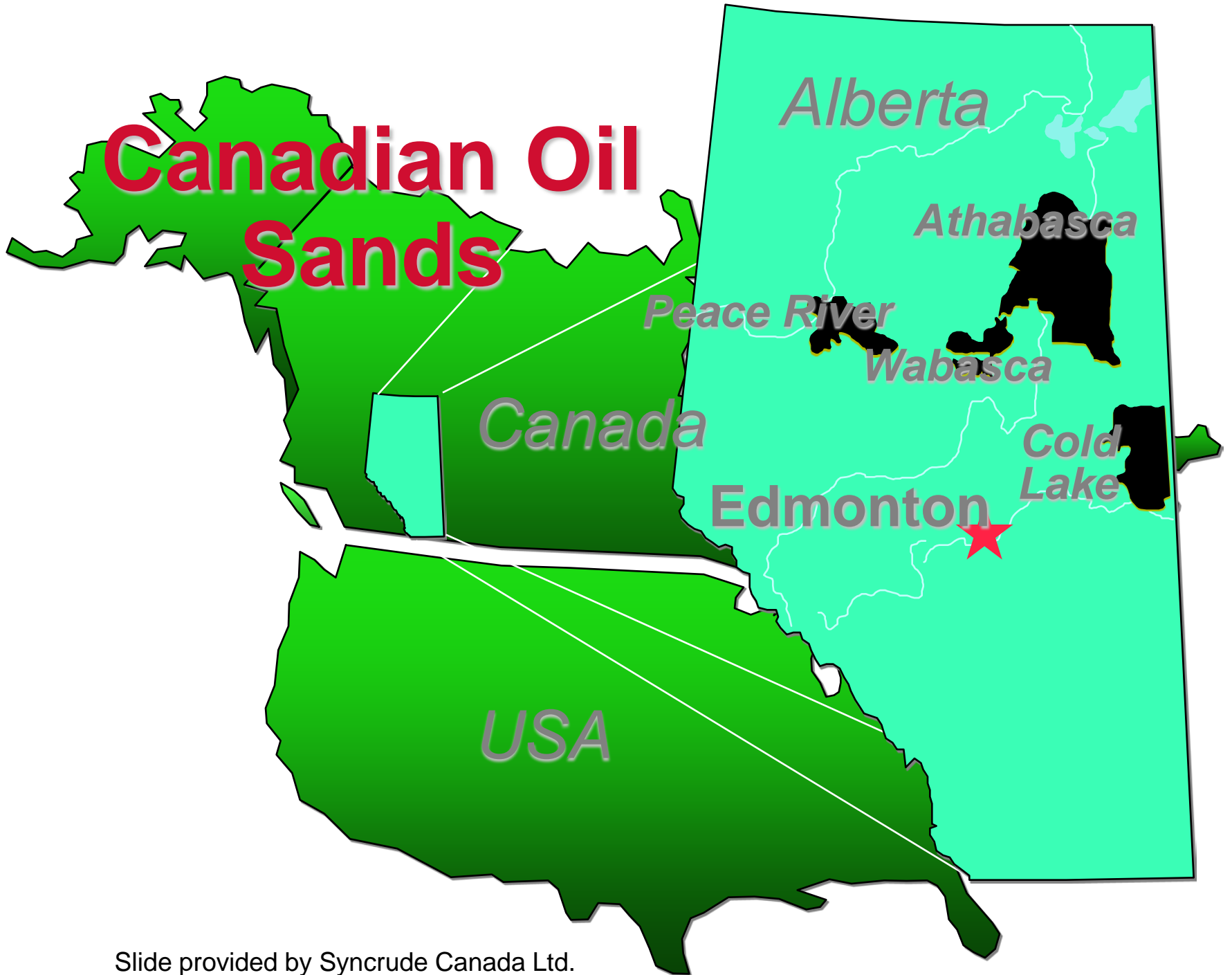


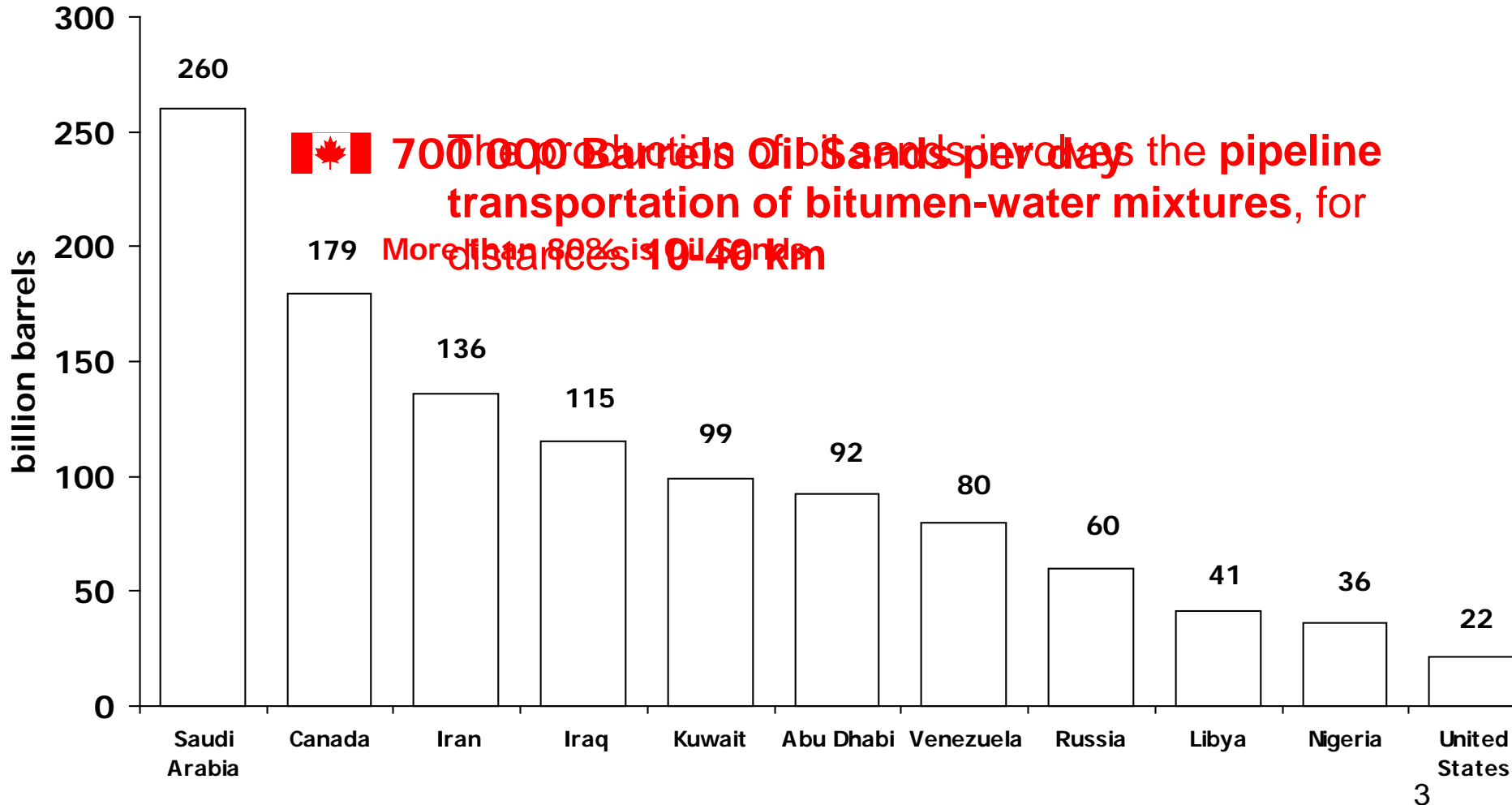
A Capacitance Sensor for Pipeline Flows of Oil-Water Mixtures

Sayed Rushd and Dr. Sean Sanders
Chemical & Materials Engineering Department
University of Alberta
Edmonton, AB, Canada

