Pakistan Journal of Hydrocarbon Research
Vol.2, No.2(July 1990), P.97-110, 1 Fig., 11 Tables

A New Technique of Preparing Oil Based Mud for Drilling

Shams-ul Ghias Malik[1]

ABSTRACT

Expensive and imported additives commonly used in preparation of oil based mud have been successfully substituted by stearic acid, a cheap and locally available material. The mud prepared in this way meets the requirements of the industry and is a complete substitute of the conventional oil based mud.

INTRODUCTION

Drilling fluids can be classified into two main categories, drilling mud and oil based drilling fluid. The first category has bentonite and water as the main constituents. The oil based drilling fluids contain diesel, asphalt, water and the weighting materials like barites. To keep these materials in a homogenous form additives are required. These additives are mostly imported at a high cost.

Petroleum Testing and Research Laboratories (PTRL) of Hydrocarbon Development Institute of Pakistan (HDIP) Islamabad have developed a new process to prepare oil based mud using stearic acid, a substitute to imported additives. The new mud mainly comprises diesel, asphalt, solids and water. The drilling fluid thus prepared remains in a stable emulsion form. The composition of emulsion can be changed to the desired requirement. The addition of weighting material can be adjusted to any desired gravity of the mud (Tables 1-11). All the materials used in preparation of this fluid emulsion are indigenous, cheap and readily available in the market.

METHOD OF MIXING

In normal procedure of mixing or making of oil based mud, first the wet mud is prepared and then the oil portion is added to it. The technique developed in the PTRL Islamabad is just in the reverse order. Normally we require two tanks to prepare the drilling mud. In the first tank HSD and stearic acid in the proper proportion is mixed thoroughly with vigorous stirring or recycling. In winter season it will need warming to dissolve the stearic acid. The powdered asphalt is then added to it and mixed thoroughly, this can be called oil/hydrocarbon phase. The asphalt will dissolve at 60-80 °C with stirring. In the second tank a calculated amount of water is taken, then calcium chloride is added and if sodium chloride is required it is also dissolved in water. If the solution is already alkaline, ammonia solution is not required, otherwise a small (1-1.5%) amount of ammonia solution (37%) may be added. The ammonia solution can be replaced with alkali solution according to the Sap.Value of stearic acid. The mixture is stirred sufficiently to dissolve every portion of the solids. This can be called water phase.

The water mixture phase is added to oil phase gradually with constant stirring and mixing, it will result in formation of a stable emulsion of water and oil. To this emulsion any solids like barites, lime, etc. can be mixed and the emulsion remains stable for a long time.

The microscopic pictures of this emulsion show properly dispersed water in oil phase (Figure 1 a & b).

A technique can also be developed to prepare the mud in a continuous flow system instead of a tank (batch method).

COMPOSITION

The following ingredients have been used in preparation of the new mud under discussion:

Asphalt (industrial or road paving)	0-20%
Diesel	0-70%
Stearic acid	1.5 to 5%
Water	0-40%
Ammonia 37% soln.	1 to 1.5%
Calcium chloride	0-50%
Sodium chloride	0-15% of water
Barites	0-50%
Lime	0-50%

The sodium chloride and lime can be added whenever required.

The calcium can be used without ammonia solution or with very little ammonia, this can emulsify the oil and water. The emulsion becomes stable if 70% of the required calcium chloride is mixed with water and the remaining 30% portion is added as solid.

The stability of emulsion depends on the thorough mixing of diesel and stearic acid. The two components must be mixed thoroughly. Another factor which controls the

[1]Hydrocarbon Development Institute of Pakistan, Islamabad.

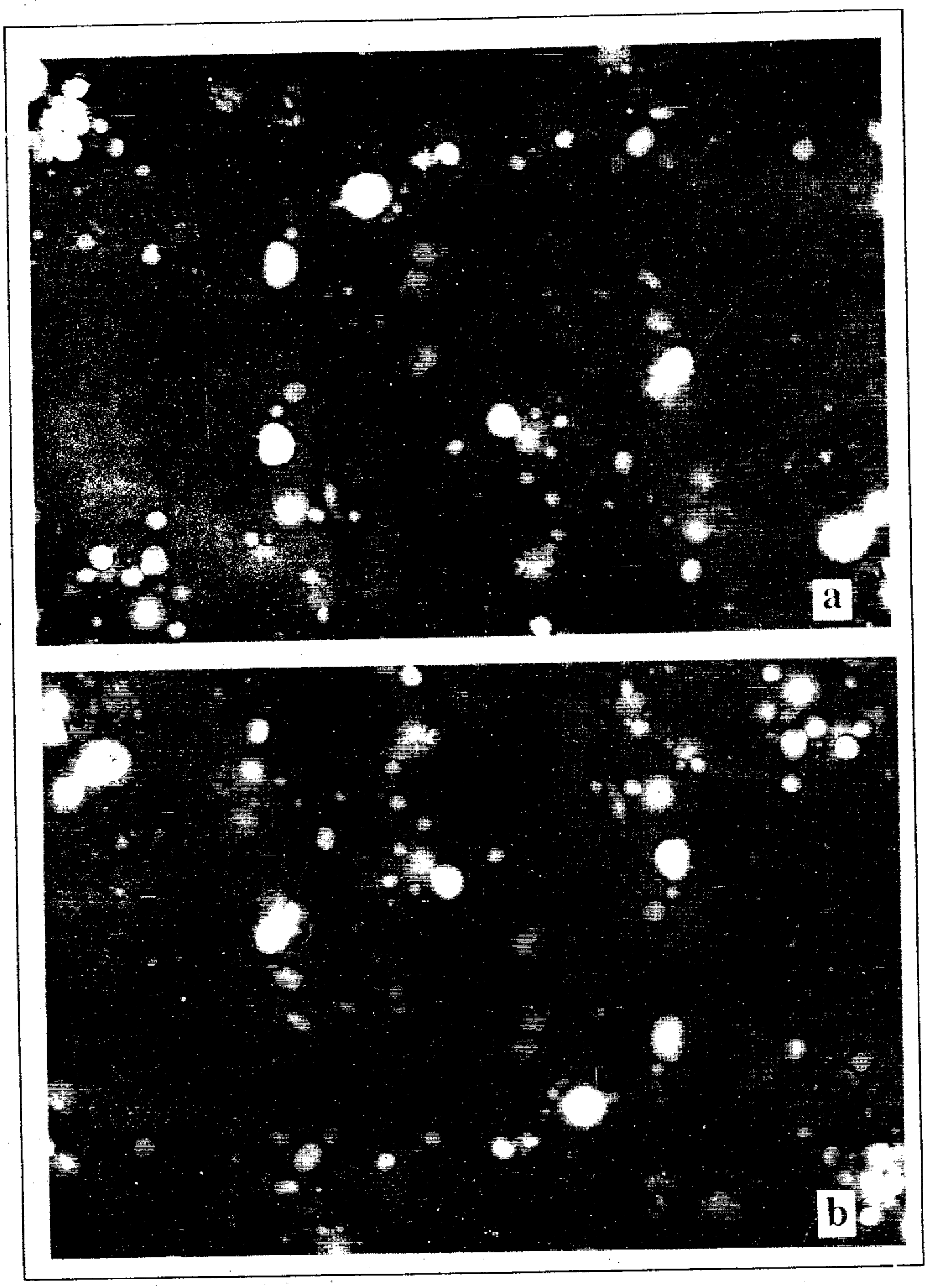

Figure 1— Emulsion of HSD, asphalt with: (a) 30% water, (b) 40% water; shades of dark grey correspond to asphalt mix, light grey to HSD and white to water (x1200).

