

ESMER CapCon Water Cut Meter

TECHNOLOGY OVERVIEW

esmerCAPCON is a full range water cut meter based on capacitance and conductance technology. esmerCapCon is particularly suited for the exit leg of separators, works across the full water cut range and can tolerate the presence of gas up to 10 % GVF.

PSL has developed the technology through an extensive R&D program involving electro-mechanical design followed by flow loop and field testing.

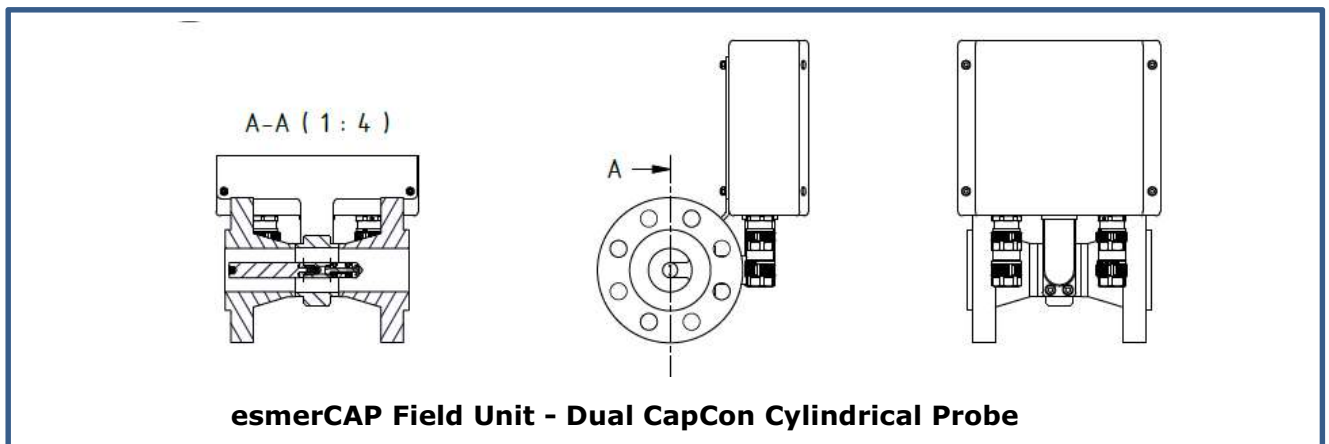
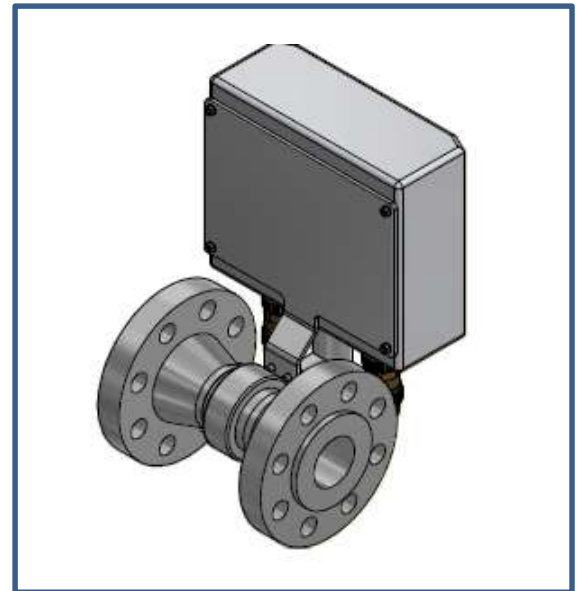
The primary measurements of esmerCAPCON are dielectric constant (oil continuous phase) and conductivity (water continuous phase).

Capacitance is measured between a cylindrical probe (acting as an electrode in isolation from the pipe) and the pipe itself. Conductance is measured between two isolated electrode rings installed on the cylindrical probe.

The switch from capacitance to conductance is activated automatically. Measurements are automatically compensated for changes in salinity, oil density and temperature.

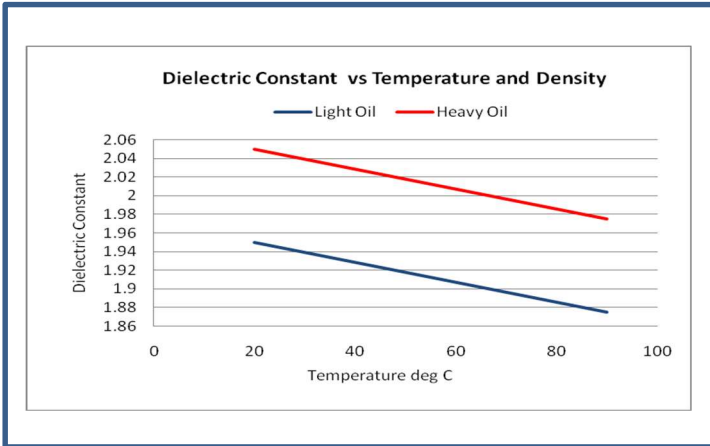
esmerCAPCON consists of the following components:

- **Field Unit** as a flanged spool piece for in-line installation
- **Flow Computer** in Exd enclosure mounted on the field Unit



OIL CONTINUOUS FLOW

In the oil continuous regime (< 40% water in oil), water composition measurement is based on the “characterisation of the dielectric constant of the fluid”, taking advantage of the wide difference in the dielectric constant of oil (1.8 – 2.4) and water (50-88). Effect of temperature (decrease in hydrocarbon oils of 0.05% and water 0.37% per degree Celsius) and effect of oil density is compensated automatically by software.

