



CHEMICAL AND PHYSICAL PROPERTIES

Section A10

Water Absorption and Desorption

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A10.1 Introduction

Concentrated formate brines are hygroscopic, and therefore absorb water from the atmosphere when left in an open container over time. At higher temperatures, however, the evaporation process is more significant and water is desorbed from the brine.

A10.2 Absorption / desorption - influence of brine concentration

Simple tests to determine the rate of water absorption into formate brines have been conducted on cesium formate brine samples of various density over a period of 96 hours [1]. Brine density between 1.2 g/cm³ / 10 lb/gal and 2.1 g/cm³ / 17.5 lb/gal were evaluated. The tests were carried out at ambient temperature (approximately 20°C / 68°F) and pressure, and 50% relative humidity.

The results shown in Figure 1 suggest that two competing processes occur. Water is lost by evaporation and gained by absorption. At low densities the evaporation rate exceeds the absorption rate and brine density increases. At high densities the rate of absorption is higher than evaporation and density decreases. The rate of each of these two processes is dependent on temperature and humidity. The effect these processes have on brine density also depends on the sample surface area-to-sample volume ratio.

A10.3 Absorption / desorption - influence of fluid agitation

Absorption testing has been conducted to investigate the influence of fluid agitation on water absorption / desorption in a concentrated cesium formate brine (2.3 g/cm³ / 18.3 lb/gal) [1][2]. Two samples were kept at a constant temperature of 22.8°C / 73°F. One sample (497.7 g) was stirred and the other sample (504.6 g) was left static. Both samples had a surface area of 5.93 in², giving a sample surface area-to-sample volume ratio equal to that of a standard 55 gallon barrel. The ambient temperature was 23°C / 73°F. Results are listed in Table 1.

The results confirm that an agitated formate brine sample absorbs / desorbs water faster than a sample left static. It is therefore recommended that the pits are agitated as little as possible to reduce the effect of these two phenomena.

A10.4 Absorption / desorption - influence of temperature

Absorption / desorption tests have been carried out on concentrated cesium formate (2.28 g/cm³ / 19.0 lb/gal) to assess the influence of temperature [2]. The sample size was 520 g (228 mL) and the surface area 4.15 in², giving a sample surface area-to-sample volume ratio equal to that of a standard 55 gallon barrel. The relative humidity was 45% – 55%. Weights of the samples were monitored over a two-day period. The measured weight changes are listed in Table 2.

The temperature influence on water absorption / desorption was also tested on another high concentration cesium formate brine sample (2.20 g/cm³ / 18.3 lb/gal) [2]. A concentrated zinc bromide sample was also tested for comparison. Weight changes of the two samples were monitored over five days at three different temperatures.

These tests show that a standard 2.20g/cm³ / 18.3 lb/gal cesium formate sample desorbs water at temperatures from 35°C / 95°F and above. A more concentrated cesium formate sample of 2.28 g/cm³ / 19.0 lb/gal continues to absorb water up to 38°C / 100°F.

A10.5 Practical considerations

Water adsorption in a drilling fluid can be monitored during field use by monitoring filtrate density. Experience from field use is that the net effect of water adsorption / desorption is negligible.

References

- [1] "Water absorption data elf95.doc".
- [2] "Water adsorption-evaporation.doc".

