NUMERICAL SIMULATION OF CHAMBER DESIGN FOR PULSED ELECTRIC FIELDS PROCESSING OF WET OLIVE POMACE

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Introduction: PEF is applied on WOP for extracting a certain kind antioxidant. The aim of the FEM modeling is geometry optimization and treatment homogeneity investigation for colinear and coaxial PEF chambers.

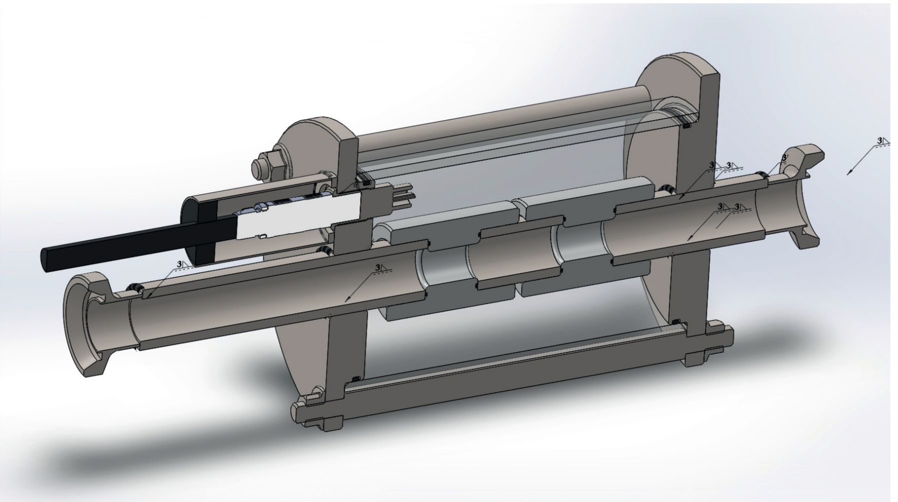

Figure 1. Cross section of colinear PEF chamber model

Requirements for both chambers:

Same pulse electric power (3[kW])
Same flow rate (100 kg/h)

Computational methods: Usage of three kinds of coupled interfaces

1.Laminar Flow $\frac{\partial\rho}{\partial t} + \nabla\cdot(\rho\mathbf{u}) = 0$

2.Electric Currents $\rho\frac{\partial\mathbf{u}}{\partial t} + \rho\mathbf{u}\cdot\nabla\mathbf{u} = -\nabla p + \nabla\cdot\left(\mu(\nabla\mathbf{u} + (\nabla\mathbf{u})^T) - \frac{2}{3}\mu(\nabla\cdot\mathbf{u})\mathbf{I}\right) + \mathbf{F}$

3.Heat Transfer in Fluids $\rho C_p\frac{\partial T}{\partial t} + \rho C_p\mathbf{u}\cdot\nabla T = \nabla\cdot(k\nabla T) + Q$

COMSOL model requirements:

- Simplified model: instead of pulse voltage (rectangular shape) constant voltage is applied; stationary study
- Usage of temperature dependent material interpolation functions based on measurements for WOP
- 2D axisymmetric geometry
- External heat source by Joule heat
  - $Q = \sigma\cdot E^2\cdot\tau\cdot f$

σ	Electrical conductivity [S/m]
E	Electric field norm [V/m]
!	Pulse width [s]
f	Frequency [Hz]

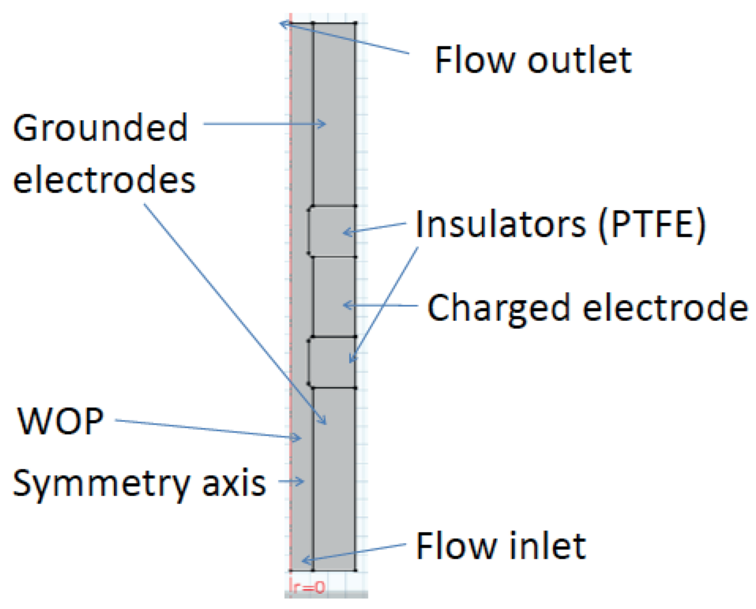

Figure 2. Conditions for colinear chamber

Results:

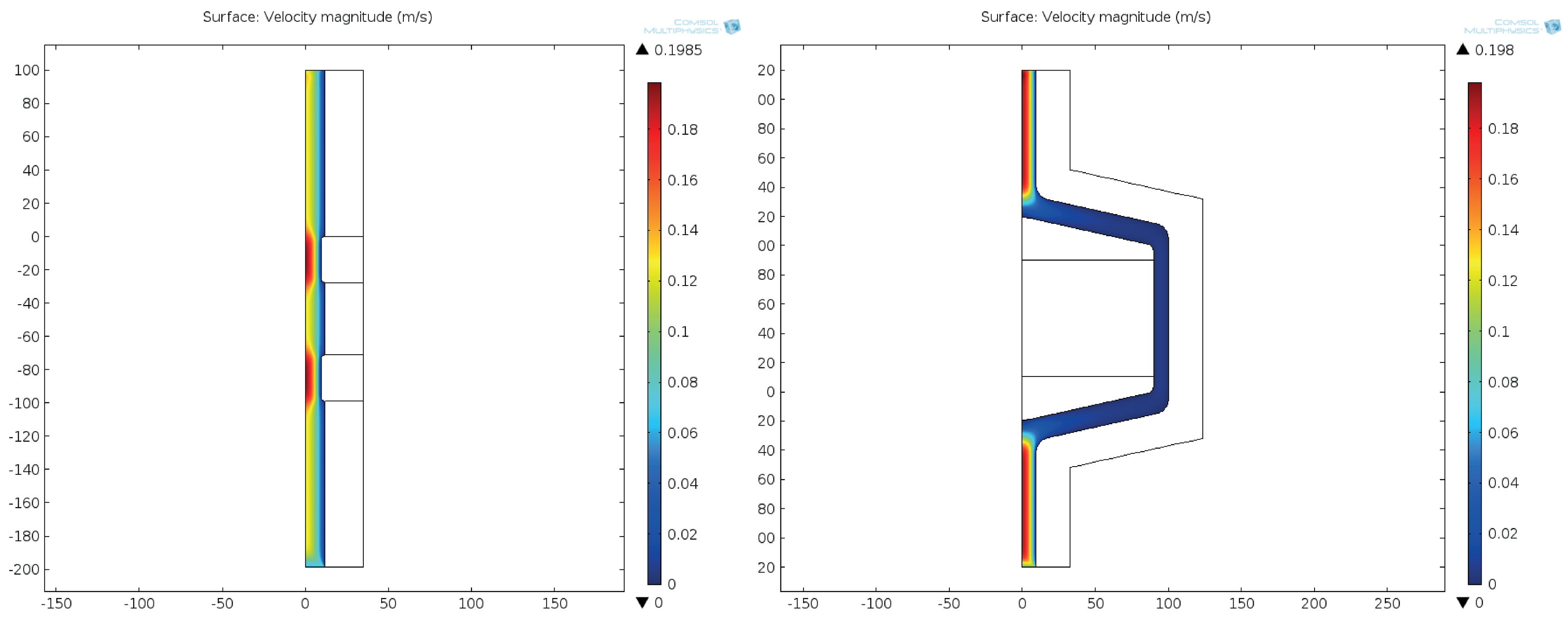

Figure 3. Velocity magnitude in colinear and in coaxial chambers

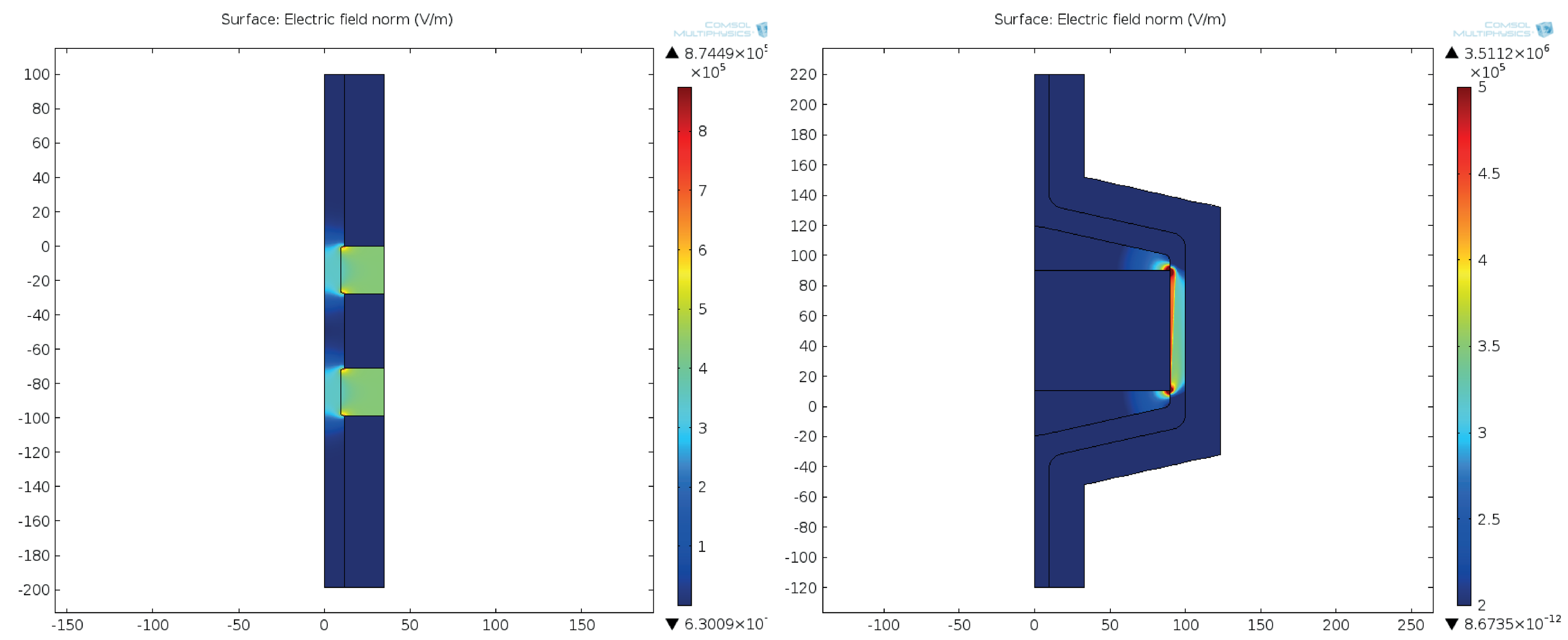

Figure 4. Electric field norm in colinear and in coaxial chambers. In case of coaxial the manual colour range changes between 2e5 and 5e5 [V/m]

