



Politecnico
di Torino



ISTITUTO ITALIANO
DI TECNOLOGIA
CENTRE FOR SUSTAINABLE
FUTURE TECHNOLOGIES

10th International Conference on Sustainable Solid Waste Management

Influence of acetate concentration on acetone production by a modified *Acetobacterium woodii*

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Chania – 23rd June 2023

Presentation outline



❖ Introduction:

- The context
- The catalyst
- The bioreactor

❖ Results:

- Acetone production in serum bottles
- Acetone production in reactor at atmospheric pressure
- Acetone production in reactor at high pressure
- Acetate influence on acetone production

❖ Conclusions



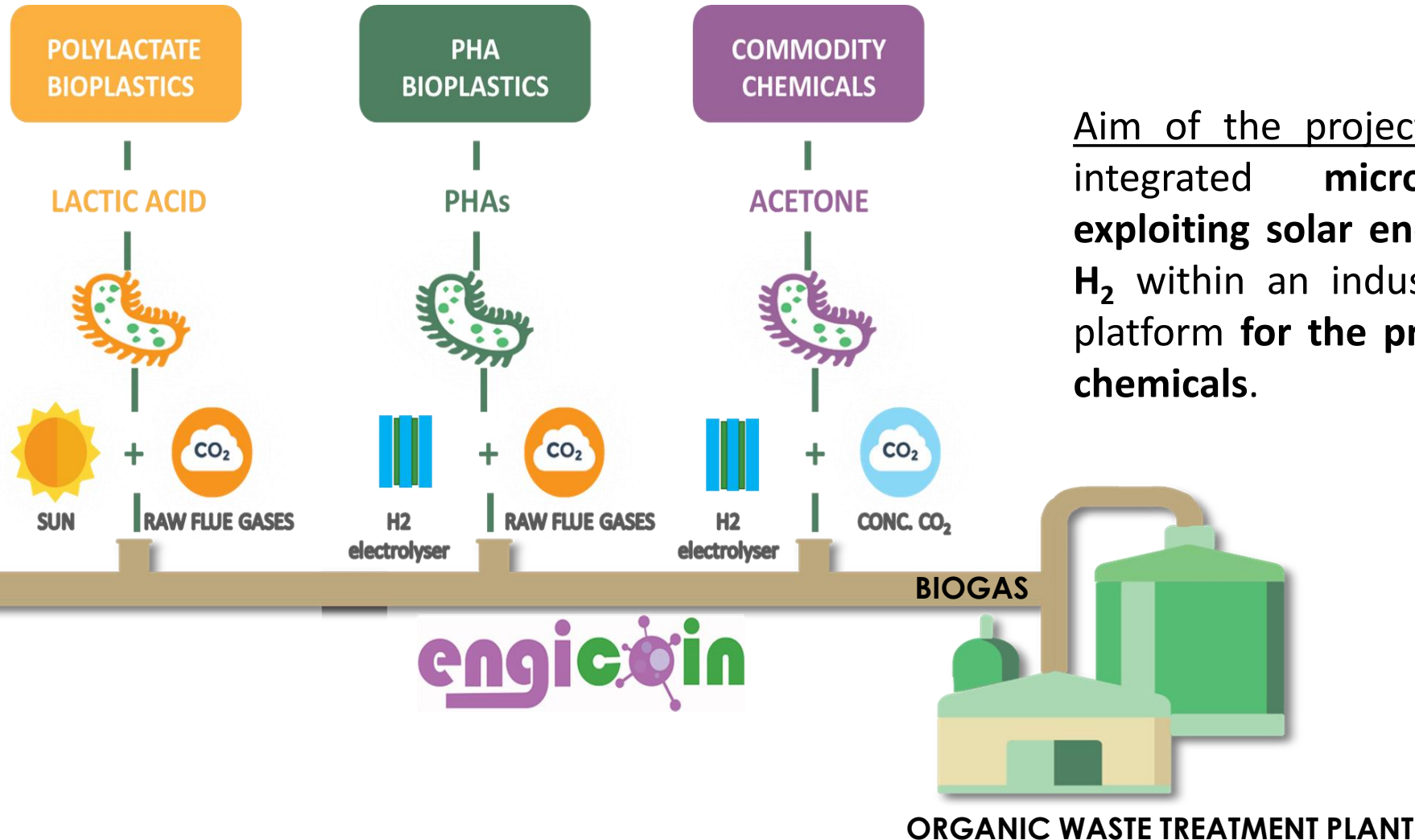
The project



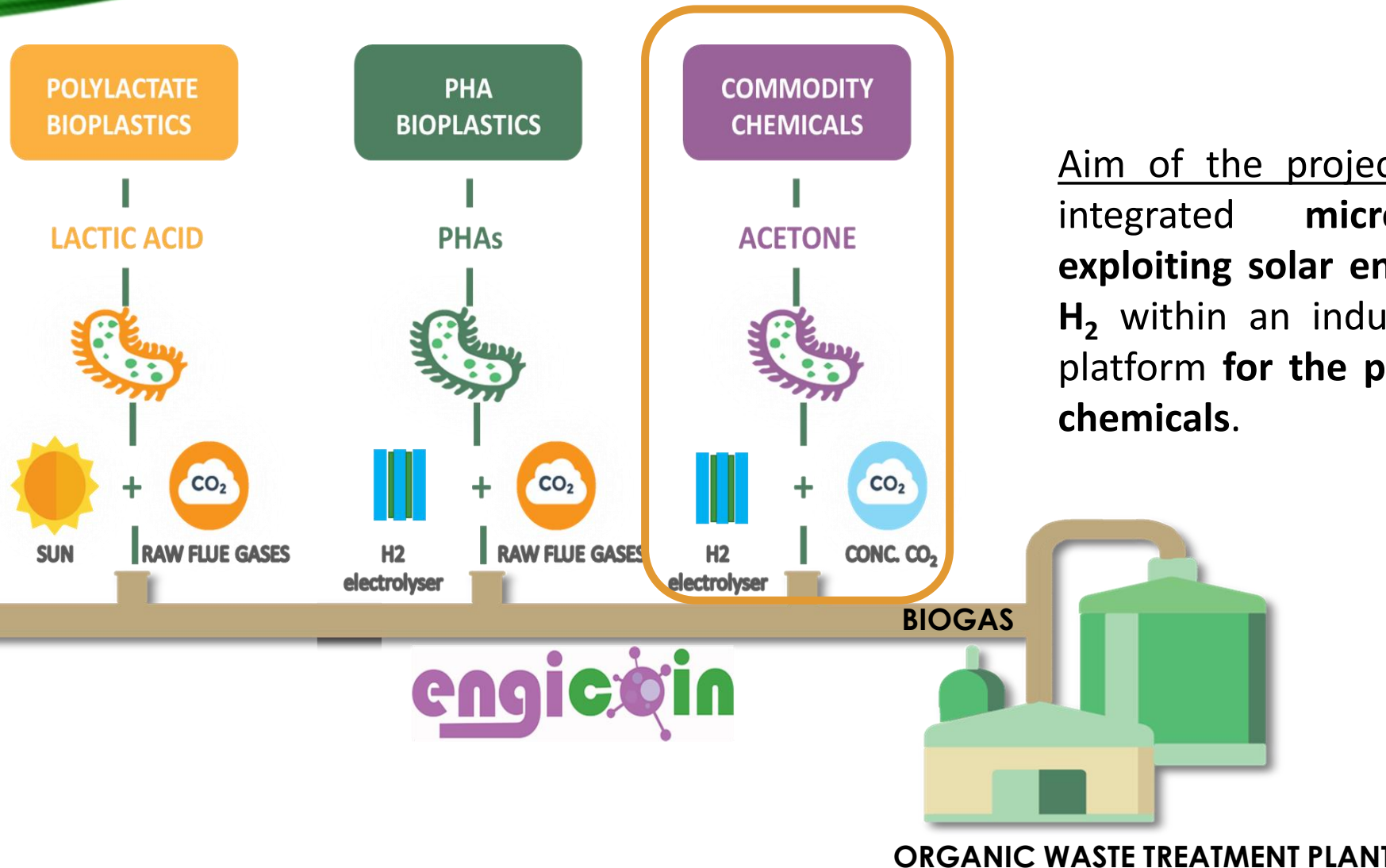
Aim of the project: development of three integrated **microbial factories (MF)** exploiting solar energy, CO₂ and renewable H₂ within an industrial anaerobic digestion platform for the production of value-added chemicals.



<https://engico.eu>



The project

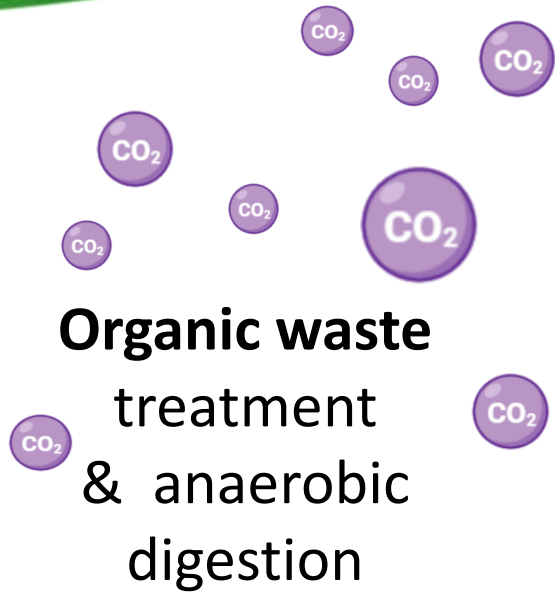


Aim of the project: development of three integrated **microbial factories (MF)** exploiting **solar energy, CO₂** and **renewable H₂** within an industrial anaerobic digestion platform **for the production of value-added chemicals.**



