Aeration and BOD mineralization in a pond

December 31, 2016

In this example we will model a batch system containing a aerobically degrading substrate that recieves dissolved oxygen through aeration. The parameters of the experiment are assumed to be as follows:

- **Area:** $0.2m^2$
- **Depth:** $0.3m$
- **Aeration model:** *Ratelimited*
- **Oxygen transfer rate coefficient:** $2day^{-1}$
- **Initial BOD concentration:** $25mg/L$
- **Initial DO concentration:** $7mg/L$
- **BOD mineralization rate, (k_d):** $10day^-1$
- **DO half saturation concentration:** $2mg/L$
- **BOD half saturation concentration:** $5mg/L$

Below are the steps to create the model:

1. Start GIFMod or create a new project

2. **Add constitients:** Add two constituents called BOD and DO by right-clicking on **Project Explorer→Water Quality→Constituents** and then clicking on **Add Constituents**

3. **Creating an external flux object:** Right-click on **Project Explorer→Water Quality→External Fluxes** and click on **Add External Flux**

4. Set the following properties for the external flux object that was just added:
   - **Name:** *Aeration*
   - **Coefficient:** *2 day^{-1}*
   - **Constituent:** *DO*
   - **Model:** *Constant rate*
   - **Saturation:** *8.5 mg/L*

5. **Add a pond:** A pond block is used to represent the batch system. From the top tool bar, click on the pond icon .

6. Set the following properties for the pond that was added.
   - **Bottom area:** *0.2m^2*
   - **Initial water depth:** *0.3 m*
   - **Constituent initial concentration:** *BOD=25 mg/L, DO=7mg/L*

Figure 1: Reaction network for the simple BOD model

- **External Flux:** *Aeration*

7. **Adding three reactions parameters:** Right click **Reaction Parameters** from **Project Window→Water Quality→Reactions** and click **Add Reaction Parameter**, repeat this two more times:
   - Rename the first parameter to k_d (BOD maximum decay rate) with value = 10 day^{-1}
   - The second to K_o (DO half saturation constant) value = 2 mg/L
   - The third to K_s (BOD half saturation constant) value = 5 mg/L

8. **Setting reactions:** Right click **Reaction Network** from **Project Window→Water Quality→Reactions** and click **Open reaction network window**. Set the reaction network as shown in Figure 1.

9. **Setting simulation duration:** **Project Window→Settings→Project Settings** Set the simulation duration to 20 days by setting the **Simulation end time** to Jan-20-1990.

10. **Running the model:** The model is ready to run. Click on the **forward run bottom** and wait until the simulation ends.

11. **Inspecting the results:** Right-click on the block identified as **Pond (1)** and choose **Plot Water Quality Results→DO**. Similarly check the BOD results. The graphs should look like figure 2.

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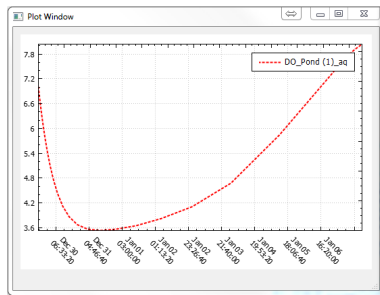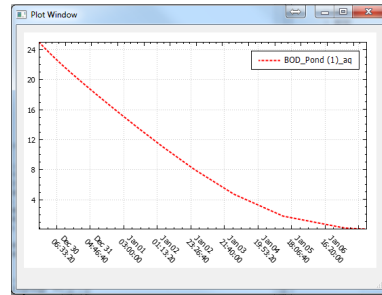
Figure 2: Temporal variation of a) DO and b) BOD in the simple batch test with aeration example