

School of Chemical, Biological  
and Environmental  
Engineering



# Effects of Chlorinated Methanes on the Reductive Dehalogenation of TCE

**Emma Ehret, Mohammad Azizian, Lewis Semprini**

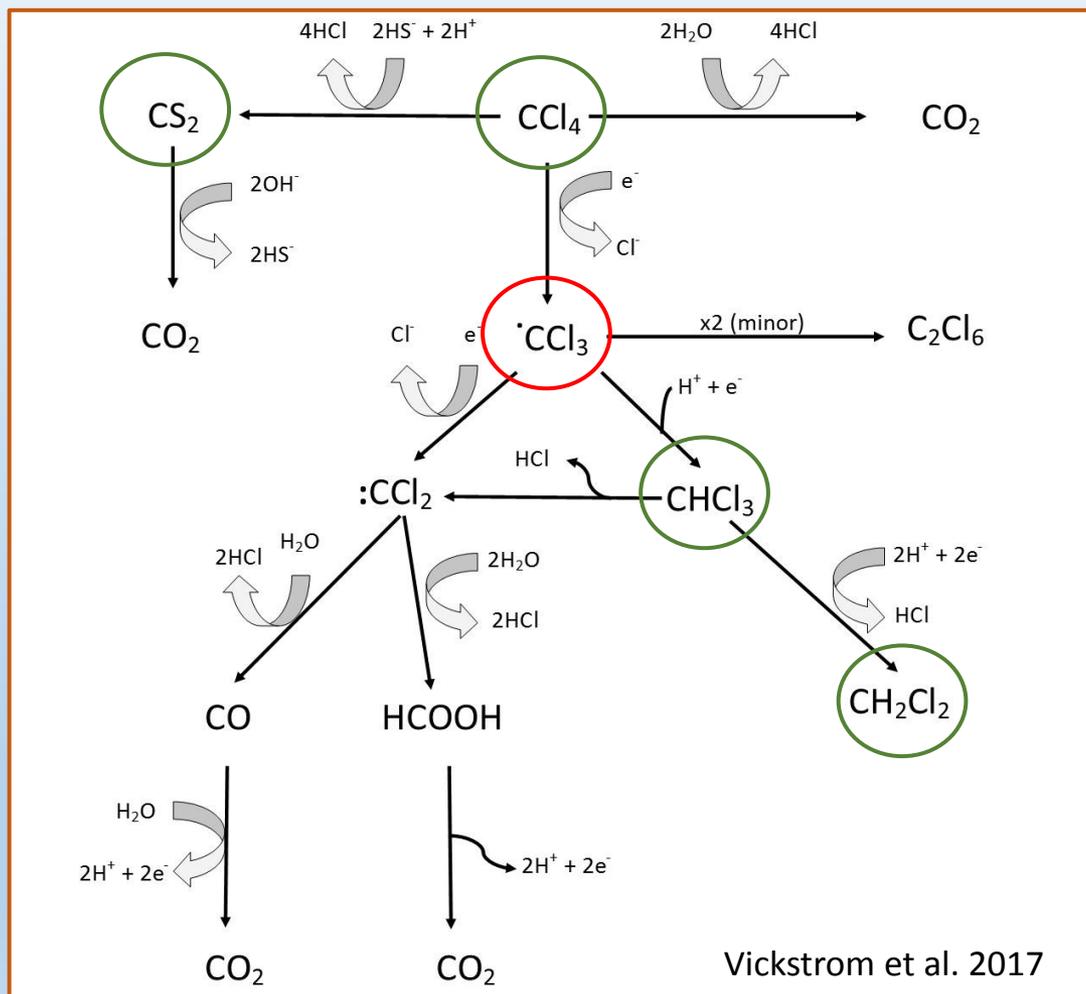
*Fourth International Symposium on Bioremediation and  
Sustainable Environmental Technologies*

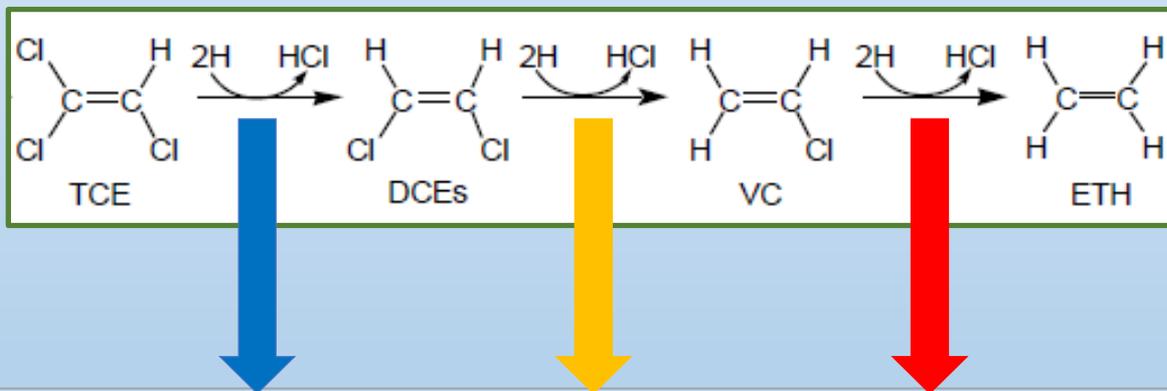
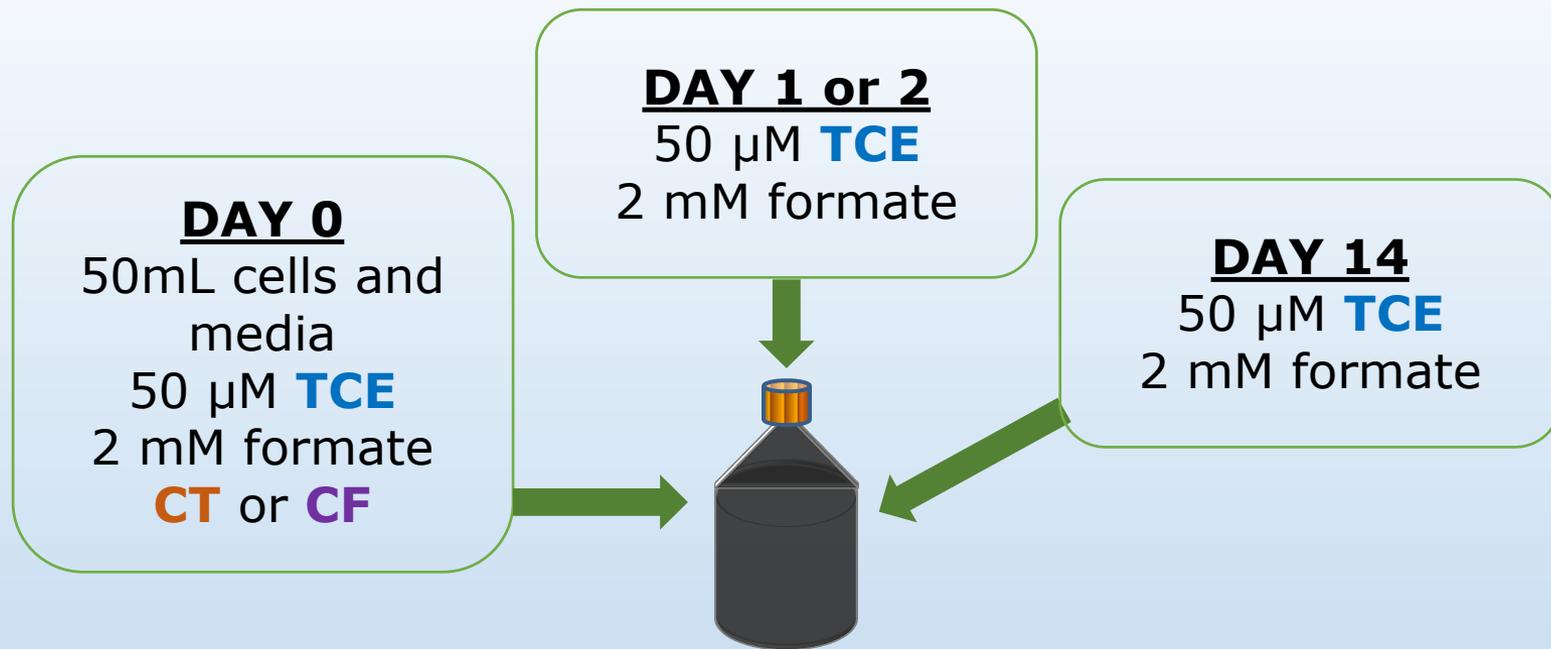
***Abstract #557***