<https://engico.in>

The strategy



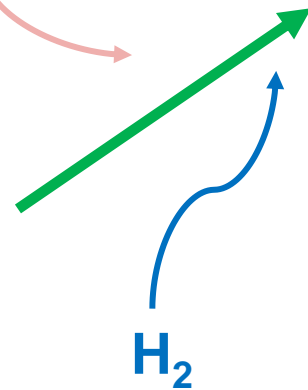
The strategy



**Organic waste
treatment
& anaerobic
digestion**



Bioreactor



The strategy



Organic waste
treatment
& anaerobic
digestion

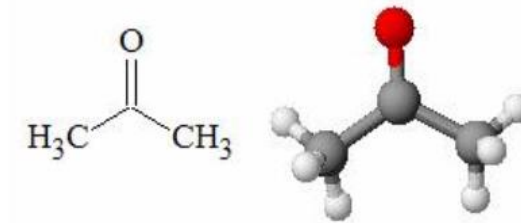


CO₂

H₂



Bioreactor



Acetone

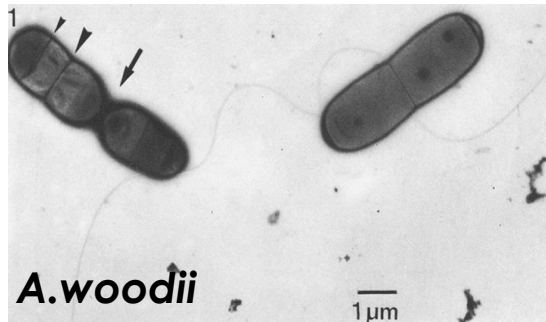
Solvent



Building
block



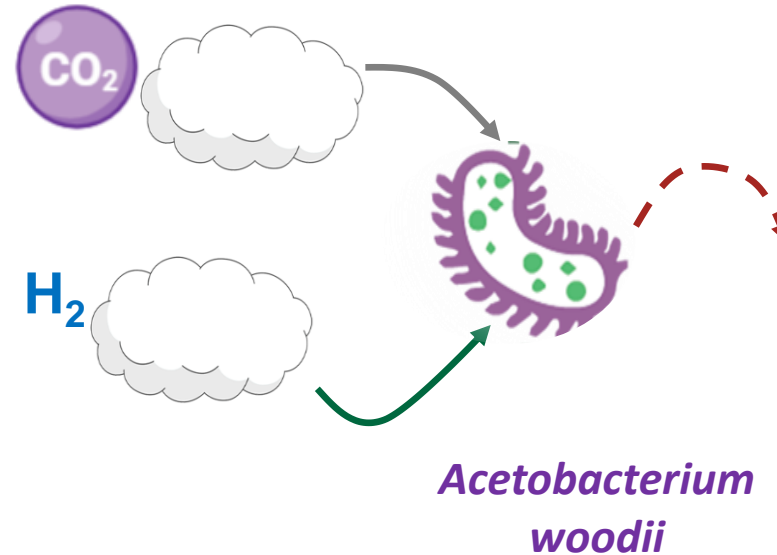
The catalyst



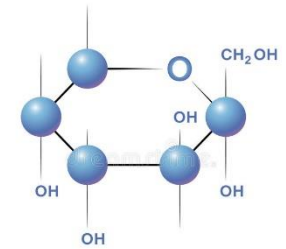
Mayer et al., Arch. Microbiol. (1977)



AUTOTROPHIC metabolism



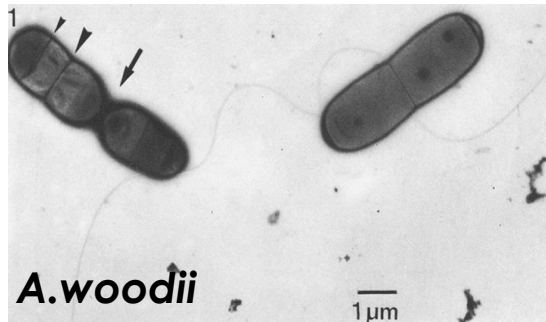
Heterotrophic metabolism



Fructose

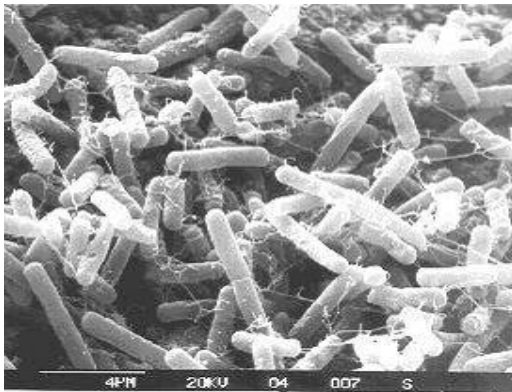


The catalyst



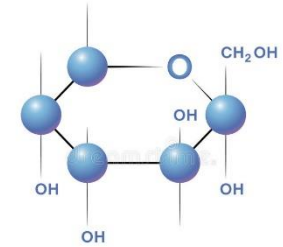
Mayer et al., Arch. Microbiol. (1977)

Genes from *Clostridium* species



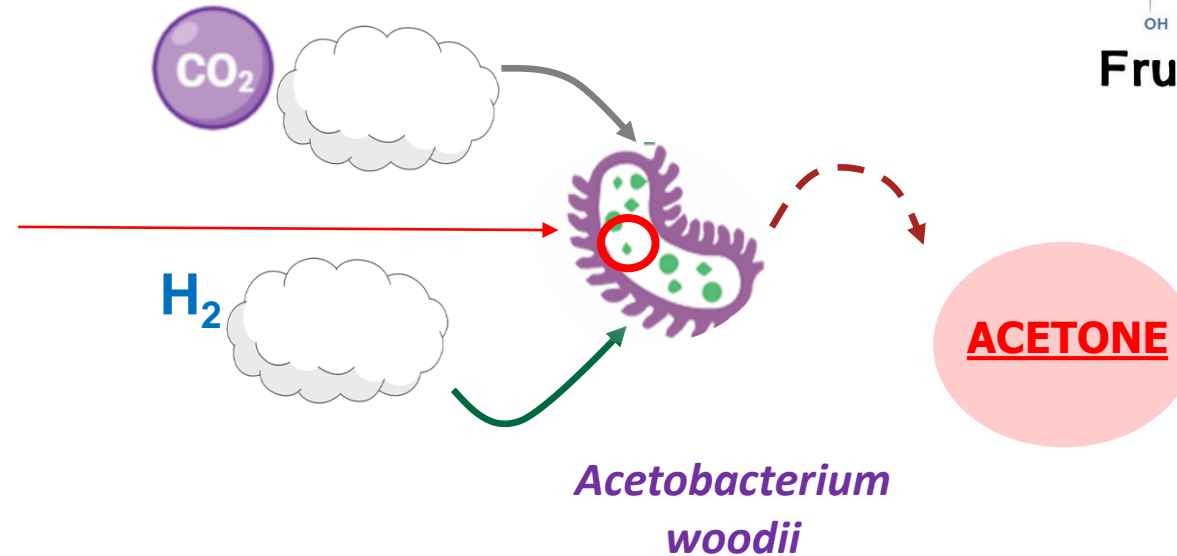
Hoffmeister et al., Metabolic Engineering (2016)

Heterotrophic metabolism

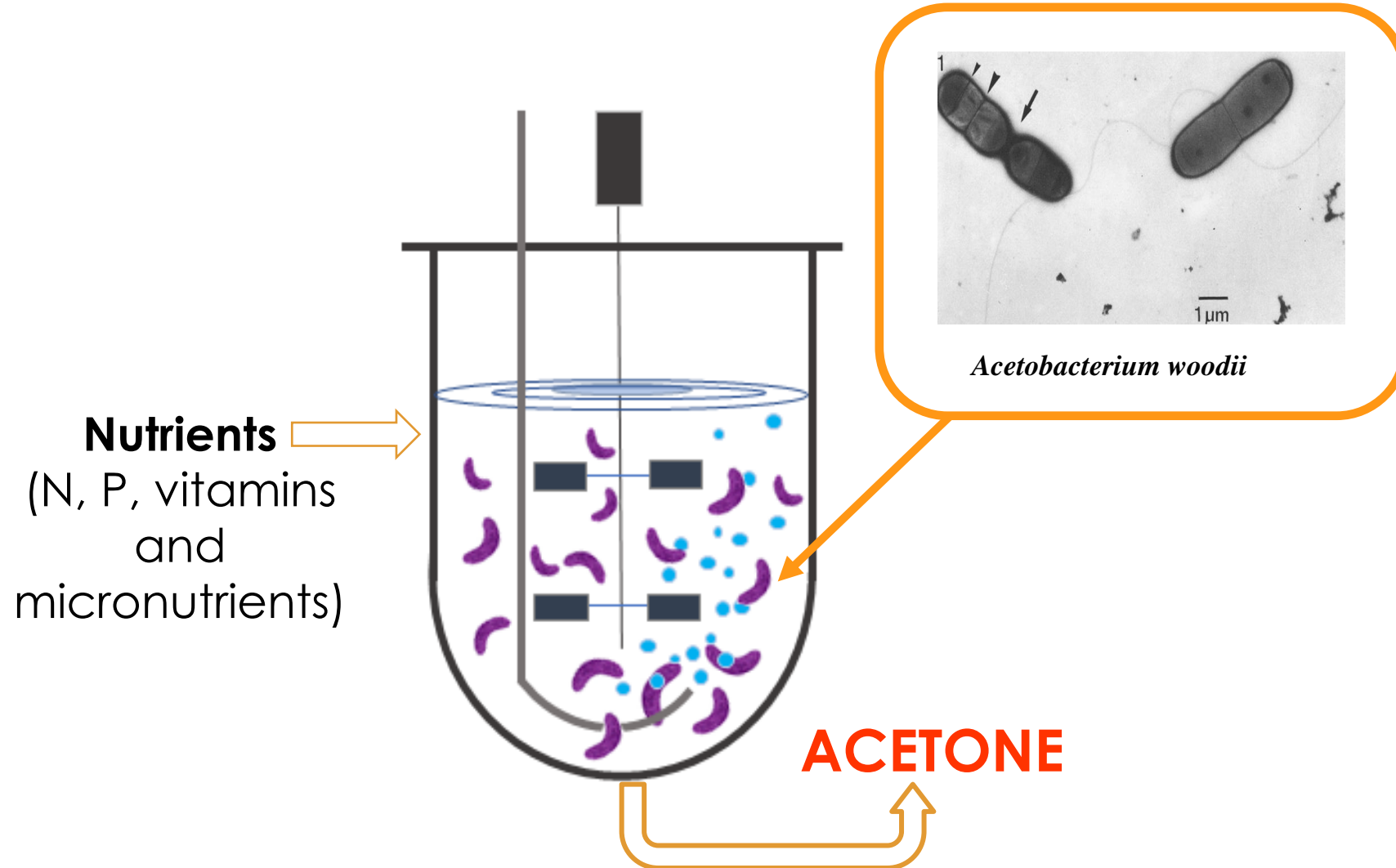


Fructose

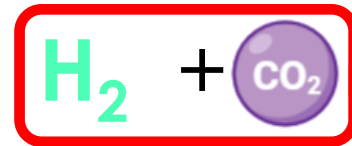
AUTOTROPHIC metabolism



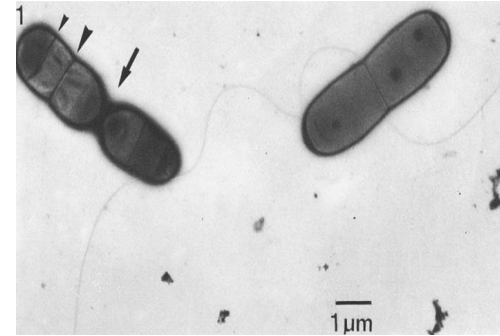
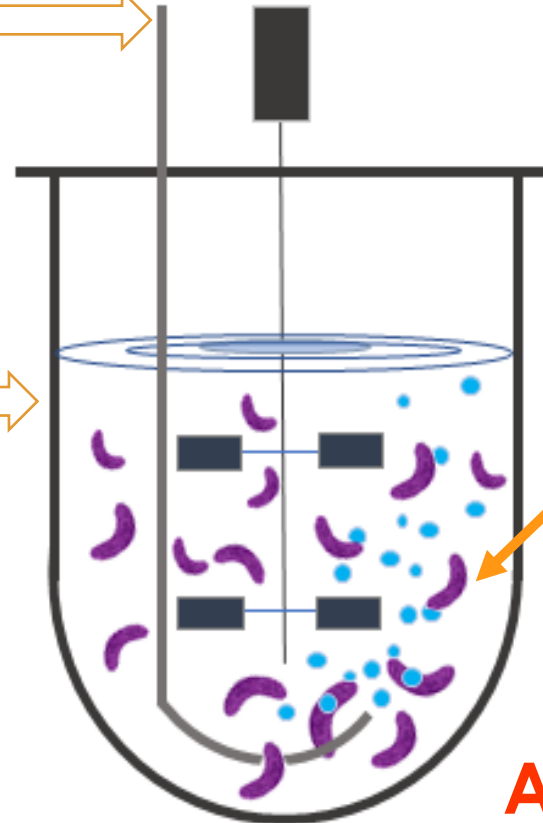
Gas fermentation



