


Pressure & Temperature

KAPPA TOOLS

Module #6
Pressure & Temperature

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Pressure

STRAIN GAUGE SENSOR
QUARTZ GAUGE SENSOR

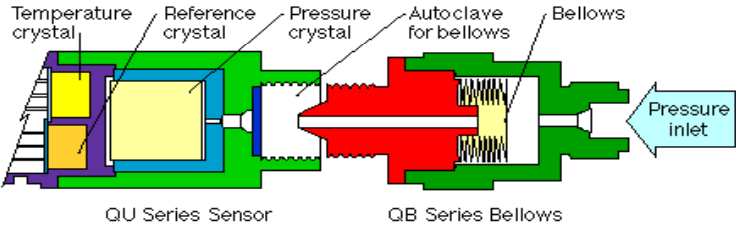
- The pressure measurement is a continuous profile of the pressure in the wellbore.
- The major reason to measure the pressure is to be able to accurately predict the PVT properties of the fluids.
- The curve also reflects changes in the borehole fluid composition (density). It is possible to derive a density measurement from the pressure.
(derivative with respect to depth, dP/dZ)
- Use the pressure in SIP analysis technique

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Quartz sensor

Quartzdyne Sensor and Bellows




- Uses 3 crystals
- Resolution 0.01 psi

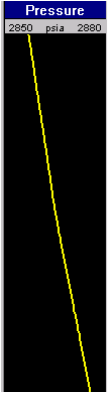
Courtesy Quartzdyne

The well Pressure distorts the crystal, changing the oscillator resonant frequency.
 This is reduced by the reference crystal frequency.
 Master Calibration coefficients required for absolute accuracy
NOTE: Internal Temperature Data required for thermal corrections.

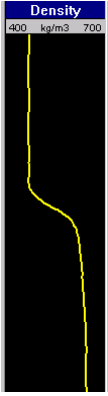
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Pseudo-density

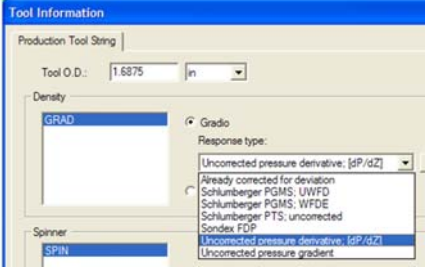


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A dP/dZ created from the pressure within EMERAUDE will be handled automatically


An Schlumberger dP/dZ such as "MWFD" from Schlumberger must be defined accordingly during "Tool Info"



A dP/dZ pseudo density needs:

- correction for pipe friction
- correction for deviation


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Pressure Tools

	SONDEX Quartz	SPARTEK 15,000psi	SCHLUMBERGER Strain	SCHLUMBERGER Quartz
Accuracy	+/- 2 psi	0.024% FS	+/- 6psi	+/- 1 psi +/- 0.01% fs
Resolution	0.01psi	0.003% FS	0.1psi	0.01psi

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Comparison of Quartz Pressure Sensors

	Introduction Year	Sensor size (OD x OAL)	Pressure Range (PSI)	Temperature Range (C)	Accuracy	Resolution (psi)	Transient Response	Temperature Compensation	Isolation Method	1993 Price (US\$)
HEWLETT PACKARD 2813D/E	1970	1.0"x3.4"	11,000	177	(1 PSI +0.01% READING)	0.001	POOR	NO	BUFFER TUBE	27,700 21,600*
HALLIBURTON HMR	1988	0.72"x1.9"	16,000	180	(1 PSI +0.01% READING)	<0.01	EXCELLENT	YES	BUFFER TUBE	NFS
SCHLUMBERGER COG	1992	1.0"x1.5"	15,000	175	(1 PSI +0.01% READING)	0.004	EXCELLENT	YES	BUFFER TUBE	NFS
PAROSCIENTIFIC/ WELLTEST	1983	0.12"x0.6"†	15,000	177	<0.01%F.S.‡	<0.01	FAIR TO GOOD	YES	BOURDON & BUFFER TUBE	6,800
QUARTZDYNE QU16K-B	1991	0.58"x0.6"	16,000	177	0.02%F.S.	<0.006	VERY GOOD	YES	BELLOWS	7,900
QUARTZDYNE TMC16K-B	1993	0.58"x1.2"	16,000	177	0.02%F.S.	<0.006	EXCELLENT	YES	BELLOWS	10,795