Table 1. Controlled Activity Cotton Seed Oil Muds.
Activity A_w = 0.75* (lbs. $CaCl_2$ based on material of 77-80% purity).

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Cotton Seed Oil (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
8.8	0.350	58.22	0.511	30.68	10.22	10.5	4.77
9.0	0.345	57.38	0.509	30.49	21.82	10.5	4.77
9.2	0.340	56.54	0.508.	30.30	33.41	10.5	4.77
9.4	0.335	55.70	0.506	30.11	45.01	10.5	4.77
9.6	0.330	54.86	0.505	29.92	56.60	10.5	4.77
9.8	0.325	54.02	0.504	29.73	68.19	10.5	4.77
10.0	0.320	53.19	0.502	29.54	79.79	10.5	4.77
10.2	0.315	52.35	0.501	29.35	91.38	10.5	4.77
10.4	0.309	51.51	0.500	29.16	102.98	10.5	4.77
10.6	0.304	50.67	0.498	28.97	114.57	12.24	5.56
10.8	0.299	49.83	0.497	28.78	126.17	12.24	5.56
11.0	0.294	49.00	0.495	28.59	137.76	12.24	5.56
11.2	0.289	48.16	0.494	28.41	149.35	12.24	5.56
11.4	0.284	47.32	0.493	28.22	160.95	12.24	5.56
11.6	0.279	46.48	0.491	28.03	172.54	12.24	5.56
11.8	0.274	45.65	0.490	27.84	184.14	12.24	5.56
12.0	0.269	44.81	0.488	27.65	195.73	12.24	5.56
12.2	0.264	43.97	0.487	27.46	207.32	12.24	5.56
12.4	0.259	43.14	0.486	27.27	218.92	12.24	5.56
12.6	0.254	42.30	0.484	27.08	230.51	12.24	5.56
12.8	0.249	41.46	0.483	26.89	242.11	12.24	5.56
13.0	0.244	40.63	0.481	26.70	253.70	12.24	6.36
13.2	0.239	39.79	0.480	26.51	265.29	12.24	6.36
13.4	0.234	38.95	0.479	26.32	276.88	12.24	6.36
13.6	0.229	38.12	0.477	26.13	288.48	12.24	6.36
13.8	0.224	37.28	0.476	25.94	300.07	12.24	6.36
14.0	0.219	36.45	0.474	25.75	311.66	12.24	6.36
14.2	0.214	35.61	0.473	25.56	323.26	12.24	6.36
14.4	0.209	34.77	0.472	25.37	334.85	12.24	6.36
14.6	0.204	33.94	0.470	25.18	346.44	12.24	6.36
14.8	0.199	33.10	0.469	24.99	358.03	12.24	6.36
15.0	0.194	32.27	0.467	24.80	369.63	12.24	6.36
15.2	0.189	31.43	0.466	24.61	381.22	12.24	6.36
15.4	0.184	30.60	0.465	24.42	392.81	12.24	6.36
15.6	0.179	29.77	0.463	24.23	404.40	12.24	6.36
15.8	0.174	28.93	0.462	24.04	415.99	12.24	6.36
16.0	0.169	28.10	0.460	23.85	427.58	15.75	7.15
16.2	0.164	27.26	0.459	23.66	439.17	15.75	7.15
16.4	0.159	26.43	0.458	23.47	450.76	15.75	7.15
16.6	0.154	25.60	0.456	23.28	462.36	15.75	7.15
16.8	0.149	24.76	0.455	23.09	473.95	15.75	7.15
17.0	0.144	23.93	0.453	22.90	485.54	15.75	7.15
17.2	0.139	23.10	0.452	22.71	497.13	15.75	7.15
17.4	0.134	22.27	0.450	22.52	508.71	15.75	7.15
17.6	0.129	21.44	0.449	22.33	520.30	15.75	7.15
17.8	0.124	20.60	0.448	22.14	531.89	15.75	7.15
18.0	0.119	19.77	0.446	21.95	543.48	15.75	7.15
18.2	0.114	18.94	0.445	21.76	555.07	15.75	7.15
18.4	0.109	18.11	0.443	21.57	566.66	15.75	7.15
18.6	0.104	17.28	0.442	21.38	578.25	15.75	7.15
18.8	0.099	16.45	0.440	21.19	589.83	15.75	7.15
19.0	0.094	15.62	0.439	21.00	601.42	15.73	7.15

* To obtain an activity of 0.750 use 0.2500 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 2. Controlled Activity Cotton Seed Oil Muds.
Activity A_w = 0.70* (lbs. $CaCl_2$ based on material of 77-80 purity).

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Cotton Seed Oil (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
8.8	0.343	65.37	0.512	30.78	5.19	10.5	4.77
9.0	0.338	64.42	0.511	30.59	16.86	10.5	4.77
9.2	0.333	63.48	0.510	30.40	28.53	10.5	4.77
9.4	0.328	62.54	0.508	30.21	40.19	10.5	4.77
9.6	0.323	61.60	0.507	30.02	51.86	10.5	4.77
9.8	0.318	60.65	0.505	29.83	63.53	10.5	4.77
10.0	0.313	59.71	0.504	29.64	75.20	10.5	4.77
10.2	0.308	58.77	0.503	29.45	86.87	10.5	4.77
10.4	0.303	57.83	0.501	29.26	98.54	10.5	4.77
10.6	0.298	56.88	0.500	29.07	110.21	12.24	5.56
10.8	0.293	55.94	0.498	28.88	121.87	12.24	5.56
11.0	0.289	55.00	0.497	28.68	133.54	12.24	5.56
11.2	0.284	54.06	0.496	28.49	145.21	12.24	5.56
11.4	0.279	53.12	0.494	28.30	156.88	12.24	5.56
11.6	0.274	52.17	0.493	28.11	168.55	12.24	5.56
11.8	0.269	51.23	0.491	27.92	180.21	12.24	5.56
12.0	0.264	50.29	0.490	27.73	191.88	12.24	5.56
12.2	0.259	49.35	0.488	27.54	203.55	12.24	5.56
12.4	0.254	48.41	0.487	27.35	215.22	12.24	5.56
12.6	0.249	47.47	0.486	27.16	226.88	12.24	5.56
12.8	0.244	46.53	0.484	26.96	238.55	12.24	5.56
13.0	0.239	45.59	0.483	26.77	250.22	12.24	5.56
13.2	0.234	44.65	0.481	26.58	261.88	12.24	5.56
13.4	0.229	43.71	0.480	26.39	273.55	12.24	5.56
13.6	0.224	42.77	0.479	26.20	285.22	12.24	5.56
13.8	0.219	41.83	0.477	26.01	296.88	12.24	5.56
14.0	0.215	40.89	0.476	25.82	308.55	12.24	5.56
14.2	0.210	39.95	0.474	25.63	320.21	12.24	5.56
14.4	0.205	39.01	0.473	25.44	331.88	12.24	5.56
14.6	0.200	38.07	0.471	25.24	343.54	12.24	5.56
14.8	0.195	37.14	0.470	25.05	355.21	12.24	5.56
15.0	0.190	36.20	0.469	24.86	366.87	12.24	5.56
15.2	0.185	35.26	0.467	24.67	378.54	12.24	5.56
15.4	0.180	34.32	0.466	24.48	390.20	12.24	5.56
15.6	0.175	33.39	0.464	24.29	401.87	12.24	5.56
15.8	0.170	32.45	0.463	24.10	413.53	12.24	5.56
16.0	0.165	31.51	0.461	23.90	425.20	15.75	7.15
16.2	0.160	30.58	0.460	23.71	436.86	15.75	7.15
16.4	0.155	29.64	0.459	23.52	448.52	15.75	7.15
16.6	0.151	28.70	0.457	23.33	460.18	15.75	7.15
16.8	0.146	27.77	0.456	23.14	471.85	15.75	7.15
17.0	0.141	26.83	0.454	22.95	483.51	15.75	7.15
17.2	0.136	25.90	0.453	22.76	495.17	15.75	7.15
17.4	0.131	24.97	0.451	22.56	506.83	15.75	7.15
17.6	0.126	24.03	0.450	22.37	518.49	15.75	7.15
17.8	0.121	23.10	0.448	22.18	530.15	15.75	7.15
18.0	0.116	22.16	0.447	21.99	541.81	15.75	7.15
18.2	0.111	21.23	0.446	21.80	553.47	15.75	7.15
18.4	0.106	20.30	0.444	21.60	565.13	15.75	7.15
18.6	0.102	19.37	0.443	21.41	576.79	15.75	7.15
18.8	0.097	18.44	0.441	21.22	588.45	15.75	7.15
19.0	0.092	17.51	0.440	21.03	600.11	15.75	7.15

