TITLE OF THE INVENTION

FUELING APPARATUS

Field of the Invention

[0001.] The present invention relates to a fueling apparatus, and more particularly to a technique for preventing vapor generated during fueling from flowing out of the fueling apparatus.

Description of the Related Art

[0002.] For example, when fueling a highly volatile fuel such as gasoline into a fuel tank of an automobile, a large amount of vapor is generated in the fuel tank. If such vapor is released into the atmosphere, it may cause risks of ignition and environmental pollution. Techniques for recovering the vapor in the fuel tank through a fueling nozzle have been proposed accordingly (see Patent Documents 1 and 2). In addition, a vapor recovery system (VR system) has been proposed for recovering vapor to (a storage tank of) a fueling apparatus. In such a VR system, the amount of fueling and the amount of vapor recovery should be equal to prevent the release of vapor into the atmosphere during fueling. This is because when the amount of fueling is large, vapor is released into the atmosphere from the fueling port of the vehicle tank, and when the amount of vapor recovery is large, a vapor is released into the atmosphere from a discharge pipe that communicates with an underground tank of the fueling apparatus.

[0003.] Here, back pressure of the VR system is approximately equal to the pressure in the underground tank, and the pressure in the underground tank fluctuates based on daily temperature fluctuations and the amount of fuel to be supplied to vehicles using a fueling apparatus. The back pressure of the VR system also fluctuates accordingly. When the back pressure of the VR system fluctuates, the outlet pressure of the vapor recovery pump (VR pump) in the VR system also fluctuates, and the amount of recovered vapor also fluctuates, which makes it difficult to adjust the amount of fueling and the amount of vapor recovery to be the same. Since the back pressure of the VR system fluctuates, it is difficult to prevent vapor from being released into the atmosphere with a conventional fueling apparatus using the VR system. In fueling apparatuses with a VR system, it is therefore desirable to keep the outlet pressure of the VR pump constant, but this has not yet been proposed.

[0004.] The contents of JP-A-H02-219794 gazette and JP-A-2014-58341 gazette are incorporated herein by reference in their entireties.

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0005.] The present invention has been proposed in view of the above-described problems in the prior art, and it is an object of the present invention to provide a fueling apparatus capable of making the outlet pressure of the VR pump constant.

[0006.] A fueling apparatus 100 according to the present invention is characterized by including: a vapor recovery line (VR line) 1 communicating with a fueling nozzle 6 and an fuel storage tank 5 to return a vapor generated during fueling to the fuel storage tank 5; a vapor recovery pump (VR pump) 2 interposed in the vapor recovery line 1 to suck and discharge the vapor; and a back pressure regulating valve 3 interposed in a region of the recovery line 1 on the discharge side of the vapor recovery pump 2 to maintain a pressure on the discharge port side of the vapor recovery pump 2 at a set value.

[0007.] Further, a fueling apparatus 100-1 according to the present invention is characterized by including: a vapor recovery line (VR line) 1-1 communicating with the fueling nozzle 6 and the fuel storage tank 5 to return a vapor generated during fueling to the fuel storage tank 5; the vapor recovery pump (VR pump) 2 interposed in the vapor recovery line1-1 to suck and discharge the vapor; a pressure sensor 7 interposed in a region of the recovery line 1-1 on the discharge side of the vapor recovery pump 2 to measure a pressure of the region and send the pressure to a control device; and the control device 10 determining, based on the pressure measured with the pressure sensor 7, the number of rotations of the vapor recovery pump 2 such that fueling amount and amount of the vapor recovered become equal.

