Bioreactor Technology: Upgrade your Gas Flow Control

By Paul de Waal

Bioreactor Techfors-S (courtesy of Infors AG)

Vögtlin is a global solutions provider for scientific gas flow measurement and control tasks to companies around the world. Our thermal mass flow meters and mass flow controllers are much appreciated in the biotech/life science amongst many other applications.

In September Vögtlin won the 2016 Flow Control Innovation Award for key innovations with its battery powered red-y compact 2 instrument.

Why upgrade?

To create repeatability, accuracy, stability, reliability and implement automatic data collection.

In recent years we have an increasing demand for reliable, repeatable and flexible gas supply systems for bioreactors. This is due to the ever more demanding, critical and delicate processes in the bio-industry where VA meters are no longer suitable and mass flow controllers are improving the process. As an example the adequate supply of oxygen to the bioprocess is important. The metabolism of the microorganisms is dependent on the dissolved oxygen concentration, so that a precise control is desirable. Therefore the oxygen concentration must be lowered or increased as required by adding of either nitrogen or oxygen.

Why are VA meter less suitable?

VA meters have no output signal and are not suitable for automatization of your process. They are extremely sensitive to changes in pressure and temperature, a small change creates a relative big error in the indicated mass flow. This uncertainty creates non-repeatability in your process. MFC's measure true mass, independent of pressure and temperature, constantly providing a predefined mass flow.

Another important variable is the pH value. For microbial bioprocesses this is done with the addition of liquid acids and alkalis. For cell culture, on the other hand, one uses only liquid alkalis. The liquid acid can damage the cells so you use CO2 instead of liquid acid. There are many different bioreactor processes and each has it specific reason to use gases, but they all have in common that gas flow control plays an important and not to be underestimate role in the process. Gas needs to be measured and controlled on a reliable and safe way.

Traditionally these gas flows were done using manual VA meters with integrated valves. But nowadays users want to automate their process. Some more demanding processes also require a higher performance (mainly repeatability). Due to these demands we often get the request to upgrade older VA-based gas supply systems to modern automated controls with this better performance. In this article we show that it is relatively simple to implement a "plug-and-play" upgrade solution with the Vögtlin modular system, based on your demands, requirements and budget.

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Testimonial

"At Infors we strive to provide highly advanced bioprocessing solutions based on reliable hardware, intelligent control systems and innovative bioprocess platform software in order to create maximum value for our customers. The Vögtlin mass flow controllers fit perfectly into this concept and enable us to provide our customers with solutions for precise pO2 control at all times. Therefore, we're happy to recommend Vögtlin to all our customers."

Dr. Dirk Hebel, Product Manager Bioreactors, Infors AG

Gas control solutions

Vögtlin supplies complete gas mixing solutions of mass flow controllers including all required inlet and outlet configurations that can directly be connected to your reactor. In these sets we can optionally integrate all kind of accessories like pressure sensors, non-return valve, inlet filters, shut-off valves, etc.: Plug-and-play.

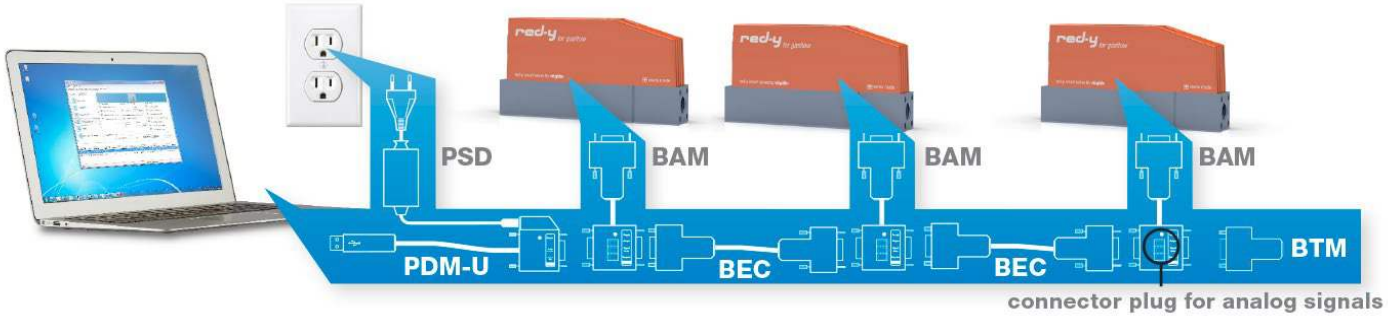
The wetted materials of this block can be anodized aluminum eco solutions or advanced 3.1 certified, FDA-compliant stainless steel. It is also possible to supply IP67 or Ex approved units.

Most customers prefer to keep their VA meter in their gas supply so that there is a visual confirmation of flow. As long as there is enough inlet pressure, this is no problem. However you might see considerable differences between them, especially if the pressure varies a lot. Due to the insensitivity in pressure and temperature the mass flow controller will be more accurate than the VA meter.

Cabling

Once the mechanical block is defined we can create the cabling system for the controls and power supply of your MFC's. You can make your own cables (Use D9 plugs) but alternatively Vögtlin has a modular system with which you quickly and simply build a complete cable system. The system is suitable for analogue and digital control.

