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APPENDIX A

THERMOGRAM OF OILS

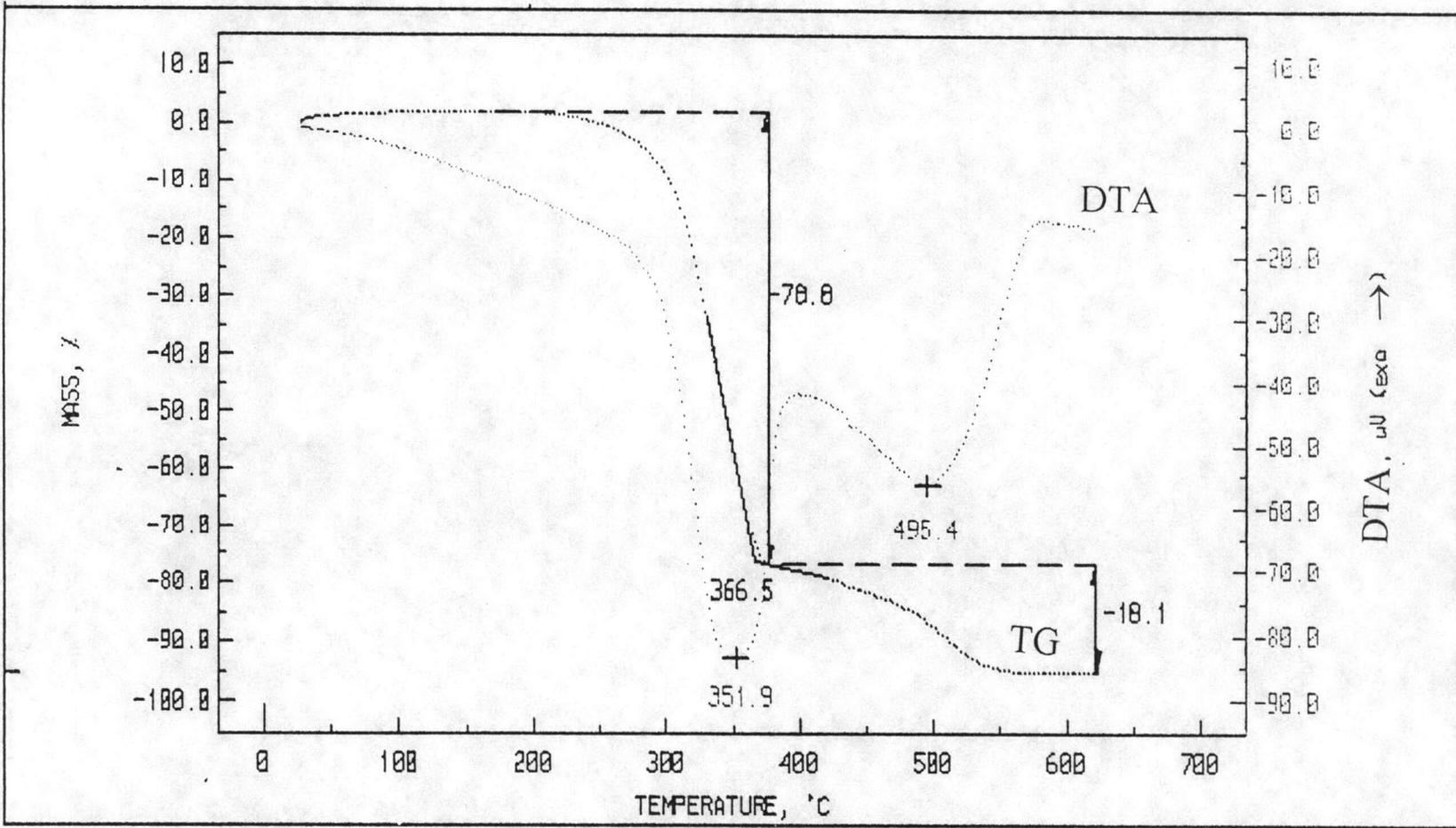


Figure A1 Thermogram of used lubricating oil

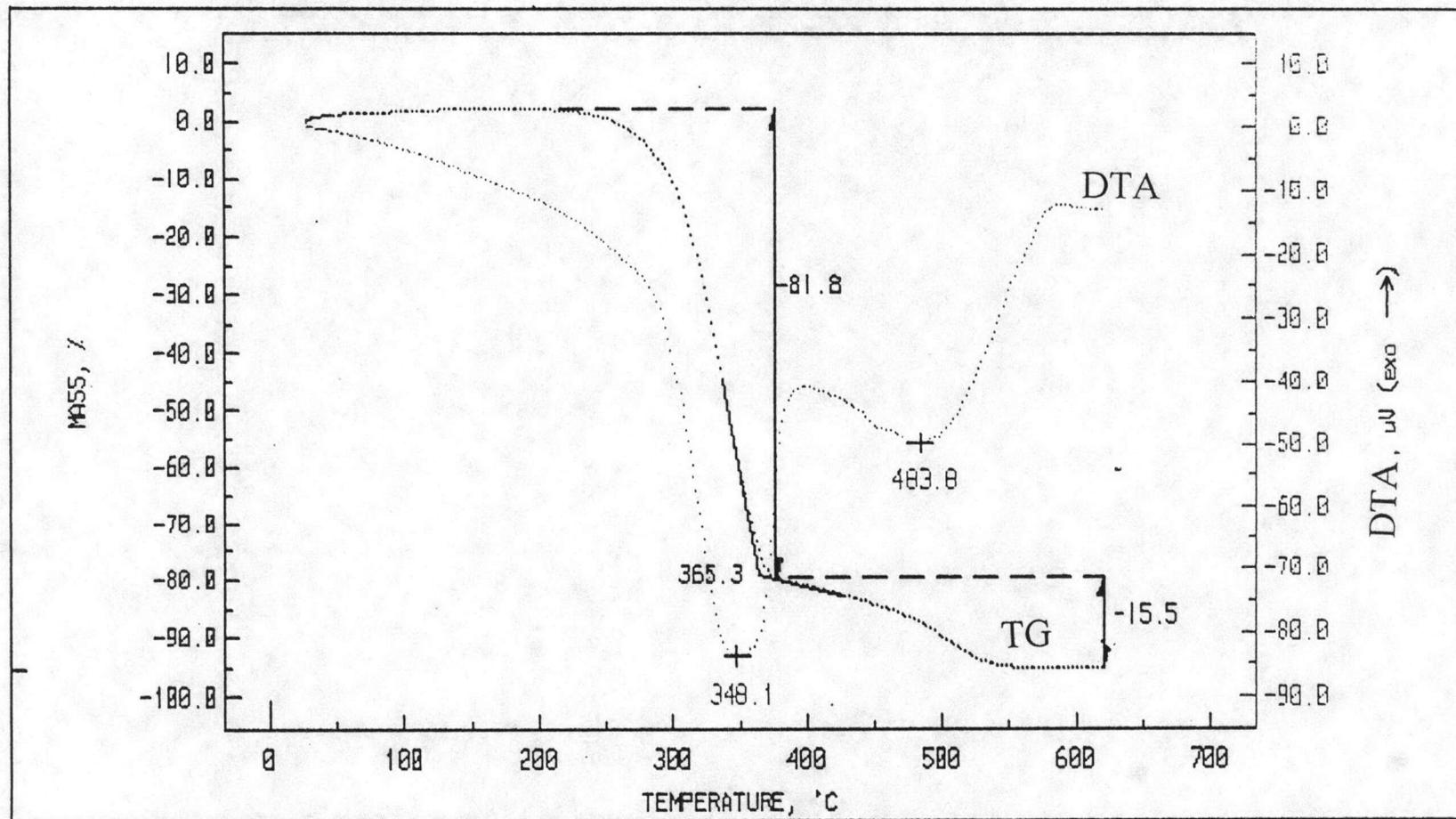


Figure A2 Thermogram of acid-clay treated oil

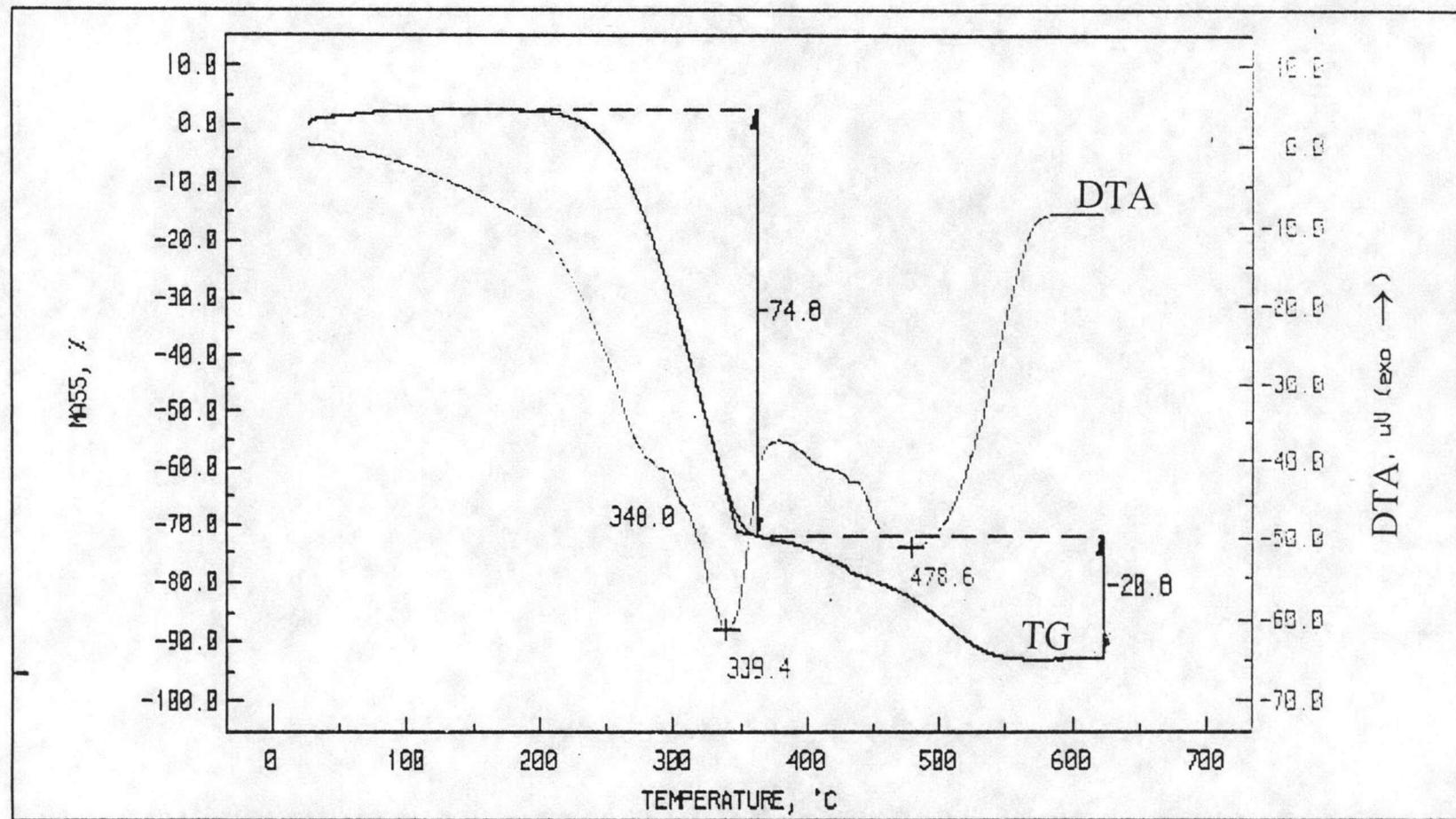


