Better Pump Capacity Calculation

Data-driven pump control and maintenance is getting more and more important. With the smart combination of high-resolution input data, the Sulzer pump control ABS PC 441 calculates real-time pump capacity and efficiency with extreme precision. The ability to monitor these values — for Sulzer pumps and pumps from other manufacturers — helps customers to make better service decisions.

1 Sulzer enables smart volumetric flow calculations for pump stations that process municipal sewage water.

Municipal sewage water stations (Fig. 1) run a full network of pumps. Collecting data from these stations is becoming increasingly important. Knowing the water inflow and outflow volumes is significant for the operating personnel, especially when heavy rainfalls occur.

Not every station is equipped with a flowmeter to measure the water volumes, but most of the stations have level sensors. Sulzer looked for a smart way to use these level sensors in combination with a pumping station control to deliver this important information.

For terminal and stormwater pumping stations

The pump control ABS PC 441 is a monitoring and controlling device for one to four pumps. The pump control can be used for Sulzer pumps, but pumps from other brands can also be connected to the ABS PC 441. It is designed for use in municipal wastewater pumping stations — mainly in terminal pumping stations or stormwater pumping stations. It allows pumps to be started, stopped, or regulated to increase availability, minimize energy use, and reduce stress on the water-network downstream. In addition, the system allows the surveillance of pumps and pumping stations, and

the logging of hydraulic and electrical data. The pump control offers a wide variety of functions: Settings, alarms, pump status, level information, and trends can be accessed instantly. Customers can see those values on-site or remotely via the AquaWeb software.

Traditional flow calculation

The "drop test method" has been used for many years by customers to calculate the capacity of the pump station manually. The method is also used to check the condition and pumping capacity of each pump. This time-consuming method has a large margin of error because it is based on assumptions and not on measurements. Sometimes, these assumptions are incorrect.

The three assumptions are:
1. The level change in the sump is directly related to volume change in the sump.
2. The inflow rate during pump operation is the same as the inflow rate between pump operations.
3. The pumping rate is constant.

How does the drop test calculation work? Customers literally place a bucket with a known volume under the inlet in the station and measure how fast the bucket fills up. Based on this, they can roughly estimate the inflow rate.

It is possible to use another method if customers know the volume of the basin and can check two marked level points. The inflow is calculated by measuring the time it takes to fill the basin from level point 1 to level point 2. When the pump starts working, the same level points are used to determine the outflow.

Automated calculation method

Based on the basic principles of this method, Sulzer developed a more automated and accurate way of doing these calculations. The ongoing and precise calculation method of Sulzer has several benefits:
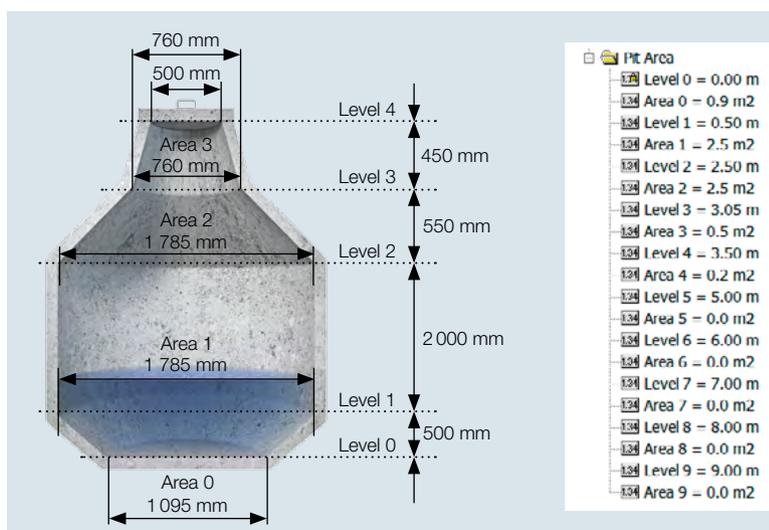

2 The volume definition of the basin and required data for the software program.

- The control detects a reduced outflow volume quite quickly. The lower outflow is often caused by a decline of the pumping efficiency, which indicates that a pump should be serviced. This maintenance can be planned in advance and done before a breakdown occurs.
- Because pumps with a lower efficiency are switched off, the pump control helps to save energy.
- The accurate overflow measurement does not require a sensitive, external flow meter.

Calculation principles and sensors

To enable the pump control ABS PC 441 to measure automatically, initial programming is required. For accurate calculations, it is necessary to enter into the controller the shape and volume of the basin where the pumps are installed (Fig. 2). Either float switches or hydrostatic sensors with 4 to 20 mA signals can be connected to the PC 441 control device. Two hydrostatic sensors are necessary to calculate the flow.
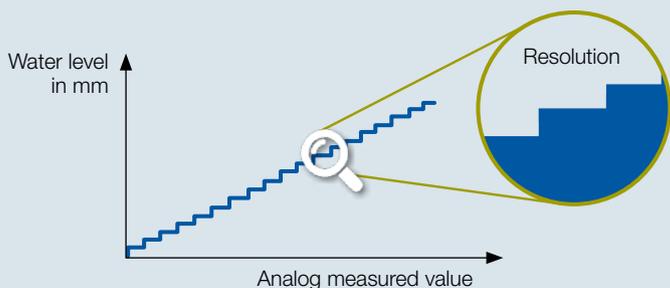
3 Water-level measurement with analog level sensor and other controls.
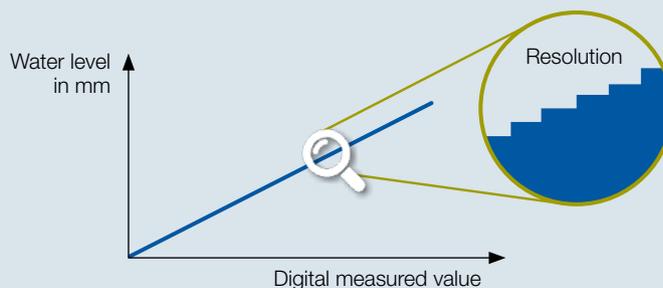
4 Exact water-level measurement with two-wire level sensor and ABS PC 441 control.

