Two-Tank control with DeltaV using MPC

TABLE OF CONTENST

1 INTRODUCTION

In this tutorial you will learn how to:

- Create a program to control the level in the lower tank 2 of a Two-Tank system with MPC using DeltaV Database Administration, -Explorer, -Control Studio and –I/O Configuration.
- Create a MPC model for a Two-Tank system and do validation using DeltaV Predict, - MPC Operate and –MPC Simulate.
- Create a HMI for a Two-Tank system using DeltaV Operate Configure.
- Control and tune the level performance of a Two-Tank system using the MPC controller in DeltaV Operate Run.

Figure 1.1 shows the Two-Tank system.

Figure 1.1 The Two-Tank system.

Figure 1.2 shows a P&ID drawing of the Two-Tank system.
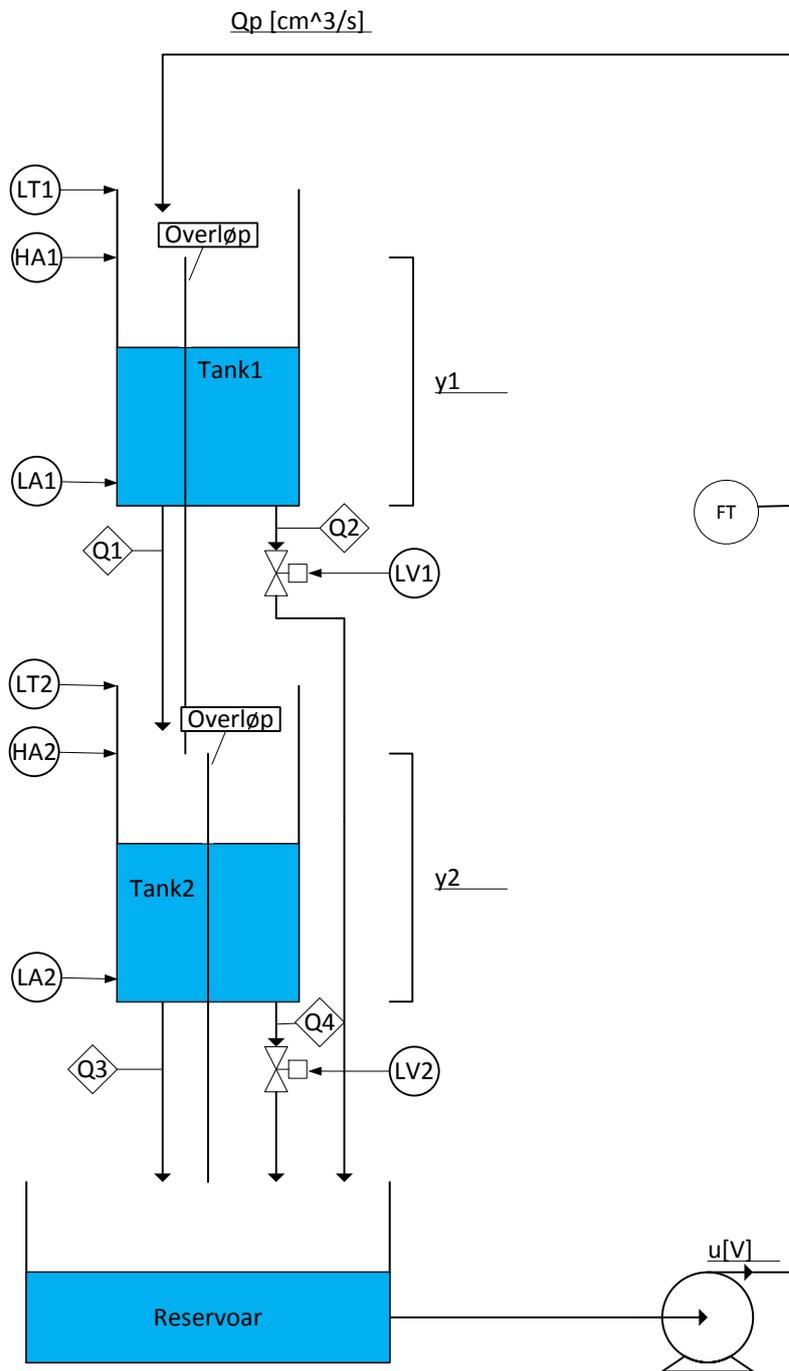
Figure 1.2 P&ID drawing of the Two-Tank system.

Equation (1-1) is the mathematical calculation of the volume in tank 1.

Equation (1-2) is the mathematical calculation of the volume in tank 2.

Tank 1:

$$A_1 \frac{dy_1}{dt} = Qp - Q1 - Q2$$

(1-1)

Tank 2:

$$A_2 \frac{dy_2}{dt} = Q1 - Q3 - Q4$$

(1-2)

Where:

- A_1[Area in tank1 = 113,1 cm^2]
- y1[Level in tank1]
- Qp[The flow to tank1]
- Q1[The flow out of tank1]
- Q2[The flow out of the solenoid valve]
- A_2[Area in tank2 = 113,1cm^2]
- y2[The Level in tank2]
- Q1[The flow to tank2]
- Q3[The flow out of tank2]
- Q4[The flow out of the solenoid valve]

2 PROGRAM

In this section you will learn how to create the program used to control the level in the lower tank 2 of the Two-Tank model using DeltaV Database Administration, -Explorer, -Control Studio and –I/O Configuration.

2.1 Step 1: Creating a new database

Before we start to program in DeltaV we would like to start on an empty program where no inputs or outputs are assigned to the hardware controller. This is easily done with the use of database. To avoid adding all the hardware configurations each time there has been premade a database that is empty, but contains the hardware configurations we need.

The first thing you need to do is log on to the DeltaV station with username: **Administrator** and password: **deltav**. When this is done choose DeltaV Desktop. Click on the start-menu and Database Administration. Double click on the icon Copy Database, choose Student1 and write your name in the Copy to field. Figure 2.1 is showing you how it should look like.
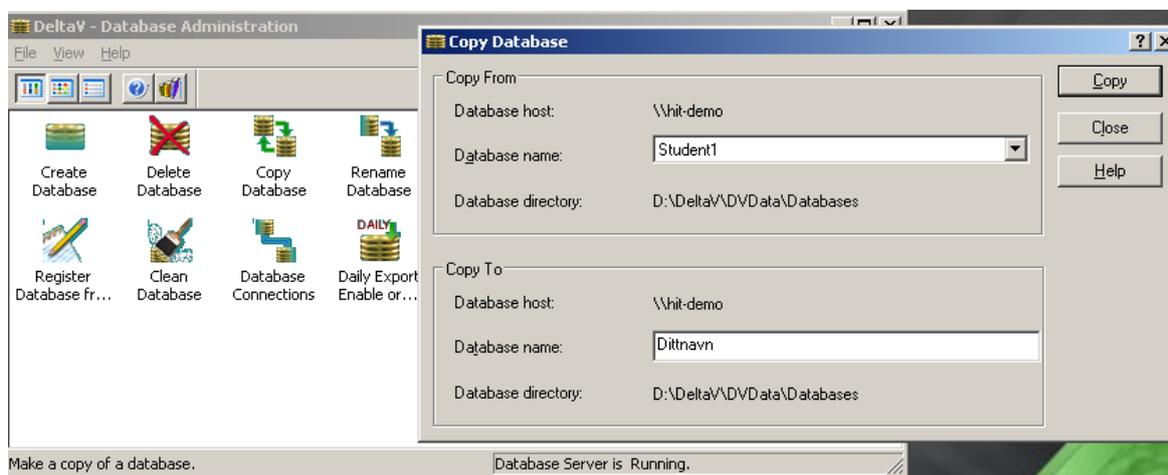
Figure 2.1 How to set up your database using Database Administration.

Now set the database you just made active with the Set Active Database button. This button is found in the Database Administration window. Select the database you just made and press ok.

Your database is now created and active.

2.2 Step 2: Creating MPC- and I/O control modules in an area

Go back to the start menu and run DeltaV Explorer.

Right click on "Control Strategies" and select "New Area". Name your new Area TWO_TANK.

We now have a new area called TWO_TANK. Now we just need to configure two control modules, one for the MPC loop and one for I/O's.

Grab a MPC module from the library by choosing Library → Module Templates → Analog Control. Select the MPC_LOOP and drag and drop it down to your Area called TWO_TANK, see Figure 2.2.
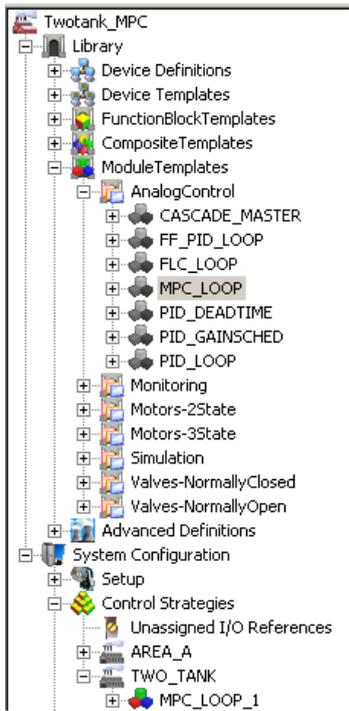
Figure 2.2 Control module MPC_LOOP_1 from library.

You will find the MPC loop you just added in your TWO_TANK area.

To get a more structured program we want to separate the I/O's into its own control module.

Go to DeltaV Explorer and right click on your area TWO_TANK. Then choose New → Control Module, see Figure 2.3.
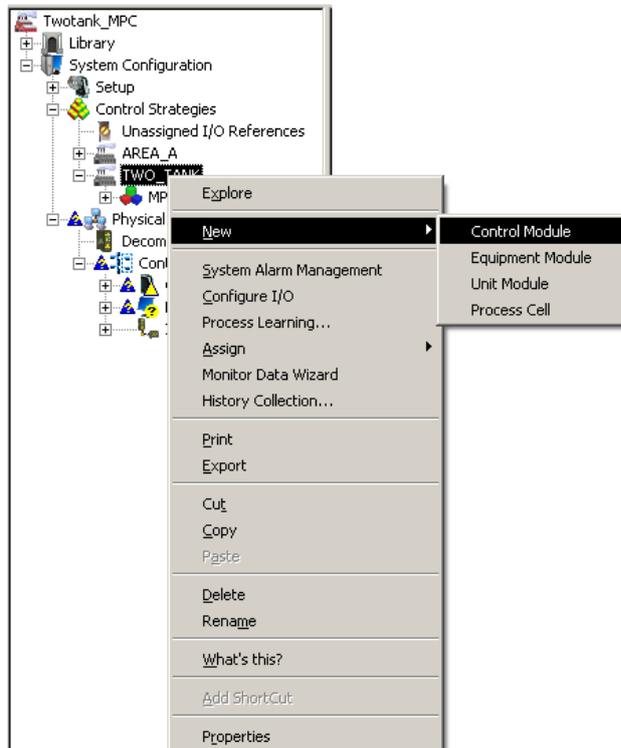
Figure 2.3 Creating a controle module for the I/O's.

Name the Object name I_O, see Figure 2.4, then press OK.
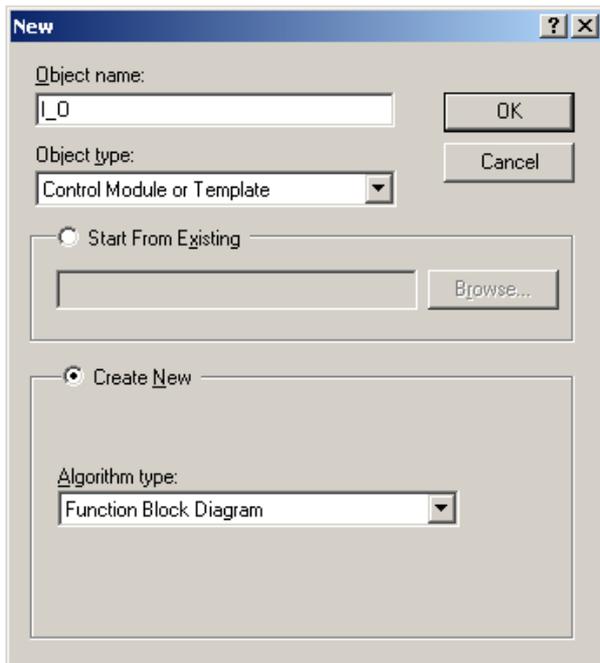
Figure 2.4 Naming the I/O controle module.

You will find the IO module in your TWO_TANK area.

2.3 Step 3: Activate I/O configuration

The I/O's are already terminated on the hardware module, but we need to activate them in the
Exploring DeltaV software. Choose Applications → I/O configuration, see Figure 2.5.
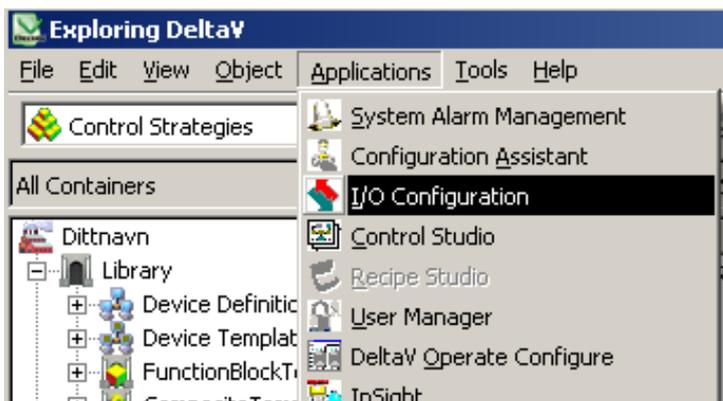
Figure 2.5 I/O Configuration from Exploring DeltaV.

Table 2-1 is an overview over hardware cards with channels connected to the hardware
controller. Right click on the channels, as shown in Figure 2.6, and enable all the channels
presented in the table. When the channels are active they should change color from grey to
yellow.

Table 2-1 Hardware cards and channels.

IN	CARD/CHANNEL	DESCRIPTION
LT1	C01CH03	LEVEL TANK1
LT2	C01CH04	LEVEL TANK2
FT1	C01CH05	FLOW
HA1	C03CH01	HIGH ALARM TANK1
LA1	C03CH02	LOW ALARM TANK1
HA2	C03CH03	HIGH ALARM TANK2
LA2	C03CH04	LOW ALARM TANK2
OUT		
P1	C02CH03	PUMP
LV1	C04CH01	SOLONOID VALVE TANK1
LV2	C04CH02	SOLONOID VALVE TANK2
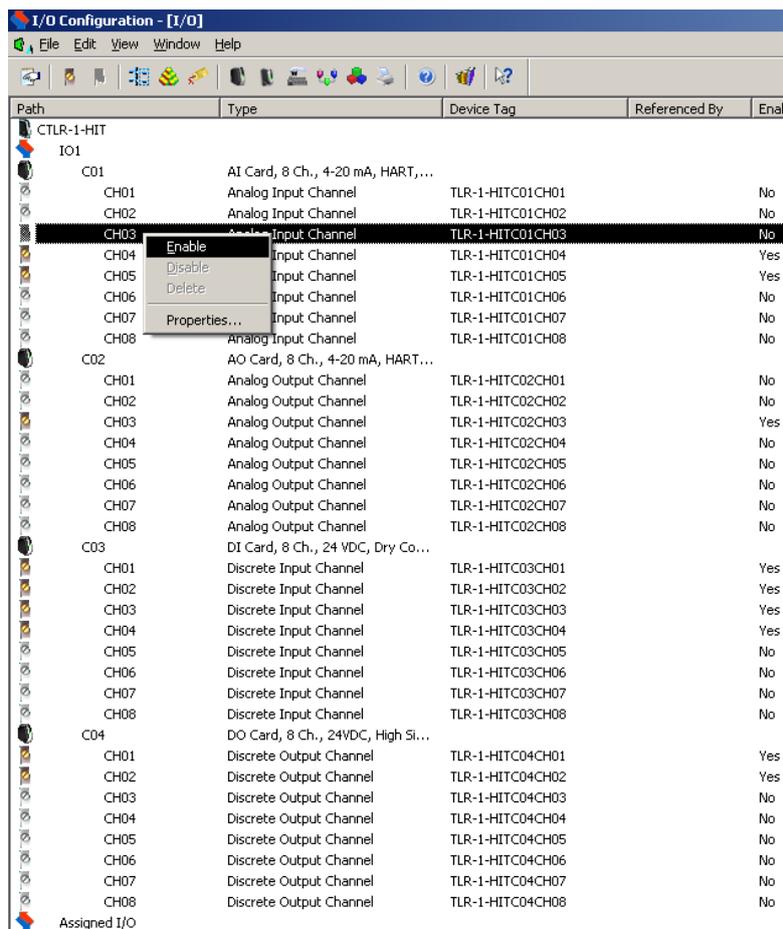
Figure 2.6 Enabling I/O Configuration.

All I/O's that we need to control the TWO-TANK should now be active.