Miami, Florida

May 24, 2017

# Carbon Tetrachloride (CT) Transformation

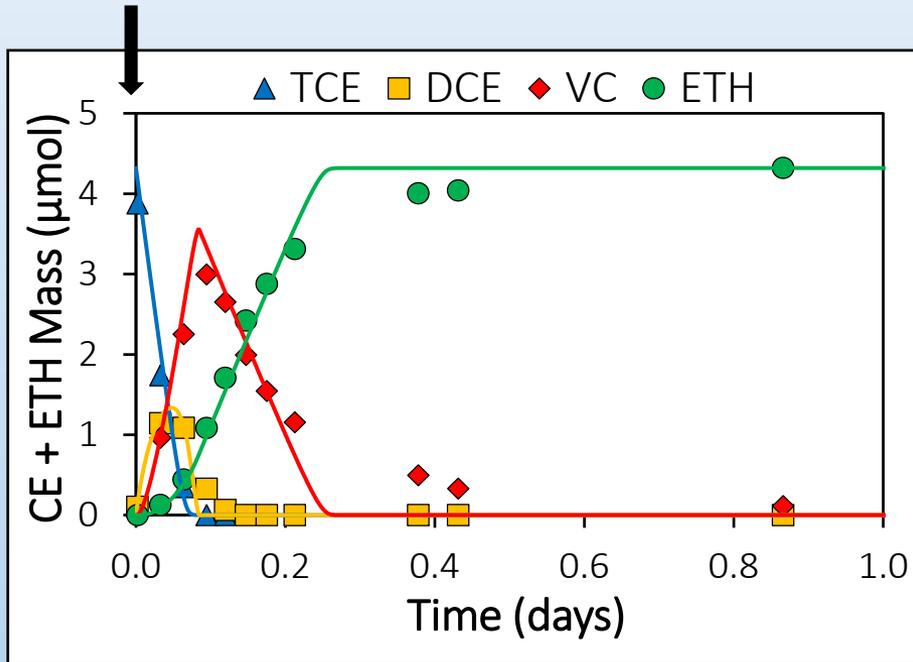




**Maximum utilization rate ( $k_m X$ ) for each addition =**  
***Proxy for microbial health***

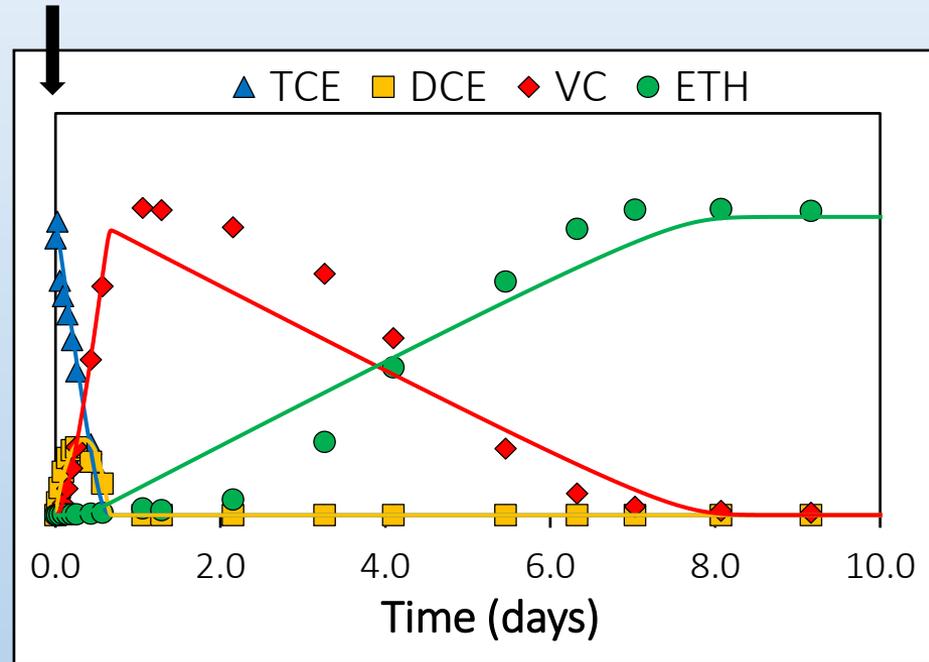
# Background: Time of Exposure to CMs

Day 0 addition



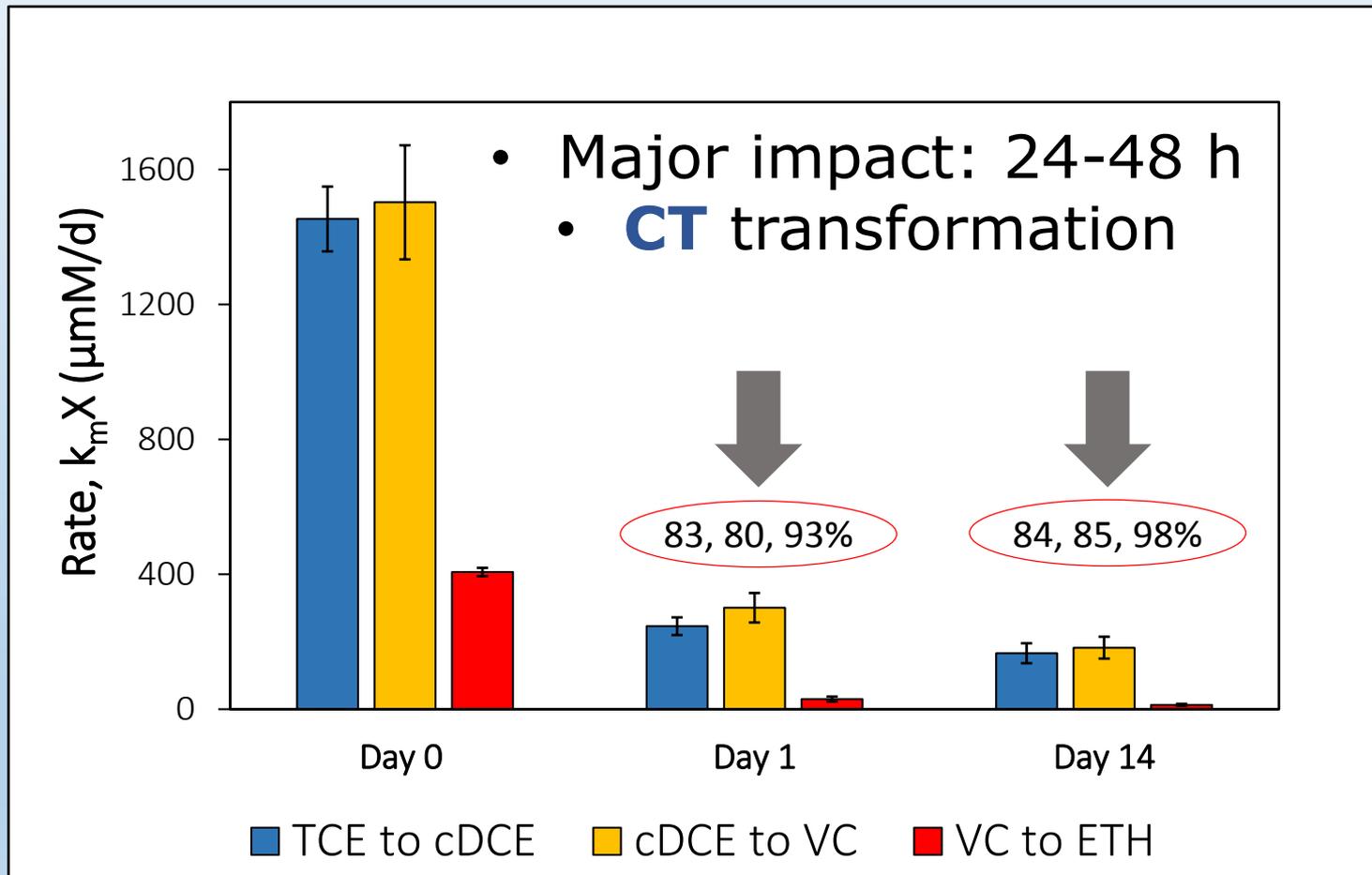
< 24 hr to  
ethene

Day 14 addition

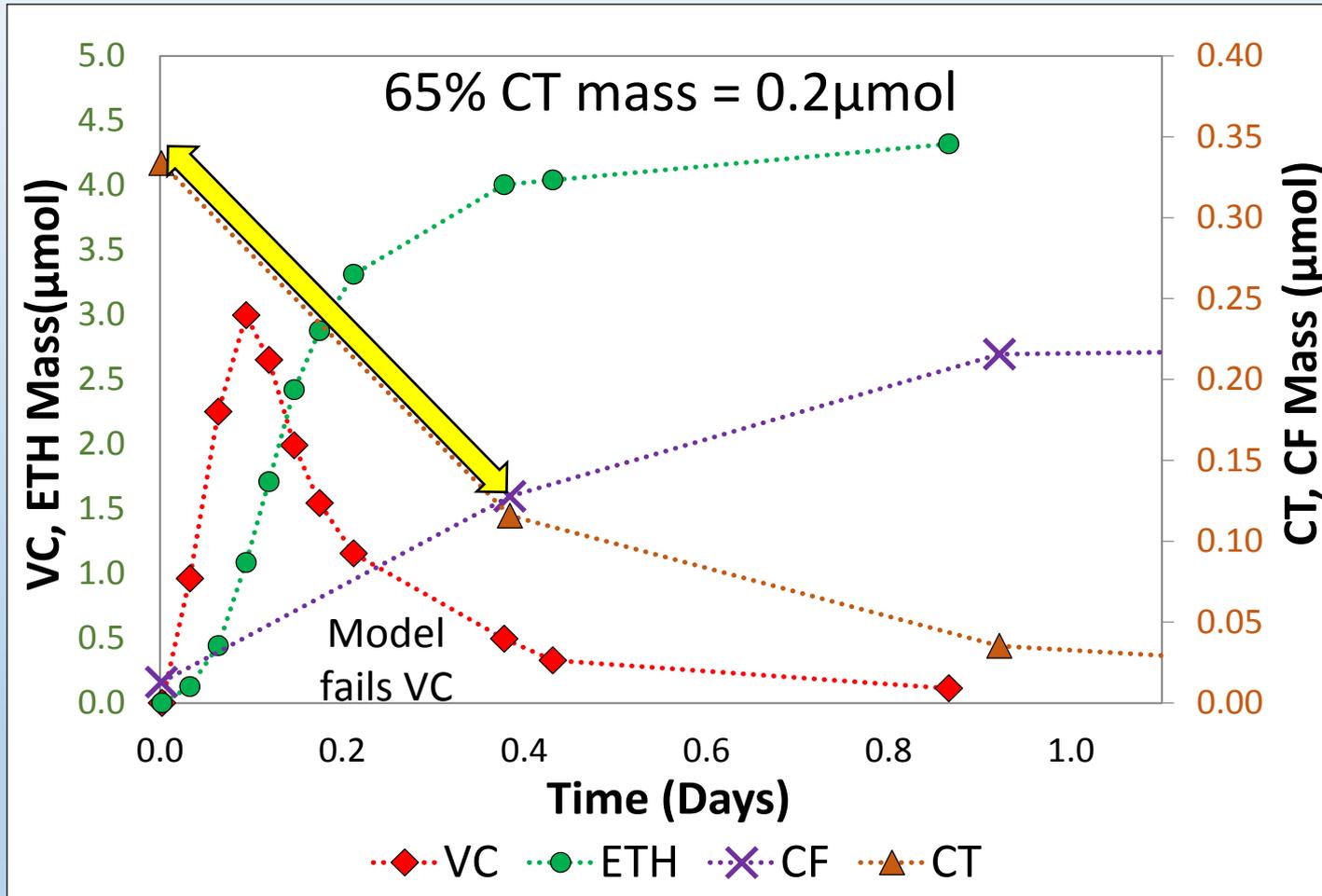


