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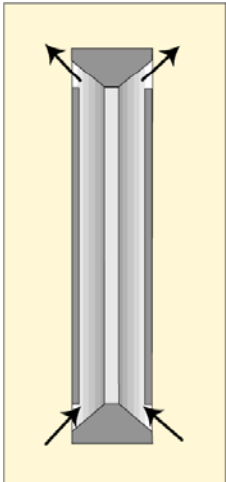
CAPACITANCE

Module #9

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Capacitance Tools



Water Hold-up

↓

Dielectric Constant

↓

Capacitance

↓

Counts / Sec


↓

Water Hold-up


Cause and effect

calculation


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Capacitance Tool



Courtesy: Weatherford




Courtesy: Spartek

Measurement chamber

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Capacitance

This group of widely-used tools depend for their operation on the difference between the dielectric constant of water (78) and that of oil or gas (4).

A simple way to find the dielectric constant of a fluid is to use the fluid as the dielectric between the plates of a capacitor

The capacitance may be found by classical methods such as including it in an RC network and finding the resonant frequency

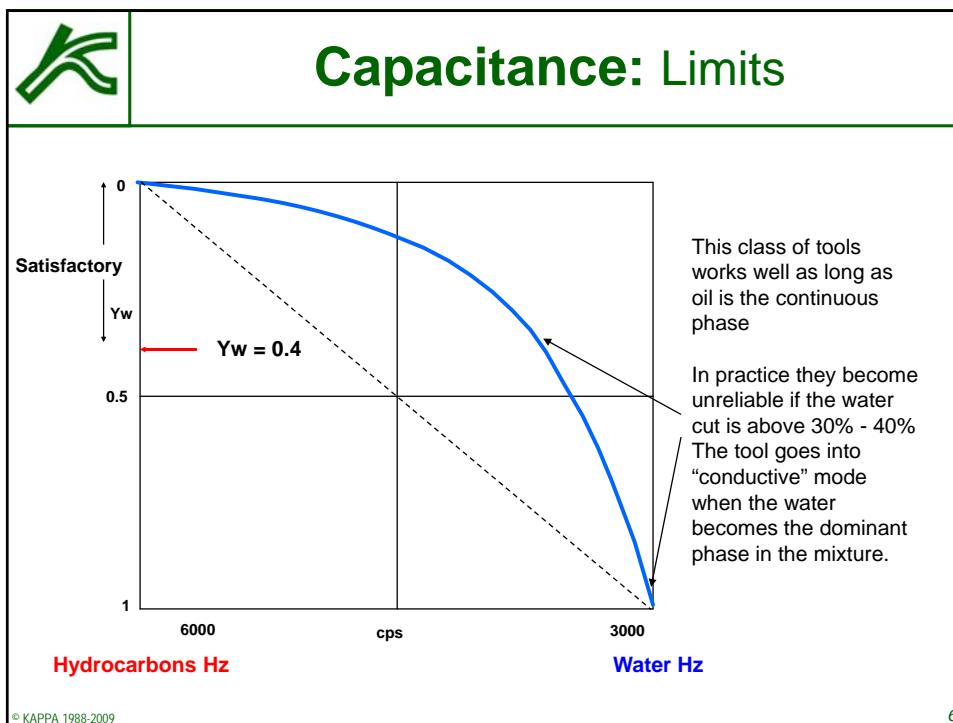
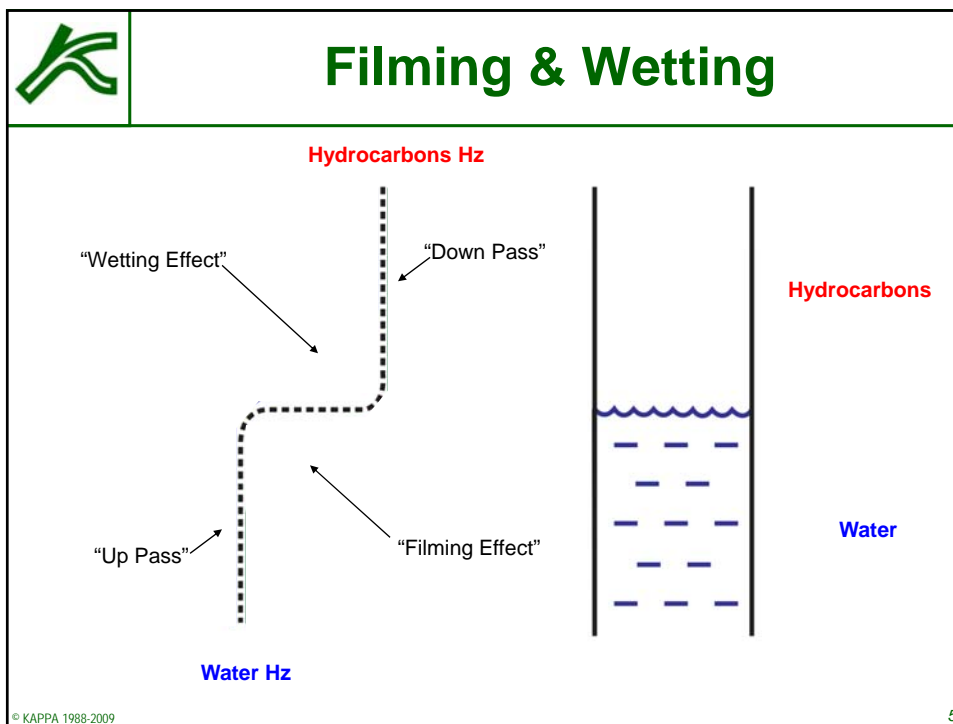
Hence the tools generally output frequency... counts /sec