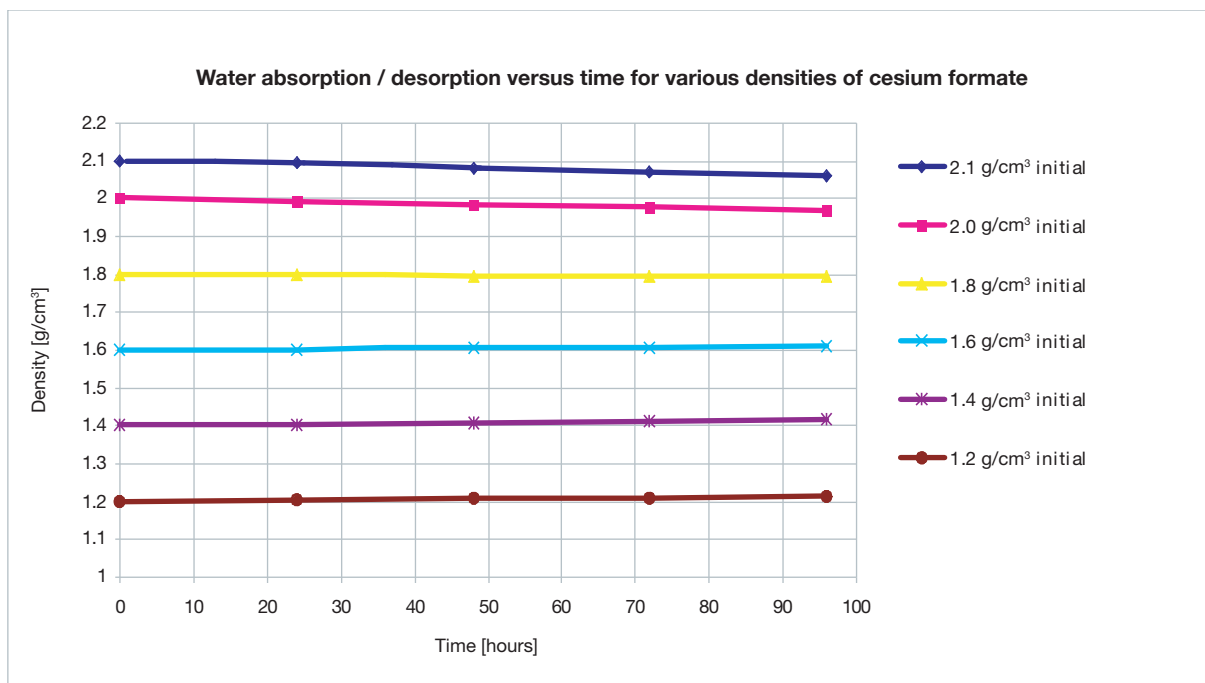


Figure 1 Cesium formate density as a function of time for various densities of cesium formate brine. Temperature ~ 20°C / 68°F. Relative humidity ~ 50%.

Table 1 Weight change of stirred and unstirred cesium formate sample (2.28 g/cm³ / 19.0 lb/gal) at various conditions. Sample sizes: stirred sample = 497.7 g; static sample 504.6 g. Surface area exposed to air = 26.8 cm² / 4.15 in² for both samples. Temperature = 23°C / 73°F and relative humidity = 45 – 55%.

Conditions	16 hrs	70 hrs	14 days
Stirred	+0.20%	+1.32%	+5.41%
Static	+0.17%	+0.92%	+3.86%

Table 2 Weight changes of a 2.28 g/cm³ / 19.0 lb/gal cesium formate brine sample as a function of temperature. The sample size was 520 g and the surface area exposed to air 26.8 cm² / 4.15 in². Relative humidity = 45 – 55%.

Temperature	48 hrs
38°C / 100°F	+0.11%
66°C / 150°F	-4.33%

Table 3 Percent weight change in concentrated cesium formate (2.20 g/cm³ / 18.3 lb/gal) and zinc bromide (2.18 g/cm³ / 18.2 lb/gal) as a function of time. Sample size = 100 mL. Surface area = 22.8 cm² = 3.54 in².

35°C / 95°F	2 hrs	5 hrs	7 hrs	22 hrs	5 days
CsFo	-0.07	-0.17	-0.24	-0.65	-2.2
ZnBr₂	+0.08	+0.18	+0.22	+0.54	+1.3

65°C / 149°F	2 hrs	5 hrs	7 hrs	22 hrs	5 days
CsFo	-1.3	-2.9	-4.0	-8.4	-13.1
ZnBr₂	-1.0	-1.7	-2.2	-4.3	-7.8

89°C / 192°F	3 hrs	5 hrs	20 hrs	118 hrs	
CsFo	-5.3	-8.1	-14.9	-15.9	
ZnBr₂	-4.0	-5.8	-11.8	-14.7	