2.4 Step 4: Connecting I/O to the MPC_LOOP

We will now return to Exploring DeltaV to connect some I/O's to the MPC controller. We will find it in the AREA → TWO_TANK. Right click on the MPC_LOOP_1 and choose open with Control Studio, see Figure 2.7.
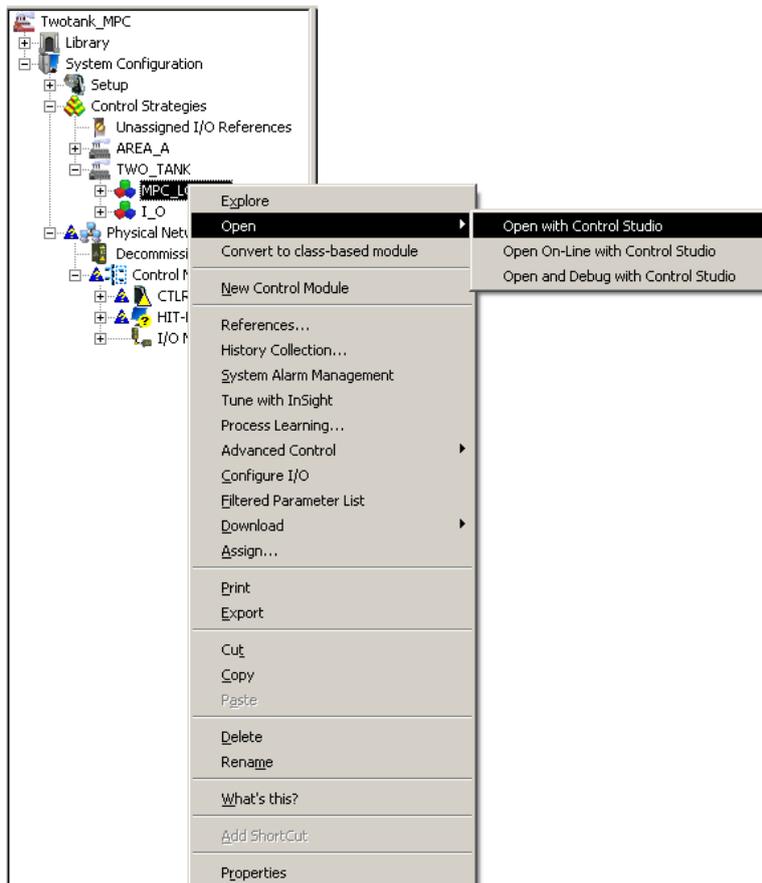
Figure 2.7 Open control module in Control Studio.

From Control Studio we see that we have a MPC block. In addition we have one analog in block and one analog out block, for our case being the controlled variable (CV) for the level in tank 2 and manipulated variable (MV) to the pump respectively. These IO needs to be assigned to the hardware controller and IO modules. Since the level is measured in percent, then we need to scale this value into cm. Also, the level transmitter on the tank has a 4mA output signal when the level is at 100%. Because of this we need to reverse the signal to the controller.

Drag and drop a Scaler block found under the Analog Control tab, see Figure 2.8. Wire a connection from the AI block to the Scaler block and from the Scaler block to the CNTRL1 on the MPC block. Mark the Scaler block and double click IN_SCALE in the property section to the left. Write 0 under 100% scale and 100 under 0% of scale. Press OK. Then, double click OUT_SCALE, and write 30 under 100% scale. Press OK.
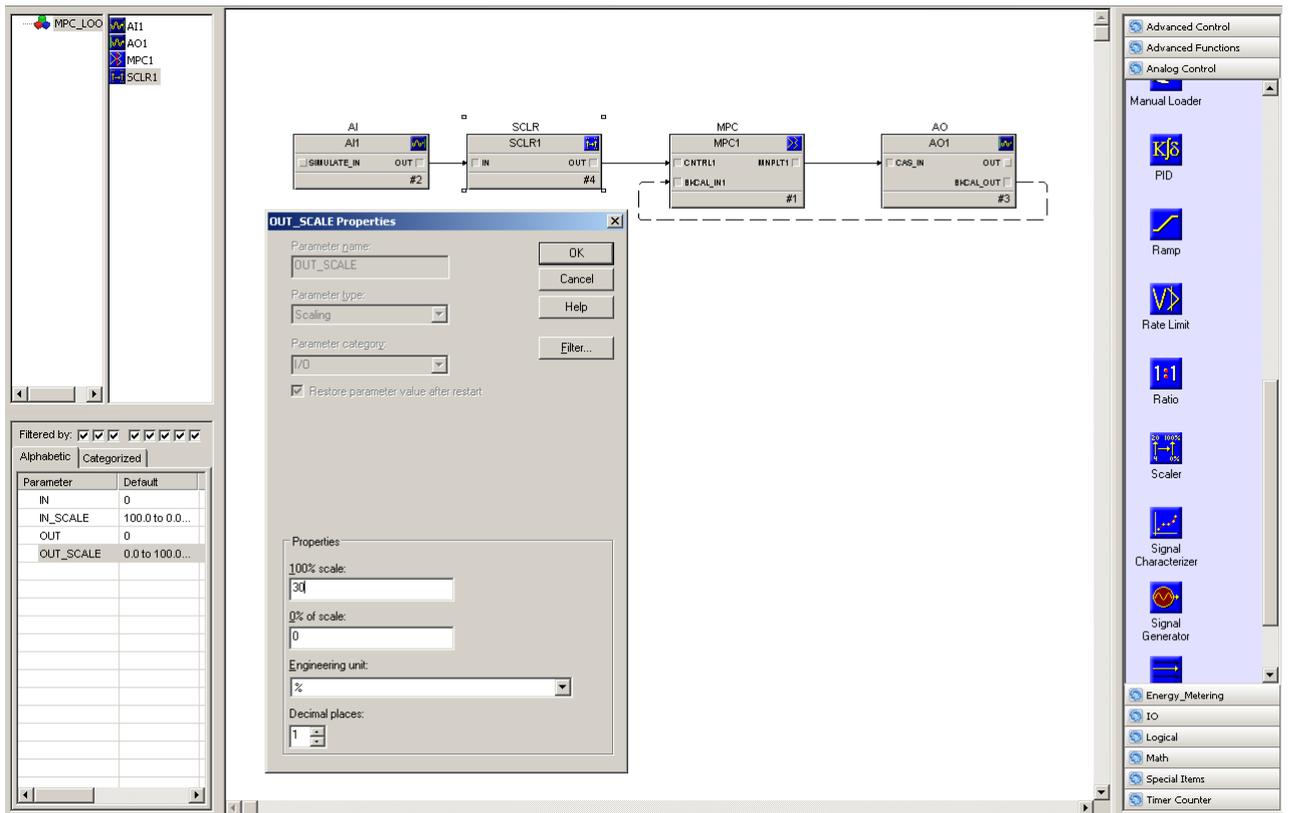
Figure 2.8 Connecting AI and Scaler block to the MPC block.

Right click the AI block and choose Assign I/O → To Signal Tag. An IO_IN Properties window will then appear, see Figure 2.9.
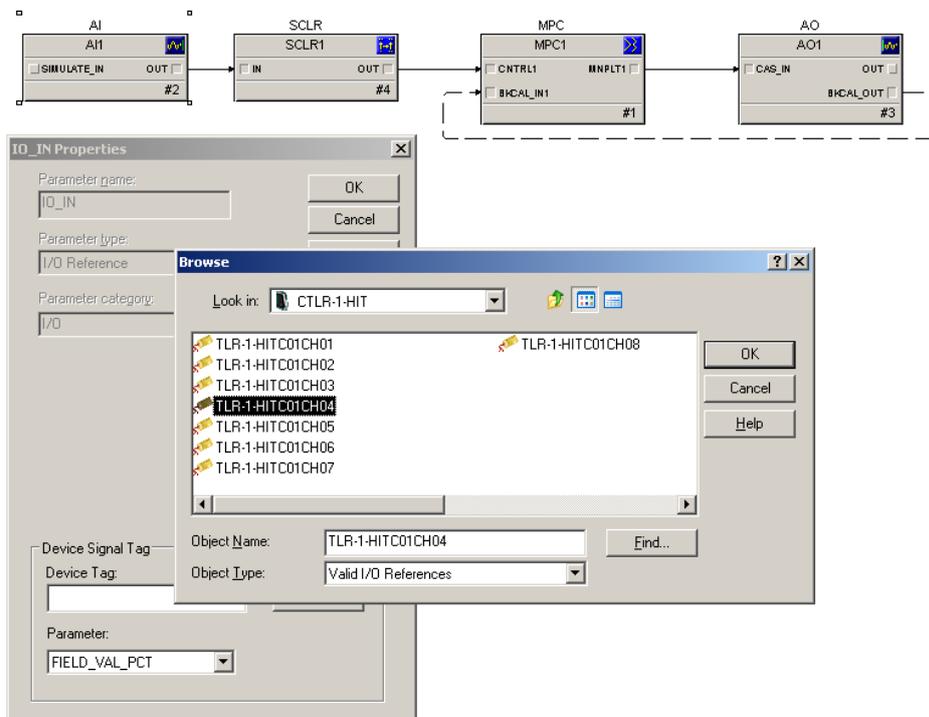
Figure 2.9 Assign I/O to Signal Tag.

Browse Device Tag, double click on CTLR and choose TLR-1-HITC01CH04. This is the fourth IN on the analog input module (CH04). Press ok until you are back to the MPC loop.

Now, right click the AO block and choose Assign I/O → To Signal Tag, and double click IO_OUT. Browse Device Tag, double click on CTLR and choose TLR-1-HITC02CH03. This is the third OUT on the analog out module (CH03). Press OK and then close. We have now connected the I/O to the MPC controller.

In addition, for MPC we will also include constraints (AV) on the level in the lower tank 2, and disturbance (DV) being the level in tank 1. These are typical variables in a process and often affect the performance. To include them we need to add these parameters to the MPC block.

Right click the MPC block and choose Extensible Parameters. Then double click on NOF_DSTRB and add 1 to the Modify Extensible Parameter - NOF_DSTRB, see Figure 2.10. Click OK and add 1 to the NOF_CONSTR. Again click OK and Yes until you are back to the MPC loop.
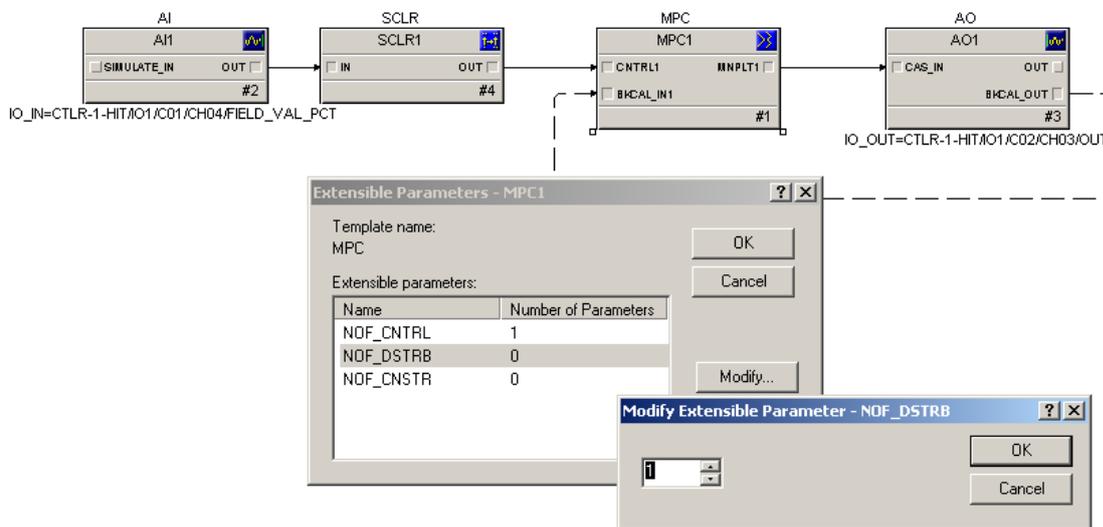
Figure 2.10 Adding constraint and disturbance variables.

Next step is to set the properties for the parameters.

Right click the MPC block and choose properties. A MPC1 Properties window appears for all the parameters. Double click the first row under the Controlled tab and type e.g. a tag-name in the Description field, see Figure 2.11. Also, enter 30 under SP high limit. Then press OK.
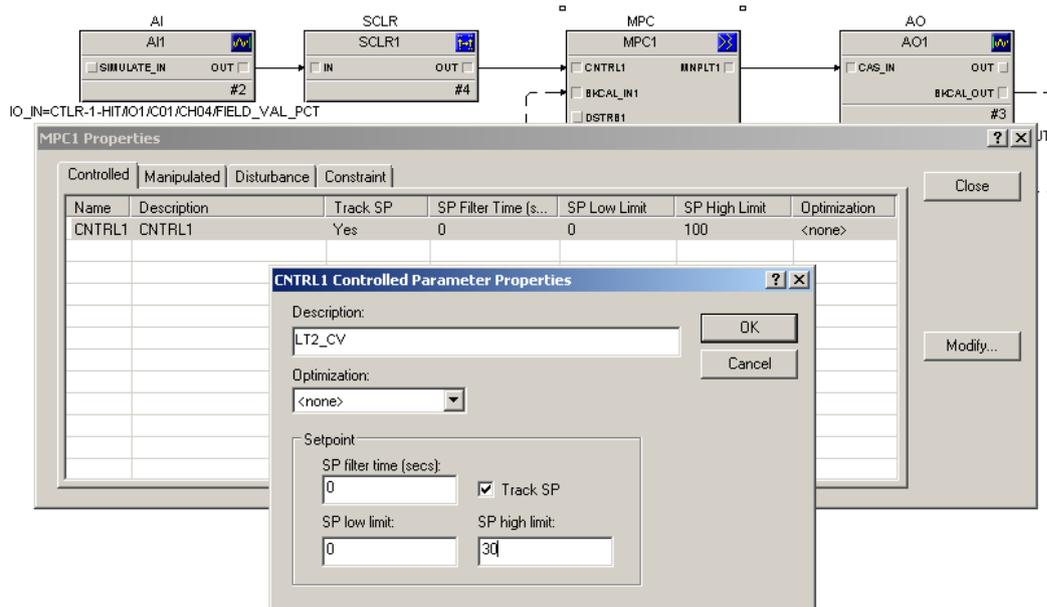
Figure 2.11 Set parameter properties for the MPC variables.

Do the same with the other parameters. For the Constraint parameter, also include CNTRL1 under Related CV, and add a Low limit and High Limit being 10 and 20 cm respectively. When finished close the property window.

The level in the lower tank 2 is the constrained parameter and then we need to connect the Scaler block OUT to the CNSTR1 input on the MPC block, see Figure 2.12.

Since the level in the upper tank 1 is the measured disturbance we need to add an AI block from the IO tab. Then, right click the new AI block and choose Assign I/O → To Signal Tag. Browse Device Tag, double click on CTLR and choose TLR-1-HITC01CH03. This is the third IN on the analog input module (CH03). Press ok until you are back to the MPC loop.

As for the level transmitter on tank 2, the tank 1 transmitter signal needs to be reversed due to the 4mA output signal when the level is at 100%. Add a Scaler block from the Analog Control tab, and double click IN_SCALE in the property section to the left. Write 0 under 100% scale and 100 under 0% of scale. Press OK. Then, double click OUT_SCALE, and write 30 under 100% scale. Press OK.

When this done connect the AI block and Scaler block to the DSTRB1 input on the MPC block, as seen in Figure 2.12. By clicking on the default names on the blocks, e.g. AI1, you can change the name to a preferable tag.
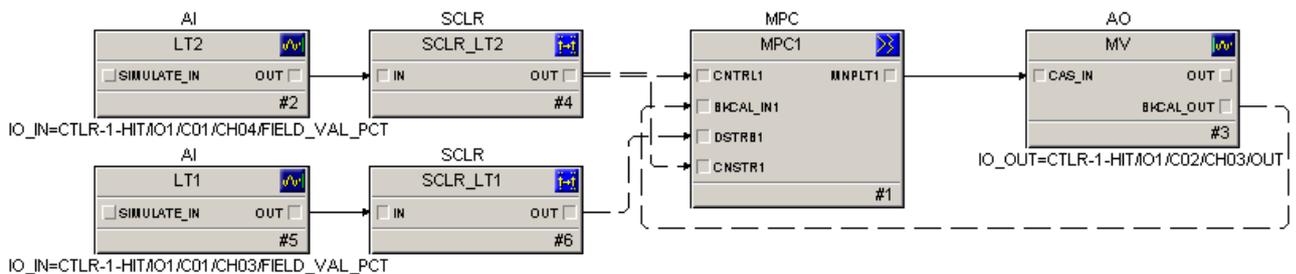
Figure 2.12 Constraint and disturbance parameters connected to the MPC block.

Now, press the [Download] button in Control Studio. Then, press yes, and choose CTLR-1-HIT and click OK. Press yes, and OK until the download is completed.

Close Control Studio. Press yes if you get question about saving.

2.5   Step 5: Connecting I/O to the rest of the signals

Now we need to connect the remaining I/O's to the physical model. Open the control module I_O you created under the area TWO_TANK in Exploring DeltaV, e.g. by right clicking I_O and choosing Open → Open with Control Studio.

All the blocks we need are found under the I/O tab. Drag and drop four Discrete Input (DI) blocks, two Discrete Output (DO) blocks and one Analog Input (AI) block, see Figure 2.13. The DI/DO blocks are w.r.t. the valves and alarms for the model, and the AI block is w.r.t. the flow transmitter.