Figure A3 Thermogram of oil obtained from hydrogenation of acid-clay treated oil by using 4% Raney nickel catalyst

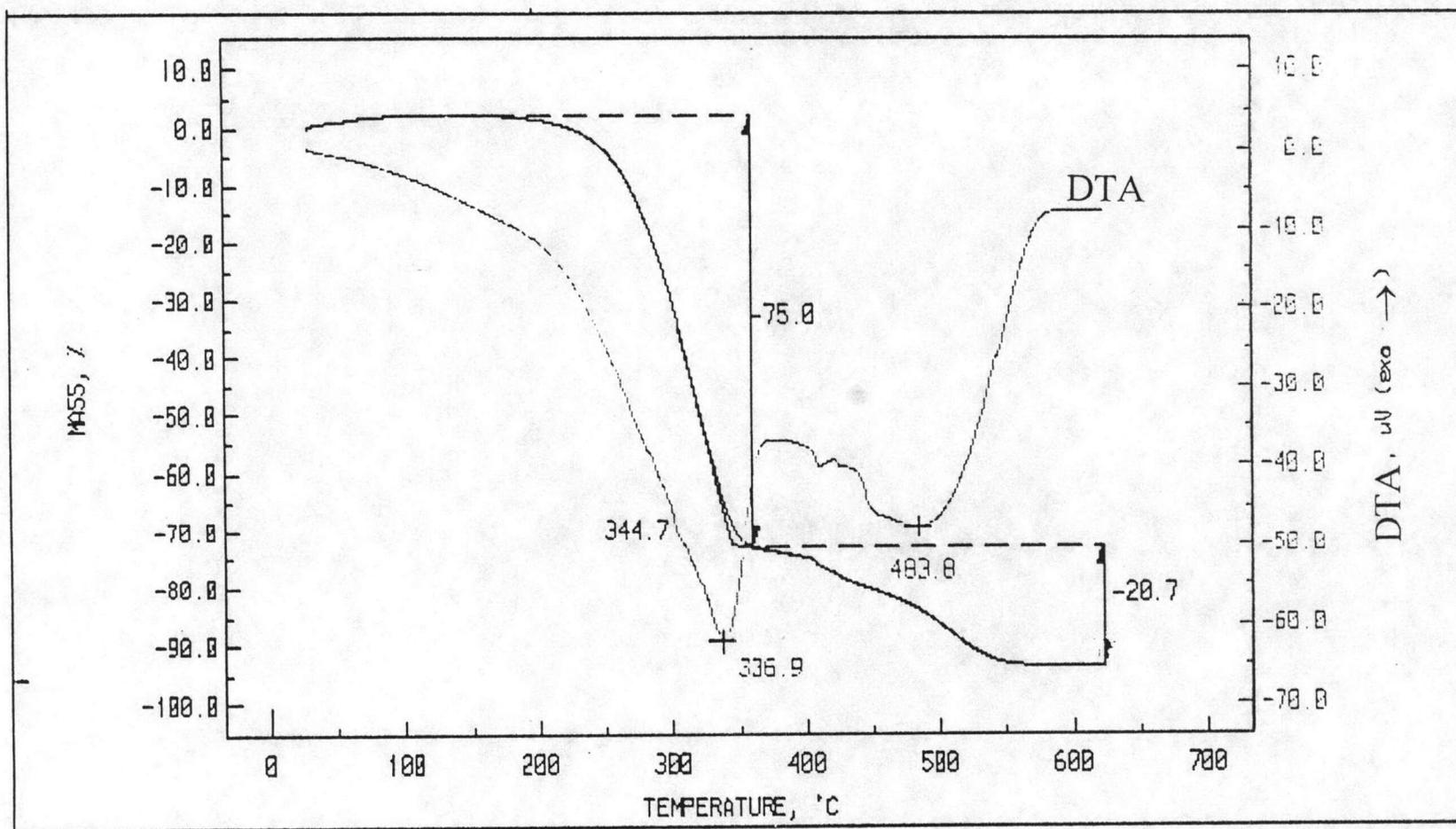


Figure A4 Thermogram of oil obtained from hydrogenation of acid-clay treated oil by using 4% NiO/MoO₃/Al₂O₃ catalyst

