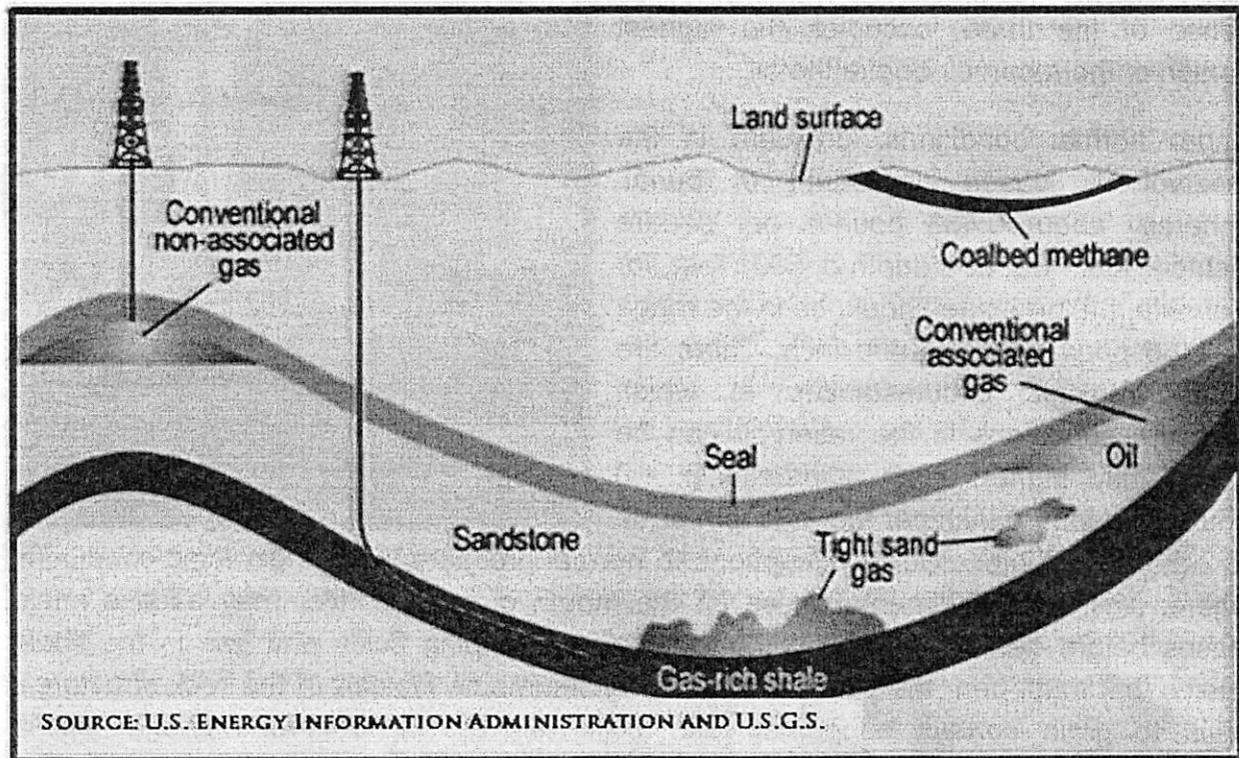


## Establishing Efficient Gas-Oil Ratios

By Charles Holbrook, MEC Member

The Regulation Requirements contained in SL 2012-143 Number 26, ***“Require the operation of wells with efficient gas-oil ratios and to fix such ratios.”*** This requirement as practiced in other states has historically been applied to the production of oil and natural gas from conventional reservoirs rather than to unconventional hydrocarbon production from such sedimentary rocks as shale and “tight” sandstone and limestone where horizontal drilling and hydraulic fracturing are required to free the hydrocarbons from their rocky entombment in non-permeable reservoirs.

The schematic cross-section below illustrates the difference between conventional and unconventional hydrocarbon accumulations.