By clicking on the blocks default name you can change the name on each of the blocks to a preferable tag.
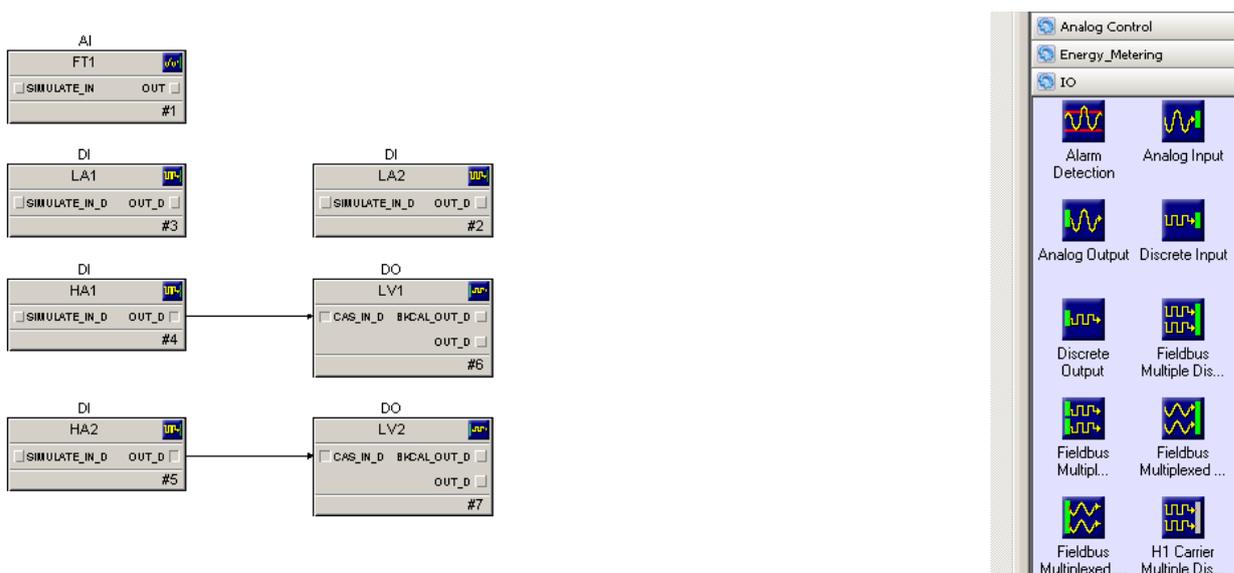
Figure 2.13 Analog- and Digital signal blocks for the physical model.

We also want to create interlocks for the system to make sure that e.g. a high critical limit level is respected. Therefore, connect, as seen in Figure 2.13. HA1 output to the LV1 input and HA2 output to the LV2 input. This connection makes sure that whenever a high limit level is reached for tank 1 or tank 2, then the valves for the respective tanks will open.

Now we need to connect the blocks to the correct I/O.

Right click on **FT1** and choose Assign I/O to Signal Tag, then press browse, double click on CTLR-1-HIT, mark TLR-1-HIT**C01CH05** and press OK.

Right click on **LA1** and choose Assign I/O to Signal Tag, then press browse, double click on CTLR-1-HIT, mark TLR-1-HIT**C03CH02** and press OK.

Right click on **LA2** and choose Assign I/O to Signal Tag, then press browse, double click on CTLR-1-HIT, mark TLR-1-HIT**C03CH04** and press OK.

Right click on **HA1** and choose Assign I/O to Signal Tag, then press browse, double click on CTLR-1-HIT, mark TLR-1-HIT**C03CH01** and press OK.
Right click on **HA2** and choose Assign I/O to Signal Tag, then press browse, double click on CTLR-1-HIT, mark TLR-1-HIT**C03CH03** and press OK.

Right click on **LV1** and choose Assign I/O to Signal Tag, mark IO_OUT, press Modify then Browse, double click on CTLR-1-HIT, mark TLR-1-HIT**C04CH01** and press OK.

Right click on **LV2** and choose Assign I/O to Signal Tag, mark IO_OUT, press Modify then Browse, double click on CTLR-1-HIT, mark TLR-1-HIT**C04CH02** and press OK.

Figure 2.14 shows all the blocks connected to the correct IN and OUT.
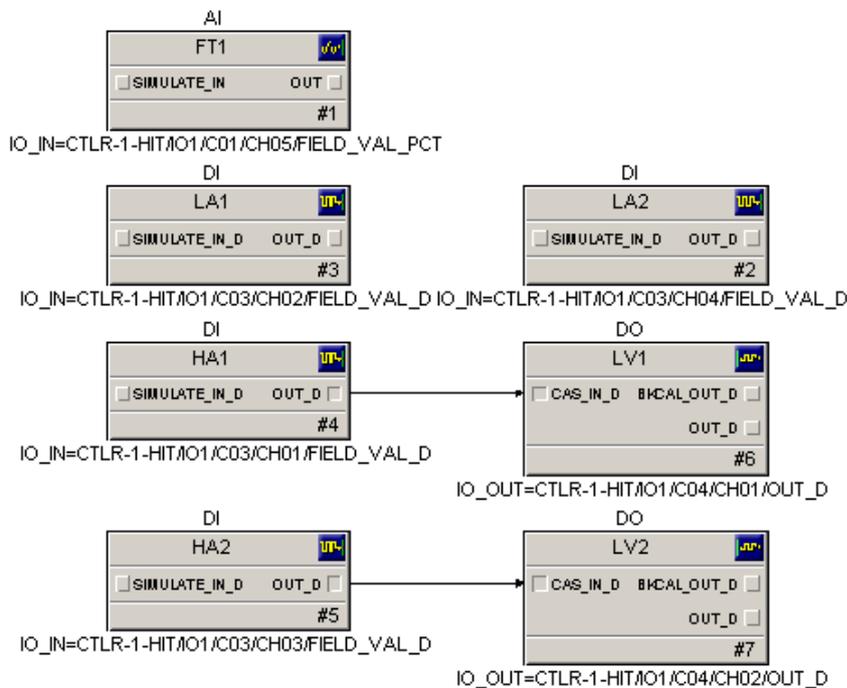
Figure 2.14 Connected and configured Analog- and Digital blocks.

Now, press the ⬇ Download button in Control Studio. Then, press yes, and choose CTLR-1-HIT and click OK. Press yes, and OK until the download is completed.

Close Control Studio. Press yes if you get question about saving.

2.6 Step 6: Assigning area to alarm and events and continuous historian

The control modules and I/O is now connected to the hardware module. For alarms and events and data collecting to work we need to connect this to the history module that's premade in DeltaV.

Go to Exploring DeltaV, choose your area TWO-TANK under Control Strategies and drag and drop it down to Alarms And Events, see Figure 2.15. Also, since we need to collect input/output data to create a model as in section 3, then drag and drop the area to Continuous Historian as well.
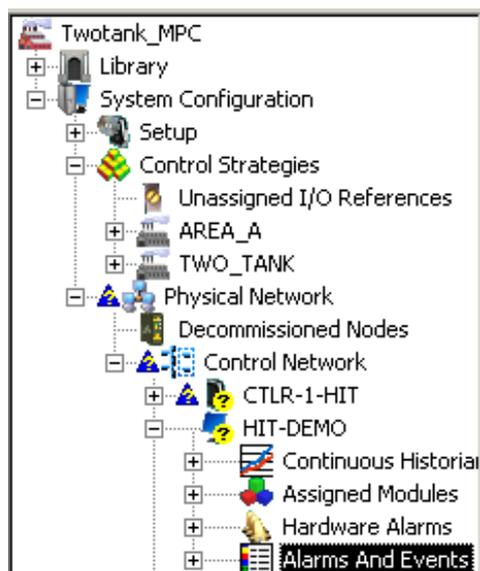
Figure 2.15 Assigning TWO_TANK area to Alarms and Events and Continuous Historian.

The last thing that needs to be done before we start making the user interface is to make sure everything is downloaded. Right click on Physical network and choose Download physical network. Whenever there has accrued changes in the physical network this need to be downloaded again. If minor changes, e.g. setup data, then instead of downloading the whole physical network there could be more appropriate to right click the physical network and download Setup Data, see Figure 2.16.
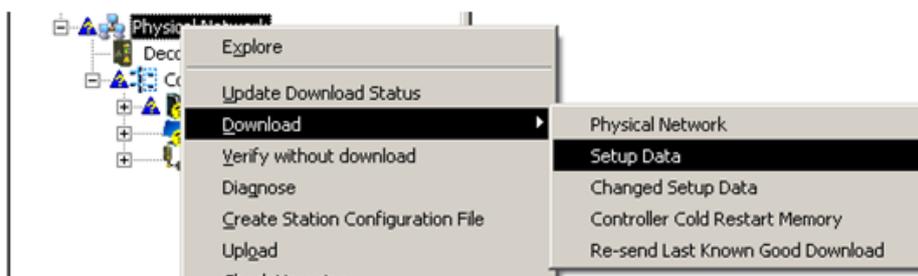
Figure 2.16 Downloading the program in Explorer.

Also, every time you make a change in a program in Control Studio, this needs to be saved and downloaded again as well.

After the downloading, the program should now be ready.

3 MODELLING AND VALIDATION

In this section we will learn how to create a MPC model for the MPC controller and do validation of the model, using DeltaV Predict, -MPC Operate and MPC Simulate.

3.1 Step 1: Connecting the Two-Tank process

Since the MPC block has an inbuilt feature making a model from input/output system identification, we first need to physically connect the Two-Tank system to DeltaV.

The connection is done by putting the connection pins together. They are marked, and the wire with nr 1 from the model is connected to the wire with nr 1 on DeltaV. Figure 3.1 shows a sketch of how the model is to be wired.
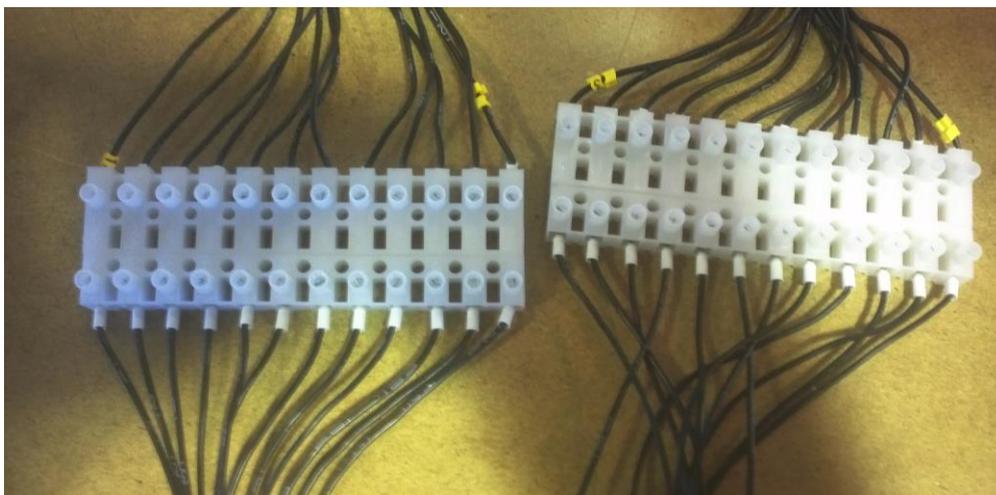
Figure 3.1 Wire Connection of the Two-Tank and DeltaV.

The model also needs to be connected to 230V and turned on. When turning the power on, make sure the components inside the model are powered.

3.2 Step 2: Creating the MPC model

The application were we create the model is called DeltaV Predict. Go to the MPC_LOOP_1 in Control Studio and right click the MPC block and choose Advanced Control → Predict, see Figure 3.2.
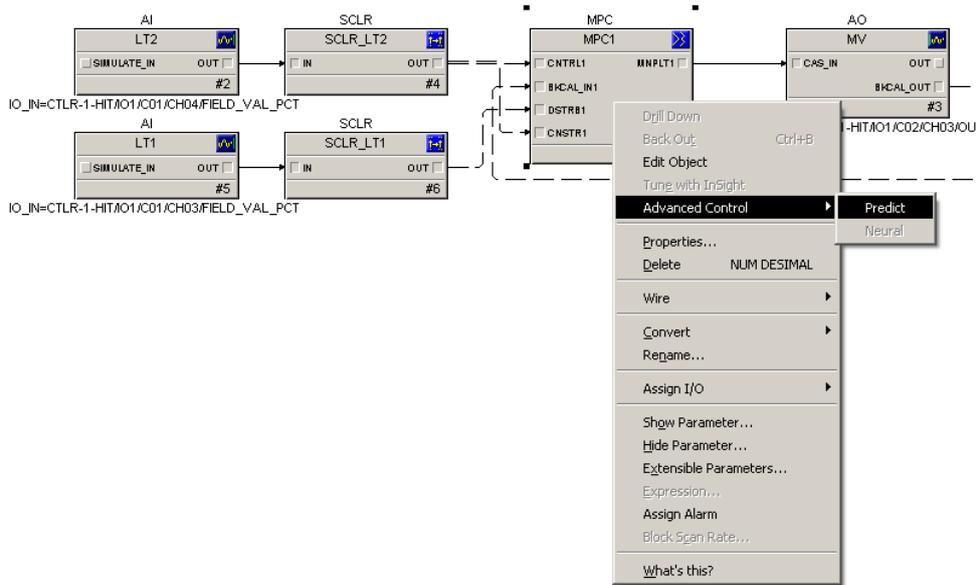
Figure 3.2 Opening DeltaV Predict application.

The application then appears similar to as seen in Figure 3.3.
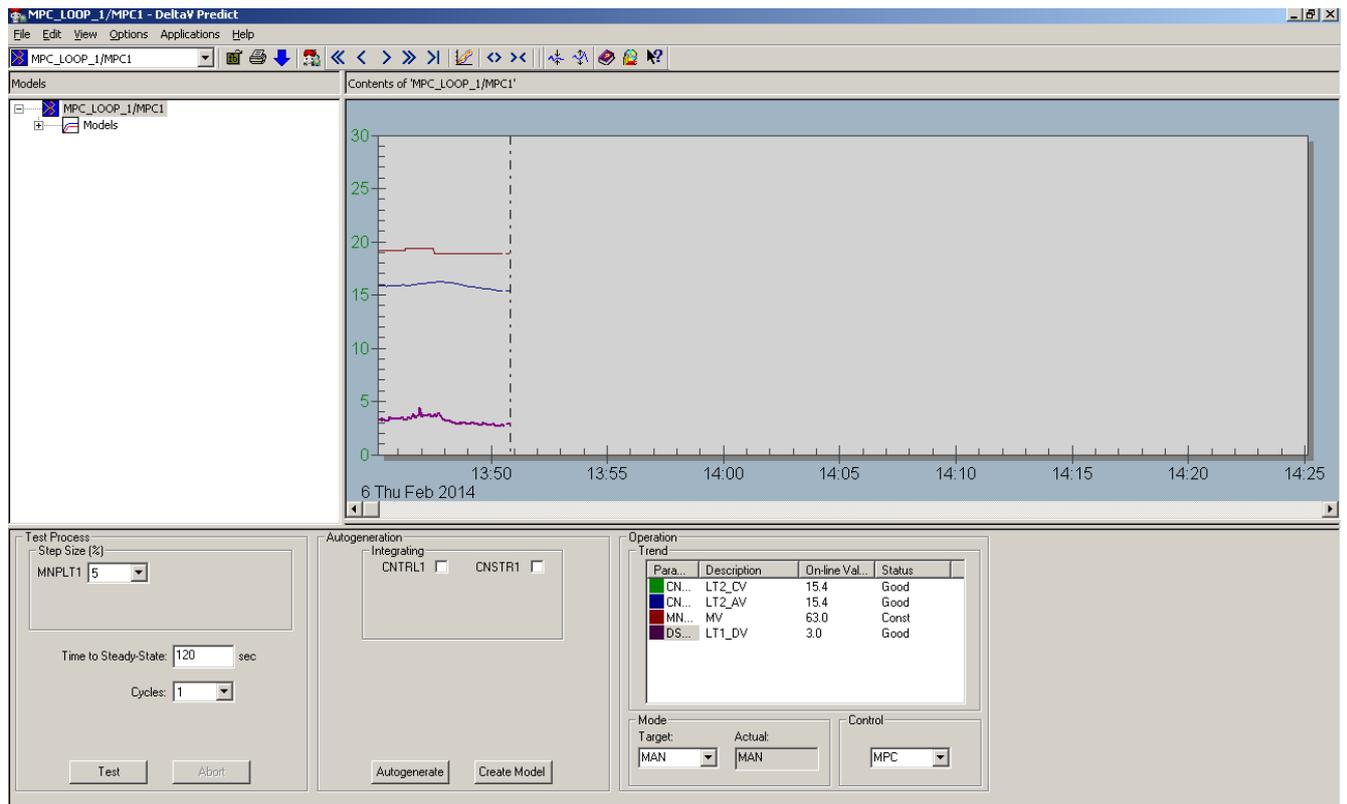
Figure 3.3 DeltaV Predict application.

Start by going to Options in the application menu and chose Expert. This gives additional features which we want to use.

From the Figure 3.3, the upper left part is where the model hierarchy is found. On the upper right is a trending picture which shows the MPC parameters configured, and chosen by double-clicking the respective parameter under Operation and Trend. The lower left part is for modelling configuration and the lower middle is for model generation.

Before we start modelling we want to find a preferred operational point, e.g. around 15 cm.

Click Application in the application menu and choose MPC Operate.

A new application appears, and with the physical process connected we have the choice to run the MPC control either in manual or in auto mode. Since we do not have a model yet only the manual mode will work.

On the bottom in the MPC Operate application all the MPC parameters are shown.