200+ hr to  
ethene

# Background: Time of Exposure to CMs



# First 24 hours: 2.3 $\mu$ M CT

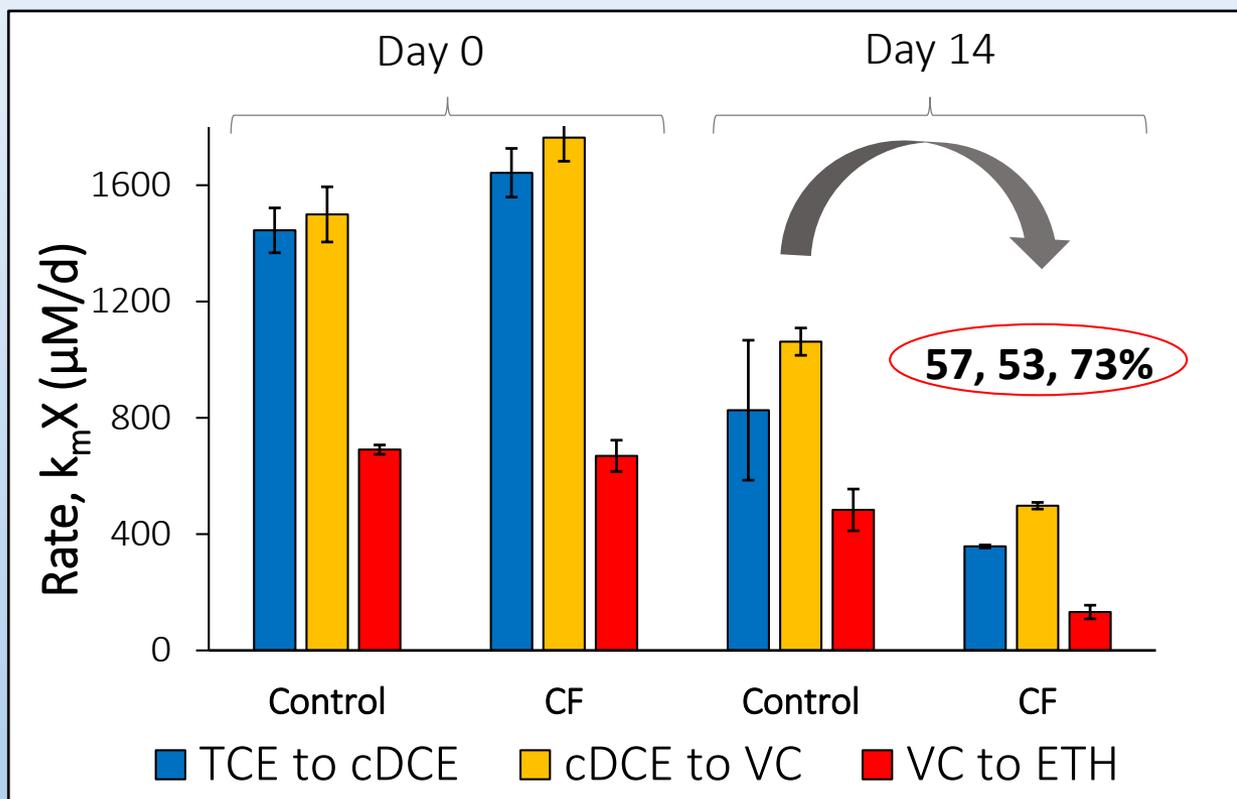


CT transformation!

# Research Questions

1. Does direct CF injection affect the system's CE rates and H<sub>2</sub> utilization the same as CT?
2. Are non-CF CE rate effects due to CT concentration or its transformation?
3. Does recovery differ between direct CF and CT exposed reactors?

