Standard Operating Procedure (SOP) for Electroflotation Device Operation and Current Density Calculation

# 1. Overview of the Electroflotation Device

The electroflotation device used in this experiment consists of an electrode array with two distinct configurations: inner and outer arrays. Each array contains electrodes of two different sizes:  
- Large Electrode: Has a larger surface area and acts as an anode or cathode depending on the operation phase.  
- Small Electrode: A smaller surface area counterpart to the large electrode.

## Inner and Outer Arrays:

- Inner Array: Contains both large and small electrodes that are utilized during the concentration process when the bacteria or other particles are concentrated at the surface level.  
- Outer Array: Also contains large and small electrodes but is only energized during the recovery process, where the concentrated particles are recovered from the surface.

# 2. Turbulence in Electroflotation Operation

- High Turbulence: In this mode, the electrodes are subjected to more vigorous agitation, which impacts the concentration and recovery efficiency.  
- Low Turbulence: Provides a gentler environment, used in different stages of the process to control the flow dynamics around the electrodes.

# 3. Concentration and Recovery Processes

- Concentration Process: Collimated microbubbles from the inner electrode array direct particulates into an inverted conical collection area in the lid of the cartridge.  
- Recovery Process: To eject concentrated particulates in the recovery step, both inner and outer electrodes are energized to force gas into a trap, displacing the sample from a port at the top of the collection area.

# 4. Diaz Paper Calculations Overview

In the paper by Diaz, the current densities were calculated to understand the electrochemical reactions occurring on the electrodes. This involved using specific frequencies, duty cycles, and voltages. For reference, Diaz used the following conditions:  
- High Turbulence:  
 - Frequency: 100 Hz  
 - Duty Cycle: 75%  
 - Voltage: 500 mA for concentration, 650 mA for recovery.  
- Low Turbulence:  
 - Frequency: 20 Hz  
 - Duty Cycle: 30% for concentration, 50% for recovery.  
 - Voltage: 300 mA for concentration, 600 mA for recovery.  
  
Note: While frequency, duty cycle, and voltage play a role in the electroflotation process, they have no direct influence on the calculation of current density. The current density solely depends on the current supplied to the electrodes and their surface area. Therefore, the code provided focuses on using the current and electrode area for calculating the current density.

# 5. Purpose of the Code

The code is designed to calculate the current density for both the concentration and recovery processes under varying conditions of turbulence. It considers the surface areas of both large and small electrodes in the inner and outer arrays. The final goal is to determine the current density using the input current and electrode surface areas.

# 6. Input Parameters for the Code

1. Electrode Areas (in cm²):  
 - Inner Large Electrode Area (A\_IL)  
 - Inner Small Electrode Area (A\_IS)  
 - Outer Large Electrode Area (A\_OL)  
 - Outer Small Electrode Area (A\_OS)  
2. Current (in mA) for Each Process:  
 - High Turbulence:  
 - Concentration Current (I\_HC)  
 - Recovery Current (I\_HR)  
 - Low Turbulence:  
 - Concentration Current (I\_LC)  
 - Recovery Current (I\_LR)

# 7. Calculation Process

## Concentration Process:

- Step 1: The code calculates the current density for both the inner large and inner small electrodes.  
- Step 2: The formula used is:  
 - For the inner large electrode:  
 Current Density = Current (I) / Inner Large Electrode Area (A\_IL)  
 - For the inner small electrode:  
 Current Density = Current (I) / Inner Small Electrode Area (A\_IS)

## Recovery Process:

- Step 1: For the recovery process, the code considers both the inner and outer electrodes.  
- Step 2: The combined area for both large and small electrodes is used in the calculation.  
 - For the combined large electrodes:  
 Current Density = Current (I) / (Inner Large Electrode Area (A\_IL) + Outer Large Electrode Area (A\_OL))  
 - For the combined small electrodes:  
 Current Density = Current (I) / (Inner Small Electrode Area (A\_IS) + Outer Small Electrode Area (A\_OS))

# 8. Using the Code (Step-by-Step)

1. Run the Code: Start the Python script. A window will pop up with fields for entering the necessary parameters.  
2. Input Electrode Areas: Enter the areas for the inner large, inner small, outer large, and outer small electrodes in their respective fields.  
3. Input Current Values: Provide the currents for each turbulence and process combination:  
 - High Turbulence Concentration Current  
 - High Turbulence Recovery Current  
 - Low Turbulence Concentration Current  
 - Low Turbulence Recovery Current  
4. Click 'Calculate Current Density': After entering all the values, click the 'Calculate Current Density' button.  
5. View Results: The results will be displayed in a table format in the window, showing the calculated current densities for each process. The table includes detailed calculations for each entry.

# 9. Output Interpretation

- The output displays the current densities for both concentration and recovery processes in mA/cm² for each electrode type.  
- Additionally, the output includes the range of current densities calculated, showing the highest and lowest values.

# 10. Important Notes

- Frequency, Duty Cycle, and Voltage: These parameters, mentioned in Diaz’s paper, affect the electroflotation process but are not directly used in the current density calculation. The code strictly focuses on the current supplied and the electrode surface area.  
- Data Persistence: The code saves the input values for future use. The next time you run the script, it will load the previously entered values, simplifying subsequent calculations.