LEVITRONIX FLOW CONTROL BASED MEDIUM MIXING CONCEPT

Application Note PR-2400-13 Rev00

Introduction

Levitronix provides a wide range of solutions for high accurate chemical mixing. The following concept allows a homogenous mixing of two or more chemicals with:

- **Defined and controlled total flow rate**
- **Defined and controlled mixing ratio**
- **Uniform mixing**

Concept

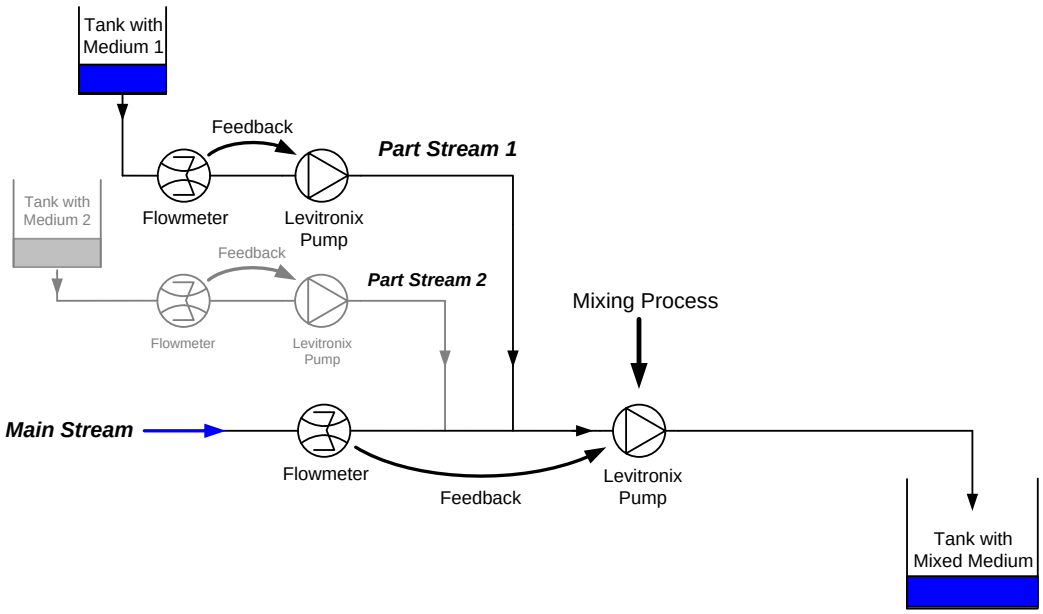

Figure 1: Levitronix Mixing Concept

Each medium stream consists of a flow controlled loop with a pump and a flow meter. The Levitronix flow based mixing concept allows two or more different mediums to be mixed together. E.g. DHF with two streams, SC-1 with three streams.

Advantages

- **Absolute accurate mixture concentration**
- **High repeatability of mixture concentration**
- **Wide range of mixing ratio**
- **Uniform mixing behavior without additional mixer**
- **Fast preparation of mixed chemicals (in situ)**
- **Fast and flexible change of mixing ratio**
- **Low cost of ownership**
- **Advantages of Levitronix pump: No pulsation, less particles, high MTBF**