Start by marking all the parameter check boxes in the bottom of the figure. Click on the manipulated variable (MV). At the left side a slide-bar for the parameter is then shown. Adjust the slide-bar so that the level gets steady and about 15 cm, see Figure 3.4.
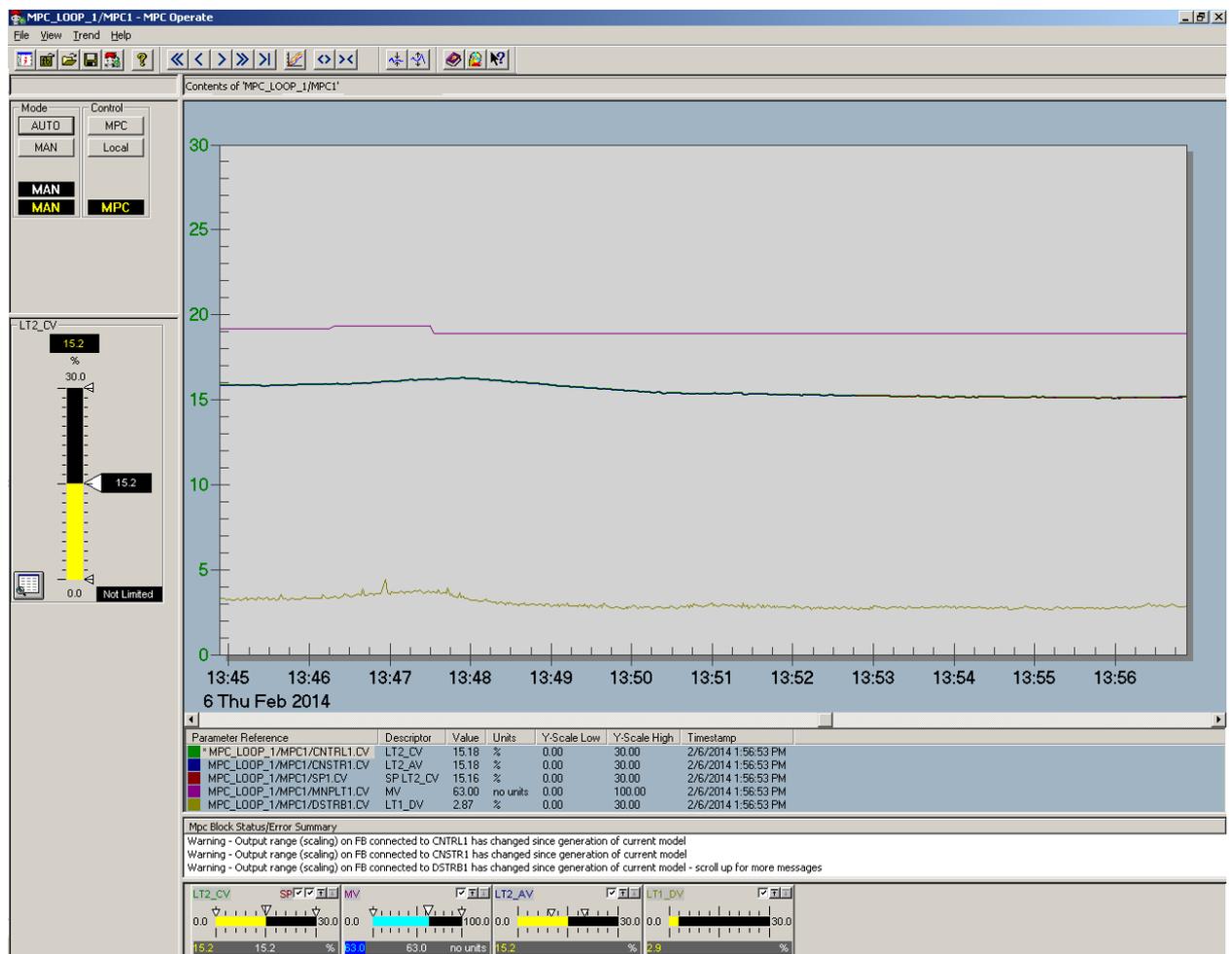
Figure 3.4 Adjusting level manually in MPC Operate.

When you have the operational point steady around 15 cm, go back to the DeltaV Predict application and set the Test Process parameters Step Size to 5 %, Time to Steady-State to 180 s and Cycles to 2, as seen in Figure 3.5. Then press the Test button.
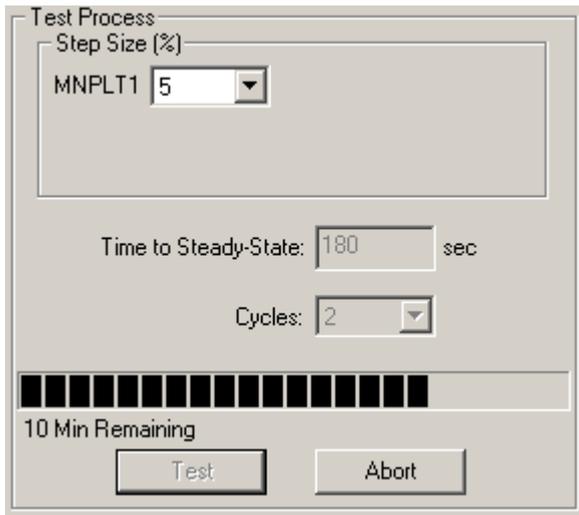
Figure 3.5 Test Process parameters.

The application is now starting to collect input/output data to create the model. For the above Test Process settings it will take some time to finish this test process. This will be indicated by a blue progression bar under Test Process.

When the test process is finished this is indicated by the green area layered on the period of data collection seen on the trend picture and as in Figure 3.6.
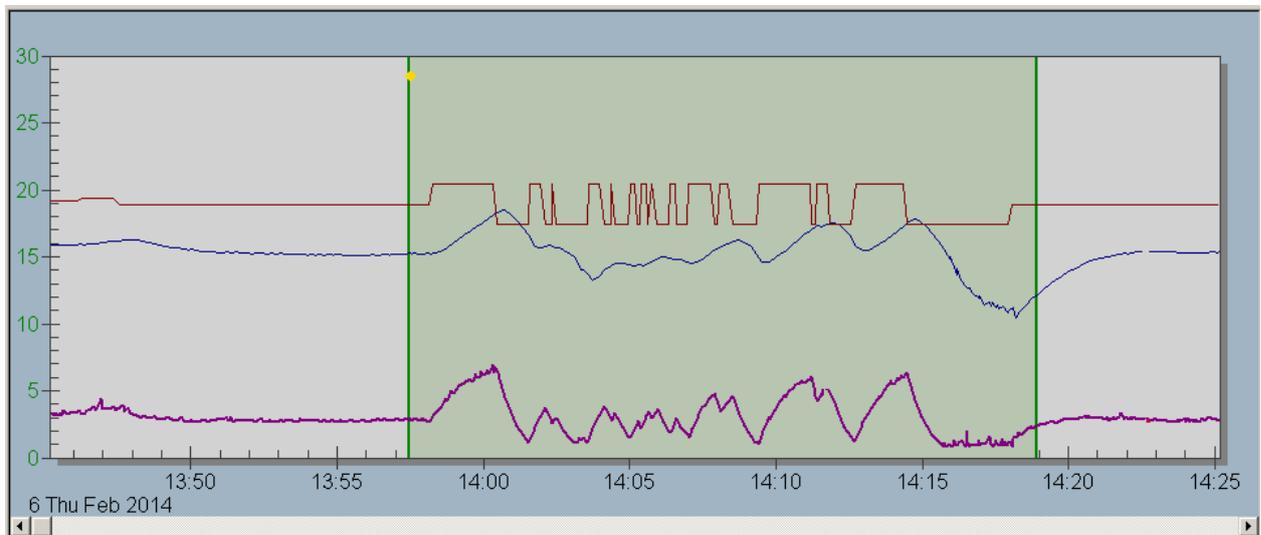
Figure 3.6 Period of data collection.

Click the Autogenerate button to generate the model.

The model will then be generated and all step responses for the inputs and outputs can be seen as in Figure 3.7. The step responses may be investigated in further details by choosing the different input/output relations in the model hierarchy under Models.
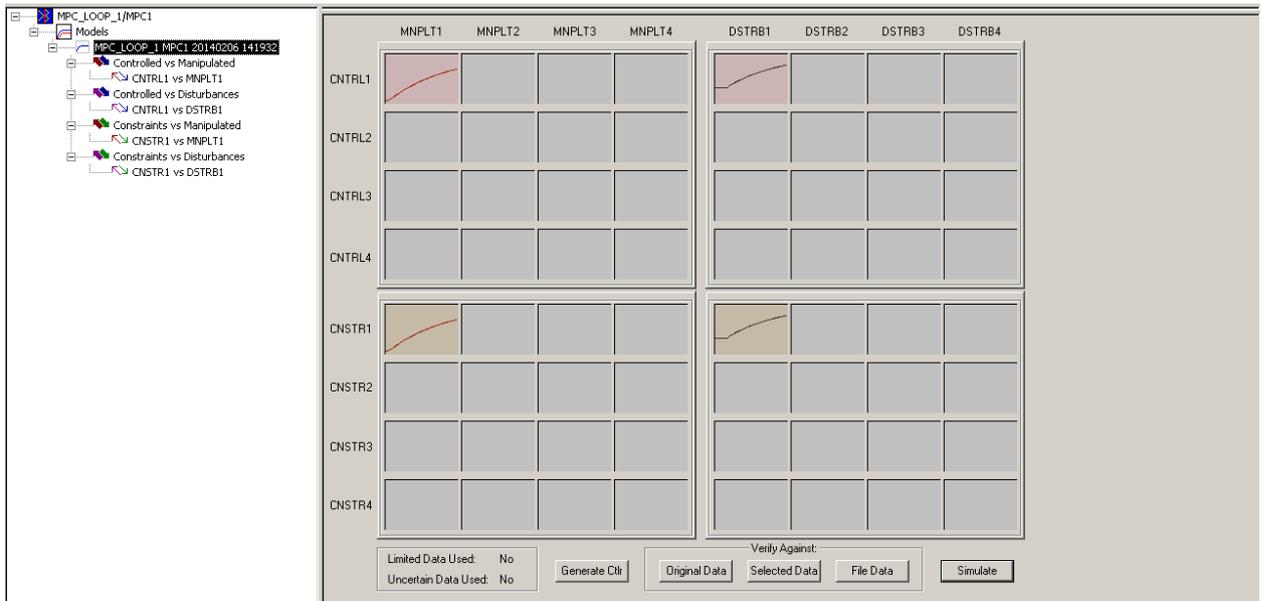
Figure 3.7 Generated model and step responses.

3.3 Step 3: Verification of the MPC model

To verify the model we first want to e.g. check the actual measurement vs the predicted. Click the Original Data button seen in Figure 3.7 (be sure to have chosen Expert under Options to get these buttons available). A Model Verification window, as in Figure 3.8, will then appear. This may give a good indication of how the model is, preferable having smallest possible deviation, and smallest possible Squared Error and R-Squared. The graph in Figure 3.8 seems to show a somewhat ok model. By choosing Actual vs. Predicted the corresponding best fit line can also be investigated.
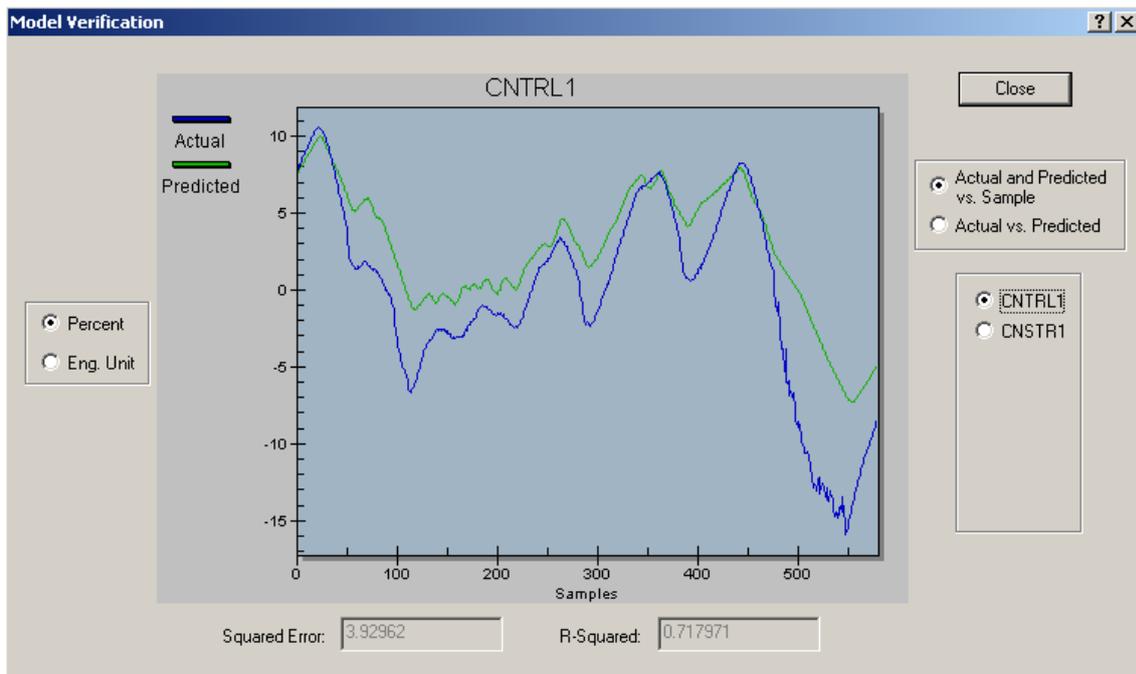
Figure 3.8 Model verification of the actual measurement vs the predicted.

To possible improve the model, e.g. remove uncertain data, we may adjust the period of data collection as seen in Figure 3.6. However, note that doing this may also worsen your model, and should be done with cautiousness.

If you want to adjust the period of data collection, then click on and adjust the edges of the green layered area, see Figure 3.9. From the figure the data seems to correlate better within the new green area.
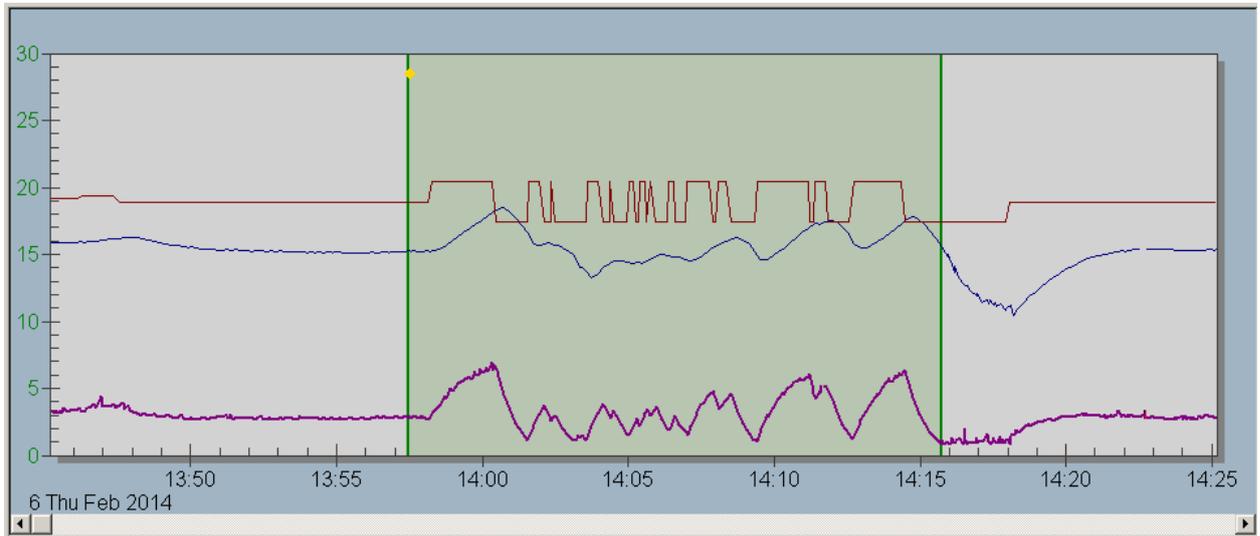
Figure 3.9 Adjusting the period of data collection.

As before click the Autogenerate button to generate the model.

Do the verification again and see if the model may have been improved. Figure 3.10 indicates improvement in the model.
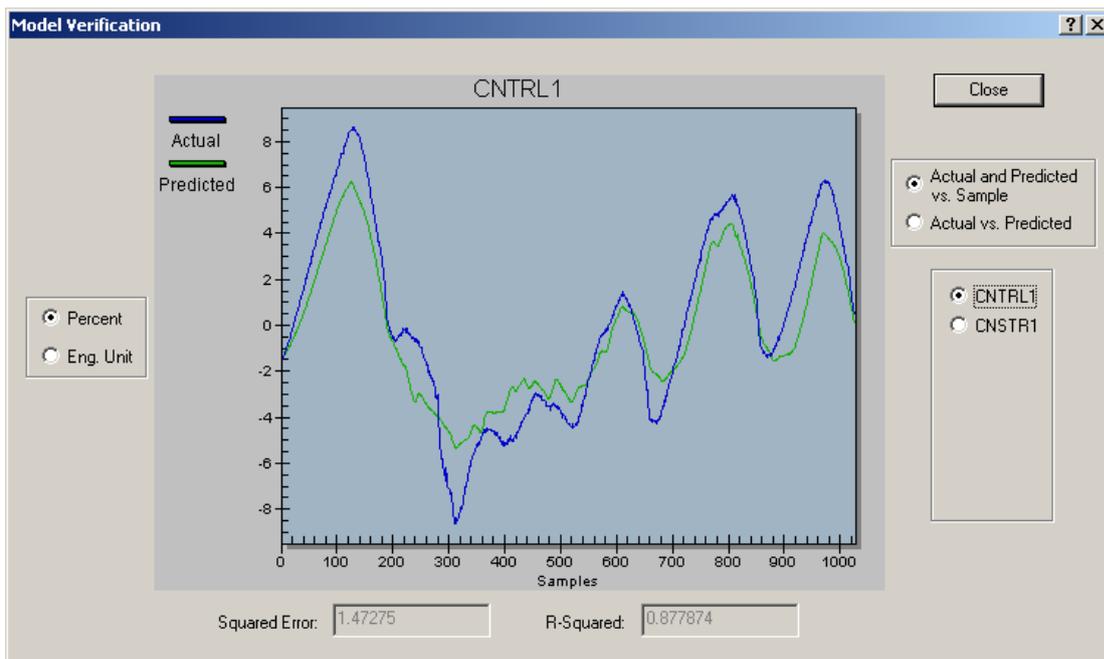
Figure 3.10 New model verification of the actual measurement vs the predicted.

