# On Destruction of Volatile Organic Compounds using a Dielectric Pellet Packed-Bed Reactor

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## Introduction

- Volatile Organic Compounds (VOC's) are widely used in industrial application (chemical processing, pharmaceutical industry)
- Appearance in e.g. paint, rubber, solvents or detergents
- Ethylene for example is world-wide used in the petrochemical industry
- VOC's are suspected or known to cause cancer or damage the central nervous system of humans
- Toluene e.g. is suspected to harm the embryo
- Accumulation of VOC's in the environment (air, ground water) has to be avoided
- Therefore, VOC contaminated waste gas exhaust has to be cleaned

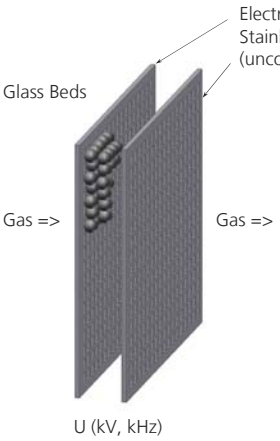
## Conventional techniques of VOC removal [1]

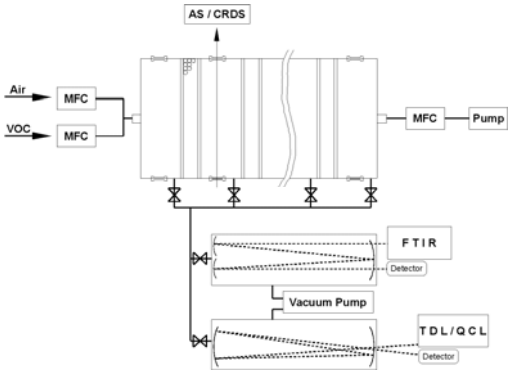
- Active carbon adsorption
  Restriction: disposal costs of carbon
- Thermal incineration
  Restriction: high energy to heat the gas volume
- Thermal catalysis
  Restriction: expensive catalyst, high energy for heating

## The Dielectric Pellet Packed-Bed Reactor

- New five stage reactor developed and tested
- Based on work of Whitehead and co-workers [1]
- Five stages arranged in series
- Tube connection between each stage for gas sampling
- IR transparent windows between each stage for IR Spectroscopy

### One Stage



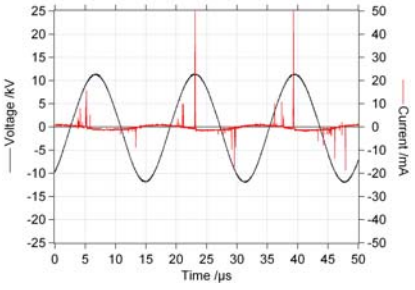



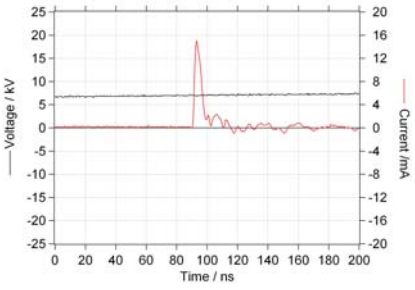

**Ex situ Diagnostic:**

- Fourier Transform Infrared (FTIR) Spectroscopy
- Tuneable Diode Laser Absorption Spectroscopy (TDLAS)
- Quantum Cascade Laser Absorption Spectroscopy (QCLAS) [2]
- Cavity Ring Down Spectroscopy (CRDS) (Planed to use)

## Voltage and Current Measurement

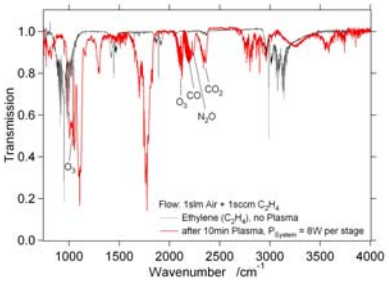
- Two glass beds (6mm Diameter) hold between two stainless steel electrodes
- Power Supply: Softal 6320 + AT6006L
- Current Measurement: Tektronix CT-1 (Rogowski Coil)
- Voltage Measurement: Tektronix P6015A




## Results of the first Measurements of Ethylene Destruction

- Three stages were used
- Each stage was fed with P = 8W
- Each stage was driven with a NeonPro High Voltage Power Supply (NP-10000-30)
- Species identification was done using a Fourier Transform Infrared (FTIR) Spectrometer (Bruker IFS 66v/S) combined with a 32.5m long path cell (White Cell).
- Input Gas Mixture: 1slm Air + 1sccm $C_2H_4$




- Ethylene was removed from the gas stream
- Produced By-products: $O_3$, $N_2O$, CO at a input power of P=8W per stage
- Unmarked species are not identified yet
- Synergetic Effect was reported [1]
- Connecting single stages in series is more efficient in Ethylene destruction than a parallel arrangement

References:

[1] Harling, A.M., Glover, D.J., Whitehead, J.C., Zhang, K., Novel Method for enhancing the destruction of environmental pollutants by the combination of multiple plasma discharges, Environ. Sci. Techol.

[2]Harling, A.M., Glover, D.J., Whitehead, J.C., Zhang, K., Industrial Scale Destruction of Environmental Pollutants using a Novel Plasma Reactor, Industrial and Engineering Chemical Research

[3] Röpcke, J., Lombardi, G., Rousseau, A. and Davies, P.B., *Plasma Sources Sci. Technol.* (2006) 148-168.

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