BP

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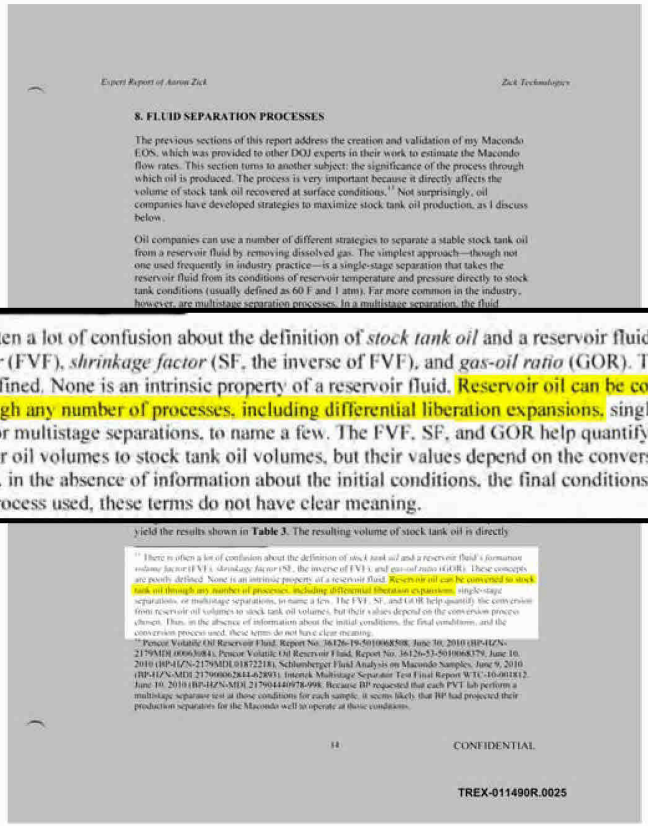

Expert Report of Aaron Zick *Zick Technologies*

8. FLUID SEPARATION PROCESSES

The previous sections of this report address the creation and validation of my Macondo EOS, which was provided to other DOJ experts in their work to estimate the Macondo flow rates. This section turns to another subject: the significance of the process through which oil is produced. The process is very important because it directly affects the volume of stock tank oil recovered at surface conditions.[13] Not surprisingly, oil companies have developed strategies to maximize stock tank oil production, as I discuss below.

Oil companies can use a number of different strategies to separate a stable stock tank oil from a reservoir fluid by removing dissolved gas. The simplest approach—though not one used frequently in industry practice—is a single-stage separation that takes the reservoir fluid from its conditions of reservoir temperature and pressure directly to stock tank conditions (usually defined as 60 F and 1 atm). Far more common in the industry, however, are multistage separation processes. In a multistage separation, the fluid

[13] There is often a lot of confusion about the definition of *stock tank oil* and a reservoir fluid's *formation volume factor* (FVF), *shrinkage factor* (SF, the inverse of FVF), and *gas-oil ratio* (GOR). These concepts are poorly defined. None is an intrinsic property of a reservoir fluid. Reservoir oil can be converted to stock tank oil through any number of processes, including differential liberation expansions, single-stage separations, or multistage separations, to name a few. The FVF, SF, and GOR help quantify the conversion from reservoir oil volumes to stock tank oil volumes, but their values depend on the conversion process chosen. Thus, in the absence of information about the initial conditions, the final conditions, and the conversion process used, these terms do not have clear meaning.

yield the results shown in **Table 3**. The resulting volume of stock tank oil is directly

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[14] Pencor Volatile Oil Reservoir Fluid, Report No. 36126-19-5010068508, June 30, 2010 (BP-HZN-2179MDL00063084); Pencor Volatile Oil Reservoir Fluid, Report No. 36126-53-5010068379, June 10, 2010 (BP-HZN-2179MDL01872218); Schlumberger Fluid Analysis on Macondo Samples, June 9, 2010 (BP-HZN-MDL21790800628EE42F93); Intertek Multistage Separator Test Final Report WTC-16-001812, June 30, 2010 (BP-HZN-MDL21790444978-998. Because BP requested that each PVT lab perform a multistage separator test at those conditions for each sample, it seems likely that BP had projected their production separators for the Macondo well to operate at those conditions.

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