* To obtain an activity of 0.700 use 0.2740 calcium chloride by weight).
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 3. Controlled Activity Cotton Seed Oil Muds.
Activity A_w = 0.60* (lbs. $CaCl_2$ based on material of 77-80% purity).

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Cotton Seed Oil (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
8.8	0.325	77.85	0.514	30.79	7.62	10.5	4.77
9.0	0.320	76.71	0.513	30.59	19.43	10.5	4.77
9.2	0.316	75.56	0.511	30.40	31.24	10.5	4.77
9.4	0.311	74.42	0.510	30.20	43.04	10.5	4.77
9.6	0.306	73.28	0.508	30.01	54.85	10.5	4.77
9.8	0.301	72.14	0.507	29.82	66.66	10.5	4.77
10.0	0.296	70.99	0.506	29.62	78.46	10.5	4.77
10.2	0.292	69.85	0.504	29.43	90.27	10.5	4.77
10.4	0.287	68.71	0.503	29.24	102.08	10.5	4.77
10.6	0.282	67.57	0.501	29.04	113.88	10.5	4.77
10.8	0.277	66.43	0.500	28.85	125.69	10.5	4.77
11.0	0.273	65.29	0.498	28.66	137.50	10.5	4.77
11.2	0.268	64.15	0.497	28.46	149.30	10.5	4.77
11.4	0.263	63.01	0.495	28.27	161.11	10.5	4.77
11.6	0.258	61.87	0.494	28.08	172.91	10.5	4.77
11.8	0.254	60.73	0.493	27.88	184.72	10.5	4.77
12.0	0.249	59.59	0.491	27.69	196.52	10.5	4.77
12.2	0.244	58.45	0.490	27.50	208.33	10.5	4.77
12.4	0.239	57.31	0.488	27.30	220.13	10.5	4.77
12.6	0.235	56.17	0.487	27.11	231.94	10.5	4.77
12.8	0.230	55.03	0.485	26.91	243.74	12.24	6.36
13.0	0.225	53.89	0.484	26.72	255.55	12.24	6.36
13.2	0.220	52.76	0.482	26.53	267.35	12.24	6.36
13.4	0.216	51.62	0.481	26.33	279.15	12.24	6.36
13.6	0.211	50.48	0.480	26.14	290.96	12.24	6.36
13.8	0.206	49.34	0.478	25.94	302.76	12.24	6.36
14.0	0.201	48.21	0.477	25.75	314.56	12.24	6.36
14.2	0.197	47.07	0.475	25.56	326.36	12.24	6.36
14.4	0.192	45.94	0.474	25.36	338.16	12.24	6.36
14.6	0.187	44.80	0.472	25.17	349.96	12.24	6.36
14.8	0.182	43.67	0.471	24.97	361.77	12.24	6.36
15.0	0.178	42.53	0.469	24.78	373.57	12.24	6.36
15.2	0.173	41.40	0.468	24.59	385.37	12.24	6.36
15.4	0.168	40.26	0.466	24.39	397.17	12.24	6.36
15.6	0.163	39.13	0.465	24.20	408.97	12.24	6.36
15.8	0.159	38.00	0.463	24.00	420.76	13.99	6.36
16.0	0.154	36.87	0.462	23.81	432.56	13.99	6.36
16.2	0.149	35.74	0.460	23.62	444.36	13.99	6.36
16.4	0.144	34.60	0.459	23.42	456.16	13.99	6.36
16.6	0.140	33.47	0.457	23.23	467.95	13.99	6.36
16.8	0.135	32.34	0.456	23.03	479.75	13.99	6.36
17.0	0.130	31.21	0.454	22.84	491.55	13.99	6.36
17.2	0.126	30.09	0.453	22.64	503.34	13.99	6.36
17.4	0.121	28.96	0.451	22.45	515.14	13.99	6.36
17.6	0.116	27.83	0.450	22.25	526.93	13.99	6.36
17.8	0.111	26.70	0.448	22.06	538.72	13.99	6.36
18.0	0.107	25.58	0.447	21.87	550.52	13.99	6.36
18.2	0.102	24.45	0.445	21.67	562.52	13.99	6.36
18.4	0.097	23.33	0.444	21.48	574.10	13.99	6.36
18.6	0.093	22.20	0.442	21.28	585.89	13.99	6.36
18.8	0.088	21.08	0.441	21.09	597.68	15.74	7.15
19.0							

* To obtain an activity of 0.600 use 0.3170 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 4. Controlled Activity Cotton Seed Oil Muds.
Activity A_w = 0.50* (lbs. $CaCl_2$ based on material of 77-80% purity).

