# Efficient Butanol Vapor Removal Eliminates Measurement Cross-Sensitivity and Health Risks

H.-J. Schulz, V. Berger, P. S. Bauer, M. Dollner, A. Boies, J. Swanson

**APT 2026 – Aerosol & Particle Technology**

Catalytic Instruments GmbH & Co.KG, 83026 Rosenheim, Germany

# Introduction

- New EU Directive requires Particle Number Concentration (PNC)
- EN16976:2024 requires butanol as working fluid in CPCs
- **Butanol-CPCs...**
  - show good activation behavior, i. e. small particles can be detected
  - are generally well characterized due to their widespread use


# Introduction

- **Disadvantages of butanol:**
  - Flammable
  - Pollution of our environment if vented
  - Unpleasant smell (odor threshold 1 to 15 ppm)
  - Health hazard


H226 Flammable liquid and vapour. H302 Harmful if swallowed. H315 Causes skin irritation. H318 Causes serious eye damage. H335 May cause respiratory irritation. H336 May cause drowsiness or dizziness.

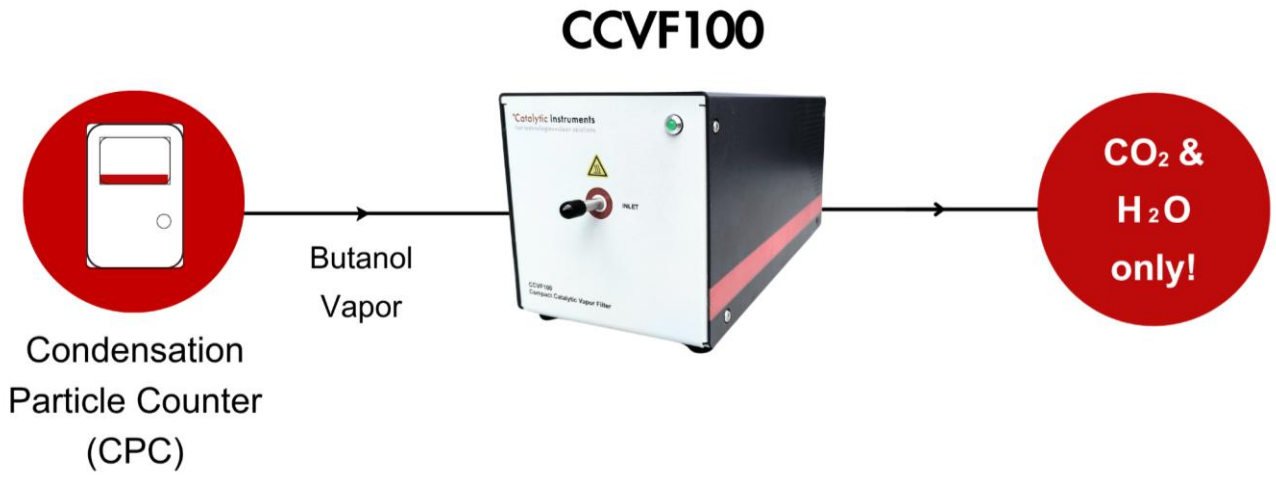
# Butanol Shows Cross-Sensitivity with Benzene

- Cross Sensitivity with Benzene
  (shown at 8. GRIMM Erfahrungsaustausch, Saxon State Company for Environment and Agriculture)
- Typical immission benzene values range between 0.5 and 1.0 µg/m³
- Cross-sensitivity can lead to values between 16 and 33 µg/m³
- Toluene and xylene measurements remain unaffected

⇨ butanol vapor from CPC exhaust needs to be treated

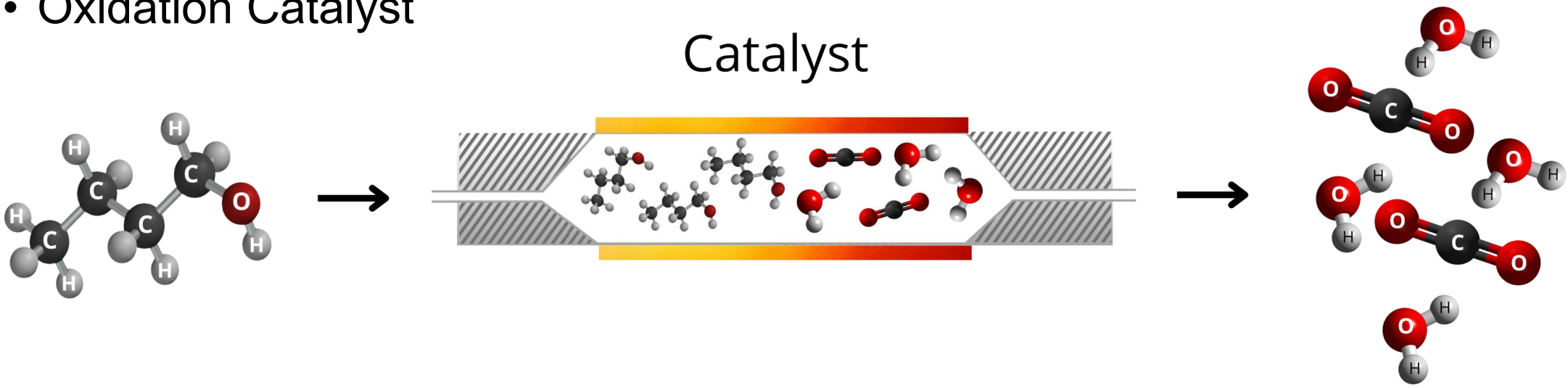
# How to Treat  Butanol

- Dilution is the solution to pollution?
  - High dilution ratio needed, e. g. 1:1000, resulting in 1000 L/min for a 1 L/min-CPC
- Charcoal filters
  - need to be replaced frequently
- Catalytic Vapor Filter (CVF)