Description of basic concept

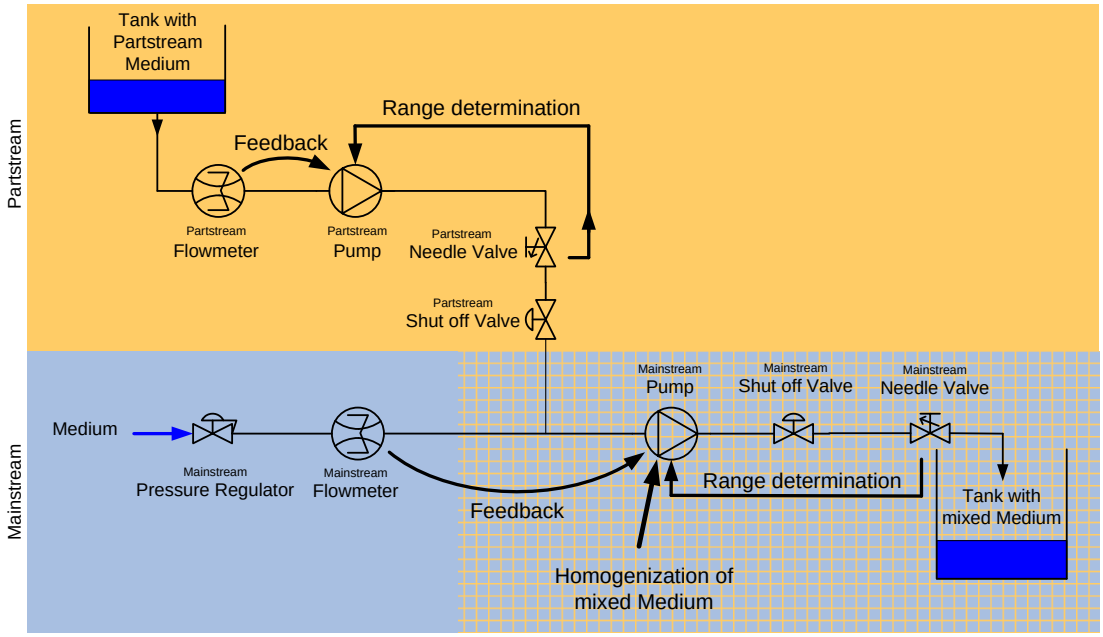

Figure 2: Basic Concept with one Partstream and Mainstream (e.g. for DHF Mixing)

Closed Loop Control for each Medium stream

The Levitronix pump is used as an actuator to generate a flow rate dependant on the pump speed (rpm). A flow meter measures the flow rate and delivers a feedback signal to the pump, thus the pump and flow meter are constantly interacting in a “closed loop” with the pump speed continuously adjusting to generate the desired flow rate. Additionally, the main stream pump acts as a mixer to homogenize the medium.

Part & Main Stream Needle Valves

The needle valves act as a hydraulic load for the pumps and define a specific flow range for each medium. E.g. let’s assume the needle valve of the part stream is almost closed. The part stream pump generates a flow rate 10mL/min @ 1000 rpm and 100mL/min @ 8000 rpm (max speed). With this setting a resolution of 77 rpm / 1mL/min is defined. But it will not be possible to exceed the maximum flow rate of 100mL/min. By opening the needle valve the flow range is increased and the resolution is decreased. E.g. 20 mL/min to 200mL/min with a resolution of 39 rpm per mL/min.

Part & Main Stream Shut Off Valve

These valves are used to start and stop the mixing procedure. The Levitronix pump is a centrifugal pump that has an open path in case of no rotation. This means, the pressurized medium of the main stream will still flow through the pump even when the pump is not activated. To avoid uncontrolled medium flow when the mixing system is stopped, a shut off valve is required and shown in the picture above.

Main Stream Pressure Regulator

To ensure independency from pressure fluctuations of the facilities supply for the main stream, a pressure regulator is used.
This device has two functions:

1) Any pressure fluctuations of the chemical supply unit are smoothed.
2) The pressure level for the subsequent flow controlled loop is defined and constant. This is an important point to avoid fidgety flow control behavior.

Options

Several options are available to meet the specifications of an application:

For increased mixing range

Replacement of the needle valve with an electrical proportional valve

If the specified range of flow exceeds the fixed range from one needle valve setting, an electrical proportional valve can be introduced to alter the hydraulic load for a dynamic flow range adjustment. This allows for a drastically increased range of flow within a single part stream controlled by an electrical signal. i.e.

