

S/W Tool Development – Water Industry

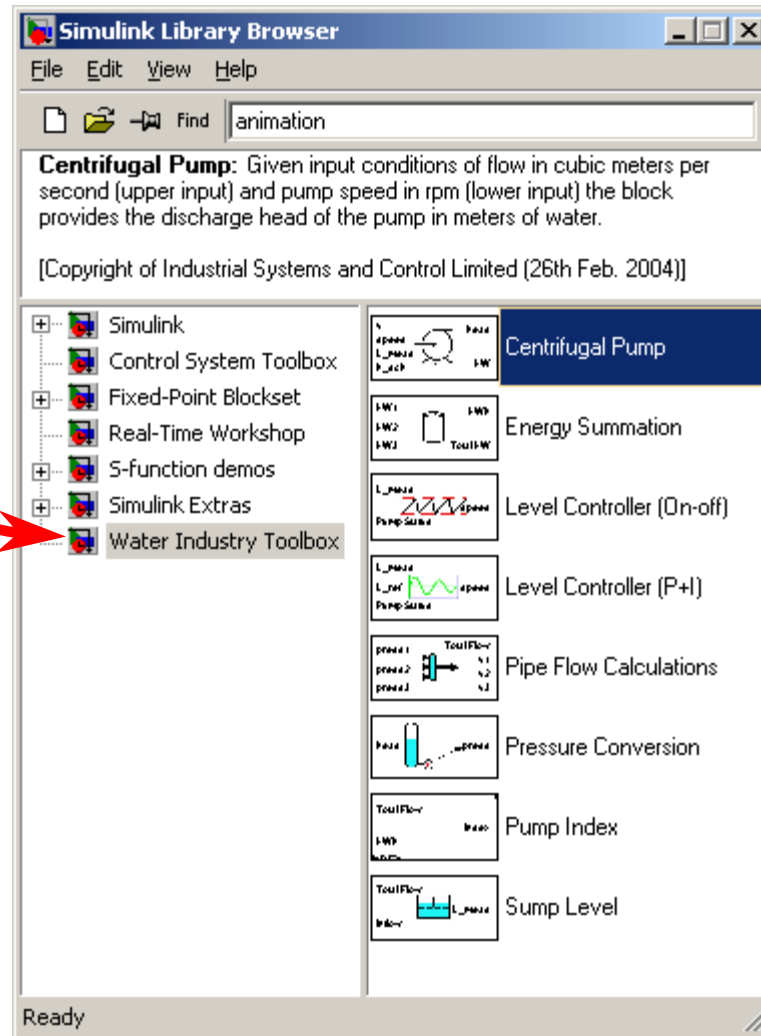


Simulation of Water Pumping Applications

Water Pumping Toolbox

Simulink Browser

“Water Industry Toolbox”
icon added to Simulink
Library Browser



“Water Industry Toolbox”
Blocks

Water Pumping Toolbox



Library

The screenshot displays the 'Library: Water_Industry_Library' window. The interface includes a menu bar (File, Edit, View, Format, Help), a toolbar with icons for file operations, and a 'Model Browser' on the left. The browser lists the following components:

- Centrifugal Pump
- Energy Summation
- Level Controller (On-off)
- Level Controller (P+I)
- Pipe Flow Calculations
- Pressure Conversion
- Pump Index
- Sump Level

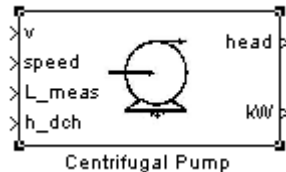
The main workspace contains several component icons with their associated variables:

- Centrifugal Pump:** Inputs: v, speed, L_meas, h_dch; Outputs: head, kW.
- Sump Level:** Inputs: Total Flow, Inflow; Output: L_meas.
- Pipe Flow Calculations:** Inputs: press1, press2, press3; Outputs: Total Flow, v1, v2, v3.
- Level Controller (P+I):** Inputs: L_meas, L_ref; Output: speed.
- Energy Summation:** Inputs: kW1, kW2, kW3; Output: Total kW.
- Pump Index:** Inputs: Total Flow, PUMP INDEX; Output: Index.
- Pressure Conversion:** Inputs: head; Output: press.
- Level Controller (On-off):** Inputs: L_meas; Output: speed.