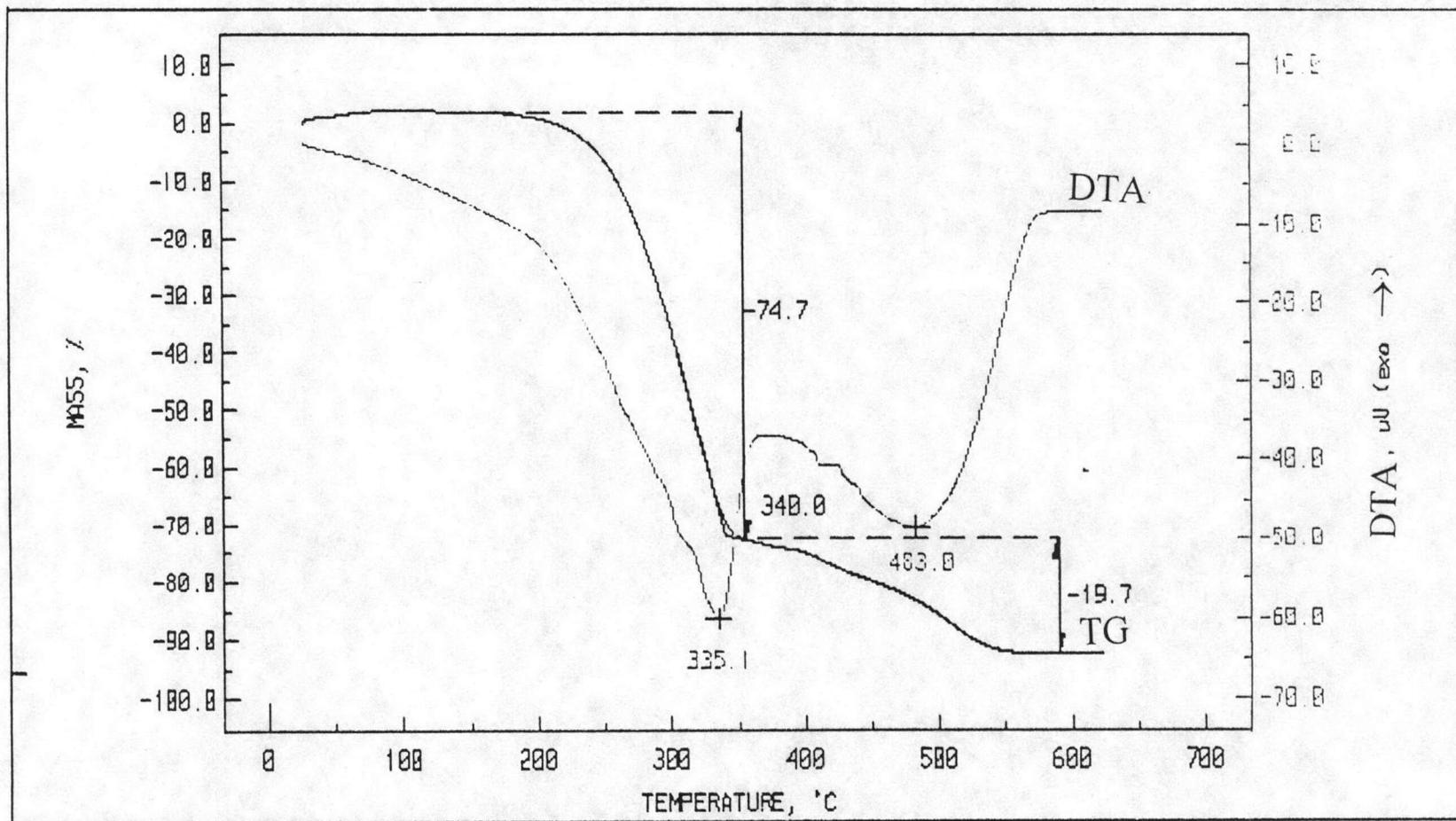


Figure A5 Thermogram of oil obtained from hydrogenation of acid-clay treated oil by using 4% NiO/WO₃/Al₂O₃ catalyst