# How does the Catalytic Vapor Filter work?
## The Principle

- Oxidation Catalyst

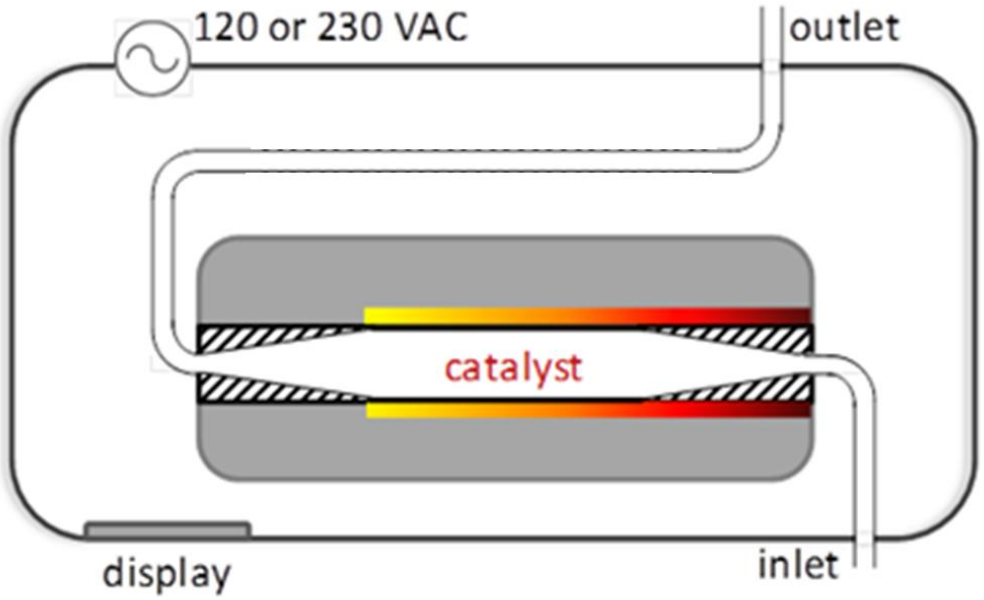



Butanol + Oxygen → Carbon Dioxide + Water

- Hot catalyst enables chemical reaction at lower temperatures
- We use a custom formulation of precious metals for our catalysts

# How does the Catalytic Vapor Filter work?
## The Implementation

- Catalyst temperature is controlled to > 300 °C
- Catalyst is thermally insulated
- Gas is cooled before exiting the device
- CVF can be used upstream or downstream of the CPC pump

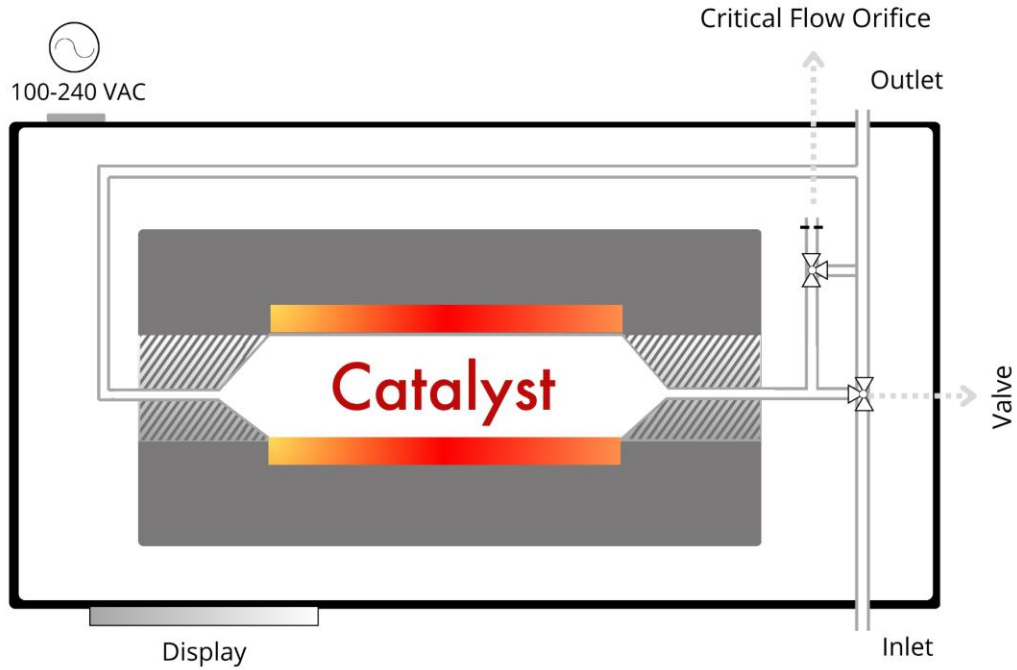


# Advantages of the Catalytic Vapor Filter


- No consumable parts
- Low maintenance
- Excellent thermal insulation
  - Housing gets hand-warm
  - Low heat emission
- No moving parts
- Low electric energy consumption (exothermal reaction)
- Safe to use:
  - Flame arrestor
  - Optional safety valve function

# CVF400-V

- 400 = 4 L/min max. flow rate
- -V = Valves = safety valves inside the housing
- Optional 19“ rack mount
- Alarm output
  - Relais
- Manual alarm reset
  - Close electrical contact to reset