*1992 PRICE--HP STOPPED PRODUCTION 3/93; NFS=NOT FOR SALE; N/A=NOT APPLICABLE
 †WIDTH AND LENGTH OF SENSOR
 ‡NOT SPECIFIED; ESTIMATED FROM OTHER SPECIFICATIONS

From "QUARTZ PRESSURE TRANSDUCER TECHNOLOGIES", ROGER W. WARD & ROBERT B. WIGGINS , QUARTZDYNE, INC.


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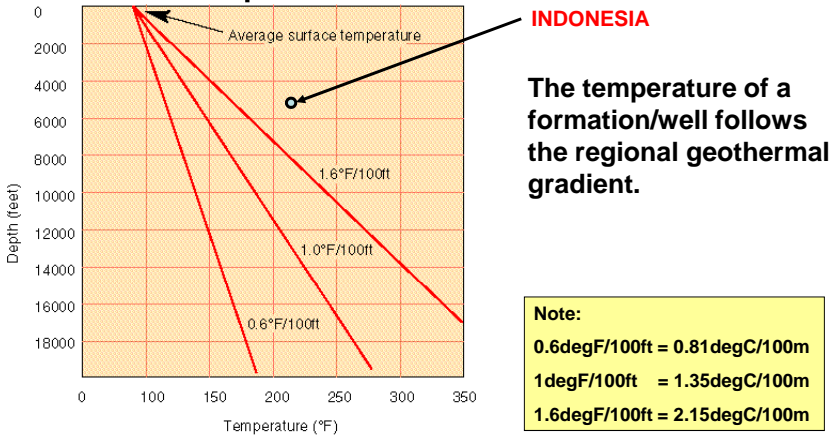
QA/QC - Pressure

- Look for repeatability between passes to see if the well is stable or not.
- Make dP/dZ pseudo densities and compare with actual densities, in order to check validity of pressure data.
- Confirm correct wellsite gauge calibration was used if absolute pressures are in doubt.
- Use draw line option in Emeraude to check pressure gradients through the log.
- Ensure Pressure data is sufficient quality and accuracy for input to PVT in EMERAUDE.
- Ensure rate & pressure data is stable enough and accurate enough for SIP purpose.
- If SIP analysis is to be performed, then pressure data must be of sufficient absolute accuracy

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Temperature



INDONESIA

The temperature of a formation/well follows the regional geothermal gradient.

Note:

0.6degF/100ft = 0.81degC/100m

1degF/100ft = 1.35degC/100m

1.6degF/100ft = 2.15degC/100m

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Temperature sensor



Temperature sensor

Courtesy SPARTEK

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Uses of Temperature

- Evaluate production profile
- Identify deepest production or injection
- Distribution of injected fluids
- Understanding Frac job
- Understanding Acid job
- Identifying casing and tubing leaks
- Locating gas entries
- Look for channeling behind casing
- Lost circulation zones
- Isolating cement tops
- Input to EMERAUDE for PVT module

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Temperature

- Temperature is one of the most useful “auxiliary” measurements made in production logging.
- Combined with pressure it helps compute the PVT parameters.
- In addition it will detect very small fluid entries:
 - The derivative of temperature wrt depth (dT/dZ) can be used to clarify fluid entries in complex environments.
- It is the only tool in the string that “sees” behind casing, hence it can be used to detect channeling.