Canadian Oil Sands

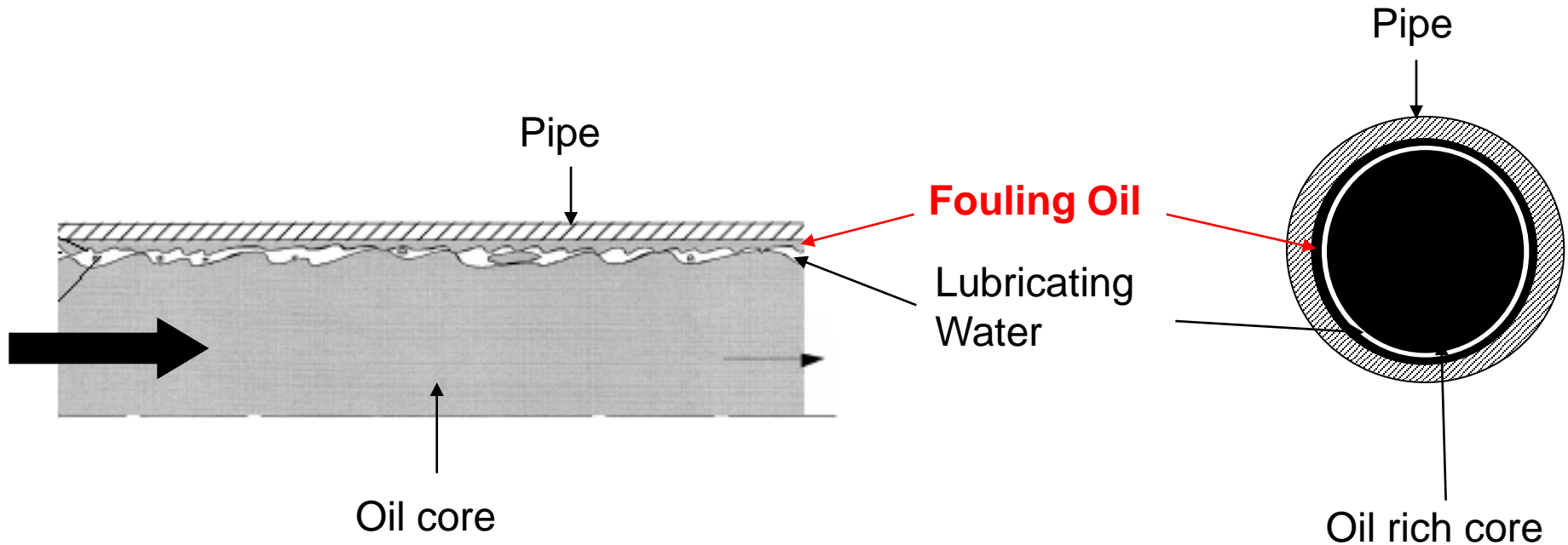


Global Crude Oil Reserves



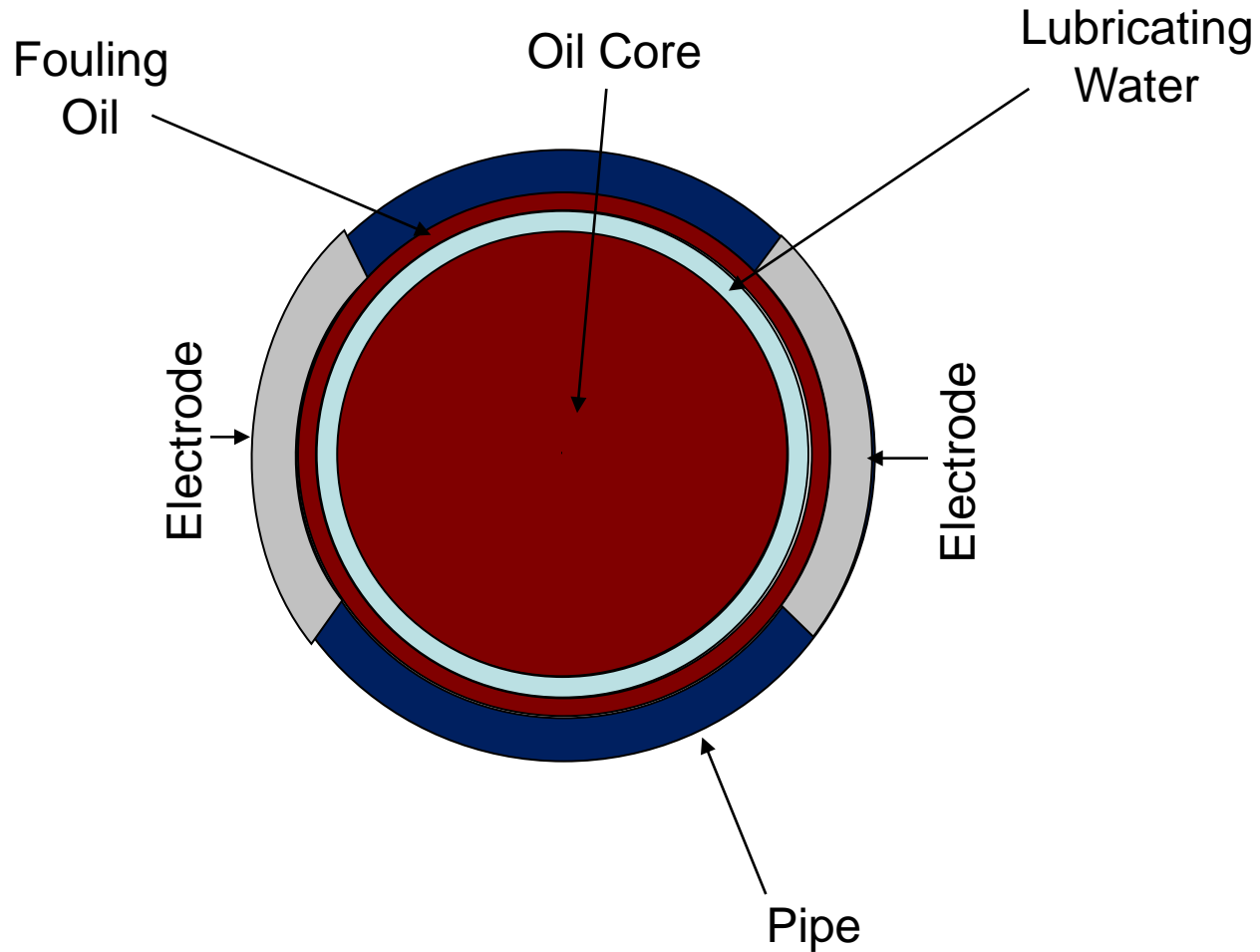
Pipeline Transportation

Lubricated Pipe Flow



[Joseph et al., J. Fluid Mech., 1999;
McKibben et al., Can. J. Chem. Eng., August 2000]

Capacitance Sensor



Governing Physics

$$\text{Capacitance, } C = \epsilon_0 \epsilon_r K$$

ϵ_0 : Permittivity of free space
 ϵ_r : Relative permittivity
K: Constant for a capacitor