Gas fermentation



Nutrients
(N, P, vitamins
and
micronutrients)



Acetobacterium woodii

ACETONE



Gas fermentation



- Low CO_2 and H_2 solubility



Gas fermentation



- Low CO_2 and H_2 solubility



Gas fermentation



- Low CO_2 and H_2 solubility



Increasing of CO_2 and H_2
availability by **pressure**
increasing



Gas fermentation



➤ Low CO₂ and H₂ solubility



Increasing of CO₂ and H₂
availability by **pressure**
increasing

Fermentations in
a **High-Pressure Bioreactor**
for improving gas solubility and
increasing acetone production



Pressurized
Bioreactor



RESULTS



❖ Introduction:

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❖ Results:

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❖ Conclusions

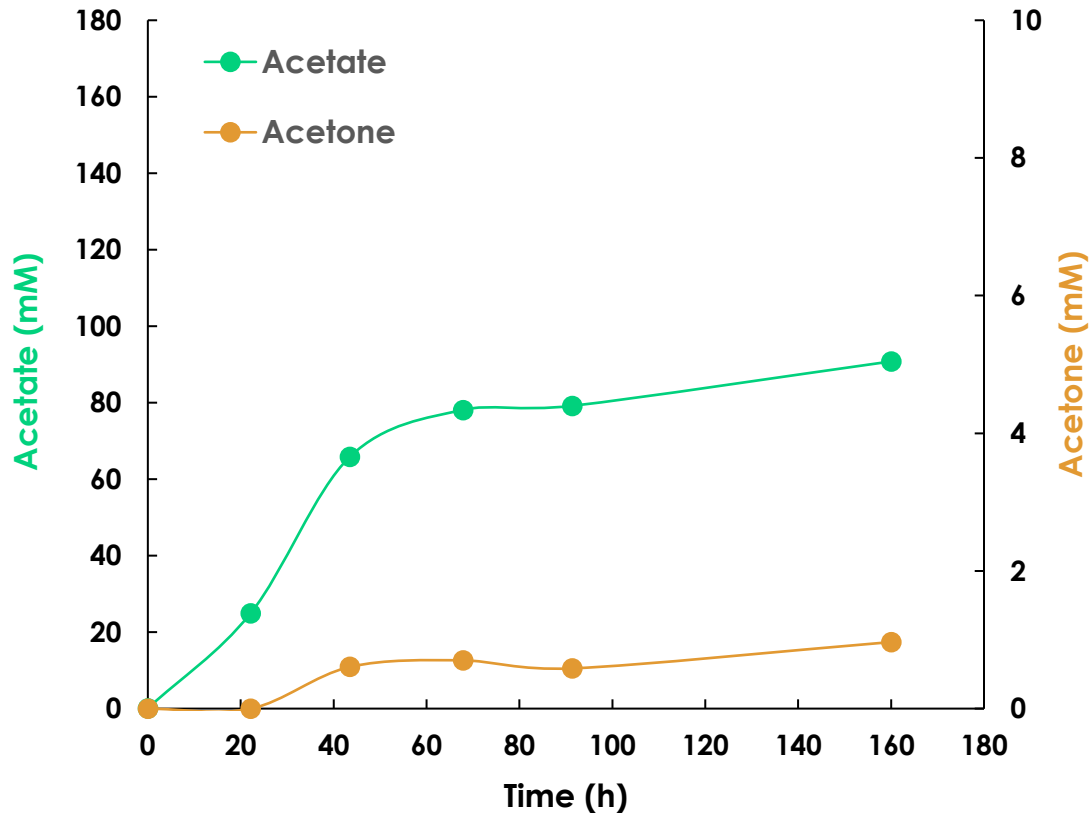


Acetone production

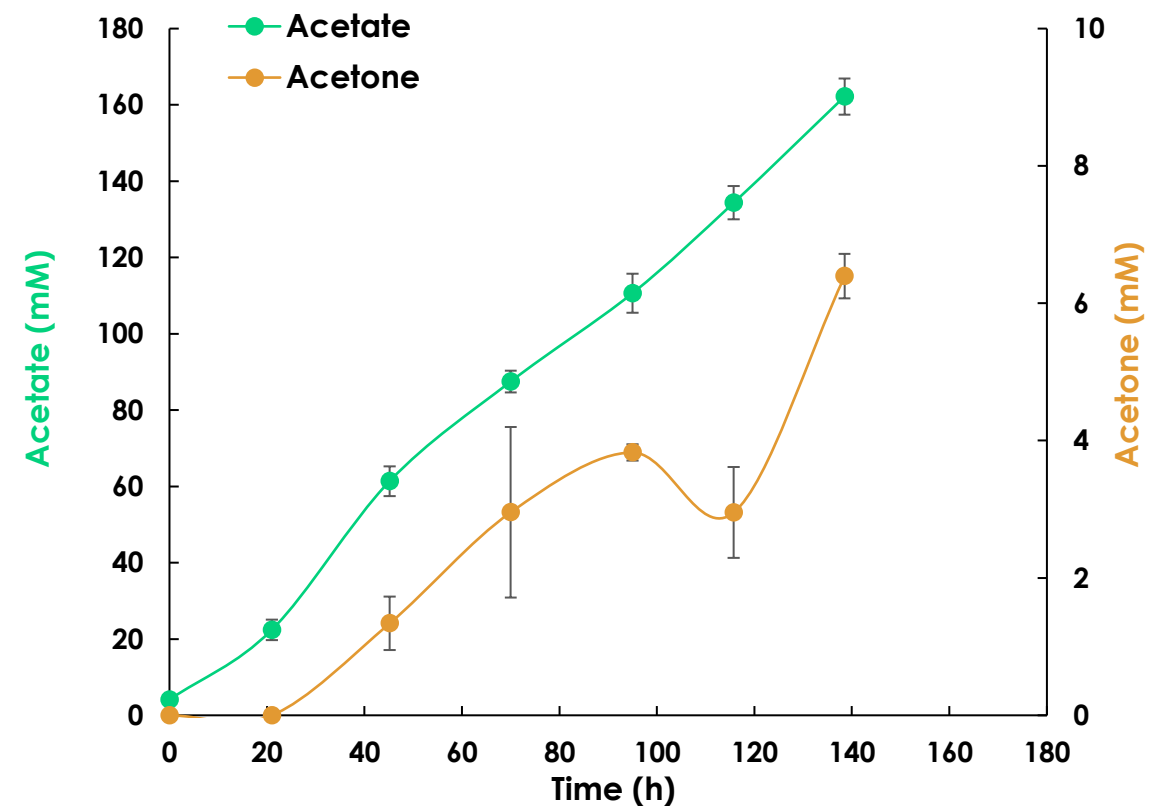


Serum bottles

(Gas fed-batch, P atm, 70% H_2 - 30% CO_2)