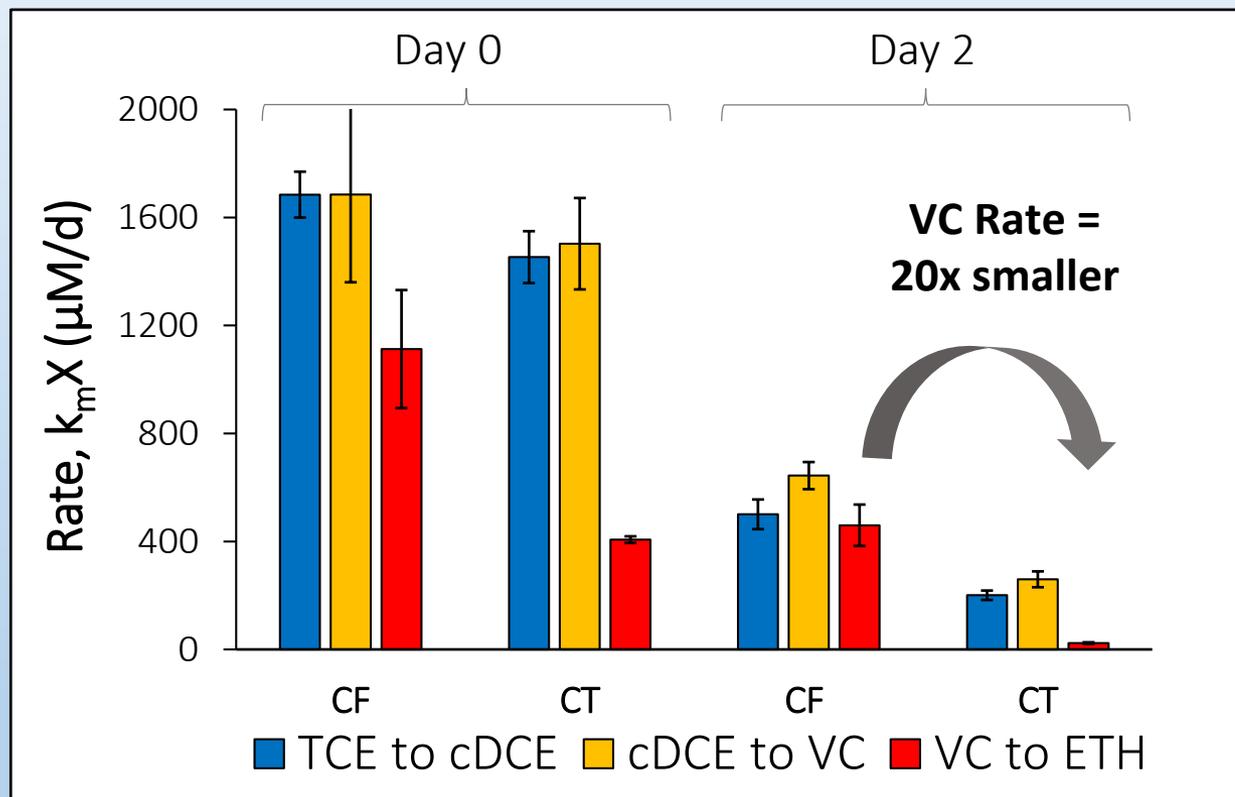
# 1. Direct CF Exposure: Long Time



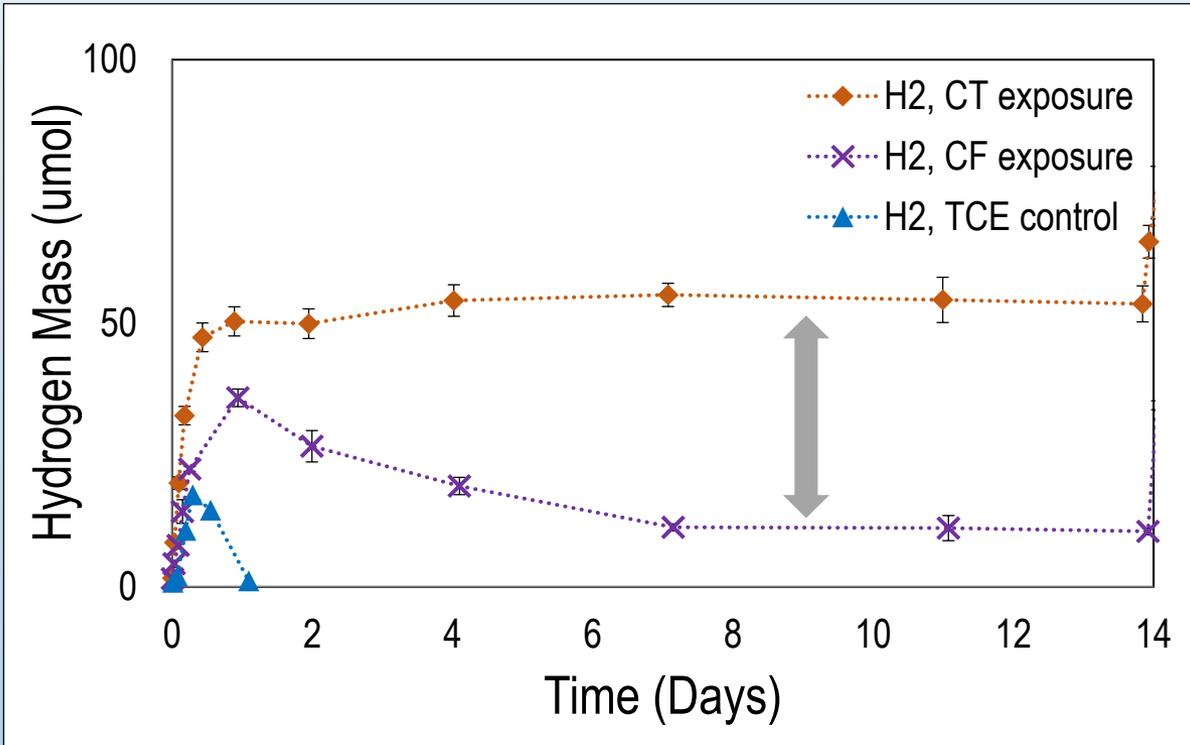
- Day 0: no difference from control
- Day 14: Rates decrease LESS than with CT treatment (84, 85, 98%)

# 1. CF Exposure: Short Time

- VC rate is 20 times higher at Day 2 **CF** treatment.
- Short time **CT** effects are NOT due to **CF** alone.



# 1. CT vs CF: H<sub>2</sub> Utilization



Formate to H<sub>2</sub>:



→



(Aulenta et al. 2006)

**CT** transformation inhibits **H<sub>2</sub>** uptake more than exposure to **CF**.

# Research Questions

1. Does direct CF injection affect the system's CE rates and H<sub>2</sub> utilization the same as CT?

NO. The full CM effect is not due to CF alone.

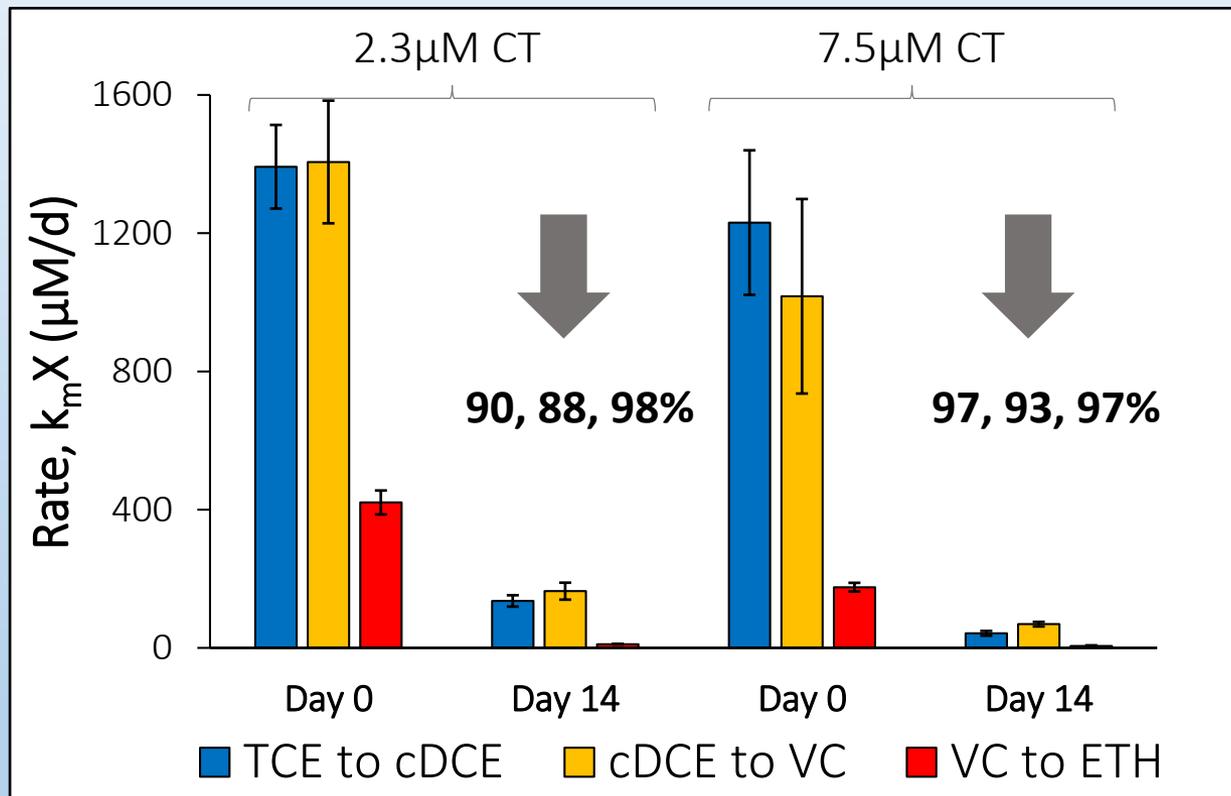
2. Are CE rate effects due to CT concentration or its transformation?