Once you are satisfied that the model fairly reflects the process dynamics, select Generate Ctlr to update the MPC configuration for the new model.

When the control is generated from a selected model, control parameters used to generate the control are displayed and shown in Figure 3.11. Here we can somewhat tune the controller. Normally only the Penalty On Move (PM) and Penalty On Error (PE) should be adjusted. In short:

- Increase the PM value (in fifty percent increments) for any manipulated variables that are moving more than the acceptable limits.
- Decrease the PM for manipulated variables that are not responsive. It is recommended that they do not go below the default minimum PM values (the PM min = 3).
- Increase or decrease the PE, depending on process control requirements.

We might want to wait to do this kind of tuning since we have not tested the controller yet. However, normally the default values give a good performance.
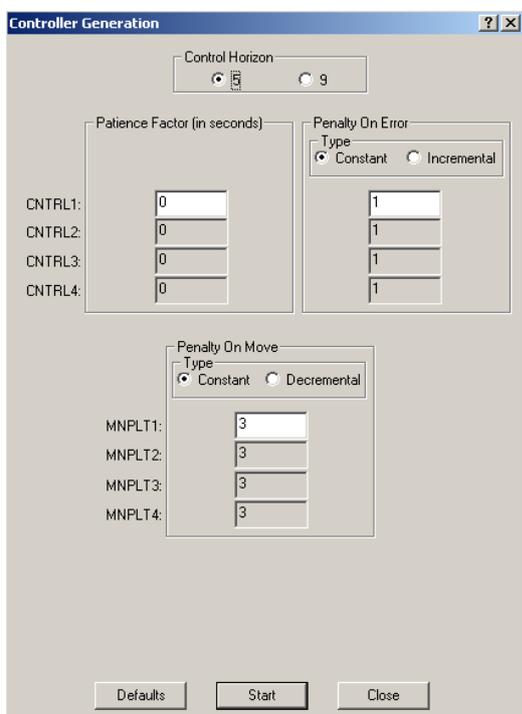
Figure 3.11 Controller generation and tuning parameters.

Now, press Start to continue, and then Close after the progression bar has finished.

To download the MPC controller click the blue arrow in the DeltaV Predict application as seen in Figure 3.12.

Figure 3.12 Downloading the MPC controller.

3.4   Step 4: Validation of the MPC controller

Next step is to simulate the performance of the generated controller. This can be done in the MPC Simulate application.

Press the Simulate button, seen in Figure 3.7, to open the application. Figure 3.13 shows the simulation environment.
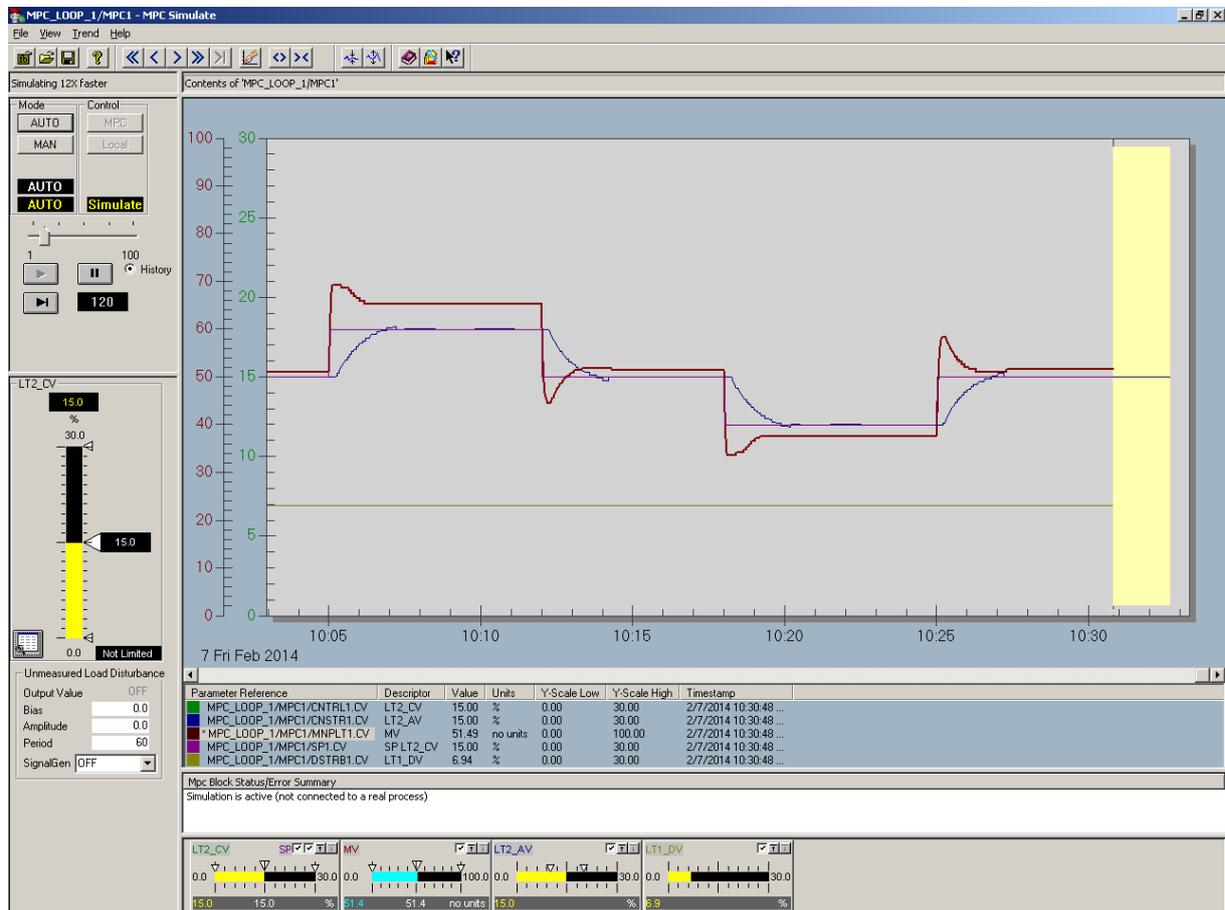
Figure 3.13 Simulation in MPC Simulate.

Start by marking all the parameter check boxes in the bottom of the figure.

Then select AUTO under Mode, and start the simulation by clicking the play button.

Now you can adjust the controlled variable using the slide-bar to the left and see the simulation performance of the MPC controller. If you want the simulation to go faster you can do so by adjusting the horizontal slide-bar above the play button. The yellow area in the trend is the predicted future measurement.

If the performance is satisfactory then you can test it on the Two-Tank, e.g. using the MPC Operate application in the same manner as in the simulation environment, and see if the response is similar. The green area in the trend is the predicted future measurement. Figure 3.13 vs Figure 3.14 shows that the controlled variable response is fairly similar. The manipulated variable deviates some. The reason for this is that in the simulations the disturbance is constant, however, on the real Two-Tank process the disturbance affects the manipulated variable, which then again affects the controlled variable. The constant value in the simulation is set w.r.t. the average value of the earlier collected disturbance data.
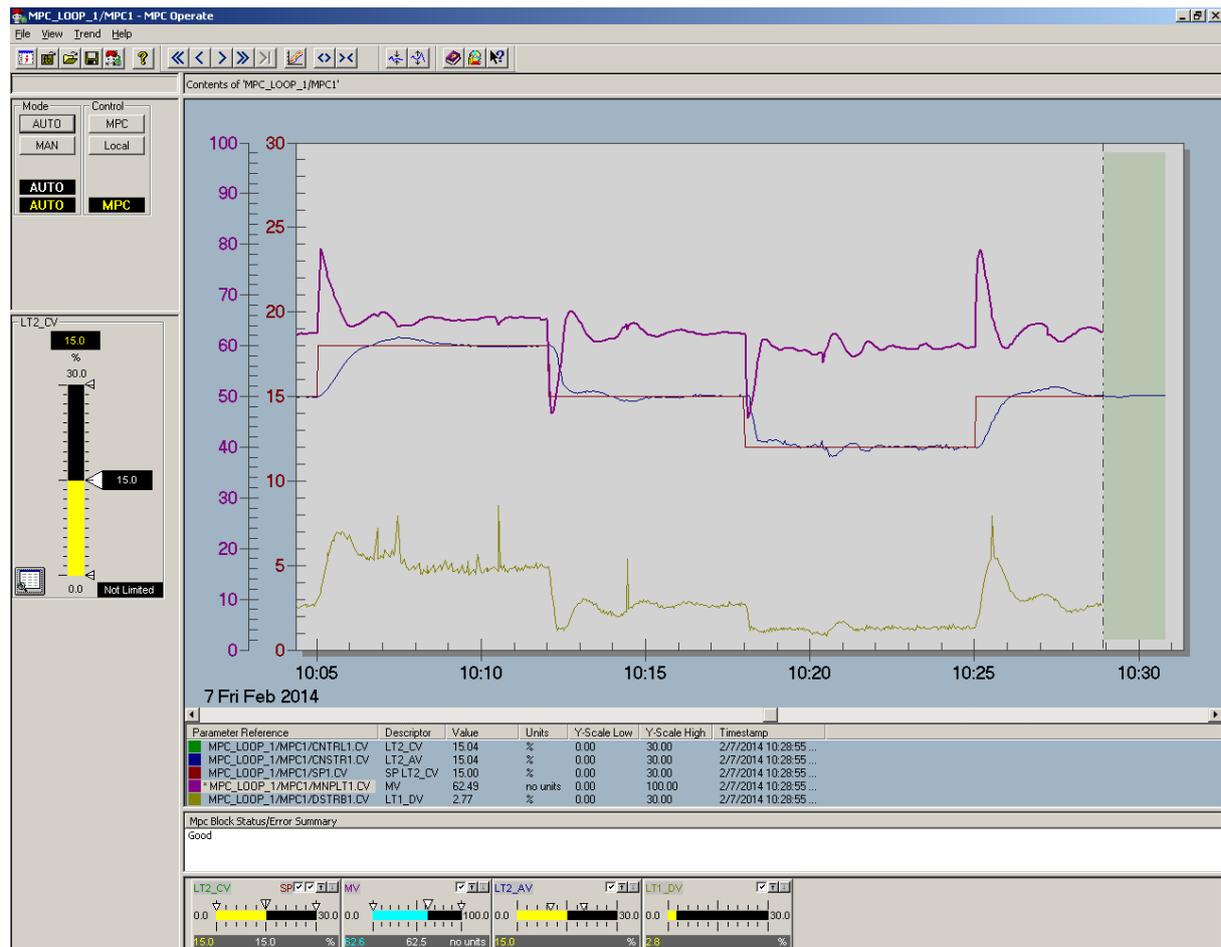
Figure 3.14 Testing the MPC controller in MPC Operate.

Note! If your model or simulations doesn't look to good it could be a good idea doing the test process again and possible change the test process parameters, e.g. try to vary the period of testing w.r.t. number of samples.

4   CREATING THE HMI

To be able to read and write values and simulate a process we need to create an HMI.

4.1   Step 1: Open a new picture

When you are in Exploring DeltaV. Go to applications and press DeltaV Operate Configure. See Figure 4.1
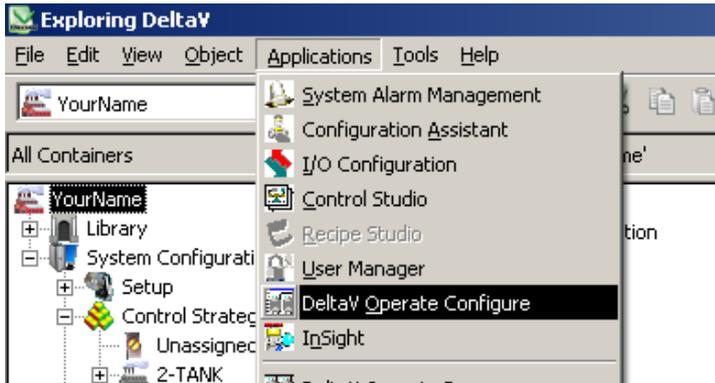
Figure 4.1 DeltaV Operate Configure

Press the +sign on the folder Pictures →Templates and double click on main. You will then get a standard template picture, see Figure 4.2.
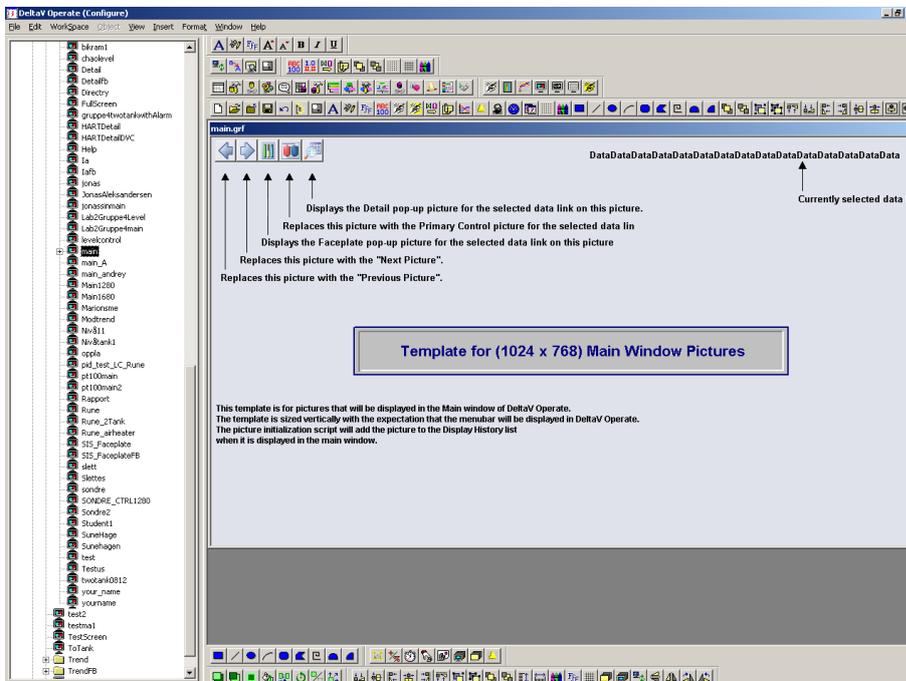
Figure 4.2 Using main picture template.

Mark and delete all the text on the picture so you get a blank picture like the one below, see Figure 4.3.
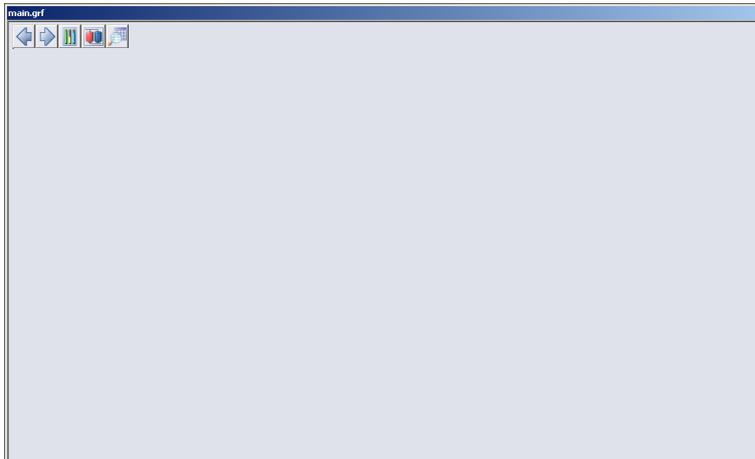
Figure 4.3 Crating blank picture.

4.2 Step 2: Creating picture interface using dynamos

Now we can begin creating our interface. In the left column you can find many premade dynamo components. We need different tanks, two valves, pump, flow transmitter,some piping and alarm indicators.

We start with the tanks.