[0008.] Still further, a fueling apparatus 100-2 according to the present invention is characterized by including: a vapor recovery line (VR line) 1-2 communicating with the fueling nozzle 6 and the fuel storage tank 5 to return vapor generated during fueling to the fuel storage tank 5; the vapor recovery pump (VR pump) 2 interposed in the vapor recovery line1-1 to suck and discharge the vapor; and the back pressure regulating valve 3 interposed in a region of the recovery line 1-2 on the discharge side of the vapor recovery pump 2 to maintain a pressure on the discharge port side of the vapor recovery pump 2 at a set value; the pressure sensor 7 interposed in a region of the recovery line 1-2 on the discharge side of the vapor recovery pump 2 to measure a pressure of the region and send the pressure to a control device, wherein when the pressure in the region of the recovery line 1-2 on the discharge side of the vapor recovery pump 2 becomes equal to or exceeds the pressure at which the pressure on the discharge port side of the vapor recovery pump 2 cannot be maintained at the set value with the back pressure regulating valve 3, the control device 10 activates a warning means and/or stops fueling operation.

EFFECTS OF THE INVENTION

[0009.] According to the present invention with the above-described construction, since the back pressure regulating valve 3 is interposed on the discharge side of the VR pump 2 of the VR line 1, even if the inlet pressure of the VR pump 2 and the back pressure of the VR system fluctuates, the pressure on the inlet side of the back pressure regulating valve 3 or the pressure on the discharge port side of the VR pump 2 is always the set pressure. As a result, when fueling, for example, to the vehicle C with the fueling apparatus 100 of the present invention, fueling amount and amount of the vapor recovered become equal, and a vapor is prevented from being released into the atmosphere from a fueling port of a tank (not shown) of the vehicle C, and a vapor is prevented from being discharged into the atmosphere from a discharge pipe 8 also.

[0010.] Further, in the present invention, instead of interposing the back pressure regulating valve 3, the pressure sensor 7 may be used to measure the back pressure of the VR system (20-1) (the pressure on the outlet side of the VR pump 2). With this configuration, the pressure sensor 7 monitors the back pressure of the VR system 20-1 (the pressure on the discharge side of the VR pump 2) and transmits the measurement result of the pressure sensor 7 to the control device 10. Then, the rotation speed of the VR pump 2 can be controlled (by controlling the pump drive motor 9) corresponding to the back pressure of the VR system 20-1 measured with the pressure sensor 7. As a result, the amount of vapor suctioned with the VR pump 2 can be stably controlled, which makes it possible to control the amount of fueling and the amount of vapor recovery to be the same, preventing the vapor from being released into the atmosphere from the fueling port of the tank (not shown) of the vehicle C and from the discharge pipe 8

[00 11.] Still further, in the present invention, in addition to interposing the back pressure regulating valve 3, the pressure sensor 7 may be disposed to measure the back pressure of the VR system 20-2 (the pressure on the outlet side of the back pressure regulating valve 3). With this configuration, the pressure sensor 7 can detect an abnormal situation where the back pressure of the VR system 20-2 exceeds the adjustment range of the back pressure adjustment valve 3. In such a case, a warning is given to the operator, or a fueling operation can be stopped immediately.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012.] [Figure 1] A block diagram showing a first embodiment of the present invention.

[Figure 2] A front sectional view showing an example of a back pressure regulating valve used in the first embodiment.

[Figure 3] An explanatory view showing arrangement of the back pressure regulating valve shown in Fig. 2 and a vapor recovery pump.

[Figure 4] Characteristic diagrams showing the characteristics of inlet side pressure and outlet side pressure of the back pressure regulating valve.

[Figure 5] A block diagram showing a second embodiment of the present invention.

[Figure 6] A flowchart showing control in the second embodiment.

[Figure 7] A block diagram showing a third embodiment of the present invention.

[Figure 8] A flowchart showing control in the third embodiment.