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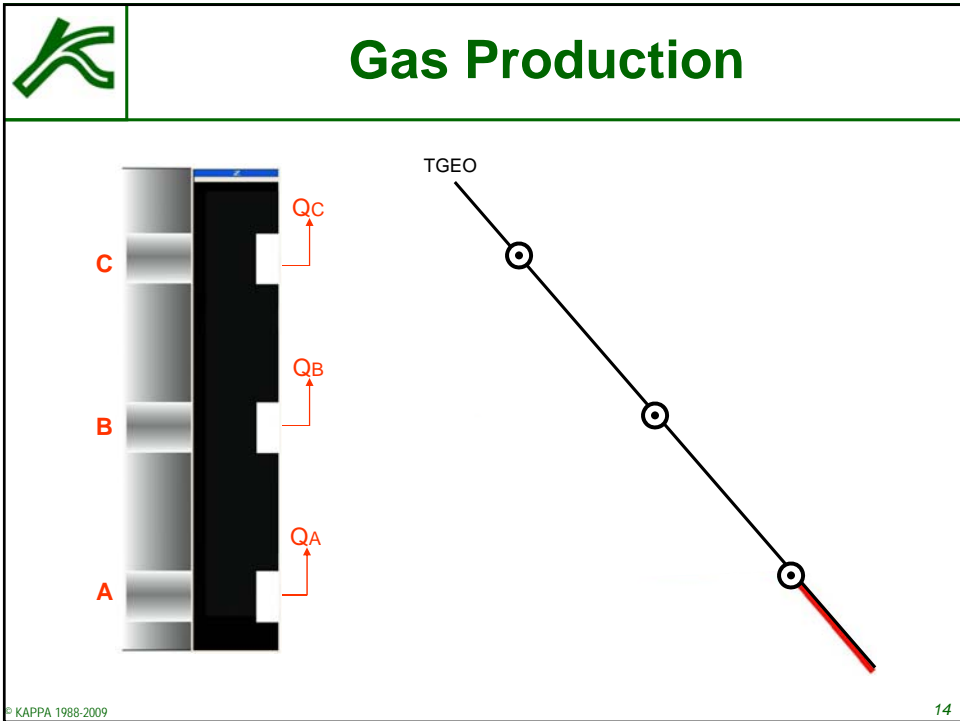
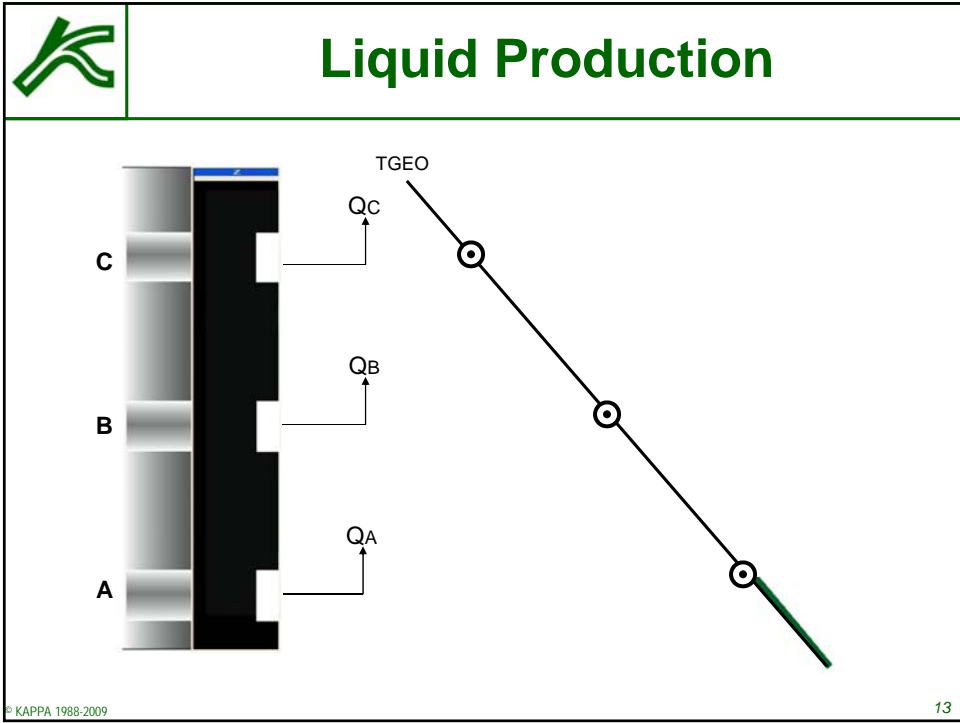