NO pH CONTROL



pH CONTROL

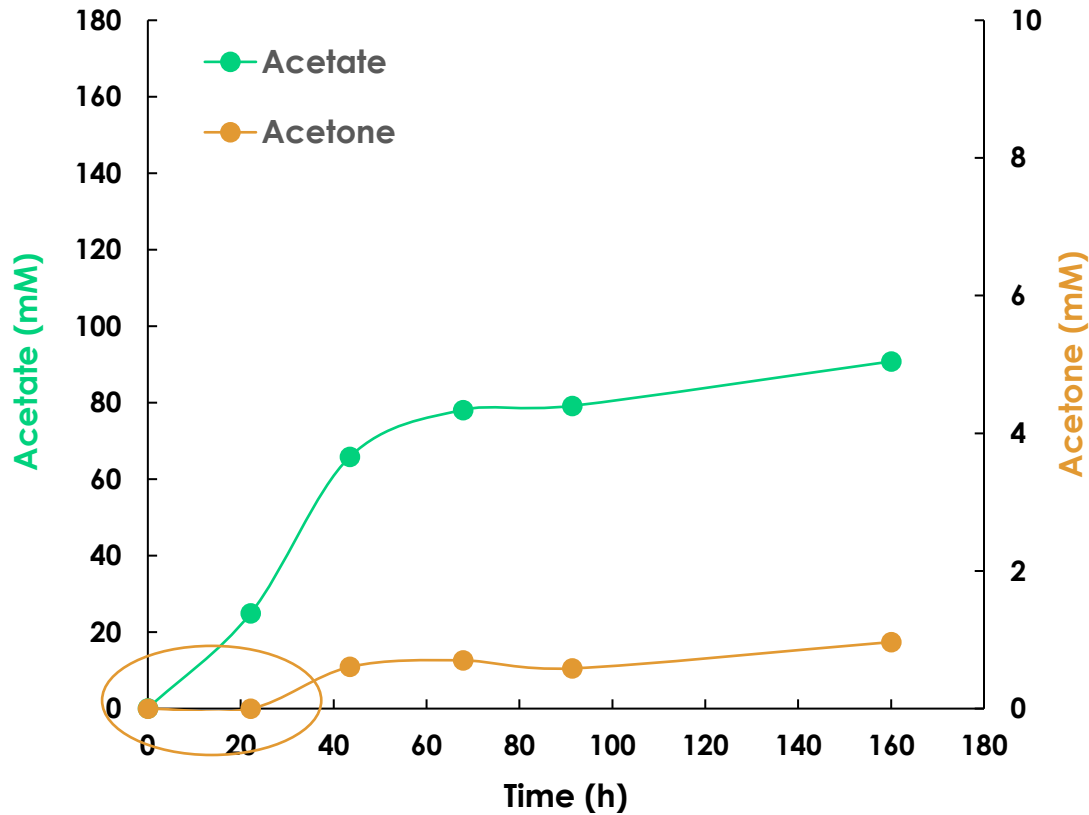


Acetone production

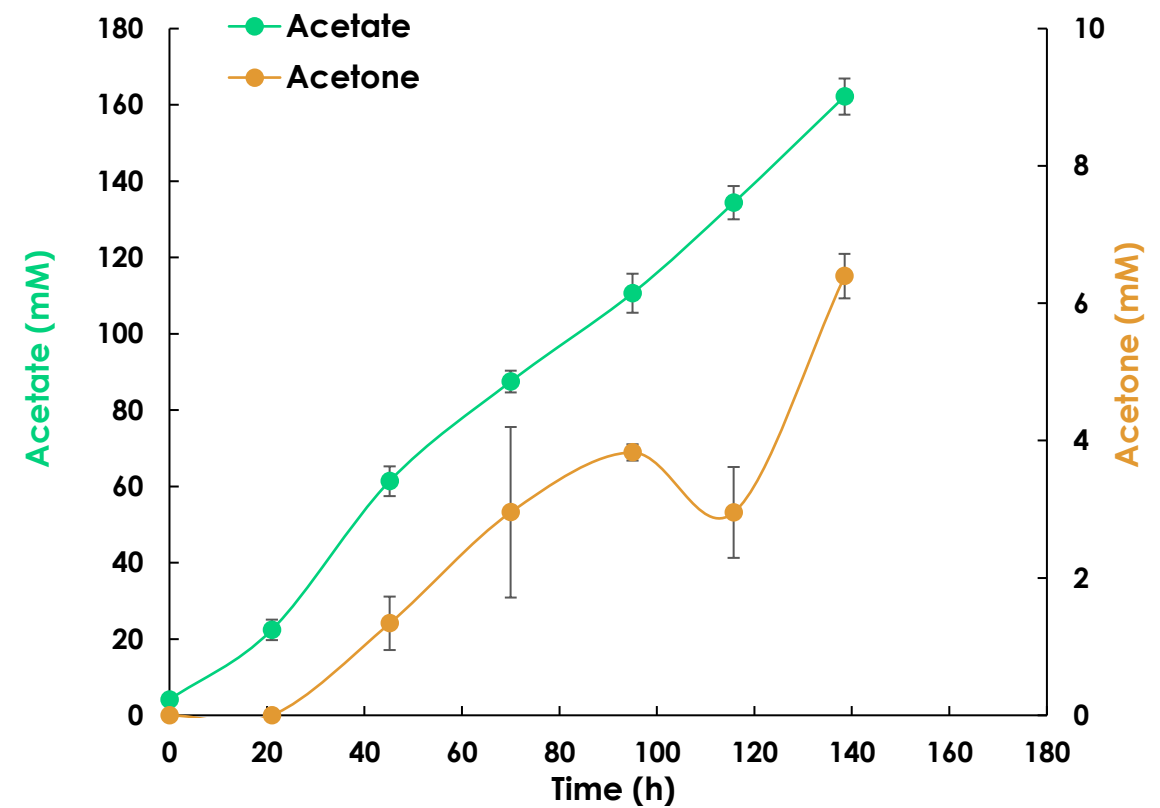


Serum bottles

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pH CONTROL

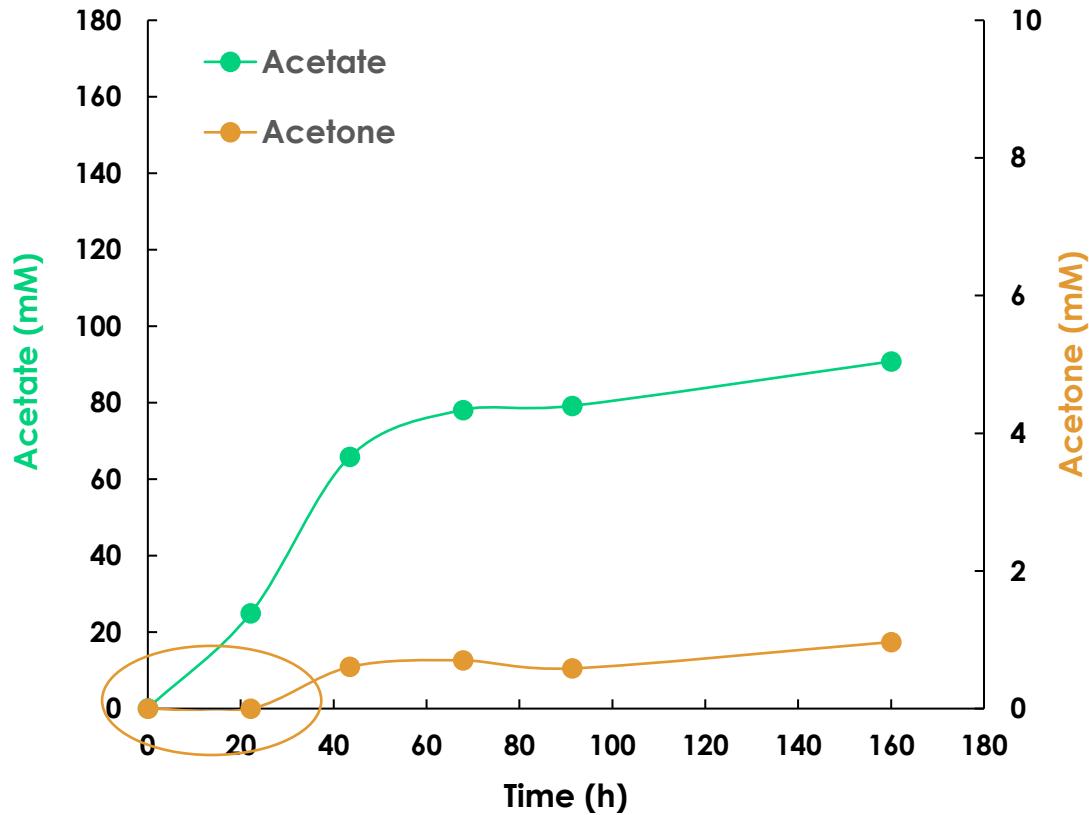


Acetone production

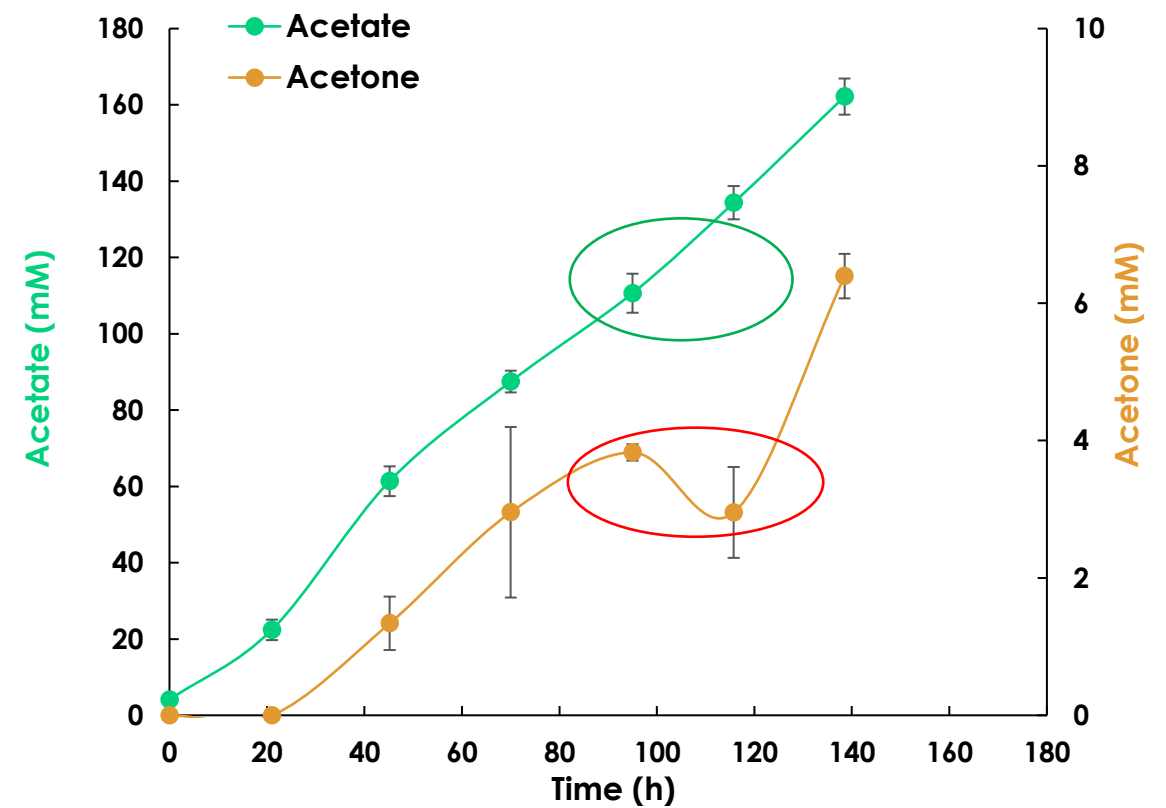


Serum bottles

(Gas fed-batch, P atm, 70% H_2 - 30% CO_2)