Choose Dynamo Sets → TanksAnim. Drag and drop the tank to our picture, see Figure 4.4. This tank needs to be connected to our I/O to be able to simulate the level.
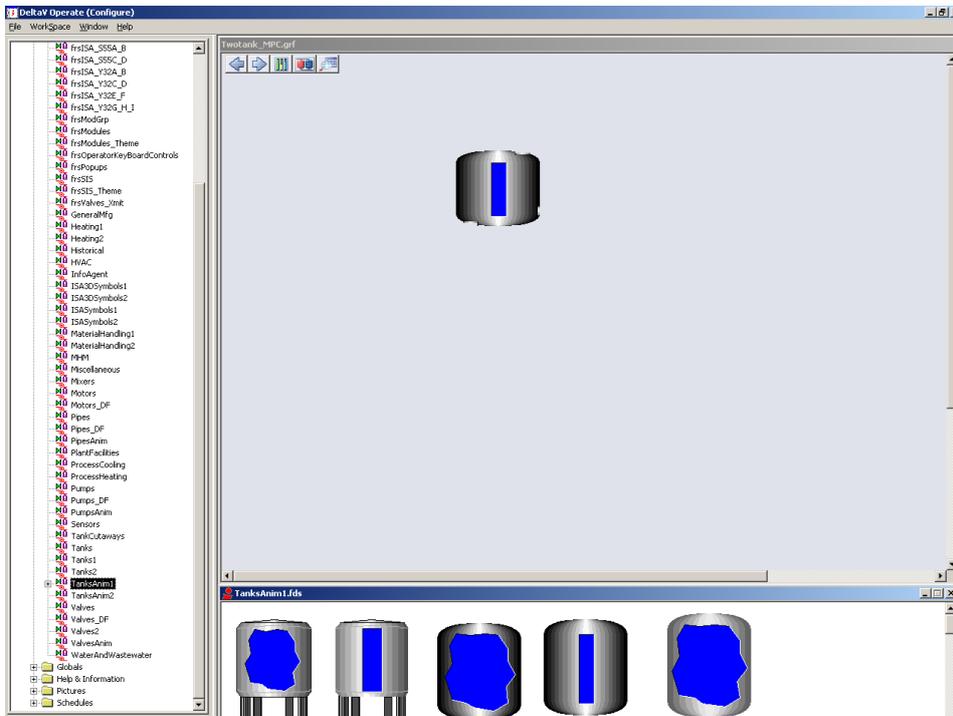
Figure 4.4 Adding a tank to the picture interface.

A Dynamo box will appear after you have placed your tank, as shown in Figure 4.5**Error! Reference source not found.**. Start by entering 30 (cm) in Highest Input Value under Input Ranges. Press the [...] button, then press Browse DeltaV Control Parameters → TWO_TANK → MPC_LOOP_1 → MPC1 → DSTRB1 → CV.
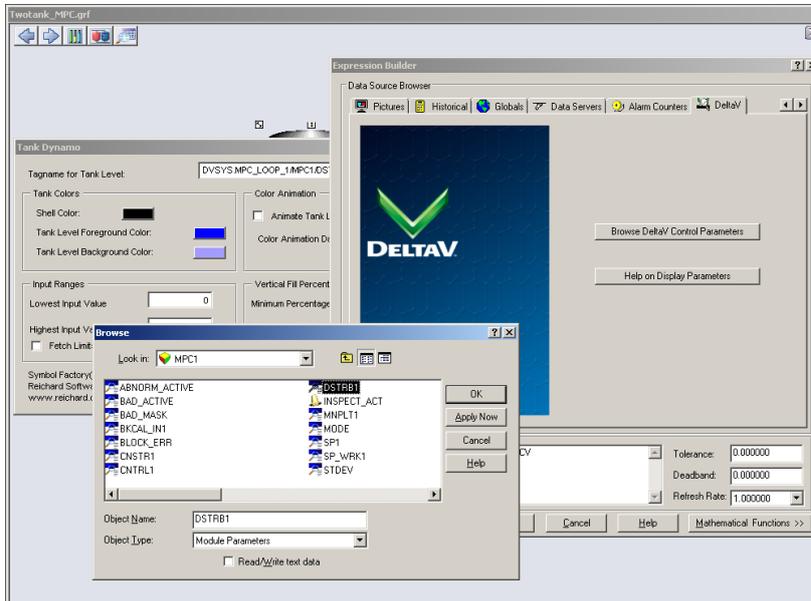
Figure 4.5 Linking level data to tank 1.

Press OK until you are back to your picture.

We are now done with one tank. Now grab another tank, similar to the first one. Again, a Dynamo box will appear after you have placed your tank, as shown in Figure 4.6. Start by entering 30 (cm) in Highest Input Value under Input Ranges. Press the [...] button, then press Browse DeltaV Control Parameters → TWO_TANK → MPC_LOOP_1 → MPC1 → CNTRL1 → CV.
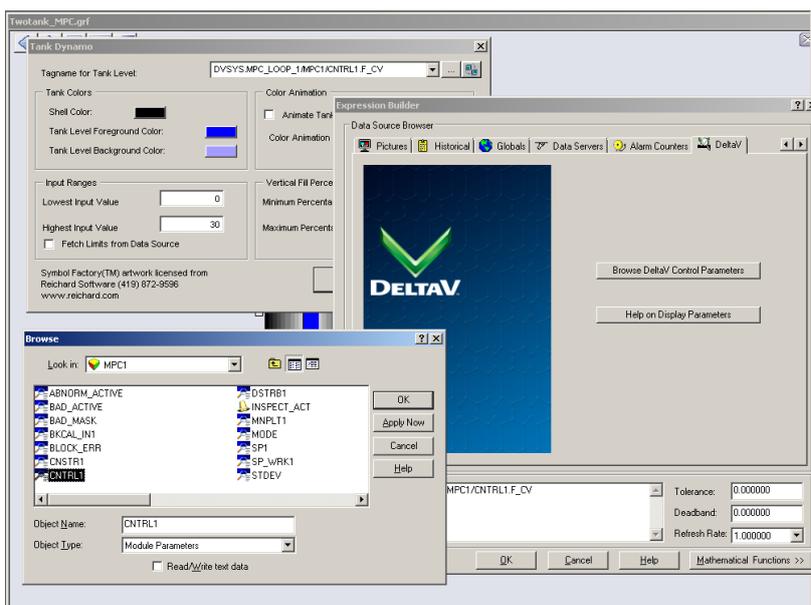
Figure 4.6 Linking level data to tank 2.

Next we are going to add two solenoid valves, one to each tank. Valves are found in Dynamo Sets and Valves_DF. Find two suitable valves and place them at the outlet of each tank, see Figure 4.7.
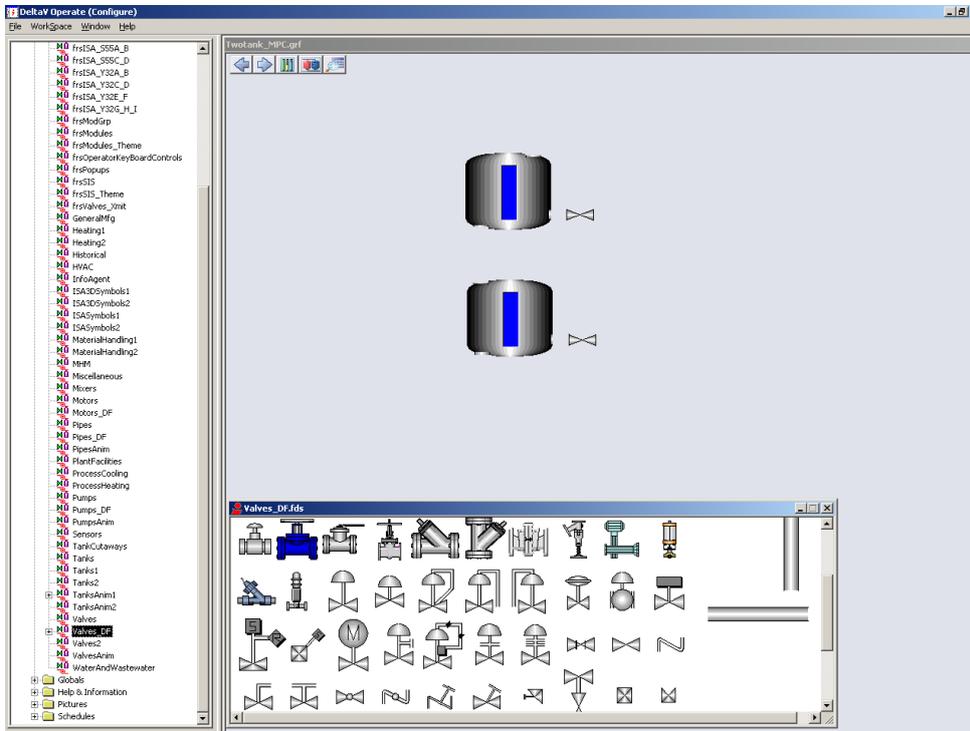
Figure 4.7 Adding valves to the picture interface.

Double click on the valve you placed next to tank 1. Basic Animation Dialog, as in Figure 4.8, will appear. Make sure Foreground Color is checked and press the button next to it.
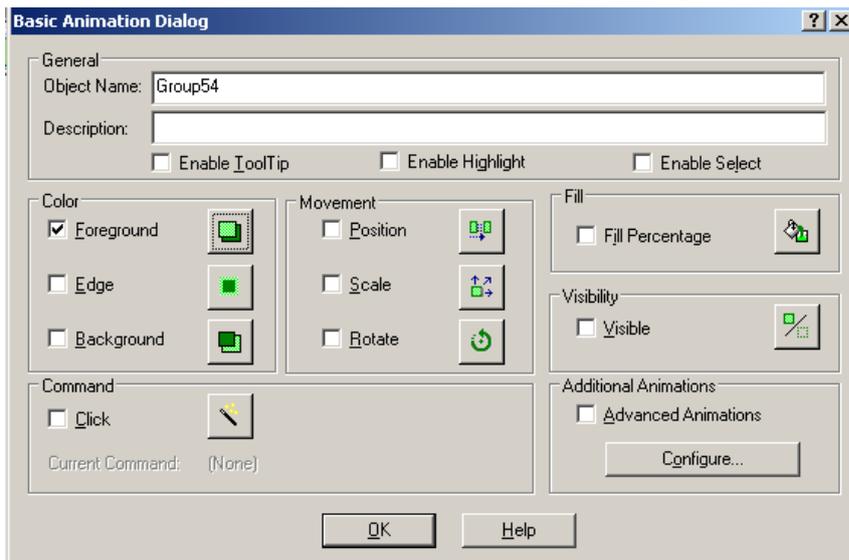
Figure 4.8 Basic Animation Dialog for the valve.

As in Figure 4.9, make sure Exact Match is checked. Delete all the rows and add two new rows. The color of the valve at value 0 should be gray. At value 1 the valve should be green.
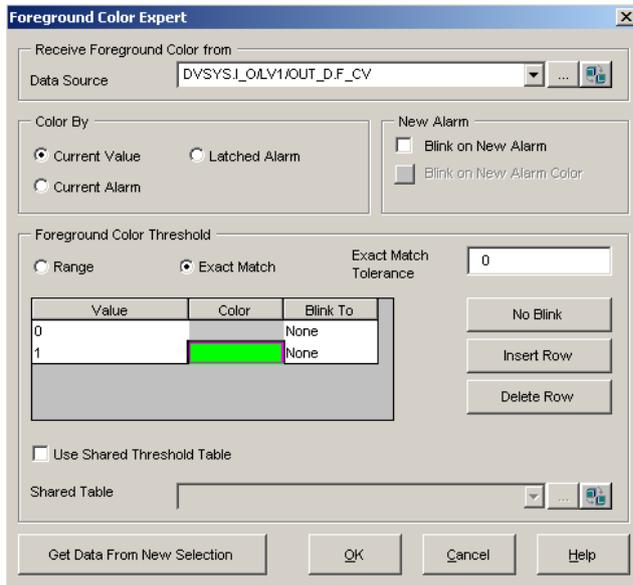
Figure 4.9 Adding color to the valve.

Then press the [...] button, choose Browse DeltaV Control Parameters → TWO_TANK, I_O → LV1 → OUT_D → CV, see Figure 4.10, and press Ok until you return to your picture.

The valve will now change color from gray to green when it's open.
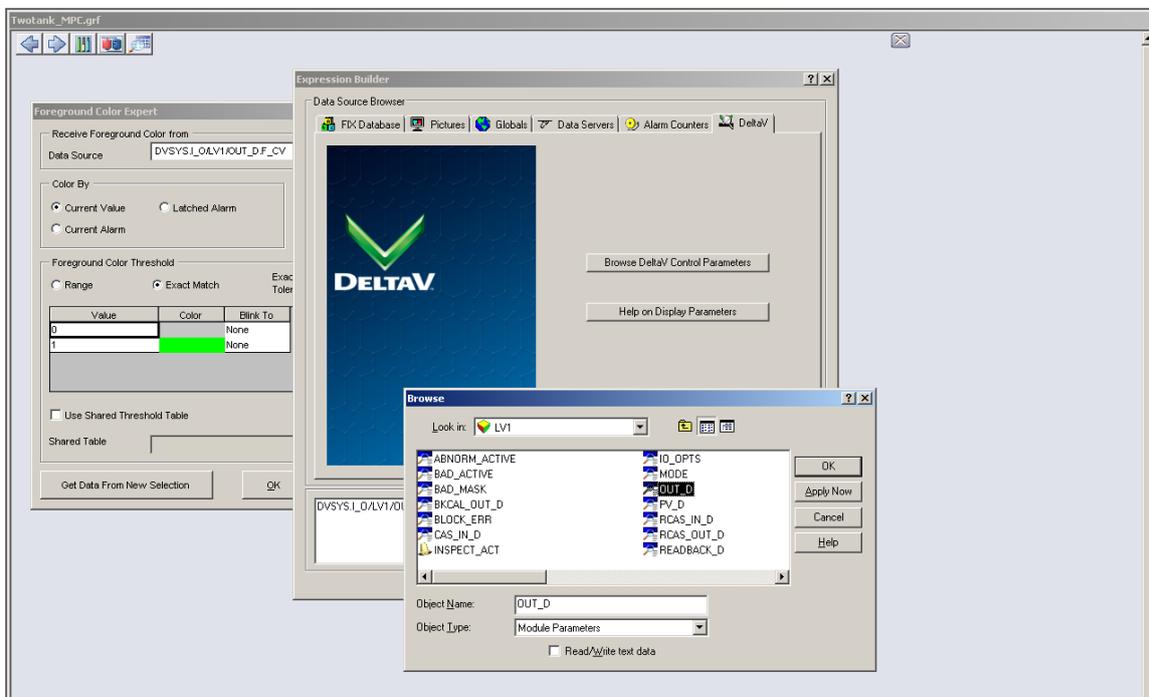
Figure 4.10 Adding datalink to the valve.

Now do the same thing with the valve you placed beside tank 2. The only difference is that you need to choose LV2 instead of LV1 when you configure the other valve parameter.

We will now find a pump. Choose a suitable pump from the Dynamo Sets, e.g. from Pumps_DF, and drag and drop it onto the drawing board.

Check the box for Animate Pump Color. Press the [...] button and link it to the I/O exactly the same way as you did when linking the tanks, except that you will choose MNPLT1 instead of DSTRB1/CNTRL1.

We can also choose what kind of color the pump will have at different values. Choose green color for when the pump is running, see Figure 4.11.
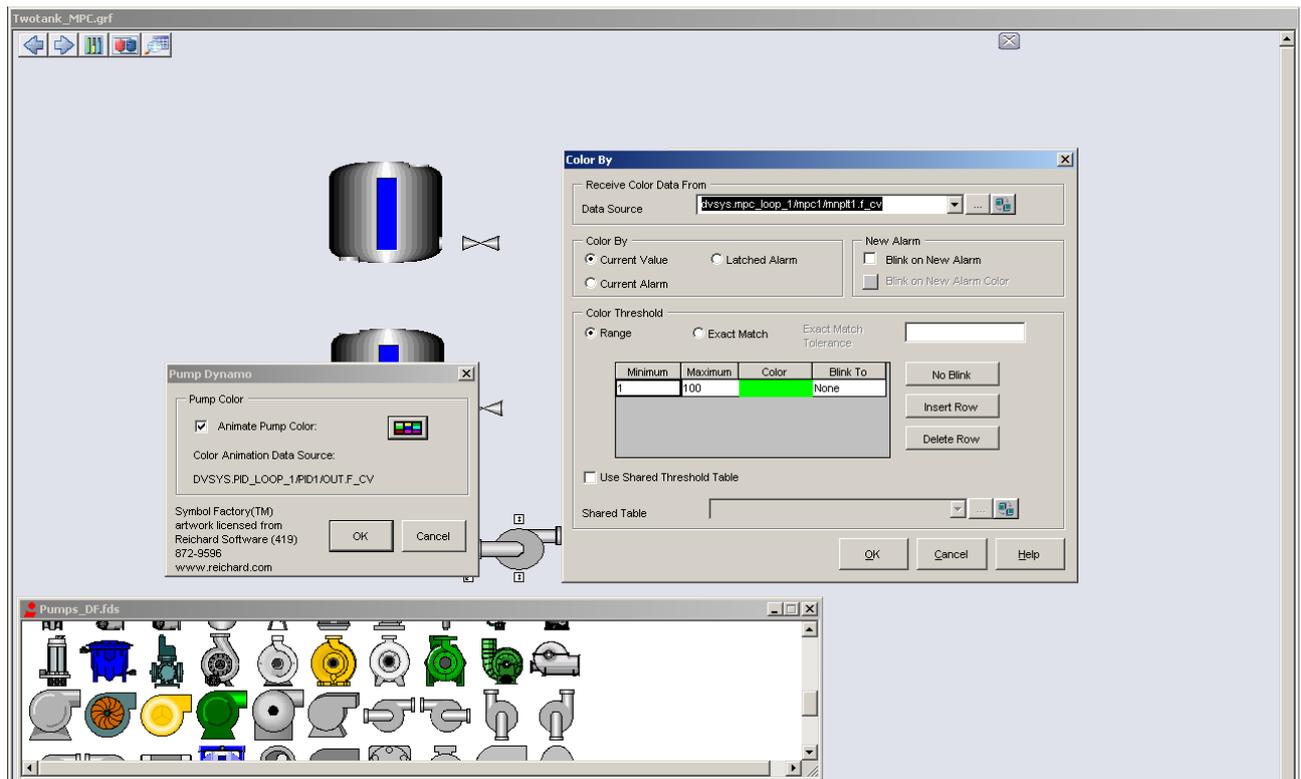
Figure 4.11 Linking manipulated variable data to the pump and adding animation color.