3. Does recovery differ between direct CF and CT exposed reactors?

# Research Questions

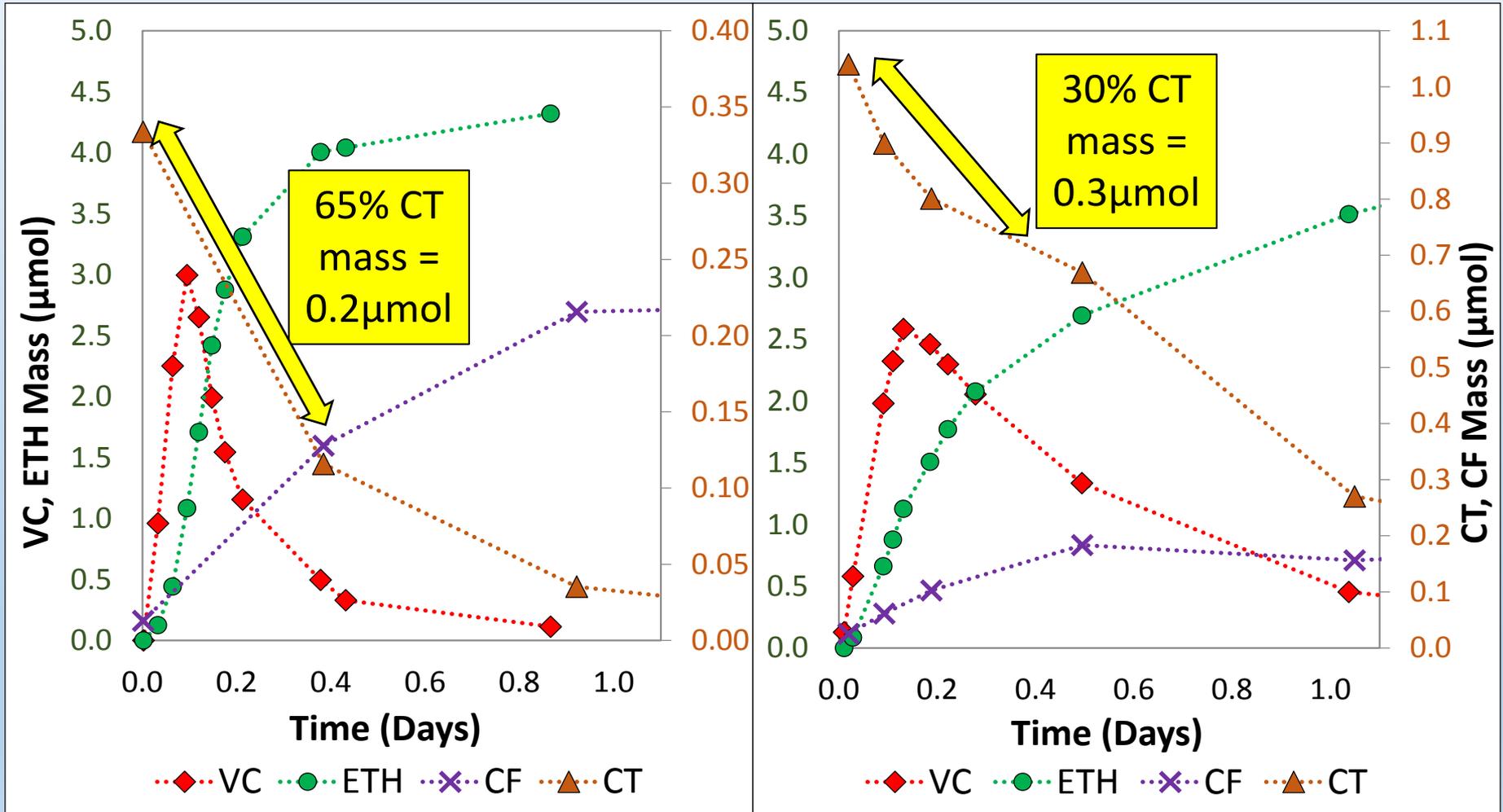
1. Does direct **CF** injection affect the system's **CE** rates and H<sub>2</sub> utilization the same as **CT**?
2. Are non-CF **CE** rate effects due to **CT** concentration or its transformation?
3. Does recovery differ between direct **CF** and **CT** exposed reactors?

## 2. CT Concentration Effect



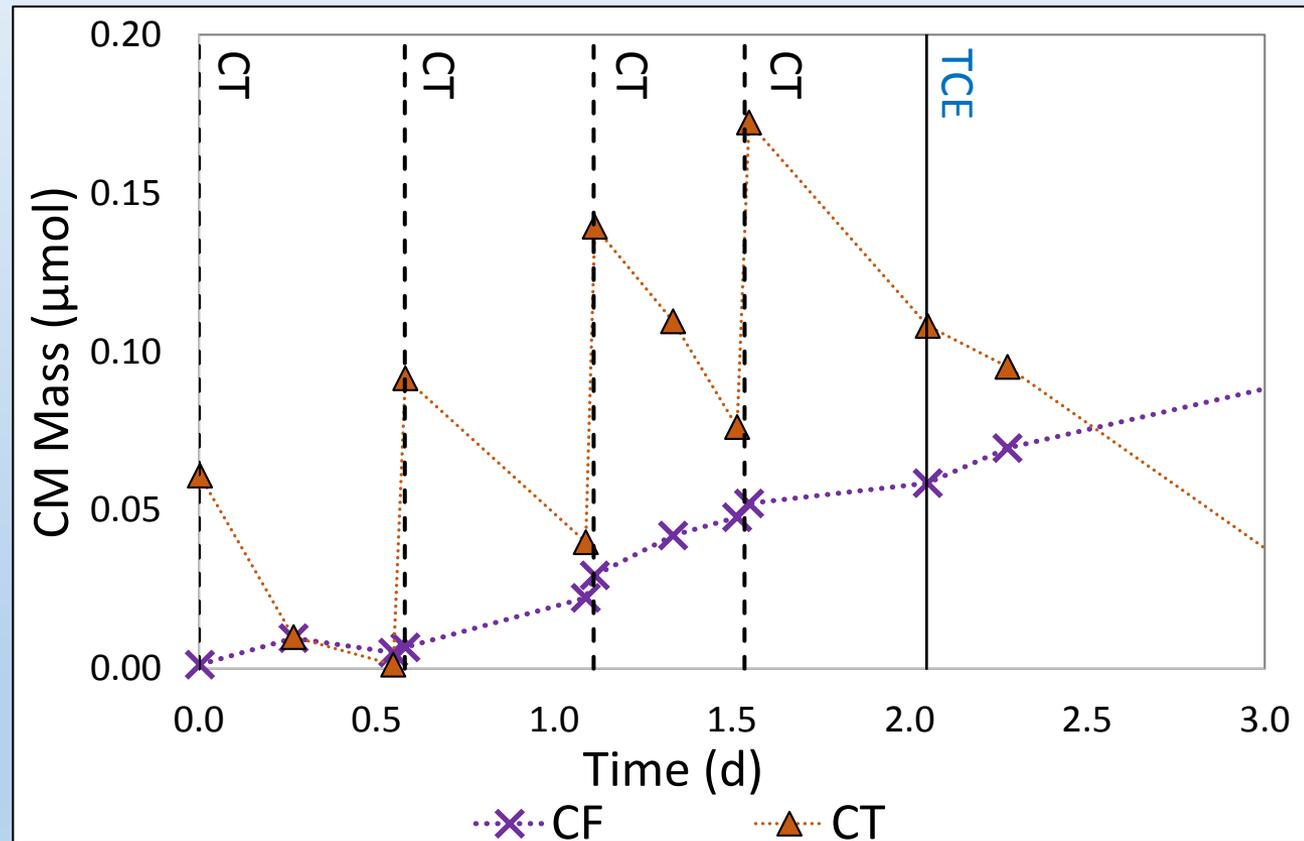
- Higher [CT] leads to slower rates
- VC rate effect not as apparent
- Possible concentration effect.

