
ABB DRIVES FOR WATER AND WASTEWATER

Soft pipe fill ACQ580

This guide explains the ACQ580 Soft pipe fill function in detail.



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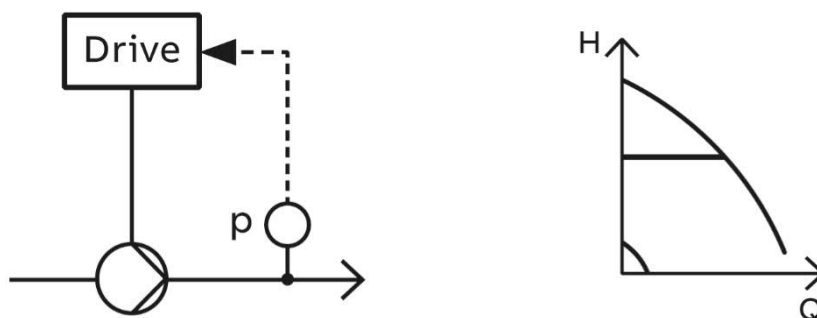
Introduction

Filling empty pipes should be done with care to avoid water hammer, and unintended stress on pipes, sensors and valves. The result could be severe and cause failure in the installation.

By using the ACQ580 Soft pipe fill function, the risk can be eliminated. The pipes will be gradually filled in a controlled way, and unintended stress will be avoided.

The Soft pipe fill function is linked to a closed loop control, typically a constant pressure control. The following sections will explain the behavior of the system without using the pipe fill function and with the function activated.

The system looks like this:



A pressure sensor (p) at the pump outlet is closing the feedback loop for the closed loop control and the PID is controlling the speed based on the provided setpoint

The second figure shows how constant outlet pressure will look using the pumps HQ curve.

System behavior without Soft pipe fill function

The pipe is empty, and the setpoint active waiting for the start signal to be given. Since the pipe is empty, there is currently no feedback from the pressure sensor, which means that the PID controller will ask for higher speed, and the motor will accelerate until it reaches the maximum speed. Thus, the pipe is being filled at full speed/flow and the pressure sensor will not detect the desired pressure until the pipe is full. In the case where the pipe is closed at the end, water hammer will occur, and a pressure spike will travel back through the pipe stressing all junctions, bends, sensors and valves. It's at this time the PID will start decreasing the speed, but the damage to the system has already been done. Additionally, it will take a while before the system settles.

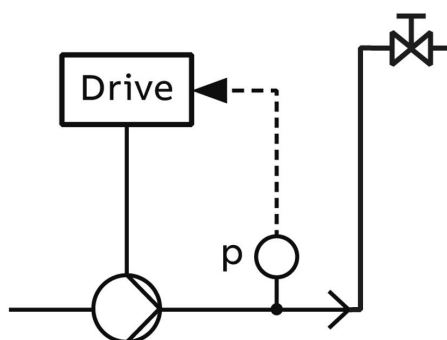
System behavior with Soft pipe fill function activated

The pipe is empty, the setpoint is active and the start signal is given. Rather than using the desired running pressure setpoint directly upon start, the ACQ580 gradually increases the internal setpoint from zero to the running setpoint. Since the setpoint is gradually changed over time, the speed will change with the changing setpoint, the feedback from the sensor will be increasing as the pipe is filled with water (at least for ascending pipes) and the system will not see the water hammer or the pressure spikes. The PID control will keep the system in control after the predefined filling time, running at the predefined setpoint.

Limitations of the Soft pipe fill function

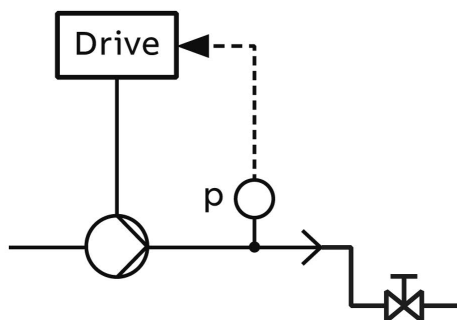
The Soft pipe fill function relies on the feedback from the sensor. The sensor signal should be increasing as the pipes are being filled. Filling descending pipelines and 100% horizontal pipelines can be a challenge using the Soft pipe fill function depending on the position of the pressure sensor. However, most pipeline systems have sections with ascending lines, making it possible to use the function in almost all applications. Timers can be used for filling descending or horizontal lines at a reduced speed to avoid making damage to the systems.

Example with ascending pipe:



The pressure sensor will see increasing pressure as the pipe is being filled with liquid.

