

# INSTALLATION FOR ANALYSING AN ATMOSPHERE

The present invention relates to the field of atmospheric analysis equipment, and quite particularly deals with the case in which it is necessary to analyse one or more elements of an atmosphere at a plurality of points of an enclosure employing this atmosphere, or of a gas distribution network, this being in multiplexing mode (batch mode: sequential analysis of the points in an order which may be varied and with an addressing time for each measurement point which can also be varied).

These analysis applications fall within a context in which users of industrial gases (heat treatment, electronics, food, etc.) increasingly frequently need to analyse one or more components of the atmosphere which they are employing in a given user station, or alternatively one or more impurities (such as oxygen or alternatively water vapour) of a distributed gas before it is injected into their process, this being so as to be capable of carrying out comprehensive quality control on the articles being processed, this comprehensive quality control presupposing that it is possible to know the atmospheric conditions under which each article has been processed.

Customers using gases therefore often wish to be able to know these atmospheric conditions, or to display and archive them, with trackability, or even to process these values thus archived.

It can therefore be seen that the possibility should be available of providing these customers, who use industrial gases, with analysis methods and equipment allowing gas samples to be taken at the various analysis points which are monitored (whether these are various points of an enclosure employing the atmosphere for a given treatment, or various analysis points on a gas distribution network), making it possible:

- to minimize the response time of the analyser or analysers in question;

- to ensure that the analysis bay is provided with samples of gas to be analysed which are representative of the atmosphere of the enclosure or of the gas flowing in the distribution network to be analysed, and in particular, as will be understood, in the case when the analysis bay is far away from the tapping points;

- to take samples and carry out analyses irrespective of the order of each measurement point;

10       - to take samples and carry out analyses whatever the addressing time of a given measurement point, depending on the species analysed and the type of analyser employed.

For such multiplexing applications, it has been proposed to use rotary valves based on stepwise advance of the valve, which becomes positioned in turn in front of each channel to be analysed. The use of such rotary valves is not, however, without its drawbacks, in particular linked with complex hardware, whose operational robustness remains to be proven, but above all for which a very precise rotational advance order needs to be adhered to.

The object of the present invention is in particular to provide solutions to the technical problems mentioned above.

The installation for analysing the level of at least one element, from at least two initial gas sources, according to a sampling procedure, using at least one analyser capable of analysing the said element, according to the invention then includes:

- at least two sources of initial gases to be analysed;
- at least two tapping lines, each line being connected in its upstream part to one of the said initial gas sources, and in its downstream part to a respective flow-directing component;
- at least two discharge lines, each discharge line being connected in its upstream part to one of the

said directing components and in its downstream part to a discharge or to a storage point;

- at least two secondary lines, each secondary line being connected in its upstream part to one of the said directing components and, in its downstream part, to a collecting point, each directing component being capable of directing a sample from the initial gas source which is associated with it to its respective discharge line or to the collection point via its respective secondary line;

- a tertiary line, connected in its upstream part to the collection point and in its downstream part to a discharge or to a storage point;

- at least one analysis line, connected in its upstream part to the tertiary line and in its downstream part to at least one of the said at least one analysers.

The analysis installation according to the invention may moreover have one or more of the following characteristics:

- a pumping component, located between the collection point and the point of connection between analysis line and tertiary line;

- the tertiary line includes a non-return valve downstream of the point of connection of the analysis line to the tertiary line;

- the tertiary line includes an overflow downstream of the point of connection of the analysis line to the tertiary line, and the analysis line or at least one of the analysis lines is provided with a component for creating a pressure head loss;

- the discharge line or at least one of the discharge lines is provided with a pumping component;

- the or each analysis line is provided with a directing component which makes it possible, depending on the case, to direct a calibration gas or a purging gas to the analyser of the gas to be analysed;

- the said directing component or components consist of a three-way solenoid valve;

- the said directing component or components of the tapping lines consist of the assembly formed by the point of connection of the associated tapping, discharge and secondary lines, each secondary and  
5 discharge line being provided, downstream of this point, with a component capable of allowing or interrupting the flow of gas through the line in question;

- the initial sources to be analysed are at a  
10 pressure above atmospheric pressure;

- the initial sources to be analysed are at a pressure substantially equal to atmospheric pressure or below atmospheric pressure.

- the initial sources consist of gas samples  
15 taken from a distribution network;

- the initial sources consist of gas samples taken from various points of an enclosure employing a gas atmosphere;

- the installation includes a plurality of  
20 analysers, the analysis lines being connected to the tertiary line at a feed tank;

- the installation includes a single analysis line connecting the tertiary line and the analysers arranged in series;

25 - the installation includes one analysis line per analyser.