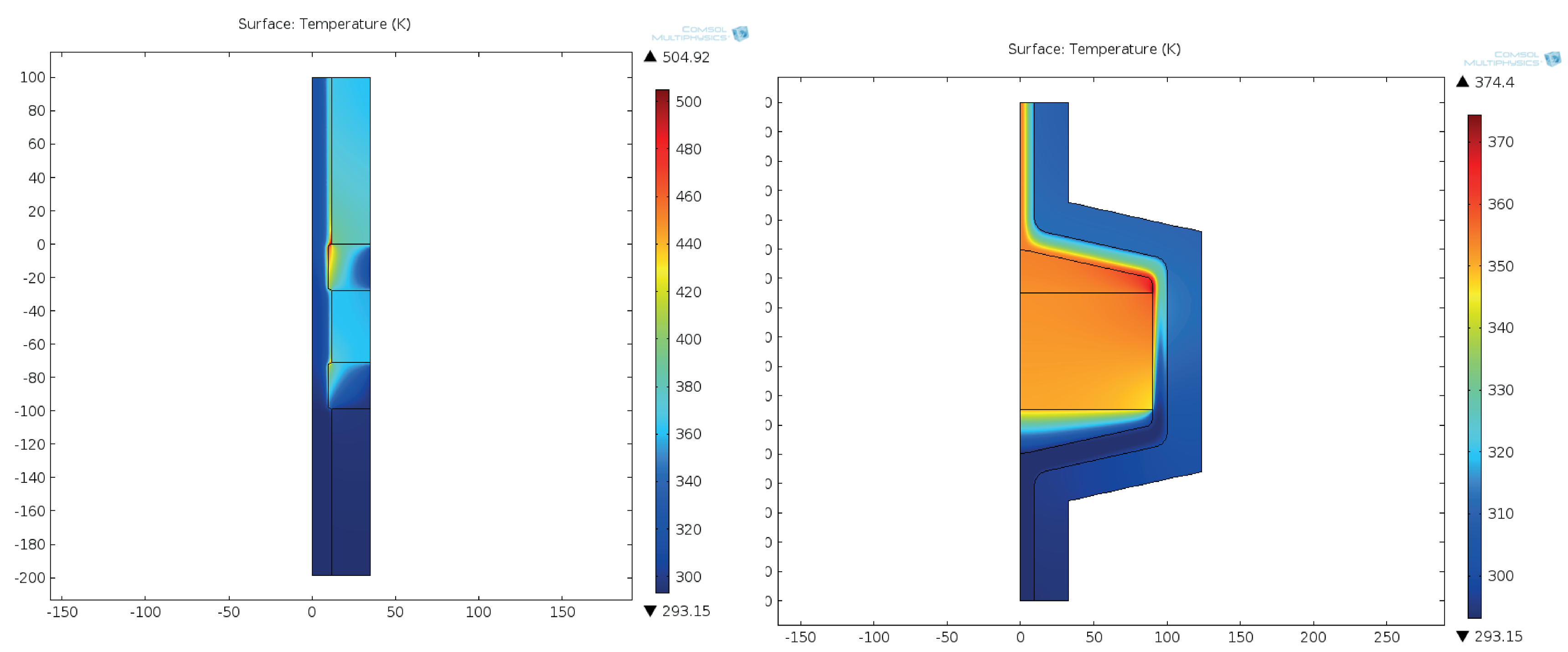

Figure 5. Temperature distribution in colinear and in coaxial chambers

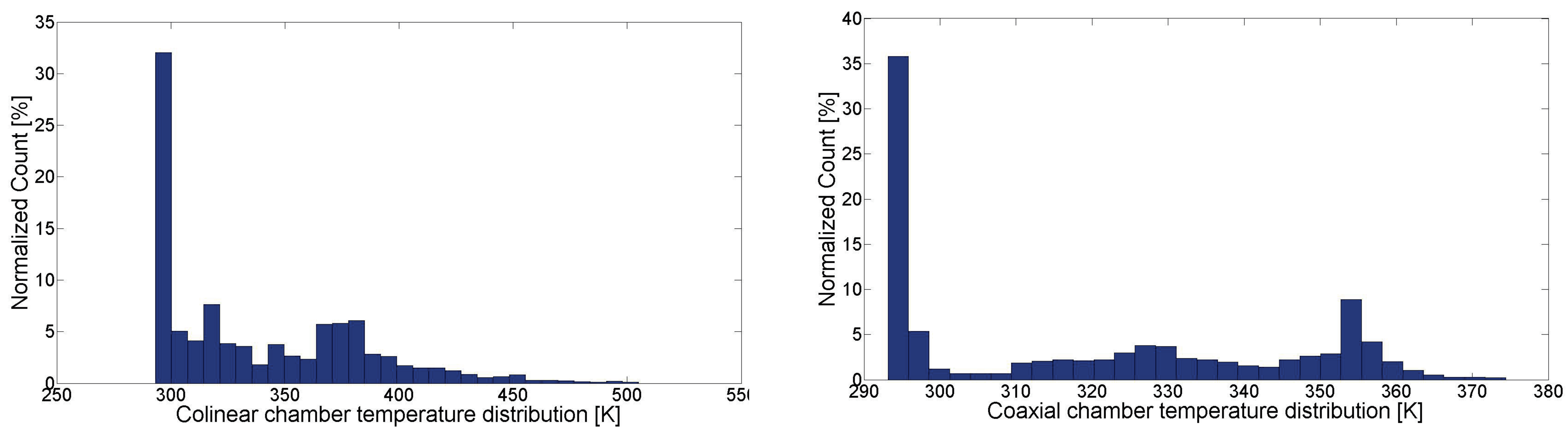

Figure 6. Temperature distribution only in the WOP's flowing area colinear in the left, coaxial in the right

Conclusions:

Coaxial chamber has more homogeneous treatment intensity, because of more uniform temperature distribution in the flowing area of the WOP.
Colinear is more appropriate because of olive stones.
Further measurements and both for material and for validation could improve the results.

References:
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