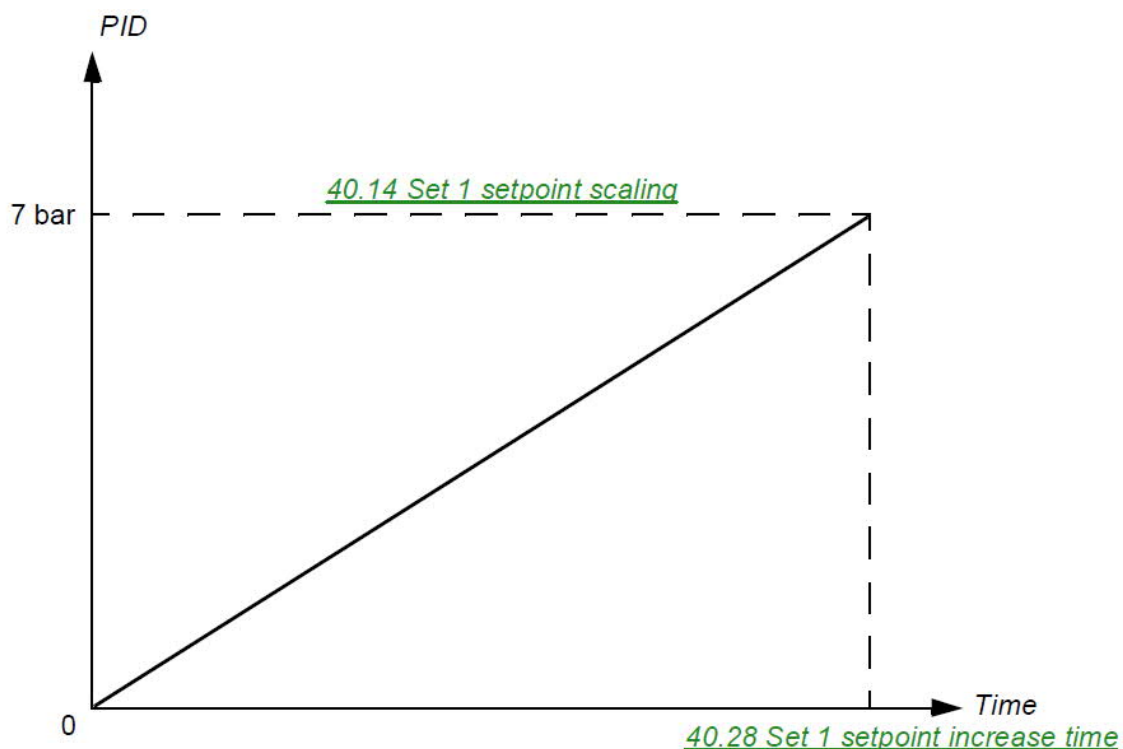
Example with descending pipe:



The pressure sensor will not see an increase in pressure during the filling of the pipe in this case, until the pipe is filled.

The Soft pipe fill function

The Soft pipe fill function is based on the basic elements shown below:



Where the setpoint is gradually increased over time and ending at the full setpoint after the time has elapsed. (The 7 bar is an example)

The changing setpoint combined, with the increasing feedback signal from the sensor, will result in a situation where the pipe is filled gradually and the speed when the pipe is filled will fit to the speed to maintain the required pressure.

The setup of the Soft pipe fill function is done by using the Primary settings menu, but before setting up the pipe fill function, the following setup needs to be in place

- A pressure sensor should be connected to AI2 (AI1 is an option, AI2 is the default setting)
- The control method should be PID control

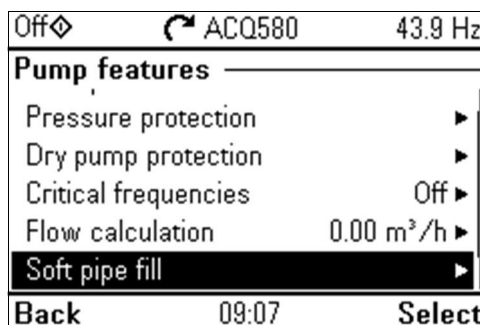
The programming section will include the information on how to setup the sensor and select the control method to be PID control.