NO pH CONTROL



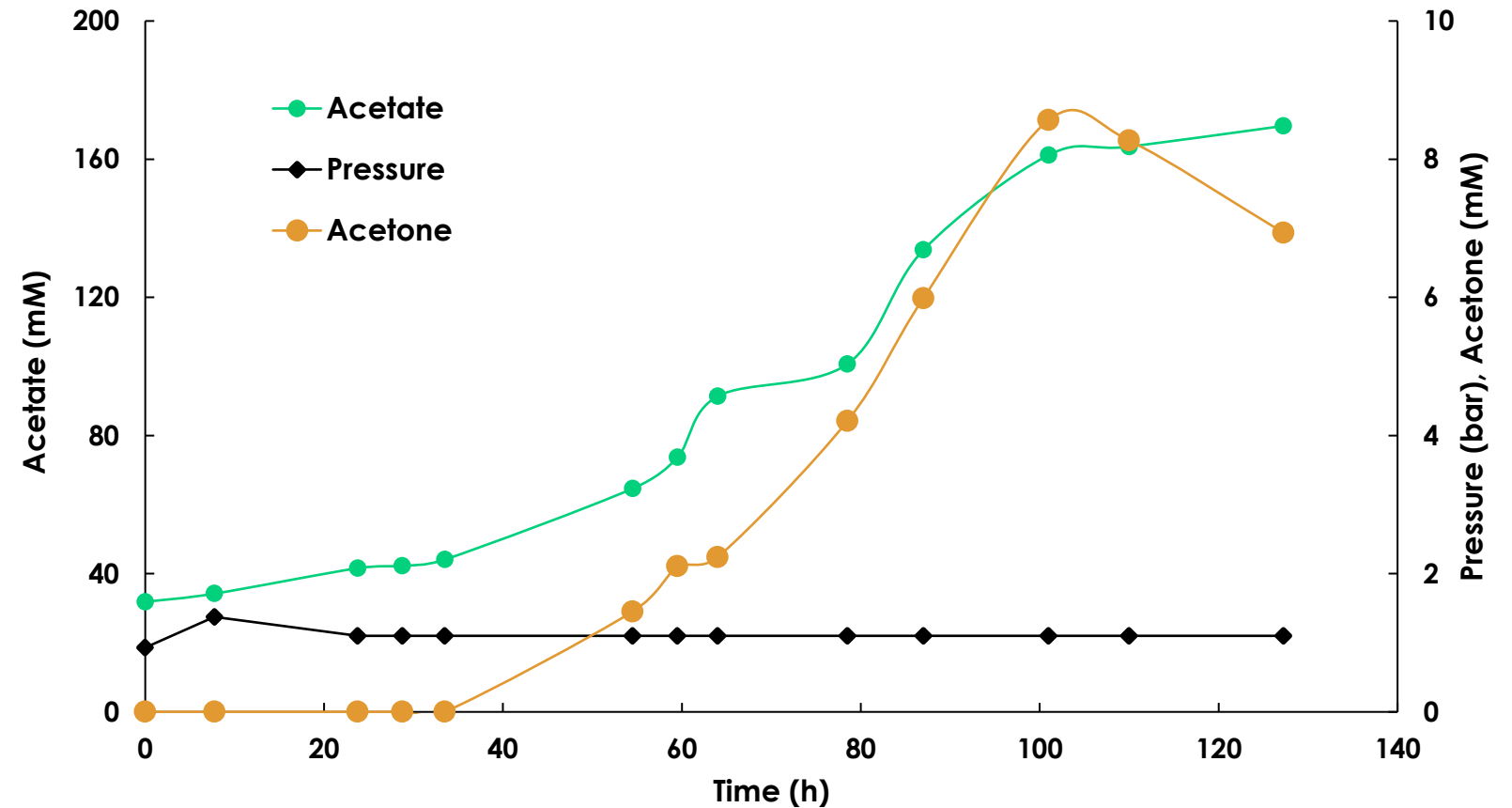
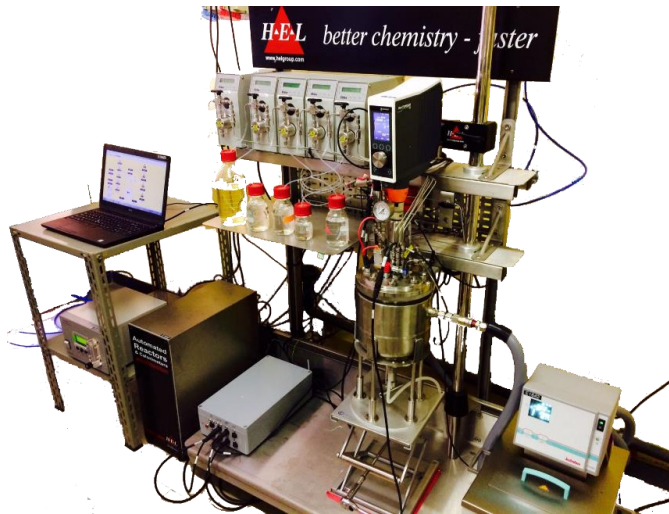
pH CONTROL



Acetone production



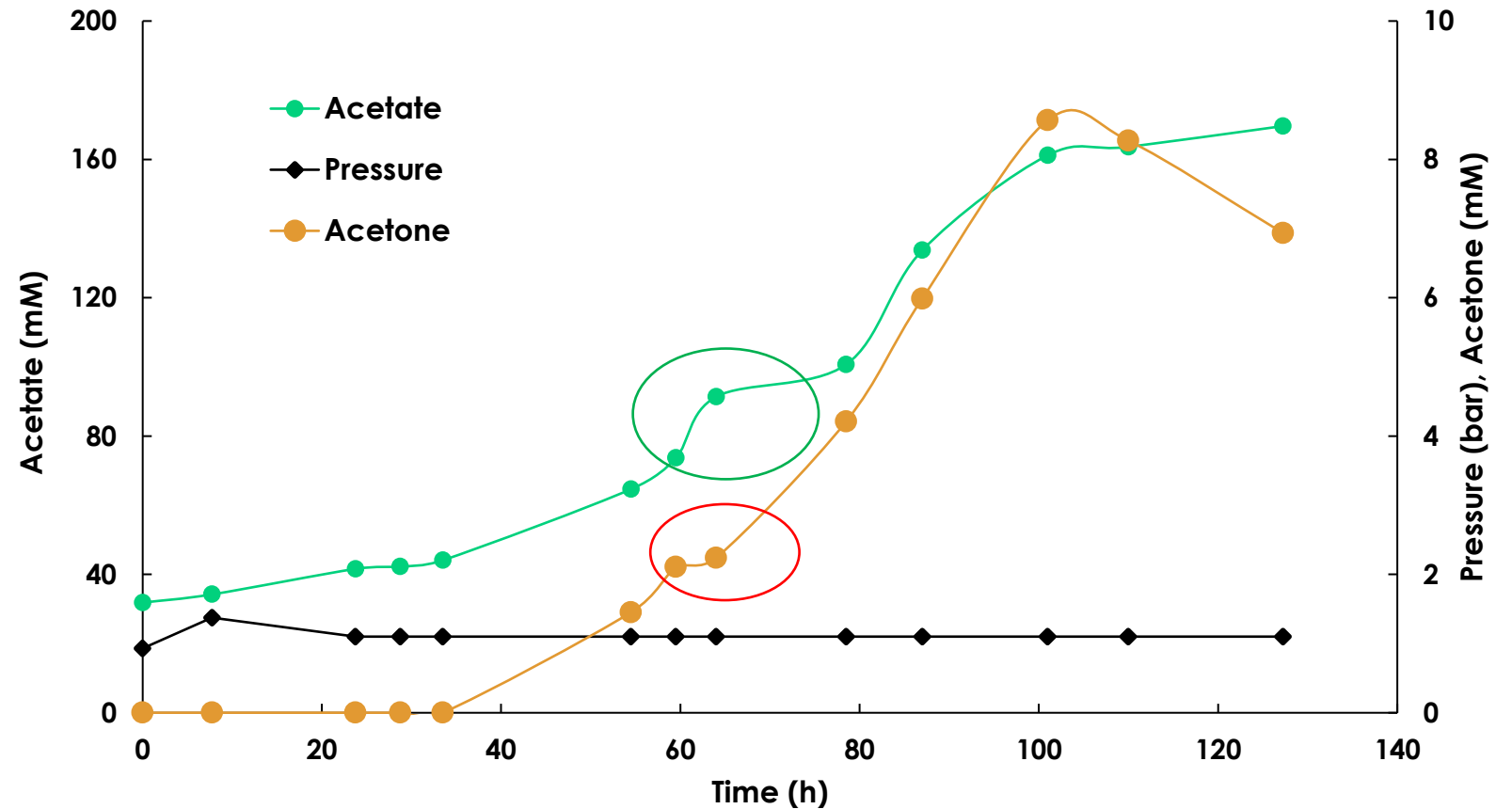
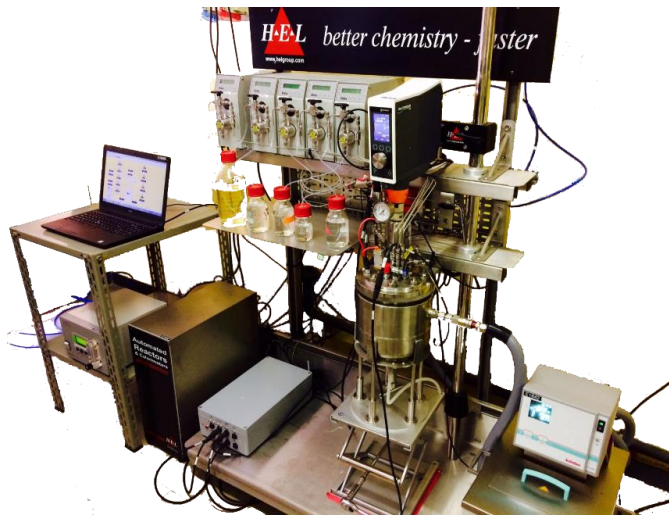
REACTOR - Liquid batch, gas continuous, 1.1 bar



Acetone production



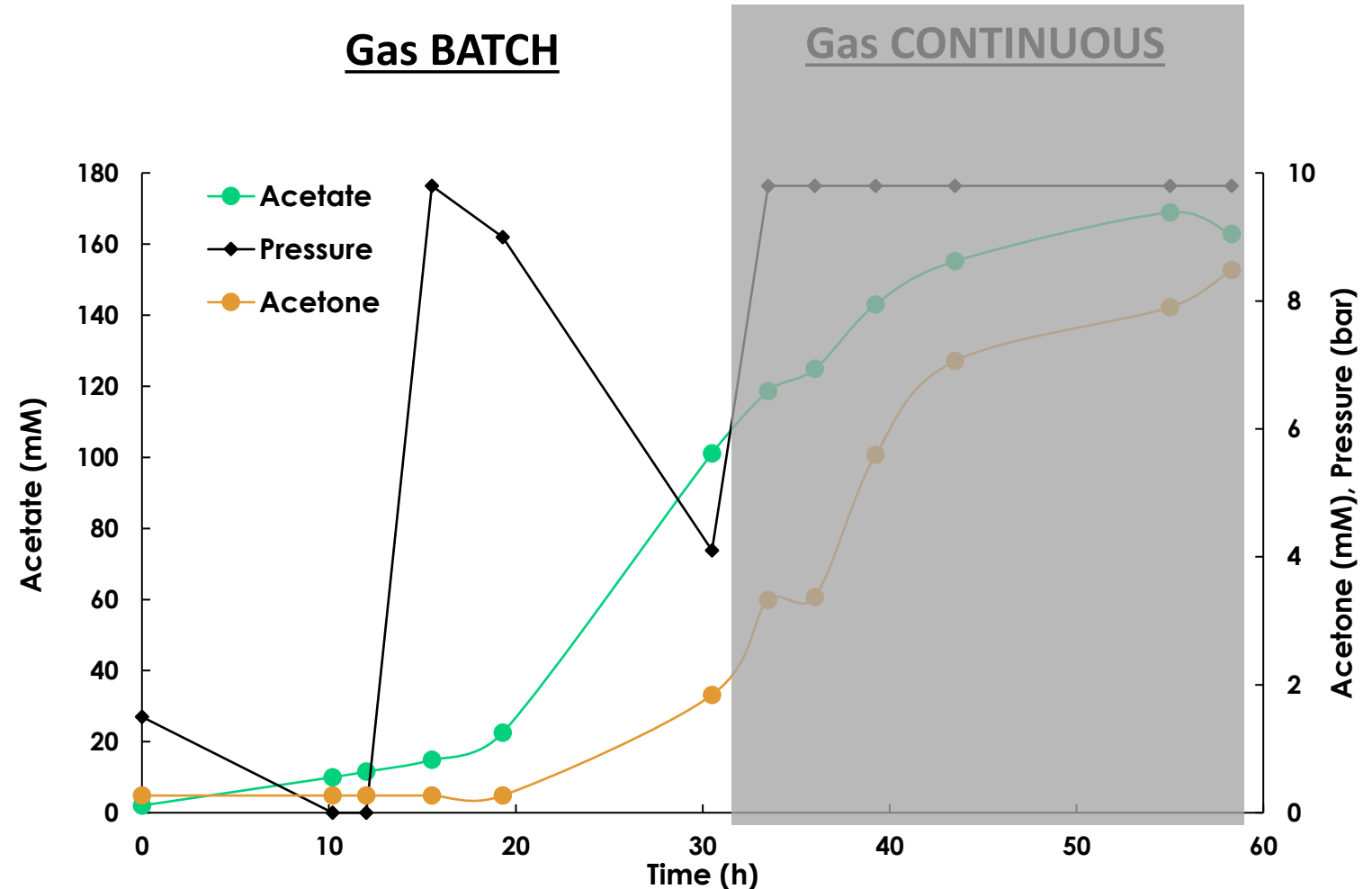
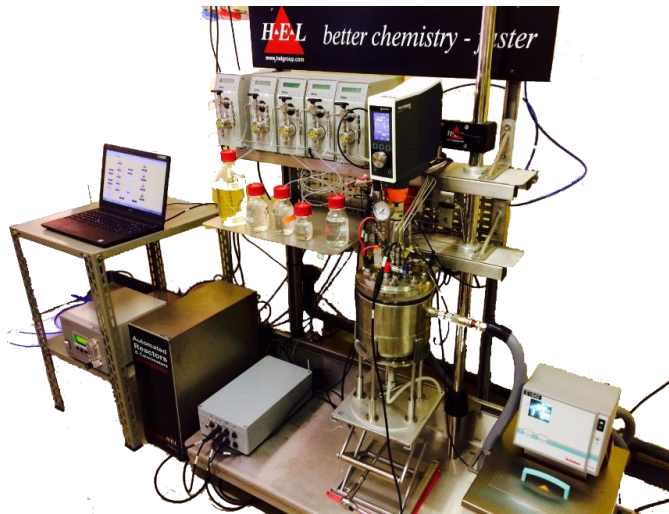
REACTOR - Liquid batch, gas continuous, 1.1 bar



