

METHOD AND SYSTEM FOR BLENDING GAS STREAMS

Technical Field

The present invention generally relates to a method
5 and system for blending gas streams for use in industrial
cutting and welding applications.

Background

Laser cutting, e.g. of metal plate, is usually
10 performed with the aid of a jet of gas directed on to the
cutting area. The type of gas used depends on the
workpiece material, and is selected so as to prevent
undesired chemical reactions affecting the cutting
surfaces.

15 Oxygen is excellent for cutting or welding ferrous
materials, such as ferrous alloys, due to the exothermic
reaction produced at high temperatures of over 720°C.
Acetylene gas is also used in conjunction with oxygen for
cutting or welding steel. Combustion of acetylene with
20 oxygen produces a flame of over 3600K. The initial
combustion of the acetylene gas heats the steel to a
molten state and the addition of a pressurized stream of
oxygen cuts the steel by burning through it.

However, the properties of acetylene confer many
25 disadvantages on its use. Acetylene gas is highly
flammable and is prone to explosion when pressurized.
Thus, the handling of acetylene can be very inconvenient,
leading to high transportation and production costs.
Acetylene also has an unpleasant odor and the energy
30 consumption during cutting or welding is high.

Compressed natural gas (CNG) has been used as a
substitute for acetylene in cutting applications. CNG is
more environmentally friendly and is safer to handle. CNG
also provides cleaner cuts than acetylene. However, the

flame temperature of CNG is relatively low, resulting in slower cutting or welding speeds and the need for higher amounts of gas.

CNG is thus mixed with other gases to increase the burning temperature. However, gas pressures typically differ over time, thereby requiring the need for a monitoring system. Furthermore, many instruments, such as pressure transmitters, are relied upon to monitor and control the flows of the gases during mixing. However, the use of a large number of instruments inevitably gives rise to a higher risk of failure. The instruments are also typically controlled by complicated and high-cost programmable logic controllers, thereby increasing the cost of production.

There is therefore a need to provide a method and system for mixing gases that overcome, or at least ameliorate, one or more of the disadvantages described above.

20

Summary

In a first aspect, there is provided a method of blending gas streams to produce blended gas, the method comprising the steps of: providing a natural gas stream via a pressure regulator; providing a dosing gas via a dosing gas stream; controlling the differential pressure across the pressure regulator to target a constant flow rate of said natural gas in said natural gas stream; setting a target flow rate of the dosing gas stream relative to the natural gas stream; blending the natural gas stream with the dosing gas stream to produce the blended gas.

30

Advantageously, the step of controlling the differential pressure across the natural gas pressure regulator enables the flow rate of the natural gas

downstream of the pressure regulator to be substantially constant. Since the flow rate of the natural gas downstream of the pressure regulator is targeted to be constant, there may not be a need for controlling the flow of the natural gas, e.g. by control loops or instrumentation, before blending. Advantageously, the disclosed method reduces the need for at least a step of controlling the flow rate of the natural gas before the blending step. Thus, the disclosed method provides a simpler method for blending gas streams.

Advantageously, the flow rate of the dosing gas stream is set relative to the flow rate of the natural gas stream, which is substantially constant. Particularly, the step of setting the flow rate of the dosing gas stream relative to the flow rate of the natural gas stream is conducted before the step of blending the gas streams. Since the flow rates of the gas streams immediately upstream of the blending step are substantially constant, the composition of the blended gas may advantageously be substantially consistent.

In a second aspect, there is provided a system for blending gas streams to produce blended gas, the system comprising: a first inlet for receiving a natural gas stream, the first inlet comprising a pressure regulator for controlling the differential pressure across the pressure regulator to target a constant flow rate of said natural gas in said natural gas stream; a second inlet for receiving a dosing gas stream, the second inlet comprising a dosing gas flow regulator for setting a target flow rate of the dosing gas stream relative to the natural gas stream; the first and second inlets being in fluid communication with a chamber for blending the natural gas stream with the dosing gas stream to produce the blended gas.

The natural gas pressure regulator controls the flow rate of the natural gas downstream of the pressure regulator to target a constant flow rate. The first inlet may therefore not require a flow control loop to control the flow of the natural gas. The disclosed system thus provides for a simpler and more economical system for blending gas streams.

In a third aspect, there is provided a method of providing blended gas for use as cutting gas or welding gas using the disclosed system.

Definitions

The following words and terms used herein shall have the meaning indicated:

The term "differential pressure" as used in the context of the present specification refers to the ratio of pressures between two points. Accordingly, the phrase "differential pressure across the pressure regulator" as used in the context of the present specification refers to the ratio of pressures between the pressure at a point before the pressure regulator and the pressure at a point after the pressure regulator.