- fixed needle valve = 10 – 100ml/min, 50 – 500 ml/min or 100 – 1000 ml/min
- Dynamic proportional valve = 10 – 1000ml/min

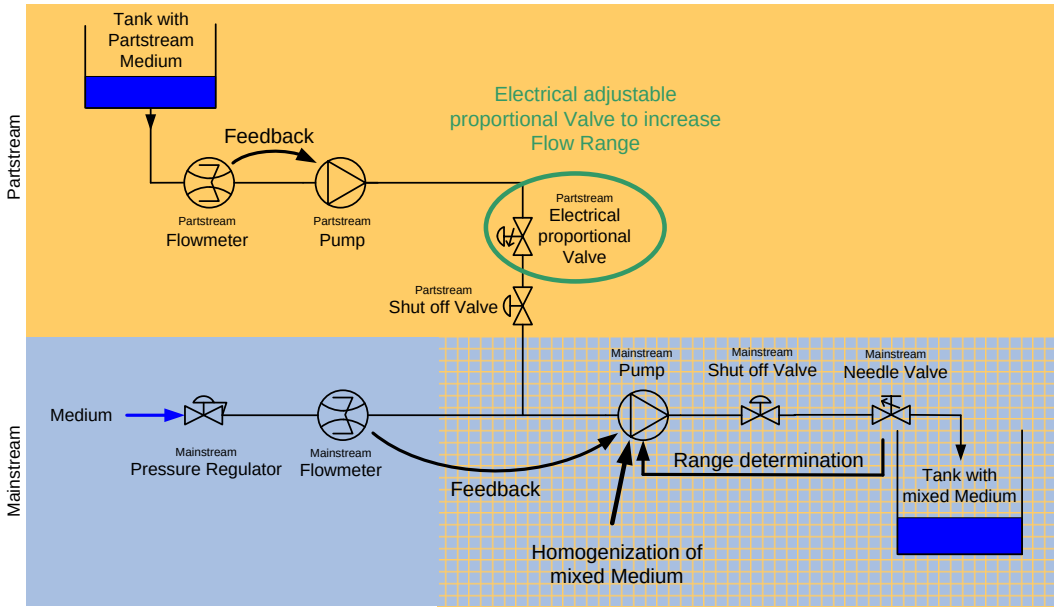

Figure 3: Electrical proportional valve increases mixing range and flexibility

For more flexibility with switchable path

Multiple Fixed Flow Paths

An additional flow path with a different hydraulic load can be used in case one specific hydraulic load doesn't cover the full specification. A typical usage for a second path situation would be when tank filling at a high flow rate (e.g. 10 L/min) and then extending the bath lifetime using a very low spiking flow rate. For example, with the setup in figure 4 the needle valve 1 is adjusted to allow a high flow rate of 10 L/min and needle valve 2 is adjusted to cover the spiking flow rate of 10 mL/min.

