

# CMR-Plus Combinable Magnetic Resonance Tool

High-speed, high-resolution NMR measurements for permeability, water cut, and hydrocarbon pore volumes

## APPLICATIONS

- Lithology-independent porosity for storage quantification
- Pore-size distribution for reservoir rock quality
- Bound- and free-fluid volume indicators of reservoir producibility
- Identification of thin, permeable beds in laminated reservoirs
- Hydrocarbon identification, especially in low-contrast, low-resistivity pay zones
- Determination of hydrocarbon pore volume for reserve calculations
- Improved irreducible water saturation estimates for reducing or eliminating water production
- Comparison with neutron, density, and data from the MDT\* modular formation dynamics tester for porosity, lithology, and fluid determination
- Critical information for setting pipe, determining coring and testing needs, and optimizing completion and fracture programs
- Integrated solutions of CMR-Plus tool logging and PowerSTIM\* well optimization service, combining petrophysical expertise and reservoir knowledge with completion design, execution, and evaluation
- Salt-saturated muds, deviated and horizontal holes, large (no limit) and small (to 5 $\frac{7}{8}$ -in) boreholes
- Increased efficiency of formation testing program in combination with the MDT tester

The CMR-Plus\* combinable magnetic resonance tool makes nuclear magnetic resonance (NMR) measurements of the buildup and decay of the polarization of hydrogen nuclei (protons) in the liquids contained in the pore space of rock formations. One primary measurement of the CMR-Plus tool is the total formation porosity. Borehole NMR measurement is unaffected by solid materials, so the measurement is not sensitive to matrix type and therefore lithology independent. The total porosity can be partitioned into the spectrum of pore sizes present, which provides information on the irreducible water saturation. Permeability can be estimated from the free-fluid to bound-fluid ratio and the shape of the pore-size distribution. NMR measurement is also useful for fluid identification because it is a hydrogen index measurement, and various fluids have different hydrogen index values as well as polarization characteristics. NMR data can be processed to yield formation fluid properties such as gas and oil saturation and oil viscosity.



CMR-Plus tool.

# CMR-Plus Combinable Magnetic Resonance Tool

## Measurement Specifications

	CMR-Plus Tool
Output	Transverse relaxation time ( $T_2$ ) distribution, total porosity, free- and bound-fluid volumes, permeability determined with Schlumberger-Doll Research (SDR) and Timur-Coates equations, capillary bound porosity, small-pore bound porosity, quality control curves and flags MRF* magnetic resonance fluid characterization station log: Saturation; oil, gas, and water volumes; oil viscosity; water and oil $T_2$ distributions; hydrocarbon-corrected permeability; oil and water log-mean $T_2$ distributions
Logging speed	Bound-fluid mode: 3,600 ft/h [1,097 m/h] Short time constant for the polarizing process ( $T_1$ ) environment: 2,400 ft/h [731 m/h] Long $T_1$ environment: 800 ft/h [244 m/h]
Range of measurement	Porosity: 0 to 100 pu Minimum echo spacing: 200 us $T_2$ distribution: 0.3 ms to 3.0 s Nominal raw signal-to-noise ratio: 32 dB
Vertical resolution	Static: 6-in [15.24-cm] measurement aperture Dynamic (high-resolution mode): 9-in [22.86-cm], three-level averaging Dynamic (standard mode): 18-in [45.72-cm] vertical resolution, three-level averaging Dynamic (fast mode): 30-in [76.20-cm] vertical resolution, three-level averaging
Accuracy	Total CMR porosity standard deviation: $\pm 1.0$ pu at 75 degF [24 degC], three-level averaging CMR free-fluid porosity standard deviation: $\pm 0.5$ pu at 75 degF [24 degC], three-level averaging
Depth of investigation	Blind zone (2.5% point): 0.50 in [1.27 cm] Median (50% point): 1.12 in [2.84 cm] Maximum (95% point): 1.50 in [3.81 cm]
Mud type or weight limitations	None
Combinability	Combinable with most tools
Special applications	Station logging for MRF magnetic resonance fluid characterization method

## Mechanical Specifications

	CMR-Plus Tool
Temperature rating	350 degF [177 degC]
Pressure rating	20,000 psi [138 MPa] High-pressure version: 25,000 psi [172 MPa]
Borehole size—min.	Without integral bow spring: 5 $\frac{1}{8}$ in [14.92 cm] With integral bow spring: 7 $\frac{1}{8}$ in [20.00 cm]
Borehole size—max.	No limit, but must be eccentric
Outside diameter	Without bow spring: 5.3 in [13.46 cm] With bow spring: 6.6 in [16.76 cm]
Length	15.6 ft [4.75 m]
Weight	Without bow spring: 374 lbm [170 kg] With bow spring: 413 lbm [187 kg]
Tension	50,000 lbf [222,410 N]
Compression	50,000 lbf [222,410 N]

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