantity.

25. The machine-readable medium as in claim 24, the instructions further cause the machine to:

determine the consumption quantity of the supply fluid consumed by the fluid consuming system from the first compensated quantity and the second compensated quantity.

26. The machine-readable medium as in claim 24, the consumption quantity being difference between the first compensated quantity and the second compensated quantity,

wherein the return fluid is a portion of the supply fluid.

27. The machine-readable medium as in claim 24,, the first compensated quantity being a function of the first flow quantity and the first flow temperature, the second compensated quantity being a function of the second flow quantity and the second flow temperature.

28. The machine-readable medium as in claim 24, the instructions further cause the machine to:

match the first flow temperature against at least one of a reference table and a reference chart to obtain a first compensation factor corresponding substantially with the first flow temperature,

wherein the first compensated quantity is a function of the first flow quantity and the first compensation factor.

29. The machine-readable medium as in claim 28, the instructions further cause the machine to:

match the second flow temperature against at least one of the reference table and the reference chart to obtain a second compensation factor corresponding substantially with the second flow temperature,

wherein the second compensated quantity is a function of the second flow quantity and the second compensation factor.

30. The machine-readable medium as in claim 24, the first flow quantity being pulse count measured from pulse signals transduced from a first flow meter disposed along the supply path, and the second flow quantity being pulse count measured from pulse signals transduced from a second flow meter disposed along the return path.

31. The machine-readable medium as in claim 24, the first flow quantity being flow volume of the supply fluid travelling along the supply path, and the second flow quantity being flow volume of the return fluid travelling along the return path.

32. The machine-readable medium as in claim 24, each of the first flow temperature and the second flow temperature being an average of temperatures measured within a sampling window, the sampling window having a fixed duration.

33. The machine-readable medium as in claim 24, each of the supply fluid and the return fluid being hydrocarbon fuel with the fluid consuming system comprising an engine wherethrough the hydrocarbon fuel is consumable.

34. A temperature compensated measurement method comprising:

measuring a flow quantity and a first flow temperature of supply fluid travelling along a supply path, the supply fluid being providable to a fluid consuming system; and

adjusting the measured first flow quantity based on the flow temperature and a reference temperature to thereby obtain a first compensated quantity of the supply fluid substantially at the reference temperature,

wherein fluid consumption quantity of the fluid consuming system is determinable from the compensated quantity.