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Full Length Research Paper

Chemical method for monitoring demulsification in oil industry

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A special and fast chemical method to detect and determine water separation from emulsified crude with accuracy (>97%) was developed. The method was applied successfully to determine the total amount of water in crude and its derivatives. Most methods available for the detection and estimation of low concentrations of water require either sophisticated equipment and/or take a long time. Chemical method depends on a chemical reaction between calcium hydride and water (both soluble as well as suspended droplets). The hygroscopic nature of some petroleum derivatives was followed with this method.

Key words: Diesel fuel, gasoline, kerosene, reaction, demulsification, and water in crude.

INTRODUCTION

Presence of water even in trace amounts in crude or its derivatives such as ATK, kerosene, gasoline diesel fuel, lubricating or hydraulic oil can cause many undesirable effects such as corrosion, raise conductivity, leaching of additives etc. Most methods available for detection and estimation of low concentrations of water require either sophisticated equipment and/or take a long time (Hobson, 1975). There are many different methods for the determination of water in petroleum or its derivatives. These methods can be divided into two groups: Those which depend on measuring a change in a physical property, and those which depend on chemical reaction. Figure 1 shows both main groups (Nelson, 1958; Evans, 1977). This method is capable of detecting and measuring the high accuracy of the total water in crude and its derivatives.

METHODOLOGY

The method is based on a reaction which takes place between calcium hydride and water, be it suspended or dissolved in the medium. The general chemical and physical properties from (New report for, "Acetylene production technology", 2007; Kirkpatrick, 1976).

The generated volume of hydrogen is measured and the quantity

$$CaH_2 + H_2O \rightarrow \uparrow 2H_2 + CaO$$

of water present can be found from the chemical reaction. Trial methods showed that concentrations as low as ppm can be measured accurately. The method is rather simple and fast. Figure 2 shows a diagram for the setup used. One main application of the method was to monitor demulsification process in crude. Depends on an expermental samples specify for expermental work.

This method was used also to monitor the hygroscopic nature of some petroleum derivatives such as kerosene, ATK and gas oil. The results are outlined in Table 1.

Demulsifier[1] was added to a known volume of crude containing some water. The demulcifier was added in trace quantaties (ppm). Not only various concentrations of the additive were examined but also the temperature was varied between 40 to 60°C for each additive concentration. The settling time varied between 1 to 3 h at each temperature. In all about 45 tests were carried out and the results are outlined in Table 3. In each case 150 g of the crude oil was placed in along glass tube 8 cm in diameter and 30 cm in length. Additive was added then stirred mechanically for one hour, during which the glass tube was immersed in a water bath maintained at the required temperature. Settling was carried out at this temperature. Then three equal samples were drawn from the crude oil one from the top of the tube, the second from the middle, and finally the third from the bottom of the tube. These three samples were then analyzed with the hydride method for water content. From the monitor can be measured the amounts of gas hydrogen then depends on chemical reaction can be measured

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[1]The demulcification additive used was a commercial one and of unknown structure.

Table 1. Measure the accuracy of chemical method.

Quantity of water in mol/ 50 g (10^{-4})			Mean (10^{-4})	Standard deviation (10^{-4})	Percentage error
Added	Found	Difference			
2.777	2.7730	0.004	2.7404	0.025	0.144
	2.7600	0.017			0.612
	2.7320	0.045			1.620
	2.7150	0.062			2.230
	2.7220	0.055			1.980
5.555	5.5580	0.003	5.5157	0.029	-0.054
	5.5140	0.041			0.738
	5.4890	0.066			1.188
	5.5020	0.053			0.954
8.333	8.3440	-0.011	8.3166	0.070	-0.132
	8.3200	0.013			0.156
	8.2800	0.053			0.636
	8.4130	-0.080			-0.960
	8.2260	0.107			1.284
16.666	16.6630	0.003	16.618	0.050	0.018
	16.5620	0.104			0.624
	16.6600	0.006			0.036
	16.5890	0.077			0.462

Table 2. Water absorption by three different petroleum products.

Sample	Time (h)	Water content in mole/kg x10^{-4}
Gas oil	3	6.48
	4	13.69
	5	15.51
	6	17.42
	8	19.35
Kerosene	1	7.09
	1.5	7.75
	3	14.26
	4	17.66
	5	23.28
A.T.K.	1	2.53
	4	7.83
	6	12.63
	7	15.47

amounts of moisture. Table 1 gives a very good identifcation about the accuracy of this method.

RESULTS AND CALCULATIONS

From the reaction that has been previously described, it is seen that the volume of hydrogen used to calculate the mole of hydrogen can be measured. Depending on the chemical reaction, each 1 mole from moisture equal 2 moles from hydrogen. So, results in Table 1 illustrate the accuracy of this method. In each case, a known amount of water was added to (150 g) crude and was analyzed. These results indicate that the method employed was

Table 3. Demulsification of crude please to find the total amount of water in organic crude.