Needs calibration (surface check, and downhole in-situ calibration)
Before job (in air, water, and possibly a liquid hydrocarbon.. diesel)
During job (in water and hydrocarbon from shut-in pass data)

NOTE: "Wetting" and "Filming" effects

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Capacitance Calibration

Calibration: convert cps to water holdup

$Y_w = f(\text{Normalized response})$

Normalized response = $\frac{100\%HC - \text{Response}}{100\%HC - 100\%H_2O}$
(Recommended)

Diel = f(Resp) $Y_w = \frac{\text{Diel} - \text{Diel}(100\%HC)}{\text{Diel}(100\%H_2O) - \text{Diel}(100\%HC)}$

Survey
- Tool Information


Capacitance

This capacitance calibration option is for conventional capacitance tools. This is not for the Multiple Probe Tools.

DIEL

Type of calibration chart:
 Yw vs norm. resp. Calibration
 Diel vs norm. resp. Copy from...
 Dielectric vs cps
 CAPI Water-Oil

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Capacitance Calibration

SURVEY
- TOOL INFO

Capacitance

This capacitance calibration option is for conventional capacitance tools. This is not for the Multiple Probe Tools.

DIEL

Type of calibration chart:
 Yw vs norm. resp. Calibration
 Default chart:
 CAPI Water-Oil Copy from...
 None
 CAPI Water-Oil
 CAPI Water-Gas
 FCAP Water-Oil
 FCAP Water-Gas
 HUM Water-Oil
 HUM Water-Gas
 CWH Water-Hydrocarbon
 SDI Water-Hydrocarbon

CAPI – Sondex
 FCAP – Atlas
 HUM – Schlumberger
 CWH – New Sondex
 SDI – Scientific Drilling

Yw vs norm. resp.

	Normalized resp.	Yw	
1	0	0.000	Delete
2	0.17	0.100	Insert
3	0.35	0.200	Add
4	0.54	0.300	Sim
5	0.88	0.400	
6	0.79	0.500	View Plot

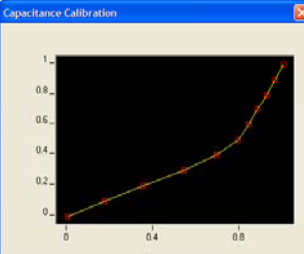
In situ tool readings

100% Water: 5000 cps

100% Hydrocarbon: 14300

Help Cancel OK


Capacitance Calibration



Y=0.5893X+0.7867

Help OK


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Capacitance Tool Specs

	SONDEX	SPARTEK	SCHLUMBERGER
Accuracy	+/- 3% Water Holdup	2% (0-30%WC) 5% (30-60%WC)	N/A
Resolution	1% (0-45%) Water Cut	0.1%	N/A


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QA/QC: Capacitance

- Check range of frequencies against surface tool checks
- Repeatability of passes
- Identify wetting (up passes) & filming (down passes) at water hydrocarbon contacts.
- Select water and hydrocarbon end frequencies
- Do not define as a reference channel in Emeraude, unless it is going to be used in the numerical analysis.
- Normally use slow down passes for interpretation

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Gas Holdup Tool


The Sondex Gas Hold Up Tool was originally developed by Halliburton to provide a reliable, cross wellbore means of measuring gas volume fraction in any flow regime and at any deviation.

The tool response is said to be representative of the entire cross section of the well bore within the casing and is almost completely independent of salinity, water cut and oil/water densities.