Other characteristics and advantages of the present invention will emerge from the following description of embodiments which is given by way of  
30 illustration but without implying any limitation and in conjunction with the appended drawings, in which:

Figure 1 is a schematic representation of an installation according to the invention, employing a single analysis line and a single analyser;

35 - Figure 2 is a schematic representation of an installation according to the invention, including three analysers and three analysis lines, which are connected to the tertiary line at a feed tank;

- Figure 3 illustrates an embodiment of a directing component according to the invention, as constituted by the assembly formed by the point of connection of the associated sampling, discharge and secondary lines, each secondary and discharge line  
5 being provided with a two-way valve;

- Figures 4 and 5 illustrate two alternative embodiments of the invention with the analysis line being taken off from the tertiary line which leads to a  
10 vent;

- Figure 6 is a partial representation of an installation according to the invention, the tertiary line comprising an overflow downstream of the point of connection of the analysis line, the analysis line  
15 being itself provided with a component for creating a pressure head loss.

Figure 1 is a schematic representation of an installation according to the invention, including six tapping lines  $L_{pi}$ , each starting from an initial gas  
20 source  $S_i$ , each tapping line being connected to a flow-directing component  $V_i$ , here, in each case, a three-way solenoid valve, by passing through a filter  $F_i$ .

The initial sources may for example consist of  
25 gas samples taken from a distribution network (a typical application of monitoring impurities before authorizing introduction into a process), or alternatively, for example, may consist of gas samples taken at various points of an enclosure employing a gas  
30 atmosphere (furnace, tunnel, storage container, etc.).

The initial sources to be analysed are then, depending on the case, at a pressure above atmospheric pressure (which is the case with distribution networks in which several bar, or even tens of bar may be  
35 reached), or alternatively at a pressure substantially equal to atmospheric pressure or below atmospheric pressure. It is known for example that in many enclosures employing industrial gases, such as heat treatment furnaces or tunnels for processing food

products, the pressure inside such "open" enclosures is equal to atmospheric pressure to within a few millibar ( $P = P_A + (1 \text{ to } 50 \text{ mbar})$ ).

According to the invention, a secondary line  $L_{Si}$  (which joins a collection point R), and a discharge line  $L_{Ei}$ , which in the embodiment represented joins a vent  $E_i$ , through a pumping component  $P_i$ , are connected to each three-way solenoid valve  $E_i$ .

As will have been noted, in the embodiment represented, two discharge lines have been combined on one vent, for example discharge lines 1 and 2 at one vent  $E_1$ , the installation with six lines which have been represented then including only three discharge vents  $E_1$ ,  $E_2$  and  $E_3$ .

Continuing the description of the installation in Figure 1 downline, it can be seen that a tertiary line  $L_T$ , starting from the collection point R, is capable of discharging gas to a vent E, by passing through a pumping component P and a non-return valve C.

An analysis line  $L_A$ , capable of sending gas to be analysed to an analyser A, by passing through a three-way solenoid valve  $V_A$ , is taken off from this tertiary line.

The analyser A is also provided with a gas outlet which can discharge the received gas to a vent  $E_A$ .

It will furthermore be noted that the plant is supplemented by a three-way solenoid valve  $V_P$ , the solenoid valves  $V_A$  and  $V_P$  in combination making it possible, depending on the case, to direct gas to be analysed (along the line  $L_A$ ), calibration gas (taken from the line  $L_C$ ), or alternatively a purging gas (taken from the line  $L_{PR}$ ) to the analyser A.

The numbers 1, 2 and 3 have been used to denote the three ways of the solenoid valve  $V_6$ , so as to describe its operation more conveniently, and, generally, the way in which the installation in Figure 1 operates.

When the coil of the solenoid valve  $V_6$  is on, the passage 1-2 is employed, that is to say the gas taken from the source  $S_6$  is sent to the collection point R. However, when the coil of the solenoid valve  $V_6$  is  
5 off, the passage 1-3 is then employed, in order to send the gas taken from the source  $S_6$  to the discharge  $E_3$  along the discharge line  $L_{E6}$ .

It can therefore be seen that the installation for multiplex-mode analysis in Figure 1 makes it  
10 possible to take gas samples at six different points and distribute them to the analyser, the design of the installation making it possible, using a monitoring/control system which has not been represented in the figure (such as an automation unit),  
15 to tap the various analysed points continuously, by directing a given gas source to the analyser A, through the collection point R, while all the other gas samples taken from the sources  $S_i$  are directed to the discharges  $E_i$ , and so forth, the source which was previously  
20 undergoing analysis then being directed to its discharge while the solenoid valve of another source is now activated to carry out its analysis, leaving the others intact, that is to say directed to the discharges.