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Ready 100% Unlocked

Centrifugal Pump Block



Block Parameters: Centrifugal Pump

Centrifugal Pump Discharge Delta H/static Head Calculator (mask)

Given input conditions of flow in cubic meters per second (upper input) and pump speed in rpm (lower input) the block provides the discharge head of the pump in meters of water and power consumed in kW.

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Parameters

Flow Data (m³/s) - Upper Input
[40 80 120 160 200 240 280 320 360 400 440 480 520 560 600]/1e3

Pump Speed (rpm) - Lower Input
[25 30 35 40 45 50]

Discharge Head (m) - Out
[4.2 5.85 8.1 10.6 13.3 16.45;3.9 5.6 7.75 10.25 12.9 16;3.56 5.2 7.3]

Power Consumed (kW) - Out
[5.5 8.8 14 21.0 29.8 41.5;5.55 9 14.4 21.5 30.36 42.6;5.6 9.3 14.8 21.5]

OK Cancel Help Apply

Help

File Edit View Go Web Window Help

Help Navigator

Product filter: All Selected Select...

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Begin Here

Simulink Masked Block: Centrifugal Pump Disch Add to Favorites

Using Simulink [Block Reference](#)

Centrifugal Pump Discharge Delta H/static Head Calculator

This block utilises a 2-D look-up table to provide the discharge head in meters of water, given block inputs of flow in cubic meters per second (input 1) and pump speed in rpm or Hz (input 2). Input 3 provides the pump inlet hydrostatic head. This is internally added to the delta hydrostatic head developed across the pump. The discharge hydrostatic head must also be provided (input 1) to be subtracted from the discharge head. After these summations the (pipe) discharge pressure is made available (output 1). A second 2-D look-up table provides the power that the pump requires for any flow and pump speed input conditions. The pump power in kW is available at output 2.

Parameter Entry for Centrifugal Pump



- Double click on the 'Centrifugal Pump' Block (Parameter window appears)
- Data is entered (by first clicking on the field) as individual values with a 'space' character between each entry. The total data set is placed inside '['' brackets.
- Flow data for each flow point selected from the target pump's H-Q characteristic curve is entered into the 'Flow Data' field (m points).
- Speed data for each speed given on the pump curve is entered into the 'Pump Speed' field (n entries).
- 'Discharge Head' data for a given flow point is entered as a ('space' character separated) set of n data points (for each speed) terminated with a ';'. This process is repeated for each of the m flow data points.
- The same entry procedure is used for entering the 'Power Consumed' data.