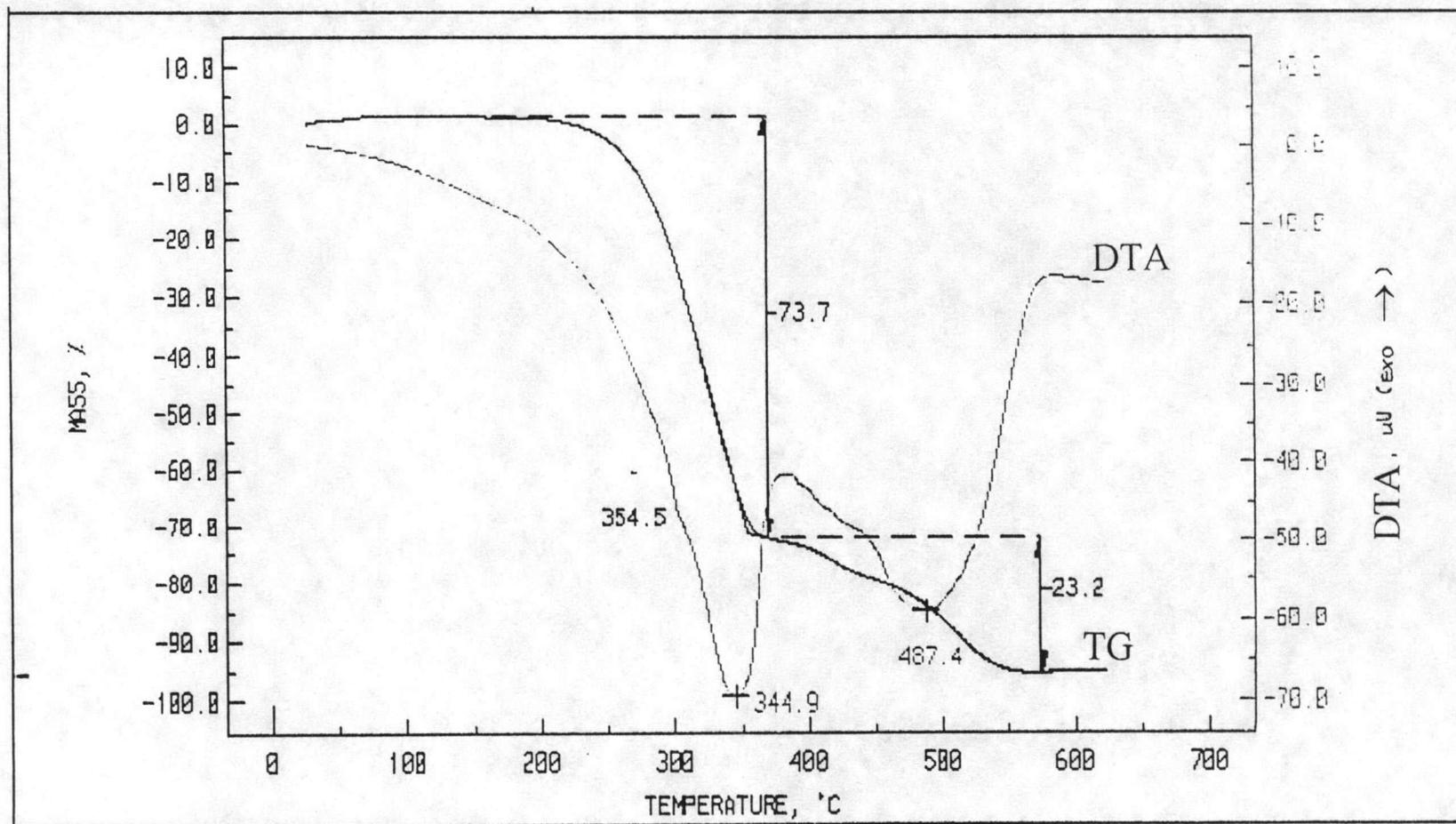


Figure A6 Thermogram of oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst

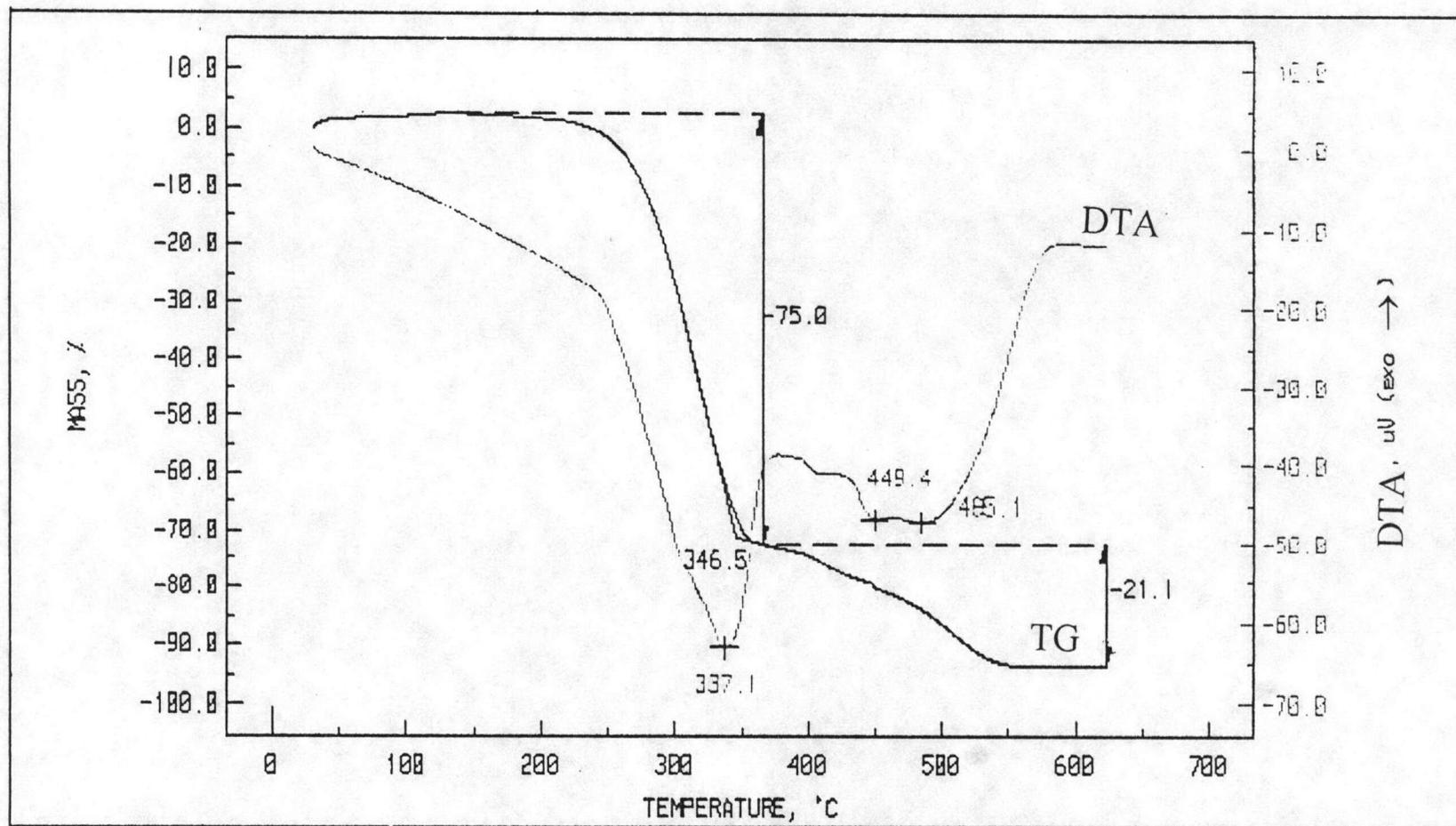


Figure A7 Thermogram of oil obtained from hydrogenation of used oil by using 4% NiO/MoO₃/Al₂O₃ catalyst

