

PITBULL VACUUM VALVE CONTROLLER FEATURES

Created from the International Patent Application, titled,
A distributed control system for a vacuum sewer system.

The PitBull Vacuum Valve Controller (“Valve Controller”) is a new solution to some very old problems seen in vacuum sewer systems. A vacuum sewer system absolutely justifies its existence in areas with high water tables; however, the challenge of maintaining the numerous vacuum valve pits during normal everyday use can consume many man hours, tracking down and correcting the problems before they start affecting other valve pits. The PitBull Vacuum Valve Controller solves many of the common problems at the valve pit site automatically, and prevents them from spreading to other valve pits. If there is a problem that the PitBull Vacuum Valve Controller cannot overcome, an alarm is sent to the Control Center so that a truck can be dispatched.

Use of the PitBull Vacuum Valve Controller decreases the annual man hours needed to maintain vacuum sewer valve pits by detecting and correcting common problems seen during everyday use. For example, the PitBull Vacuum Valve Controller will detect an obstruction in the valve that causes it to be stuck partially open, and then the PitBull Vacuum Valve Controller will automatically open the vacuum valve in an attempt to pass the obstruction. Whether or not the obstruction was cleared, a warning alarm is sent to the Control Center to indicate that the vacuum valve pit should be inspected. This saves many man hours of searching for a stuck vacuum valve, which may have cleared itself before being located.

Using an IP Sensing Vacuum Sewer Monitoring System provides the system operators with daily warning indicators to the exact vacuum valve pits developing problems so that a preventative maintenance call can be made to the specific vacuum valve pits for inspection. This pinpointing of the vacuum valve pits needing attention saves man power resources by servicing only the valve pits developing problems instead of wasting many man hours in routinely inspecting all vacuum valve pits throughout the year. For example, a vacuum valve pit that has the Sensor Tube becoming clogged with grease will send a warning alarm to the Control Center indicating a Sensor Tube problem and that the vacuum valve pit should be inspected.

Overall improvement in vacuum sewer system efficiency and man power resource management is achieved by using the IP Sensing Vacuum Sewer Monitoring System with the PitBull Vacuum Valve Controller. The main feature of the PitBull Vacuum Valve Controller that enables it to efficiently manage a vacuum valve pit and solve common problems is its ability to determine the amount of liquid sewage flow from the amount of air flow through the vacuum valve and then calculate the Air-to-Liquid ratio. It is well known that the most important condition to maintain in a vacuum sewer system is the Air-to-Liquid ratio in the vacuum sewer transport lines. So let’s get to the features of the PitBull Vacuum Valve Controller that help maintain this important Air-to-Liquid ratio and improve overall efficiency in maintaining a vacuum sewer system.

PITBULL VACUUM VALVE CONTROLLER FEATURES:

1. SUMP EVACUATION CONTROL - The Valve Controller determines when to open/close the vacuum valve to evacuate the sump and inject air into the transport line. The Valve Controller monitors the sump level and when the transport line has sufficient vacuum, the vacuum valve is opened until all sewage is evacuated and then kept open until a sufficient amount of air follows the liquid sewage to achieve a desired Air-to-Liquid ratio of 3:1.
 - a. SUMP FULL DETECTION – The Valve Controller determines the sump full condition when the sensor tube pressure level reaches a preset threshold corresponding to the sump full condition, which is usually a sewage level of about 6” up the sump sensor tube from the end of the tube.
 - b. TRANSPORT LINE VACUUM RECOVERY MONITOR – The Valve Controller will only open the vacuum valve when there is sufficient vacuum of 8” Hg available in the transport line. Holding the sewage in the sump until the vacuum recovers to a suitable level will help prevent waterlogging in the transport line during peak times or surge flow conditions, e.g., special community events or rain storms where broken cleanouts exist.
 - c. AIR/LIQUID RATIO MONITOR - Vacuum sewer transport lines operate efficiently when there is a proper Air-to-Liquid ratio, which is largely determined by the Valve Controller injecting air into the transport line after the sewage has been evacuated from the sump. The Valve Controller controls the Air-to-Liquid ratio using real-time control algorithms to determine when enough air has been injected into the transport line and then closes the vacuum valve.
 - d. VACUUM VALVE ACTUATION – The Valve Controller is connected to a solenoid valve for delivering vacuum or atmospheric pressure to the vacuum valve, wherein energizing/latching the solenoid valve in one direction delivers a vacuum to the vacuum valve, which is used to open the vacuum valve and energizing/latching the solenoid valve in the opposite direction delivers atmospheric pressure to the vacuum valve, which is used to close the vacuum valve. The vacuum valve is opened when the Sump Full level is reached and will remain open until the Air-to-Liquid ratio is greater than 3:1 and the vacuum valve has been open for at least 5 seconds.
2. AUTOMATIC CLEARING OF OBSTRUCTION IN VALVE – When a partially open or stuck open valve is detected, the controller will repeatedly cycle the valve in attempt to clear the obstruction.
 - a. VALVE OPEN/CLOSE DETECTION - The Valve Controller determines the open/close state of the vacuum valve by monitoring the vacuum on each side of the vacuum valve,
 - b. VALVE PARTIALLY OPEN DETECTION – The Valve Controller will determine the vacuum valve to be partially open if the suction pipe vacuum is greater than atmosphere when the valve is expected to be closed,
 - c. VALVE ACTUATION TO CLEAR OBSTRUCTION – Upon detection of a partially open or stuck open valve, the Valve Controller will fully open the valve until air flow is detected and a minimum of 3 seconds have elapsed This is repeated 3 times an hour until the valve fully closes;
3. AUTOMATIC SUMP EVACUATION – Once a vacuum valve pit problem has been detected, the Valve Controller will automatically evacuate the sump if the valve has not cycled in 12 hours. This will allow the operators plenty of time to inspect the vacuum valve pit while preventing any sewer backups.
4. AUTOMATIC AIR INSERTION CONTROL - Vacuum sewer transport lines will become waterlogged when not enough air and too much liquid are present in the lines. The Valve Controller will attempt to

automatically clear this condition by opening the vacuum valve to inject air into the transport line. When the vacuum in the transport line at the valve pit is depleted to less than 8" Hg for more than 4 minutes, the vacuum valve is automatically opened and the valve will remain open until 10 seconds of air has been injected into the transport line at a maximum rate of 60 seconds of air per hour.

5. VALVE PIT DIAGNOSTICS – The Valve Controller is continuously monitoring the valve pit sensors and conducting valve pit diagnostics as follows:
 - a. SENSOR TUBE SENSOR DIAGNOSTICS – If the valve has not cycled in 12 hours, then the Valve Controller will automatically cycle the valve to see if a large amount of liquid is in the sump that was not detected by the sensor tube,
 - b. SUCTION TUBE SENSOR DIAGNOSTICS – When the valve is cycled, the Valve Controller will verify that the suction tube sensors are working properly,
 - c. TRANSPORT LINE SENSOR DIAGNOSTICS – When the valve is cycled, the Valve Controller will verify the transport line sensor is working properly,
 - d. SUMP AIR VENT OBSTRUCTION DIAGNOSTICS – When the valve is cycled, the Valve Controller will verify the sump air vents are adequate by observing the atmospheric pressure drop in the sump,
 - e. VACUUM VALVE DIAGNOSTICS – When the valve is cycled, the Valve Controller will verify the valve is opening and closing within a maximum of 2 seconds delay from initiation;

6. WIRELESS COMMUNICATIONS FEATURES- The Valve Controller has a radio frequency transceiver for wirelessly communicating to and from other wireless communication devices external of the valve pit for Drive-by and Fixed-base data exchange, as follows:
 - a. PROPERLY OPERATING VALVE PIT – The Valve Controller continuously communicates its operating status to the Control Center to confirm that the Valve Controller and its valve pit are operating properly. An alarm at the Control Center is activated if the Valve Controller loses communications with the Control Center for more than 6 hours. This will identify any possible failure with the Valve Controller and valve pit before the customer has a sewer backup,
 - b. AIR INJECTION COMMAND INITATED FROM CONTROL CENTER – An operator can command a Valve Controller to inject air into the transport line for any reason from the Control Center. An Air Injection command sent to the Valve Controller will open the valve and keep it open until 10 seconds of air has been injected into the transport line,
 - c. VALVE CYCLE COUNTER – The Valve Controller keeps track of the vacuum valve cycles and communicates this Valve Cycle Counter to the Control Center for historical charting of a valve pits usage. An important usage of the cycle counter is tracking valve actuations during rain storms to see which pits increased usage indicating water infiltration and inflow,
 - d. VALVE PIT ALARMS – When the Valve Controller cannot clear a problem at the valve pit on its own, the problem will be stored in memory and communicated back to the Control Center as the following alarm conditions:
 - i. FULL SUMP ALARM – When a Full Sump is detected and cannot be evacuated by opening the valve with the Valve Controller,
 - ii. OPEN VALVE ALARM – When a fully or partially open valve is detected and cannot be closed by the Valve Controller,