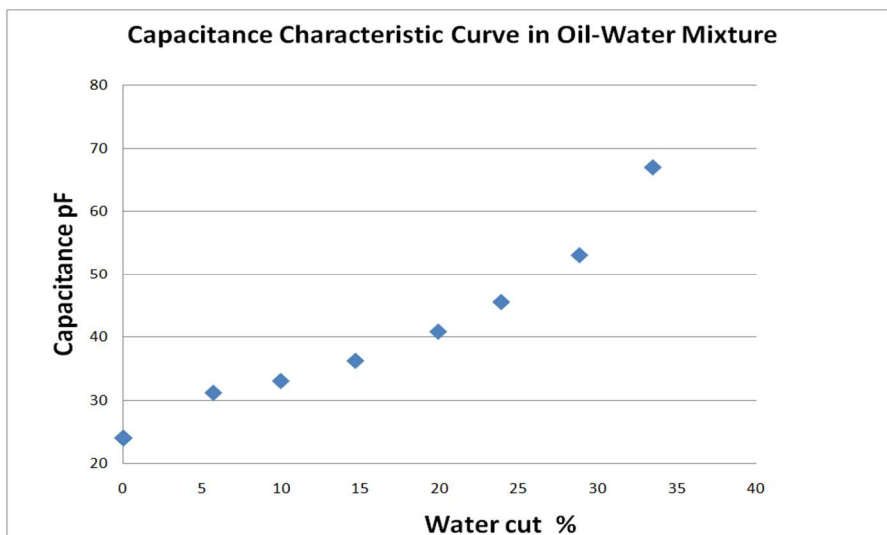


Dielectric Constant of Common Materials	
Vacuum	1.00
Metals	Infinite
Gases	1.00xx
Water	87.9 (0 degC) to 55.5 (100 degC)
Hexane	1.8865 (20 degC)
Cyclohexane	2.0243 (20 deg C)
Benzene	2.285 (20 degC)
Hydrocarbon lubricating oils	2.1 to 2.4 (room temperature)

In flow loop experiments conducted with esmerCAPCON, it has been shown empirically (figure below) that the dielectric constant will exhibit a direct (S curve) relationship to water composition.

Capacitance pF = fn(WaterComposition, Temperature, Oil Density)

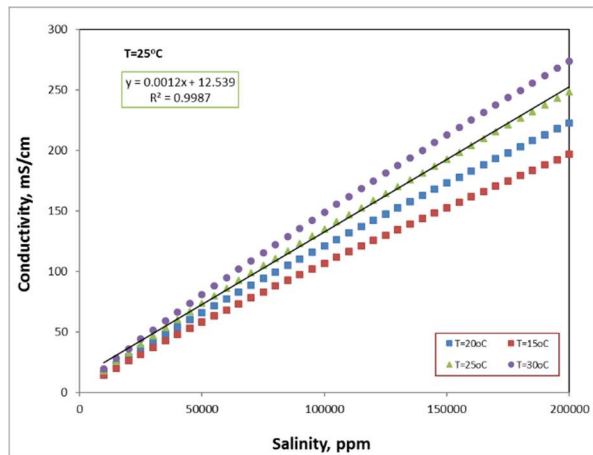
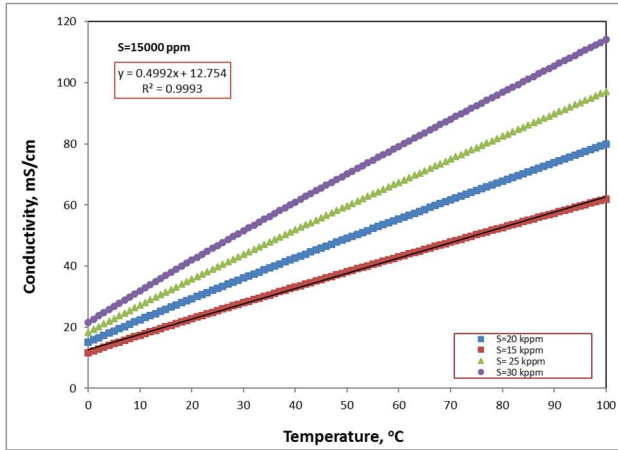
The function is resolved by software online to determine the water composition.



Note: The capacitance function will depend on flow regime (formation of emulsion / foaming, etc) to a certain extent and tune up of field calibration will be required to compensate for such dependency.