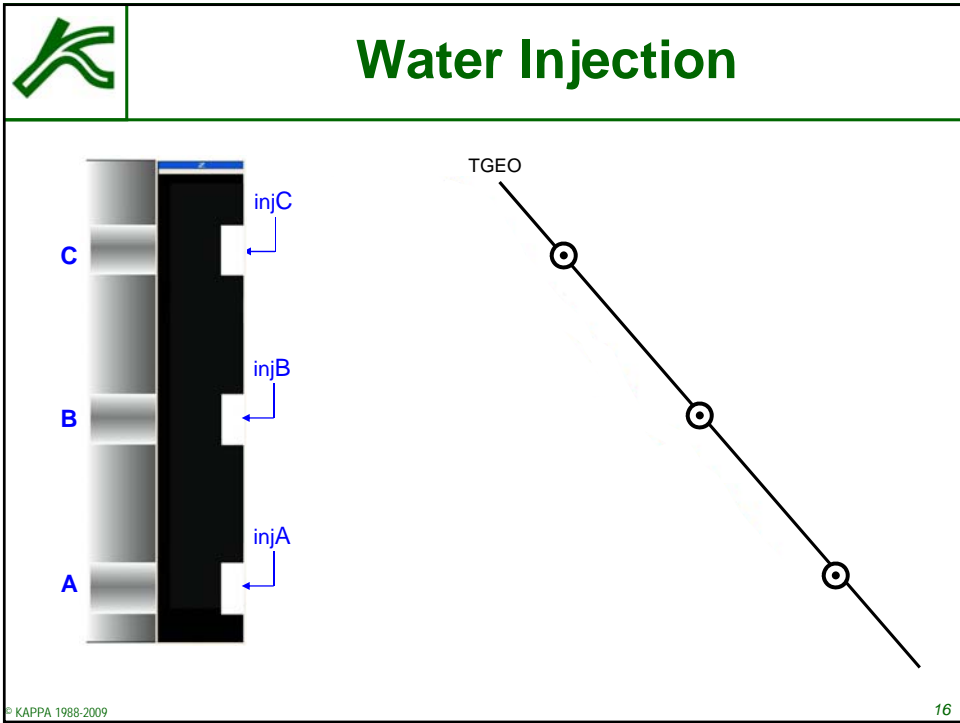
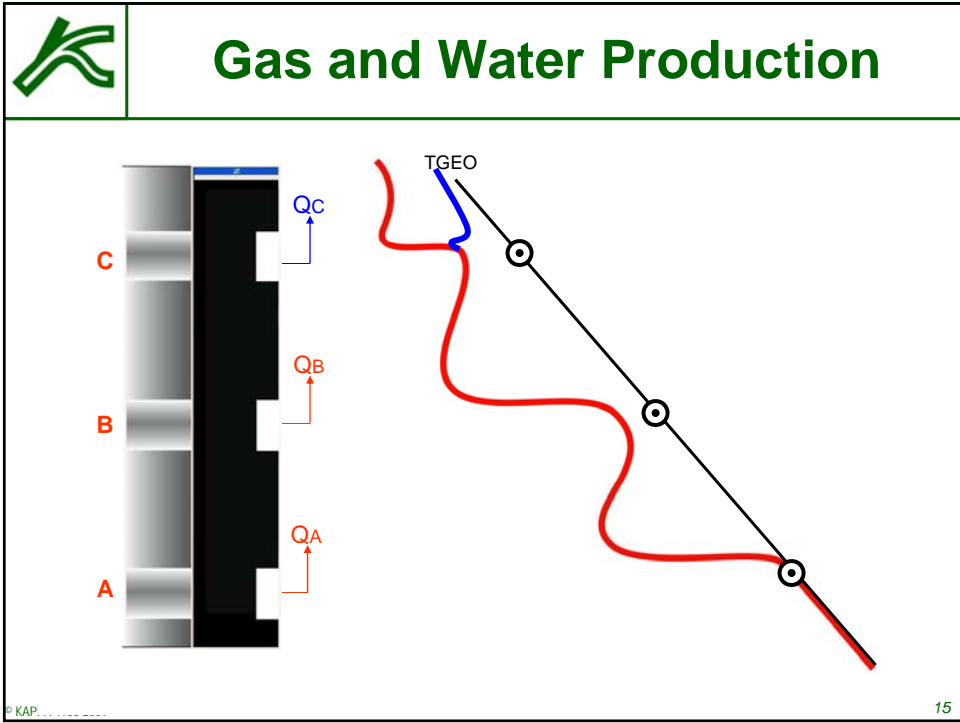
Interpreting Temperature