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Cotton Seed Oil (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
9.2	0.308	89.62	0.516	30.77	10.78	10.5	4.77
9.4	0.303	88.28	0.514	30.58	22.73	10.5	4.77
9.6	0.299	86.94	0.513	30.38	34.67	10.5	4.77
9.8	0.294	85.61	0.511	30.18	46.60	10.5	4.77
10.0	0.289	84.27	0.510	29.99	58.54	10.5	4.77
10.2	0.285	82.93	0.508	29.79	70.48	10.5	4.77
10.4	0.280	81.59	0.507	29.60	82.42	10.5	4.77
10.6	0.276	80.26	0.505	29.40	94.36	10.5	4.77
10.8	0.271	78.92	0.504	29.20	106.30	10.5	4.77
11.0	0.266	77.58	0.503	29.01	118.24	12.24	5.56
11.2	0.262	76.25	0.501	28.81	130.18	12.24	5.56
11.4	0.257	74.91	0.500	28.62	142.11	12.24	5.56
11.6	0.253	73.57	0.498	28.42	154.05	12.24	5.56
11.8	0.248	72.24	0.497	28.22	165.99	12.24	5.56
12.0	0.243	70.90	0.495	28.03	177.93	12.24	5.56
12.2	0.239	69.57	0.494	27.83	189.86	12.24	5.56
12.4	0.234	68.24	0.492	27.64	201.80	12.24	5.56
12.6	0.230	66.90	0.491	27.44	213.73	12.24	5.56
12.8	0.225	65.57	0.489	27.24	225.67	12.24	5.56
13.0	0.221	61.57	0.488	27.05	237.60	12.24	5.56
13.2	0.216	62.91	0.486	26.85	249.54	12.24	5.56
13.4	0.211	61.57	0.485	26.65	261.47	12.24	5.56
13.6	0.207	60.24	0.483	26.46	273.41	12.24	5.56
13.8	0.202	58.91	0.482	26.26	285.34	12.24	5.56
14.0	0.198	57.58	0.480	26.06	297.27	12.24	5.56
14.2	0.193	56.25	0.479	25.87	309.20	12.24	5.56
14.4	0.189	54.92	0.477	25.67	321.14	12.24	5.56
14.6	0.184	52.27	0.476	25.48	333.07	12.24	5.56
14.8	0.179	50.94	0.474	25.28	345.00	12.24	5.56
15.0	0.175	49.61	0.473	25.08	356.93	12.24	5.56
15.2	0.170	48.29	0.471	24.89	368.86	12.24	5.56
15.4	0.166	46.96	0.470	24.69	380.79	12.24	5.56
15.6	0.161	45.64	0.468	24.49	392.72	12.24	5.56
15.8	0.157	44.31	0.467	24.30	404.64	12.24	5.56
16.0	0.152	42.99	0.465	24.10	416.57	15.74	7.15
16.2	0.148	41.67	0.464	23.90	428.50	15.74	7.15
16.4	0.143	40.34	0.462	23.70	440.42	15.74	7.15
16.6	0.139		0.461	23.51	452.35	15.74	7.15
16.8	0.139	39.02	0.459	23.31	464.27	15.74	7.15
17.0	0.129	37.70	0.458	23.11	476.20	15.74	7.15
17.2	0.125	36.38	0.456	22.92	488.12	15.74	7.15
17.4	0.120	35.06	0.454	22.72	500.04	15.74	7.15
17.6	0.116	33.75	0.453	22.52	511.96	15.74	7.15
17.8	0.111	32.43	0.451	22.33	523.88	15.74	7.15
18.0	0.107	31.11	0.450	22.13	535.80	15.74	7.15
18.2	0.102	29.80	0.448	21.93	547.72	15.74	7.15
18.4	0.098	28.48	0.447	21.73	559.64	15.74	7.15
18.6	0.093	27.17	0.445	21.54	571.56	15.74	7.15
18.8	0.089	25.86	0.444	21.34	583.47	15.74	7.15
19.0	0.084	24.55	0.442	21.14	595.39	15.74	7.15

* To obtain an activity of 0.500 use 0.3560 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 5. Controlled Activity Cotton Seed Oil Muds.
Activity A_w = 0.40* (lbs. $CaCl_2$ based on material of 77-80% purity.

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Cotton Seed Oil (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
9.2	0.294	103.84	0.519	30.96	1.52	10.5	4.77
9.4	0.289	102.29	0.517	30.77	13.60	10.5	4.77
9.6	0.285	100.73	0.516	30.57	25.69	10.5	4.77
9.8	0.281	99.17	0.514	30.37	37.77	10.5	4.77
10.0	0.276	97.62	0.513	30.17	49.85	10.5	4.77
10.2	0.272	96.06	0.511	29.97	61.93	10.5	4.77
10.4	0.267	94.51	0.510	29.77	74.02	10.5	4.77
10.6	0.263	92.96	0.508	29.57	86.10	10.5	4.77
10.8	0.259	91.40	0.507	29.58	98.18	12.24	5.56
11.0	0.254	89.85	0.505	29.18	110.26	12.24	5.56
11.2	0.250	88.30	0.504	28.98	122.34	12.24	5.56
11.4	0.245	86.75	0.502	28.78	134.42	12.24	5.56
11.6	0.241	85.20	0.501	28.58	146.50	12.24	5.56
11.8	0.237	83.65	0.499	28.38	158.57	12.24	5.56
12.0	0.232	82.10	0.498	28.18	170.65	12.24	5.56
12.2	0.228	80.55	0.496	27.98	182.73	12.24	5.56
12.4	0.224	79.00	0.495	27.79	194.81	12.24	5.56
12.6	0.219	77.45	0.493	27.59	206.88	12.24	5.56
12.8	0.215	75.90	0.492	27.39	218.96	12.24	5.56
13.0	0.210	74.35	0.490	27.19	231.04	12.24	5.56
13.2	0.206	72.81	0.489	26.99	243.11	12.24	5.56
13.4	0.202	71.26	0.487	26.79	255.19	12.24	5.56
13.6	0.197	69.72	0.486	26.59	267.26	12.24	5.56
13.8	0.193	68.17	0.484	26.39	179.33	12.24	5.56
14.0	0.189	66.63	0.483	26.19	291.41	12.24	5.56
14.2	0.184	65.09	0.481	25.99	303.48	12.24	5.56
14.4	0.180	63.54	0.480	25.79	315.55	12.24	5.56
14.6	0.175	62.00	0.478	25.60	327.62	12.24	5.56
14.8	0.171	60.46	0.476	25.40	339.69	12.24	5.56
15.0	0.167	59.92	0.475	25.20	351.76	12.24	5.56
15.2	0.162	57.38	0.473	25.00	363.83	12.24	5.56
15.4	0.158	55.84	0.472	24.80	375.90	12.24	5.56
15.6	0.154	54.31	0.470	24.60	387.96	12.24	5.56
15.8	0.149	52.77	0.469	24.40	400.03	12.24	5.56
16.0	0.145	51.24	0.467	24.20	412.09	15.74	7.15
16.2	0.141	49.70	0.466	24.00	424.16	15.74	7.15
16.4	0.136	48.17	0.464	23.80	436.22	15.74	7.15
16.6	0.132	46.64	0.462	23.60	448.28	15.74	7.15
16.8	0.128	45.10	0.461	23.40	460.35	15.74	7.15
17.0	0.123	43.57	0.459	23.20	472.41	15.74	7.15
17.2	0.119	42.05	0.458	23.00	484.47	15.74	7.15
17.4	0.115	40.52	0.456	22.80	496.52	15.74	7.15
17.6	0.110	38.99	0.454	22.60	508.58	15.74	7.15
17.8	0.106	37.47	0.453	22.40	520.64	15.74	7.15
18.0	0.102	35.94	0.451	22.20	532.69	15.74	7.15
18.2	0.097	34.42	0.450	22.00	544.75	15.74	7.15
18.4	0.093	32.90	0.448	21.80	556.80	15.74	7.15
18.6	0.089	31.38	0.446	21.60	568.85	15.74	7.15
18.8	0.084	29.68	0.445	21.40	580.90	15.74	7.15
19.0	0.080	28.34	0.443	21.20	592.95	15.74	7.15

* To obtain an activity of 0.400 use 0.3960 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 6. Controlled Activity Asphalt (Industrial) Muds. Activity A_w = 1.00*.

