

Invasion and Reservoir Damage in Tight Reservoirs; Options of Avoiding and Stimulation Based on Damage Mechanisms

Wael El Sherbeny¹, Robert Kennedy¹, Jean F. Aly Madkour¹, and Ali E. Farag²

¹Baker Hughes GE

²British University in Egypt

ABSTRACT

Formation (reservoir) damage is normally thought of as being equivalent to “skin damage”. However, it is not always identifiable by skin measurements or calculations. Formation damage should be defined as any barrier to production within the confines of the near wellbore reservoir or wellbore completion interval that restricts maximum natural production of fluids or gases. One author states, “Formation Damage is simply any process, which would cause a reduction in the productivity and/or injectivity.” Barriers to production are normally thought of as being artificially induced during drilling, completion (cementing, perforating, hydraulically fracturing) or production (workovers), but they are also often naturally induced by the flow of native clays or fines within the reservoir, or by a natural oil wet condition of the rock.

An industry misconception exists that formation damage is not (or of less) concern in tight (low permeability) reservoirs. Gas/oil permeability can be reduced to a great extent due to the invasion of the liquid phase of the drill in or completion fluid. Deep invasion depths, enhanced by capillary forces, have been documented. Effect on productivity depends on the depth to which the formation damage occurs. The same situation can occur in hydraulically fractured formations. This emphasizes how important avoiding formation damage can be.

Primary damage mechanisms and factors that have a significant influence in tight gas reservoirs include mechanical damage to formation rock, water blocking, relative permeability reduction around the wellbore resulting from filtrate invasion and fluid leak-off into the formation during hydraulic fracturing. Formation damage may also result from physical, chemical or biological conditions, i.e., plugging of the pores with muds, formation fines, native clays, bacteria or scale precipitates, cement filtrate invasion, changing the wettability of the formation with surfactants, or by changing the water saturation of a formation with invasion of water from an extraneous source.

The discussion covers methods and tools to avoid, remediate formation damage resulting from various damage mechanisms to which tight reservoirs are subjected, and focuses on hydraulically fracturing.

It is concluded that avoiding and remediating are the most important issues to be resolved during exploitation of tight reservoirs, and every effort should be made to minimize both the severity and the depth of formation damage.