APPLICATIONS

- Multi-phase Production Profiling
- Fluid Identification
- Bubble Point Determination
- Gas Entry Detection

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Gas Holdup Tool

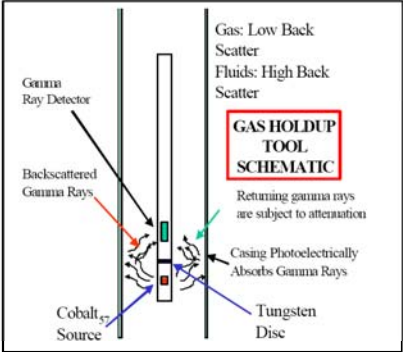


Mode	Memory or SRP	
Measurement Range	0-100% gas holdup	
Pipe Size	2.9 – 9.9 inch	
Accuracy	± 3%	
Resolution	1%	
Vertical Resolution	2.5 in	64 mm
Source	Cobalt 57 – 3mCi	Cobalt 57 – 111 MBq
Pressure Rating	15,000 psi	103 MPa
Temperature Rating	350 DegF	177 DegC
Make-up Length	27 in	686 mm
Tool Body Diameter	1 11/16 in	43 mm
Weight	10 lb	4.5 kg

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Courtesy: Sondex
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GHT Tool Design



The choice of source energy level is such that the tool measures only the fluid in the wellbore and not the formation.

The measurement discriminates on the amount of back scatter.

Gas has low electron density and has low back scatter.


Water has a high electron density and displays more back scatter.

Oil has a lower electron density than water, but due to compensating effects from the absorption in the oil, the difference between the oil and water response is about 5%

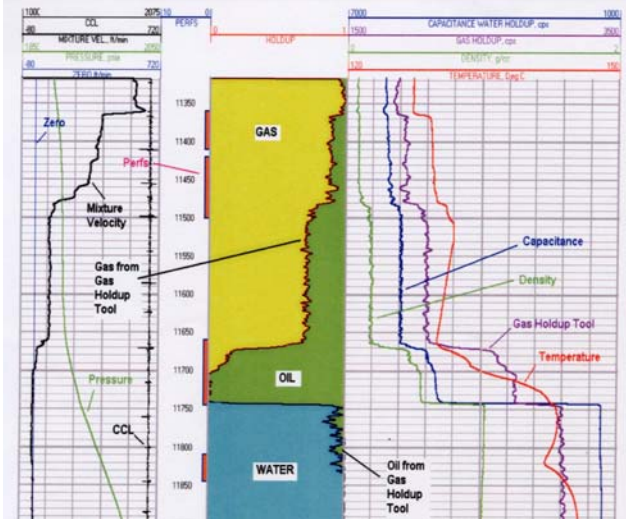
3 Millicurie Cobalt 57 gamma ray source
 Low energy gamma rays of 122 keV and 136 keV
 Tungsten shield between source and detector

Courtesy SONDEX

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Gas Holdup Tool Example



Courtesy SONDEX

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Gas Holdup Tool


Advantages:

- Gives an across wellbore measurement - virtually insensitive to stratification.
- Not influenced by the formation behind casing.
- Works at all well deviations (including horizontal).
- Unaffected by fluid velocity
- Response to hold-up is approximately linear.
- Virtually unaffected by salinity changes.

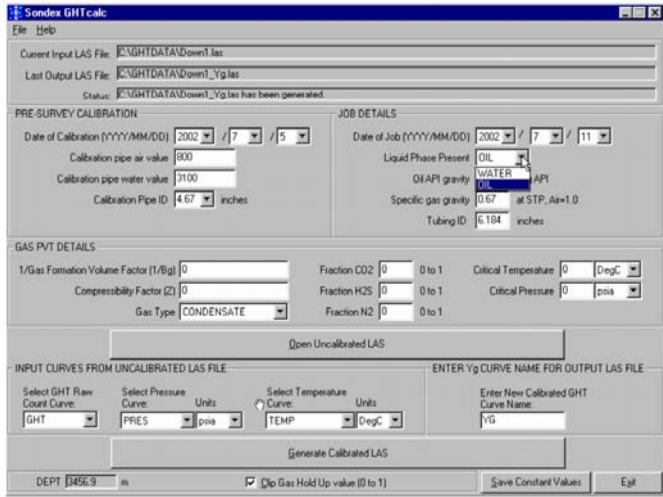
Disadvantages:

- Uses a radioactive source.
- Must be run centralised.
- Raw counts have to be corrected for changes in fluid properties with pressure and temperature variations.
- The tool is affected by pipe ID. Raw counts have to be corrected for changes in pipe ID
- Affected by presence of radioactive scale.

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GHT - Field Inputs



FIELD INPUTS

Calibration
Pipe ID
Pressure
Temperature
PVT properties

NOTE:
EMERAUDE accepts the GHT Yg curve as a direct Yg input.

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Courtesy SONDEX
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QA/QC: Gas Holdup Tool

- Check values in a known environment and fluid type.
- Verify response correct with regards other sensors eg. Density
- Remember that Y_g delivered from the WARRIOR acquisition logging system is a calculated curve, depending on wellsite inputs of a number of parameters, including ID, Pressure, Temperature, & PVT properties.