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Asphalt Industrial (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
7.6	0.046	0.00	0.850	44.98	11.75	10.5	4.77
7.8	0.046	0.00	0.844	44.58	22.40	10.5	4.77
8.0	0.045	0.00	0.838	44.18	33.05	10.5	4.77
8.2	0.045	0.00	0.832	43.78	43.70	10.5	4.77
8.4	0.045	0.00	0.826	43.38	54.34	10.5	4.77
8.6	0.044	0.00	0.820	42.97	64.99	10.5	4.77
8.8	0.044	0.00	0.815	42.57	75.64	10.5	4.77
9.0	0.044	0.00	0.809	42.17	86.29	10.5	4.77
9.2	0.043	0.00	0.803	41.77	96.94	10.5	4.77
9.4	0.043	0.00	0.797	41.37	107.59	10.5	4.77
9.6	0.043	0.00	0.791	40.97	118.24	10.5	4.77
9.8	0.042	0.00	0.785	40.56	128.89	10.5	4.77
10.0	0.042	0.00	0.779	40.16	139.54	12.24	5.56
10.2	0.042	0.00	0.773	39.76	150.19	12.24	5.56
10.4	0.041	0.00	0.767	39.36	160.84	12.24	5.56
10.6	0.041	0.00	0.761	38.96	171.49	12.24	5.56
10.8	0.041	0.00	0.755	38.56	182.14	12.24	5.56
11.0	0.040	0.00	0.749	38.15	192.78	12.24	5.56
11.2	0.040	0.00	0.743	37.75	203.43	12.24	5.56
11.4	0.040	0.00	0.737	37.35	214.08	12.24	5.56
11.6	0.039	0.00	0.731	36.95	224.73	12.24	5.56
11.8	0.039	0.00	0.725	36.55	235.38	12.24	5.56
12.0	0.039	0.00	0.719	36.14	246.03	13.99	6.36
12.2	0.038	0.00	0.713	35.74	256.68	13.99	6.36
12.4	0.038	0.00	0.707	35.34	267.33	13.99	6.36
12.6	0.038	0.00	0.701	34.94	277.98	13.99	6.36
12.8	0.037	0.00	0.695	34.54	288.63	13.99	6.36
13.0	0.037	0.00	0.689	34.14	299.29	13.99	6.36
13.2	0.037	0.00	0.683	33.73	309.94	13.99	6.36
13.4	0.036	0.00	0.677	33.33	320.59	13.99	6.36
13.6	0.036	0.00	0.671	32.93	331.24	13.99	6.36
13.8	0.036	0.00	0.665	32.53	341.89	13.99	6.36
14.0	0.035	0.00	0.659	32.13	352.54	13.99	6.36
14.2	0.035	0.00	0.653	31.73	363.19	13.99	6.36
14.4	0.035	0.00	0.647	31.32	373.84	13.99	6.36
14.6	0.034	0.00	0.641	30.92	384.49	13.99	6.36
14.8	0.034	0.00	0.635	30.52	395.14	13.99	6.36
15.0	0.034	0.00	0.629	30.12	405.79	15.74	7.15
15.2	0.033	0.00	0.623	29.72	416.44	15.74	7.15
15.4	0.033	0.00	0.617	29.32	427.09	15.74	7.15
15.6	0.033	0.00	0.611	28.91	437.74	15.74	7.15
15.8	0.032	0.00	0.605	28.51	448.40	15.74	7.15
16.0	0.032	0.00	0.599	28.11	459.05	15.74	7.15
16.2	0.032	0.00	0.593	27.71	469.70	15.74	7.15
16.4	0.031	0.00	0.587	27.31	480.35	15.74	7.15
16.6	0.031	0.00	0.581	26.90	491.00	15.74	7.15
16.8	0.031	0.00	0.575	26.50	501.65	15.74	7.15
17.0	0.030	0.00	0.569	26.10	512.30	15.74	7.15
17.2	0.030	0.00	0.563	25.70	522.96	15.74	7.15
17.4	0.030	0.00	0.557	25.30	533.61	15.74	7.15
17.6	0.030	0.00	0.552	24.90	544.26	15.74	7.15
17.8	0.029	0.00	0.546	24.49	554.91	15.74	7.15
18.0	0.029	0.00	0.540	24.09	565.56	15.74	7.15
18.2	0.029	0.00	0.534	23.69	576.21	15.74	7.15
18.4	0.028	0.00	0.528	23.29	586.87	15.74	7.15
18.6	0.028	0.00	0.522	22.89	597.52	15.74	7.15
18.8	0.028	0.00	0.516	22.49	608.17	15.74	7.15
19.0	0.027	0.00	0.510	22.08	618.82	15.74	7.15

* To obtain an activity of 1.000 use 0.000 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 7. Controlled Activity Asphalt (Industrial) Muds.
Activity A_w = 0.75* (lbs. $CaCl_2$ based on material 77-80% purity.

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Asphalt Industrial (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
7.6	0.039	6.42	0.853	45.13	6.90	10.5	4.77
7.8	0.038	6.37	0.847	44.73	17.59	10.5	4.77
8.0	0.038	6.38	0.841	44.32	28.27	10.5	4.77
8.2	0.038	6.28	0.835	43.92	38.95	10.5	4.77
8.4	0.037	6.24	0.829	43.52	49.64	10.5	4.77
8.6	0.037	6.19	0.823	43.12	60.32	10.5	4.77
8.8	0.037	6.14	0.817	42.71	71.00	10.5	4.77
9.0	0.037	6.10	0.811	42.31	81.69	10.5	4.77
9.2	0.036	6.05	0.805	41.91	92.37	10.5	4.77
9.4	0.036	6.01	0.799	41.50	103.05	12.24	5.56
9.6	0.036	5.96	0.793	41.10	113.74	12.24	5.56
9.8	0.036	5.92	0.787	40.70	124.42	12.24	5.56
10.0	0.035	5.87	0.881	40.29	135.11	12.24	5.56
10.2	0.035	5.82	0.775	39.89	145.79	12.24	5.56
10.4	0.035	5.78	0.769	39.49	156.47	12.24	5.56
10.6	0.034	5.73	0.763	39.09	167.16	12.24	5.56
10.8	0.034	5.69	0.757	38.68	177.84	12.24	5.56
11.0	0.034	5.64	0.751	38.28	188.53	12.24	5.56
11.2	0.034	5.60	0.745	37.88	199.21	12.24	5.56
11.4	0.033	5.55	0.739	37.47	209.90	12.24	5.56
11.6	0.033	5.50	0.733	37.07	220.58	12.24	5.56
11.8	0.033	5.46	0.727	36.67	231.27	12.24	6.36
12.0	0.033	5.41	0.721	36.26	241.95	13.99	6.36
12.2	0.032	5.37	0.715	35.86	252.63	13.99	6.36
12.4	0.032	5.32	0.709	35.46	263.32	13.99	6.36
12.6	0.032	5.28	0.703	35.05	274.00	13.99	6.36
12.8	0.031	5.23	0.697	34.65	284.69	13.99	6.36
13.0	0.031	5.18	0.691	34.25	295.37	13.99	6.36
13.2	0.031	5.14	0.685	33.85	306.06	13.99	6.36
13.4	0.031	5.09	0.679	33.44	316.74	13.99	6.36
13.6	0.030	5.05	0.673	33.04	327.43	13.99	6.36
13.8	0.030	5.00	0.667	32.64	338.11	13.99	6.36
14.0	0.030	4.96	0.661	32.23	348.80	13.99	6.36
14.2	0.030	4.91	0.655	31.83	359.48	13.99	6.36
14.4	0.029	4.86	0.649	31.43	370.17	13.99	6.36
14.6	0.029	4.82	0.643	31.02	380.86	13.99	6.36
14.8	0.029	4.77	0.635	30.62	391.54	13.99	7.15
15.0	0.028	4.73	0.631	30.22	402.23	15.74	7.15
15.2	0.028	4.68	0.625	29.81	412.91	15.74	7.15
15.4	0.028	4.64	0.619	29.41	423.60	15.74	7.15
15.6	0.028	4.59	0.613	29.01	434.28	15.74	7.15
15.8	0.027	4.54	0.607	28.61	444.97	15.74	7.15
16.0	0.027	4.50	0.601	28.20	455.66	15.74	7.15
16.2	0.027	4.45	0.595	27.80	466.34	15.74	7.15
16.4	0.026	4.41	0.589	27.40	477.03	15.74	7.15
16.6	0.026	4.36	0.583	26.99	487.71	15.74	7.15
16.8	0.026	4.32	0.577	26.59	498.40	15.74	7.15
17.0	0.026	4.27	0.571	26.19	509.09	15.74	7.15
17.2	0.025	4.22	0.565	25.78	519.77	15.74	7.15
17.4	0.025	4.18	0.559	25.38	530.46	15.74	7.15
17.6	0.025	4.13	0.553	24.98	541.14	15.74	7.15
17.8	0.025	4.09	0.547	24.57	551.83	15.74	7.15
18.0	0.024	4.04	0.541	24.17	562.52	15.74	7.15
18.2	0.024	4.00	0.535	23.77	573.20	15.74	7.15
18.4	0.024	3.95	0.529	23.37	583.89	15.74	7.15
18.6	0.023	3.90	0.523	22.96	594.58	15.74	7.15
18.8	0.023	3.86	0.517	22.56	605.26	15.74	7.15
19.0	0.023	3.81	0.511	22.16	615.95	15.74	7.15

* To obtain an activity of 0.750 use 0.250 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 8. Controlled Activity Asphalt (Industrial) Muds.
Activity A_w = 0.70* (lbs. $CaCl_2$ based on material 77-80% purity.