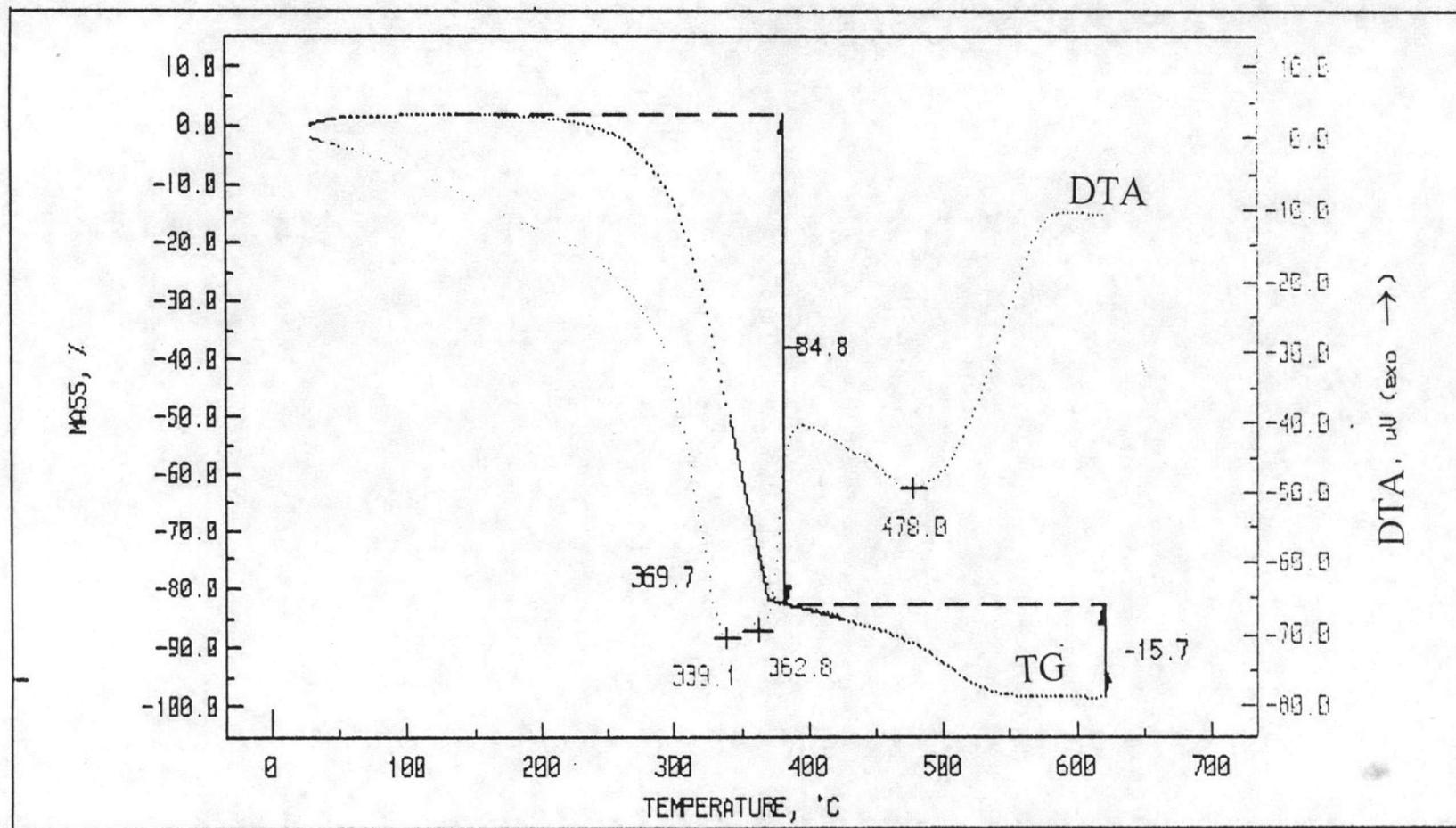


Figure A8 Thermogram of oil obtained from hydrogenation of used oil by using 4% NiO/WO₃/Al₂O₃ catalyst

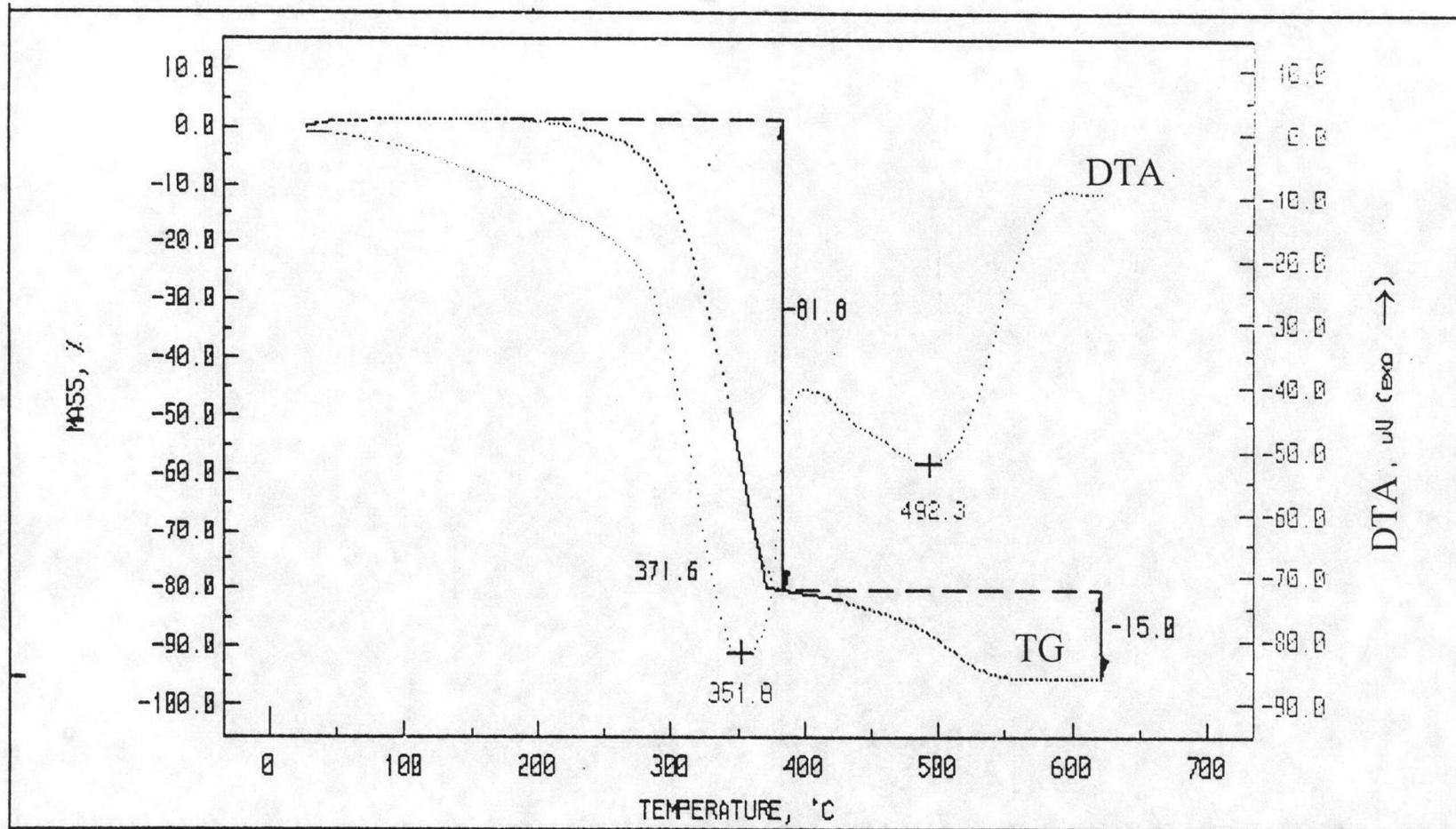


Figure A9 Thermogram of oil obtained from hydrogenation of used oil by using 6% Raney nickel catalyst