- The interpretation of temperature logs relies on patterns.
- The change in temperature with respect to the geothermal gradient has to be noted.
- Heating means a fluid is flowing from deeper to shallower, or entry of a warmer fluid into the mixture.
- Cooling means the opposite, or entry of a cooler fluid (or a gas entry....)
- The temperature is more sensitive to small flows than the flowmeters.
- Time-Lapse measurements are useful... e.g. comparing shut in and flowing temperature profiles

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Heat Capacities

Enthalpy balance :

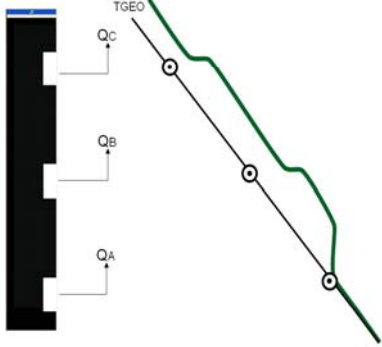
$$H_t = (Q_{ot} \times C_{po} \times \rho_o + Q_{wt} \times C_{pw} \times \rho_w + Q_t \times C_{pg} \times \rho_g) \times T_t$$

$$= \Delta H = (dQ_w \times C_{pw} \times \rho_w + dQ_o \times C_{po} \times \rho_o + dQ_g \times C_{pg} \times \rho_g) \times T_{geo}$$

$$+ H_b = (Q_{ob} \times C_{po} \times \rho_o + Q_{wb} \times C_{pw} \times \rho_w + Q_{gb} \times C_{pg} \times \rho_g) \times T_b$$


From: Q's, dQ's, Densities, Cp's^[1], Tgeo, Tb
Get: Tt

Heat capacities (PVT)	
Water	= 0.993 1
Oil	= 0.4897 0.5
Gas	= 0.2598 0.25

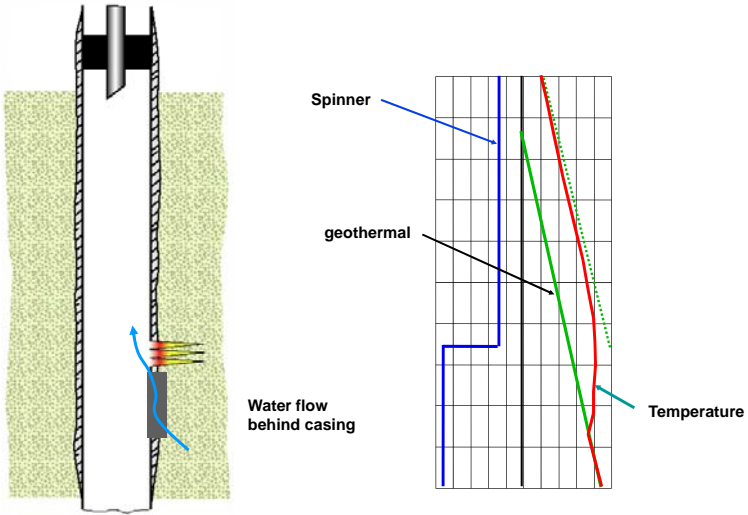


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Temperature: Channeling



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Temperature Tools

	SONDEX	SPARTEK	SCHLUMBERGER
Accuracy	+/- 1degF	+/- 1degC	+/- 1degC (+/- 1.8dgeF)
Resolution	0.0055degF	0.01 degC	0.006degC (0.01degF)

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QA/QC - Temperature

- Normally use slowest down pass for qualitative interpretation
- Normally use slowest down pass for reference channel for defining PVT in the calculation process.
- Check for repeatability in sump/no flow zone to validate sensor
- Look for repeatability to see if well is stable or not
- Make dT/dZ to emphasize temperature events, change of gradient
- Check for consistency with other sensor response (e.g. spinner)
- Use “draw line” provided in Emeraude to compare with “field” temperature gradient
- Used as qualitative indicator for flow behind casing
- Temperature can show fluid entries not detectable on the spinner
- Verify temperature data is suitable for input to PVT determination

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