The word "substantially" does not exclude "completely" e.g. a composition which is "substantially free" from Y may be completely free from Y. Where necessary, the word "substantially" may be omitted from the definition of the invention.

Unless specified otherwise, the terms "comprising" and "comprise", and grammatical variants thereof, are intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, unrecited elements.

As used herein, the term "about", in the context of concentrations of components of the formulations,

typically means $\pm 5\%$ of the stated value, more typically $\pm 4\%$ of the stated value, more typically $\pm 3\%$ of the stated value, more typically, $\pm 2\%$ of the stated value, even more typically $\pm 1\%$ of the stated value, and even
5 more typically $\pm 0.5\%$ of the stated value.

Throughout this disclosure, certain embodiments may be disclosed in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an
10 inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as
15 from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of
20 the breadth of the range.

Detailed Disclosure of Embodiments

Exemplary, non-limiting embodiments of the invention will now be disclosed.

25 There is provided a method of blending gas streams to produce blended gas, the method comprising the steps of:

providing a natural gas stream via a pressure regulator;

providing a dosing gas via a dosing gas stream;

30 controlling the differential pressure across the pressure regulator to target a constant flow rate of said natural gas in said natural gas stream;

setting a target flow rate of the dosing gas stream relative to the natural gas stream;

blending the natural gas stream with the dosing gas stream to produce the blended gas.

In the present disclosure, the natural gas may be compressed natural gas. This natural gas or compressed natural gas may comprise about 80%, about 90%, about 95%, about 99% or about 100% methane.

Initially, natural gas to be supplied to the blending system may be provided in the form of banks of gas pallets. The natural gas supplied may be in a compressed state such that the pressure of the natural gas supplied may be higher than the pressure of the natural gas after passing through a pressure regulator. These gas pallets are in fluid communication with a pressure regulating manifold optionally equipped with heating jackets to insulate against heat loss. The manifold typically regulates the pressure of the supplied natural gas in a natural gas stream to a determined lower pressure, for example from 200 barg to 15 barg, before being channeled downstream into the disclosed blending system which may comprise instrumental units such as flow meters, flow control valve, or pressure regulators etc. The pressure regulating manifold may be in fluid communication with one or more downstream pressure regulators and/or flow control instruments.

In the present disclosure, each gas pallet may comprise of several natural gas cylinders. The natural gas in these cylinders may be compressed natural gas.

Each bank of gas pallets may comprise at least one gas pallet in fluid communication with the manifold. In this way, the manifold allows the blending system to switch from one bay of gas pallets to another bay that is on standby within the bank when the natural gas supply is used up from the first bay in the gas bank. The switching

from one bay to another bay may be done automatically or manually.

The pressure of the natural gas feed stream may be regulated to any desired pressure. When required, the pressure of the natural gas feed stream may be regulated from 200 to about 2.5 barg. This may be done by channeling natural gas downstream from the natural gas cylinders through one or more pressure regulators and further passing the natural gas stream through a metering valve. The metering valve and pressure regulators may be downstream of the manifold. The pressure regulators may be further used to regulate the pressure of the natural gas stream such that the differential pressure across these regulators provides a constant velocity of the natural gas. In other words, the pressure regulators may be used for controlling the differential pressure to target a constant flow rate of the natural gas in the natural gas stream. This may be achieved by setting the pressure regulator to a fixed regulation value (position) in order to maintain constant pressure differential across the pressure regulator. The pressure regulators may be used to step down the pressure to a lower determined pressure rather than for regulating flow.

The pressure of the natural gas after passing through the pressure regulators may be regulated to any desired value but it is typically less than or equal to the upstream pressure. The above pressure regulators may be adjusted to provide a downstream natural gas pressure of 15 barg.

By controlling the pressure differential across the regulators in the above manner, the ratio of the pressure (P_2) upstream or before the regulator to the pressure (P_1) downstream or after the pressure regulator, i.e. P_2/P_1 , may be at least 1.8. By maintaining this pressure ratio, the

flowing natural gas may achieve sonic velocity so as to target constant flow velocity. By operating the system using this ratio method, complicated process control loops that involve feedback and feedforward instrumentations or
5 programmable logic controller may not need to be implemented in order to control the flow rate of the natural gas. Thus, this method can help to minimize the cost of a blending system.

According to the present disclosure, by using a first
10 pressure regulator to achieve P_2 to be 200 barg and P_1 to be 15 barg, constant sonic velocity of the methane gas may be achieved as the ratio of P_2 to P_1 will be at least 1.8 and the above advantage may be attained.