Demulsifier concentration (ppm)	Temp. (℃)	Settling time (h)	Water content (ppm.)		
			Top of the tube	Middle of the tube	Bottom of the tube
30	40	1	1129.3	1381.6	1493.8
	40	2	1334.4	1396.0	1274.3
	40	3	1307.5	1340.4	1356.0
	50	1	1125.3	1253.5	1625.9
	50	2	1205.4	1261.5	1534.6
	50	3	1059.2	1038.8	1905.8
	60	1	1518.9	1126.1	1359.2
	60	2	1276.7	1221.0	1506.6
	60	3	1318.8	1301.9	1383.6
40	40	1	1251.5	1181.4	1571.1
	40	2	1068.5	1226.6	1707.6
	40	3	1390.2	1127.5	1487.3
	50	1	1151.4	1279.5	1573.0
	50	2	1256.3	1381.2	1366.8
	50	3	1080.8	1223.4	1700.4
	60	1	1162.2	1135.3	1706.0
	60	2	1246.6	1125.7	1631.5
	60	3	1249.5	1220.2	1533.8
50	40	1	1239.5	1165.4	1597.9
	40	2	1274.7	1178.6	1551.2
	40	3	1257.1	1277.1	1470.1
	50	1	1302.3	1306.7	1395.2
	50	2	1151.8	1331.9	1520.6
	50	3	1164.9	1323.6	1515.3
	60	1	1116.2	1225.8	1661.0
	60	2	1169.5	1224.2	1610.3
	60	3	1164.6	1294.7	1545.3
60	40	1	1328.4	1139.7	1535.8
	40	2	1142.5	1204.9	1656.7
	40	3	1072.5	1172.5	1759.2
	50	1	881.0	1213.8	1907.9
	50	2	1175.8	1045.2	1782.9
	50	3	1338.3	1020.4	1641.9
	60	1	1426.9	949.1	1627.2
	60	2	1344.9	1077.3	1581.8
	60	3	1265.8	1182.9	1555.5
70	40	2	1142.1	1305.1	1557.0
	40	3	1212.6	1216.2	1575.0
	50	1	1283.5	1689.2	1031.2
	50	2	1382.8	1439.3	1182.1
	50	3	1476.5	1292.3	1235.5
	60	1	1180.6	1420.2	1341.6
	60	2	1257.5	1524.2	1221.4
	60	3	1372.0	1251.1	1381.3