# CCVF100

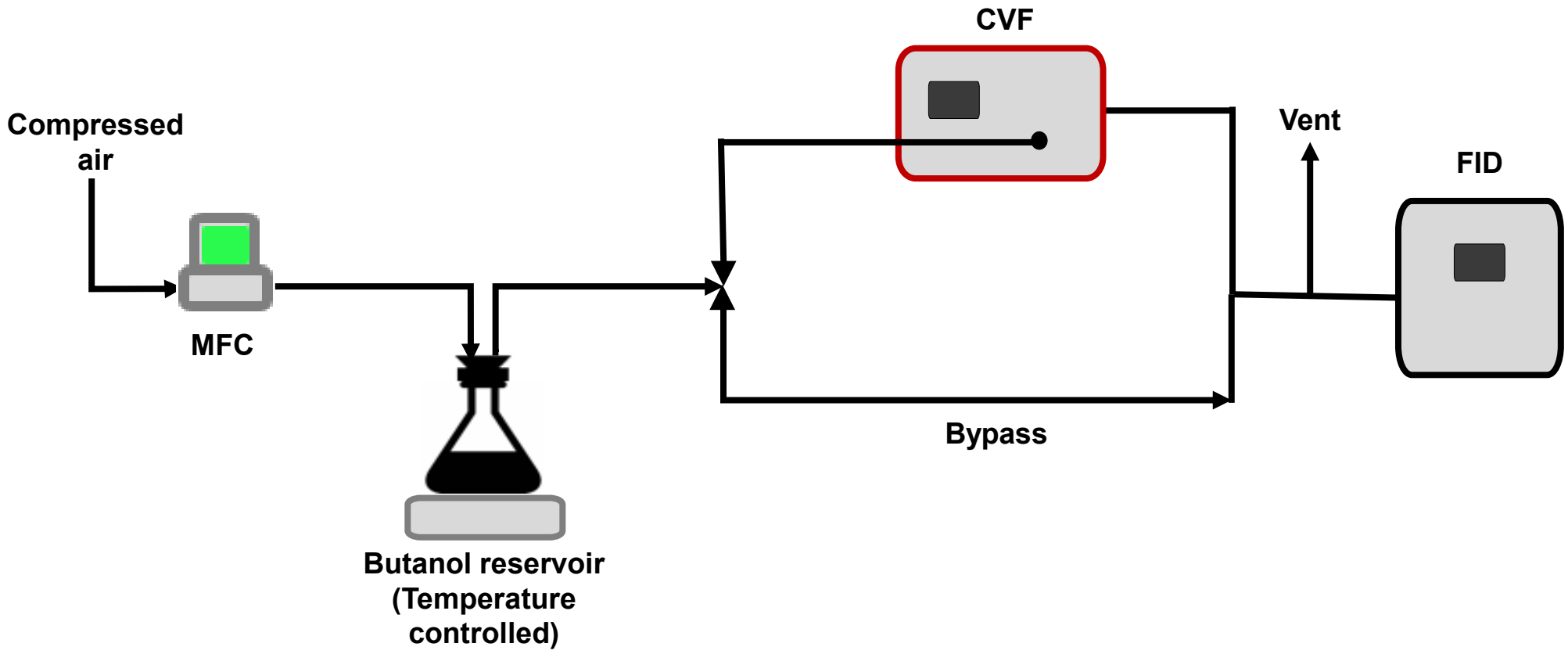
- Max. flow rate 1.5 L/min
- For one CPC
- Built-in flame arrestor
- Can be used upstream or downstream of CPC pump

**Remove noxious Butanol vapour from CPCs**

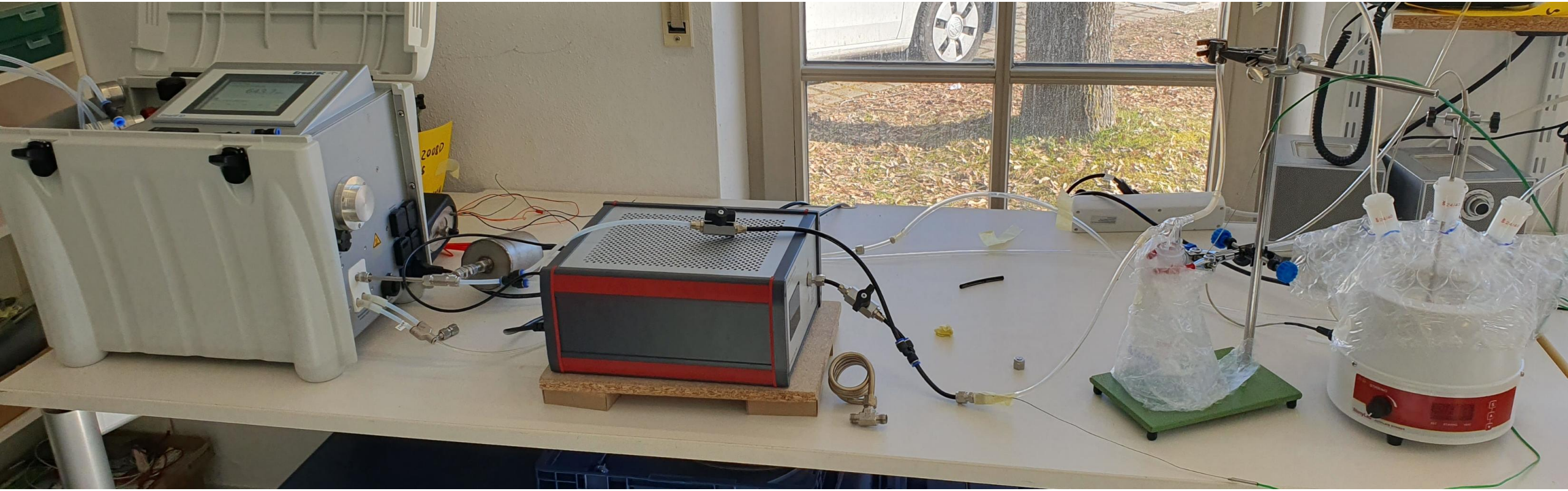

**Compact °Catalytic Vapor Filter**
**CCVF100**

# How effective is the Catalytic Vapor Filter?

- Experiments to validate Butanol Oxidation Efficiency
  - Device under test: CVF100, 1 L/min nominal flow rate



