An electrical generating system from a gas venting device

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Abstract
This creation is an automatic electrical creating and energy depositing system deduced by a gas emitting device occurred in the petroleum chemical industry. Most of the kinetic energy and potential energy inside the gas emitting device is lost during the emitting process. This invention intends to convert the kinetic energy and potential energy of the emitting fluid into electricity thru an electrical creating unit and a flow regulatory unit. Here, the volume flow rate is detected online by a volume flow sensor located inside the channel. The microcontroller will direct the step motor to decrease the opening by rotating the damper when the vented volume is large enough. Moreover, the electrical charging process of the storage battery will be monitored online. An information communication within the micro controller and the near port without wire is established by using a blue-tooth protocol. Image-monitoring via the PC, Tablet PC, and cell phone is also established using an ipcam.

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1. Introduction

Because of an increased need for energy resources, the abstraction and utilization of oil and gas has increased [1]. Oil and gas stored several kilometers below the ground is subjected to pressures of more than hundreds of atmospheres. The extraction of petroleum coincides with the extraction of natural gas [2, 3, 4]. The associated gas which is separated from the oil contains various hydrocarbons which are often deposited in the tanks and reserves. The danger in blast as a result of emitting, flaring, or the gas re-injection into gas containers will increase when storage or commercial use of the associated gas is not available. A way to decrease the danger in fire or blast is discharging the gas into the atmosphere via gas flaring or gas venting.

Gas flare or gas venting used for burning off undesirable gas or releasing over-pressured gas via pressure relief valves is necessary in chemical plants [5]. According to a report from Mourad et al. [6], the yearly natural gas flaring or expelled in 2003 reached 108 billion cubic meters. Gas flaring can cause serious environmental problems. Therefore, managing and understanding environmental issues as they relate to the extraction of fossil fuels is necessary [1].

A second discharging method of the accompanying gases is emitting. This is gas spreading into the air without burning [7]. Direct gas venting into the atmosphere occurs without flare or black particles. However, the venting process is loud and noisy [8]. Venting gas has considerable potential and kinetic energy during the blow-off process. Noise transformed from potential and kinetic energy will be generated via the large drop in pressure drop and the high speed flow rate [9, 10, 11]. Also, huge amount of energy are wasted during gas venting. In order to extract both the potential and kinetic energy during the blow-off process, an electrical generating unit via a wind generator is proposed. To automatically monitor and delineate the electrical status, a remote monitoring system in conjunction with an electricity saving device is also developed. In order to avoid an excessive flow rate into the wind generator, a remote flow controlling unit using a damper as well as a flow sensor is adopted. Further, to depress noise emission into the atmosphere, a muffler system used to eliminate sound is also attached behind the electrical generating unit.
2. Hardware of the Remote Observing/Controlling Electricity Generating and Energy Storage System

The remote monitoring/controlling electrical generating and energy saving device is illustrated in Fig. 1. As shown in Fig. 1, the system is composed of a flow detecting/control unit, an electrical generating unit, a silencing unit, a three-chamber venting chamber, an IPCAM, an electricity saving unit, a server PC (near port), a client PC (remote port), and a microcontroller – PIC18F4520. In the flow detecting/control unit, there is a gas flow rate sensor, a damper, and a step motor. In the electrical generating unit, there is a fan and an electrical generator. Each one is connected to a micro controller shown in Fig. 2. The process of gas venting, electricity generation, electrical power saving, and monitoring is shown in Fig. 3. Fig. 3 indicates that the gas emitting will be induced into the system first and then pass through the damper, the rectifier, the generating unit, and the silencing unit. Thereafter, the gas will be vented into the atmosphere.

In order to avoid damage to the electrical generating unit due to an overload of wind speed inside the venting conduit, the flow rate can be adjusted by rotating the damper at a specific angle. The algorithm for the volume flow rate control by the damper device is displayed in Fig. 4. Fig. 4 indicates that the volume flow rate sensor will first detect online the gas flow rate. The sensed gas flow rate is sent back to the microprocessor and compared to the threshold flow rate. If the current gas flow rate exceeds the allowable max gas flow rate, the microprocessor will actuate the damper to shorten the channel opening by rotating an angle step by step. Here, the microprocessor initiates the opening adjustment by sending a command to the step motor that drives the damper to every position. If the flow rate can not be efficiently reduced to an allowable value as the damper rotating angle reaches almost 90 degrees, then the bypass unit will be triggered to conduct the venting gas to another duct system. Here, the gas flow rate will be continuously detected online.

