Water level regulation

The system is based on the water level regulation system of a tank studied in the thesis redacted by Vincent Cocquempot *"Contribution à la surveillance des systèmes industriels complexes"*. Some liberty has been taken with regard to the model developed by Mr. Cocquempot.

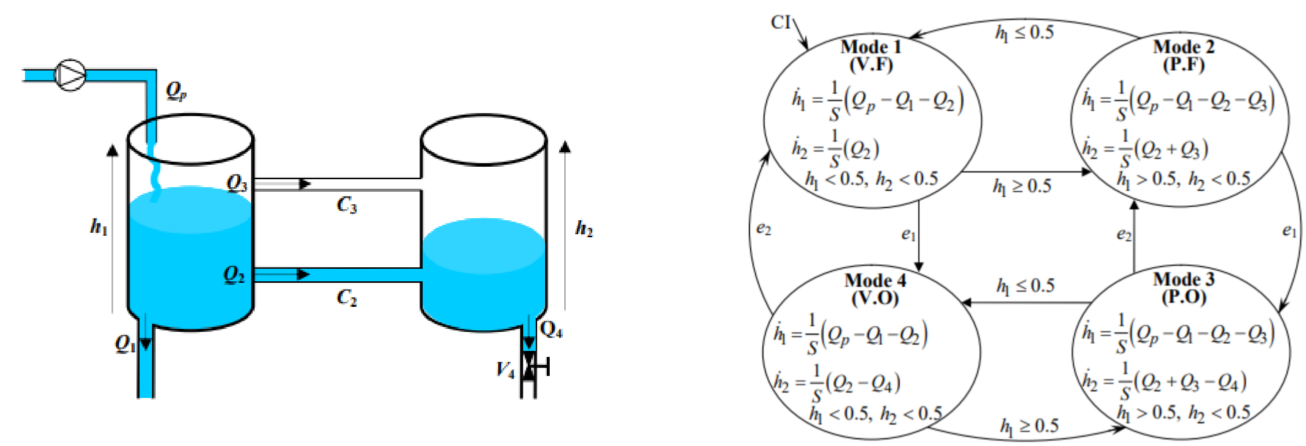

Figure 1: Schema of the system and its hybrid system modelisation (taken from Mr. Cocquempot's thesis)

The objective of the pomp is to maintain the water level of second tank in a set range. The pomp will supply or not the first tank depending on the water level state and its speed in the second tank. After a while, the valve V4 is activated for a few minutes. The state of the models are mainly defined by the water level of the first tank and the state of the valve V4. Figure 1 shows the modeling the physical system, the states are defined in the following way:

- **State 1**: The water level in the first tank h_1 is between the height of the conduits C_3 and C_2. The valve V_4 is closed.
- **State 2**: The water level in the first tank h_1 is higher than the height of the conduit C_3. The valve V_4 is closed.
- **State 3**: Same situation as State 2 except the valve V_4 is open.
- **State 4**: Same situation as State 1 except the valve V_4 is open.

Thus the transitions between the State 1 and 2 and between 3 and 4 are done by comparing the water level in the first tank with the height of the conduit C_3. The transition between the State 1 and 4 and between State 2 and 3 are done during the opening of the Valve V_4. This transition will be modeled by a timed guard.

In the model, the opening and the closing of the valve V_4 are modeled respectively by the vents e_1 and e_2. However Stateflow fave difficulties when it comes to generate and read rising edges. Thus e_1 and e_2 are modeled by a Boolean whose value will be 1 if the valve is open, 0 otherwise.

In order to establish the equations, we consider the flow is incompressible, stationary and perfect. Thanks to those hypothesis, the Bernoulli theorem can be used to establish the following relationships :

$$Q_1 = \alpha\sqrt{h_1}$$

$$Q_2 = \alpha \, sign(h_1 - h_2)\sqrt{h_1}$$

$$Q_3 = \alpha\sqrt{h_1 - 0.5}$$

$$Q_4 = \alpha\sqrt{h_2}$$

- Q_1 is the water flow

We inject those relations in the relation between the water level and the flow rates to establish the differential equations.

Q_p represents the flow of the water supply. Its value will be null or not depending on the evolution of the water level in the second tank.