25 An installation of this type then makes it possible to tap the six initial gas sources continuously, minimizing the response time of the analyser, and guaranteeing that this analyser receives gas samples representative of the atmosphere at the  
30 sources  $S_i$ , in particular in the case when the analyser is, for some reason or another, very far away from the tapping points.

It can also be seen that an installation of this type makes it possible to change from one initial  
35 gas source to another, in any order, and the addressing time for each measurement point is fully configurable, using a control system already mentioned above, making it possible for example to monitor certain measurement

points more closely when they are for example more critical.

Similarly, in order to meet the expectations of certain users who wish to view or archive certain data  
5 (for example the time profile of the level of a given element in the atmosphere of their processing enclosure), it is easy to use the installation according to the invention by recovering, for display or storage purposes, signals taken from the analyser or  
10 analysers of the installation. These signals can also be processed in order, if necessary, to trigger alarms according to one or more detected levels, or alternatively to use the automation unit, on the basis of them, to regulate the level of one or more gas  
15 elements.

Let us consider here, as an example, the case when the initial gas sources  $S_i$  are tapping points on one or more enclosures for employing industrial gases, for example furnaces for heat treatment under  
20 controlled atmosphere, the gases in these enclosures being substantially at atmospheric pressure.

Let us then, moreover, also consider the example of the case when the analyser A is provided with its own pumping component, integral with the  
25 analyser.

It can then be seen that, whatever the initial gas source in question (that is to say the point at which the gas is tapped from the enclosure or enclosures), the tapped gas reaches the collection  
30 point R and then the tertiary line  $L_T$  at a pressure substantially equal to atmospheric pressure, the analyser A tapping, via its own pumping component, only the gas flow rate which it needs in order to operate, via the take-off of the line  $L_A$  from the tertiary line,  
35 the rest of the gas reaching the tapping point R and which is not directed to the analyser being discharged along the tertiary line to the vent E.

The pumps P1, P2, P3 and P are then dimensioned according to the distance between the analysis bay and

the tapping points, the pump P being, in particular, dimensioned so that the flow rate reaching the collection point R and therefore the tertiary line  $L_T$  is higher than the flow rate which the analyser A needs  
5 (and will pump) in order to operate.

It can thus readily be seen, on inspecting this Figure 1, that the solenoid valves  $V_A$  and  $V_P$  in combination make it possible, for example during pauses or alternatively at night when the installation is  
10 offline, to direct a purge gas taken from the line  $L_{PR}$ , or alternatively a calibration gas taken from the line  $L_C$ , to the analyser A, all the tapping lines  $L_{Pi}$  then being in such a configuration, either definitively off or flushed but in communication with their associated  
15 vents  $E_i$ .

Although each directing component in Figure 1, and in particular the valves  $V_i$  of each tapping line, consists of a three-way valve, other types of directing components could of course be conceived of, without  
20 departing from the scope of the present invention, as illustrated for example in the embodiment in Figure 3, where in this case the directing component V consists of the point of connection of the tapping line  $L_P$ , taken from the source S, of the secondary line  $L_S$  which is  
25 directed towards the collection point R, and the discharge line  $L_E$ , each of the lines  $L_E$  and  $L_S$  being provided, downstream of the point, with a two-way valve (respectively  $V_S$  and  $V_E$ ) making it possible to allow or prevent the flow of the gas in each line, and therefore  
30 indeed making it possible to direct the gas taken from the initial gas source S in turn, according to requirements, to the collection point R or alternatively to the discharge.

As will be readily apparent to the person  
35 skilled in the art, although the installation in Figure 1 represents an embodiment in which the analysis line  $L_A$  is taken off from the tertiary line  $L_T$ , other configurations may be envisaged, without departing from the scope of the present invention, and should be

considered as falling within the general formulation used above in this description, according to which the installation includes "at least one analysis line connected in its upstream part to the tertiary line and  
5 in its downstream part...". Thus, the partial representation in Figure 4 repeats the connection configuration in Figure 1, while Figure 5 illustrates a variant which rather would be described by the fact that the tertiary line is taken off from the analysis  
10 line  $L_A$ , the two formulations being interchangeable:

- the two lines (analysis and tertiary) are in all cases "connected". (take-off) at one point, and
- it may be considered that, in the case of Figure 5 as well, the tertiary line is "connected in  
15 its upstream part to the collection point", even though it is through a "connection" line section symbolically represented by  $L_{CN}$  in the figure.

