

Contents

Preface	9
Introduction	11
1. Mud Circulating Systems and Solids Removal	13
1.1. Mud Circulating System in Geotechnical Drilling	13
1.2. Mud Circulating System in Oil and Gas Wells	14
2. Drilling Fluid Functions	16
3. Drilling Fluids Classifications	20
4. Drilling Fluids Properties, Testing Equipment and Testing Procedures	23
4.1. Properties of Drilling Fluids	23
4.2. Diagnostic Tests	24
4.3. Testing Equipment and Testing Procedures	24
4.3.1. Mud Density (Mud Weight)	24
4.3.2. Marsh Funnel Viscosity	26
4.3.3. Rheological Properties	26
4.3.3.1. Measurement of Plastic Viscosity (PV), Apparent Viscosity (AV), Yield Point (YP) and Gel Strength	27
4.3.4. Filtration Tests	31
4.3.4.1. Low-Temperature/Low-Pressure Filtration – API Filter Press	31
4.3.4.2. High-Temperature/High-Pressure Filtration – HTHP Filter Press	33
4.3.5. Water, Oil and Solids Content – Retort	35
4.3.6. Sand Content	39
4.3.7. Estimation of Gel Strength by Shearometer	40
4.3.8. pH Estimation	41
4.4. Chemical Analysis	42
4.4.1. Methylene Blue Capacity	42
4.4.2. Alkalinity and Lime Content	44

4.4.3. Mud Alkalinity (P_M)	45
4.4.4. Filtrate Alkalinity P_F and M_F	45
4.4.5. Lime Content	46
4.4.6. Chloride	46
4.4.7. Total Hardness	49
4.4.8. Calcium and Magnesium	50
4.4.9. Sulfide	51
4.4.10. Carbonate/Bicarbonate	54
4.4.11. Potassium Ions Concentration	56
4.4.12. Estimation of Partially Hydrolyzed Polyacrylamide (PHPA) Concentration	59
5. Drilling Fluids Selection Criteria	63
6. Drilling Fluids Components	65
6.1. Clay Minerals. Bentonite	65
6.1.1. Preparation and Physico-Chemical Phenomena in Bentonite Suspension	70
6.1.2. Drilling Fluid Bentonites	73
6.1.3. Attapulgus Clays (Attapulgite, Polygorskite)	75
6.2. Polymers. Chemistry and Application in Drilling Fluids	76
6.2.1. Natural Polymers and Derivatives of Natural Polymers	82
6.2.2. Polymers with Molecular Weight 500–10,000 g/mol – Oligomers	86
6.2.3. Synthetic Water-Dispersable Polymers	89
6.2.4. Surfactants	92
6.3. Common Inorganic Chemicals Used in Drilling Fluids	97
6.3.1. Materials to Increase Density	99
7. Water-Based Drilling Fluids	103
7.1. Non-Inhibitive Fluids	103
7.1.1. Clear Water	103
7.1.2. Native Muds	104
7.1.3. Bentonite-Water Muds	104
7.1.4. Lignite/Lignosulfonate Muds	104
7.2. Inhibitive Fluids	106
7.2.1. Calcium-Based Muds	106
7.2.2. Salt-Based Muds	111
7.2.3. Potassium-Based Muds	115
7.3. Polymer Fluids	120
7.3.1. Non-Dispersed Polymer Muds	120
7.3.2. Bentonite Polymer Fluids for Horizontal Directional Drilling	121
7.3.3. Guar Gum Muds for Hydrogeological Wells	124

7.4. High-Temperature Polymer Muds	124
7.5. Drilling Fluids for Drilling in Shale Formations	132
7.5.1. Shale Instability	132
7.5.2. Shale Instability Prevention and Shale Stabilization Mechanisms	133
7.5.3. Potassium-Polymer Drilling Fluid	138
7.5.4. Glycol-Potassium Mud	140
7.5.5. Silicate Drilling Fluid	142
7.5.6. Mixed-Metal Hydroxide Drilling Fluids	146
8. Formation Damage and Damage Protection Procedure	148
8.1. Mechanism of Formation Damage	151
8.2. Protection of Reservoir Rocks	158
9. Criteria for Selection and Properties of Completion and Workover Fluids	159
9.1. Types of Completion/Workover Fluids	159
9.1.1. Solids-Free Brine System	160
9.1.2. Solids-Laden Completion Fluids	163
9.1.3. Formate Brines for Drilling and Completion	169
10. Drilling Fluid Preparation and Treatment	173
11. Solids Control	176
11.1. Characteristic of Solids	176
11.2. Methods of Solids Control	180
11.3. Solids Control Equipment	184
11.4. Chemical Methods of Solids Control with Using the Flocculation Station	193
12. Conversion of Units	195
Bibliography	203