In the example diagram shown the following cables are used:



PSD: *Power supply 24 Vdc*

PDM-U: *Converter from Modbus RS485 to USB connection. Also provides power input.*

BEC: *Connection cables for individual units. Connects power and digital signal. Available is several lengths*

BTM: *Termination resistor for bus communication*

BAM: *Break-out cable from MFC. Creates access to the analogy signals (Screw terminals) and create ability to Daisy-chain the units with BEC cables*

For more information see https://www.voegtlin.com/en/mass-flow-meters-and-controllers-for-gases/red-y-smart-series/accessories/.

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This is only one of the many possibilities of our cable system, other systems (f.i. for Profibus MFC's or gateways to Ethernet) are also available.

Control solutions
There are several methods to control the gas flows and change the ratios.

- **Manual setting**
- **Control box**
- **Standard software**
- **Analog**
- **Digital**

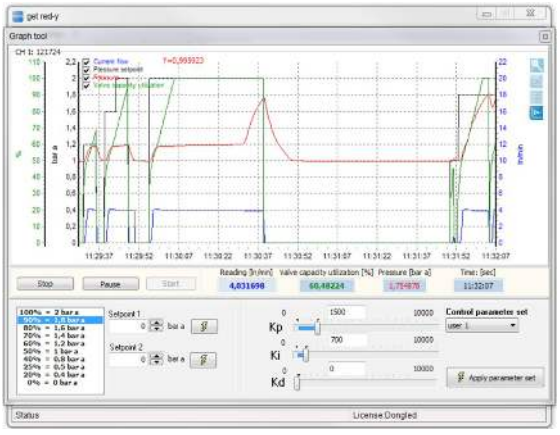
More details on each of these options below:

Manual setting: If you choose to select the integrated display and setpoint buttons, you can adjust the required flow on the MFC's themselves with push buttons.

This solution can also be added to most other control systems in case you need a back-up system in case the main system fails or if you want to have a simple way to override a system.

Control box: The Vögtlin control box offers an integrated power supply and a color touch screen to not only to give individual set points, but also have functions like an integrated ratio control system and storage of pre-defined recipes. You can connect up to 10 units to one PCU-10 box.

Standard software: Once you set-up your cabling and plug in your USB connector into your computer you can control and configure all the connected units through our free software called "get red-y". The mass flow controllers are all connected with one USB connection to your PC. Once you have installed the software, you can set and read flows and temperatures, create mixtures, and log all variables so you can review them in Excel™ afterwards. You can change the ranges and gasses for which the MFC is suited and optimize their operation, depending on your specific application. There are two add-on's to the basic program, one offers the above mentioned data collection and gas mixing software and the other offer the ability for the users to calibrate the units themselves.



Analog: If you already have a PLC or control system and use analog signals available, you can use the standard analog setpoints and output signals of the mfc. Most types of analogue signals are available on the smart instruments, (i.e. 0-5 Vdc, 4-20 mA, 0-10 Vdc etc.). The required analogue signal can be set with the free above mentioned software.

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Digital: If you already have a control system, like an embedded PC or a PLC you can communicate digitally to the mass flow controllers. Standard we use the straightforward and most commonly used Modbus serial communication. You can also request Profibus as an option.

We supply several programming examples of drivers (i.e. VI's for LabVIEW™) and a thorough digital manual so that implementation is breeze. If you need support, our software specialists will be happy to support you. Digital also has the advantage that you can monitor and use other variables. For instance you can look at the valve load. If the inlet pressure becomes lower (e.g. a leak or gas bottles getting empty) or if there is a blockage in the system, the valve load will change and an alarm can be activated before it becomes a critical problem.

Vögtlin develops and manufactures complete OEM solutions. So whatever your needs, Vögtlin has a solution for you.

Why Vögtlin?
If you work with a modern bio-reactor system with integrated MFC's, you most likely already have a Vögtlin mass flow controller in your bioreactor, since Vögtlin is the preferred supplier of most leading reactor system manufacturers. They prefer Vögtlin MEMS based MFC's because of their specific advantages, a combination of features that cannot be offered by any other manufacturer.

Great specifications: High accuracy and repeatability. High turn down, standard 100:1
Reliable craftsmanship: Smart and reliable, 3 year warranty
Low costs of ownership: Low sensitivity for pollution and long term stability.
Flexible: Modular, wide flow range 0-10 sccm up to 0-480 slpm. One device = 10 gasses
Specialists: Great global support from market specialists. Fast response time.

How to start?

1. Identify your needs for each of the segments mentioned
2. Identify your current flow meters and their ranges
3. Send this information to your Vögtlin representative.

We pride ourselves on developing custom solutions to meet our customers' exact system requirements. Contact one of our local experts today and learn how Vögtlin can help you get the best flow solution!

About the Author

Paul de Waal is Vögtlin's Business Development Director. Paul enjoys sharing his 30 years' experience in thermal gas mass flow. For questions, comments or suggestions please contact him on p.dewaal@voegtlin.com

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