Acetone production



REACTOR - Liquid batch, gas batch/continuous, 10 bar)



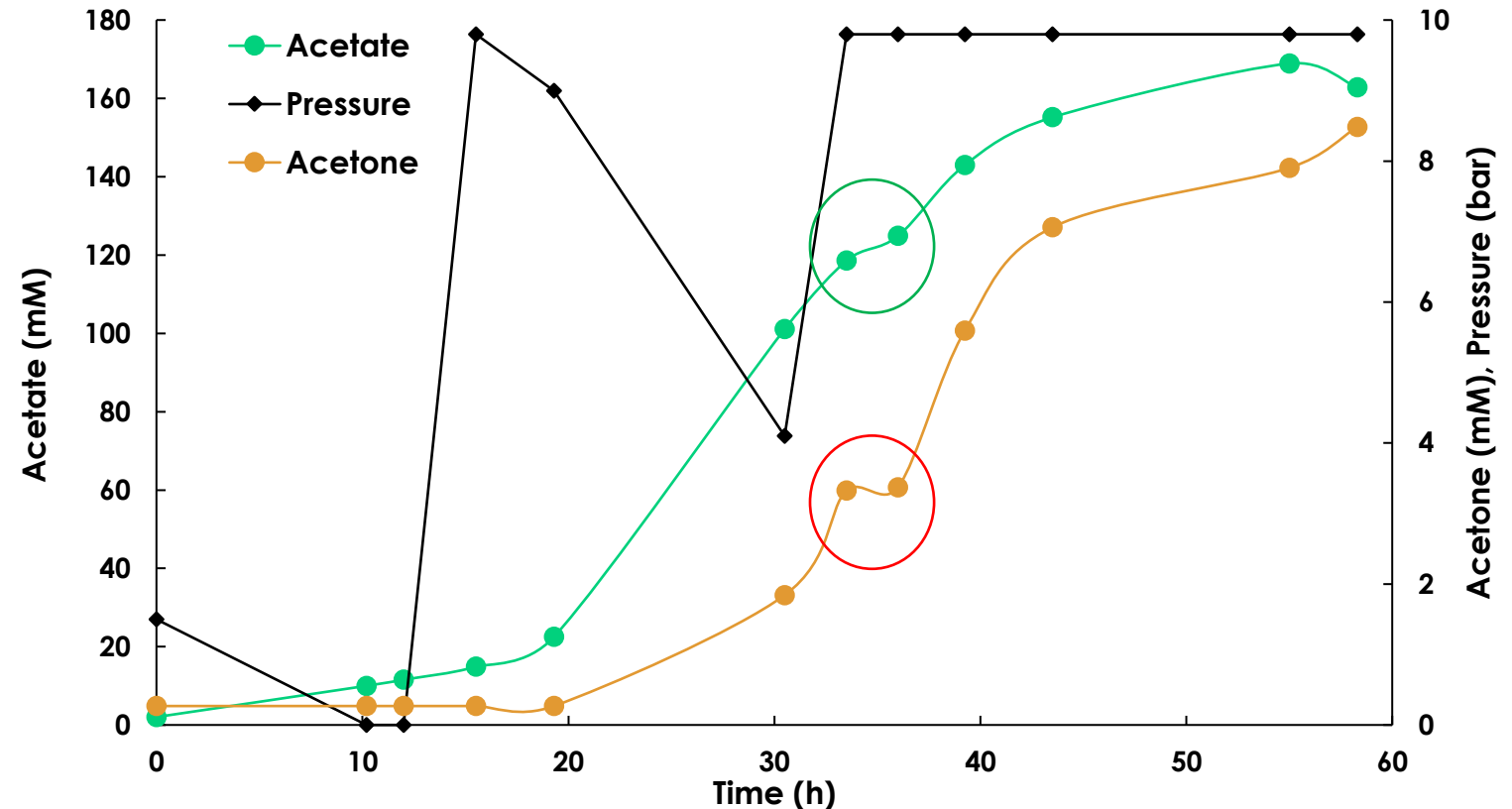
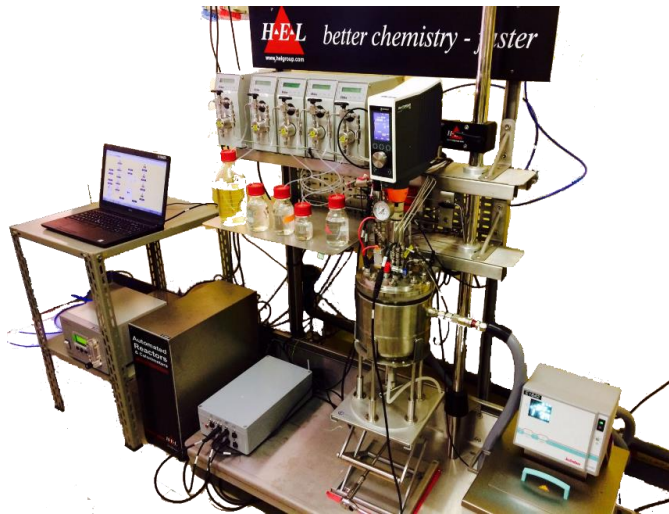
Acetone production



REACTOR - Liquid batch, gas batch/continuous, 10 bar)

Gas BATCH

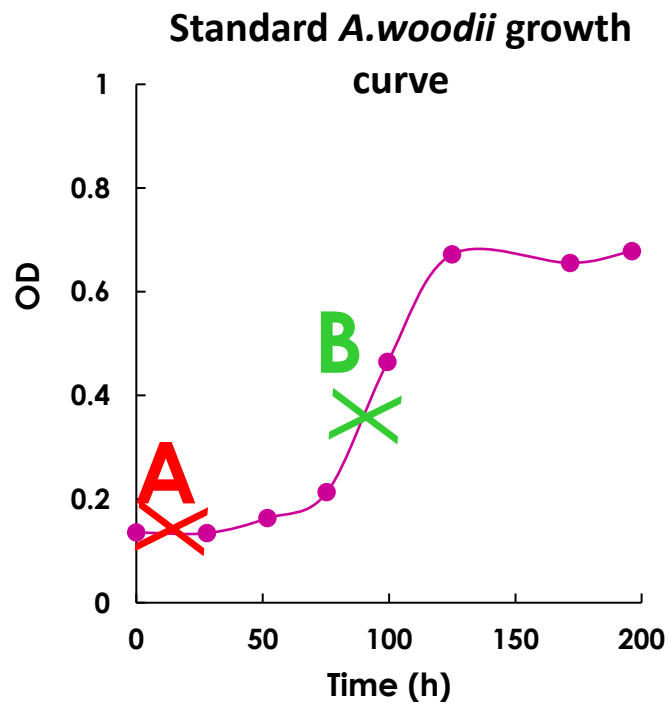
Gas CONTINUOUS



Acetone production



Serum bottles (Gas fed-batch, P atm, 70% H_2 - 30% CO_2)



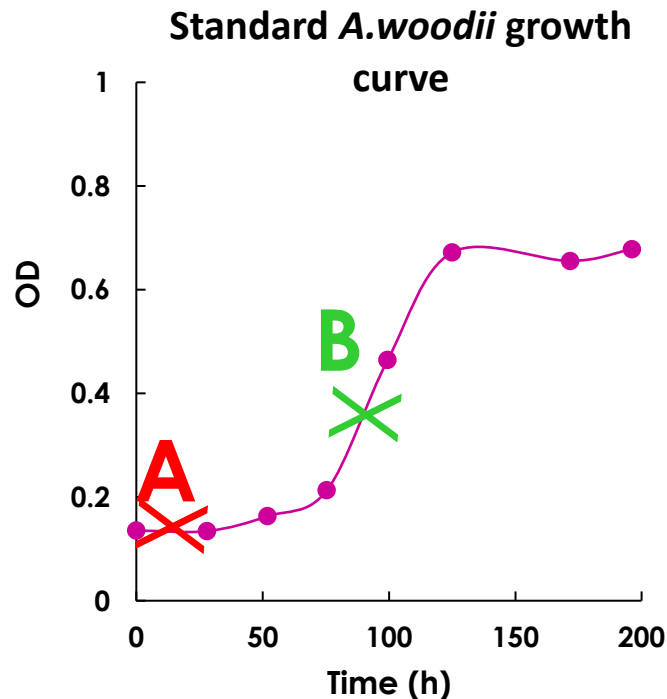
100 mM acetate added in **A** or **B**



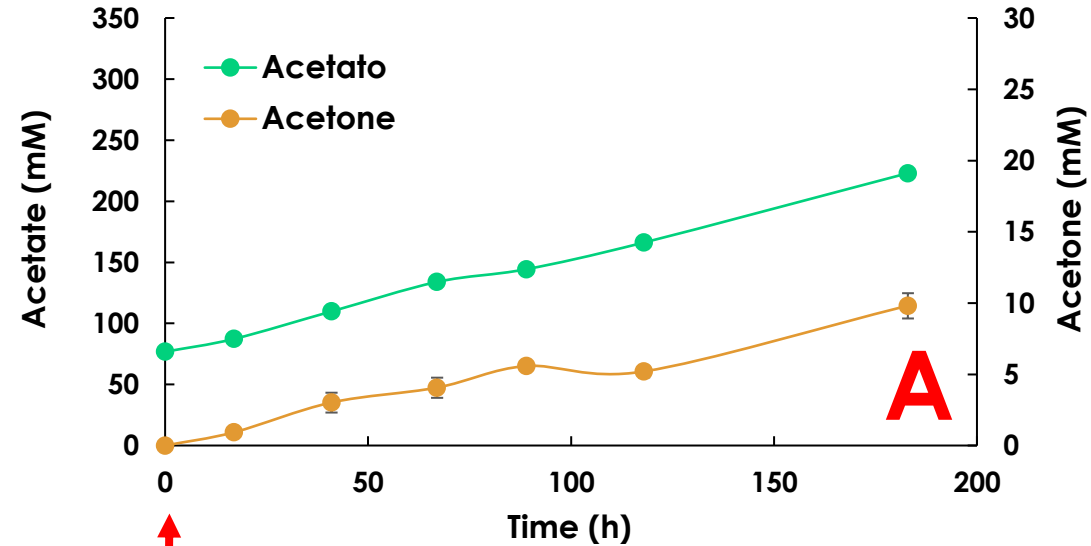
Acetone production



Serum bottles (Gas fed-batch, P atm, 70% H_2 - 30% CO_2)