Function

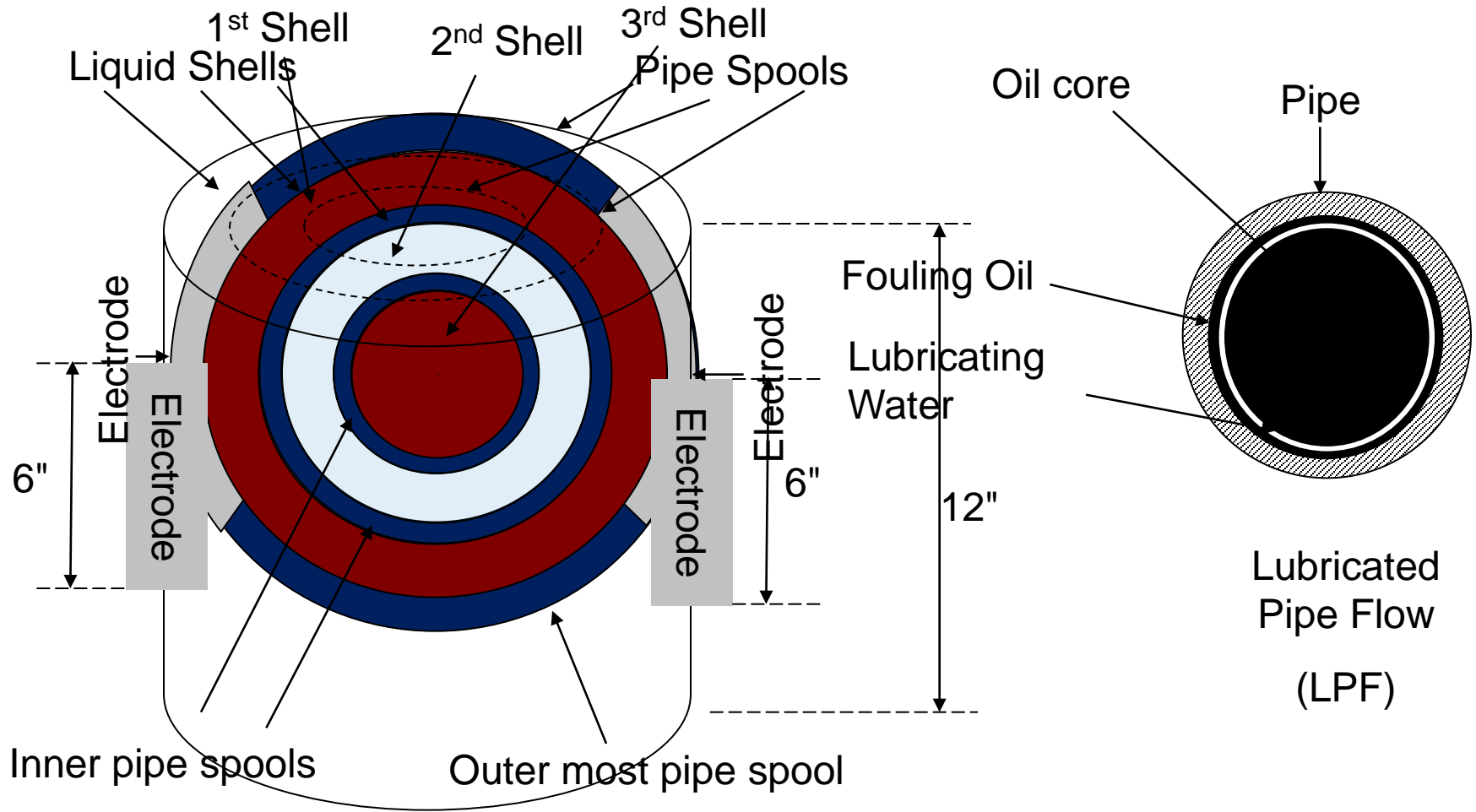
Relative permittivity (ϵ_r)