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Asphalt Industrial (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
7.6	0.038	7.18	0.853	45.15	6.37	10.5	4.77
7.8	0.037	7.13	0.847	44.74	17.06	10.5	4.77
8.0	0.037	7.08	0.841	44.34	27.75	10.5	4.77
8.2	0.037	7.03	0.835	43.94	38.43	10.5	4.77
8.4	0.037	6.98	0.829	43.53	49.12	10.5	4.77
8.6	0.036	6.93	0.823	43.13	59.81	10.5	4.77
8.8	0.036	6.88	0.817	42.73	70.50	10.5	4.77
9.0	0.036	6.83	0.811	42.32	81.18	10.5	4.77
9.2	0.036	6.78	0.805	41.92	91.87	12.24	5.56
9.4	0.035	6.72	0.799	41.52	102.56	12.24	5.56
9.6	0.035	6.67	0.793	41.11	113.25	12.24	5.56
9.8	0.035	6.62	0.787	40.71	123.93	12.24	5.56
10.0	0.034	6.57	0.781	40.31	134.62	12.24	5.56
10.2	0.034	6.52	0.775	39.91	145.31	12.24	5.56
10.4	0.034	6.47	0.769	39.50	156.00	12.24	5.56
10.6	0.034	6.42	0.763	39.10	166.68	12.24	5.56
10.8	0.033	6.37	0.757	38.70	177.37	12.24	5.56
11.0	0.033	6.31	0.751	38.29	188.06	12.24	5.56
11.2	0.033	6.26	0.745	37.89	198.75	12.24	5.56
11.4	0.033	6.21	0.739	37.49	209.44	12.24	5.56
11.6	0.032	6.16	0.734	37.08	220.13	12.24	5.56
11.8	0.032	6.11	0.728	36.68	230.81	13.99	6.36
12.0	0.032	6.06	0.722	36.28	241.50	13.99	6.36
12.2	0.032	6.01	0.716	35.87	252.19	13.99	6.36
12.4	0.031	5.96	0.710	35.47	262.88	13.99	6.36
12.6	0.031	5.91	0.704	35.07	273.57	13.99	6.36
12.8	0.031	5.85	0.698	34.66	284.26	13.99	6.36
13.0	0.030	5.80	0.692	34.26	294.95	13.99	6.36
13.2	0.030	5.75	0.686	33.86	305.63	13.99	6.36
13.4	0.030	5.70	0.680	33.45	316.32	13.99	6.36
13.6	0.030	5.65	0.674	33.05	327.01	13.99	6.36
13.8	0.029	5.60	0.668	32.65	337.70	13.99	6.36
14.0	0.029	5.55	0.662	32.24	348.39	13.99	6.36
14.2	0.029	5.50	0.656	31.84	359.08	13.99	6.36
14.4	0.029	5.45	0.650	31.44	369.77	13.99	6.36
14.6	0.028	5.39	0.644	31.04	380.46	13.99	6.36
14.8	0.028	5.34	0.638	30.63	391.15	15.74	7.15
15.0	0.028	5.29	0.632	30.23	401.84	15.74	7.15
15.2	0.027	5.24	0.626	29.83	412.53	15.74	7.15
15.4	0.027	5.19	0.620	29.42	423.21	15.74	7.15
15.6	0.027	5.14	0.614	29.02	433.90	15.74	7.15
15.8	0.027	5.09	0.608	28.62	444.59	15.74	7.15
16.0	0.026	5.04	0.602	28.21	455.28	15.74	7.15
16.2	0.026	4.98	0.596	27.81	465.97	15.74	7.15
16.4	0.026	4.93	0.590	27.41	476.66	15.74	7.15
16.6	0.026	4.88	0.584	27.00	487.35	15.74	7.15
16.8	0.025	4.83	0.578	26.60	498.04	15.74	7.15
17.0	0.025	4.78	0.572	26.20	508.73	15.74	7.15
17.2	0.025	4.73	0.566	25.79	519.42	15.74	7.15
17.4	0.025	4.68	0.560	25.39	530.11	15.74	7.15
17.6	0.024	4.63	0.554	24.99	540.80	15.74	7.15
17.8	0.024	4.58	0.548	24.58	551.49	15.74	7.15
18.0	0.024	4.52	0.542	24.18	562.18	15.74	7.15
18.2	0.023	4.47	0.536	23.78	572.87	15.74	7.15
18.4	0.023	4.42	0.530	23.37	583.56	15.74	7.15
18.6	0.023	4.37	0.524	22.97	594.25	15.74	7.15
18.8	0.023	4.32	0.518	22.57	604.95	15.74	7.15
19.0	0.022	4.27	0.512	22.16	615.64		

* To obtain an activity of 0.700 use 0.274 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 9. Controlled Activity Asphalt (Industrial) Muds.
Activity A_w = 0.60* (lbs. $CaCl_2$ based on material 77-80% purity.