It will therefore be understood that the nomenclature is of only secondary importance, and what  
20 should most of all be addressed is the real purpose of each line.

It will be noted however, that the configuration in Figure 1 and Figure 4 is advantageous because the gas tapped by the analysis line  $L_A$  from the  
25 tertiary line  $L_T$  will more reliably be at atmospheric pressure since it is being directed towards the vent E.

Returning now to the detailed description of Figure 1, although an application example was envisaged above in which the analyser A was provided with its own  
30 pumping component, it is of course also possible to envisage an analyser A which does not have its own pumping component, in which case it is advantageous to adopt according to the invention the configuration schematically represented in the scope of Figure 6, in  
35 which the tertiary line  $L_T$  includes an overflow D downstream of the point of connection of the analysis line  $L_A$  to the tertiary line, while the analysis line  $L_A$  is itself provided with a component X for creating a pressure head loss.

This component for creating a pressure head loss may be formed in a wide variety of ways from a component such as a throttling valve, or alternatively a shut-off valve, a flow limiter, a calibrated orifice, or alternatively in a very general way, this means for creating a pressure head loss may also be obtained by a particular configuration of the pipelines used at this location on the line.

It can therefore be seen that the assembly consisting of the overflow in the tertiary line (an overflow being considered as an upstream pressure regulator) and the component for creating a pressure head loss in the analysis line will make it possible to ensure that there is a constant flow rate in the analysis line and therefore reach the analyser, irrespective of the tapping point in question, and the pressure of the gas in the tapping line in question, since the pressure in the tertiary line and in the analysis line is fully fixed regardless of the variations which may take place upstream.

The same comment as made above about whether to regard the analysis line as being taken off from the tertiary line or the tertiary line as being taken off from the analysis line could be made again here.

While Figure 1 illustrates an analysis installation according to the invention which includes a single analyser A, Figure 2 illustrates, for its part, an analysis installation according to the invention which includes three analysers,  $A_1$ ,  $A_2$  and  $A_3$ .

The installation in Figure 2, upstream of the collection point R, is then unchanged compared with the installation in Figure 1, and for this reason the description below will only deal with the section downstream of the collection point R.

The installation here includes one analysis line per analyser (respectively  $L_{A1}$ ,  $L_{A2}$  and  $L_{A3}$ ), each analysis line being connected to the tertiary line  $L_T$  at a feed tank, represented on the tertiary line by a dark oblong shape.

Each analysis line furthermore includes a directing component, here consisting of three-way solenoid valve ( $V_{A1}$ ,  $V_{A2}$ , and  $V_{A3}$ ).

As before, each analyser is here again provided  
5 with a gas discharge allowing the received gas to be discharged to a vent, respectively  $E_{A1}$ ,  $E_{A2}$  and  $E_{A3}$ .

It can furthermore be seen that the installation has a solenoid valve  $V_P$ , which is connected to each solenoid valve  $V_{Ai}$  and can direct a purging gas  
10 (taken from the line  $L_{PR}$ ) or a calibration gas (taken from the calibration line  $L_C$ ) to each solenoid valve  $V_{Ai}$  and therefore to each analyser.

It can therefore be seen that an installation of this type makes it possible to analyse one or more  
15 components for each tapping point, while maintaining all the advantages already indicated in the scope of Figure 1, linked with the continuous tapping of the various analysed points upstream of the collection point R.

The variants already described in the scope of  
20 Figures 3 to 6 could of course also be adopted in the scope of this installation in Figure 2 (directing component consisting of a T and two two-way valves, or alternatively analysers not provided with their own  
25 pumping component and fed through a component for creating a pressure head drop).

Here again, the three ways of the solenoid valve  $V_{A3}$  have been numbered 1, 2 and 3 so as to give a clearer explanation of the way in which this solenoid  
30 valve and, in general, the installation operate.

When the coil of the solenoid valve  $V_{A3}$  is on, the passage 1-2 is employed, while when the coil of the solenoid valve  $V_{A3}$  is not on, it is the passage 1-3 which is employed.

Let us now consider the example of a case in  
35 which the gas taken from the source  $S_6$  is directed to the collection point R, all the other samples taken from the other sources  $S_1$  to  $S_5$  being directed to their respective vent  $E_1$  to  $E_3$ .

If the gas taken from  $S_6$  is to be analysed, for example, by the analyser  $A_3$ , the coil of the solenoid valve  $V_{A3}$  is then turned on (by an auxiliary control system which will not be described here, these being  
5 control systems already mentioned with which the person skilled in the art of analysis and process control is very familiar), allowing the gas to flow along the passage 1-2, while the other solenoid valves  $V_{A1}$  and  $V_{A2}$  are not on, allowing the analysers  $A_1$  and  $A_2$  to be  
10 flushed with the purging gas taken from the assembly  $V_p/L_{PR}$ .