MODE FOR CARRYING OUT THE INVENTION

[0013.] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. First, the first embodiment of the invention will be described with reference to Figs. 1 to 4. In Fig. 1 showing the overall configuration of the first embodiment, a fueling apparatus generally indicated by a reference numeral 100 includes a VR line 1 (vapor recovery line), a VR pump (vapor recovery pump) 2, a pump drive motor 9, a back pressure regulating valve 3, a fuel storage tank 5, a fueling nozzle 6, a control device 10 to be described later, and a VR system (vapor recovery system) 20. The VR line 1 communicates with the fuel tank 5 and the fueling nozzle 6 in order to return the vapor generated during fueling to the fuel tank 5. The VR pump 2 and the back pressure regulating valve 3 are interposed in the VR line 1. In Fig. 1, an arrow V indicates the flow of vapor. The VR pump 2 has a function of sucking vapor from the fuel supply nozzle 6 side, pressurizing it, and discharging it. The back pressure regulating valve 3 is interposed in a region of the VR line 1 on the discharge side of the VR pump 2 and has a function of maintaining the pressure on the discharge port side of the VR pump 2 at a set value. The VR pump 2 is driven with the pump drive motor 9.

[0014.] The fueling apparatus 100 has a fueling line 31 communicating with the fuel storage tank 5 and the fueling nozzle 6 in order to fill a fuel tank (not shown) of a vehicle C. A fueling pump 32 and a flow meter 34 are interposed in the fueling line 31. The fuel pump 32 is driven by a fuel motor 33. An arrow F indicates the direction of fuel flow in the fuel supply line 31. The fueling apparatus 100 also includes a discharge pipe 8 for discharging a vapor into the atmosphere when a large amount of vapor is recovered. The fueling apparatus 100 includes a control device 10 that executes fueling control and controls of the VR system 20. Regarding the fuel supply control, the control device 10 receives a measured flow rate from the flow meter 34 via a signal line SL1, and transmits a control signal to the fuel supply motor 33 via a signal line SL2. In addition, regarding the control of the VR system 20, the control device 10 transmits a control signal to the pump drive motor 9 via a signal line SL3. Information provided by the control device 10 such as the amount of fueling, emergency warning information, and

others are displayed on the display 11. In Fig. 1, a reference numeral 12 denotes a nozzle switch, and a reference numeral 13 denotes a nozzle hanger.

[0015.] In Fig. 1, for the VR pump 2 is used a positive displacement rotary pump. A vane pump, which is an example of the positive displacement rotary pump, has side clearances (due to the rotation of the rotor), and the clearances allows gas to leak from the high pressure side (discharge side) to the low pressure side (inlet side). In the first embodiment, the back pressure regulating valve 3 is provided as a countermeasure against a case where the pressure at the pump outlet is lowered due to the discharge amount being reduced due to the leakage described above.

[0016.] On the other hand, in non-rotary pumps such as a reciprocating piston pump, there is no leakage as in the vane pump described above, but they pulsate more than rotary pumps, and if the flow rate during fueling is small, the pulsation makes a user feel uncomfortable. This is because the air (vapor)/liquid (gasoline) ratio (A/L ratio) at a tip of the filling nozzle may be regulated to be 98 to 102 in the entire range of fueling flow rates, so the VR pump also operates at low speed when the flow rate during fueling is small. Based on the above reasons, a rotary pump is selected as the VR pump 2 in the illustrated embodiment. Furthermore, in the illustrated embodiment, a structurally simple and versatile vane pump is selected as the positive displacement rotary pump. However, it is also possible to use, for example, a trochoid pump, a rotary pump, etc. as a positive displacement rotary pump other than the vane pump. It is also possible to use a reciprocating piston pump by providing a valve system capable of controlling not only the rotational speed but also the A/L ratio.

[0017.] Details of the back pressure regulating valve 3 shown in Fig. 1 will be described with reference to Fig. 2. The back pressure regulating valve 3 constitutes a mechanical valve, and includes a body 3A, an inlet portion 3B, an outlet portion 3C, a primary pressure chamber 3D, a secondary pressure chamber 3E, a diaphragm 3F, a spring 3G, a pressure adjusting screw 3H and an atmospheric pressure introduction hole 3I. The inlet portion 3B communicates with the discharge port of the VR pump 2 (Fig. 1) via the VR line 1 (Fig. 1), and the outlet portion 3C communicates with the fuel storage tank 5 (Fig. 1) via the VR line 1. A protruding portion 3J protruding upward in Fig. 2 is formed near the center of the main body 3A of the back pressure regulating valve 3, and the upper end of the protruding portion 3J constitutes a valve seat 3K. The stem portion 3L, which is integrally formed with the diaphragm 3F, functions as a valve element and constitutes a valve mechanism 3M together with the valve seat 3K of the projecting portion 3J. In Fig. 2, the direction of flow of the fluid (fuel) in the back pressure regulating valve 3 is indicated by the arrow A1 on the inflow side and the arrow A2