It is possible that in the present disclosure, more
15 than one pressure regulator may be used when required. The natural gas may be directed downstream through another pressure regulator. Advantageously, the second pressure regulator may permit the natural gas stream to possess consistent pressure. This downstream pressure regulator
20 may be in fluid communication with the pressure regulating manifold. In a similar manner to the above first pressure regulator, this second pressure regulator may be used to adjust the downstream pressure of the natural gas. This second pressure regulator may also be used to control the
25 differential pressure of the natural gas across this pressure regulator so as to target a constant velocity or flow rate of the natural gas. In an embodiment, the ratio of the pressure (P_2) upstream or before the second pressure regulator to the pressure (P_1) downstream or after the
30 second pressure regulator, i.e. P_2/P_1 , is at least 1.8. Similarly, the ratio of the pressure (P_2) upstream or before a further pressure regulator to the pressure (P_1) downstream or after the further pressure regulator, i.e. P_2/P_1 , may be at least 1.8.

The pressure of the natural gas after passing through the second pressure regulator may be adjusted to any desired value but it is typically less than or equal to the upstream pressure. The second pressure regulator may
5 also be adjusted to provide a downstream natural gas pressure of 2.5 barg.

After the second pressure regulator, the natural gas may pass through a flow regulator. This flow regulator may comprise a flow control valve and flow meter. According to
10 the present disclosure, the flow regulator does not comprise a control loop to control the flow of the natural gas since the natural gas flow rate is constant. Hence, the flow control valve may be set at a particular point and may not need to be altered such that the cross-
15 sectional flow area of the natural gas flowing through the flow control valve is also fixed. The natural gas from the natural gas stream then enters a chamber for blending with the dosing gas from another dosing gas stream.

The blending chamber may be a static mixer or any
20 device that provides a means for continuous mixing of fluid materials. Such a chamber may promote mixing of two or more different fluids so that the resultant fluid leaving the blending chamber becomes a homogenously blended fluid.

25 The dosing gas may comprise of any gases selected from the group consisting of alkanes, alkenes, alkynes and mixtures thereof.

The dosing gas may also comprise compounds containing 2 to 4 carbon atoms.

30 The dosing gas may be selected from the group consisting of propane, butane, acetylene, propylene and mixtures thereof.

The dosing gas may also be a mixture of propane and butane.

The dosing gas may be liquefied petroleum gas (LPG) comprising solely propane or butane.

The dosing gas to be fed into the blending system may be provided in the form of a dosing gas tank. The dosing
5 gas may be channeled through one or more pressure regulators, and a flow regulator comprising a flow control valve and a flow meter.

Likewise, this dosing gas pressure regulator may be operated in a similar manner to control the downstream
10 pressure of the dosing gas. When required, the pressure of the dosing gas before the pressure regulator may be 5 barg. When required, the pressure of the dosing gas after the pressure regulator may be 2.5 barg. Advantageously, this dosing gas pressure regulator may aid in stepping
15 down the pressure of the gas from its supply to a safe operating pressure.

The flow control valve may further comprise a flow indicator controller. The flow meter may further comprise a flow transmitter.

20 In the present disclosure, the flow transmitter may be coupled to the flow indicator controller which in turn controls the flow control valve. This sets up a feedback loop for controlling the amount of dosing gas flowing into the downstream blending chamber. Accordingly, the dosing
25 gas flow regulator may comprise a control loop.

The method of obtaining a targeted dosing gas to natural gas flow ratio may be done manually or without electronically coupling these two gas streams. The method is illustrated as follows.

30 The orifice of the flow control valve for the natural gas may be adjusted to a fixed flowrate. In one instance, the orifice of the natural gas flow control valve is adjusted to 405 Nm³/h. This flowrate remains constant provided the differential pressure stays above 1.8. The

orifice of the flow control valve for the dosing gas may also be adjusted to a fixed flow rate according to the targeted flow ratio. Accordingly, in the instance where the target flow rate ratio of the dosing gas to natural gas is maintained at 1:9, where the orifice of the natural gas flow control valve is adjusted to 405 Nm³/h, the orifice of the dosing gas flow control valve is adjusted accordingly to 45 Nm³/h. The above manual control means comprises the use of the flow transmitter, flow indicator controller and the flow control valve itself on both the natural gas and the dosing gas pipelines. Consequently, since the natural gas and dosing gas flowrates are maintained constantly, for example, 405 Nm³/h and 45 Nm³/h respectively, the targeted flow ratio may be achieved.