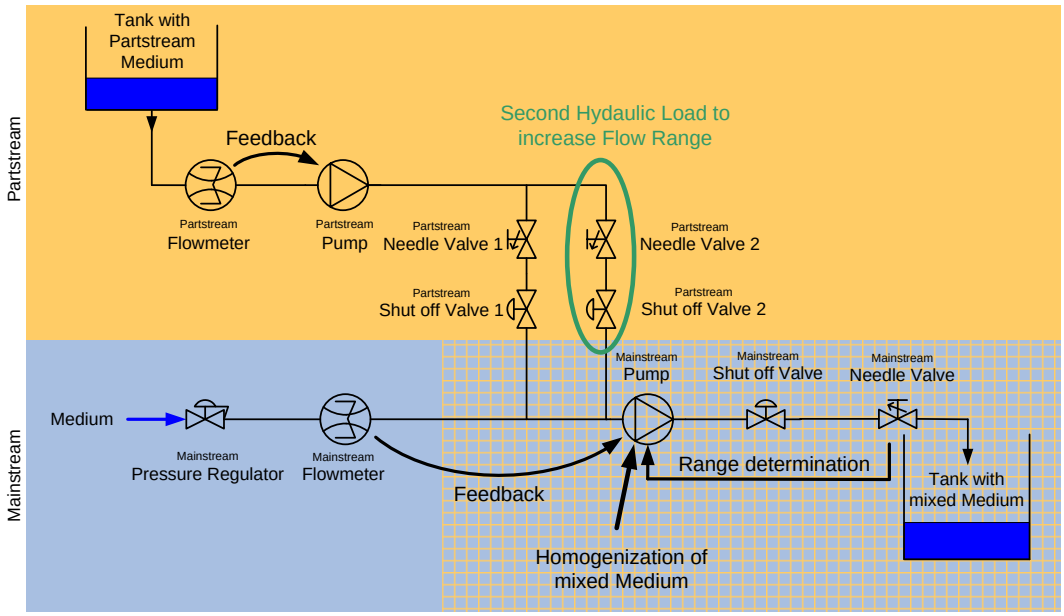

Figure 4: Second hydraulic load to increase mixing range and flexibility

For small footprint

Pressure regulator instead of buffer tank for part stream medium

For situations where a buffer tank is not an option, it is possible to substitute this with a pressure regulator and utilize the facilities pressure for mixing. For many scenarios a standard manual pressure regulator is sufficient, but in the event where an increased range for mixing is required, a pneumatic pressure regulator can be used, being controlled and adjusted by the Levitronix pump controller.

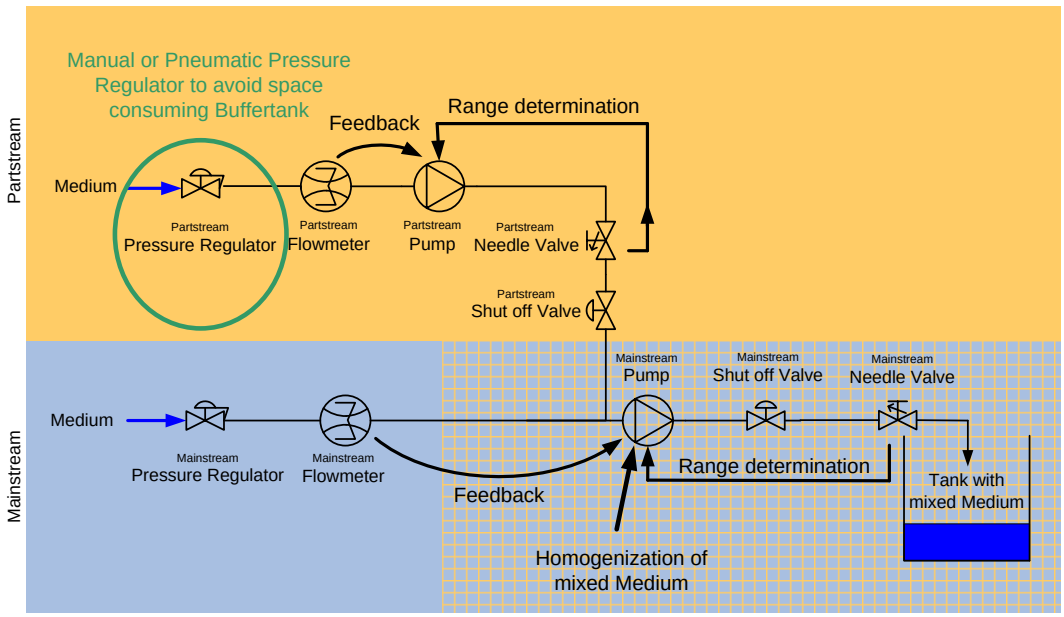

Figure 5: Pressure regulator instead of buffer tank to minimize footprint

For increased bath lifetime with spiking

Volume based spiking of a part stream medium to increase bath lifetime

In many cases a homogenized mixture is used for a certain period of time or for defined number of wafers before draining. However, in certain situations the lifetime of a bath can be increased by adding a defined amount of one of its components. The mixing concept of Levitronix allows this without adding any hardware.