on the outflow side. The back pressure regulating valve 3 adjusts an elastic repulsive force of the spring 3G by adjusting a screwing amount of the pressure adjusting screw 3H, thereby adjusting a force pressing the diaphragm 3F and the stem 3L against the valve seat 3K. As a result, when the fluid in the primary pressure chamber 3D reaches or exceeds a predetermined pressure set value, it passes through the valve mechanism 3M, flows into the secondary pressure chamber 3E, flows into the outlet portion 3C of the back pressure regulating valve 3 and is discharged to the storage tank 5 side (the arrow A2). With this configuration, the pressure of the fluid (fuel) in the primary pressure chamber 3D (pressure on the suction side: pressure in the region on the side of the VR pump 2) can always be held at a predetermined set value. Since the pressure in the fuel storage tank 5 is expected to fluctuate depending on temperature difference and use of a fueling apparatus (fueling a vehicle, etc.), the discharge pressure of the back pressure regulating valve 3 does not become exactly equal to the pressure in the fuel storage tank 5, but roughly the same.

[0018.] The back pressure regulating valve 3 shown in Fig. 2 is provided in a region on the discharge side of the VR pump 2 in the VR line 1 (see Figs. 1 and 3). In Fig. 3, the inlet 2A of the VR pump 2 communicates with the fueling nozzle 6 (Fig. 1), the outlet 2B communicates with the inlet 3B of the back pressure regulating valve 3, and the outlet 3C of the back pressure regulating valve 3 communicates with the fuel storage tank 5 (Fig. 1). In Fig. 3, the arrow A indicates the direction of fluid flow. Interposing the back pressure regulating valve 3 on the discharge side (outlet side) of the VR pump 2 of the VR line 1 holds the pressure (or the holding pressure of the fluid in the primary pressure chamber 3D of the back pressure regulating valve 3: see Fig. 2) at the set value in the region of the VR line 1 on the discharge side of the VR pump 2.

[0019.] Next, referring to Fig. 4, the relation between the pressure on the inlet side of the back pressure regulating valve 3 (that is, the pressure on the discharge port side of the VR pump 2) and the pressure on the outlet side of the back pressure regulating valve 3 (that is, the back pressure on the back side of the VR system 20) will be explained. In Fig.4, the horizontal axis indicates the back pressure of the VR system 20 (the outlet pressure of the back pressure regulating valve in the illustrated embodiment), and the vertical axis indicates the pressure on the discharge port side of the VR pump 2 (the inlet pressure of the regulating valve in the illustrated embodiment). First, when the back pressure regulating valve is not interposed (in the case of the conventional technology), the relationship between the pressure on the discharge port side of the VR pump and the back pressure of the VR system is shown with the characteristic line B in Fig. 4(2). According to the characteristic line B in Fig. 4(2), as the back pressure of the VR system 20 fluctuates (rises), the pressure on the discharge side of the VR

pump 2 gradually fluctuates (rises). Here, the back pressure of the VR system 20 is the pressure in the fuel storage tank 5, which varies according to the temperature difference between the morning and afternoon and fuel level in the tank 5. The symbol α in Fig. 4(2) indicates the boundary of the range in which the outlet pressure of the VR pump (inlet pressure of the back pressure regulating valve) does not exceed the set value in Fig. 4(1), it is also displayed in Fig. 4(2) for reference. As is clear from the characteristic line B (the characteristic line of the conventional VR system) in Fig. 4(2), since the outlet pressure of the VR pump fluctuates in accordance with the back pressure of the VR system 20, the amount of vapor collected from the fueling nozzle 6 side also fluctuates. Therefore, it is difficult to equalize the amount of fueling and the amount of vapor collected, and it is also difficult to prevent the vapor during fueling from being released into the atmosphere.