CONVENTIONAL VS. UNCONVENTIONAL OIL & NATURAL GAS

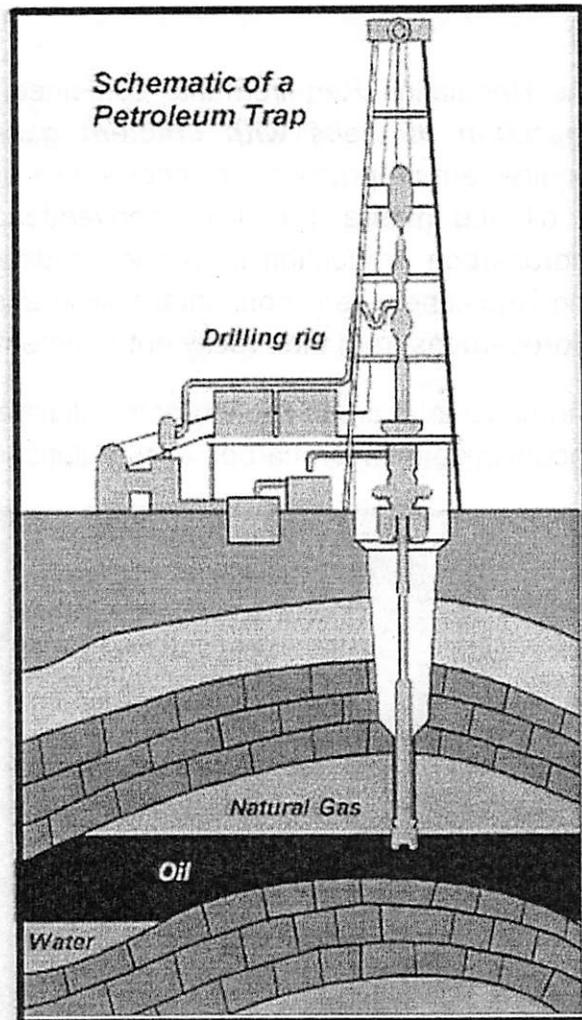
While unconventional reservoirs may contain substantial quantities of oil and/or natural gas, the pore space (porosity) in the rock that is filled with hydrocarbons are too small and lack the interconnectivity (permeability) to allow fluids to flow through the rock to a well bore. These oil and natural gas accumulations are referred to as “in situ” or in

place having never migrated from their site of origin to become trapped at a different location as is the case with conventionally trapped hydrocarbons.

In a conventional reservoir of porous and permeable rock (schematic illustration at right) such as sandstone and limestone, the hydrocarbons have migrated through permeable rocks from their site of origin to become trapped by an impermeable barrier. Oil, gas and water in a conventional reservoir have become segregated through time by gravity based on the relative specific gravity or density of the three components – oil, being lighter than water, essentially floats on the water and natural gas, being the least dense of the three, occupies the highest portion of the reservoir above the oil.

Under normal conditions, pressure in the reservoir is based on depth of burial, generally about 0.433 pounds per square inch per foot. So, at a depth of 5000 feet, for example, the pressure should be in the range of 2165 pounds per square inch. There are some geologic circumstances in which pressure conditions in the reservoir can be significantly higher, even approaching 1.0 pound per square inch per foot of depth or up to 2.3 times greater. Some exceptions to normal pressure include geologic conditions where: (1) rapid sedimentation as off the mouth of a large river may encase shale lenses before dewatering and compaction occur trapping fluids and gas in the shale lenses that must bear the burden of overlying sediments instead of the rock structure's grain to grain contact supporting the rocks above; (2) reservoirs caught up in compression tectonics may have moved to a shallower depth through folding and faulting preserving the pressure from a deeper realm; or, (3) erosion of overburden rocks may have resulted in the reservoir rock being shallower than its maximum depth of burial, again preserving pressures from a deeper realm.

Good reservoir management practices require that the oil leg in a conventional reservoir be developed first for two important reasons: the first is an economic one in that oil is more valuable than natural gas; and, secondly, the gas plays an important role in reservoir pressure maintenance. Together with the water drive from below, the gas cap



exerts pressure on the oil from above and expands down dip as oil is removed thereby prolonging optimum reservoir pressure conditions. During the life cycle of oil production from a conventional reservoir, the higher perforations may be squeezed off with cement as the gas/oil ratio increases to avoid producing the gas cap prematurely and accelerating the normal pressure decline. Likewise, the lower perforations may be squeezed off as the water cut increases to minimize the amount of produced water that must be handled at the surface. As production begins to decline, gas may be injected into the gas cap as an enhancement to reservoir pressure maintenance and water may be injected below the oil leg for the same reason.

The only known potential for oil and gas development in North Carolina is unconventional and, although operators will preferentially develop any oilier zones found to exist in a basin for obvious economic reasons, they have no control over the hydrocarbon mix that comes out of any particular zone that has been hydraulically fractured. So attempting to regulate efficient gas-oil ratios is not an option.

Should conventional oil and gas development ever come to North Carolina, it remains in the best economic interest of the operator to establish optimum reservoir management practices so state regulation is not necessary. Therefore, Regulation Requirement #26 contained in SL 2012-143 requiring the establishment of efficient gas-oil ratios should be removed from the relevant state statutes.

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