Sample Pumps in Gas Analysis Systems

The close and accurate monitoring of production processes is an essential request in a broad range of industries. Analysing the gaseous emissions of these processes, or the atmosphere under which they are running, is an appropriate method to conduct the monitoring. This gas analysis takes place either directly in the process (in-situ) or by extractive systems.

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The following article relates to the extractive gas analysis only.

An extractive gas analysis system basically consists of three functional sections:

- the sample point
- the sample transport or conduct
- the sample system cabinet

It is easy to understand that an essential requirement of such type of monitoring method is to keep the sample gas unaltered from the sample point all the way down to the analyser. Very stringent quality issues are the consequence for all sections of the entire system.

Assuming the gas sample has been drawn from the process free of particulate impurities, it now will enter the transport tube and run a more or less long distance down to the analyser cabinet.

The first question to be answered is, if the sample gas can drop out condensate and, consequently, must the tube be heated? Furthermore, is it necessary to ensure that the process pressure is sufficient to push the gas sample efficiently down to the analyser because almost all stationary analysers require a constant flow of sample gas.

Since the transportation of the sample gas is crucial, in many cases preference is given to the installation of a sample gas pump. This pump, if correctly sized and chosen, will provide the entire system with the sufficient flow and pressure from the sample point down to the analyser.

For good orders sake it should be mentioned that an air driven injector could be used in stead of a sample pump. In deed, this is sometimes done in hazardous areas but should not be the first choice due to the high demand of instrument air compared to the relatively cheap electric power.

Which are the essential requirements for sample gas pumps?

The most important asset of a sample gas pump is to keep the composition of the gas sample clean and pure. All wetted parts of the pump should be of material which does not react with the gas neither physically nor chemically and should not produce memory effects. It is therefore ideal to employ only highly resistant material and avoid coatings and glued parts. Highly resistant materials guarantee the best results, even if the sample gas composition is unpredictably varying like it does for example in incinerators.

Not directly a task for the pump itself, but still an important

Pic 1: sample gas pump P1 series

issue, is the position of the pump within the system. It needs to be determined if the pump shall run the sample gas under pressure (up-stream) or shall suck the gas through the system (down-stream). Both methods have their reasons, but it is obvious that the up-stream installation is more advantageous. In cases of leakages the pressure system will keep ambient air out and avoid false readings and on top, oxygen could not ingress and causes a dangerous mixture within the sample gas.

The condensate separated under pressure conditions in the gas cooler can be drained off just by automatic drainers. This again is more cost saving since it eliminates the need for separate condensate pumps and their consumption of electricity. Automatic condensate drainers need no electric power supply and thus are also an effective solution in hazardous areas. The down-stream position of the pump is always appropriate for such applications where liquid soluble components shall be monitored and wash out effects can be limited.

The position of the pump within the system however imposes the technical requirements for the pump.

Independent of the length of the transport tube, it always should be avoided that condensate can fall out and no dew points (water or acid) are undercut. If the pump is installed up-stream of the cooler, it can not completely be avoided that small amounts of condensate drop out and enter the pump. Therefore the pump should be able to pump liquid without the risk of being damaged.

If the ambient conditions are such that a high risk for continuous liquid fall- out exists, it might be advisable to install the pump head inside a heated cabinet and the electrical motor outside.

The same method of installation can also be a help in hazardous areas. With the wetted part of the pump in a sealed and/or purged enclosure a higher stage of security can be achieved.

Pic 2: sample gas pump P2 series / ATEX

For hazardous areas, all employed components of an analysis system must be of adequate nature. It is essential too, that in such applications it is not only the electrical components that have the right classification; the mechanical components also pose a risk and must be equally safe. It should never be underestimated that gas compressed in a pump head can reach significant temperature levels. And it is also important that not only gas can be hazardous but also a dusty atmosphere.

Pic 3: sample gas pump P2 series / ATEX with extended head

The components of a gas pump

The drive

In most cases the pump will be driven by an electrical motor. The size of the motor and the protection class must be adequate to perform 24 hours continuously. In some countries preference is given to air motors in hazardous areas. Beside the related noise, compressed air is a fairly expensive energy source.

The pump (head)

An eccentric is used to generate the required flow rate. Mounted on the drive shaft of the motor it drives a 90° mounted push rod. Attached to the push rod a bellow or a diaphragm is generating the flow volume. A head covers the cylinder and contains the flow control valves. The stroke of the eccentric provides the capacity and thus the flow rate.

Pic 4: sample gas pump P4 series

Important details

As already mentioned, the sample pump shall under no circumstances influence the nature of the gas sample. This poses a high impact on the flow generating items. On one side they need a high flexibility to execute the required stroke over a long period of time and on the other side they must be highly resistant against aggressive and corrosive gases and shall not brittle or break.

Bellow pumps have proven long service life by the thousand. Machined from one solid piece of PTFE, the bellow provides a homogenous structure of the material and thus a high chemical and mechanical resistance. The number of pleats determines the flexibility to generate the desired capacity and contributes to a long service life. This pump does not have any glued joints or seals. The crank case can be turned relative to the motor flange and allows the pump head to operate in a standing or hanging position, a very favourable option for applications where condensate is likely.

This design feature also allows the split installation of the motor outside and pump head inside of a cubicle.

Long term tests over almost a decade have proven a superior life time at very low maintenance input of this principle. This advantage is honoured with low change intervals in ATEX applications.

Another feature provided by this pump is the option of an integrated bypass valve directly into the pump head. This valve allows the flow to be set to the individual application and contributes again to a higher service life of the pump.

Not the least is the value of a sample pump determined by the accessories coming with the pump. In almost 99% of all applications the pump has to be attached to a vertical panel in a system. Common practice is to place the pump accessibly on a support. What a relief to the engineers, if the package of the pump contains not only this support, but also a set of shock absorbers. No need to chase around and to place last minute orders for this equipment.

Bild 5: sample gas pump P2 series with integrated bypass valve

Conclusion

Sample gas pumps are indeed the heart of a gas analysis system. They have to cope with variations in the sample gas but shall never have an impact on the gas. They need to be able to pump even wet gas and shall reach a high service life while maintenance and energy consumption shall be low.

It has been proven many times, that application specific designed sample pumps are the most reliable solution for gas analysis systems. The adaption of just standard pumps in this environment is only the second best decision.