Technical Seminar for Cathodic Protection to GOGC Design Unit Specialists

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Source of Development, Supplier of Energy

CP Modeling in different soil environments

Solving the fundamental electrochemical equations

- Multi-ion transport and reaction model & electroneutrality

Chemistry

$$\frac{\partial c_i}{\partial t} + \bar{v}.\bar{\nabla}c_i = z_i F \bar{\nabla}.(u_i c_i \bar{\nabla}U) + \bar{\nabla}.(D_i \bar{\nabla}c_i) + R_i \qquad \sum_i z_i c_i = 0$$

Time Flow Electricity Diffusion

- Potential Model
  - Laplace equation
  - Ohm's Law
  - Electrode Kinetics

$$\bar{\nabla}(\bar{j}) = 0$$

$$\bar{j} = -\sigma \bar{\nabla}U$$

$$\eta = V - U = f(j)$$

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CP Modeling in different soil environments

- **Special software tools using transmission line model, Maxwell electromagnetic field, BEM and FEM technology**

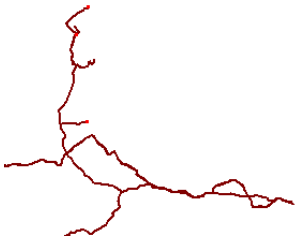
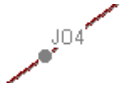
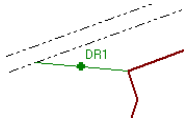
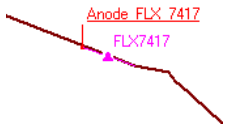
- **Modeling the pipeline section by section with different coating properties and soil resistivities**

Computer simulation tool for predicting the cathodic protection efficiency of a pipeline network taking into account field and operational data

Benefits

- visualization of true protection level for complete pipeline system
- detection of anomalies by correlation between simulated and measured values
- determining zones with potential risk
- study of “what-if-scenario’s”
- synchronizing with existing pipeline data management systems

Pipeline CP System Performance (e.g.Elsyca CatPro)

Static Input Data	**Pipe**	geo coordinates diameter/wall thickness year of construction spec. metal resistivity coating type	
	Bonds	geo coordinates resistance	
	Insulating flange	geo coordinates	
	Diodes	geo coordinates forward voltage	
	Anodebeds	geo coordinates dimensions resistance type of rectifier	

Pipeline CP System Performance (e.g.Elsyca CatPro)

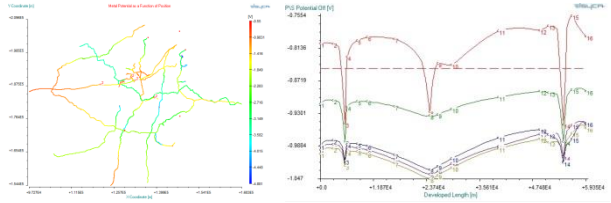
Dynamic Input Data	**Bonds**	status (open/close)
	Insulating flange	status (open/close)
	Diodes	status (open/close)
	Anodebeds	rectifier settings (I or V)

Other Input Data	**Pipe**	polarization data
	Field data (calibration purposes)	pipe potential (ON/OFF/RE) pipe axial currents soil resistivity other special data (AC, ILI, DCVG, …)
	Point-of interest (labels)	proximity to rails and HVAC lines test stations

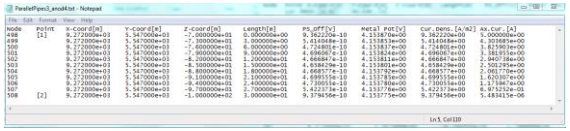
Pipeline CP System Performance (e.g.Elsyca CatPro)

Output Data	Pipe	ON potential OFF potential current density axial current
	Bonds	delta V and I
	Insulating flange	delta V and I
	Drains	delta V and I
	Anodebed/rectifier	applied V or I resulting I or V

