

Component specification

*Data format: excel file.

Software component:

Goal 1: dissolved methane calculation

1. Pandas for reading excel

data=pd.read_excel (file path)

2. Selecting methane potential data

Input: array over time

Columns: "COD", "BOD"

Index: Time in days

Unit of values: mg BOD or COD/L

Output: array over time

Save data and name as df1

3. Methane conversion from COD and BOD.

Input: df1, array over time

methane=0.35*df1

Unit of values: L methane/L

Output: array over time

Save data and name as methane

4. Selecting factors influencing methane dissolved

Input: array over time

- a. Temperature (temperature will usually be monitored in the wastewater treatment plant)

Columns: "temperature"

Index: Time in days

Unit of values: °C

Else if function to determine different temperature influencing produced methane dissolved in water.

Output: array over time, the temperature will be converted to value which is the portion of dissolved methane in the liquid.

Save data as df2

- b. Salinity (salinity might not be included in the wastewater treatment plant)

Columns: "salinity"

Index: Time in days

Unit of values: %

Else if function to write how different level of salinity influencing dissolved methane.

Output: array over time, salinity will be converted to value which is the portion of

dissolved methane in the liquid.

Save data as df3

- c. Combine the result of temperature and salinity for dissolved methane modified parameters.

Input: d2, d3, array over time

$df4 = df2 * df3$

Output: array over time

5. Choosing the minimum methane for the least methane produced by the wastewater.

Input: df4, array over time

Else if function for choosing which methane produced by COD or BOD is smaller.

Columns: "COD", "BOD"

Index: Time in days

Unit of values: mL methane/L

Output: array over time

Save the result of COD or BOD as DM

6. Give suggestion of using N-DAMO process or not

Input: DM, array over time

Else if function: if dissolved methane is below certain value, print "Methane is not enough for N-DAMO."

If dissolved methane is above certain value, print "Please enter wastewater portion."

Output: Sentences

7. In another cell, there is a space for entering different portion of wastewater input with notes. Another space is for entering the volume of the second reactor.

Input: number

#This is portion of wastewater input, please enter the portion less than 1.

$PW = 1$

#This is the volume of the reactor 2

$VR = 1.2$

Wastewater influent amount

$WIA = PW * VR$

Output: number

Goal 2: nitrate consumption based on dissolved methane

1. Pandas for reading excel (This is another excel file for nitrate removal evaluation.)

`data=pd.read_excel (file path)`

2. Recalculate nitrate and nitrite concentration:
 - Input: array over time and number
 - Columns: "nitrate", "nitrite"
 - $(1-PW)*\text{nitrate}$
 - $(1-PW)*\text{nitrite}$
 - Index: Time in days
 - Unit of values: mg-N/L
 - Output: array over time
 - Save the result of nitrate and nitrite
3. Calculate nitrate removal by dissolved methane from the result of dissolved methane calculation.
 - Input: nitrate, nitrite and DM, array over time
 - a. Nitrate conversion to nitrite
 - $DM*N\text{-DAMO archaea reaction}$
 - b. Nitrite conversion to nitrogen
 - $(DM*N\text{-DAMO archaea reaction} + \text{"nitrite"})*N\text{-DAMO bacteria reaction}$
 - c. nitrate and nitrite subtracting to N-DAMO microorganisms reaction
 - Index: Time in days
 - Unit of values: mg-N/L
 - Output: array over time
 - Save the result of effnitrate and effnitrite
4. Visualization: plot the result of nitrate and nitrite residual after N-DAMO microorganisms reaction
 - Input: effnitrate and effnitrite, array over time
 - matplotlib.pyplot and plot for plotting
 - Output: Figure

Interactions to accomplish use cases

Goal 1: Interaction in dissolved methane calculation will give a sentence for preliminary evaluating if dissolved methane is enough in reactor 1 for N-DAMO process. If dissolved methane is not enough, there will be a sentence showing up to remind N-DAMO process is not available for this wastewater. If the dissolved methane is enough, there will be a note to let civil engineer to type the portion of wastewater and the volume of the reactor. As a result, the civil engineer should have basic python ability to read the code and type the information.

Goal 2: Interaction for the user and nitrogen removal potential by N-DAMO process is that the user can see the figure showing up in their screen to see the nitrate and

nitrite concentration apparently.

Preliminary plan:

1. Complete Goal 1

Task includes:

- a. Data collection in anaerobic process
- b. Background investigation: Dissolved methane relation with salinity and temperature.
- c. 1-month data for preliminary test
- d. 1-year data test
- e. Interaction of portion of wastewater set up.

2. Complete Goal 2

Task includes:

- a. Data collection in nitrogen removal process
- b. Background investigation: N-DAMO process.
- c. 1-month data for preliminary test
- d. 1-year data test