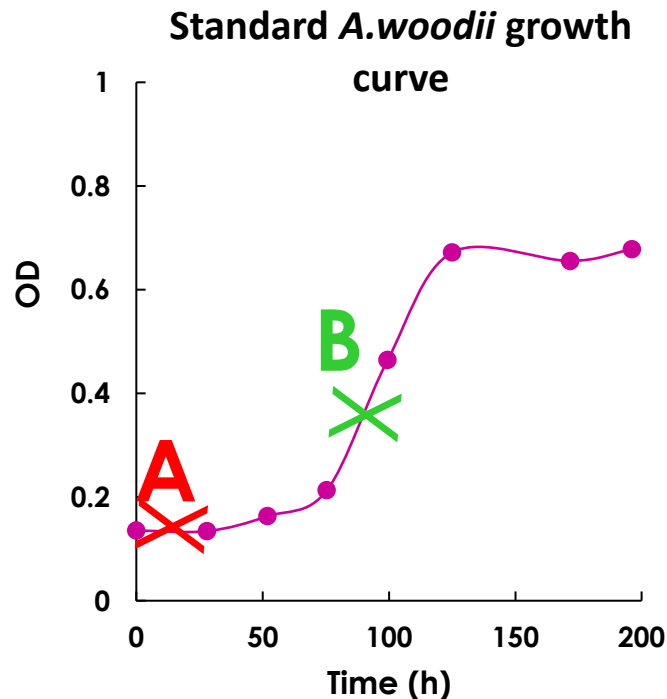
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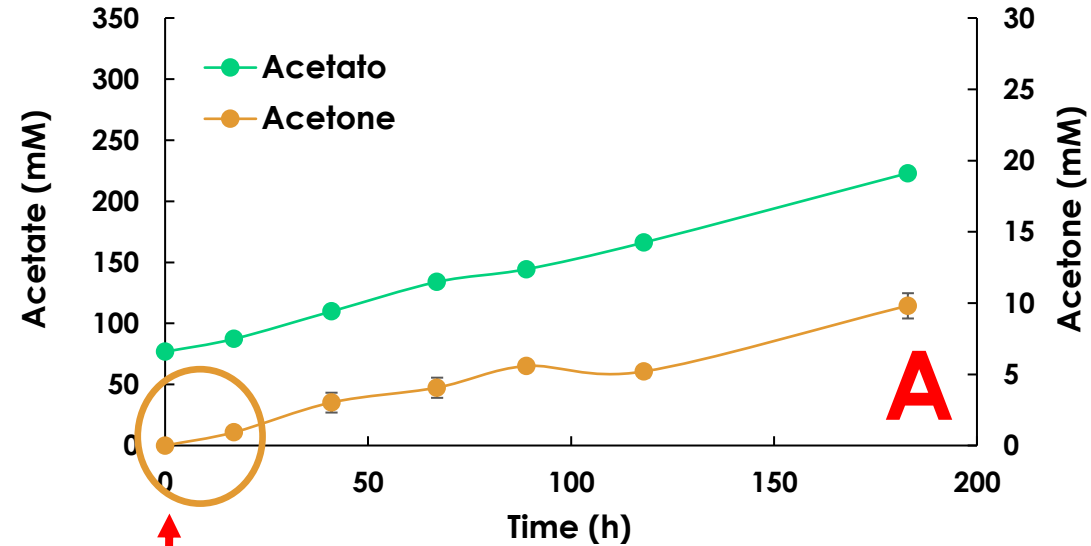
Acetone production



Serum bottles (Gas fed-batch, P atm, 70% H_2 - 30% CO_2)



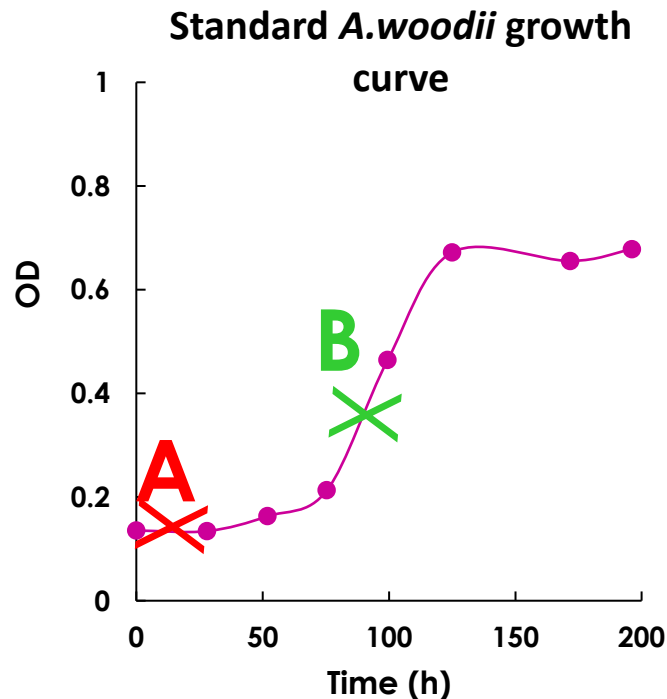
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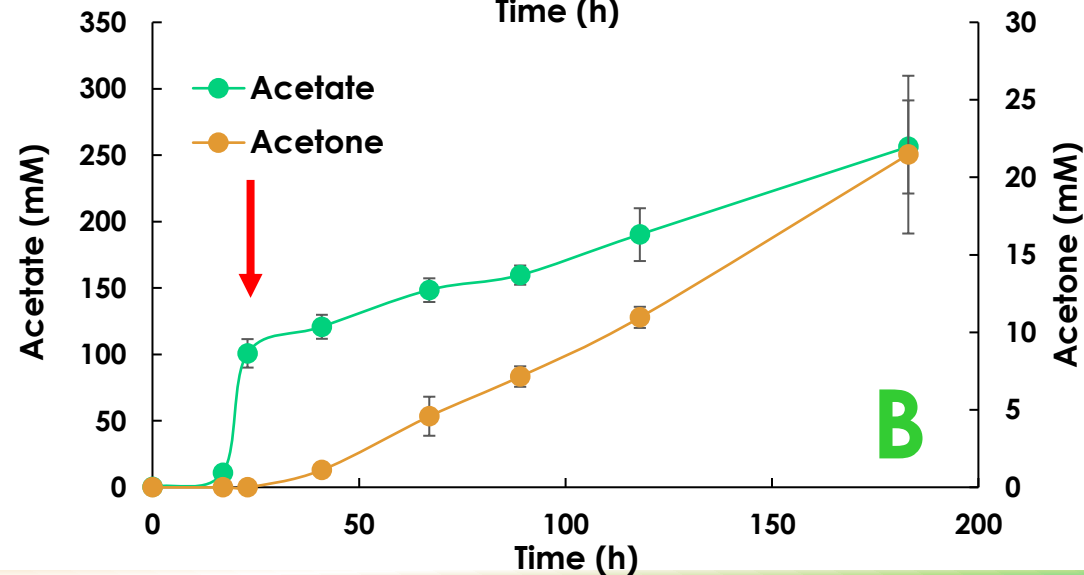
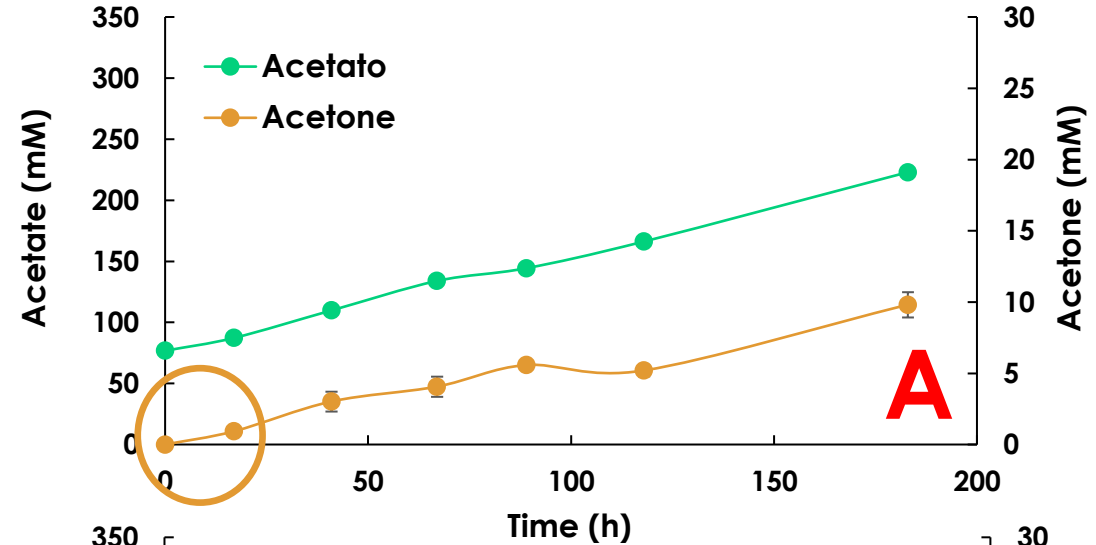
Acetone production