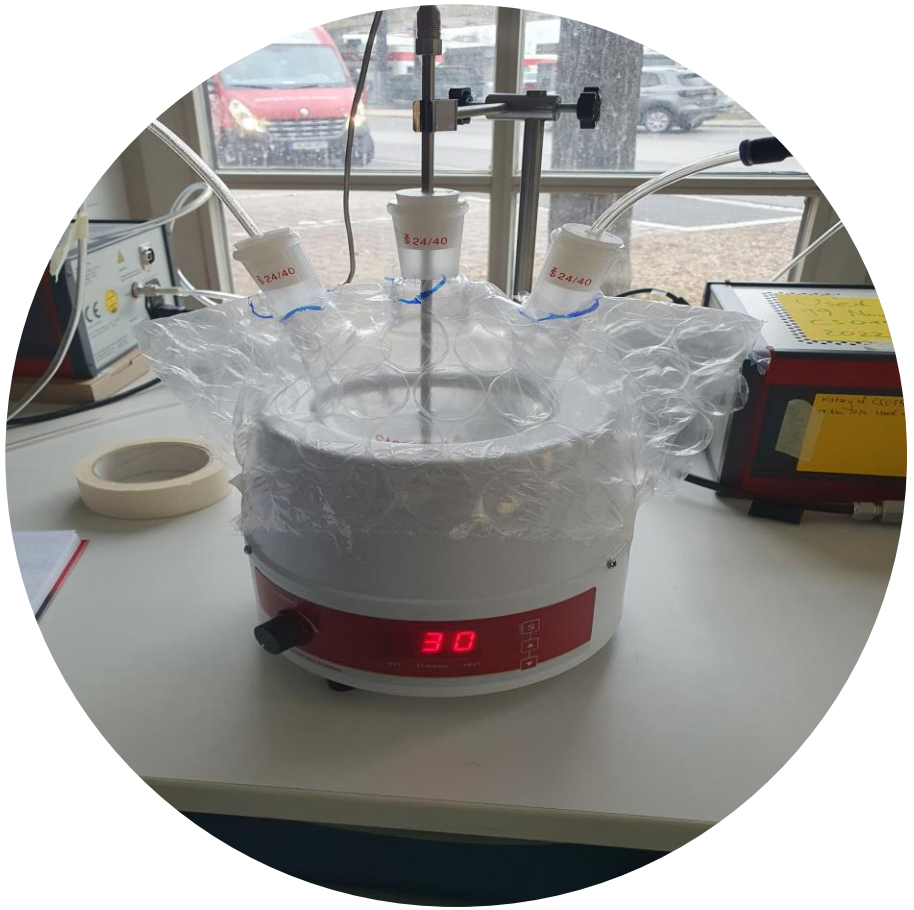
# Experimental Setup | Butanol Oxidation Efficiency



# Butanol Generator

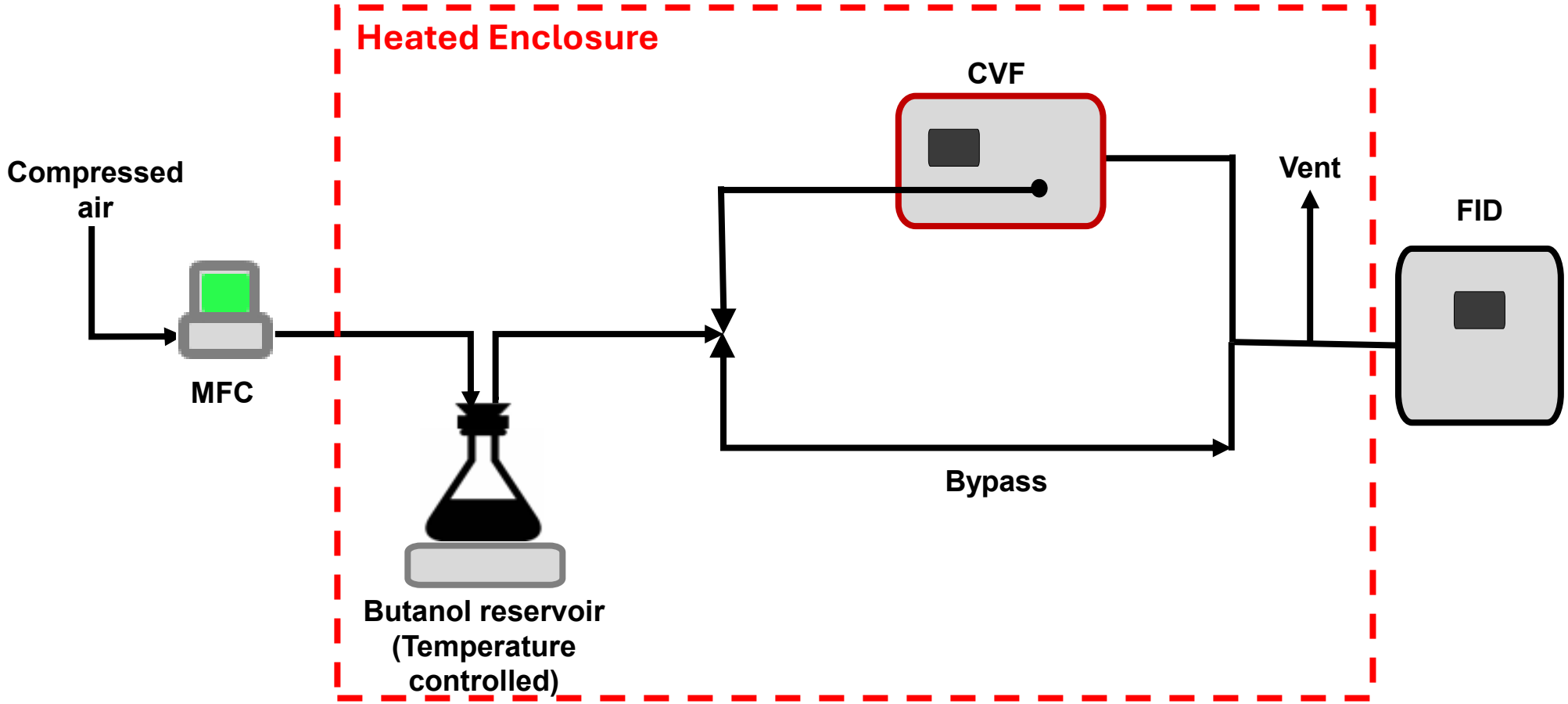
- Generated butanol vapor concentration
  ≙ dew point
- Heated lines recommended if line temperatures are lower than dew point
  - Heated lines are expensive, even low temperature (60 °C) ones