Of course, if a gas sample taken from the source  $S_6$  were then also to be analysed by another of the analysers  $A_1$  or  $A_2$ , it would then be perfectly  
15 possible to turn the coil of the solenoid valve  $V_{A3}$  off, in order to allow the analyser  $A_3$  to be purged with purging gas, and to turn on the coil of, for example, the solenoid valve  $V_{A2}$  in order to allow the gas sample taken from the source  $S_6$  to reach the analyser  $A_2$ , the  
20 solenoid valve  $V_{A1}$  then remaining off, and the analyser  $A_1$  being purged.



CLAIMS

1. Installation for analysing the level of at least one element, from at least two initial gas sources ( $S_1, S_2, \dots$ ), in a sampling procedure, using at least one analyser ( $A_1, A_2, \dots$ ) capable of analysing the said element, including:
- at least two sources ( $S_1, S_2, \dots$ ) of initial gases to be analysed;
  - at least two tapping lines ( $L_{P1}, L_{P2}, \dots$ ), each line being connected in its upstream part to one of the said initial gas sources, and in its downstream part to a respective flow-directing component ( $V_1, V_2, \dots$ );
  - at least two discharge lines ( $L_{E1}, L_{E2}, \dots$ ), each discharge line being connected in its upstream part to one of the said directing components and in its downstream part to a discharge or to a storage point ( $E_1, E_2, \dots$ );
  - at least two secondary lines ( $L_{S1}, L_{S2}, \dots$ ), each secondary line being connected in its upstream part to one of the said directing components and, in its downstream part, to a collecting point (R), each directing component being capable of directing a sample from the initial gas source which is associated with it to its respective discharge line or to the collection point via its respective secondary line;
  - a tertiary line ( $L_T$ ), connected in its upstream part to the collection point and in its downstream part to a discharge or to a storage point (E);
  - at least one analysis line ( $L_{Ai}$ ), connected in its upstream part to the tertiary line and in its downstream part to at least one of the said at least one analysers.
2. Installation according to Claim 1, characterized in that the tertiary line includes a pumping component (P), located between the collection point and the point of connection between the tertiary line and the said at least one analysis line.



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3. Installation according to Claim 1 or 2, characterized in that the tertiary line includes a non-return valve downstream of the point of connection of the said at least one analysis line to the tertiary  
5 line.
4. Installation according to any one of Claims 1 to 3, characterized in that the tertiary line includes an overflow (D) downstream of the point of connection of the said at least one analysis line to the tertiary  
10 line, and in that at least one of the analysis lines is provided with a component (X) for creating a pressure head loss.
5. Installation according to any one of Claims 1 to 4, characterized in that the discharge line or at  
15 least one of the discharge lines is provided with a pumping component ( $P_i$ ).
6. Installation according to any one of Claims 1 to 5, characterized in that the or each analysis line is provided with a directing component ( $V_{Ai}$ ) which makes  
20 it possible, depending on the case, to direct a calibration gas or a purging gas to the analyser of the gas to be analysed.
7. Installation according to any one of Claims 1 to 6, characterized in that the said directing  
25 component or components consist of a three-way solenoid valve.
8. Installation according to any one of Claims 1 to 6, characterized in that the said directing component or components of the tapping lines consist of  
30 the assembly formed by the point of connection of the associated tapping, discharge and secondary lines, each secondary and discharge line being provided, downstream of this point, with a component capable of allowing or interrupting the flow of gas through the line in  
35 question.
9. Installation according to any one of Claims 1 to 8, characterized in that the said initial gas sources are at a pressure above atmospheric pressure.



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10. Installation according to any one of Claims 1 to 8, characterized in that the said initial sources are at a pressure substantially equal to atmospheric pressure or below atmospheric pressure.
- 5 11. Installation according to Claim 9, characterized in that the said initial gas sources are analysis take-offs from a gas distribution network.
12. Installation according to Claim 10, characterized in that the said initial gas sources are
- 10 analysis take-offs from various points of an enclosure employing a gas atmosphere.
13. Installation according to one of Claims 1 to 12, characterized in that it includes a plurality of analysers, and in that the analysis line or lines are
- 15 connected to the tertiary line at a feed tank.
14. Installation according to Claim 13, characterized in that it includes a single analysis line connecting the tertiary line and the analysers arranged in series.
- 20 15. Installation according to Claim 13, characterized in that it includes one analysis line per analyser.