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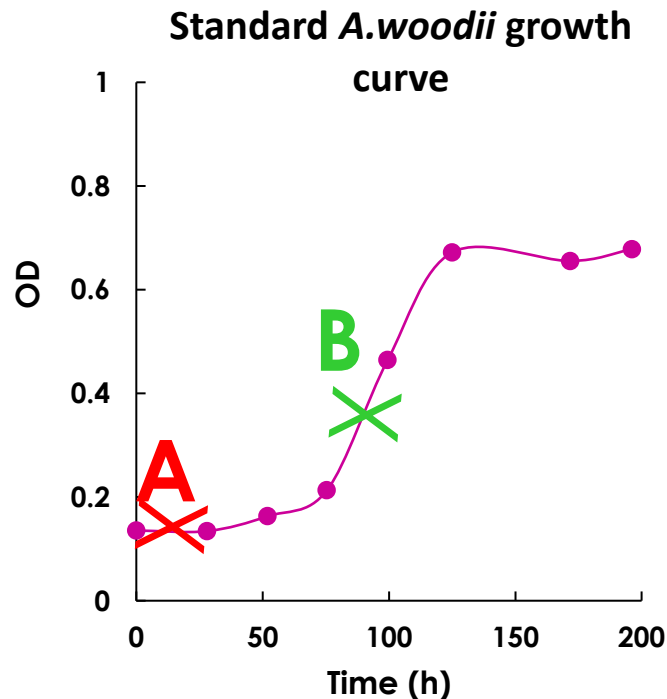
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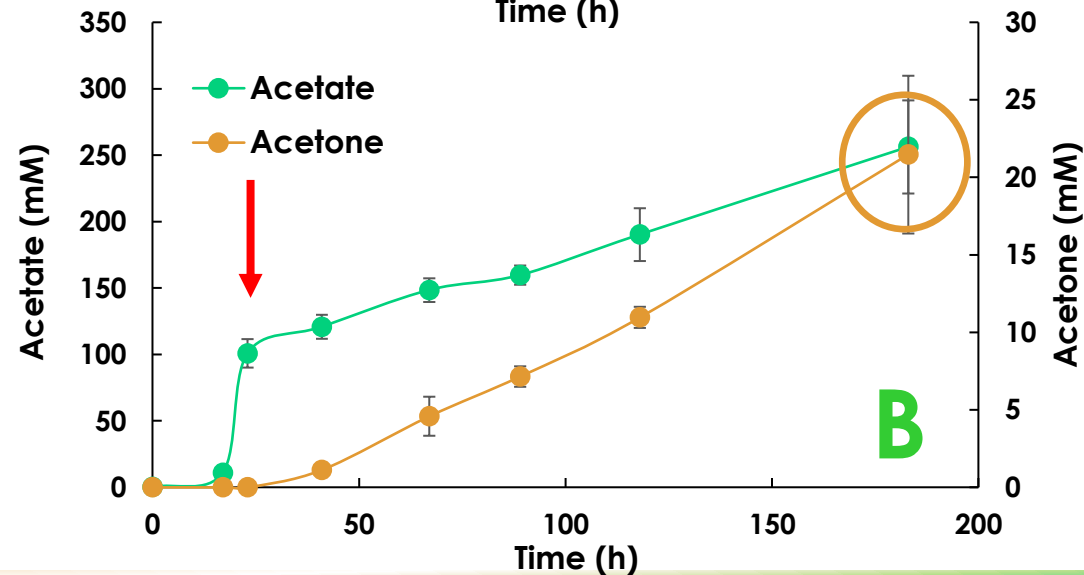
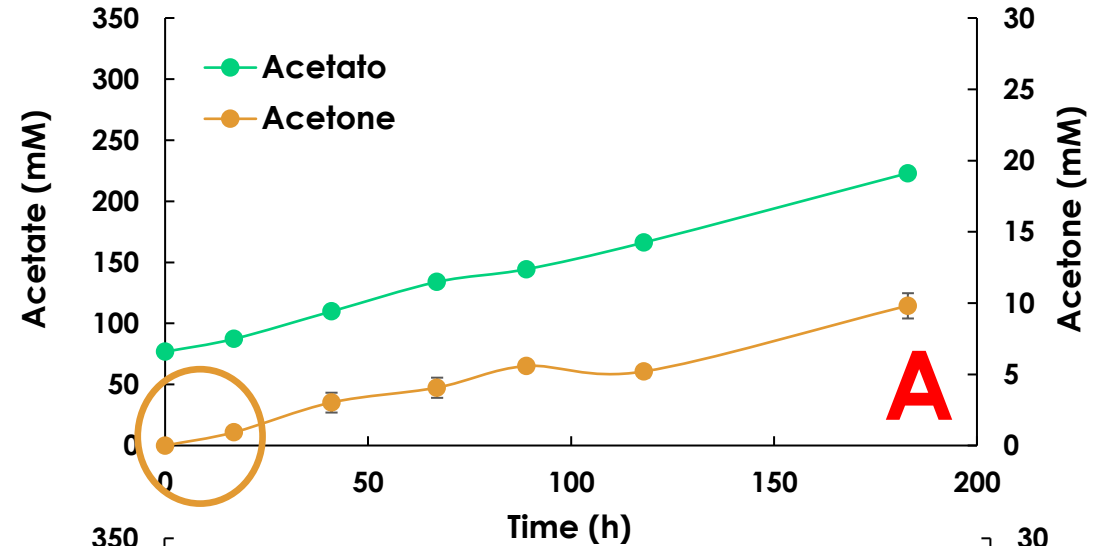
Acetone production



Serum bottles (Gas fed-batch, P atm, 70% H_2 - 30% CO_2)

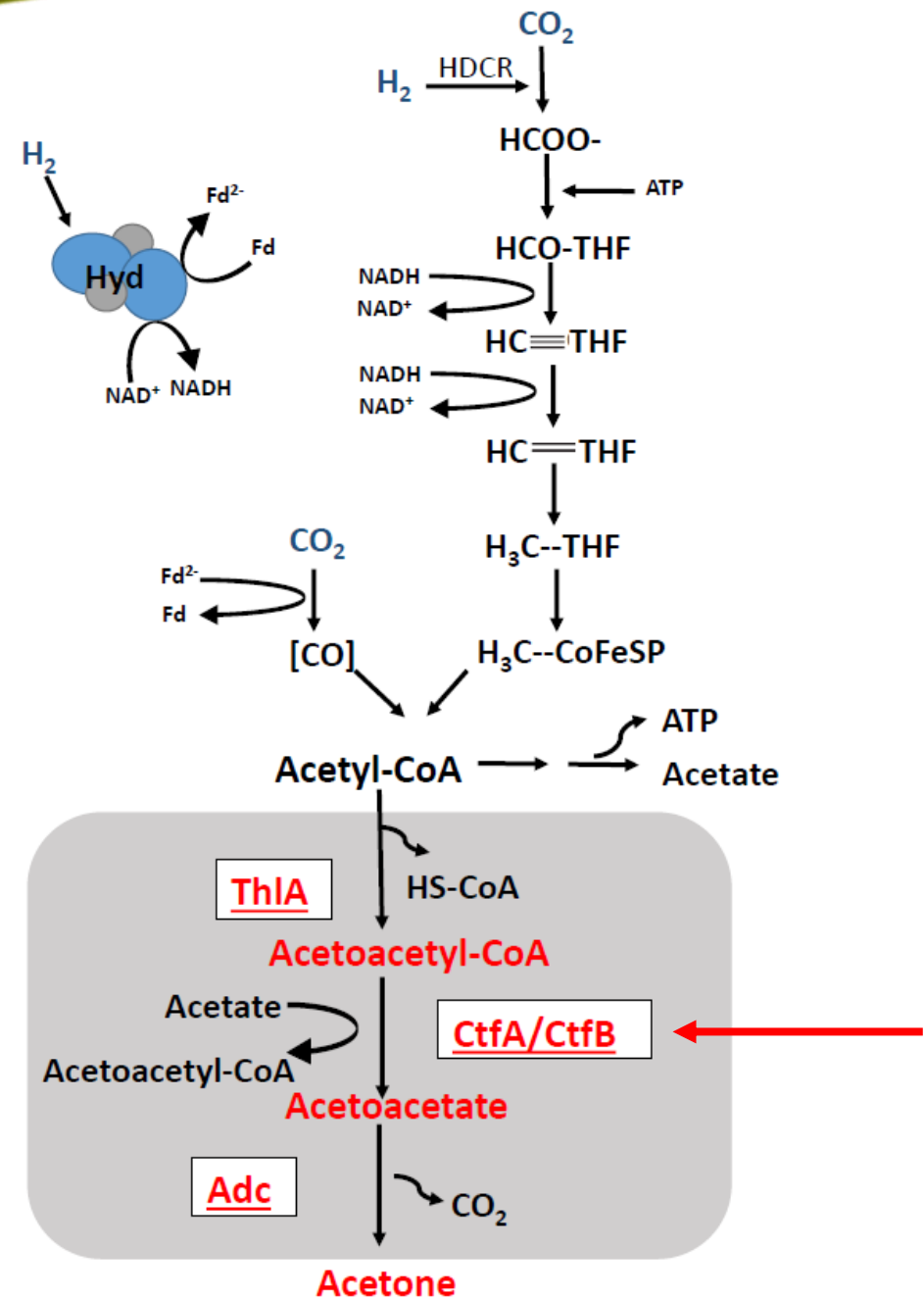


100 mM acetate added in **A** or **B**



Acetone production

Influence of acetate on acetone production



Conclusions



❖ Growth of a **modified *A. woodii*** strain for **acetone production**

❖ Influence of **acetate** concentration on **acetone** synthesis

Serum bottles at
atmospheric pressure

Reactor at atmospheric
pressure

Reactor at 10 bar pressure



Conclusions



❖ Growth of a **modified *A. woodii*** strain for **acetone production**

❖ Influence of **acetate** concentration on **acetone** synthesis

Serum bottles at
atmospheric pressure

Reactor at atmospheric
pressure

Reactor at 10 bar pressure

Serum bottles at atmospheric
pressure
WITH EXOGENOUS ACETATE

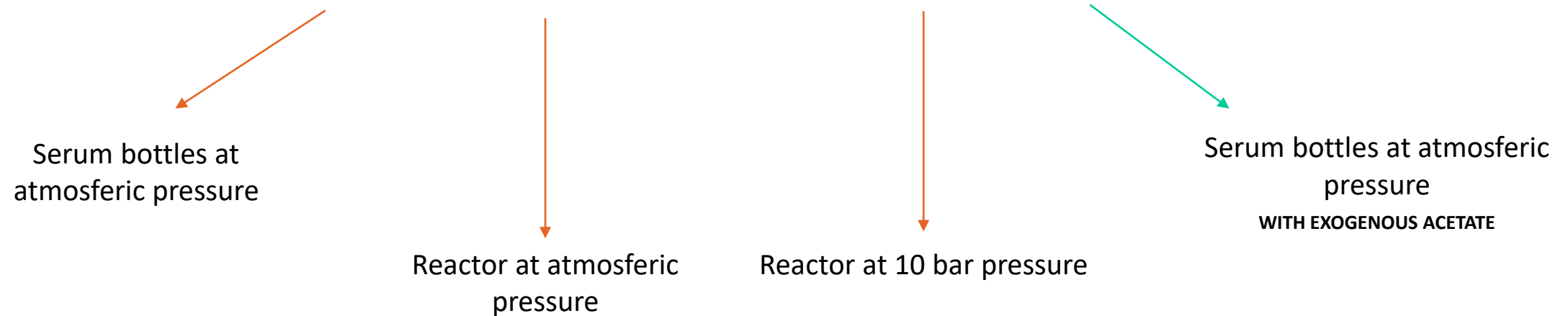


Conclusions



❖ Growth of a **modified *A. woodii*** strain for **acetone production**

❖ Influence of **acetate** concentration on **acetone** synthesis



- Process at high acetate concentration in the medium
 - Metabolic engineering of the strain



Aknowledgements



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The ENGICOIN project has received funding from
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Thank you for your attention



Acetone production



REACTOR - Liquid batch, gas batch/continuous, 10 bar