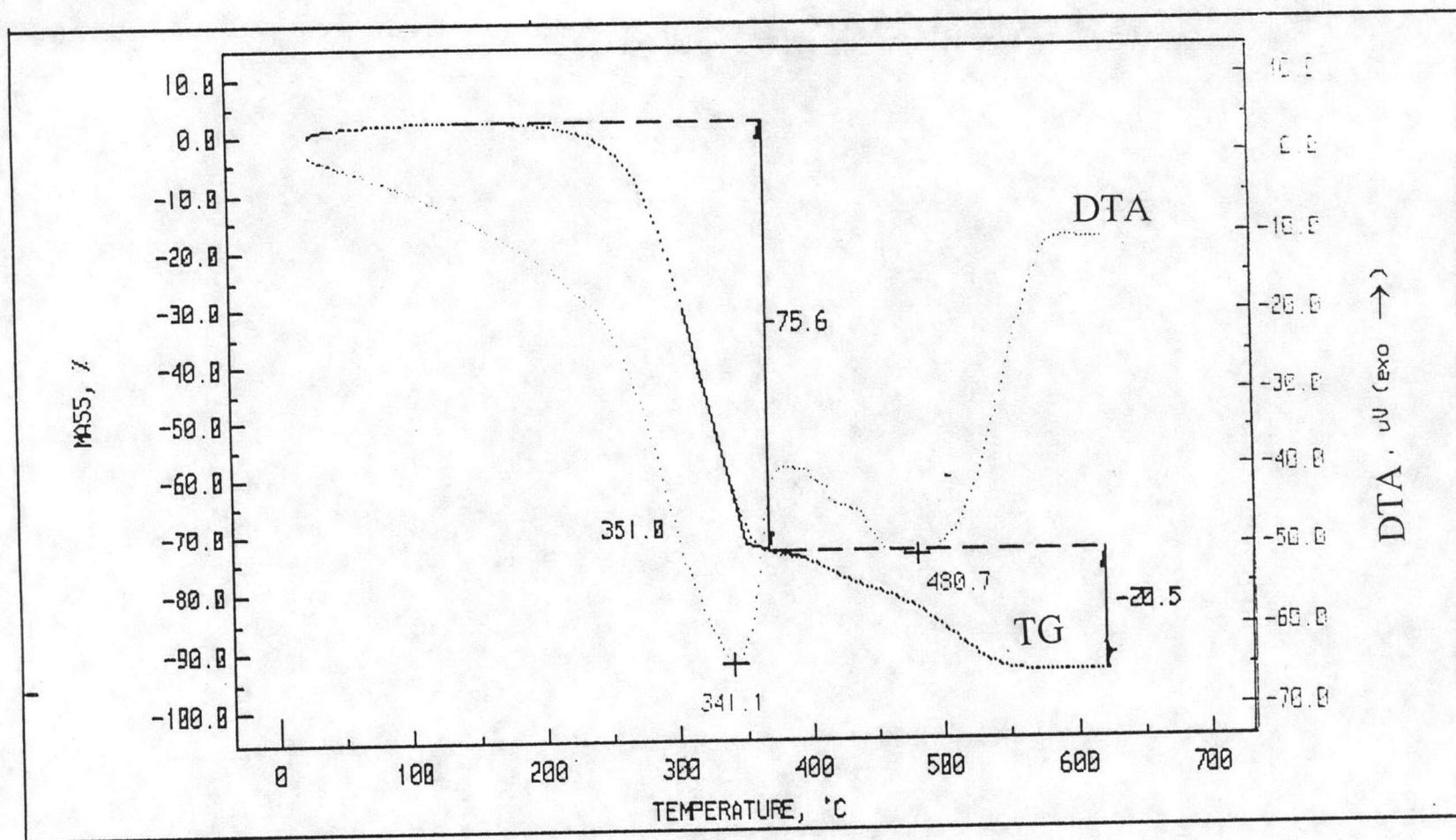


Figure A10 Thermogram of oil obtained from hydrogenation of used oil by using 8% Raney nickel catalyst

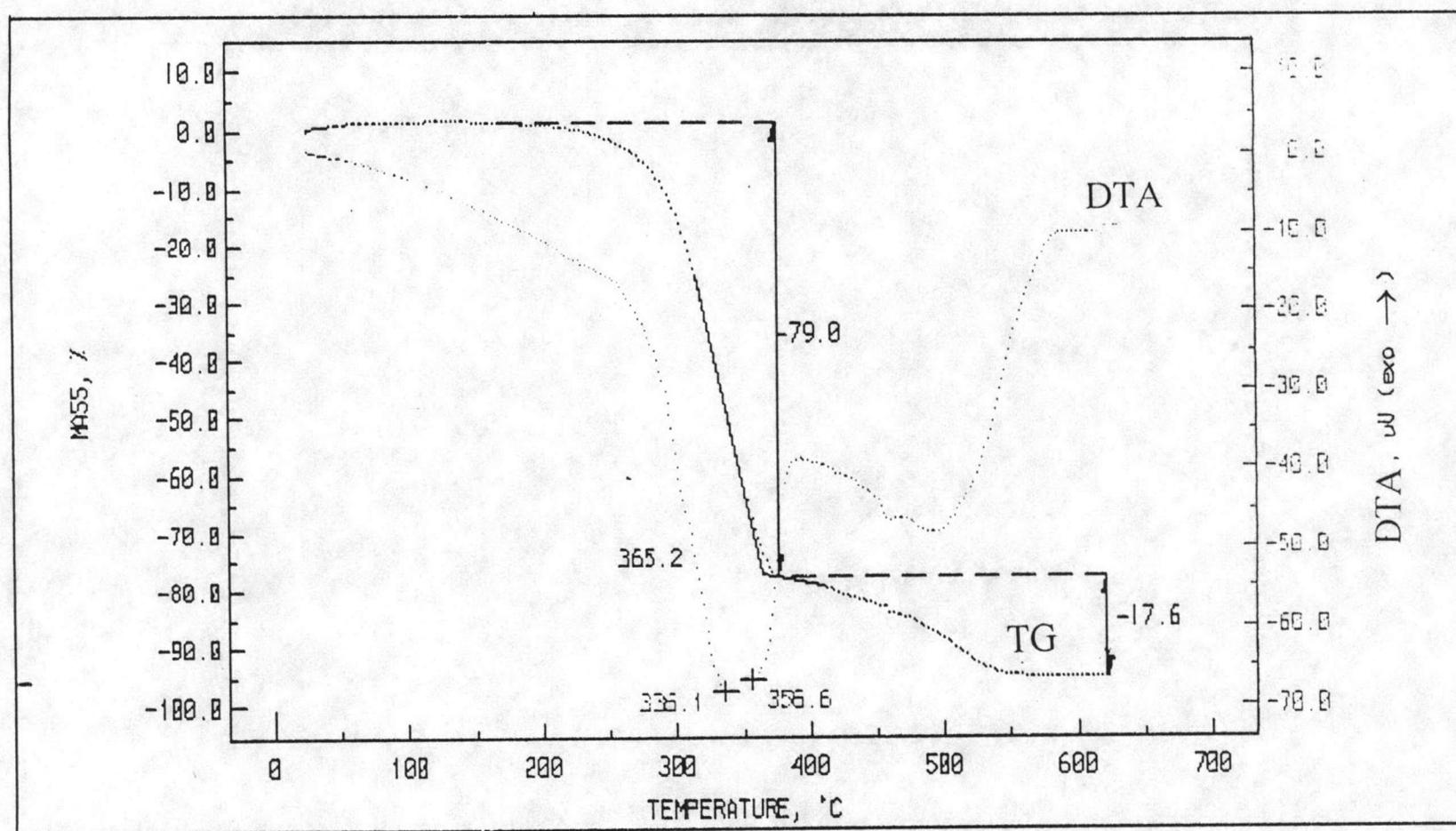


Figure A11 Thermogram of oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst with 6 hours reaction time

