

TANK CONTROL

Controlled System – General Description

- A medium- size tank is supplied by a 300mm, gravity fed Steel pipeline.
- The supply pipe length is 11Km, elevation of supply dam +200m .
- Max. filling rate 580m³/h, flow velocity 2.3m/s
- Demand from the tank is variable, at high differences between day and night.

Requested control functions - customer`s definition

- Maintaining very accurate level control, between maximal level (3300mm) and minimal level (3000mm)
- Manual Remote closure of the filling valve, regardless of tank level.

Control Considerations

- Level control at such accuracy cannot be met by a standard hydraulic or electric float, and electronic means are needed. As electricity is available on site, this control can be used.
- The size of the control valve should be selected according to maximal velocity and head-loss, rather than the pipe diameter. Allowing velocity of 5.5m/s in the valve, a 200mm (8.) **valve, model 31-8** was selected.
- This valve, at fully-open position, generates 7.4m loss. Approximate analysis of the pipeline + valve combination indicates that the valve restriction reduces the maximal flow to 538m³/h (93% of the pipe flow, without valve). As the demand from the tank does not exceed the restricted flow- the selection was approved.
- Closure of the valve, at the end of a long pipeline, may generate water hammer. Surge analysis indicated a possible pressure surge of 39bar in case the valve closes within 20sec., and 34bar if it closes in 60sec. These results were not acceptable

Control Solution

- A 31-8-EC valve was selected. The valve is controlled by Dorot ConDor controller, through two 12VDC. Normally- Closed solenoids.
- The controller can perform 4 control functions simultaneously, so the following control applications were programmed:
 1. Level control, using an analogue level sensor. The controller closes the valve when the level reaches 3360mm, and opens it when the level drops to 2900mm. The accuracy of the control depends on the range of the level sensor: the minimal deviation from the set point (= high or low level) is 1/256 of the sensor range. So- in case the sensor range is 0-5000mm, the accuracy of level control is +/- 20mm.
 2. In order to prevent pressure surges through valve closure, when the tank has been filled, the ConDor was programmed to reduce the flow rate when the level rises. The following Level / Flow ratios table was inserted:

Level	Flow line
<3100	300
<3150	100

Consequently, when the level will reach its maximum, and the valve closes, the flow velocity in the upstream pipe will be 0.4m/s only- and no dangerous surge can be generated.

- As the operator may close the valve by remote control, when the level is low and the flow rate at maximal value- there is still a risk of dangerous pressure surge. In order to prevent it, an additional control function was activated in the **ConDor**: The Surge - preventing closure routine. This application reduces the flow rate in the network in a pre-set number of stages, when the time gap between the stages is adjustable. Unlike other automatic closure, that cause uniform valve closure and, hence, non-uniform flow reduction, the **ConDor** procedure closes the valve in a linear flow rate reduction until full-closure. This application is starting when the remote .stop. signal is sent by the operator.

Schematic Layout of the system:

