



# Decomposition of chlorinated organic compounds using non-equilibrium plasma reactor



Bogdan Ulejczyk, Krzysztof Krawczyk, Magdalena Hajduk, Marta Musiał, Bartłomiej Wnęk, Michał Młotek, Krzysztof Schmidt-Szałowski

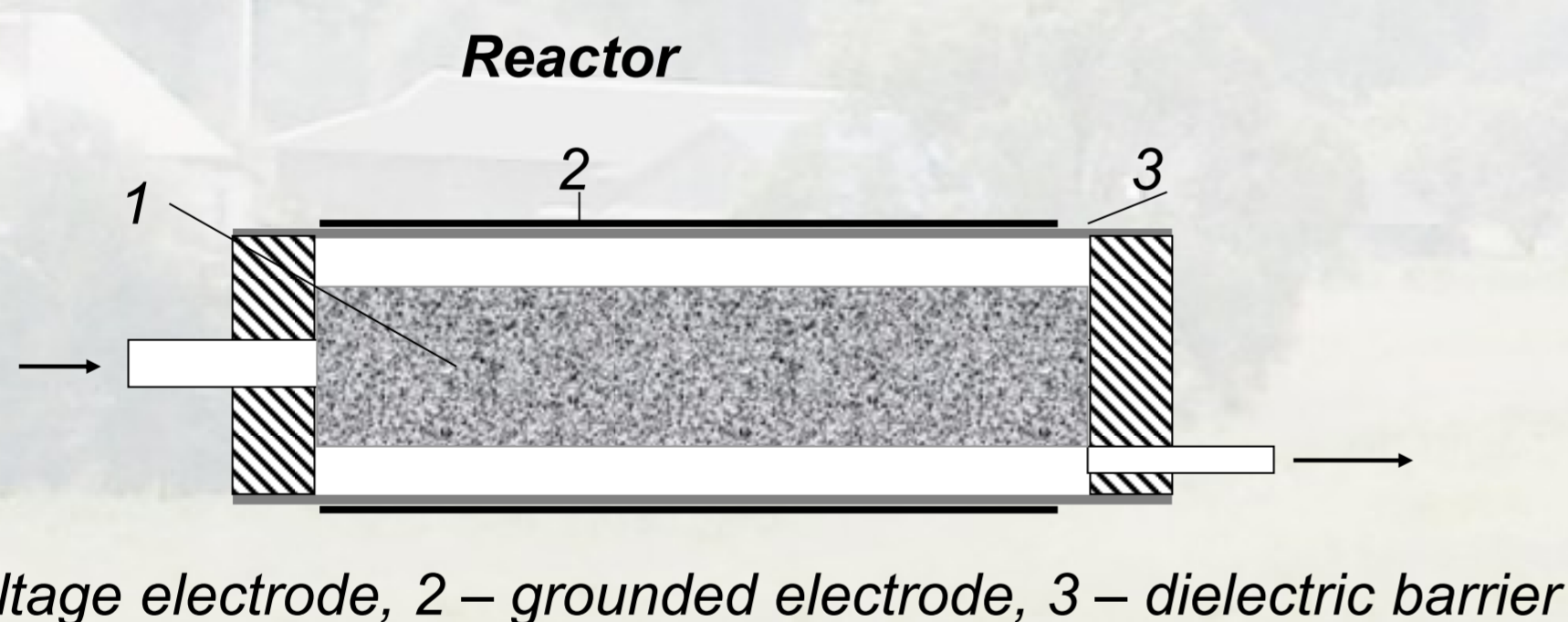
Faculty of Chemistry, Warsaw University of Technology, Noakowskiego 3, 00-664 Warszawa, Poland

Volatile organic compounds cause the greenhouse effect. They often possess toxic properties. Moreover some of them cause decomposition of ozone. For the utilization of pollutants in the place of their emissions one can use biological decomposition, catalytic decomposition, plasma decomposition or plasma-catalytic processes. Plasma which is used for the decomposition pollutants, can be generated in electron beam or various electric discharges: corona, barrier, gliding, microwave and spark.

This study is focused on the decomposition of  $\text{CCl}_4$ ,  $\text{CHCl}_3$  and  $\text{C}_2\text{HCl}_3$  using a semi-corona discharge. The decomposition process was run in a new construction of the reactor to improve the efficiency of the chemical reactions initiated by the discharge. In this reactor, a high-voltage electrode was made from a porous tube of stainless steel. Gas stream was passed through channels in the porous tube into the active zone of discharge, located around of the high-voltage electrode. This construction enables a good contact of the gas stream with plasma.

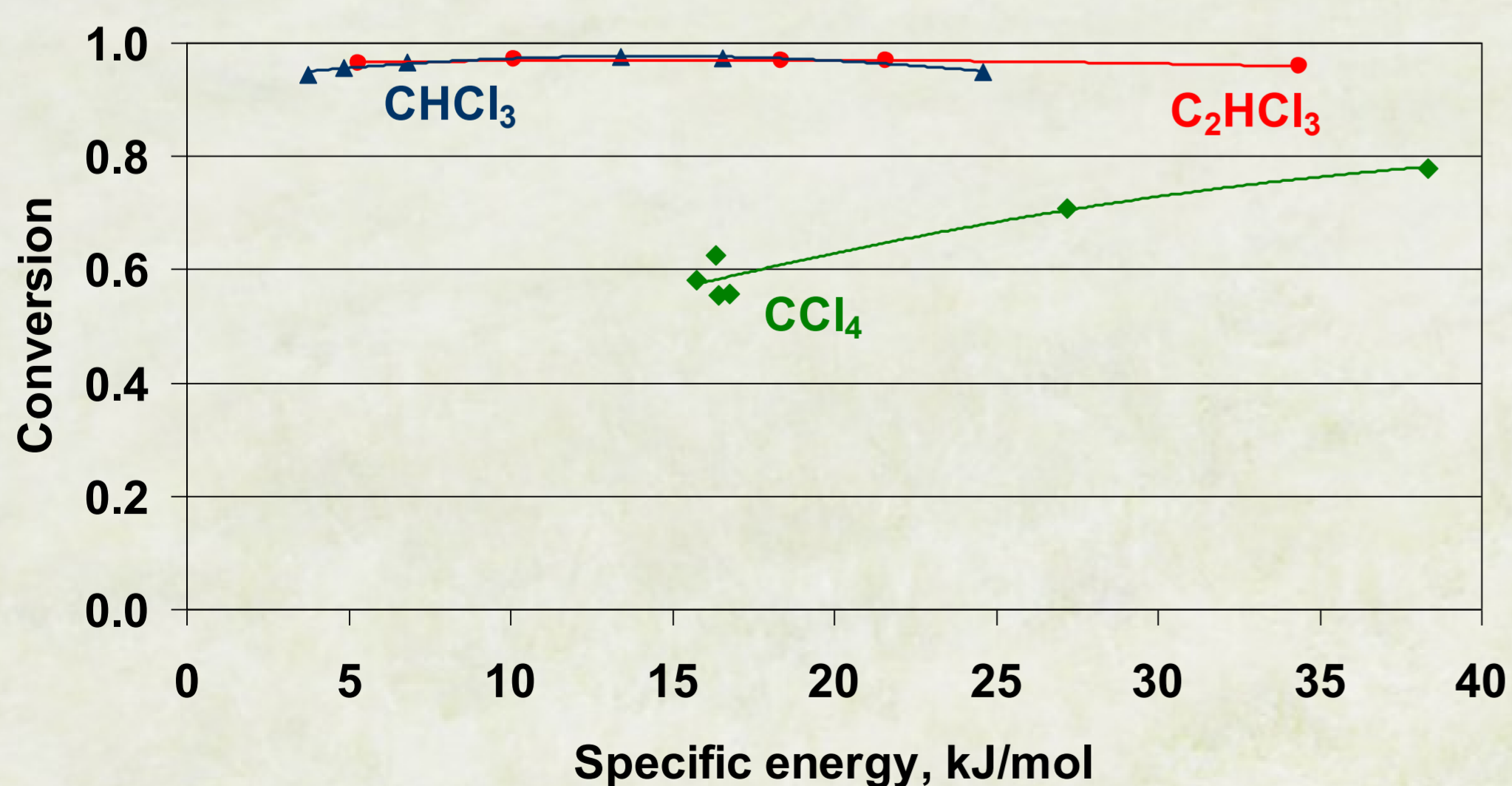
## Experimental conditions

Gas mixture – argon, oxygen and volatile organic compounds  
Volatile organic compounds -  $\text{CCl}_4$ ,  $\text{CHCl}_3$ ,  $\text{C}_2\text{HCl}_3$   
Total gas flow - 10 Nl/h  
Volatile organic compounds concentration – 0.4%.  
Oxygen concentration – 25%

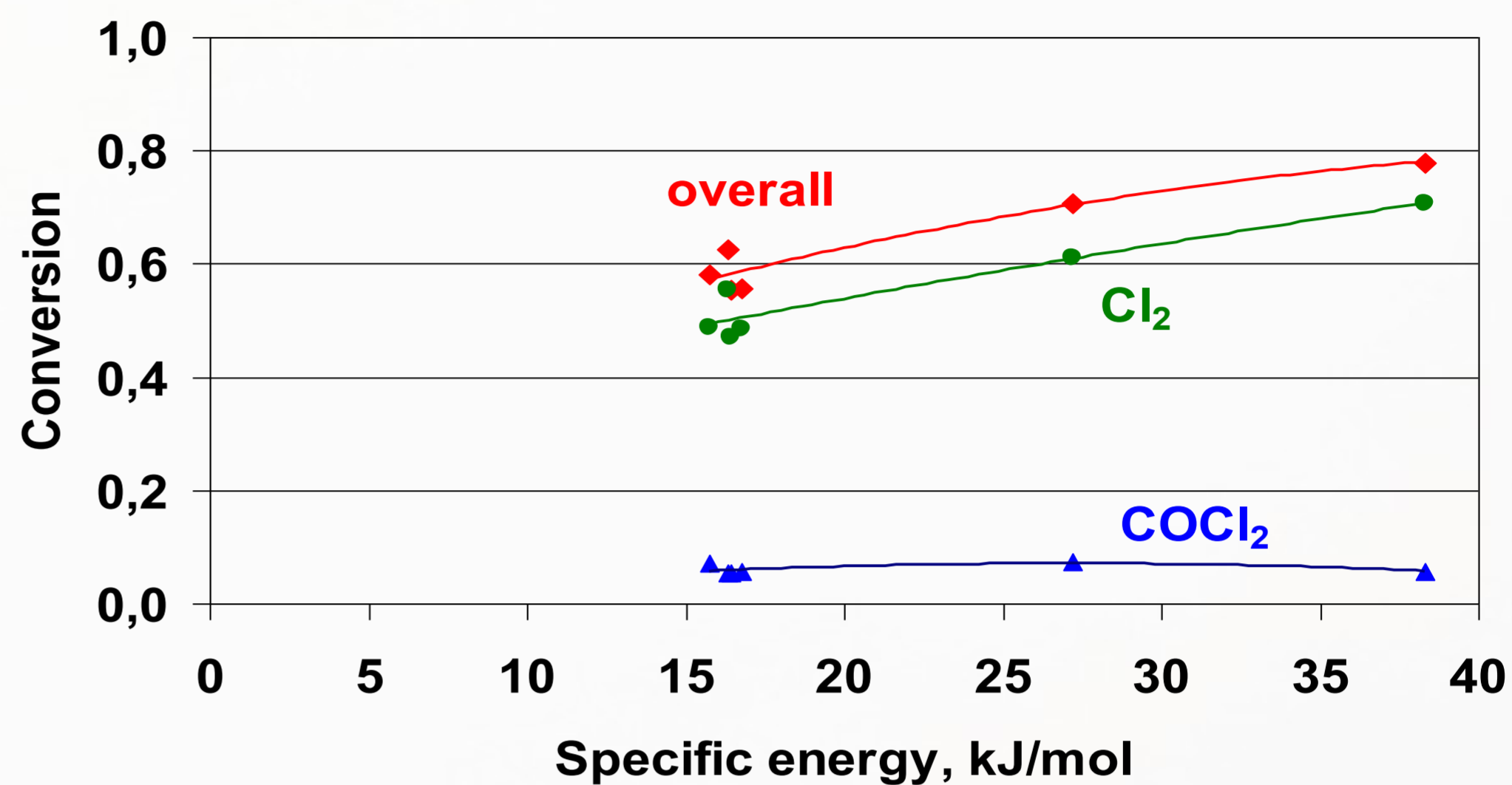


Effective porosity of the high-voltage electrode - 19%

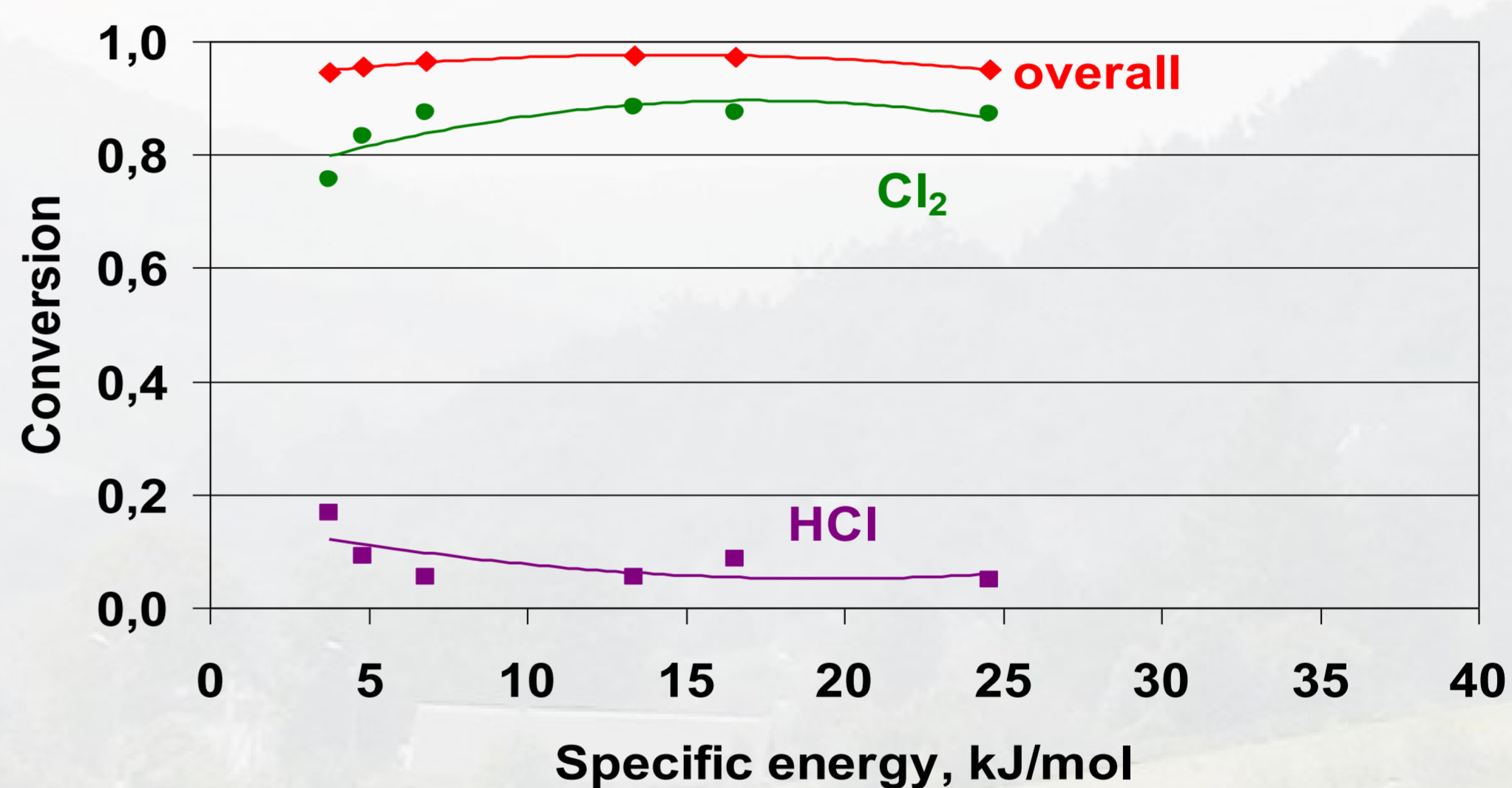
## Results



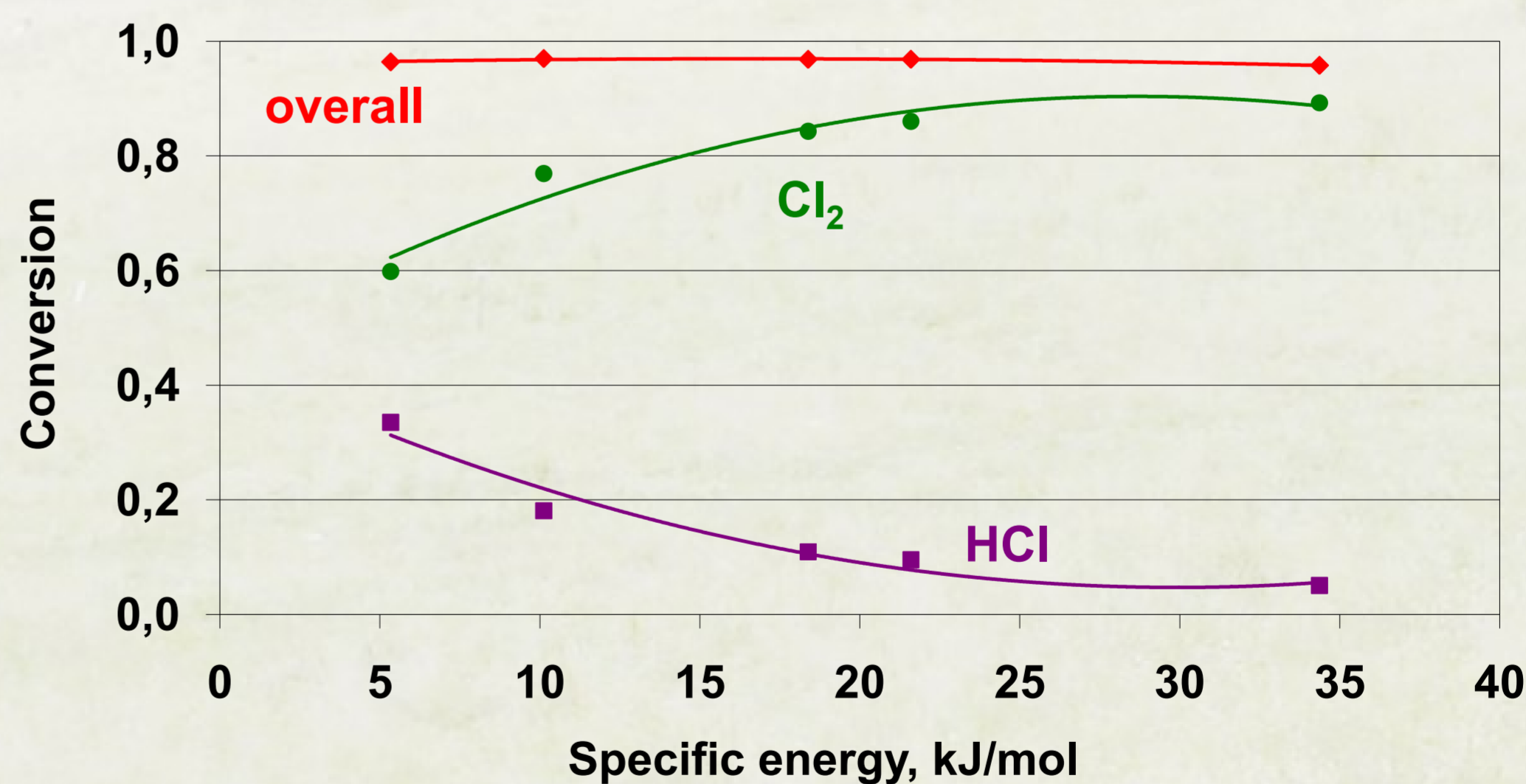
The influence type of volatile organic compounds on the overall conversion of  $\text{CCl}_4$ ,  $\text{CHCl}_3$  and  $\text{C}_2\text{HCl}_3$



The dependence between the  $\text{CCl}_4$  conversion and specific energy



The dependence between the  $\text{CHCl}_3$  conversion and specific energy



The dependence between the  $\text{C}_2\text{HCl}_3$  conversion and specific energy

## Conclusions

- Non-equilibrium plasma reactor with gas passing through the porous electrode into the active zone of discharge can be effectively used in the decomposition of volatile organic compounds.
- The overall  $\text{CHCl}_3$  and  $\text{C}_2\text{HCl}_3$  conversion was 95-98%.
- $\text{CCl}_4$  was more difficult to decompose than  $\text{CHCl}_3$  and  $\text{C}_2\text{HCl}_3$ .
- Overall  $\text{CCl}_4$  conversion reached 78%.
- Main products of  $\text{CCl}_4$ ,  $\text{CHCl}_3$  and  $\text{C}_2\text{HCl}_3$  decomposition was  $\text{Cl}_2$ .