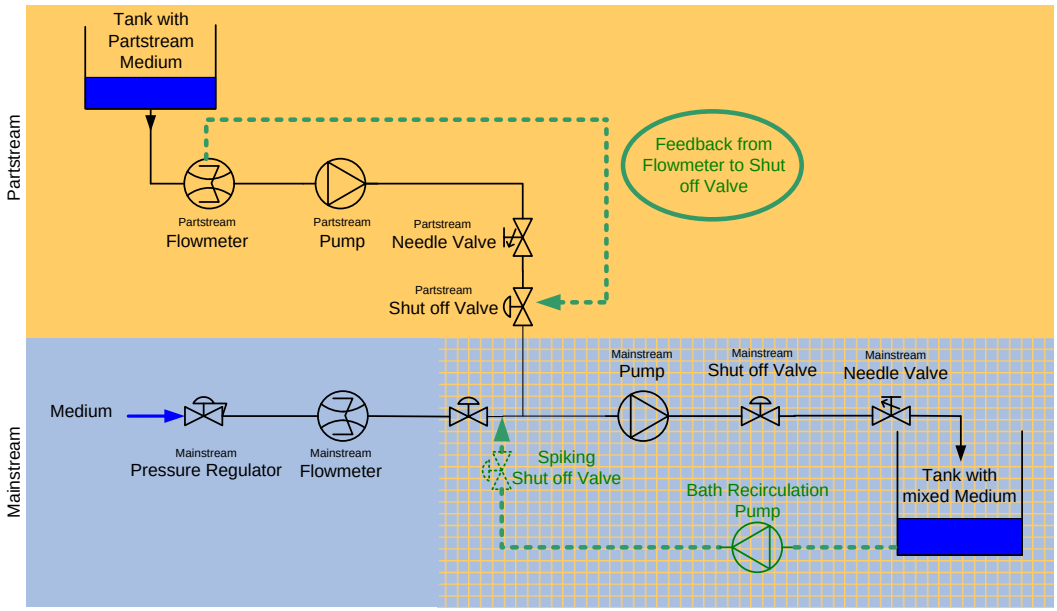

Figure 6: Spiking with small amount of components to increase bath lifetime

For time saving with pre-heating of Mainstream

Temperature controlled mixing

Many processes in the semiconductor industry need higher temperature of medium than ambient temperature. In this case, the traditional approach is to mix and subsequently heat the medium until the specified temperature is reached. This time consuming approach can be drastically accelerated by mixing the mainstream medium (typically UPW) with hot UPW that is often available in traditional wafer fabs. The desired temperature can be achieved by calculating and mixing the corresponding parts of hot and cold UPW together. This increases the “ready for process” time significant because the time consuming heating process is minimized.

