

Byproduct formation of TCE abatement: comparison between a plasma-alone and a post-plasma Pd/Al₂O₃ catalytic system

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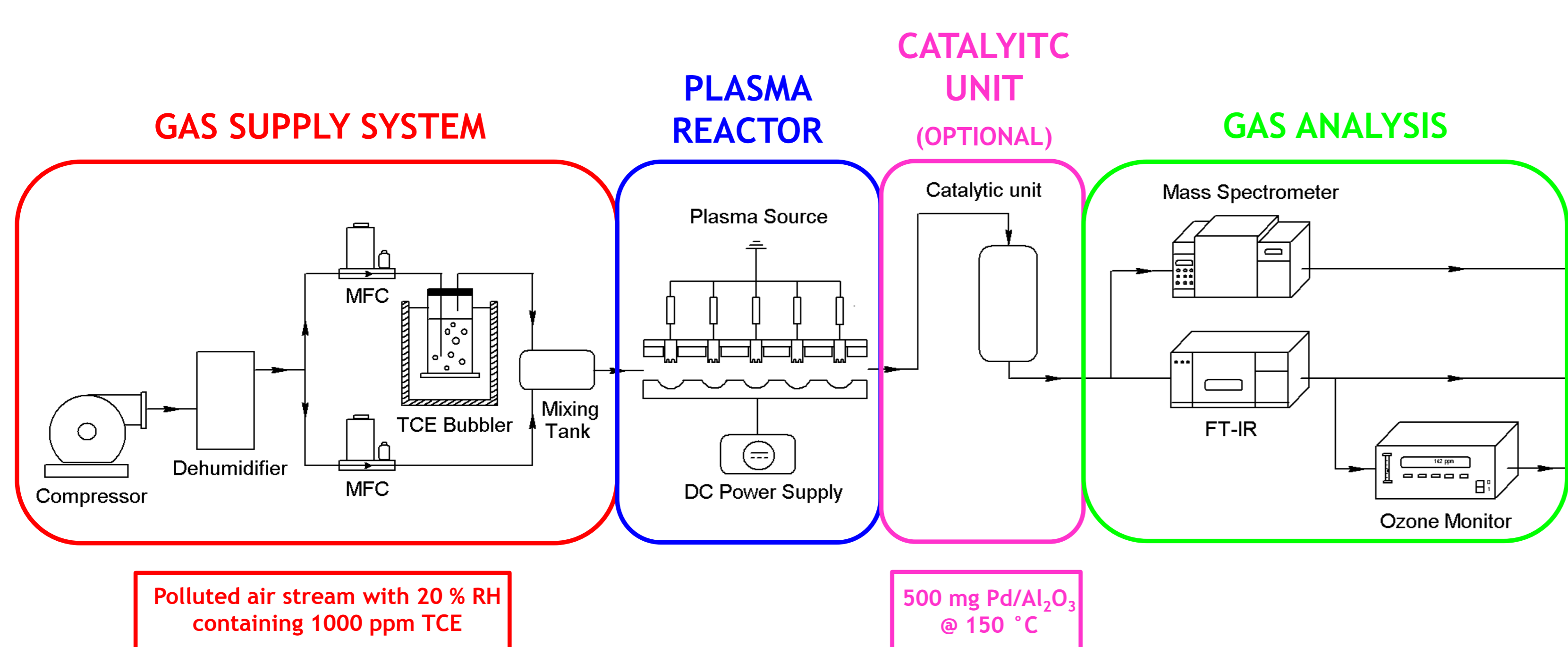
Introduction

Trichloroethylene is a volatile organic compound (VOC) that has adverse effects on the environment and on human health [1]. Non-thermal plasma (NTP) generated at atmospheric pressure, has proven to be an effective technology to remove VOCs from waste gas streams [2]. The selective acceleration of electrons (1-10 eV) produces radicals through collisions with background gas molecules (e.g. N₂, O₂, H₂O) which remain near ambient temperature. These radicals are capable of destroying different VOCs simultaneously at a low operating cost. However, the formation of unwanted byproducts and a low mineralization degree remain bottlenecks to scale this technique to industrial size [3].

To resolve these weak points, the combination of NTP with heterogeneous catalysis has been investigated and has shown to induce a synergy in certain hybrid systems. Also, a higher CO₂-selectivity and energy-efficiency have been reported [4].

In this study, a DC excited atmospheric pressure glow discharge has been coupled with a catalytic unit downstream to effectively lower the formation of certain unwanted byproducts of TCE abatement which were detected with FT-IR and mass spectrometry.

Experimental set-up

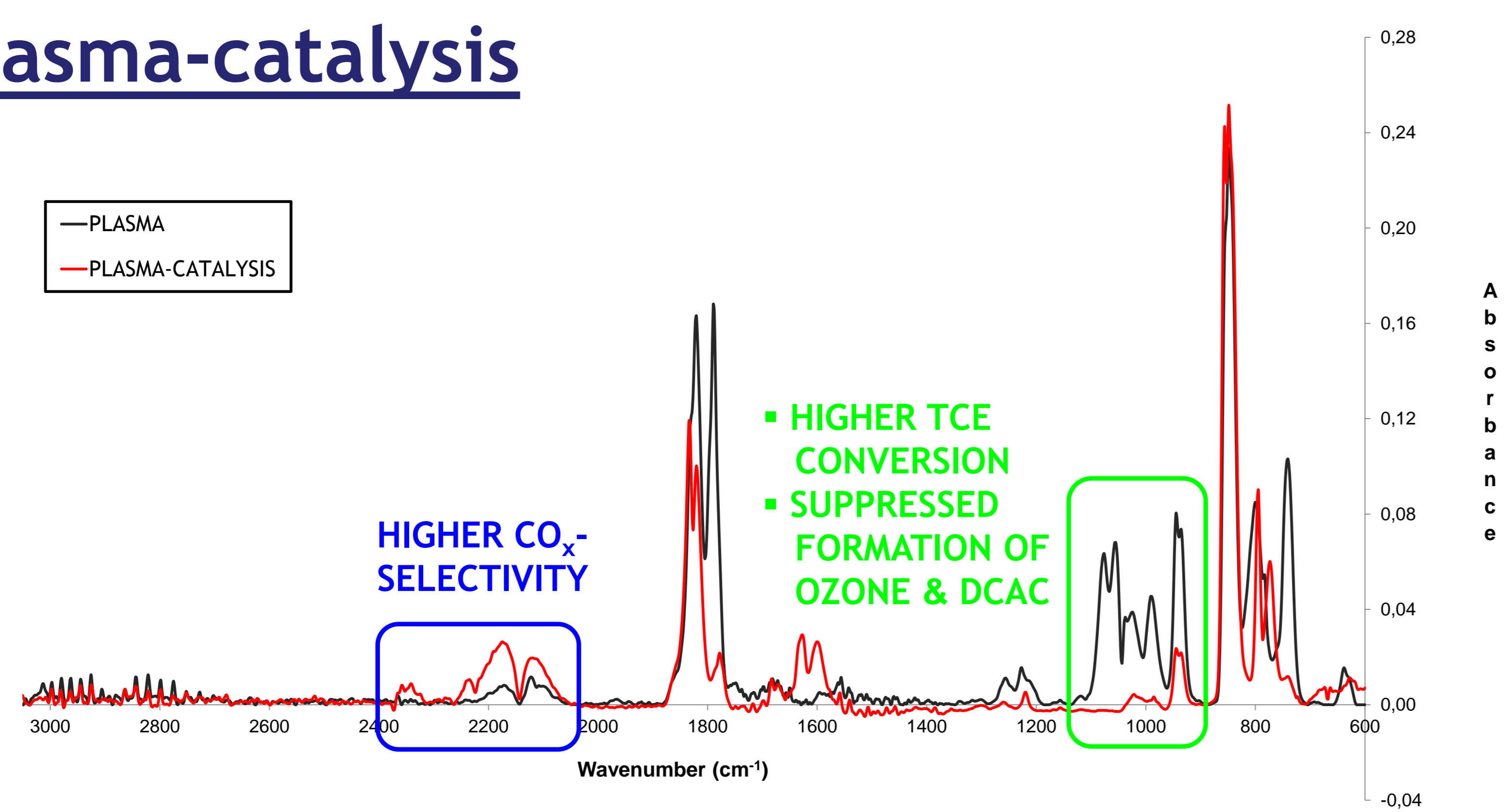


Detected byproducts with NTP

Byproduct	FT-IR	MS	Info
DCAC *	✓	✓	
COCl ₂	✓	✓	
O ₃	✓		Interference
HCl	✓		Interference
CO	✓	✓	
CO ₂	✓	✓	
Cl ₂		✓	IR transparent
TCAA **		✓	No reference IR spectrum found

DCAC *: Dichloroacetylchloride TCAA **: Trichloroacetaldehyde

Plasma-catalysis



Future work

- Calibration of the FT-IR spectrometer for chlorinated byproducts
- Elucidation of the decomposition scheme of TCE with NTP treatment
- Influence of the initial TCE concentration and air humidity on the removal process
- Tests with other catalysts such as CeO₂-MnO₂

Conclusion

The NTP treatment of waste gas containing dilute TCE has led to an incomplete oxidation due to the formation of unwanted byproducts such as DCAC, TCAA, phosgene and ozone.

By combining the plasma reactor with a catalytic unit downstream, a higher TCE conversion and CO_x-selectivity have been obtained while formation of ozone and DCAC were suppressed.

References

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- [4] Vandembroucke A.M., Morent R., De Geyter N. and Leys C., J. Hazard. Mater., 195, (2011), 30-54.