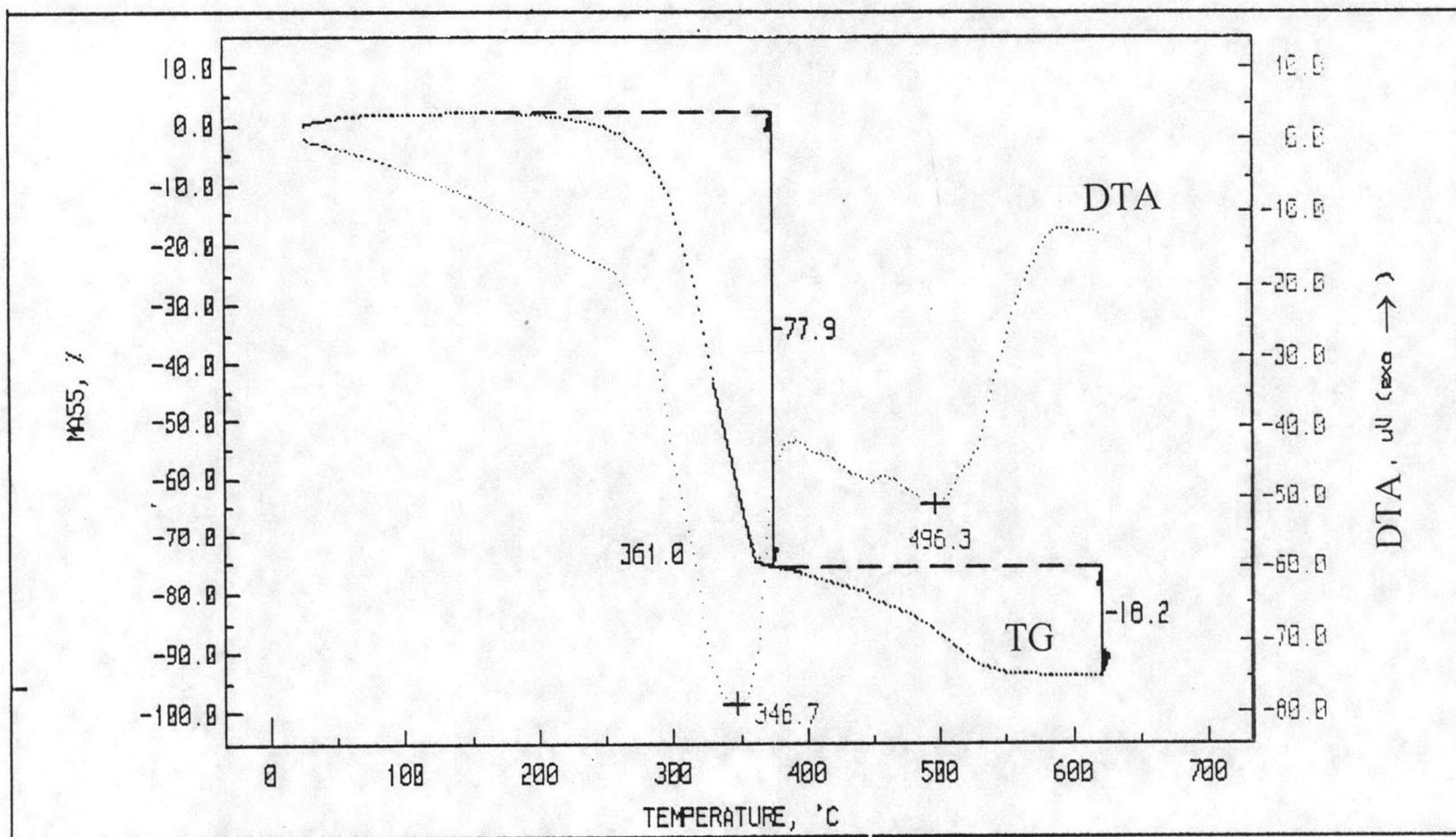


Figure A12 Thermogram of oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst with 8 hours reaction time