→ **Solution: Heated housing**



# How effective is the Catalytic Vapor Filter?

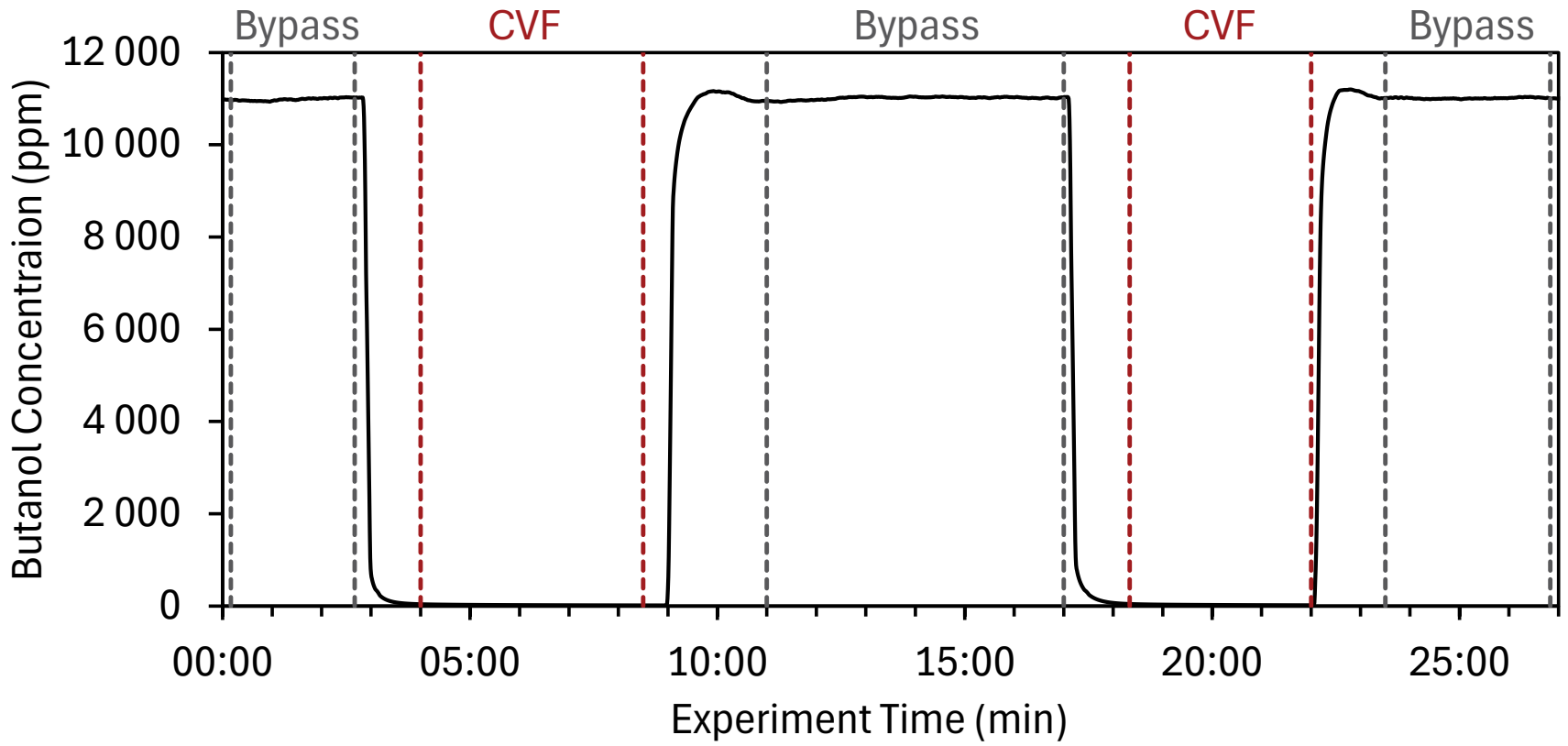
- Experiments to validate Butanol Oxidation Efficiency
  - Device under test: CCVF100, 1 L/min nominal flow rate