Colour plots



ASCII



SVG

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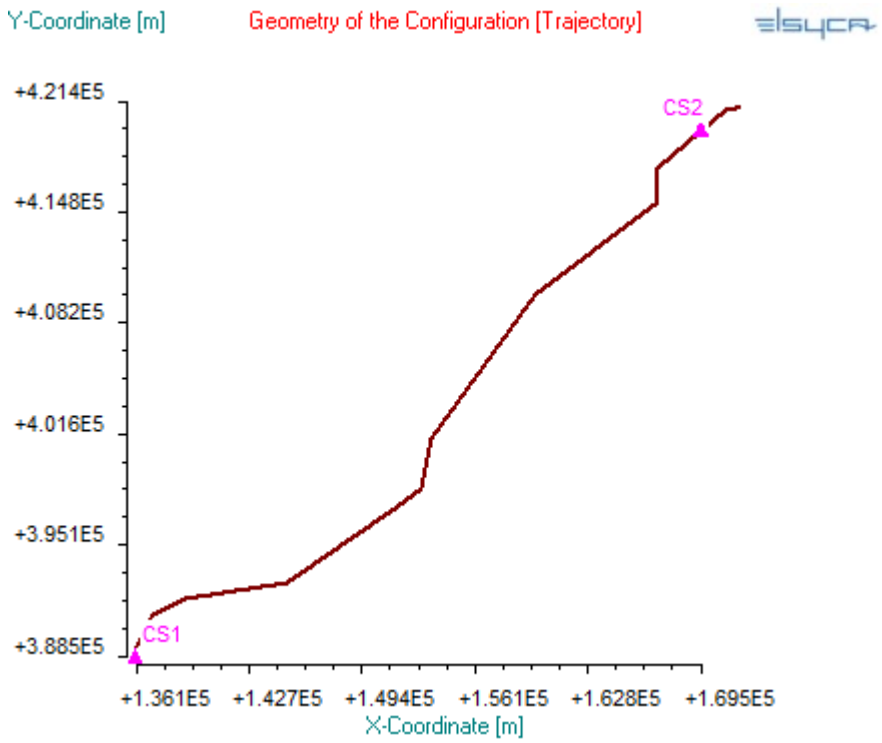
Pipeline CP System Performance (e.g.Elsyca CatPro)

Computational model



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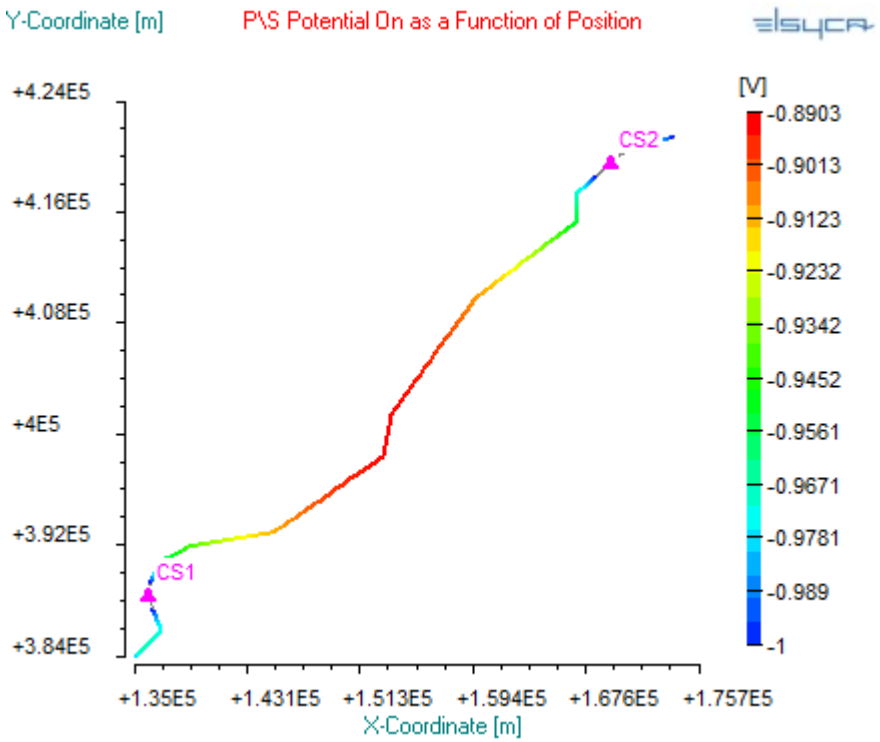
Pipeline CP System Performance (e.g.Elsyca CatPro)

Simulation results – ON/OFF potentials



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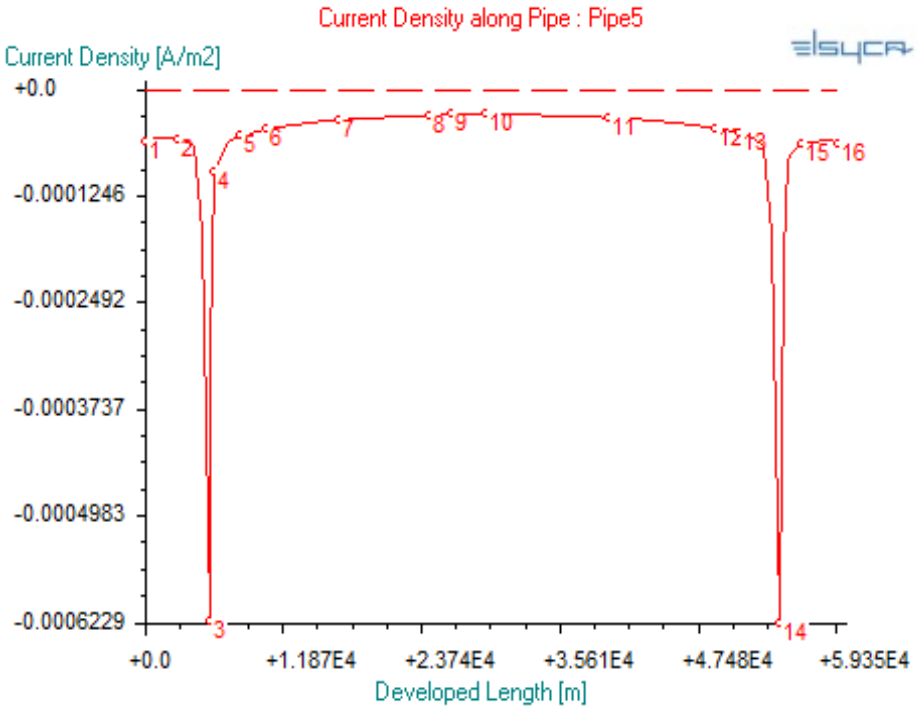
Simulation results – current density