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Asphalt Industrial (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
7.6	0.036	8.63	0.854	45.18	5.39	10.5	4.77
7.8	0.036	8.57	0.848	44.77	16.09	10.5	4.77
8.0	0.036	8.51	0.842	44.37	26.78	10.5	4.77
8.2	0.035	8.45	0.836	43.97	37.47	10.5	4.77
8.4	0.035	8.39	0.830	43.56	48.17	10.5	4.77
8.6	0.035	8.33	0.824	43.16	58.86	10.5	4.77
8.8	0.035	8.26	0.818	42.76	69.56	10.5	4.77
9.0	0.034	8.20	0.812	42.35	80.25	10.5	4.77
9.2	0.034	8.14	0.806	41.95	90.95	10.5	4.77
9.4	0.034	8.08	0.800	41.55	101.64	12.24	5.56
9.6	0.033	8.02	0.794	41.14	112.34	12.24	5.56
9.8	0.033	7.96	0.788	40.74	123.03	12.24	5.56
10.0	0.033	7.90	0.782	40.34	133.73	12.24	5.56
10.2	0.033	7.83	0.776	39.93	144.42	12.24	5.56
10.4	0.032	7.77	0.770	39.53	155.12	12.24	5.56
10.6	0.032	7.71	0.764	38.72	165.81	12.24	5.56
10.8	0.032	7.65	0.758	38.32	176.51	12.24	5.56
11.0	0.032	7.59	0.752	38.32	187.20	12.24	5.56
11.2	0.031	7.53	0.746	37.91	197.90	12.24	5.56
11.4	0.031	7.47	0.740	37.51	208.59	12.24	5.56
11.6	0.031	7.40	0.734	37.11	219.29	12.24	5.56
11.8	0.031	7.34	0.728	36.70	229.98	13.99	6.36
12.0	0.030	7.28	0.722	36.30	240.68	13.99	6.36
12.2	0.030	7.22	0.716	35.90	251.37	13.99	6.36
12.4	0.030	7.16	0.710	35.49	262.07	13.99	6.36
12.6	0.030	7.10	0.704	35.09	272.76	13.99	6.36
12.8	0.029	7.03	0.698	34.69	283.46	13.99	6.36
13.0	0.029	6.97	0.692	34.28	294.15	13.99	6.36
13.2	0.029	6.73	0.686	33.88	304.85	13.99	6.36
13.4	0.029	6.85	0.680	33.48	315.55	13.99	6.36
13.6	0.028	6.79	0.674	33.07	326.24	13.99	6.36
13.8	0.028	6.73	0.668	32.67	347.63	13.99	6.36
14.0	0.028	6.67	0.662	32.27	358.33	13.99	6.36
14.2	0.028	6.60	0.656	31.86	358.33	13.99	6.36
14.4	0.027	6.54	0.650	31.46	369.03	13.99	6.36
14.6	0.027	6.48	0.644	31.06	379.72	13.99	6.36
14.8	0.027	6.42	0.638	30.65	390.42	15.74	7.15
15.0	0.027	6.36	0.632	30.25	401.12	15.74	7.15
15.2	0.026	6.30	0.626	29.85	411.81	15.74	7.15
15.4	0.026	6.24	0.620	29.44	422.51	15.74	7.15
15.6	0.026	6.17	0.614	29.04	433.20	15.74	7.15
15.8	0.026	6.11	0.608	28.63	443.90	15.74	7.15
16.0	0.025	6.05	0.602	28.23	454.60	15.74	7.15
16.2	0.025	5.99	0.596	27.83	465.29	15.74	7.15
16.4	0.025	5.93	0.590	27.42	475.99	15.74	7.15
16.6	0.025	5.87	0.584	27.02	486.69	15.74	7.15
16.8	0.024	5.81	0.578	26.62	497.39	15.74	7.15
17.0	0.024	5.74	0.572	26.21	508.08	15.74	7.15
17.2	0.024	5.68	0.566	25.81	518.78	15.74	7.15
17.4	0.024	5.62	0.560	25.41	529.48	15.74	7.15
17.6	0.023	5.56	0.554	25.00	540.17	15.74	7.15
17.8	0.023	5.50	0.548	24.60	550.87	15.74	7.15
18.0	0.023	5.44	0.542	24.20	561.57	15.74	7.15
18.2	0.022	5.37	0.536	23.79	572.27	15.74	7.15
18.4	0.022	5.31	0.530	23.39	582.96	15.74	7.15
18.6	0.022	5.25	0.524	22.99	593.66	15.74	7.15
18.8	0.022	5.19	0.518	22.58	604.36	15.74	7.15
19.0	0.021	5.13	0.512	22.18	615.06		

* To obtain an activity of 0.6000 use 0.317 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 10. Controlled Activity Asphalt (Industrial) Muds.
Activity A_w = 0.50* (lbs. $CaCl_2$ based on material 77-80% purity.

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Asphalt Industrial (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
7.6	0.034	10.03	0.855	45.20	4.47	10.5	4.77
7.8	0.034	9.96	0.849	44.80	15.17	10.5	4.77
8.0	0.034	9.89	0.843	44.40	25.87	10.5	4.77
8.2	0.034	9.82	0.837	43.99	36.57	10.5	4.77
8.4	0.033	9.75	0.831	43.59	47.27	10.5	4.77
8.6	0.033	9.68	0.825	43.19	57.98	10.5	4.77
8.8	0.033	9.61	0.819	42.78	68.68	10.5	4.77
9.0	0.033	9.53	0.813	42.38	79.38	10.5	4.77
9.2	0.032	9.46	0.807	41.98	90.08	10.5	4.77
9.4	0.032	9.39	0.801	41.57	100.78	12.24	5.56
9.6	0.032	9.32	0.794	41.17	111.48	12.24	5.56
9.8	0.032	9.25	0.788	40.76	122.18	12.24	5.56
10.0	0.032	9.18	0.782	40.36	132.88	12.24	5.56
10.2	0.031	9.11	0.776	39.96	143.59	12.24	5.56
10.4	0.031	9.03	0.770	39.55	154.29	12.24	5.56
10.6	0.031	8.96	0.764	39.15	164.99	12.24	5.56
10.8	0.031	8.89	0.758	38.75	175.69	12.24	5.56
11.0	0.030	8.82	0.752	38.34	186.39	12.24	5.56
11.2	0.030	8.75	0.746	37.94	197.09	12.24	5.56
11.4	0.030	8.68	0.740	37.53	207.79	12.24	5.56
11.6	0.030	8.61	0.734	37.13	218.50	12.24	5.56
11.8	0.029	8.53	0.728	36.73	229.20	12.24	5.56
12.0	0.029	8.46	0.722	36.32	239.90	13.99	6.36
12.2	0.029	8.39	0.716	35.92	250.60	13.99	6.36
12.4	0.029	8.32	0.710	35.52	261.30	13.99	6.36
12.6	0.028	8.25	0.704	35.11	272.01	13.99	6.36
12.8	0.028	8.18	0.698	34.71	282.71	13.99	6.36
13.0	0.028	8.11	0.692	34.30	293.41	13.99	6.36
13.2	0.028	8.03	0.686	33.90	304.11	13.99	6.36
13.4	0.027	7.96	0.680	33.50	314.82	13.99	6.36
13.6	0.027	7.89	0.674	33.09	325.52	13.99	6.36
13.8	0.027	7.82	0.668	32.69	336.22	13.99	6.36
14.0	0.027	7.75	0.662	32.29	346.92	13.99	6.36
14.2	0.026	7.68	0.656	31.88	357.63	13.99	6.36
14.4	0.026	7.60	0.650	31.48	368.33	13.99	6.36
14.6	0.026	7.53	0.644	31.08	379.03	13.99	6.36
14.8	0.026	7.46	0.638	30.67	389.74	13.99	6.36
15.0	0.025	7.39	0.632	30.27	400.44	15.74	7.15
15.2	0.025	7.32	0.626	29.86	411.14	15.74	7.15
15.4	0.025	7.25	0.620	29.46	421.84	15.74	7.15
15.6	0.025	7.18	0.614	29.06	432.55	15.74	7.15
15.8	0.024	7.10	0.608	28.65	443.25	15.74	7.15
16.0	0.024	7.03	0.602	28.25	453.95	15.74	7.15
16.2	0.024	6.96	0.596	27.85	464.66	15.74	7.15
16.4	0.024	6.89	0.590	27.44	475.36	15.74	7.15
16.6	0.023	6.82	0.584	27.04	486.06	15.74	7.15
16.8	0.023	6.75	0.578	26.63	496.77	15.74	7.15
17.0	0.023	6.68	0.572	26.23	507.47	15.74	7.15
17.2	0.023	6.60	0.566	25.83	518.17	15.74	7.15
17.4	0.022	6.53	0.560	25.42	528.88	15.74	7.15
17.6	0.022	6.46	0.554	25.02	539.58	15.74	7.15
17.8	0.022	6.39	0.548	24.62	550.29	15.74	7.15
18.0	0.022	6.32	0.542	24.21	560.99	15.74	7.15
18.2	0.021	6.25	0.536	23.81	571.69	15.74	7.15
18.4	0.021	6.18	0.530	23.40	582.40	15.74	7.15
18.6	0.021	6.10	0.524	23.00	593.10	15.74	7.15
18.8	0.021	6.03	0.518	22.60	603.81	15.74	7.15
19.0	0.020	5.96	0.512	22.19	614.51	15.74	7.15

* To obtain an activity of 0.500 use 0.356 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

Table 11. Controlled Activity Asphalt (Industrial) Muds.
Activity A_w = 0.40* (lbs. $CaCl_2$ based on material 77-80% purity.