Hence, these instruments may be set to work together in a way wherein the dosing gas is provided at a flow rate based on the flow rate of the natural gas. According to the present disclosure, the target flow rate of the dosing gas in the dosing gas stream is set relative to the natural gas in the natural gas stream using the above instrument configuration, such that the target flow rate ratio of the dosing gas to natural gas may be maintained at 1:9. This means that the composition of the blended gas leaving the blending chamber may comprise 10% dosing gas and the remaining 90% may be the natural gas. Conventional dosing gas compositions tend to be heavier than air and do not disperse easily should there be a leakage from the system; inevitably, any user or operator may suffer from asphyxiation. Advantageously, the disclosed composition of blended gas may be lighter than air. Thus, the 1:9 flow rate ratio attained by this method advantageously minimizes the safety risk of any user or operator in the event of a dosing gas leakage. Moreover, as the dosing gas used may be more flammable compared to the natural gas,

the above flow rate ratio reduces the chances of any explosion or fire disasters.

When necessary, the target flow rate ratio of the dosing gas to natural gas may be adjusted to any other ratio determined to achieve both safety and combustion temperature.

Where it is not possible to use the ratio method to maintain constant flow velocity of the dosing gas, a feedback loop may be configured to control the flow of the dosing gas in the dosing gas stream.

In the present disclosure, the setting of the target flow rate of the dosing gas stream may be selected at an amount for increasing the combustion temperature of the blended gas. When needed, the target flow rate of the dosing gas may be selected such that it forms the above target ratio of 1:9, thereby arriving at 10% of the blended resultant fluid. Advantageously, the purpose of adding the dosing gas is to improve the cutting or welding capability of the blended gas due to the resultant higher combustion temperature. Furthermore, the dosing gas mentioned above is much more environmentally friendly compared to conventional dosing gases such as acetylene.

After the dosing gas and the natural gas are blended in the chamber, the resultant homogenous blended gas may be directed to a buffer tank. In the present disclosure, the pressure of the buffer tank may be maintained at a desired value to ensure that the blended gas mixture may be at a constant pressure. The buffer tank may also be maintained at a pressure of 2.5 barg to ensure that there may be pressure homogeneity between the natural gas stream and the dosing gas stream and thereby ensure homogenous blending. In this way, maintaining this constant pressure may allow the blended gas to be extracted consistently from a downstream manifold, which may be in fluid

communication with the buffer tank, to ensure uniform cutting. The blended gas may be extracted from the system, e.g. by using a valve, at a similar pressure to that of the buffer tank. The blended gas may be extracted at 2.5 barg.

The system may further comprise an analyzer for analyzing the composition of the blended gas. A gas analyzer may be installed at the buffer tank to examine the composition of the blended gas. If the proportion of the gas mixture is not obtained as desired, the system may be shutoff, either automatically or manually, to correct any deficiency resulting in the disproportion. Any disproportions may compromise efficiency or safety as higher combustion temperature may not be attained for cutting or welding and if the amount of dosing gas exceeds 10% of the blended gas mixture respectively. Hence, the installation of an analyzer at the buffer tank advantageously helps to achieve cutting or welding efficiency and mitigates safety hazards.

There is provided a system for blending gas streams to produce blended gas, the system comprising:

a first inlet for receiving a natural gas stream, the first inlet comprising a pressure regulator for controlling the differential pressure across the pressure regulator to target a constant flow rate of said natural gas in said natural gas stream;

a second inlet for receiving a dosing gas stream, the second inlet comprising a dosing gas flow regulator for setting a target flow rate of the dosing gas stream relative to the natural gas stream;

the first and second inlets being in fluid communication with a chamber for blending the natural gas stream with the dosing gas stream to produce the blended gas.

As mentioned above, the dosing gas may comprise of any gases selected from the group consisting of alkanes, alkenes, alkynes and mixtures thereof. The dosing gas may comprise compounds containing 2 to 4 carbon atoms. The dosing gas may be selected from the group consisting of propane, butane, acetylene, propylene and mixtures thereof. The dosing gas may be a mixture of propane and butane.

The dosing gas may also be liquefied petroleum gas (LPG) comprising solely propane or butane.

As mentioned above, the natural gas may comprise compressed natural gas. This natural gas or compressed natural gas may comprise about 80%, about 90%, about 95%, about 99% or about 100% methane. The blending system may comprise banks of gas pallets in which natural gas is initially provided. Each bank of gas pallets may comprise at least one gas pallet in fluid communication with a pressure regulating manifold. In this way, the blending system may possess the capability to switch from one bay of gas pallet to another bay that is on standby when the compressed natural gas supply is used up from the first bay in the gas bank. The switching from one bay to another bay may be done automatically or manually. In the present disclosure, the pressure regulating manifold may comprise at least one pressure regulator and/or several valves. In the present disclosure, the pressure regulating manifold may be in fluid communication with downstream pressure regulators and/or flow control instruments.