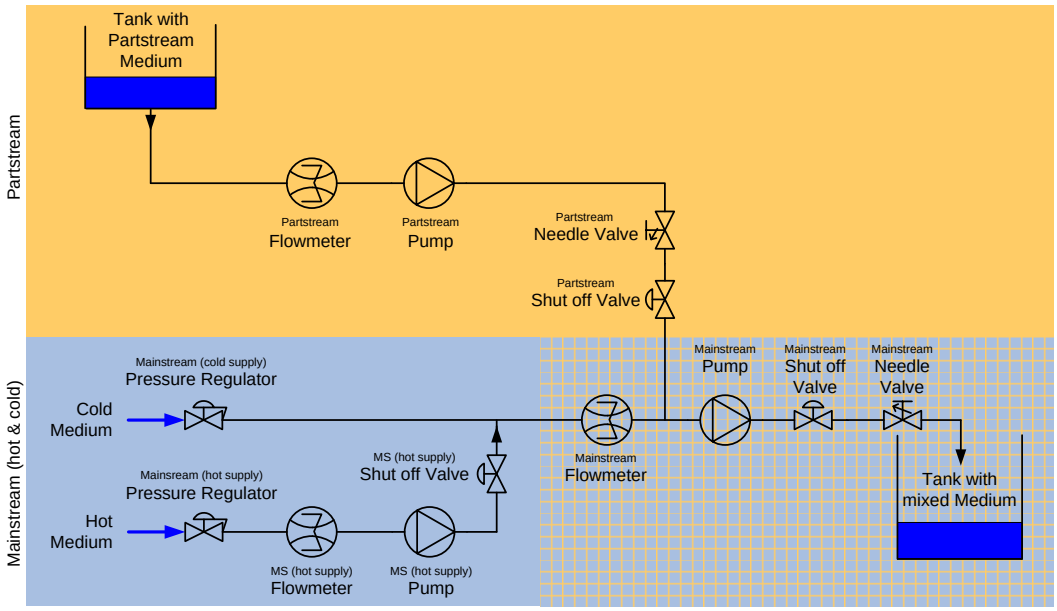

Figure 7: Temperature controlled mainstream to increase "ready for process" time

Concentration Data of Levitronix Mixing Concept

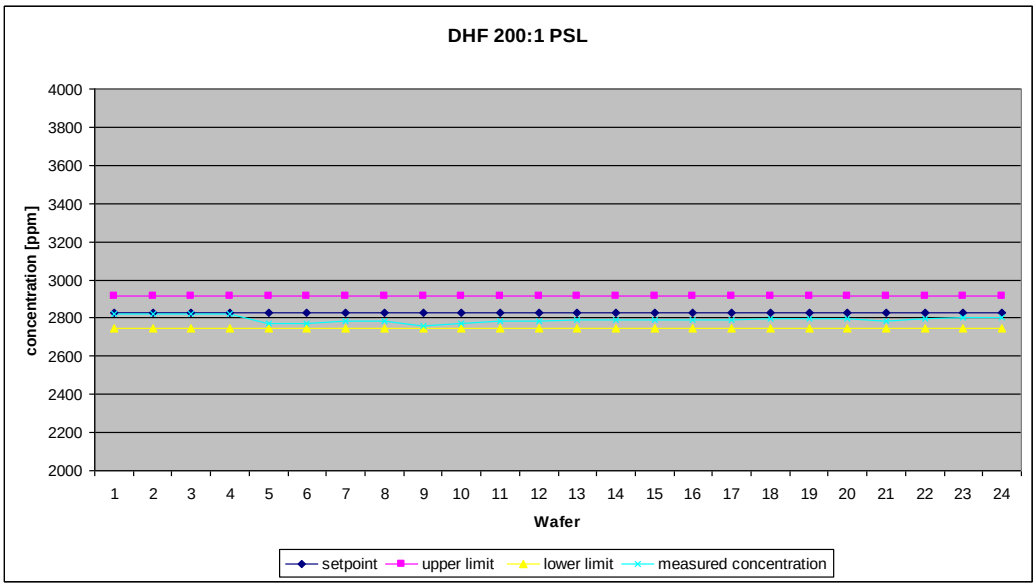

Figure 8: Concentration behavior of DHF-mixture 200:1 measured with Horiba HF960 concentration measurement device

Figure 8 shows field data of a typical DHF mixing system with specified upper limit (pink) +3% of reading and lower limit (yellow) -3% of reading, set point (blue) for concentration and measured concentration (cyan) with a HF960 device. The data shows very low fluctuations and constant concentration within specified range.

Technical Support

For troubleshooting, support and detailed technical information contact *Levitronix®* *Technical Service Department*:

Levitronix Technical Service Department
Technoparkstr. 1
CH-8005 Zurich
Switzerland
Phone: +41-44-445 19 13
E-Mail: TechSupport@levitronix.com