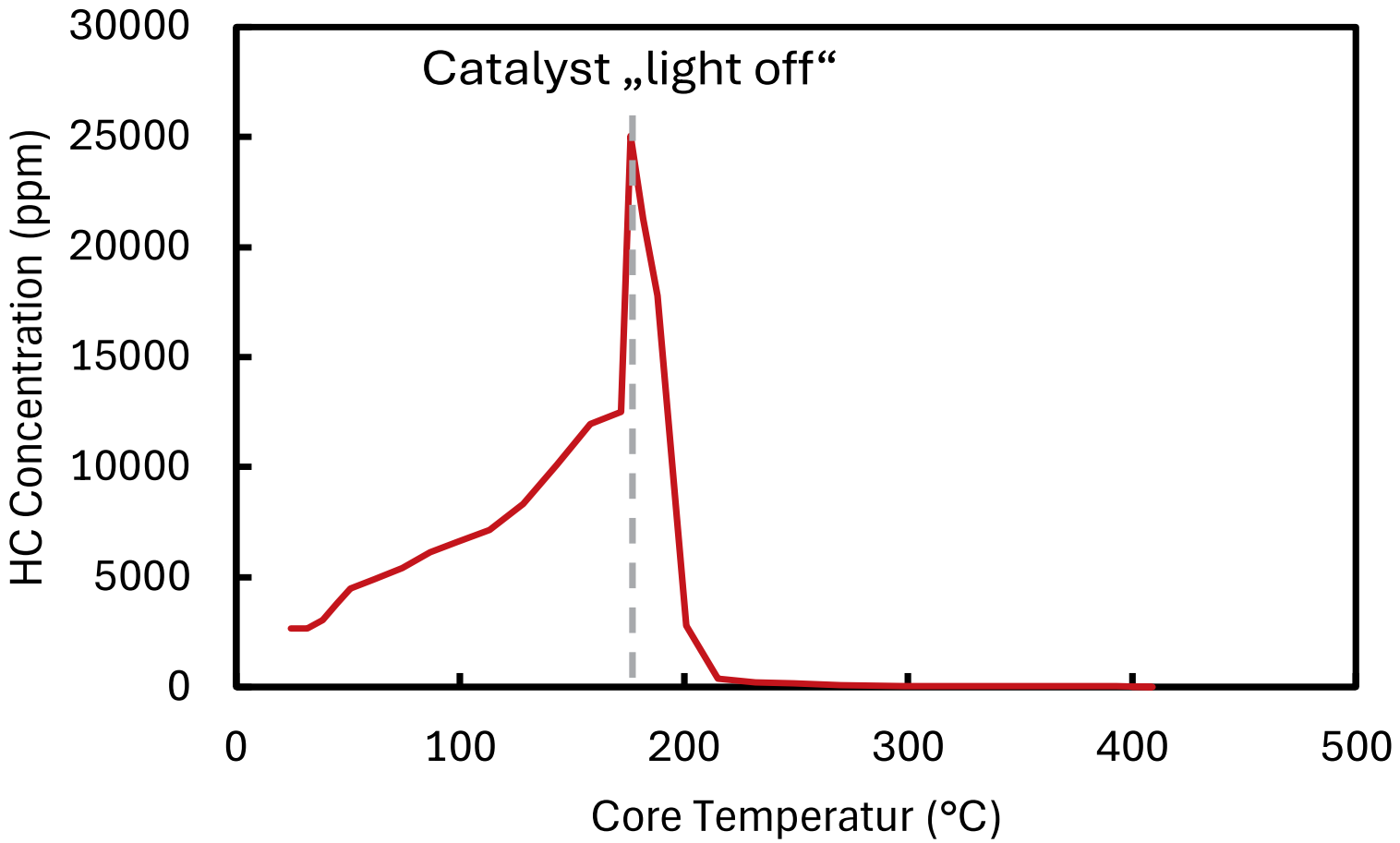
# Butanol Oxidation Efficiency

- Flame Ionization Detector measures hydrocarbon concentration
- Comparison of inlet and outlet concentration at CVF