Particularly, each gas pallet may comprise of several natural gas cylinders. The natural gas in these cylinders may be compressed natural gas. These gas pallets may be in fluid communication with a pressure regulating manifold optionally equipped with heating jackets to insulate against heat loss. The manifold typically regulates the

pressure of the supplied natural gas in a natural gas stream to operating pressure before being channeled downstream into the disclosed blending system which may comprise instrumental units such as flow meters, flow control valve, or pressure regulators etc.

The pressure of the natural gas flowing through the first inlet may be 200 barg.

The first inlet for receiving the natural gas stream may be in fluid communication with this pressure regulating manifold, in which natural gas may be supplied into the blending system. According to the present disclosure, the manifold may comprise this first inlet.

The first inlet may comprise a length of pipeline in fluid communication upstream with the pressure regulating manifold and/or in fluid communication downstream with a blending chamber. The first inlet may comprise, downstream, one or more pressure regulators used for controlling the differential pressure of natural gas across this pressure regulator so as to provide a constant flow velocity of the natural gas. The pressure regulator may be in fluid communication with the pressure regulating manifold. The pressure regulator may be any kind of pressure regulator known to any skilled person as long as it fulfills the primary function of matching the flow of natural gas through the regulator to the demand for gas placed upon the system. For instance, if the load flow decreases, then the regulator flow may be decreased in order to maintain constant differential pressure. If the load flow increases, then the regulator flow may be increased in order to prevent the controlled pressure from decreasing due to a shortage of gas in the blending system. The pressure regulators may be used to step down the pressure to a lower determined pressure rather than

for regulating flow. The pressure regulator may be a single stage or multi-stage regulator.

The pressure regulator may comprise a restricting element such as a valve; a loading element for applying
5 the needed resistive force to the restricting element, which may be a weight, a spring, a piston actuator, or more commonly the diaphragm actuator in combination with a spring; and a measuring element which may be used to determine the inlet flow and outlet flow of the pressure
10 regulator.

The above pressure regulator may be used for maintaining a downstream pressure of 15 barg. This may be the first pressure regulator situated on the natural gas pipeline.

15 Based on the above, P_2 and P_1 of the above pressure regulator may be at 200 barg and 15 barg respectively. This may help to achieve a pressure ratio, P_2/P_1 , of at least 1.8 (where P_2 is the upstream pressure or pressure of the natural gas before the pressure regulator, and P_1 is
20 the downstream pressure or pressure after the pressure regulator). Accordingly, when the system achieves a differential pressure ratio of at least 1.8 across the above pressure regulator, the natural gas may be able to attain constant sonic velocity. By attaining such a
25 constant sonic velocity, the present system advantageously minimizes or eliminates the use of complicated process control loops that involve feedback and feedforward instrumentations or programmable logic controller in order to control the flow rate of the compressed natural gas,
30 thereby lowering the cost of such a blending system. Hence, in the present disclosure, the system excludes a programmable logic controller.

In instances, more than one pressure regulator may be used when required. The system may also comprise another

pressure regulator disposed downstream of the above pressure regulator in which natural gas passes through. The pressure regulator may be in fluid communication with the pressure regulating manifold. Similarly, this second pressure regulator may be any pressure regulator known to the skilled person as long as it fulfills the same function as the above pressure regulator. This second pressure regulator may be used to control the differential pressure across the pressure regulator to target a constant flow rate of said natural gas in said natural gas stream. This pressure regulator may be used to regulate the natural gas pressure to 2.5 barg. Advantageously, the second pressure regulator may confer consistent pressure to the natural gas stream. In instances, more than one pressure regulator may be used when required.

In the present disclosure, the first inlet further comprises, downstream of the pressure regulator(s), a natural gas flow regulator. The flow regulator may comprise a flow control valve and a flow meter. The flow control valve may comprise of any valves known to the skilled person, e.g. ball valve, butterfly valve, gate valve or check valve, as long as it fulfills the functions of regulating the pressure or flow of a fluid. The flow meter may further comprise a flow transmitter. As the name implies, a flow meter is an instrument for monitoring, measuring, or recording the rate of flow, or discharge of the fluid.

Likewise, the flow transmitter is a device used for measuring the flow of a fluid through a tubing or pipe. Additionally, the measurements are converted from electrical signals by the flow transmitter and sent to a designated receiving agent, such as a computer or an automated control station. They may then be translated by the flow transmitter to allow control operators to

visualize the amount of liquid being transferred through pipelines in order to regulate the flow and ensure that the proper volumes may be transported at all times. A flow transmitter may be installed in conjunction with the flow meter to transmit the results produced by the flow meter to the control station manned by the operator.

Subsequently, the natural gas may be directed into a chamber for blending the gases.

In the present system, the dosing gas may be provided in the form of a dosing gas tank.