The Flow Transmitter can be found under Dynamo Sets and FlowMeters, see Figure 4.12. Find a suitable flow transmitter and add it to your picture.
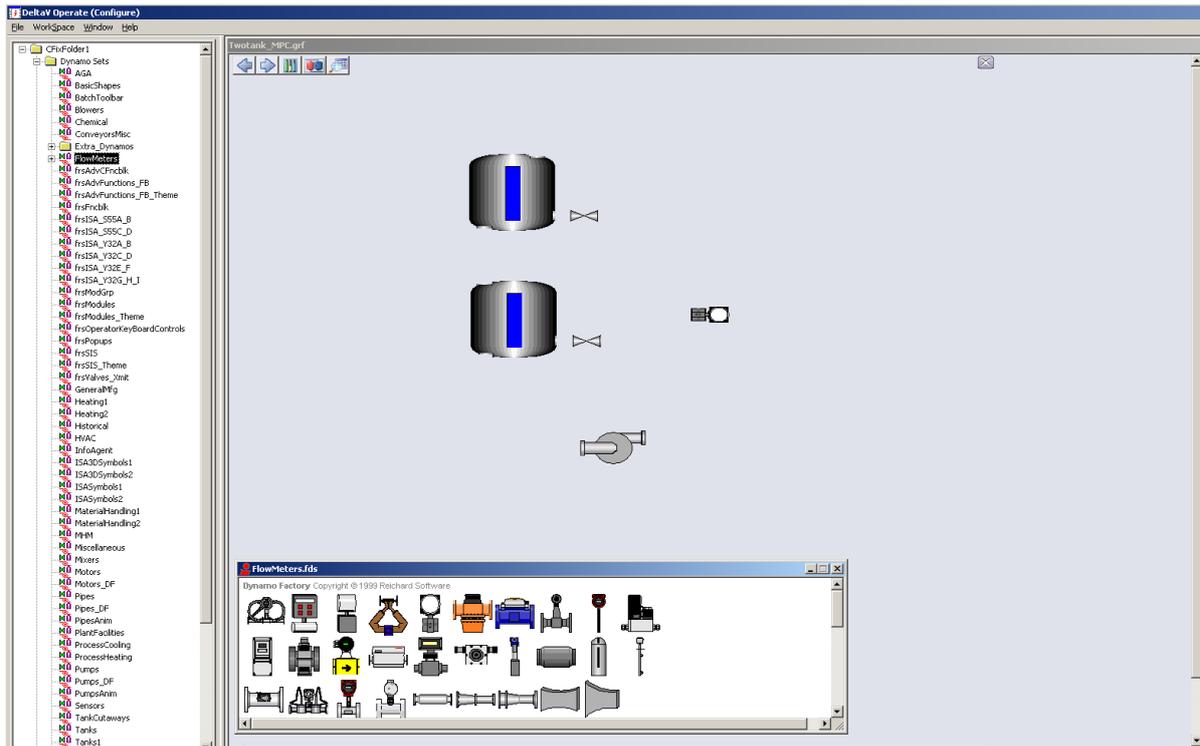
Figure 4.12 Adding a flow transmitter to the picture interface.

Now we need to draw a reservoir tank and add some pipes. The tank can be drawn e.g. using drawing tools in the toolbar. For the pipes, drag and drop some pipes into the drawing board and adjust them similar to as seen in see Figure 4.13. The pipes are found in Pipes_DF, under Dynamo Sets.
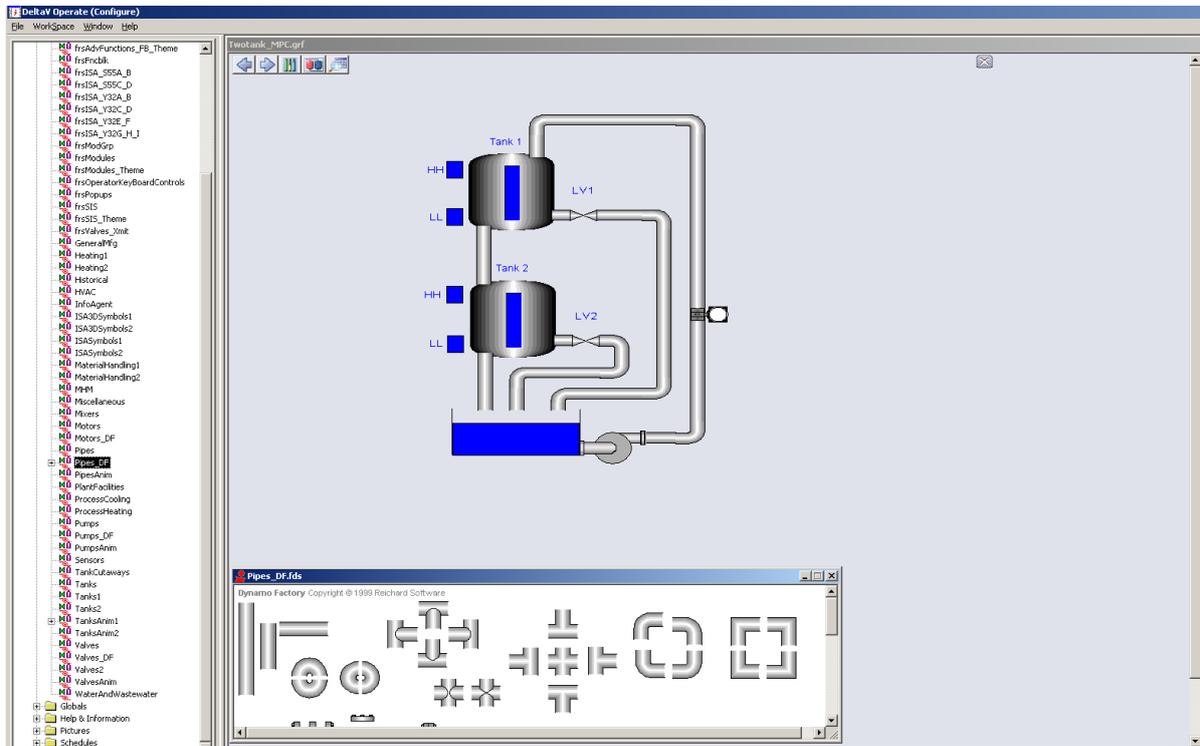
Figure 4.13 Adding a reservoir tank and pipes to the picture interface.

Finally, we need to add some alarm indicators. Choose four squares from the toolbar and place them next to the tanks, see Figure 4.14. These will be the High-High and Low-Low alarms for tank 1 and tank 2 respectively.
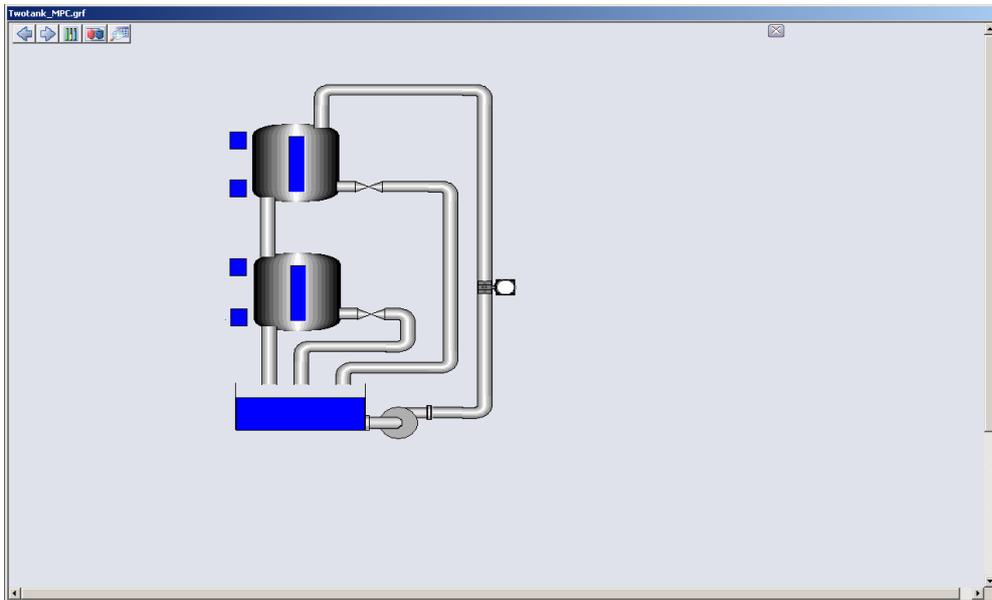
Figure 4.14 Adding alarm indicators to the picture interface.

Double click the upper square for tank 1. Similar as for the valves, check Foreground and click the button beside it in the Basic Animation Dialog. As in Figure 4.15, make sure Exact Match is checked. Delete all the rows and add two new rows. The color of the alarm at value 0 should be grey. At value 1 the alarm should be red.
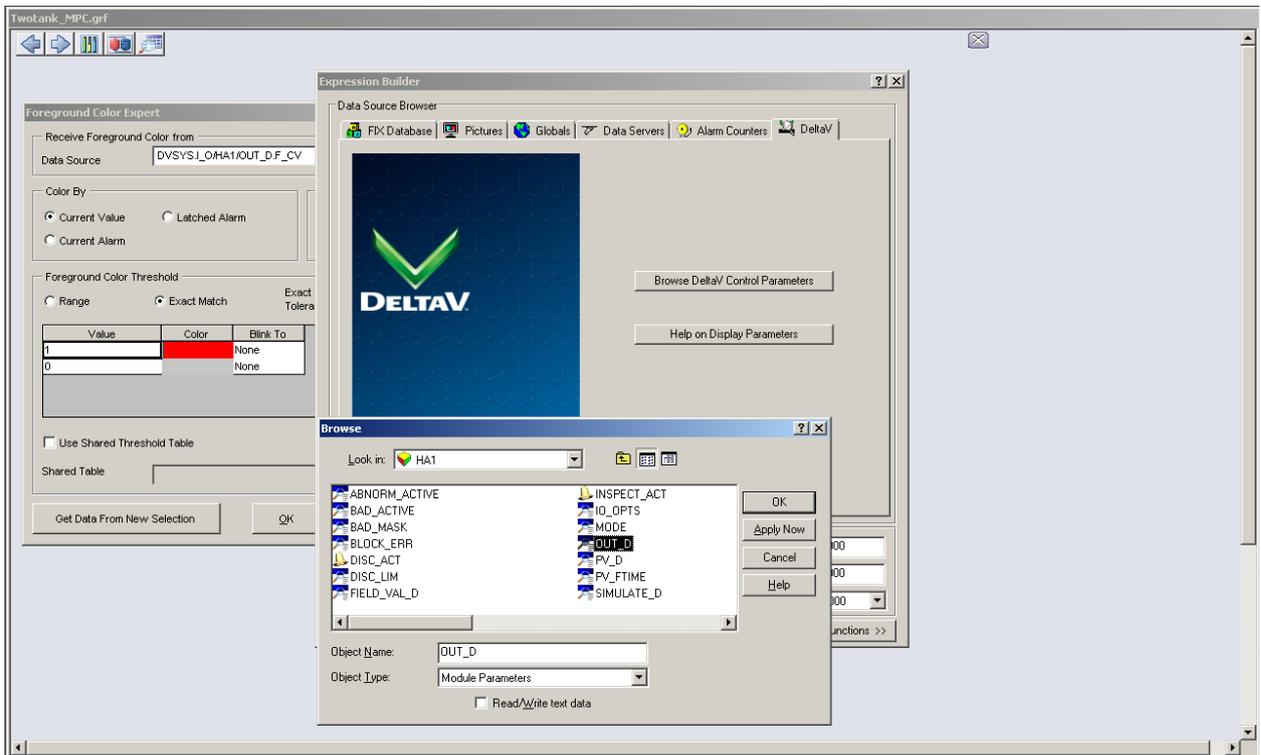
Figure 4.15 Adding link and color to the alarm.

Then press the [...] button, choose Browse DeltaV Control Parameters → TWO_TANK, I_O → HA1 → OUT_D → CV, see Figure 4.15, and press Ok until you return to your picture.

The alarm indicator will now change color from grey to red when it's activated.

Do the same with the lower indicator for tank1, except when you Browse DeltaV Control Parameters, choose LA1 instead of HA1.

Also, do the same for tank 2, except that you now choose HA2 and LA2 instead of HA1 and LA1 respectively.

4.3   Step 6: Creating names and datalinks

We start by making some names. We are going to make names for the MPC controller (CV, SP, MV and DV), tanks, valves, alarm indicators and flow transmitter. Here we use the tool bar above the picture. Press the big A and write the different variable names we need, see Figure 4.16.
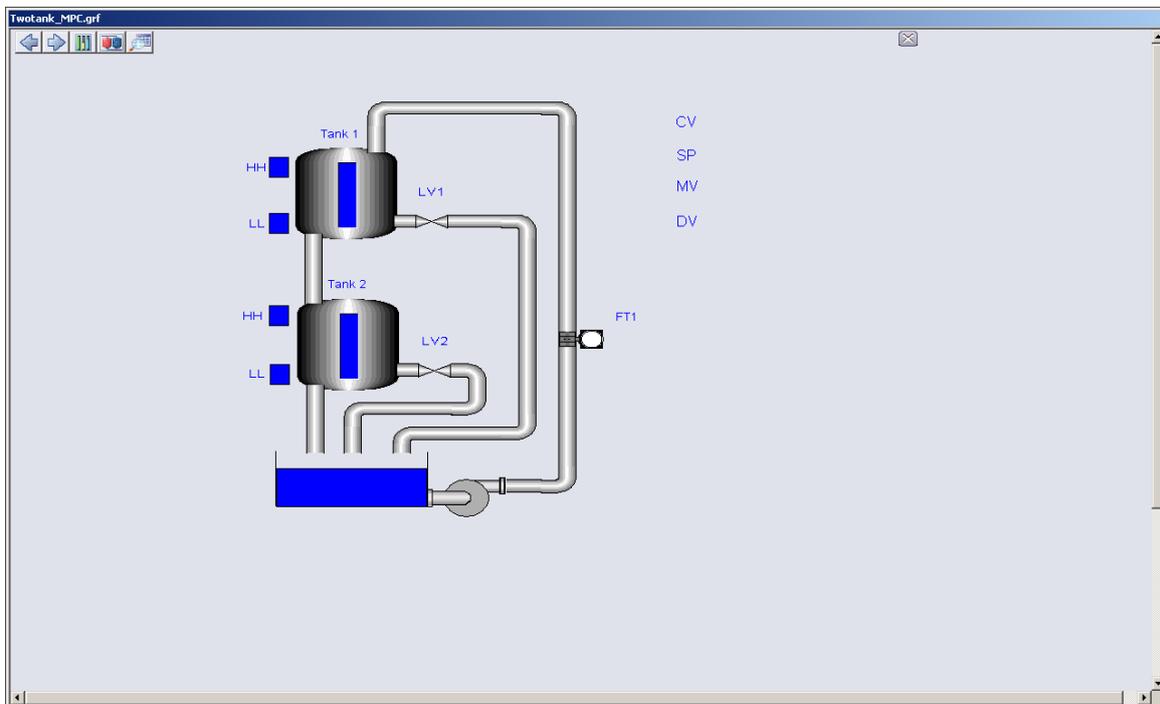
Figure 4.16 Adding names to the picture interface.

Next, we add datalinks connected to the CV, SP, MV, DV and FT1.

Let's start with the CV. Press [ABC 100] that you can find in the toolbar. Then press the [...] button. Browse DeltaV Control Parameters → TWO_TANK → MPC_LOOP_1 → MPC1 → CNTRL1 → CV. Then press ok until you get back the Datalink box. Here, change Type to Numeric and press ok. Place the variable next to CV, see Figure 4.17.
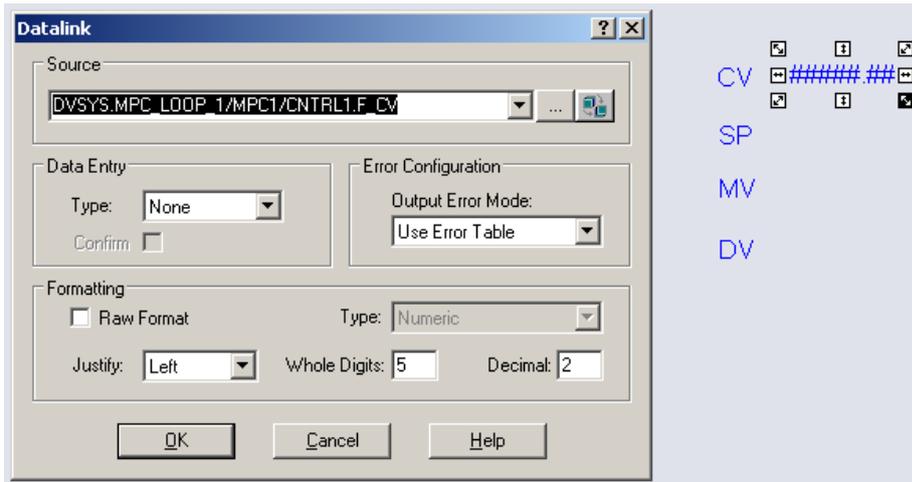
Figure 4.17 Creating datalinks for the variables.

Do exactly the same for SP, but choose SP1 instead of CNTRL1, and in Datalink box we need to choose in-place on the data entry to be allowed to change the variable. Place it next to SP.

For the MV, do exactly the same procedure as we did with SP, except that we choose MNPLT1. Place the variable next to MV.