$$\eta = 1 - \frac{C_{out}}{C_{in}}$$

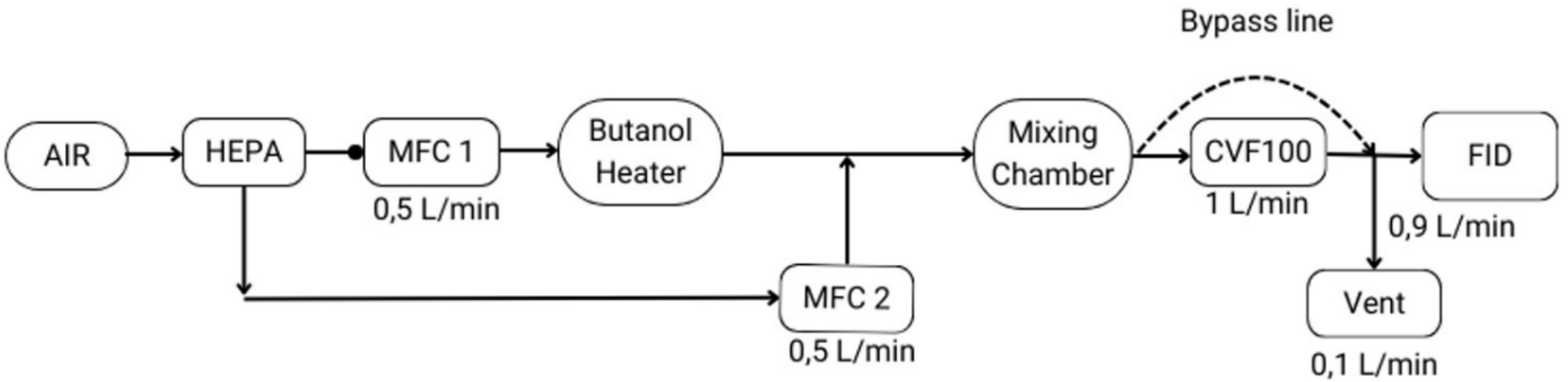


# CVF Catalyst Light Off

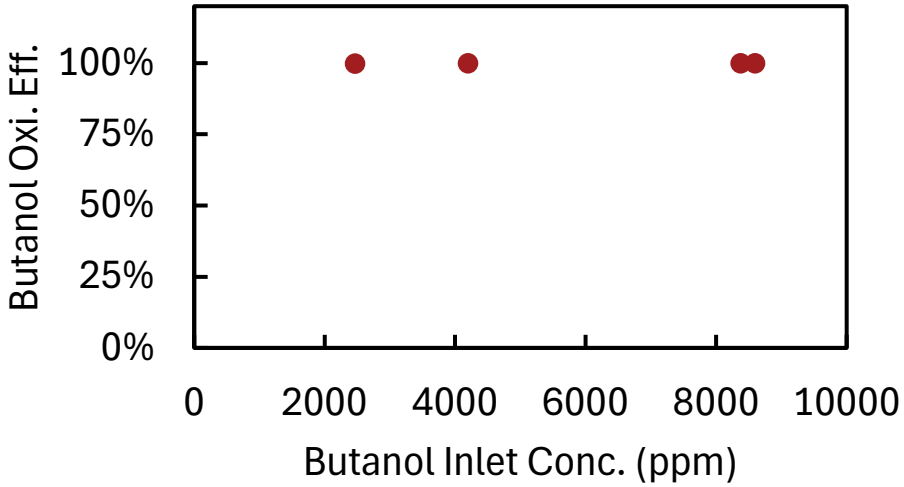


# Variation of Butanol Concentration

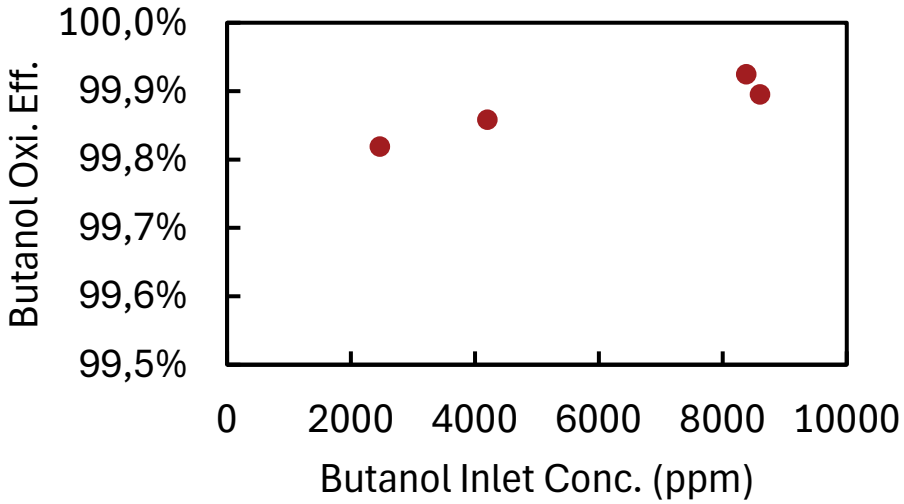
- Dilution is the solution
- Typical CPC exhaust butanol concentration ≈ 9000 ppm
- Flow rate kept at 1 L/min (= nominal flow rate of CVF100)