The second inlet may comprise a length of pipeline in fluid communication downstream with a blending chamber. The second inlet may comprise, downstream, a pressure regulator in fluid communication with the dosing gas tank.

Likewise, this pressure regulator may comprise any pressure regulator known to the skilled person as long as it fulfills the basic function similar to the abovementioned pressure regulators installed on the natural gas pipeline. Inherent differential pressure across this dosing gas pressure regulator may not be sufficient to achieve constant flow velocity. Accordingly, a feedback loop may be disposed downstream of the dosing gas pressure regulator for controlling the dosing gas flow prior to it entering the blending chamber.

The second inlet comprises a dosing gas flow regulator for setting a target flow rate of the dosing gas stream relative to the natural gas stream. The dosing gas flow regulator may be located downstream of the dosing gas pressure regulator. The target flow rate of the dosing gas flow regulator may be set relative to the natural gas flow regulator. The flow regulator may comprise a flow control valve and a flow meter. The dosing gas flow regulator may comprise a control loop.

A flow transmitter may be installed in conjunction with the flow meter as described earlier. This flow control valve may be similar to the earlier flow control valve in which natural gas passes through.

5 Additionally, this dosing gas flow control valve may include a flow indicator controller installed in conjunction with it. The flow indicator controller may comprise of any controller known to the skilled person as long as it is suitably designed and calibrated to
10 automatically control the flow rates of the dosing gas for the current application.

 The dosing gas flow transmitter may be coupled to the dosing gas flow indicator controller which in turn controls the dosing gas flow control valve. This sets up
15 the feedback loop for controlling the amount of dosing gas flowing into the downstream blending chamber.

 Notably, the natural gas and dosing gas flow control instruments comprising the flow control valve, flow meter, flow indicator controller and/or flow transmitter may
20 serve as flow regulators. Based on this, it is understood that the dosing gas flow instruments may be combined to act as the dosing gas flow regulator, forming the dosing gas feedback control loop. It is also understood that flow control instruments may involve metering valves where
25 necessary.

 Based on the abovementioned system configuration, the dosing gas flow regulator for setting a target flow rate of the dosing gas stream may be set relative to the targeted flow rate of the natural gas stream. In other
30 words, these flow regulators may work together in such a way wherein the dosing gas is provided at a targeted flow rate based on the targeted flow rate of the natural gas.

 The working principle of how to attain a targeted dosing gas to natural gas flow ratio manually or without

electronically coupling these two gas streams in the system is as illustrated above.

In the present disclosure, the dosing gas and natural gas flow regulators may ensure that the flow ratio of the dosing gas to the natural gas may be maintained at 1:9. This means that the composition of the blended gas leaving the blended chamber may comprise 10% dosing gas and the remaining 90% may be the natural gas. This is because conventional dosing gas compositions tend to be heavier than air and do not disperse easily should there be a leakage from the system; inevitably, any user or operator may suffer from asphyxiation. Thus, the present system configuration may provide the capability of having a 1:9 flow ratio, thereby advantageously minimizing the safety risk of any user or operator in the event of a dosing gas leakage. Moreover, in instances where the dosing gas used may be more flammable compared to the compressed natural gas, the above flow ratio reduces the chances of any explosion or fire disasters.

In the present system, the blending chamber may be a static mixer or any device that provides a means for continuous mixing of fluid materials. Such a chamber may promote mixing of two or more different fluids so that the resultant fluid leaving the blending chamber becomes a homogeneously blended fluid.

According to the present disclosure, based on the above proportion of natural gas and dosing gas, a homogeneous blended gas mixture comprising 90% of the earlier gas and 10% of the latter gas produced from the blending chamber may be channeled downstream into a buffer tank through an outlet.

The blending chamber may comprise an outlet for receiving the blended gas in a blended gas stream. This outlet may comprise an outlet pressure regulator to

maintain the blended gas at a constant pressure. The blended gas may be maintained at 2.5 barg.

In the present disclosure, the pressure of the buffer tank may be maintained at any desired value to ensure
5 constant pressure of the blended gas mixture. The buffer tank may be maintained at a pressure of 2.5 barg to ensure pressure homogeneity between the two gas lines. In this way, constant downstream system pressure will allow the blended gas to be extracted consistently from a downstream
10 manifold, which is in fluid communication with the buffer tank and the chamber outlet, to ensure uniform cutting or welding. The blended gas may be extracted from the system at a similar pressure to that of the buffer tank. The blended gas may be extracted at 2.5 barg.