For the DV, do exactly the same procedure as when we did with CV, except that we choose DSTRB. Place the variable next to DV.

The only datalink left is the FT1. From the Browse DeltaV Control Parameters, then choose TWO_TANK → I_O → FT1 → OUT → CV. Place the variable below FT1.

Your picture should now look similar to Figure 4.18.
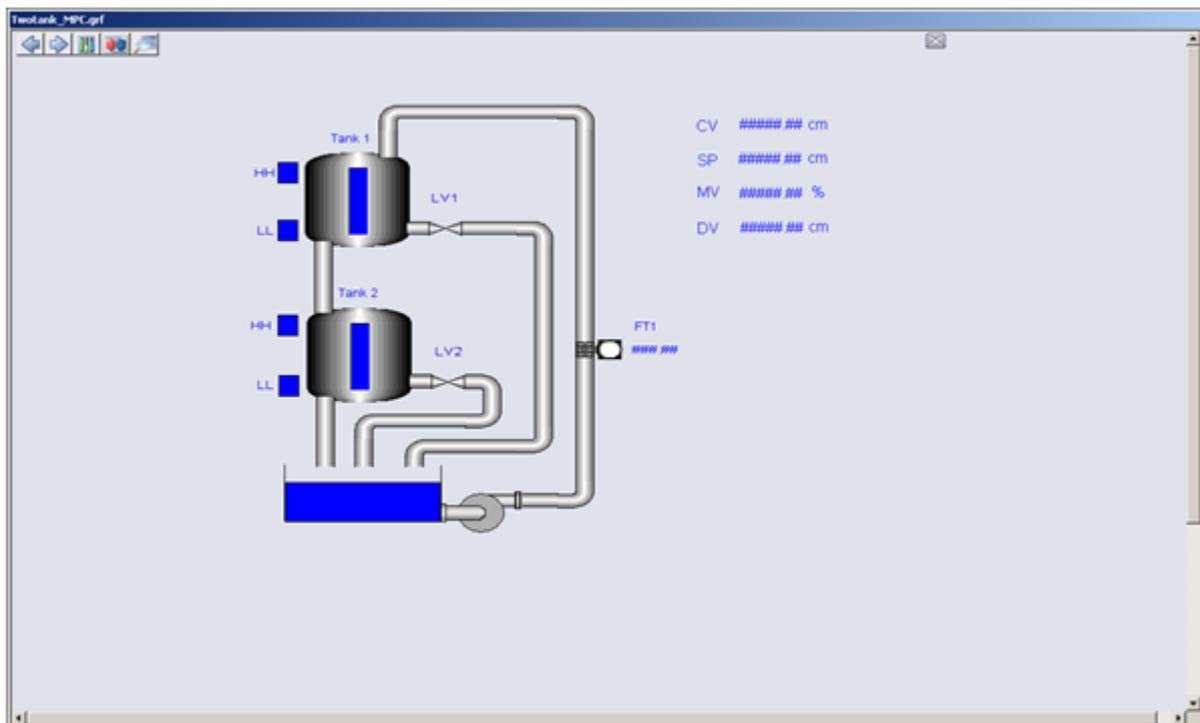
Figure 4.18 Picture interface with added datalinks.

4.4 Step 7: Creating faceplate- and MPC operator interface buttons

First we will make a button to open a faceplate to our controller when the program is running. First create the text Open Faceplate, then choose a circle from the toolbar and place it next to the text, see Figure 4.19.

Double click the circle. Under command make sure to activate click.

Double click on DeltaV Open Faceplate, press the ⬚ button and choose Browse DeltaV Control Parameters. Then choose TWO_TANK → MPC_LOOP_1 → MPC1 → CNTRL1 → CV and press OK until you are back to your picture.

Figure 4.19 is showing you how to configure the button to open the faceplate.
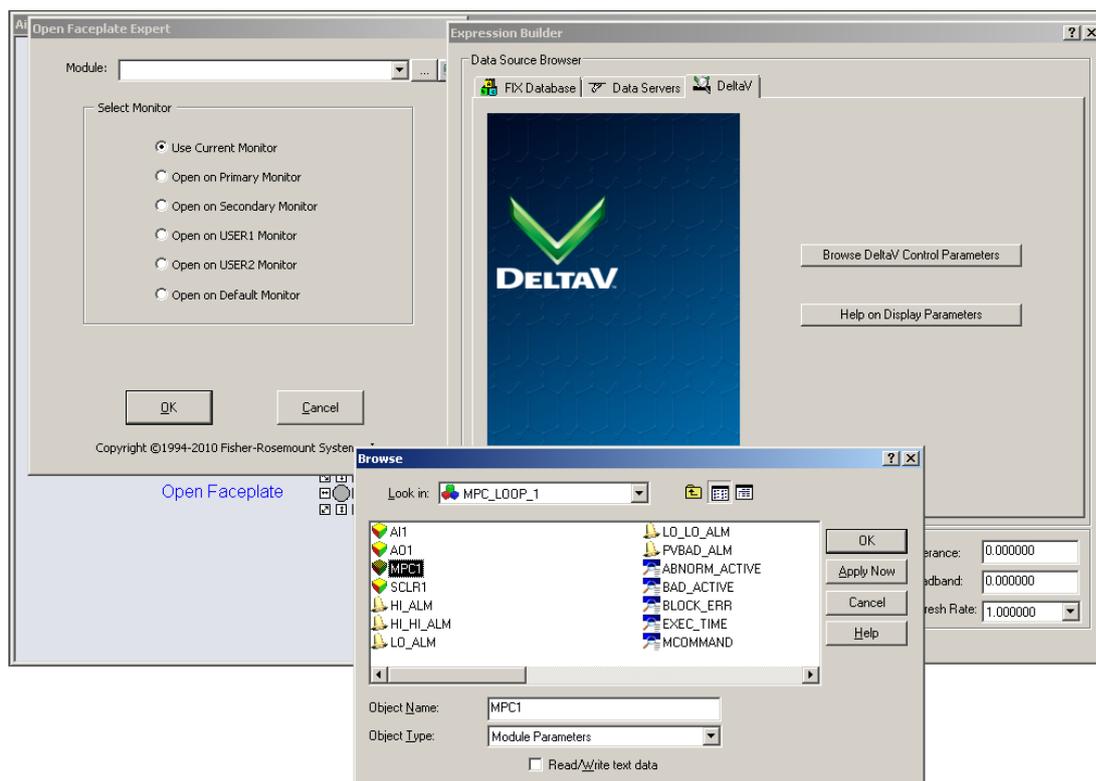
Figure 4.19 Creating a button to open the MPC-controller faceplate.

We have now made it possible to open a faceplate to our controller.

Also, we want to create a button that opens the MPC Operate interface. Choose Dynamo Sets and double click frsAdvCFncblk. Then drag and drop MPCOperMode into the picture, see Figure 4.20.
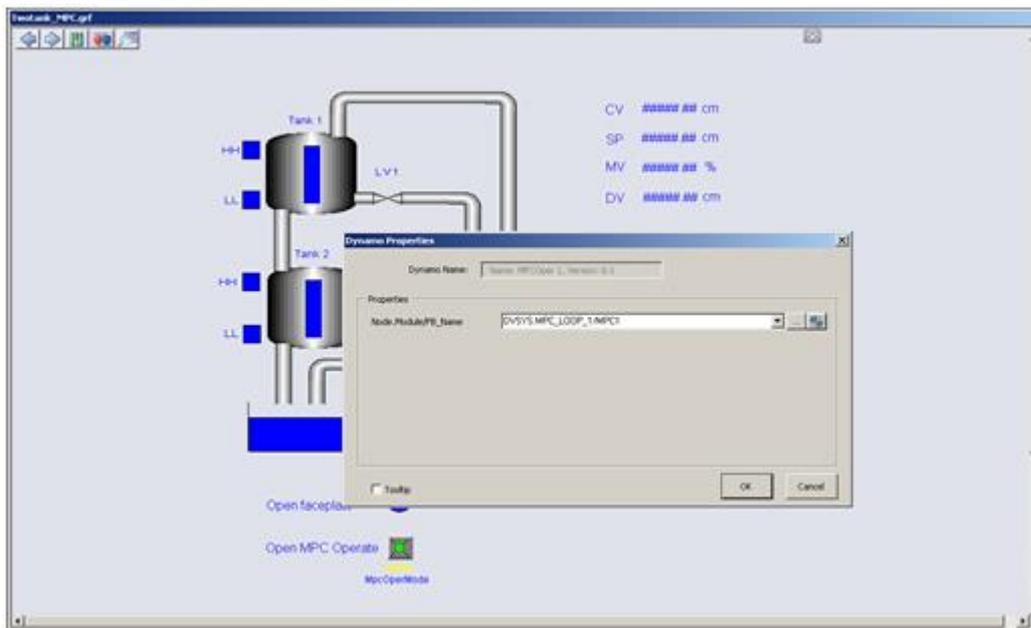
Figure 4.20 Button to open the MPC Operate interface.

A Dynamo Properties window appears. As for the faceplate press the [...] button and choose Browse DeltaV Control Parameters. Then choose TWO_TANK → MPC_LOOP_1 → MPC1 → CNTRL1 → CV and press OK until you are back to your picture.

You have now made the interface that can be used to control the temperature for the Level Tank. If you haven't already saved your picture then do this now by choosing Save As under File. Save the picture with yourname.grf.

5 OPERATING THE TWO-TANK SYSTEM

To operate the Two-Tank system we need to physically connect it to DeltaV. Wire up the model as shown in section 3.1.

When the model is connected press Ctrl + w in the previous HMI picture you created to enable the run mode, DeltaV Operate Run. The model is now ready to be controlled.

The running application can be seen in Figure 5.1.
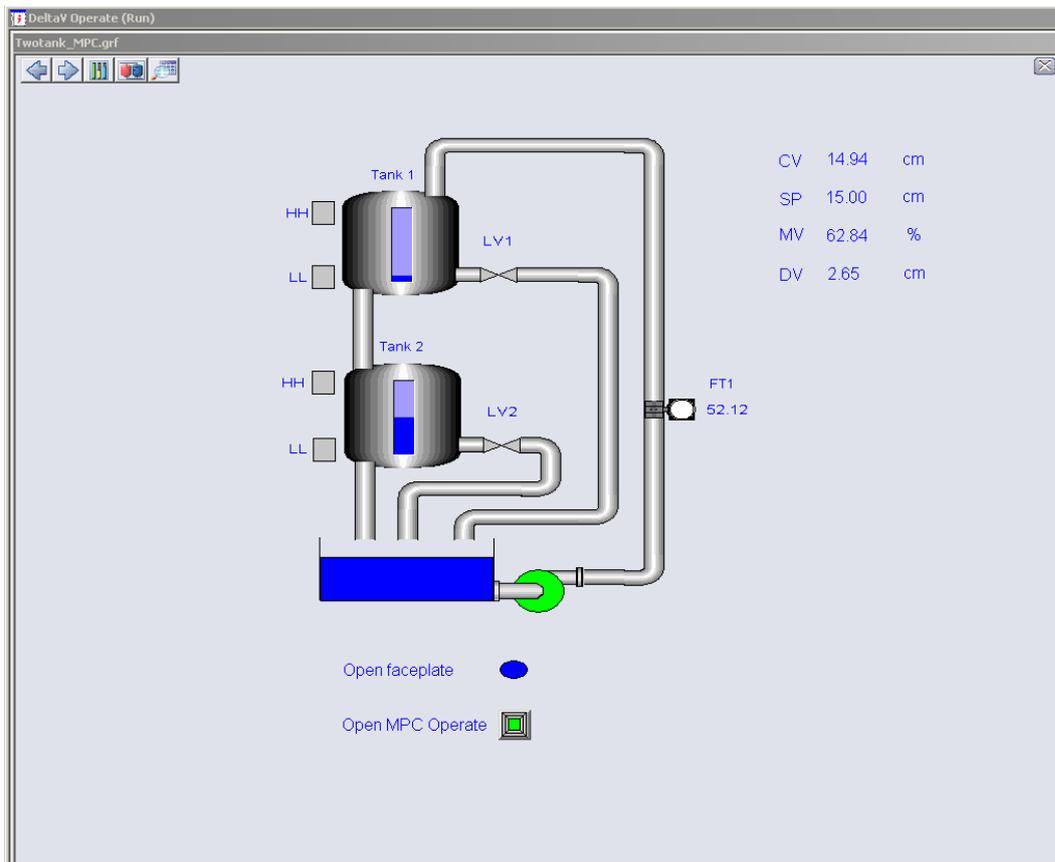
Figure 5.1 Running Level Tank system in DeltaV Operate Run.

To open the MPC Operate application just press the Open MPC Operate button you created. You can then control the Two-Tank as explained in section 3.

Press the Open Faceplate button to open the faceplate. Alternatively you can mark either SP or MV and then press the faceplate button in upper left corner. Here you have the options to control the process manually or set it to auto.

You can see the trend of the variables by pressing the button that looks like a graph in the faceplate. You will then see the CV, SP, MV and DV.

If you press the button with the magnifying glass in the faceplate, a detail window will appear. Here you can e.g. try to do further tuning changing the SP Filter Time. If your controller f.ex. has to fast control response, then by increasing the setpoint filter time the response will be relaxed.

Figure 5.2 shows the running model with its associated faceplate and detail window.

.
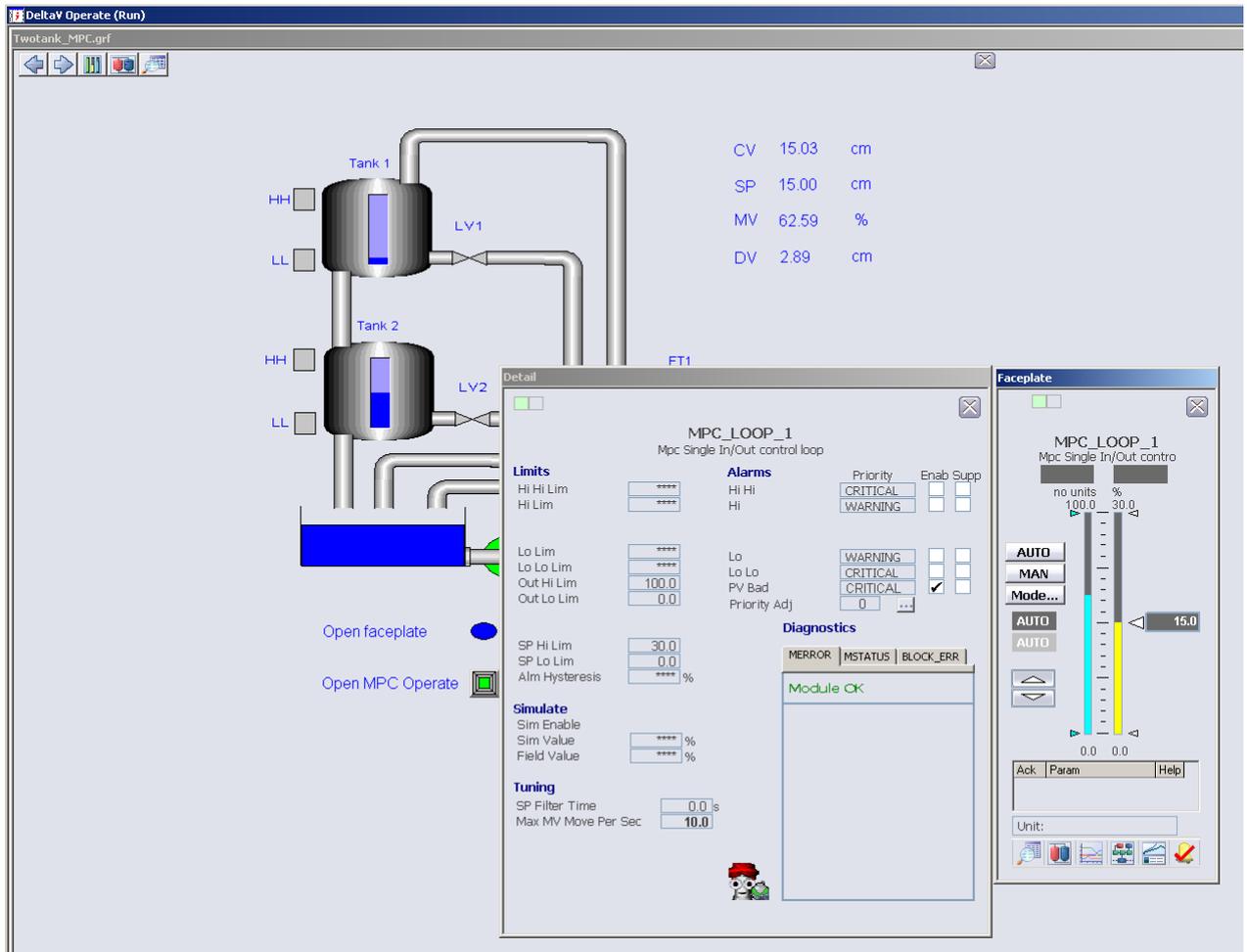
Figure 5.2 Running the Level Tank system in DeltaV Operate Run with associated faceplate and detail window.

Further tuning can be done changing the PM and PE by pressing the Generate Ctlr button in the DeltaV Predict application, and explained in section 3.3. Feel free to experiment and try to find values that might improve the performance.

In Auto mode, try to set the setpoint to 25- or 5 cm, starting from e.g. an operational area around 15 cm, and see what happens.

You may also want to add water to tank 1 manually as a sudden disturbance change (be careful not to overfill the system), and see the performance by the controller.