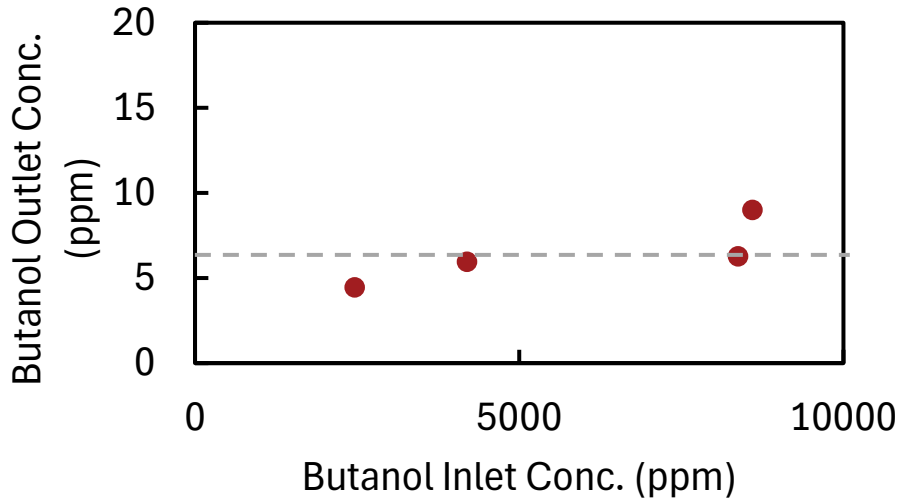


# Variation of Butanol Concentration



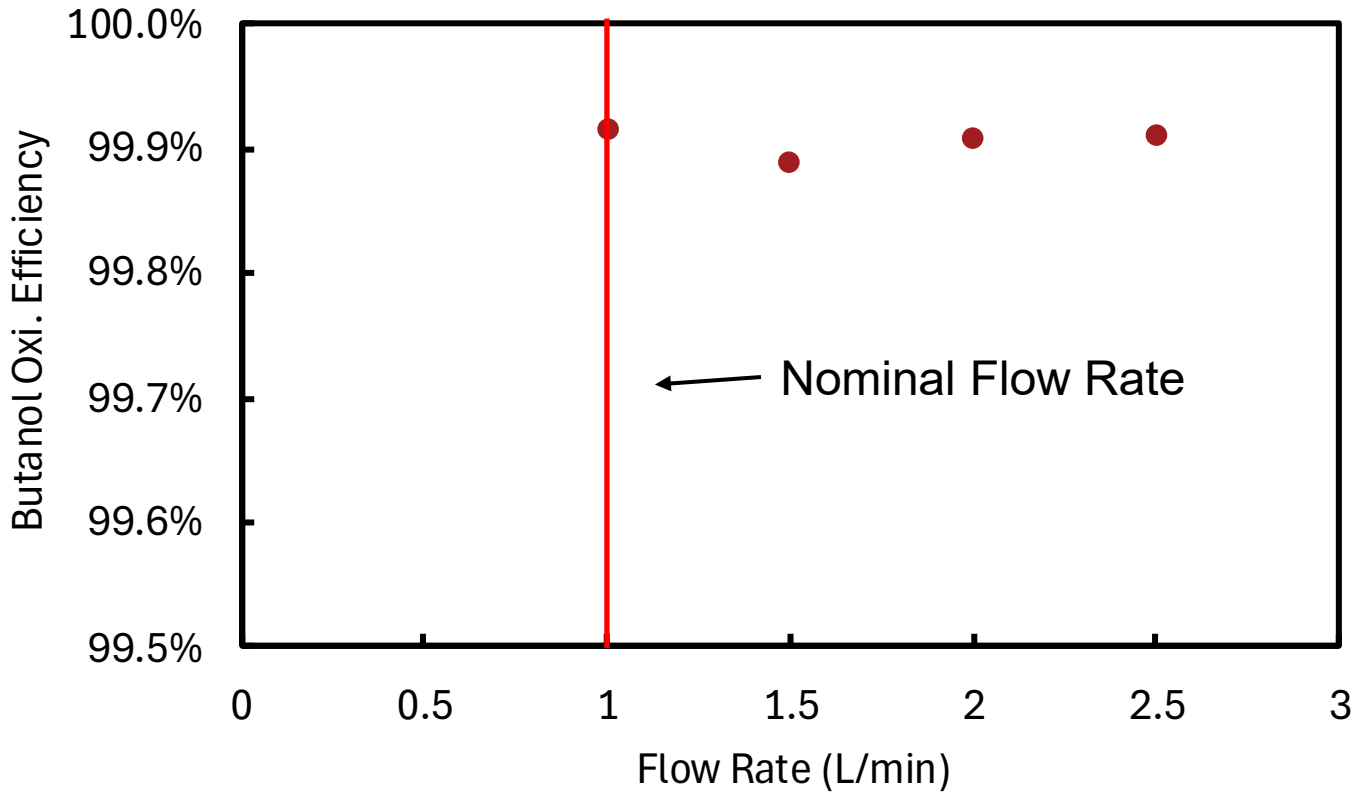

- CVF100 shows excellent butanol oxidation efficiency



# Butanol Vapor Flow Rate Variation

- Caution! CVF100 is operated beyond its specification!
  - Outlet temperatures rise above specification for more than 1.5 l/min



# Summary

- Butanol is commonly used as CPC working fluid
- To avoid health hazards and wrong benzene readings due to cross-sensitivity, CPC butanol vapor needs to be treated
- The Catalytic Vapor Filter is an effective and reliable way to remove butanol by converting it into harmless carbon dioxide and water
- CVF butanol oxidation efficiency is higher than 99.8 %

# °Catalytic Instruments®

hot technologies · clean solutions


## Contact us

Elevate Your Aerosol Measurement Precision with us!

sales@catalytic-instruments.com

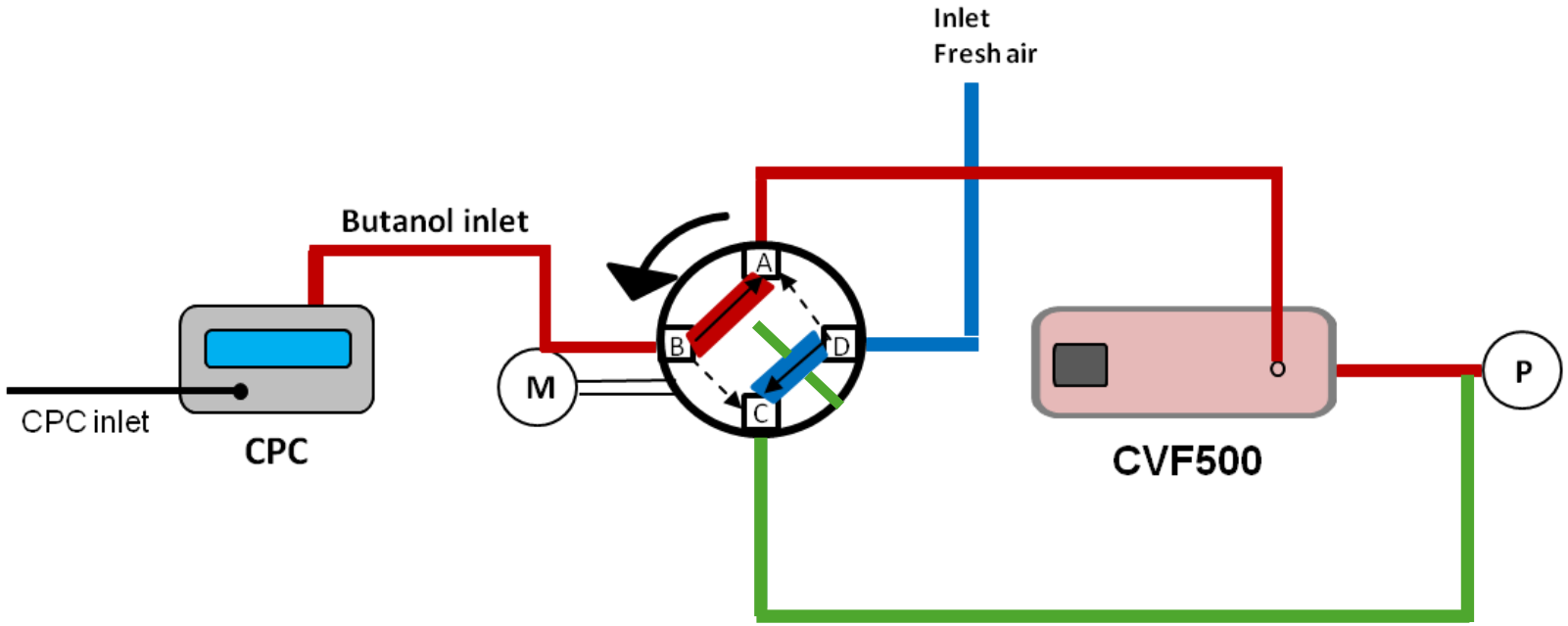
# Thank you for your attention!

# CVF400-V

- 400 = 4 L/min nominal flow rate
- -V = Valves = safety valves inside the housing
- Optional 19“ rack mount
- Alarm output
  - Relais
- Manual alarm reset
  - Close electrical contact to reset

# CVF500 Safety Valve Function

- If temperature is not within operating range: alarm condition
- Safety valve switches, butanol bypasses the catalyst, catalyst is purged with air
- Upgrade for continuous CPC operation available (green lines + CFO)



# CVF500 Safety Valve Function

- If temperature is not within operating range: alarm condition
- Safety valve switches, butanol bypasses the catalyst