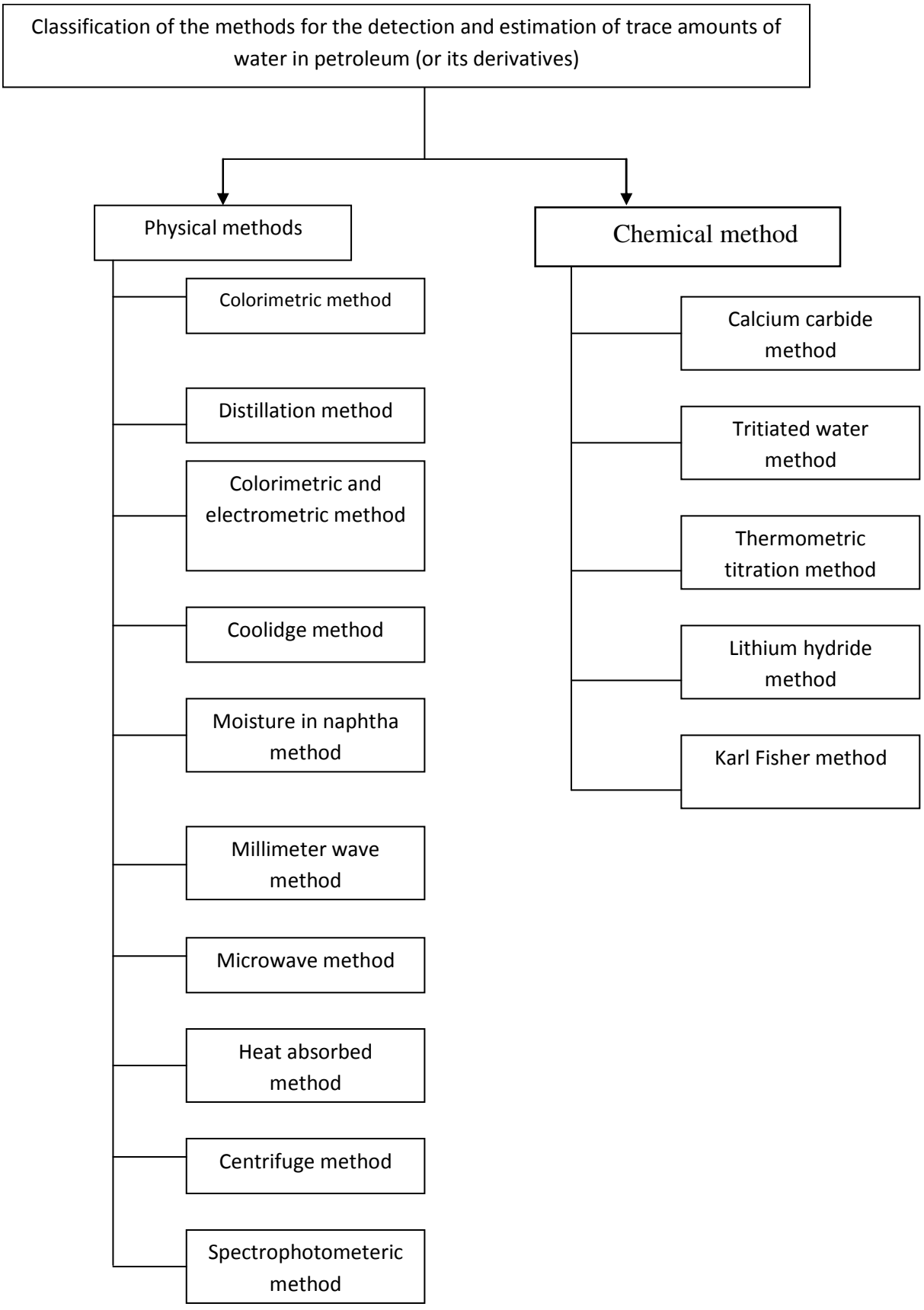

Figure 1. Main methods of detection and estimation of trace amounts of water in petroleum (or its products).

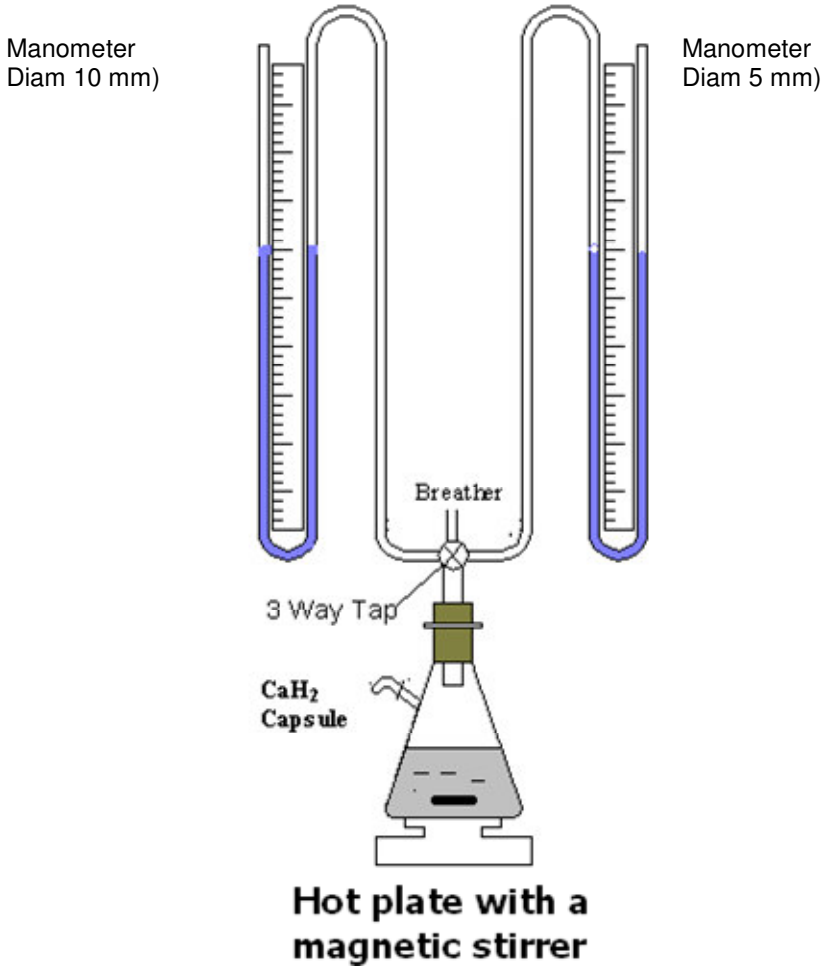

Figure 2. Schematic diagram for the apparatus used.

rather accurate in determining water content with high accuracy. The method was applied in other cases such as:

1. To monitor the hygroscopic nature of some petroleum products (Gas oil, Kerosene and A.T.K) the results are illustrated in Table 2.
2. To follow the settling time during demulcification at three different concentrations and three different temperatures, the results are illustrated in Table 3.

Conclusions

This method for determining trace amounts of water in crude or its derivatives was developed based on the reaction of powdered calcium hydride with free and dissolved water. The accuracy was in most cases more than 97%.The method is rather sensitive and was applied to:

1. Monitor the absorption of water from the atmosphere by kerosene, Gas oil and A.T.K.
2. Monitor settling time when demulcifiers are used with crude.
3. Temperature has no big effects on the system.

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