Eicosapentaenoic acid (EPA) production using *Phaeodactylum tricornutum*

**Background Information**

**Objective**: Design a process to produce Eicosapentaenoic acid (EPA) using the algae strain UTEX 640 *Phaeodactylum tricornutum*

**Bioreactors**: Green Wall Panel (GWP) photobioreactors

**Production Rate**: 2678 kg/year

**Plant Location**: Northern Thailand

**Market Price of EPA**: $22,800/kg at 97% purity

**Global Market Share**
- $1.6 Billion (Year 2021)
- $3.82 Billion (Year 2029)

**What is EPA?**
- **Commonly used as a dietary supplement**
- Lowers the risk of cardiovascular diseases
- Help treat psychiatric & neurological disorders
- Promotes hair growth & prevents hair loss

**Environmental Analysis**

- **CO₂**: 7,017 ton/year < BC CO₂ emission limit (10,000 ton/yr)
- **Live Algae**: 5,700 ton/year - repurpose into animal feed
- **Contaminated biomass**: Cleaning & treating
- **Organic solvents**: 10,997 ton/year - external treatment
- **HCl**: 91 ton/year - neutralization before disposal

**Process Description**

1. **Biomass cultivation**
   - 6-day batch algae growth in 1375 Green Wall Panel photobioreactors

2. **Dewatering of biomass**
   - Product from the GWP photobioreactors is centrifuged, then filtered to remove 90% of water

3. **Cell lysing**
   - Methane, acetyl chloride and hexane are added to biomass sludge to lyse the cells, allowing for the extraction of EPA

4. **Cell debris removal**
   - After the solution undergoes liquid-liquid separation, it is centrifuged and filtered to remove the remaining cell debris

5. **EPA separation**
   - EPA is separated from leftover cell debris and from lysing chemicals using alternating affinity columns with the addition of acetone

6. **EPA purification**
   - EPA is purified further through the use of a flash column. Hexane and acetone are recycled back into the process

**Economic Analysis**

- **Net Present Worth**: $141.21 M
- **Annual revenue**: $58.91 M
- **Payback period**: 6 years
- **Plant life**: 30 years
- **Total CAPEX**: $48.16 M
- **Annual OPEX**: $47.16 M

**Plant Layout**

- **Bioreactors**
- **Tanks**
- **Control Room**
- **Reactors/Columns**
- **Separators**
- **Gas Vessels**
- **Cooling Water Tower**
- **Steam Tower**

**EPA Product**