Methods for Computing SWI And BVI from NMR Logs

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Irreducible water saturation (S_{wi}) and bulk volume irreducible (*BVI*) water from nuclear magnetic resonance logging are not directly measured quantities but are derived from the T_2 distribution and the effective porosity. Thus, they are dependent on models and the associated parameter used in the interpretation of the T_2 distribution data.

It has been standard practice to use a $T_{2cutoff}$ value to partition the T_2 spectrum into irreducible and moveable fluids. This assumes that small pores are filled with irreducible water and that large pores contain moveable fluids (either hydrocarbons or water). Such an approach brings forth arguments both from scientific considerations and from the practical applications point of view. Scientifically, it is also possible that pores are incompletely drained; a film model may be more suitable for describing *BVI*. In practice, a sharp $T_{2cutoff}$ may result in very small or "zero" *BVI,* if either the $T_{2cutoff}$ value or the estimated T_2 distribution is inaccurate. Such a phenomenon has been observed on logs from the Gulf of San Jorge Basin, Argentina and is known also to occur in formations elsewhere.

We investigated the relationship between $T_{2cutoff}$ and the film model and, for simple pore geometric models, derived transcendental equations for predicting film model *BVI* weighting functions based on $T_{2cutoff}$ values. We found that the *BVI* weight functions are not very pore geometry sensitive and based on that, a procedure to compute a generic *BVI* weighting function is derived. The method is illustrated with core samples from the Gulf of San Jorge Basin and has been applied routinely since 1995 to several hundred NMR well logs.

In addition, we used a second approach to estimate *BVI* weighting functions by forming the ratio of individual incremental porosity bins of the 100% saturated and desaturated core NMR T_2 distributions. This approach appears more reasonable for cases when the short T_2 bin porosities in the desaturated T_2 distribution exceed the corresponding bin porosities in T_2 distribution of the fully saturated data. Both approaches work well with San Jorge Basin data and are easy to use.