[0020.] Fig. 4(1) shows, in the illustrated embodiment, the relationship between the pressure on the inlet side of the back pressure regulating valve 3 (that is, the pressure on the discharge port side of the VR pump 2) and the pressure on the outlet side of the back pressure regulating valve 3 (that is, the back pressure of the VR system 20) with the characteristic line A. As shown with the characteristic line A in Fig. 4(1), the region where the pressure on the outlet side of the back pressure regulating valve 3, that is, the back pressure of the VR system 20 does not exceed the allowable range (the region on the left side of the symbol α in Fig. 4), the pressure on the inlet side of the back pressure regulating valve 3, that is, the pressure on the discharge port side of the VR pump 2 is always held at a predetermined set value. The dashed characteristic line shown in addition to the characteristic line A is an imaginary line of the above relationship when the back pressure regulating valve 3 is not provided. According to the illustrated embodiment with the characteristic indicated with the characteristic line A in Fig. 4(1), even if the inlet pressure of the VR pump 2 (or the suction pressure of the VR pump 2) varies, the pressure on the discharge port of the VR pump 2 (that is, the pressure on the inlet side of the pressure regulating valve 3) is always the set pressure, the amount of vapor recovery can be adjusted easily and accurately. Therefore, the amount of fuel supplied is prevented from becoming larger than the amount of collected vapor, and the vapor is prevented from being released into the atmosphere from the fueling port of the vehicle tank. Also, the amount of collected vapor is prevented from becoming larger than the amount of fueling, and the discharge of vapor from the discharge pipe 8 into the atmosphere is also prevented.

[0021.] Next, the second embodiment of the present invention will be described with reference to Figs. 5 and 6. In the first embodiment (see Figs. 1 to 4), the back pressure regulating valve 3 is provided on the

discharge side of the VR pump 2 to keep the outlet pressure of the VR pump 2 constant. No back pressure regulating valve is provided in the second embodiment shown in Fig. 5. In the second embodiment, a pressure sensor 7 is interposed in the region of a VR line 1-1 on the discharge side of the VR pump 2 to monitor the back pressure of the VR system 20-1 (pressure on the discharge side of the VR pump 2), and the measurement results of the pressure sensor 7 are transmitted to the control device 10. The control device 10 has a function of controlling the rotation speed of the VR pump 2 in response to the back pressure of the VR system 20-1 measured with the pressure sensor 7, resulting in stable control of the amount of vapor suction from the fueling nozzle 6 side. In the description of the second embodiment made with reference to Figs. 5 and 6, the configuration and effects different from those of the first embodiment shown in Figs. 1 to 4 will be mainly described. The same constituent members as in the first embodiment (VR pump 2, fuel storage tank 5, fueling nozzle 6, control device 10, etc.) will be described with the same reference numerals.

[0022.] In Fig. 5, the fueling apparatus according to the second embodiment, wholly denoted by the reference numeral 100-1, includes the VR line 1-1 communicating with the fueling nozzle 6 and the fuel storage tank 5, and a fueling line 31 communicating with the fuel storage tank 5 and the fueling nozzle 6, a discharge tube 8 for releasing vapor to the atmosphere, and the control device 10 for performing fueling control and other controls. The fuel supply line 31 and the discharge pipe 8 in the second embodiment, including the devices interposed therein, are the same as those in the first embodiment. As in the first embodiment, the VR line 1-1 is provided with the VR pump 2 for sucking, pressurizing, and discharging vapor. The second embodiment differs from the first embodiment in that the pressure sensor (or pressure switch) 7 is interposed in the region of the VR pump 2 on the discharge side of the VR line 1-1. The pressure sensor 7 has a function of measuring the pressure in the region on the discharge side of the VR pump 2 in the VR line 1-1 (that is, the back pressure of the VR system 20-1), and the measurement result is sent to the control device 10 via the signal line SL4.