Distribution of dielectrics (liquids) in electric field

Amount

Position

Pipe Spool Capacitor

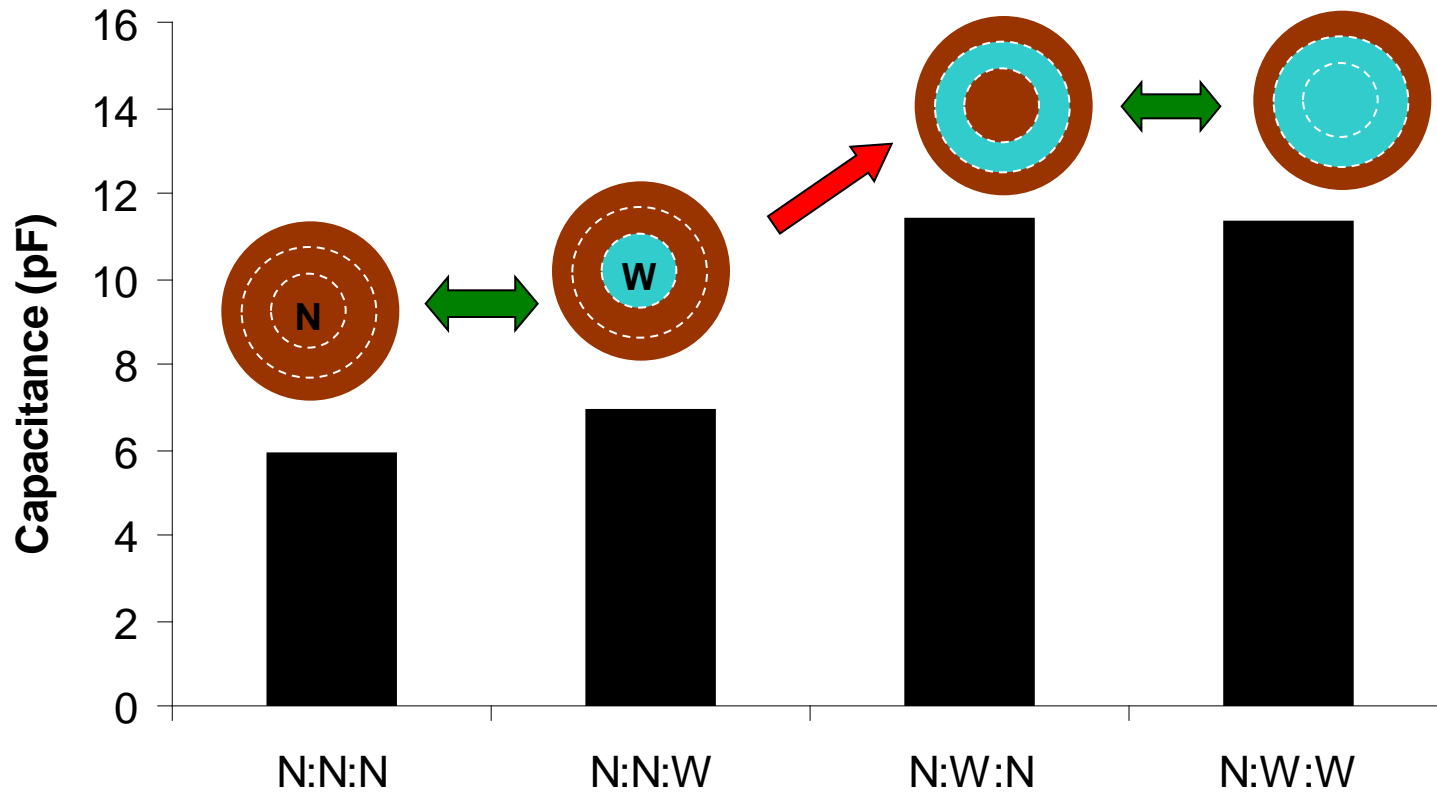


Pipe Spool Capacitor



Results

Experiment

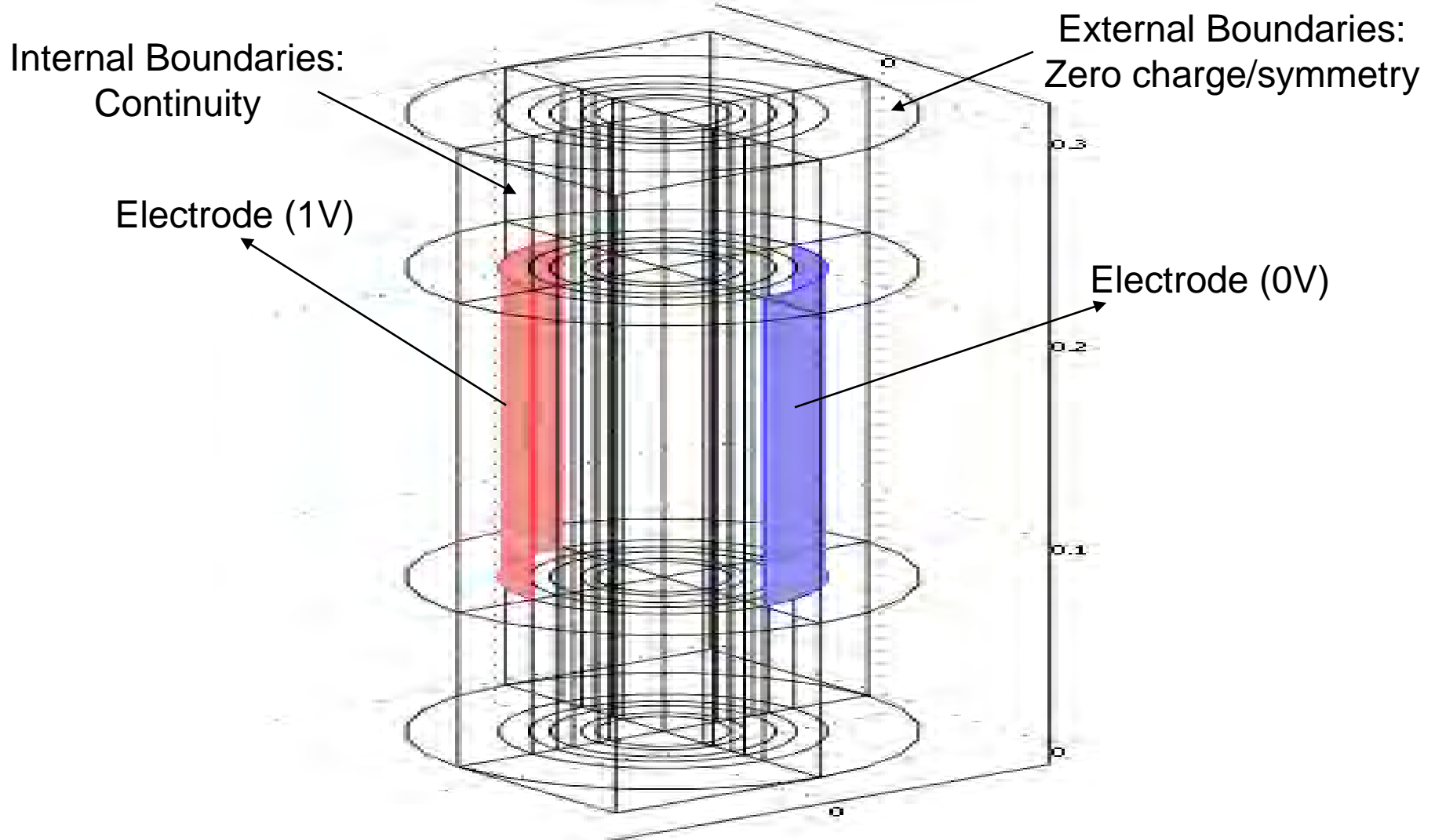


Annular Liquids in PSC

N: Naphtha, W: Water

Simulation

