

# LIST OF TABLES

Table No.	Title	page
2.1	Properties of PEAA Adhesive Copolymer	50
2.2	Typical Analysis of Linear Long-Chain Alcohol Blends (Nafol 20+).	53
2.3	Compositions, Pour Point and Location of Production Field of Mixed Karama Crude Oil.	64
2.4	Physicochemical Properties of the Tested Crude Oils.	65
2.5	Physico-chemical characteristics of PPD	66
3.1	Carbon Number Distribution of n-Paraffin Fraction Separated with KARAMA Crude	82
3.2	Carbon Number Distribution of n-Paraffin Fraction Separated with BS Crude	83
3.3	Effect of Concentration Additives on the Pour Point of QPC Crude Oil	109
3.4	Pour Point Measurements for PEAA-1 (PPD) at QPC Crude	117
3.5	Pour Point Measurements for PEAA-2 (PPD) at QPC Crude	117
3.6	Pour Point Measurements for PEAA-3 (PPD) at QPC Crude	118
3.7	Pour Point Measurements for PEAA-4 (PPD) at QPC Crude	118
3.8	Cold Finger Measurements PEAA-1 using QPC Crude	133
3.9	Cold Finger Measurements PEAA-2 using QPC Crude	134
3.10	Cold Finger Measurements PEAA-3 using QPC Crude	135
3.11	Cold Finger Measurements PEAA-4 using QPC Crude	136
3.12	Rheological Data of Untreated Different Crude Oils at Different Temperatures	143

3.13	Rheological Data of BS Crude Oil with PEAA Grafts at 48 °C	144
3.14	Rheological Data of BS Crude Oil with PEAA Grafts at 36 °C	145
3.15	Rheological Data of BS Crude Oil with PEAA Grafts at 15 °C	146
3.16	Rheological Data of Treated BS+20%WR Crude Oil with PEAA Grafts at 48 °C	147
3.17	Rheological Data of Treated BS+20%WR Crude Oil with PEAA Grafts at 36 °C	148
3.18	Rheological Data of Treated BS+20%WR Crude Oil with PEAA Grafts at 15 °C	149
3.19	Rheological Data of KARAMA Crude Oil with PEAA Grafts at 48 °C	150
3.20	Rheological Data of KARAMA Crude Oil with PEAA Grafts at 36 °C	151
3.21	Rheological Data of KARAMA Crude Oil with PEAA Grafts at 15 °C	152
3.22	Summary of Experimental Results of QPC Crude Oils Using Lab Flow Loop with 10,000 ppm and without PEAA Additives	168
3.23	Experimental Yield Stress Results of QPC Crude Oils Using Lab Flow Loop with 10,000 ppm	168

## LIST OF FIGURES

Fig. No.	Title	Page
2.1	Schematic Representation of Esterification Reaction Kettle.	57
2.2	Scheme for Synthesis of Rosin Acid Derivatives.	62
2.1	Apparatus with Cold Finger for Encrustation Studies.	71
2.2	Cold Finger and Recipient of Stainless Steel (Vessel).	72
2.3	Cold Finger with Paraffin Deposit.	72
2.4	Flow Chart of Laboratory Flow Loop.	74
3.1	GLC of n-Paraffin Distribution of KARAMA Crude Oil	80
3.2	n-Paraffin Molecular Weight Distribution of KARAMA Crude Oil	80
3.3	GLC of n-Paraffin Distribution of BS Crude Oil	81
3.4a	<sup>1</sup> HNMR Spectrum for Rosin Acid and	86
3.4b	<sup>1</sup> HNMR Spectrum for Rosin Acid - Nafol 20 <sup>+</sup> ester	87
3.4c	<sup>1</sup> HNMR Spectrum for Rosin Acid - PEG ester	88
3.4d	<sup>1</sup> HNMR Spectrum for Rosin Acid - amide	89
3.5a	IR Spectrum for Rosin Acid - maleic Anhydride Adduct	90
3.5b	IR Spectrum for Rosin Acid Adduct Ester of (Nafol 20 <sup>+</sup> -PEG)	91
3.5c	IR Spectrum for Rosin Acid Adduct Diester with Nafol 20 <sup>+</sup>	92
3.1	Scheme of Grafting of PEAA Copolymers	96
3.6a	IR Spectrum for a) PEAA	99
3.6b	IR Spectrum for b)PEAA-1	100
3.6c	IR Spectrum for c) PEAA-2	101
3.7a	<sup>1</sup> HNMR Spectrum for a) PEAA	102
3.7b	<sup>1</sup> HNMR Spectrum for b)PEAA-1	103

3.7c	<sup>1</sup> HNMR Spectrum for c) PEAA-2	104
3.8	Dependence of Vessel 1 Temperature with Deposit Thickness along Time, using KARAMA Petroleum with hot Bath Temperature at 40, 50 and 60 °C and Cold Finger Temperature at -1 °C	123
3.9	Dependence of Vessel 1 Temperature with Deposit Thickness along Time, using KARAMA Petroleum with hot Bath Temperature at 40, 50 and 60 °C and Cold Finger Temperature at 3 °C	124
3.10	Dependence of Vessel 1 Temperature with Deposit Thickness along Time, using KARAMA Petroleum with hot Bath Temperature at 40, 50 and 60 °C and Cold Finger Temperature at 7 °C	125
3.11	Dependence of Vessel 1 Temperature with Deposit Thickness along Time, using BS+20%WR Petroleum with hot Bath Temperature at 40, 50 and 60 °C and Cold Finger Temperature at -1 °C	126
3.12	Dependence of Vessel 1 Temperature with Deposit Thickness along Time, using BS+20%WR Petroleum with hot Bath Temperature at 40, 50 and 60 °C and Cold Finger Temperature at 3 °C	127
3.13	Dependence of Vessel 1 Temperature with Deposit Thickness along Time, using BS+20%WR Petroleum with hot Bath Temperature at 40, 50 and 60 °C and Cold Finger Temperature at 7 °C	128
3.14	Deposit Thickness formed for of KARAMA Petroleum with Cold Finger Temperature at 3 °C in Vessel 1	129
3.15	Deposit Thickness formed for of BS/20%WR Petroleum with Cold Finger Temperature at 3 °C in Vessel 1	129

3.16	Effect of PEAA-4 on the Apparent Viscosity on BS Crude at Temperature 48°C	153
3.17	Effect of PEAA-4 on the Apparent Viscosity on BS Crude at Temperature 36°C	154
3.18	Effect of PEAA-4 on the Apparent Viscosity on BS Crude at Temperature 24°C	155