## 2. First 24 hours: 2.3 vs 7.5 $\mu\text{M}$ CT



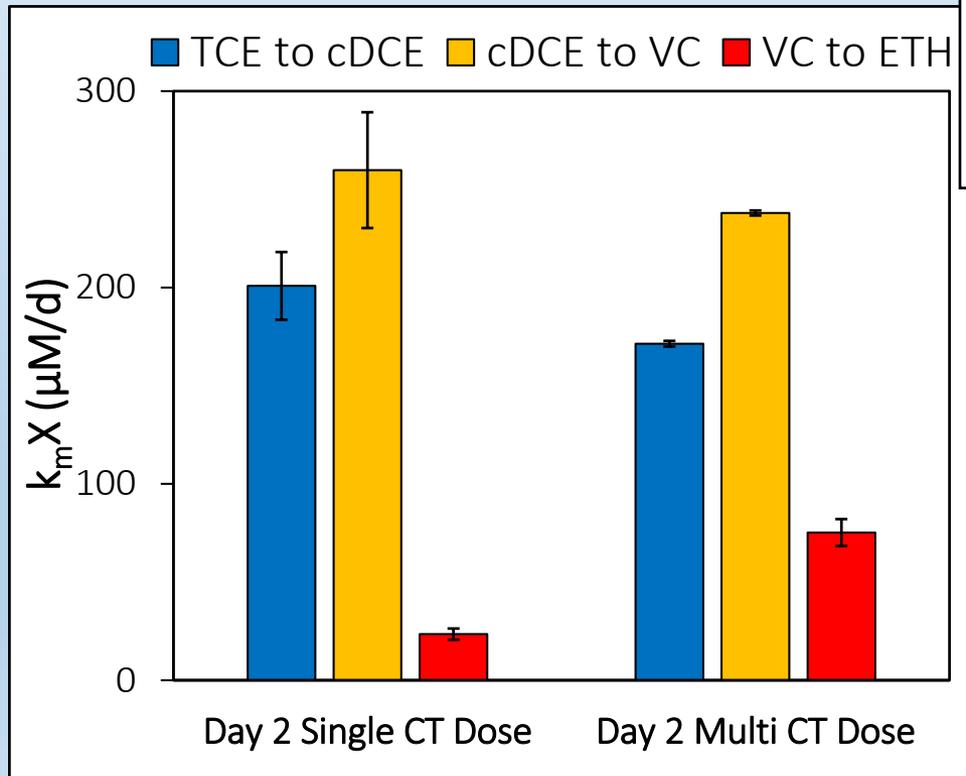
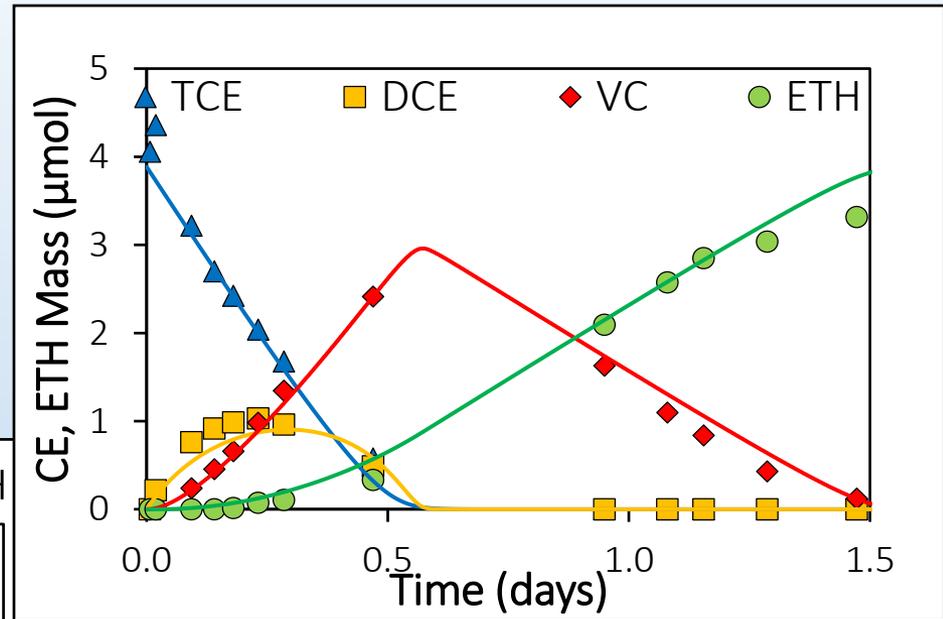
## 2. Multiple Spike CT Delivery

- Different delivery of the same CT mass
- **TCE** added Day 2
- Compare rates to Day 2 single spike



## 2. Multiple Delivery

- Minor CE rate change.



- NOT a CT concentration effect!
- Transformation product?

# Research Questions

1. Does direct CF injection affect the system's CE rates and H<sub>2</sub> utilization the same as CT?

2. Are non-CF CE rate effects due to **CT** concentration or its transformation?

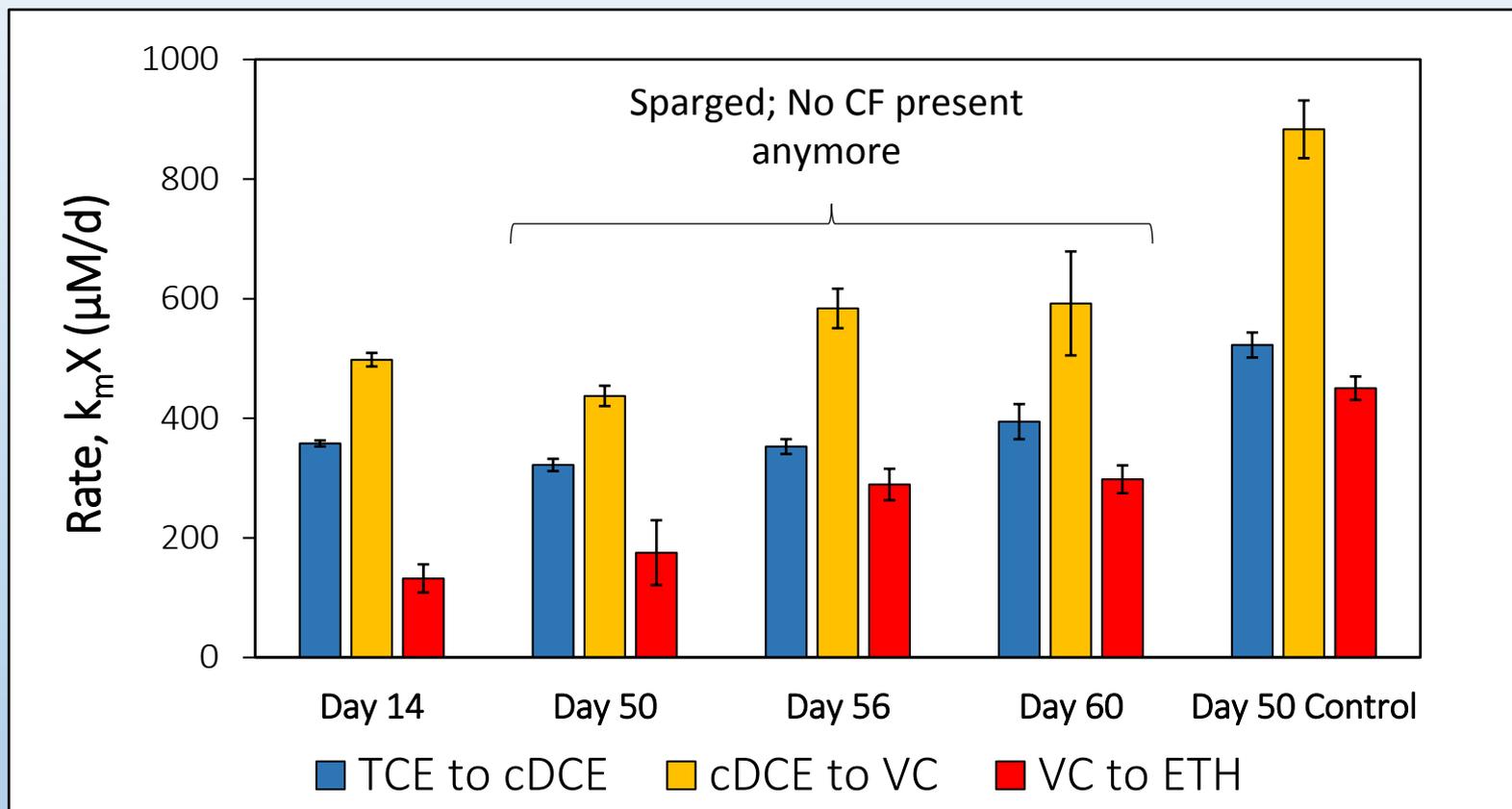
CT transformation products are highly suspect.