Block Parameters: Centrifugal Pump

Centrifugal Pump Discharge Delta H/static Head Calculator (mask)
Given input conditions of flow in cubic meters per second (upper input) and pump speed in rpm (lower input) the block provides the discharge head of the pump in meters of water and power consumed in kW.
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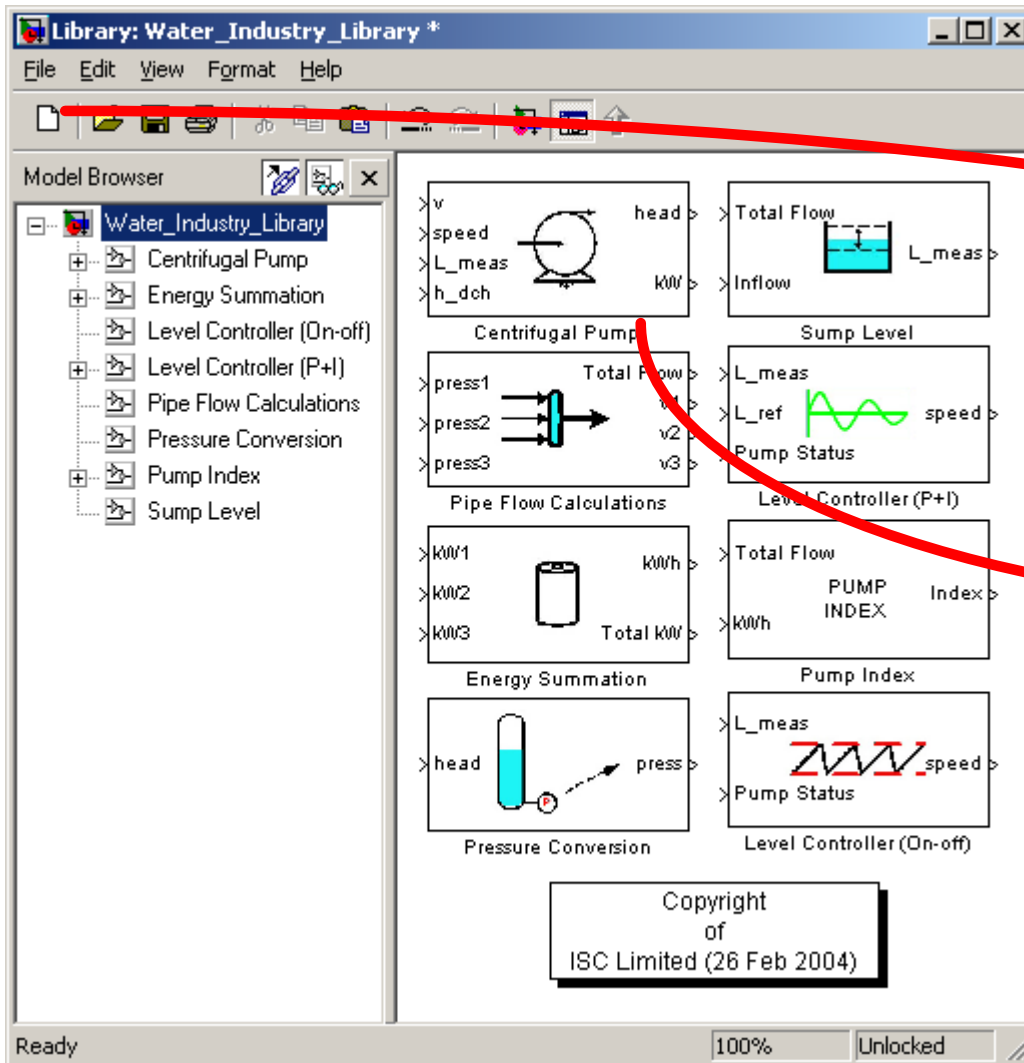
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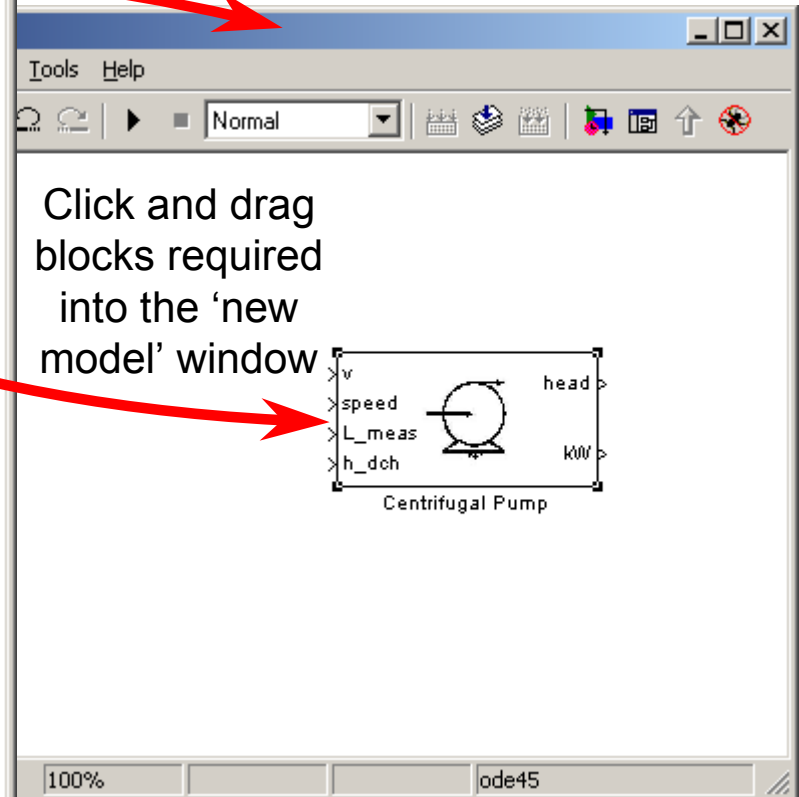
Power Consumed (kW) - Out
[5.5 8.8 14 21.0 29.8 41.5;5.55 9 14.4 21.5 30.36 42.6;5.6 9.3 14.8 2

