Anaerobic Digestion of Dissolved Air Flotation (DAF) Sludge from Dairy Industries: Substrate Characterization and Technological Innovations

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Introduction

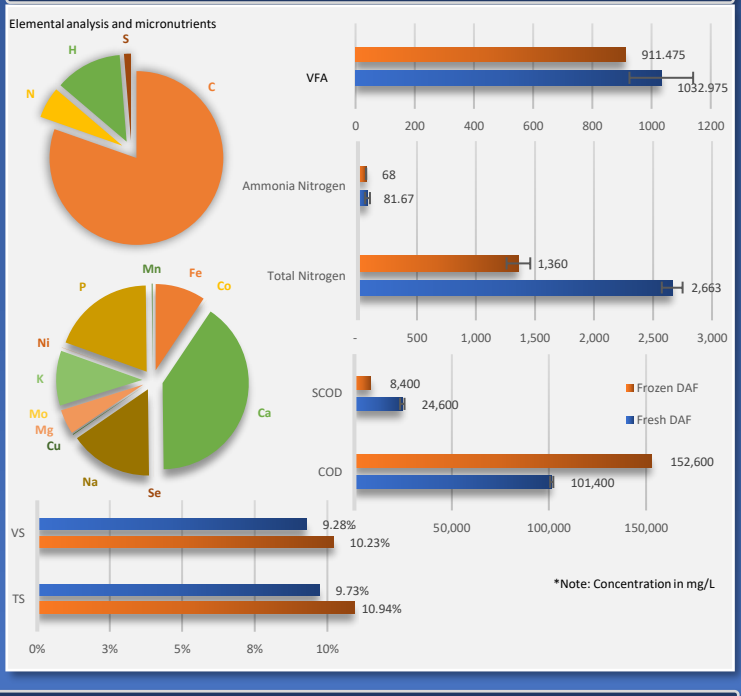
Dairy processing industries produce a significant amount of wastewater and sludge that have big potencies to be converted to biogas as a solution for greenhouse gases mitigation and renewable energy development.

Dissolved Air Floatation (DAF) is commonly used as a primary treatment to separate solids and reduce fats and proteins in wastewater. The side product is the DAF sludge that is rich in fats, oils, grease (FOG), proteins, and other organic materials.

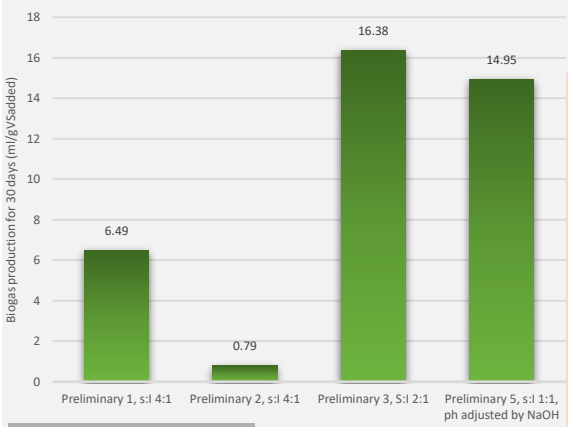
DAF sludge is a potential resource for recovery and reuse through anaerobic digestion (AD), however it poses some problems: High organic content, Odor, nutrient imbalance, high nitrogen (including ammonia) and Phosphorous, dewatering characteristics, fouling and scaling, insufficient C:N Ratio, low pH, microbial imbalance, foaming and scum formation.

Characterization is an important step to determine the matrix of the substrate to get the right treatment to optimize the AD process.

Characterization of the DAF sludge



Anaerobic Digestion of DAF Sludge



Inhibition Occurred → Solutions and how they can help:

Pretreatment	Anaerobic Co-Digestion	Additives	Reactor Configuration Modification
Digestibility	Nutrient and microbial balance	Nutrient recovery	Digestibility
Dewaterability	C/N ratio	Deodorization	Improve the rate limiting steps
Alkalinity	Feedstock availability	Electron transfer	Faster hydrolysis rate
Deodorization	Process stability	Buffering capacity-alkalinity	Reduce inhibition
	Dewaterability	Bacterial immobilization and attachment	
	Deodorization		

Pretreatment

Physical Pretreatment
- High pressure homogenization
- Microwaves
- Ultrasounds

Chemical Pretreatment
- Thermochemical (saponification)
- Enzymatic hydrolysis
- Bioaugmentation

Biological pretreatment
- Lipase
- Lipid degrading bacteria

Anaerobic Co-Digestion

High rate activated sludge

Manure

Waste activated sludge

Food Waste

Lignocellulosic Biomass

Additives

Micronutrient

Inert materials:
- Activated Carbon
- Biochar
- Bentonites
- Other clays

Conductive Materials

Reactor Configuration Modification

Thermophilic

Two-stage reactor

Dilution for pH adjustment

Different inoculum

All identified technologies to enhance the AD process of the DAF Sludge

Conclusion and Future Directions

- Characterization plays important role on determining the appropriate actions to enhance AD performance and found out the reasons of why inhibition occurred
- Changes occurred during the process of storing (freezing)
- List of actions to prevent inhibition and enhance the AD process are identified
- Selection of the most promising technologies will be performed

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