3. Human/Machine Interface

The near port is wirelessly linked to the micro controller by the RS-232 protocol and the blue tooth communication standard. Here, the microcontroller connects to the actuator (step motor) and the volume flow rate sensor. The electricity from the fan generator is charged into the electrical saving unit (battery). A current charging electrical circuit and voltage will be sent to the PC port. The IPCAM that linked to the movable
AP router can also obtain the object’s image and send the image to the near port.

To remotely manipulate the step motor, detect the gas flow rate, and do visually monitor both the site’s image and battery’s saving status (charging electrical circuit and voltage), an interface of the near port coded by VB is necessary. As shown in Figure 5, the interface of the near port/remote port is started. By turning on the communication to the electrical generating and energy storage system, the current value of the gas flow rate detected by the volume flow rate sensor can be turn back to the near port and shown on the interface. Three button sets which are symbolized as @1S, @2S, and @3S on the interface include the manipulating button, the automatic function, and the monitoring function (site image and electricity saving status). As seen in Fig. 5(e), the angle of damper and the threshold of the gas flow rate emitting inside the channel can be preset. As revealed in Fig. 5(c) and Fig. 5(f), the gas flow rate is reduced when the damper’s angle is adjusted from 0 degrees to 45 degrees.

4. System Communication Design [12, 13]

To reach the remote control, the TCP/IP protocol between the near port and the remote port is used and performed via Winsock component in the Visual Basic software. The related interfaces for the near port and the remote port are displayed in Fig. 6 and Fig. 7.

(1) A listening for the near part: The status “To Listen” in the near part is executed when the near port is waiting to link to the remote port at the ready status. Besides, a WINSOCK device of the near part is applied to react to a remote part merely. A WINSOCK device is in authority of the “Listen” while a local part is fixed as the “To Listen” status.

(2) A connecting for the remote part: A link invitation can be transmitted thru the WINSOCK device. The WINSOCK device can specify a number for the near part.

(3) A reception for the near part: The near part can receive a connection request event emitted from the remote port when the remote port sends an “To Connect” invitation. Also, the remote part’s connection invitation can be recognized by the near part by the “To Accept” thru a new “WINSOCK” device.
(4) Information sent from the remote port: The remote part will deliver the information to the near port by the “To SendData” if the internet of the near part is successfully linked to the remote part.

(5) Information received at the near part: The information arrival event emitted from the remote part can be obtained by the near part if the remote part delivers information to the near part. The near part will obtain the information from the remote part thru the “To GetData.”

(6) Information received at the remote part: The remote part can generate an acknowledgement of the data arrival event if the near part delivers information to the remote part. The remote part also can obtain the information thru “To GetData.”

(7) Termination: The link is going to finish while ticking “To Close” if the remote transmission is accomplished.

5. Results and Discussion

The remote observing/controlling electricity generating and energy storage system equipped with near port/remote port has been introduced. The gas flow rate induced from venting gas can be automatically detected and remotely controlled via near port/remote port. In addition, the electricity generated from the fan generator can be charged into the electricity saving unit. The immediate electrical information of the electricity saving unit can also be distantly observed in the near port/remote port control ports. The demonstration of gas venting, electricity generation, electrical power saving, and monitoring (large amounts of gas venting) process is displayed in Fig. 8(a)-(j). Fig. 8(b) reveals that the venting gas is conducted through the volume flow rate controlling unit which is equipped with a damper in conjunction with a stepper motor (in the first chamber). As shown in Fig. 8(c), in order to generate more electricity in the fan generator using an uniform flow, the venting flow is rectified using a rectifier instated behind the damper before it enters into the wind electricity generating unit (in the second chamber). As illustrated in Fig. 8(d), the fan is rotated and the electricity generation is initiated when the venting gas passes through the fan. As depicted in Fig. 8(e), because of noise emitted by the venting gas, noise elimination is performed using a silencing unit installed behind the electrical generating unit. Finally, the silenced venting gas will be vented into the atmosphere as shown in Fig. 8(f). During the gas venting and electrical generating
process, the site’s condition will be monitored online via IPCAM’s vision and displayed on the near port/remote port control ports.