Commissioning the drives

Setup of Soft pipe fill:

Using the assistant control panel, access the Soft pipe fill settings:

Menu - Primary settings – Pump features – Soft pipe fill

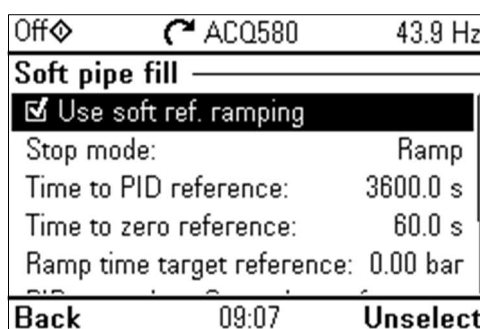


Activate the function by selecting: Use Soft ref. ramping
(The parameters will be visible after the activation)

Program the filling time to reach the setpoint in the parameter:
Time to PID reference

Program the time for decreasing pressure in case the actual pressure is above the target reference, use parameter:
Time to zero reference
(This parameter has no influence during the pipe filling process)

Program the target pressure that should be reached within the time limits (set in the previous parameter), use parameter:
Ramp time target reference

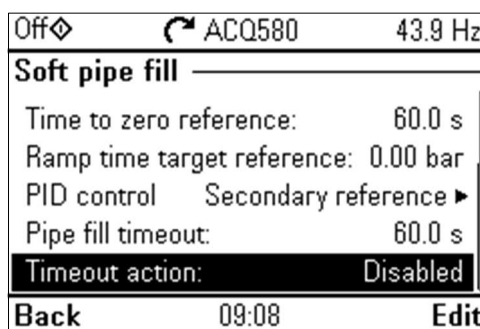


Use the PID control menu to setup the PID control of the drive.
(see section below)

In case the target pressure is not met in the time reference, the function can be programmed to generate a warning or fault. This might be due to leakage or blockage in the pipeline.

Program the Soft pipe fill timeout in the parameter:
Pipe fill time out (should be linked to the selected filling time)

In case the target reference is not met within the pipe fill timeout period a timeout action can be programmed in the timeout action menu.
Options: No action, warning, fault

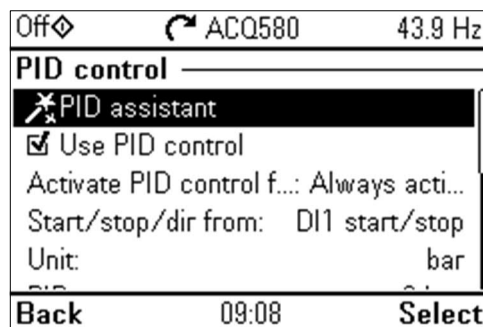


Setup of PID:

Select the PID control section and activate: Use PID control

Select where the start and stop signal comes from. In this example DI1 is selected

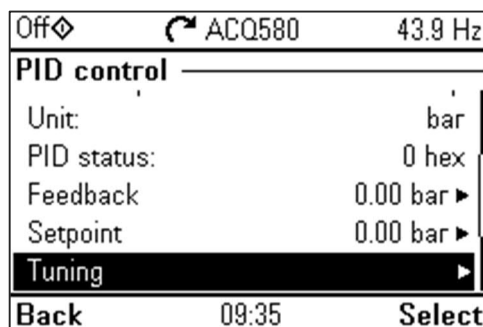
Select the unit for the feedback



The setpoint source can be selected in the Feedback menu, the default setting is AI2.

Signal type and sensor range can be changed as well.

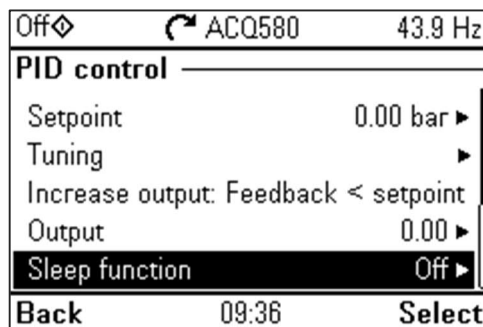
It is essential for good performance to select a sensor with a range that fits the application to have the highest possible resolution.



The tuning section will give you access to the classic PID parameters: Gain, Integration time and derivation time.

Change only one of the PID parameters at a time, to avoid oscillations on the output.

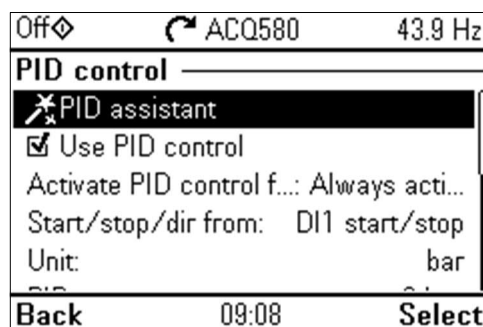
Select how the speed should change depending on the feedback Normal or inverse control by editing the Increase output menu



Go to the topline and select PID assistant and follow the instructions on the screen to set

- Feedback scaling
- Setpoint source
- Setpoint

And finalize the PID settings



This guide is designed to help assist with using the Soft pipe fill function available in the ACQ580 VFD. Please consult your local ABB for additional assistance.