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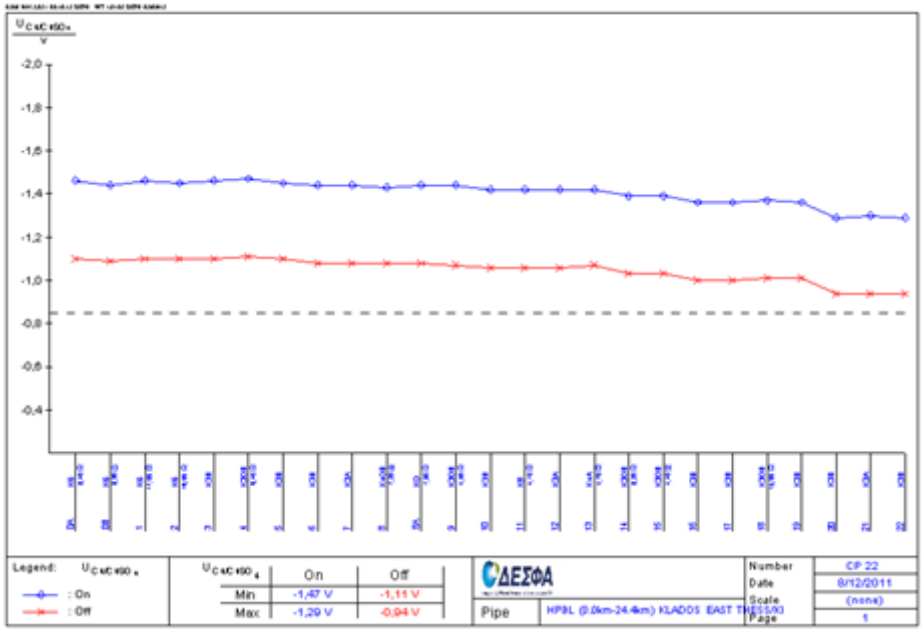
An example from DESFA pipelines

During pipeline construction an insulating joint was installed in-between to enable an acceptable potential distribution. This insulating joint is bridged through a potentiometer inserting in series an ohmic resistance (around 65 Ohm) able to carry out a potential drop otherwise we would have an overprotection on the long part of the line.

An example from DESFA pipelines



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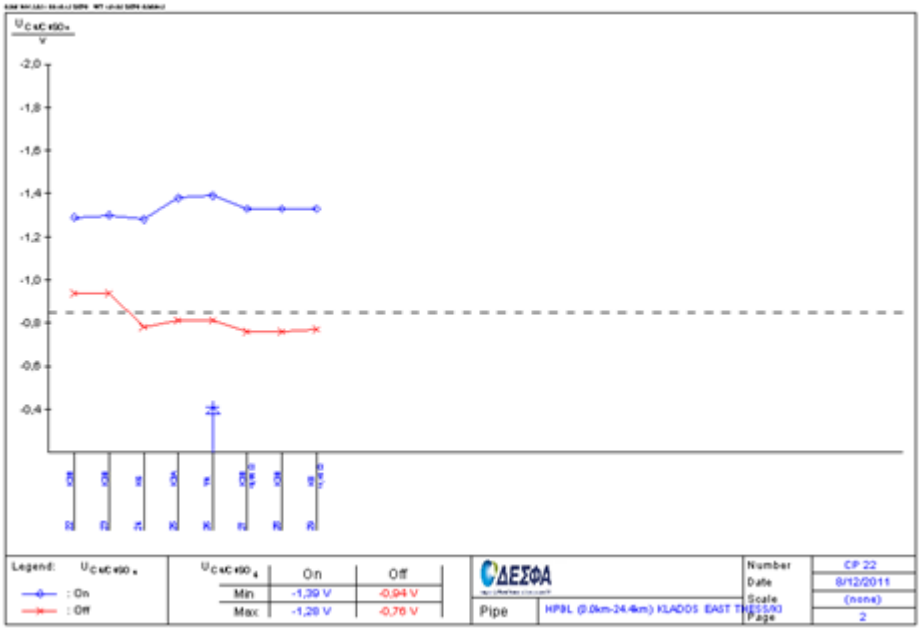
An example from DESFA pipelines



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