Orthogonal Pressurized Planar Electrochromatography (OPPEC)

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Introduction
Different selectivity is advantageous with respect to application of PPEC to two-dimensional (2D) separations.
Principle of two dimensional separation with HPTLC and PPEC (2D HPTLC/PPEC). Chromatographic plate with margins of silicone sealant on its whole periphery. Starting spot of the mixture to be separated is marked with a dot. Directions of the mobile phase migration in (1D) TLC and (2D) PPEC processes is marked with arrows.
Digital picture of TLC chromatogram, HPTLC RP18W plate (Merck), mobile phase: 45% methanol in buffer pH 3.0; (1) rhodamine 6G, (2) PAR, (3) patent blue, (4) green S, (5) azorubine, (6) brilliant blue, (7) allura red, (8) brilliant black.

Digital picture of the chromatographic plate after 2-D HPTLC/PPEC separation, the mobile phase of the first dimension (HPTLC) as in previous slide, the mobile phase of the second dimension (PPEC): 75 % ACN in buffer pH 3.0, polarization voltage 2.5 kV.

Apparatus for simultaneous chromatography and electrophoresis; 1 - 20x20 cm plate of 2 mm thickness, 2 - electrolyte reservoirs, 3 - graphite electrodes, 4 - electrical connectors, 5 - sintered glass disc OD 11 mm and thickness 3 mm, 6 - holes for sample applications, 7 - TLC plate

Simultaneous chromatography and electrophoresis (SCE) apparatus with dual solvent reservoir. TLC plate depicts sections I and II for characterization of horizontal migration

Principle of action of OPPEC
OPPEC = OPLC + PPEC

OPPEC = Orthogonal Pressurized Planar Electrochromatography

OPLC = Overpressure Layer Chromatography

PPEC = Pressurized Planar Electrochromatography
Principle of action of the device for Overpressure Layer Chromatography (OPLC)
Principle of action of the device for Pressurized Planar Electrochromatography (PPEC)
Principle of action of the device for Orthogonal Pressurized Planar Electrochromatography (OPPEC) - analytical mode
Principle of action of the device for Orthogonal Pressurized Planar Electrochromatography - preparative mode
Device for OPPEC
Conceptual view of the device for orthogonal pressurized planar electrochromatography (OPPEC):
1 – OPPEC chamber, 2 – security cabinet, 3 – syringe pump, 4 – microinjection valve, 5 – DC high voltage power supply, 6 – thermostat, 7 – hydraulic pump, 8 – thermocouple, 9 – temperature digital display, 10 – waste reservoir

The picture of the complete OPPEC device for continuous separation
Photography of the OPPEC chamber (patent pending)
Conceptual view of principle of action of the OPPEC chamber, 1 – mobile phase in, 2 – chromatographic plate, 3 – sample entry position, 4 - direction of electric field, 5 – electrode compartment (it is above the chromatographic plate), 6 – sealing margin, 7 – mobile phase out, 8 – anode, 9 – cathode; patent pending
Examples of separations with OPPEC
The picture of the chromatographic plate after OPPEC separation of a six food dye mixture (the plate is cut, with no sealing margin). Sample volume (1 µL) introduced with microsyringe, polarization voltage 1.0 kV, the mobile phase (70% ACN) flow velocity 75 L/min; (1) not identified dye, (2) rhodamine G, (3) PAR, (4) green S, (5) patent blue, (6) brilliant blue, (7) brilliant black.

(a) The picture of the chromatographic plate after OPLC separation of two dye mixture: (1) patent blue and (2) brilliant black (no electric field was applied, and (b) after OPPEC separation, polarization voltage 1.0 kV, the mobile phase 30% ACN, mobile phase flow velocity 100 μL/min, sample solution flow velocity 1.0 μL/min;
Buffer pH = 2.0  \hspace{1cm} \text{pH} = 3.2  \hspace{1cm} \text{pH} = 7.4

Stationary phase: HPTLC RP18W (Merck); mobile phase: 45% methanol i buffer, potential 1.0 kV; flow velocity of the mobile phase: 0.1 mL/min; flow velocity of sample (patent blue, PAR, azorubine) solution 0.0004mL/min; time of experiment 120 min
The challenges:

• development of equipment
• repeatability
• Joule heat generation
• sample application/injection
• stationary phases (chromatographic plates or ...?)
Conclusions

Orthogonal pressurized planar electrochromatography is especially attractive for preparative separations, however, its application to analytical mode requires further investigations.