[0023.] In the second embodiment, the control device 10 has a function of controlling the number of revolutions of the VR pump 2 based on, for example, the characteristics (prestored characteristics) between back pressure of the VR system and flow rate of vapor suctioned with the VR pump. That is, the control device 10 has a function of determining the number of revolutions of the VR pump 2 so that the amount of fueling and the amount of vapor recovery are equal based on the characteristics of the above-mentioned between back pressure of the VR system and flow rate of vapor suctioned with the VR pump using the pressure of the discharge side region of the VR pump 2 (the back pressure of the VR

system 20-1) measured with the pressure sensor 7. The control device 10 has a function of transmitting a control signal to the pump drive motor 9 via the signal line SL3 to control the rotation speed of the VR pump 2 to a rotation speed at which the fuel supply amount and the vapor recovery amount are equal. The function of the control device 10 makes it possible to stabilize the amount of vapor suctioned by the VR pump 2 and control the amount of fuel supplied and the amount of vapor collected to be equal. Here, it is possible to use instead of the above characteristics, an arithmetic expression representing the relationship between the VR system back pressure and the vapor suction flow rate by the VR pump to determine the pressure in the region on the discharge side of the VR pump 2 measured with the pressure sensor 7 (VR system 20-1 back pressure), and control the rotation speed of the VR pump 2 to a rotation speed at which the amount of fuel supply and the amount of vapor recovery are equal.

[0024.] Control in the second embodiment will be described mainly with reference to Fig. 6. In Fig. 6, in step S1, the pressure in the region of the VR line 1-1 on the discharge side of the VR pump 2 is measured. The pressure measurement in step S1 is performed with the pressure sensor 7, and the measurement result is transmitted to the control device 10 via the signal line SL4. In step S2, based on the pressure in the region on the discharge side of the VR pump 2 (back pressure of the VR system 20-1) measured in step S1, the rotation speed of the VR pump 2 that matches the measured pressure is determined. As described above, the rotation speed of the VR pump 2 is determined by taking into account the previously determined characteristics between back pressure of the VR system and flow rate of vapor suctioned with the VR pump, so that the fueling amount and the vapor recovery amount are equal. Then, the process proceeds to step S3. In step S2, instead of storing the characteristics between back pressure of the VR system and flow rate of vapor suctioned with the VR pump, an arithmetic expression corresponding to the characteristic can be used by the control device 10 to calculate the rotation number of the VR pump 2.

[0025.] In step S3, the VR pump 2 is controlled to operate at the rotational speed determined in step S2. Then, the process returns to step S1 to continue the control. In Fig. 6, when the control is to be terminated, it is sufficient to terminate without returning in step S3. Other configurations and effects of the second embodiment shown in Figs. 5 and 6 are the same as those of the first embodiment shown in Figs. 1 to 4.

[0026.] The third embodiment of the present invention will be described with reference to Figs. 7 and 8. In the third embodiment, the back pressure regulating valve 3 in the first embodiment (Figs. 1 to 4) is provided, and the same pressure sensor (or pressure switch) 7 as in the second embodiment (Figs. 5 and 6) is interposed in the region of the VR

line 1-2 on the outlet side of the back pressure regulating valve 3. The third embodiment shown in Fig. 7 has the back pressure regulating valve 3 as in the first embodiment, but the pressure sensor 7 detects the back pressure of the VR system 20-2 (the outlet side pressure of the back pressure regulating valve 3) is measured, and when the back pressure of the VR system 20-2 exceeds the adjustment range of the back pressure regulating valve 3, the pressure sensor 7 detects this and issues a warning to the fueling operator or stops fueling. In the following description of the third embodiment, the configurations and actions that are different from those of the first and second embodiments will be mainly described. The same constituent members as in the first and second embodiments (VR pump 2, back pressure regulating valve 3, fuel storage tank 5, fueling nozzle 6, sensor 7, control device 10, etc.) are given the same reference numerals.