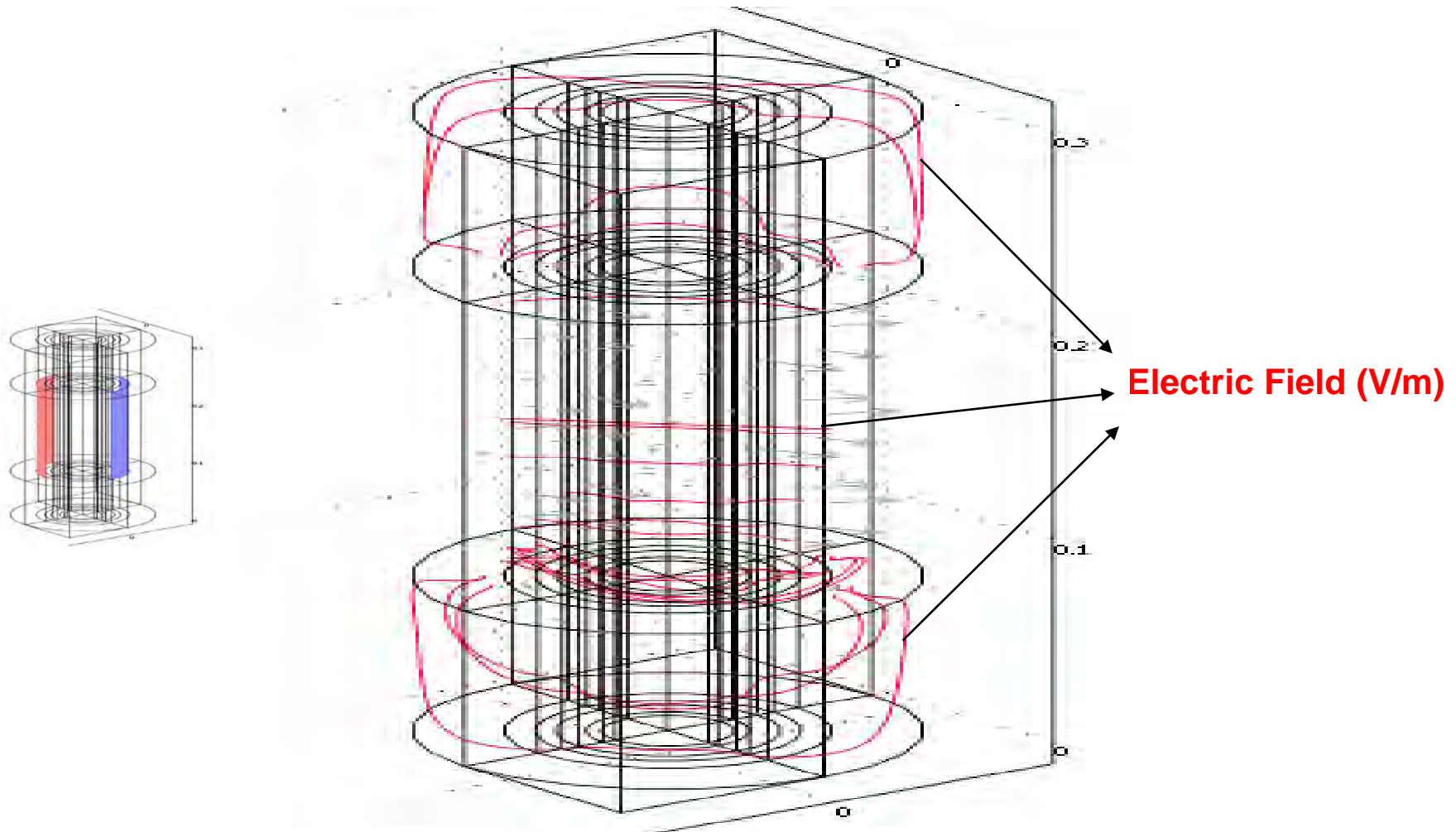
COMSOL



PSC: Geometric Model

Simulation

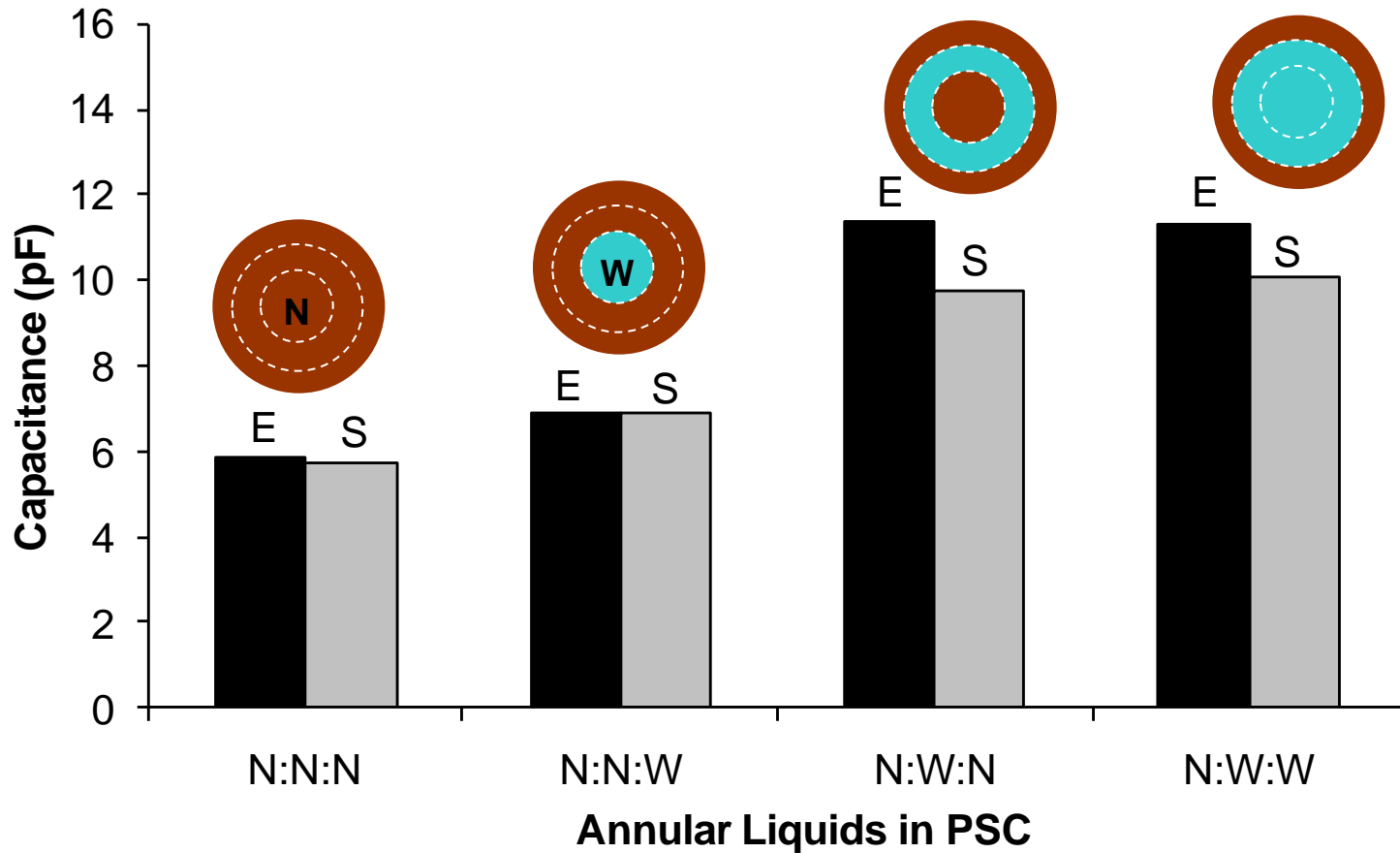
COMSOL



PSC: Post Processing Result

Results

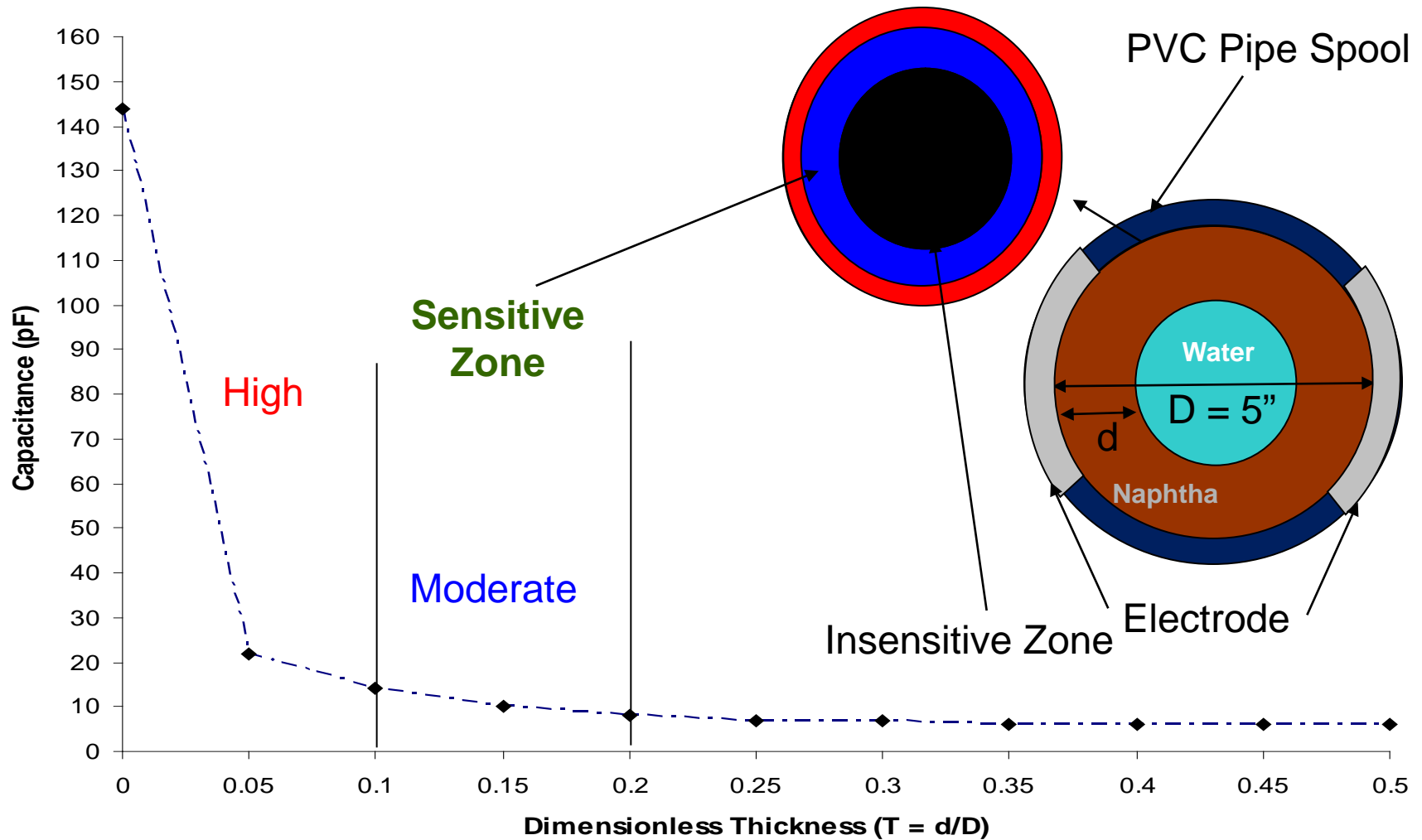
Experiment & Simulation



N: Naphtha, W: Water

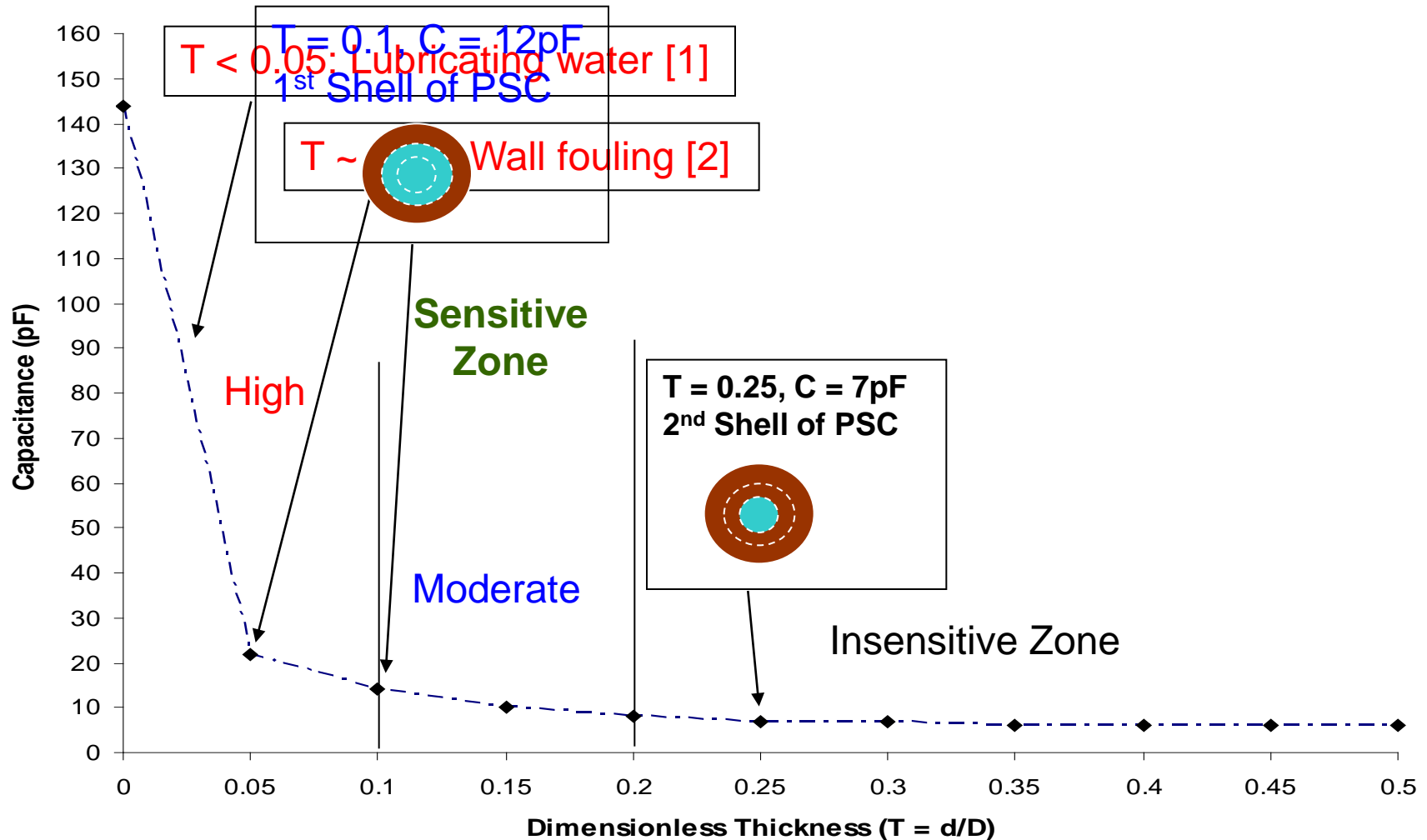
Results

Simulation



Results

Simulation



[1. Joseph et al., J. Fluid Mech., 1999;
 2. Schaan et al., Multiphase Technology, BHR Group 2002]

Conclusions

- A capacitance sensor has the potential to quantify wall fouling- and lubricating water-layer in LPF
- Electrodes of a capacitance sensor can be conveniently placed along the LPF pipeline
- COMSOL simulation can be utilized to design and calibrate a capacitance sensor

Acknowledgements

- Mr. Walter Boddez, Instrument Shop
- Mr. Dave Parlin, Machine Shop
- The NSERC Industrial Research Chair in Pipeline Transport Processes