WATER CONTINUOUS FLOW

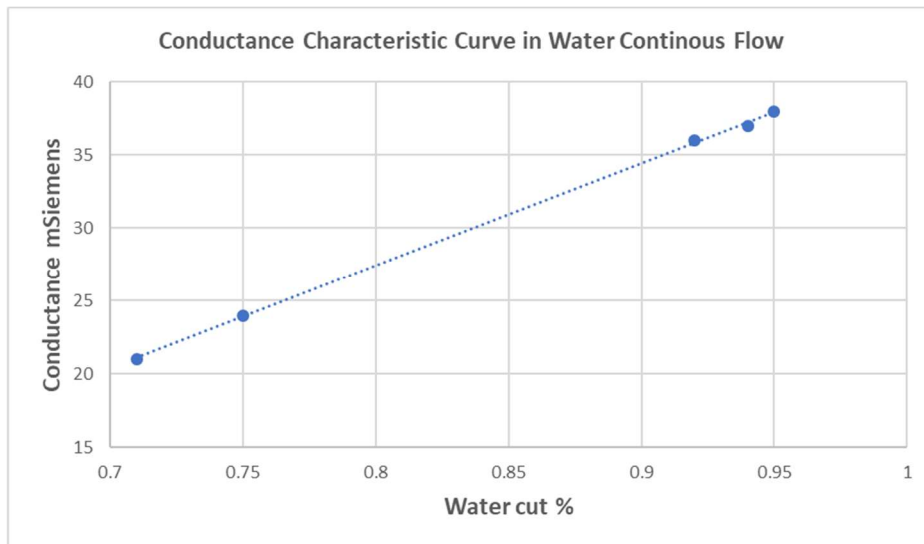
In the water continuous regime (> 60% water in oil), water composition measurement is based on the “characterisation of the conductance of the fluid”, taking advantage of the wide difference in the conductivity of oil (effectively zero) and water. Effect of temperature and salinity on water conductivity (charts below) are compensated by software.



In flow loop experiments conducted with esmerCAPCON, it has been shown empirically (figure below) that the conductivity will exhibit a linear relationship to water composition.

$$\text{Conductivity mSiemens / cm} = \text{fn}(\text{WaterComposition, Temperature, Salinity})$$

The function is resolved by software online to determine the water composition.



Note: The conductance function will depend on flow regime (formation of emulsion / foaming, etc) to a certain extent and tune up of field calibration will be required to compensate for such dependency.

DATA SHEET

Calibration Inputs

- Water & Oil density
- Water salinity
- Tune Up Coefficients

Outputs

- Water composition (volume fraction water in oil)
- Output: MODBUS / Analog (4-20mA) / Digital Display / Excel / PDF

Operating Envelope

Water cut : 0 – 100 %
 GVF: up to 10 %

Uncertainty

Uncertainty: +/- 2 % absolute

Limits

Ambient temperature: -40 to 85°C
 Process temperature: -40 to 120°C
 Process pressure: Maximum 100 bara

Mechanical and Electrical

Pipe Diameter Customer specification
 Materials: Customer specification (NACE compliant)
 Flange connections: Customer specification
 Certification: EEx ia IIC T4/T6
 Power Supply: 24 VDC or 110/220 VAC

Size	LxWxH cm	Weight kg
2"	25x50x88	40
3"	35x55x94	60
6"	65x70x110	100

Transmitters

Capacitance - X62 by Exalon Delft

The capacitance transmitter (X62 provided by Exalon Delft) is housed in an Exd rated enclosure mounted adjacent to the cone on the skid frame. The probe is connected to the transmitter through a short coaxial cable to minimize stray capacitance. Effective measurement frequency of the electronic circuit is 100 kHz.

Operating range	0 – 1000 pf
Supply	24VDC
Output	4-20mA
Ex certification	CENELEC EEx ia IIC T6...T4 Intrinsically safe

Conductivity - Stratos by Knick

The conductivity transmitter (Knick Stratos provided by Knick) is housed in an Exd rated enclosure mounted on the skid frame

Operating range	000.0 - 999.9 mS/cm
Supply	24VDC
Output	4-20mA
Ex certification	ATEX EEx ia IIC T4 Intrinsically safe

Flow Computer

The signals are processed in low power consumption computer installed on the flow line or an industrial PC in the safe area (alternative options). Measurements can be transmitted to SCADA by MODBUS.

Flow Computer: Beckhoff CX2020 microprocessor in field enclosure Zone 1
Software: esmerGL
Comms Protocol: MODBUS/HART

Software

A software package is provided for inline compensation for secondary effects such as temperature, salinity, density.

There are two models:

Conductance Model: handles the water continuous regime
 Capacitance Model: handles the oil continuous regime.

Both models are based on a number of predefined (universal) and user defined coefficients (those which depend on local process conditions). Models are selected automatically by the software.

Static Coefficients: These are the basic physical properties of the fluids and comprise water, oil density and salinity to be input by the user

Gradient Coefficients: These are physical property coefficients for compensating for the effect of temperature, salinity and density variations on the dielectric constant and conductivity of the medium.

Tune Up Coefficients: These are determined in a tune up exercise at the field. These coefficients compensate for the offset between factory conditions and field conditions.

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