- iii. FAULTY VALVE ACTUATION ALARM – When the valve fails to respond properly to an open or close command by the Valve Controller,
 - iv. AIR/LIQUID RATIO LOW ALARM – When evacuating the sump and a proper Air-to-Liquid ratio of 3:1 is not reached before the valve is closed by the Valve Controller,
 - v. TRANSPORT LINE LOW VACUUM ALARM – When the Valve Controller detects a vacuum of less than 8” Hg is present in the transport line for more than 4 minutes,
 - vi. HIGH SEWAGE USAGE DETECTION ALARM - When more than 30 valve opens per 10 minutes are needed to keep the sump evacuated by the Valve Controller,
 - vii. TRANSPORT LINE SLOW VACUUM RECOVERY ALARM – When a vacuum of less than 8” Hg is present in the transport line for more than 20 seconds after the valve is closed by the Valve Controller,
 - viii. SENSOR TUBE SENSOR ALARM – When a faulty sensor tube sensor is detected by the Valve Controller,
 - ix. SUCTION TUBE SENSOR ALARM – When a faulty suction tube sensor is detected by the Valve Controller,
 - x. TRANSPORT LINE SENSOR ALARM – When a faulty transport line sensor is detected by the Valve Controller,
 - xi. SUMP AIR VENT OBSTRUCTION ALARM – When an obstructed sump air vent is detected by the Valve Controller,
 - xii. LOW BATTERY ALARM – When the Valve Controller battery has less than 6 months battery life remaining;
- e. DRIVE-BY READING AND CONTROL OF VALVE PIT - The Valve Controller enables a wireless communicating device to communicate the real-time valve pit conditions and control the vacuum valve from a Drive-by Data Collector, whereby an operator in the field can remotely actuate a vacuum valve and monitor the results of the valve actuation,
 - f. DRIVE-BY READING OF HISTORICAL VALVE PIT STATUS AND ALARMS - The Valve Controller records and saves to memory the valve pit operating parameters and thus enabling a wireless communicating device to communicate the recorded operating parameters to and from a Drive-by Data Collector, whereby an operator in the field can download valve pit operating parameters and identify a problem that has occurred even though the problem is cleared at the present moment;
- 7. CONTROL CENTER GIS MAP DISPLAY OF VALVE PIT STATUS AND ALARMS – The Control Center computer displays the Valve Controller’s acquired information of each valve pit on a map for operator viewing via large LCD display.
 - 8. CONTROL CENTER ALARM NOTIFICATIONS - The Control Center computer can email alarm messages to field operator’s cell phones indicating the Valve Controller’s valve pit location in Google Maps and the exact alarm condition.
 - 9. CONTROL CENTER HISTORICAL REPORTS – The Control Center computer can generate reports upon request from the server’s historical database of information:

- a. EXCESSIVE CYCLE COUNT – A cycle counts threshold value is entered by the customer and a report is generated for all pits exceeding the cycle counts threshold value. This report is used for preventative maintenance, i.e., identifying valve pits with leaking gravity line hookups or illegal hookups to storm drains,
 - b. ALARMS REPORTS – Reports can be generated on any or all alarms with the option of selecting a range of dates and times, i.e., last summer’s activity versus this summer’s activity;
10. WATER SUBMERSIBLE ELECTRONICS – The Valve Controller has water-proof housings enabling operation while fully submersed in water and having the minimum requirements to meet a rating of “IP68” as defined in International Standard IEC 60529.
11. BATTERY OPERATED - The Valve Controller has a replaceable battery power supply, whereby the sensors, wireless transceiver, and solenoid valve do not need an external power source.
12. QUICK RETROFIT INSTALLATION WITHOUT REWORKING VALVE PIT OR VACUUM VALVE - The Valve Controller can be installed or changed out at an average of 20 minutes per pit.