3. Does recovery differ between direct CF and CT exposed reactors?

# Research Questions

1. Does direct **CF** injection affect the system's **CE** rates and  $H_2$  utilization the same as **CT**?
2. Are **CE** rate effects due to **CT** concentration or its transformation?
3. Does recovery differ between direct **CF** and **CT** exposed reactors?

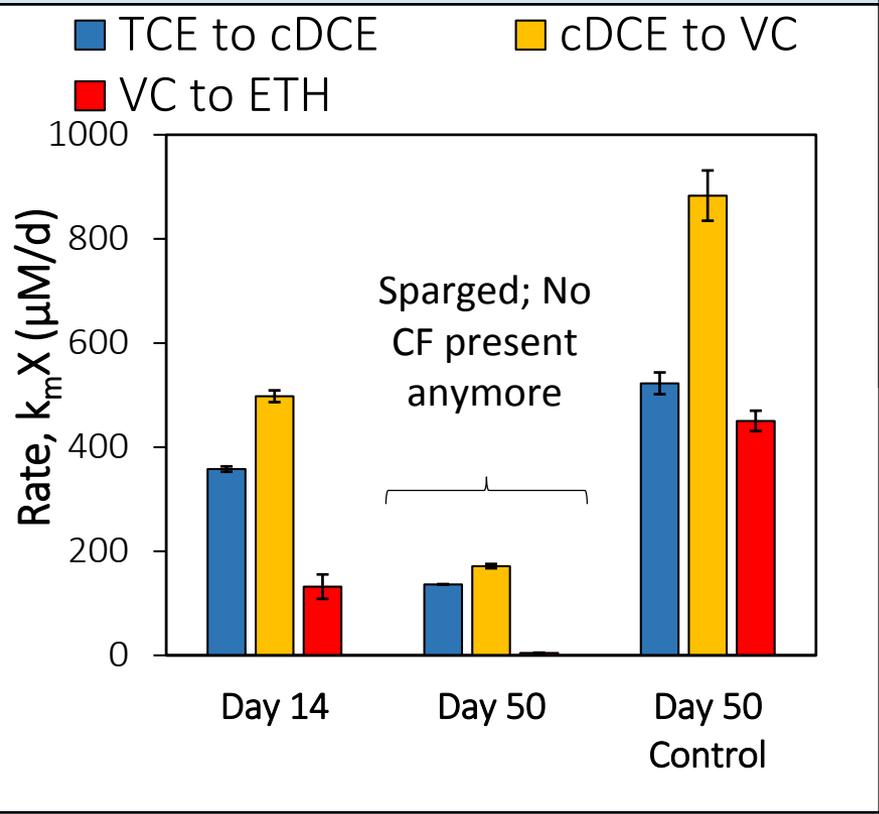
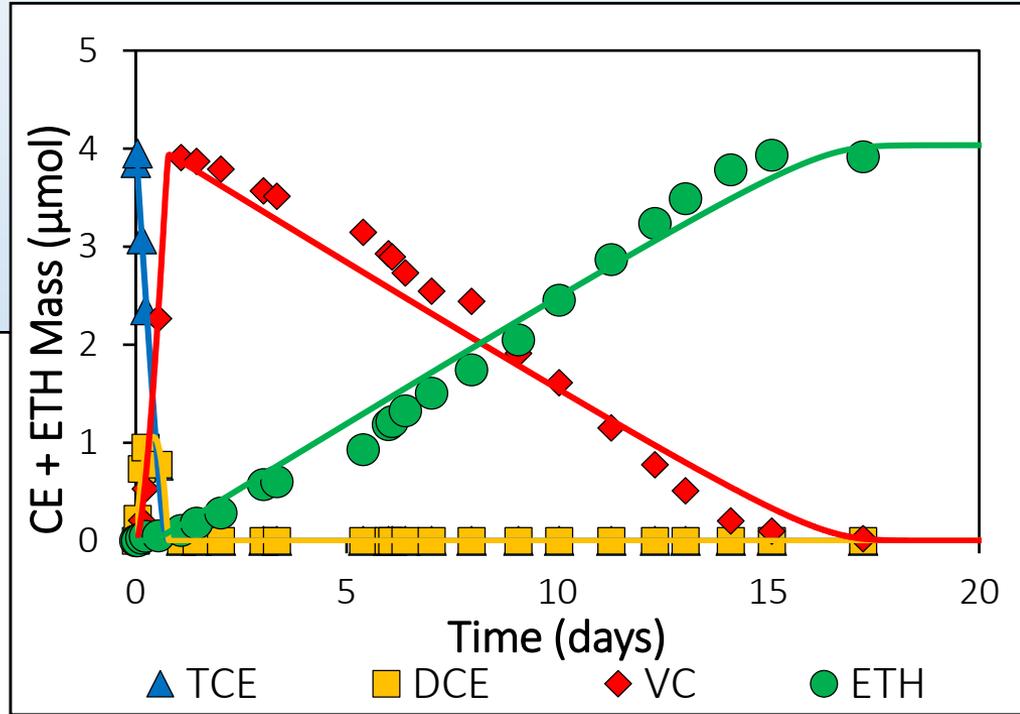
### 3. Recovery Potential: Post-CF Exposure



Slight rate recovery shown upon CF removal.

# 3. Recovery Potential: Post-CT Exposure

- Poor recovery so far



- Nearly 20 days to completion
- High H<sub>2</sub> demand

# Research Questions

1. Does direct **CF** injection affect the system's **CE** rates and  $H_2$  utilization the same as **CT**?
2. Are **CE** rate effects due to **CT** concentration or its transformation?
3. Does recovery differ between direct **CF** and **CT** exposed reactors?

Yes; possible in CF reactors, unlikely in CT reactors.

# Future Work

- Cysteine as a radical trap
- Chemostat CM exposure – transient tests
- B12 supply & homoacetogen contribution

# Acknowledgments



- Kyle Vickstrom
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# References

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