Fill operations and batch dosing for conductive, nonconductive and other critical liquids.

Measurement made easy

Introduction

In processing industries, especially in the food industry, it is frequently necessary to dose, pump, mix and blend liquids.

The required components are dosed and mixed in containers one after the other in smaller batch processes using suitable flowmeters and counting equipment. Components can also be dosed at a later stage after technical and sensory analyses.

Filling is a special case of batch dosing, in which a specific amount of liquid must be filled into larger or smaller containers as precisely as possible and with high repeatability.
Solution

Electromagnetic flowmeters are frequently used in filling applications to measure conductive liquids. However, filling can also involve media with low electrical conductivity or other critical features, such as fruit juice and beverage concentrates with high Brix concentrations, liquids with high alcohol content, oily or very fatty media, and media that form insulating or conductive thin film.

These liquids can be expensive and it is therefore prudent to ensure that only the exact amount specified is filled. Coriolis mass flowmeters are ideally suited to this. The complete solution ABB offers for such applications comprises the CoriolisMaster FCB100 mass flowmeter and the AC500-eCo compact controller as the batch controller with fast filling software.

An additional advantage of the mass flowmeter over an electromagnetic flowmeter is that it can correct for small gas inclusions, which do not cause the flowmeter to malfunction, but do lead to erroneous measurements. The direct mass is measured using the coriolis force, and the mass value of the gas component is negligible compared to the liquid component.

Because continuous dosing and regulation of the flow speed are not required in normal operation, there is also no need for the mass flowmeter to have analog outputs. With its 2 pulse/frequency outputs and fast Modbus communication, model FCB100 thus offers an ideal solution.

The batch controller is responsible for the switching inputs and outputs required for the fill applications. The controller receives the flow rate signals necessary for dosing directly via the Modbus connection, independently carries out all counting processes and switches the fill operation on or off in two stages.

The CoriolisMaster FCB100 is also available in a hygienic design, FCH100, with hygienic connectors and electropolished meter tubes; it has EHEDG certification and can accordingly be used in all food industry processes.

The fill times for this application should be 3 seconds or longer. To keep overruns to a minimum, a slow flow velocity must be selected, but it must lie within the full accuracy range of the flowmeter.

The batch controller features an internal preselection switch, which is set using the connected touchscreen display. The batch can be started via an external contact and ended via an output contact, with which the valve is controlled directly. If a two-stage shut-off valve is present, a slowed-down dosing at the end of the batch, before the main contact terminates the entire process, can be set by using a precontact.

To improve accuracy for short dosing processes, the device is equipped with automatic overrun correction, whereby the batch controller measures the quantity that continues to flow after its closing command, thus indicating excess dosing. It then calculates the earlier count level at which it must issue the closing command in future cycles in order to guarantee accurate dosing. The display on the batch controller can be used to select whether an overrun correction is to be performed and how many process cycles should be used for the calculation.

This is an easy and cost-effective solution variant, because it does not require an expensive transmitter or an additional counter.

The system is supplied in a fully assembled condition. If additional application-specific controller functions are desired, these can be implemented in the PLC, but care must be taken not to increase the cycle time excessively.
A fast shut-off valve with reproducible closing times is required for every filling system. The valve must be supplied by the customer, and is not included in the ABB scope of delivery.

The system can of course also be used for volumetric filling.

A commissioning monitor is set up on the display for parameterization of the flowmeter for different fill operations. The device is parameterized outside the normal fill operation with the short cycle time.

The controller also monitors various messages and parameters that allow interruption of the fill operation if a critical situation occurs and thus avoid damage due to incorrect filling.

**Example arrangement**

**Fig. 1:** Fill arrangement

1. Supply tank
2. Mass flowmeter FCH100
3. Modbus transmission
4. Compact controller AC500-eCo
5. Filling valve
6. Container to be filled

**Fig. 2:** Fill operation

1. Single-stage filling
2. Two-stage filling

VO Valve opens  VC Valve closes  VC1 Valve closes partially  
1. Valve closing time 2. Overrun time

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## Product information

**Coriolis mass flowmeter CoriolisMaster FCB100, FCH100**

- Coriolis mass flowmeter CoriolisMaster FCH130 / FCH150, hygienic design
- Nominal diameter: DN 15 to DN 80, adapted to the required flow rate
- Process connection: pipe fitting in accordance with DIN 11851 or Tri-clamp
- Sensor material: stainless steel 1.4404 or 1.4436, polished, conforming to EHEDG and FDA
- Measuring accuracy for mass flow: up to 0.1 %
- Permissible measuring medium temperature: -50 … 250 °C
- Outputs: Modbus RTU, 2 additional frequency outputs
- Power supply: 24 V DC

**Batch controller AC500-eCo PM554-TP**

- Compact controller AC500-eCo
- Inputs: 8 binary inputs
- Outputs: 6 binary outputs as transistor outputs
- Load capacity of transistor output: 24 V DC, 0.5 A, maximum 5 W
- Communications interface to mass flowmeter: Modbus RTU
- Program memory: 128 kByte, with special software for fill operations

**TFT operating panel CP620**

- Operating panel with 4.3" display screen and touchscreen
- Display screen: TFT Color / LED
- User flash memory: 128 MB
- Serial interfaces: RS-232, RS-485, RS-422
- Ethernet port: 2 x 10 / 100 Mbit/s
- USB port: 1 x version 2.0
- Power supply: 18 ... 30 V DC, 0.4 A (at 24 V)
Electrical connections

Fig. 3: Wiring for FCB100 and AC500eco
1 Fill enable (1 = active; 0 = inactive)  2 Pause (1 = pause)  3 Reset (1 = reset)  4 Cleaning (1 = cleaning)  5 Open valve (1 = open)  6 Fine dosing (1 = active)

Only a Modbus connection is required for interconnecting the mass flowmeter and the batch controller. During the fill operation, the flow rate data from the FCB100 is read very quickly by the controller via the Modbus, counted in the controller and further processed there. Data for parameterization or alarms is transferred with lower priority.

Preselected quantities and input commands to the system can be input into the system both via the HMI touch panel and via hardware inputs of the controller. The signals relating directly to the fill operation, such as "Start filling", "Start fine dosing" or "End filling" are implemented via hardware inputs/outputs.

If the switching power of the shut-off valve exceeds the switching power of the controller’s semiconductor output, we suggest additionally using an optoelectronic coupler. This optoelectronic coupler is not included in the ABB scope of delivery.
Filling system user interface

From the initial screen, the user can access the various levels that are required for the fill operation, e.g. for inputting preselected quantities and set point values (SW) and displaying measured values (MW), as well as pages for troubleshooting, such as device information (GI) and failure messages.

Every time the fill quantity (of the container) changes, the fill quantity to be dispensed, the switching point for starting any fine-dosing, and the number of fills can be adjusted. The counter value at which the close command is issued after overrun correction is likewise displayed. The softkeys can be used to pause, clean or reset the system.
Examples of system information

The filling system monitors itself. If unexpected problems occur during the fills and filling has to be canceled, fault diagnostics can be produced quickly using the subsequent displays, and the malfunction can be resolved.

Fig. 7: General information

These displays provide general information about the sensor and its configuration.

Fig. 8: Malfunction displays
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