OK Cancel Help Apply

Building a (Plant) Model



Create 'new model' by clicking on 'new model' icon

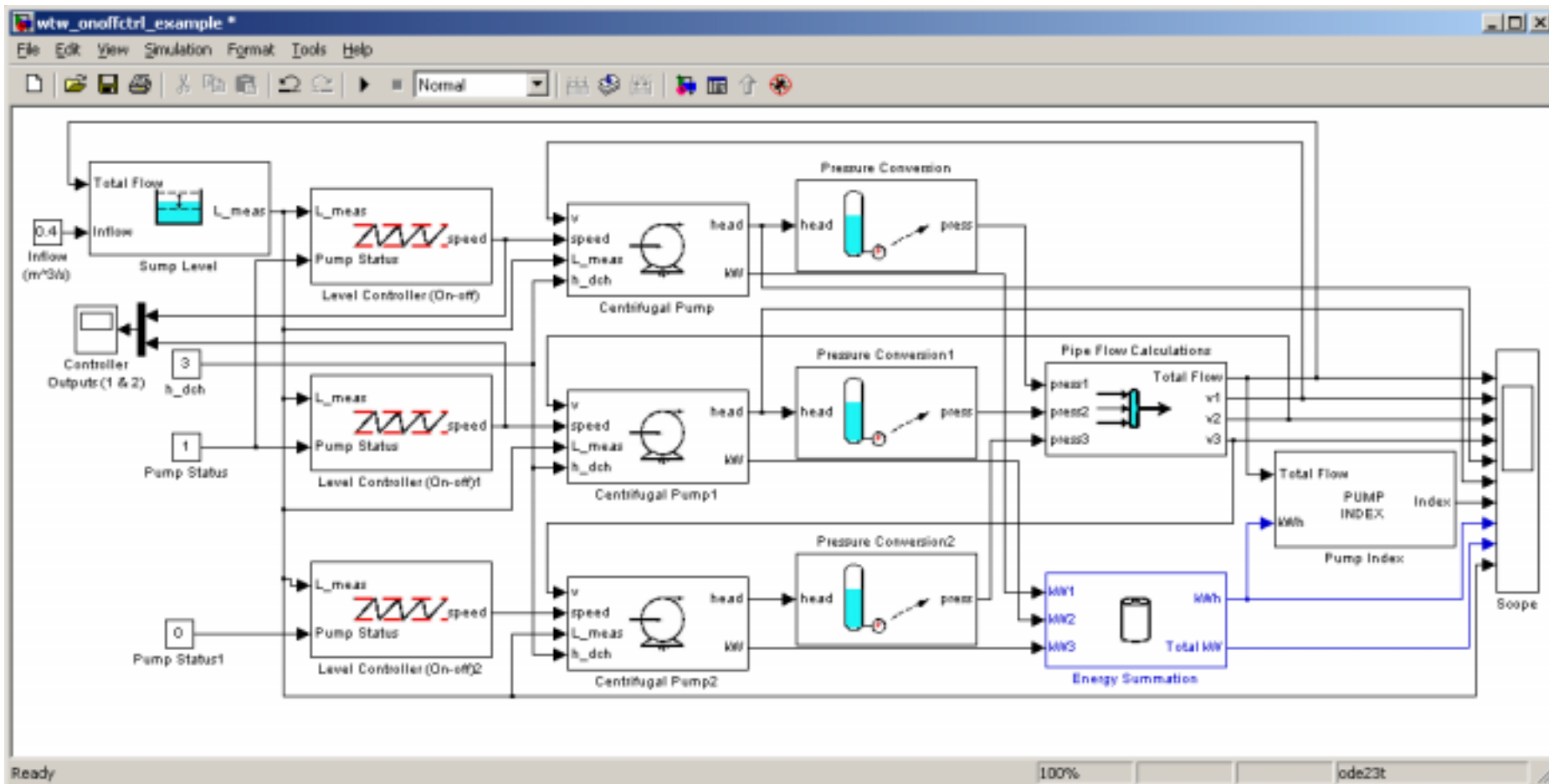


Click and drag blocks required into the 'new model' window

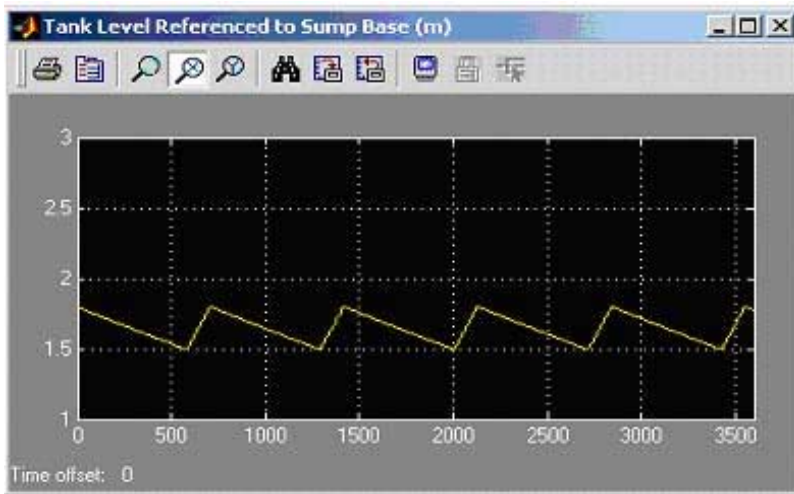
Constructed Plant Model



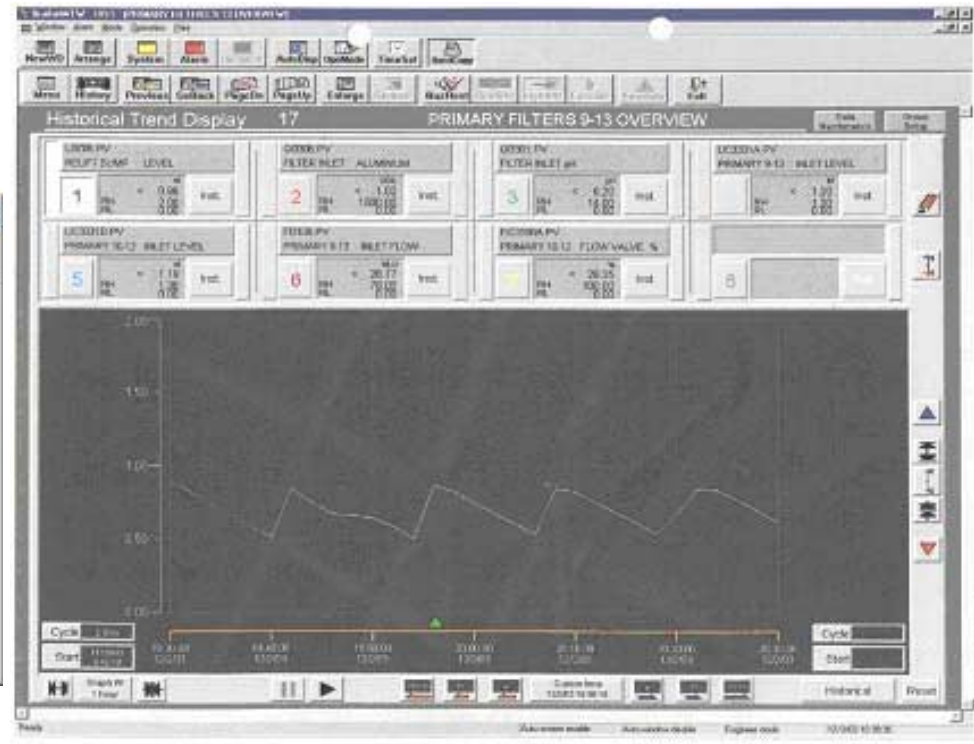
On-off Control Model



Actual Validation Results



Model Tank Level Trend



Actual Tank Level Trend

Modelling Exercise Findings



- Predicted Lift Efficiency:
 - ❑ Original on-off strategy – 24.7%
 - ❑ Single VSD pump – 33.3%
 - ❑ Dual VSD pumps – 69.4%
- Moving to Dual VSD pump would reduce energy consumption by 64.5% !!
 - ❑ due to lower pumping speeds
- Now implemented. Actual energy savings 65.1%