The site test of the automatic setting adjustment for the venting flow rate using a damper in conjunction with a step motor on server PC under small amount of gas venting is illustrated in Figure 9(a)-(e). As shown in Fig. 9(b), the system is chosen to be in the automatic electrical generating situation by clicking “@2S” on the interface. The current flow rate and the damper angle are shown online in Fig. 9(c). The current system mode of “@2S” (automatic mode) is also marked on the interface. Moreover, the site test of electrical checking in the electrical saving monitoring interface on the remote port is illustrated in Fig. 10. Fig. 10(a) indicates that the system is selected to be in an electrical monitoring situation by clicking “@3S” on the interface. The current electrical data such as the electrical voltage and circuit are monitored online and shown in Fig. 10(b) [14, 15]. In addition, an AP router is linked to the IPCAM. The object’s appearance captured by IPCAM and turned back to the near port thru the blue tooth is also illustrated in Fig. 10(b) on the interface.

Moreover, the prototype of remote observing/controlling the electricity generating and energy’s storage unit has also been demonstrated and displayed in Figure 11. Both the volume flow rate controlling unit and fan electrical generating unit are shown in Fig. 11(a) and Fig. 11(b). In order to deal with various noise waves (type 1 for a pure-tone noise, type 2 for a low-frequency noise, and type 3 for a high-frequency noise), three kinds of noise silencing units shown in Figs. 11(c)-(e) are demonstrated, accordingly [16, 17, 18]. Consequently, an electrical saving unit is introduced and shown in Fig. 11(f).

6. Conclusion

It has been shown that a wireless electrical generating and energy’s storage unit is distantly observed and handled during gas emitting. Applying both the RS-232 and BT communication, the near part can wirelessly link to the micro controller. The micro controller links to the volume flow rate sensor and step motor to automatically control the gas flow rate by a rotating damper. To implement the flow rate monitoring/controlling, an interface on the near port coded by VB6.0 has been built and illustrated in Figs. 9-10. Three system modes (manipulating mode marked by @1S, automatic flow rate controlling mode marked by @2S, and electricity saving checking marked by @3S) are designed into the interface. The current flow rate and the damper’s angle are monitored online on
the interface. In addition, the current electrical information for the battery (electricity saving unit) is also monitored online in the third system mode. Moreover, in order to distantly observe environmental condition, an AP router which links to the IPCAM wirelessly is applied. The object’s appearance will be sent to the near part thru the BT communication.

Finally, an archetype of the wireless electrical generation and energy’s storage unit is established.

Figure 1
A remote monitoring/controlling electrical generation and energy saving system.

Figure 2
The diagram of the microcontroller – PIC18F4520.
Figure 3
The process of gas venting, electricity generation, electrical power saving, and monitoring.

Figure 4
The algorithm for the volume flow rate control.
Figure 5
Function test on the server PC (small amount of gas venting).
Figure 6
The communication diagram between the server PC and the client PC.

Figure 7
Interfaces of the server PC and the client PC.
Figure 8

Automatic setting adjustment of the venting flow rate using a damper in conjunction with a step motor on a server PC (small amount of gas venting).
(a) Push the IPCAM/Battery Check Function to Initiate Electricity Saving Monitoring Interface

(b) Electricity Saving Monitoring Interface is Initiated [Server PC]

Electricity checking on the electricity saving monitoring interface of the server PC.

Figure 9
Contd...
Figure 10
Process of gas venting, electricity generation, electrical power saving, and monitoring (large amounts of gas venting).
(a) A three-chamber frame as well as a flow detecting/control unit.

(b) An electricity generation unit.

(c) A silencing unit (type 1: pure tone noise).

Contd...
(d) A silencing unit (type 2: low frequency noise).

(e) A silencing unit (type 3: high frequency noise).

(f) An electrical saving unit.

Figure 11
Prototype of a remote monitoring/controlling electrical generation and energy saving system.
References