[0027.] In Fig. 7, the fueling apparatus according to the third embodiment, wholly denoted by reference numeral 100-2, includes a VR line 1-2 communicating with the fueling nozzle 6 and the fuel tank 5, a fueling line 31 communicating with the fueling tank 5 and the fueling nozzle 6, the discharge pipe 8 for releasing vapor into the atmosphere, and the control device 10 for performing fueling control and the like. The fuel supply line 31, the discharge pipe 8, and the like including the interposed members in the third embodiment are the same as those in the first and second embodiments. The VR pump 2 is interposed in the VR line 1-2 as in the first and second embodiments. In the region of the VR line 1-2 on the discharge side of the VR pump 2, the mechanical back pressure regulating valve 3 having a function of maintaining the pressure on the discharge port side of the VR pump 2 at a set value is provided as in the first embodiment. In the third embodiment, unlike the first embodiment, the pressure sensor (or pressure switch) 7 is interposed in the region of the VR line 1-2 on the outlet side of the back pressure regulating valve 3. The pressure sensor 7 measures the pressure in the region of the VR line 1-2 on the outlet side of the back pressure regulating valve 3 (back pressure of the VR system 20-2), and transmits the measurement result of the pressure via the signal line SL4 to the control device 10.

[0028.] In Fig. 7, when the pressure on the outlet side of the back pressure regulating valve 3 (the back pressure of the VR system 20-2) exceeds the allowable range, the back pressure regulating valve 3 cannot be held the pressure on the discharge port side of the VR pump 2 (the pressure on the inlet side of the pressure regulating valve 3) at the set value, and the pressure on the discharge port side of the VR pump 2 (pressure on the inlet side of the back pressure regulating valve 3) becomes higher than the set value. In other words, the allowable range of the pressure in the area on the outlet side of the back pressure regulating valve 3 (the back pressure of the VR system 20-2) is that the

back pressure regulating valve 3 can be held the pressure on the outlet side of the VR pump 2 (the back pressure regulating valve 3 inlet side pressure) at a set value, and the allowable range is determined in advance and stored in the control device 10. The control device 10 compares the measurement result of the pressure in the region on the outlet side of the back pressure regulating valve 3 (back pressure of the VR system 20-2) obtained from the pressure sensor 7 with the "allowable range", and when the pressure in the area on the outlet side of the back pressure regulating valve 3 (the back pressure of the VR system 20-2) becomes outside the allowable range, and the back pressure regulating valve 3 can no longer hold the pressure on the discharge port side of the VR pump 2 (pressure on the inlet side of the back pressure regulating valve 3) at the set value, the control device 10 activates a warning means (not shown) and/or stops the fueling work. On the other hand, if the pressure measurement result is within the allowable range, the pressure on the discharge port side of the VR pump 2 (pressure on the inlet side of the back pressure regulating valve 3) is held at the set value, and while controlling the rotation speed of the VR pump 2 such that fueling amount and amount of vapor recovered become the same, the fueling operation is continued.

[0029.] Mainly referring to Fig. 8, control in the third embodiment will be described. In Fig. 8, in step S11, the back pressure of the VR system 20-2 (the pressure in the area on the outlet side of the back pressure regulating valve 3) is measured in the VR line 1-2. The measurement is performed with the pressure sensor 7, and the measurement result of the pressure sensor 7 is transmitted to the control device 10 via the signal line SL4. In step S12, the back pressure of the VR system 20-2 (the pressure in the area on the outlet side of the back pressure regulating valve 3) measured in step S11 is compared with the allowable range stored in the control device 10 in advance. As described above, the allowable range is the range of the back pressure of the VR system 20-2 that the pressure on the outlet side of the VR pump 2 (pressure on the inlet side of the back pressure regulating valve 3) can be maintained at a set value with the back pressure regulating valve 3. As a result of the comparison in step S12, if the back pressure of the VR system 20-2 (the pressure in the area on the outlet side of the back pressure regulating valve 3) exceeds the allowable range (if it is greater than the upper limit of the allowable range: "Yes" in step S12), the process proceeds to step S13. On the other hand, if the back pressure of the VR system 20-2 (the pressure in the area on the outlet side of the back pressure regulating valve 3) is within the allowable range (if it is equal to or lower than the upper limit of the allowable range: "No" in step S12), the process returns to step S11. The comparison in step S12 is performed with the control device 10.