15 In the present system, the buffer tank may comprise an analyzer for analyzing the composition of the blended gas. If the proportion of the gas mixture is not obtained as desired, the system may be shutoff, either automatically or manually, to correct any deficiency
20 resulting in the disproportion. Any disproportions may compromise efficiency or safety as higher combustion temperature may not be attained for cutting or welding and if the amount of dosing gas exceeds 10% of the blended gas mixture respectively. Hence, the installation of an
25 analyzer at the buffer tank advantageously helps to achieve cutting or welding efficiency and mitigates safety hazards.

The system may further include metering valves that may be disposed after the gas pallets or dosing gas tank
30 or after the pressure regulators in each respective pipelines for metering the flow. A metering valve may be made of any valve known to the skilled person, such as needle valve, as long as it can be used to regulate and stabilize fluid flow.

As with any process systems, safety devices may be the present to ensure process safety, for example, to prevent leaks, spills, equipment malfunction, over-pressures, over-temperatures, corrosion, metal fatigue and
5 other adverse conditions.

These safety devices may comprise effective alarms or control points installed at any suitable locations of a process system.

The present system may comprise at least one safety
10 alarm or control points at any suitable location. At the control point, safety devices may be installed to reduce the load (excessive increase in pressure or flow etc.) of the system. These safety devices may also be present in the system to cutoff fluid flow in the case of emergencies
15 such as gas leakage.

These safety devices may include any form of equipment or their combination thereof, for example, flow or pressure control valves, flow or pressure transmitters, safety and/or relief valves, vent valves, bursting discs,
20 flame arrestors, measuring instruments such as temperature, pressure or flow sensors coupled to safety alarms. Other safety devices known to a skilled person may also be included as long it may help to mitigate any risks arising from anomalies or deviations during process
25 operation.

Holistically, the present method and system as described above provides blended gas with improved efficiency for cutting or welding at a lower cost. As mentioned herein, the blended gas may be a cutting gas or
30 welding gas. The present method of blending and configuration of the blending system further mitigate the risk of any personnel suffering from asphyxiation in the event of a gas leakage.

Brief Description Of Drawings

The accompanying drawings illustrate a disclosed embodiment and serves to explain the principles of the disclosed embodiment. It is to be understood, however, that the drawings are designed for purposes of illustration only, and not as a definition of the limits of the invention.

Fig. 1 shows a schematic diagram of a system for blending compressed natural gas and liquefied petroleum gas.

Detailed Description Of Drawings

Fig. 1 depicts a blending system for compressed natural gas and liquefied petroleum gas.

Supplied natural gas is provided in the form of banks of compressed gas cylinder pallets 100. Typically, there will be at least two banks of compressed gas pallets so that one bay is in use while the other is on standby for auto-switchover.

From compressed gas pallets 100, compressed natural gas is regulated to operating pressure in a pressure regulating manifold with a heating jacket (not shown in Fig. 1), before feeding into the system. Once regulated, compressed natural gas is fed into the system, it is then being channeled downstream and its flow and pressure regulation are assisted by the first and second pressure regulators 200 and 201.

The first pressure regulator 200 may be used to regulate compressed natural gas from 200 barg to 15 barg while the second pressure regulator 201 may be used to regulate compressed natural gas from 15 barg to 2.5 barg. By regulating the pressure in the above manner, a

differential pressure ratio of at least 1.8 may be maintained across the pressure regulators. For instance, taking the ratio of the pressure of compressed natural gas before the first pressure regulator 200 (P_2) which is 200 barg, and after the first pressure regulator 200 (P_1) which is 15 barg, a value of at least 1.8 is obtained.

Further downstream of the second pressure regulator 201, flow control valve 1 and a flow meter with transmitter 3 are installed along the natural gas pipe line.

The dosing gas is fed into the blending system from a liquefied petroleum gas tank 101. Likewise, downstream flow and pressure of this gas are regulated via pressure regulator 202.

Further downstream of pressure regulator 202, flow control valve 2 and a flow meter with transmitter 5 are installed along the dosing gas pipe line to regulate the flow ratio between compressed natural gas and liquefied petroleum gas. Together with flow indicator controller 4, flow control valve 2 and flow meter/transmitter 5 form a feedback loop so as to regulate the amount of liquefied petroleum gas flow flowing into the downstream static mixer 102. The flow rate of the liquefied petroleum gas (dosing gas) is set relative to the flow rate of the compressed natural gas at a ratio of 1:9 prior to entering the static mixer 102.

In the static mixer 102, the two fluids are mixed and the homogenous gas mixture is subsequently directed into a buffer tank 103. A gas analyzer 104 is attached to analyze the gas composition after mixing. The blended gas from buffer tank 103 is channeled to downstream piping (not shown) for the extraction of the blended gases to be used for various welding or cutting applications.

Applications

The disclosed method advantageously provides an efficient method for producing welding gas or cutting gas.