Inflow calculation with high-resolution input signals

For the pump control ABS PC 441 to be able to measure the inflow, first, the pumps have to stop operating to bring the water to a standstill. The pumps are then brought up to full operation. At that point, the water inflow is continuously monitored and memorized during a defined time interval set by the customer. The controller continuously adapts the calculations to the current level, speed of level change, and volume of the basin. Not all pump controls on the market are able to measure and store input signals with such a high resolution as the pump control ABS PC 441.

High-precision measurement in practice

Just to understand how precise the measurements and calculations are: Imagine a two-wire level sensor (4-20 mA, 0-5 m) is installed in a pit with a surface area of 15 m². When the sensors measure a change of 0.19 mm of the water level, this equates to a calculated volume flow of 2.86 liters. This high-resolution water-level measurement, combined with a smart and extremely precise calculation algorithm allows to calculate the inflow much better. The resulting digital measurement resolution consists of small steps (Fig. 4, page 5). It allows the system to deliver the volume flow calculations extremely precisely, in contrast to the analog measurement (Fig. 3, page 5).

Precise pump capacity calculation

The pump capacity calculation takes into consideration the inflow stored in the memory. To allow the pumps to run up to full speed, a small time delay is set before the capacity calculations are started. Entering the pump curve into the ABS PC 441 control supports precise calculations as well (Fig. 5). The corrected calculated outflow (yellow line) bases on the pump curve.

By entering the pump curve (for one pump) or the system curve for a set of pumps (Fig. 6), the capacity and outflow calculation is even more accurate. If more than one pump is running, there is higher pressure built up in the sewage water pipe resulting in a higher friction loss. This is why the system curve shows a decrease in efficiency when two or three pumps are in use. If the system curve is not available, an estimated percentage value is entered to compensate for the capacity loss that occurs when two, three, or four pumps are running.

Benefits in practice

A customer in Norway conducted a test to compare the Sulzer pump control ABS PC 441 with an inductive flow meter. After trimming all the parameters, the value Sulzer calculated differed less than 1% from the flow meter. For detecting trends and pump efficiency, the calculated values have a sufficient accuracy.

Another customer in New Zealand refurbished its installation with new pumps, controllers, and level sensors. The installed pump control ABS PC 441 immediately detected a capacity difference of 20% between the two pumps. The detailed inspection showed that pump and pedestal did not fit properly. After fitting, the leakage between pedestal and flange was eliminated and both pumps worked properly with similar capacity. Sensors and smart algorithms are the basis for data collection and remote control systems like AquaWeb.

The outstanding capacity control of the ABS PC 441 system is highly valued by customers in the fields of water and sewage water because it enables them to make better decisions more quickly.

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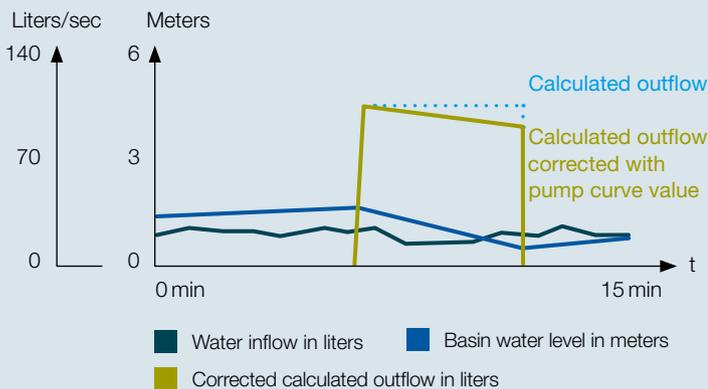
5 The corrected calculated outflow is based on the pump curve entered into the control.

Pump curve values:
P1 = 100 %, P2 = 87 %, P3 = 74 %
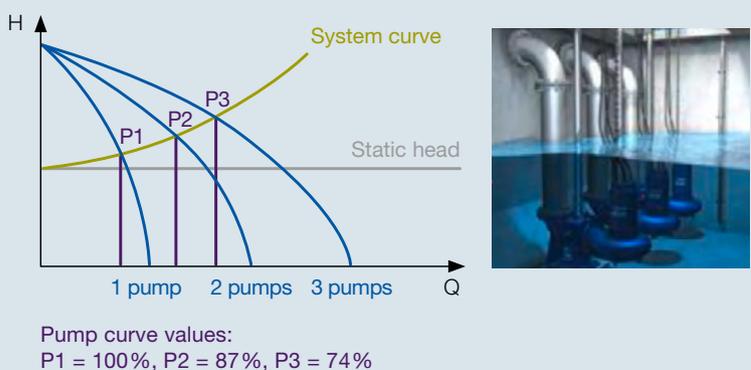
6 The system curve is valid for a set of pumps in the same basin.