[0030.] In step S13 ("Yes" in step S12: when it is determined that the back pressure of the VR system 20-2 (the pressure in the area on the outlet side of the back pressure regulating valve 3) exceeds the allowable range), it is difficult to make the amount of fueling and the amount of vapor recovery the same amount, and it is determined that there is a risk that the vapor during fueling will be released into the atmosphere, so that a warning means (not shown) is activated to issue a warning to a fueling person. At that time, instead of or in addition to the warning, it is also possible to control the fueling apparatus 100-2 to stop the fueling operation. The control device 10 executes the warning and/or the control to stop the fueling work. If the back pressure of the VR system 20-2 (the pressure in the area on the outlet side of the back pressure regulating valve 3) is within the allowable range (“No” in step S12), the process returns to step S11, and the pressure on the discharge port side of the VR pump 2 (the pressure on the inlet side of the back pressure regulating valve 3) is held at the set value, and the fueling operation is continued while controlling the rotation speed of the VR pump 2 so that the fueling amount and the vapor recovery amount are equal. Other configurations and effects of the third embodiment shown in Figs. 7 and 8 are the same as those of the first embodiment shown in Figs. 1 to 4.

[0031.] It should be noted that the illustrated embodiments are merely examples and are not intended to limit the technical scope of the present invention.

DESCRIPTION OF THE REFERENCE NUMERALS

[0032.]

1, 1-1, 1-2 ... VR lines (vapor recovery lines)
2 ... VR pump (vapor recovery pump)
3 back pressure regulating valve
5 fuel storage tank
6 fueling nozzle
7 pressure sensor
8 discharge pipe
10 control device
20, 20-1, 20-2 ... VR systems (vapor recovery systems)
100, 100-1, 100-2 ... fueling apparatuses

CLAIMS

[Claim 1] A fueling apparatus comprising:

a vapor recovery line communicating with a fueling nozzle and a fuel storage tank to return a vapor generated during fueling to the fuel storage tank;

a vapor recovery pump interposed in the vapor recovery line to suck and discharge the vapor; and

a back pressure regulating valve interposed in a region of the recovery line on the discharge side of the vapor recovery pump to maintain a pressure on the discharge port side of the vapor recovery pump at a set value.

[Claim 2] A fueling apparatus comprising:

a vapor recovery line communicating with a fueling nozzle and a fuel storage tank to return a vapor generated during fueling to the fuel storage tank;

a vapor recovery pump interposed in the vapor recovery line to suck and discharge the vapor;

a pressure sensor interposed in a region of the recovery line on the discharge side of the vapor recovery pump to measure a pressure of the region and send the pressure to a control device; and

the control device determining, based on the pressure measured with the pressure sensor, the number of rotations of the vapor recovery pump such that fueling amount and amount of the vapor recovered become equal.

[Claim 3] A fueling apparatus comprising:

a vapor recovery line communicating with a fueling nozzle and a fuel storage tank to return a vapor generated during fueling to the fuel storage tank;

a vapor recovery pump interposed in the vapor recovery line to suck and discharge the vapor;

a back pressure regulating valve interposed in a region of the recovery line on the discharge side of the vapor recovery pump to maintain a pressure on the discharge port side of the vapor recovery pump at a set value; and

a pressure sensor interposed in the region of the recovery line on the discharge side of the vapor recovery pump to measure a pressure of the region and send the pressure to a control device,

wherein when the pressure in the region of the recovery line on the discharge side of the vapor recovery pump becomes equal to or exceeds the pressure at which the pressure on the discharge port side of the vapor recovery pump cannot be maintained at the set value by the back pressure regulating valve, the control device activates a warning means and/or stops fueling operation.