5 The blended gas may advantageously be stored for use at a later time. The blended gas may also be directly provided to users for industrial cutting and welding applications.

10 The disclosed ratio method advantageously reduces the need for instrumentation by permitting the provision of a constant flow.

The blended gas provides advantages in terms of safety and efficiency of use as disclosed herein.

15 It will be apparent that various other modifications and adaptations of the invention will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the invention and it is intended that all such modifications and adaptations come within the scope of the appended claims.

20

Claims

1. A method of blending gas streams to produce blended gas, the method comprising the steps of:

5 providing a natural gas stream via a pressure regulator;
 providing a dosing gas via a dosing gas stream, wherein the dosing gas is selected from the group consisting of alkanes, alkenes, alkynes and mixtures thereof;

 controlling the differential pressure across the pressure
10 regulator to achieve a constant flow rate of said natural gas in said natural gas stream, wherein the differential pressure refers to the ratio of pressures between the pressure at a point before the pressure regulator and the pressure at a point after the pressure regulator;

15 setting a target flow rate ratio of the dosing gas stream relative to the natural gas stream by adjusting the flow rate of the dosing gas stream to increase the combustion temperature of the blended gas;

 blending the natural gas stream with the dosing gas
20 stream to produce the blended gas.

2. The method of claim 1, wherein the controlling step comprises the step of regulating the differential pressure at more than 1.8.

25

3. The method of any one of the preceding claims, wherein in the setting step, the target flow rate ratio is 1:9.

4. The method of any one of the preceding claims, further
30 comprising the step of maintaining the blended gas at a constant pressure.

5. The method of claim 4, wherein the blended gas is maintained at 2.5 barg.

35

6. The method of any one of the preceding claims, wherein the natural gas is compressed natural gas.

7. The method of claim 1, wherein the dosing gas comprises
5 compounds containing 2 to 4 carbon atoms.

8. The method of any one of the preceding claims, wherein the dosing gas is selected from the group consisting of: propane, butane, acetylene, propylene and mixtures thereof.

10 9. The method of claim 8, wherein the dosing gas is a mixture of propane and butane.

10. The method of any one of the preceding claims,
15 wherein the blended gas is a cutting gas or welding gas.

11. A system for blending gas streams to produce blended gas, the system comprising:

a first inlet for receiving a natural gas stream, the
20 first inlet comprising a pressure regulator for controlling the differential pressure across the pressure regulator to achieve a constant flow rate of said natural gas in said natural gas stream, wherein the differential pressure refers to the ratio of pressures between the pressure at a point
25 before the pressure regulator and the pressure at a point after the pressure regulator, the first inlet further comprising a natural gas flow regulator, wherein the target flow rate of a dosing gas flow regulator is set relative to the natural gas flow regulator;

30 a second inlet for receiving a dosing gas stream, wherein the dosing gas is selected from the group consisting of alkanes, alkenes, alkynes and mixtures thereof, the second inlet comprising the dosing gas flow regulator for setting a target flow rate ratio of the dosing gas stream relative to
35 the natural gas stream;

the first and second inlets being in fluid communication with a chamber for blending the natural gas stream with the dosing gas stream to produce the blended gas.

5 12. The system of claim 11, wherein said pressure regulator controls the differential pressure at more than 1.8.

13. The system of any one of claims 11-12, wherein the dosing gas flow regulator comprises a control loop.

10

14. The system of claim 13, wherein the control loop sets the target flow rate ratio at 1:9.

15. The system of any one of claims 11-14, wherein the
15 chamber comprises an outlet for receiving the blended gas in a blended gas stream.

16. The system of claim 15, wherein the outlet comprises
20 an outlet pressure regulator to maintain the blended gas at a constant pressure.

17. The system of claim 16, wherein the blended gas is maintained at 2.5 barg.

25 18. The system of any one of claims 11-17, further comprising an analyzer for analyzing the composition of the blended gas.

19. The system of any one of claims 15-18, further
30 comprising a manifold in fluid communication with the outlet of the chamber.

20. The system of any one of claims 11-19, wherein the natural gas is compressed natural gas.

35

21. The system of any one of claims 11-20, wherein the dosing gas comprises compounds containing 2 to 4 carbon atoms.

22. The system of any one of claims 11-21, wherein the dosing gas is selected from the group consisting of: propane, butane, acetylene, propylene and mixtures thereof.

5

23. The system of claim 22, wherein the dosing gas is a mixture of propane and butane.

24. The system of any one of claims 11-23, wherein the
10 blended gas is a cutting gas or welding gas.

25. The system of any one of claims 11-24, wherein the system excludes a programmable logic controller.

15 26. A method of providing blended gas for use as cutting gas or welding gas using the system of any one of claims 11-25.

20