Mud Wt (lbs)	Water (bbls)	$CaCl_2$ (lbs)	Diesel (bbls)	Asphalt Industrial (lbs)	Barite (lbs)	Stearic Acid (lbs)	NH_4OH (litres)
7.6	0.033	11.56	0.855	45.23	3.50	10.5	4.77
7.8	0.032	11.48	0.849	44.83	14.20	10.5	4.77
8.0	0.032	11.40	0.843	44.43	24.91	10.5	4.77
8.2	0.032	11.31	0.837	44.02	35.62	10.5	4.77
8.4	0.032	11.23	0.831	43.62	46.33	10.5	4.77
8.6	0.032	11.15	0.825	43.21	57.03	10.5	4.77
8.8	0.031	11.07	0.819	42.81	67.74	10.5	4.77
9.0	0.031	10.99	0.813	42.41	78.45	10.5	4.77
9.2	0.031	10.90	0.807	42.00	89.16	12.24	5.56
9.4	0.031	10.82	0.801	41.60	99.87	12.24	5.56
9.6	0.030	10.74	0.795	41.19	110.57	12.24	5.56
9.8	0.030	10.66	0.789	40.79	121.28	12.24	5.56
10.0	0.030	10.57	0.783	40.39	131.99	12.24	5.56
10.2	0.030	10.49	0.777	39.98	142.70	12.24	5.56
10.4	0.029	10.41	0.771	39.58	153.41	12.24	5.56
10.6	0.029	10.33	0.765	39.18	164.12	12.24	5.56
10.8	0.029	10.24	0.759	38.77	174.83	12.24	5.56
11.0	0.029	10.16	0.753	38.37	185.53	12.24	5.56
11.2	0.029	10.08	0.747	37.96	196.24	12.24	5.56
11.4	0.028	10.00	0.741	37.56	206.95	12.24	5.56
11.6	0.028	9.91	0.735	37.16	217.66	12.24	5.56
11.8	0.028	9.83	0.729	36.75	228.37	13.99	6.36
12.0	0.028	9.75	0.723	36.35	239.08	13.99	6.36
12.2	0.027	9.67	0.717	35.94	249.79	13.99	6.36
12.4	0.027	9.59	0.711	35.54	260.50	13.99	6.36
12.6	0.027	9.50	0.705	35.14	271.21	13.99	6.36
12.8	0.027	9.42	0.699	34.73	281.91	13.99	6.36
13.0	0.026	9.34	0.693	34.33	292.62	13.99	6.36
13.2	0.026	9.26	0.687	33.92	303.33	13.99	6.36
13.4	0.026	9.17	0.681	33.52	314.04	13.99	6.36
13.6	0.026	9.09	0.675	33.12	324.75	13.99	6.36
13.8	0.025	9.01	0.669	32.71	335.46	13.99	6.36
14.0	0.025	8.93	0.663	32.31	346.17	13.99	6.36
14.2	0.025	8.84	0.657	31.90	356.88	13.99	6.36
14.4	0.025	8.76	0.651	31.50	367.59	13.99	6.36
14.6	0.024	8.68	0.645	31.10	378.30	13.99	6.36
14.8	0.024	8.60	0.639	30.69	389.01	15.74	7.15
15.0	0.024	8.52	0.633	30.29	399.72	15.74	7.15
15.2	0.024	8.43	0.627	29.88	410.43	15.74	7.15
15.4	0.023	8.35	0.621	29.48	421.14	15.74	7.15
15.6	0.023	8.27	0.615	29.08	431.85	15.74	7.15
15.8	0.023	8.19	0.609	28.67	442.56	15.74	7.15
16.0	0.023	8.10	0.603	28.27	453.27	15.74	7.15
16.2	0.022	8.02	0.597	27.86	463.98	15.74	7.15
16.4	0.022	7.94	0.591	27.46	474.69	15.74	7.15
16.6	0.022	7.86	0.585	27.06	485.40	15.74	7.15
16.8	0.022	7.77	0.579	26.65	496.11	15.74	7.15
17.0	0.022	7.69	0.573	26.25	506.82	15.74	7.15
17.2	0.021	7.61	0.567	25.84	517.53	15.74	7.15
17.4	0.021	7.53	0.561	25.44	528.24	15.74	7.15
17.6	0.021	7.44	0.555	25.04	538.95	15.74	7.15
17.8	0.021	7.36	0.549	24.63	549.66	15.74	7.15
18.0	0.020	7.28	0.543	24.23	560.38	15.74	7.15
18.2	0.020	7.20	0.537	23.82	571.09	15.74	7.15
18.4	0.020	7.12	0.531	23.42	581.80	15.74	7.15
18.6	0.020	7.03	0.525	23.02	592.51	15.74	7.15
18.8	0.019	6.95	0.519	22.61	606.22	15.74	7.15
19.0		6.87	0.513	22.21	613.93		

* To obtain an activity of 0.400 use 0.396 calcium chloride by weight.
Source: Magcobar Oil Mud Engineering Manual, 1970, modified.

stability of emulsion is the water premixed with calcium chloride, with ammonia added in small proportion, while the mixture is being stirred continuously.

In preparation of mud the roles of calcium chloride and weighting materials are adjusted to the requirement of the mud. Low viscosity and high weight muds are most suitable for abnormal surface pressures. The activity of mud is controlled with calcium chloride and weight of mud is controlled with the help of weighting material. The viscosity of mud can be decreased with the help of phosphates of alkali metals or other thinners. The mud weight is related directly to the specific gravity of the materials used and it can be adjusted easily.

Tables 1 to 11 showing the composition of mud with reference to mud weight have been taken from Magcobar Oil Mud Engineering Manual (1970). These tables have been modified and suitable replacements of the additives have been substituted.

Emulsifying Agents

Stearic acid has been used as a solubilizer for mixing diesel with water and industrial alcohols by the PTRL previously (Malik and Sarwar, 1988). This experience has been utilized to develop the drilling fluid. These types of fatty acids have also been studied as corrosion inhibitors for alcohol gasoline blends (Tachiki et al, 1988).

ECONOMY

The materials used for preparing the drilling fluid are indigenous and cheap. No special additive (imported component) has been used. The materials, HSD and asphalt, which are being produced in the local refineries are quite suitable to make drilling fluids. Hence, no special request for specifications is required for the refineries. However, if the Government could give a special consideration and diesel required for this purpose is exempted or relaxed from the taxes, the mud will become cheaper than the water based bentonite mud.

ADVANTAGES OF OIL BASED MUD

The advantages of the oil based mud according to Gatlin (1960) are as follow:

1. Plugging action of oil on filter cake will cause less fluid loss.
2. Oil reduces friction which in turn increases the rate of penetration. The oil and fatty acids are the form of grease which will serve as lubricant.
3. Use of oil makes the hole smooth, thus risk of stuck pipe is reduced.
4. Oil reduces friction which increases the life of bit. Better bit life saves power and rig time.
5. Producing zones are protected due to lower surface tension in filterate achieved by the use of oil, it also results in lower fluid loss.
6. Less washouts increase annular velocity of mud.
7. Balling of bit is prevented by the use of oil.

CONCLUSION

At present expensive additives are used in preparation of oil based mud. The present research has indicated that stearic acid is a perfect substitute for such additives.

The new mud developed by the present research has been tested at lab scale and found suitable for using as drilling fluid.

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