APPENDIX B

^{13}C - NMR SPECTRUM OF OILS

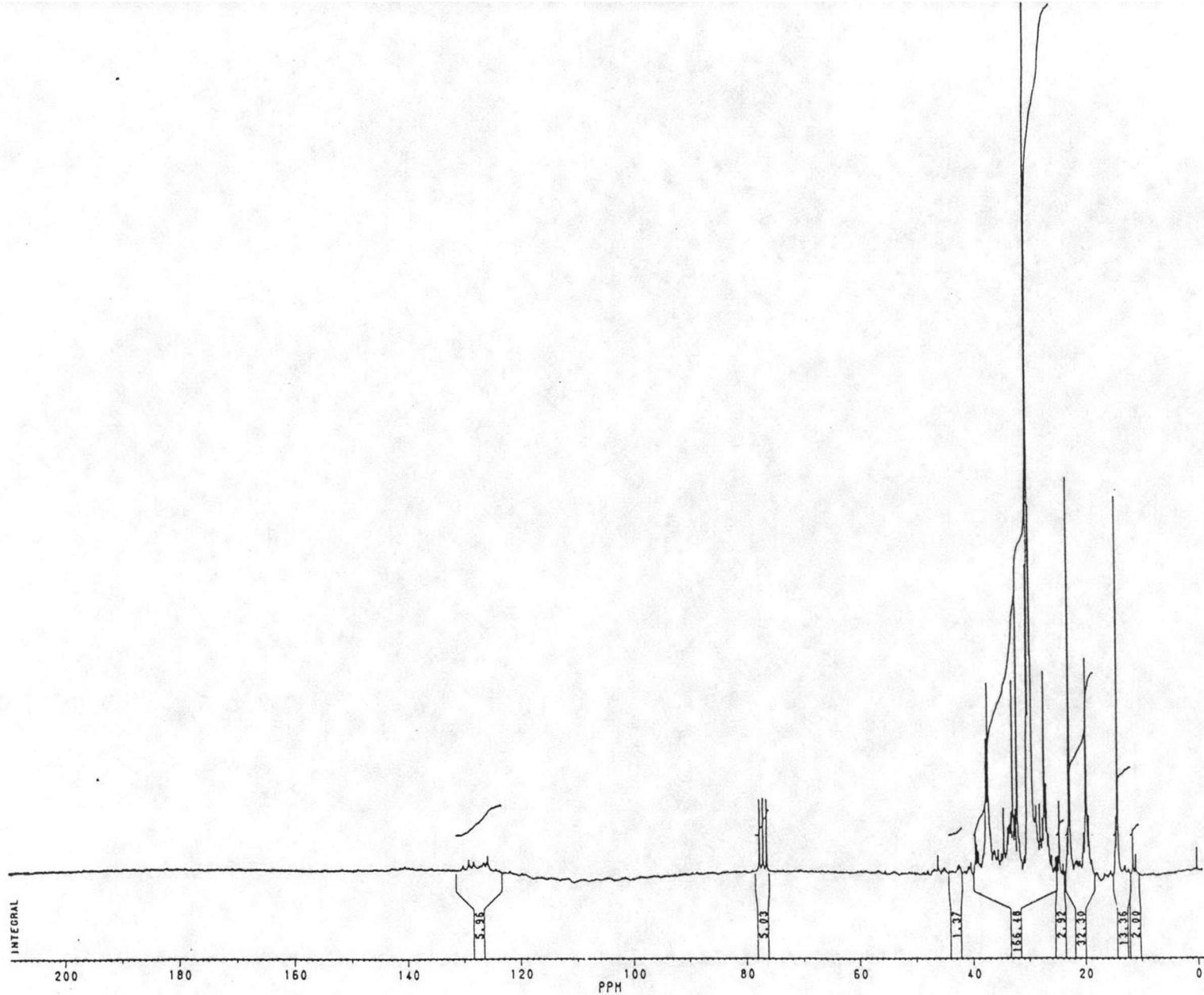


Figure B1 ^{13}C -NMR spectrum of used lubricating oil

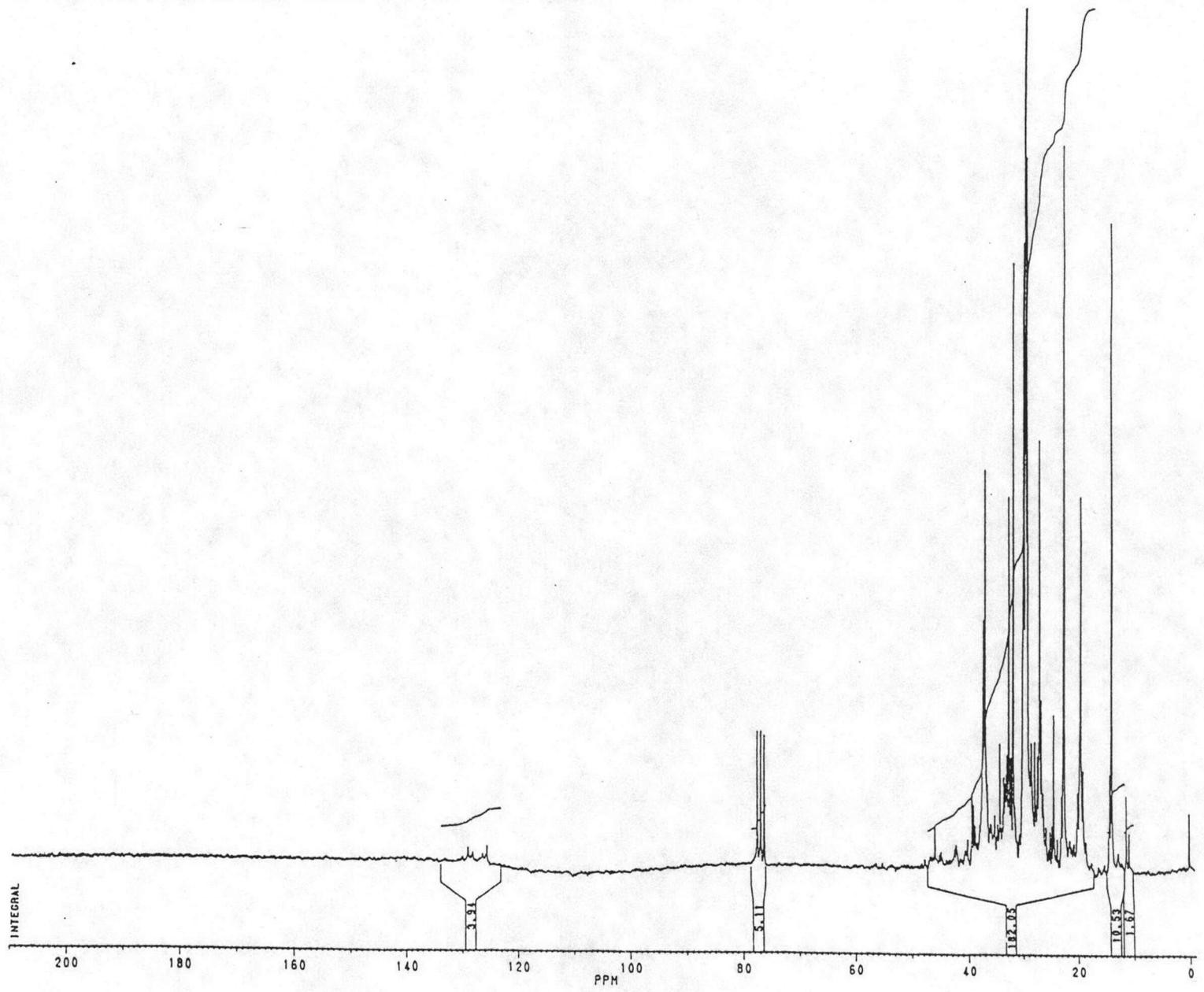


Figure B2 ^{13}C -NMR spectrum of acid-clay treated oil

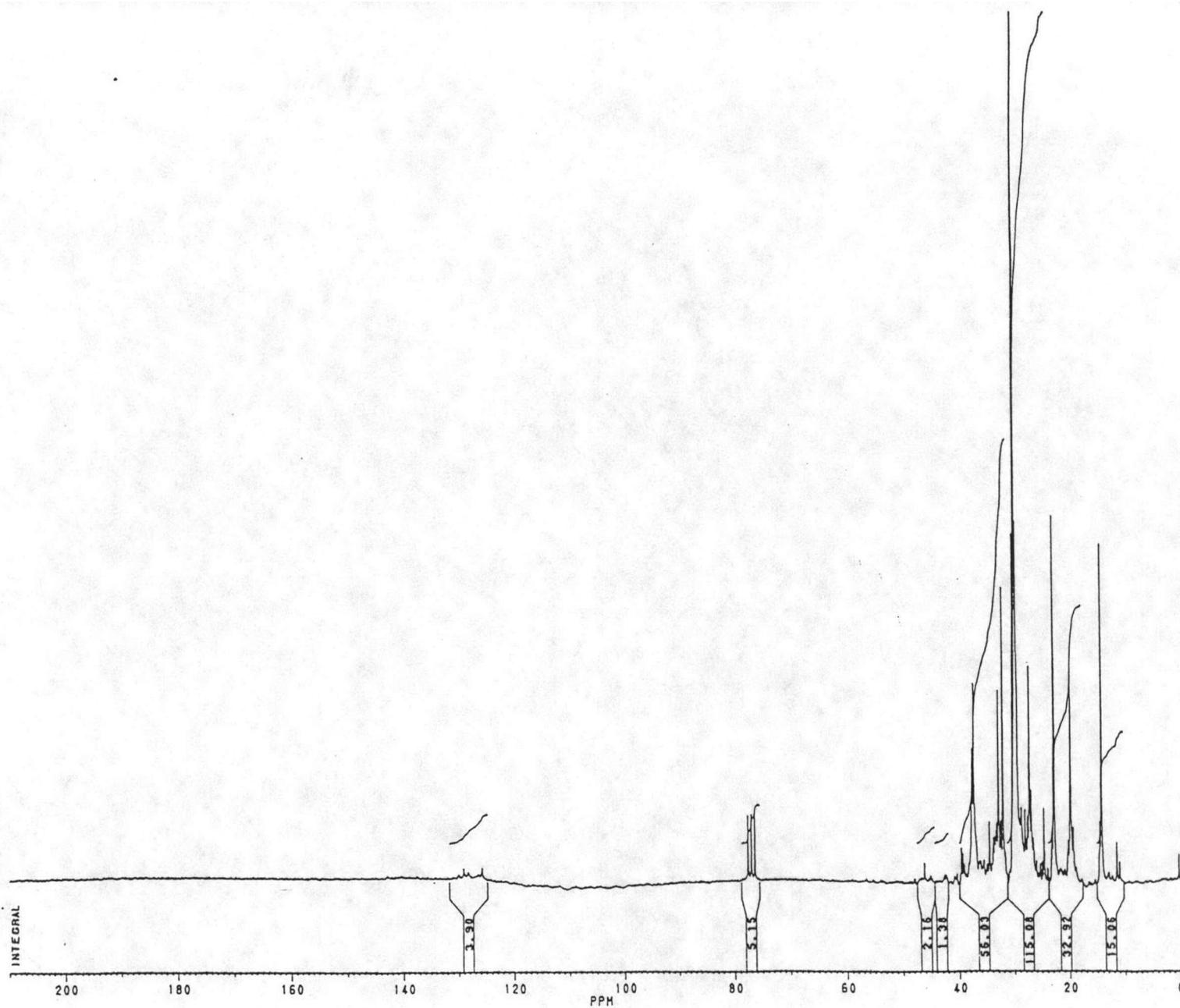


Figure B3 ^{13}C -NMR spectrum of oil obtained from hydrogenation of acid-clay treated oil by using 4% Raney nickel catalyst 113

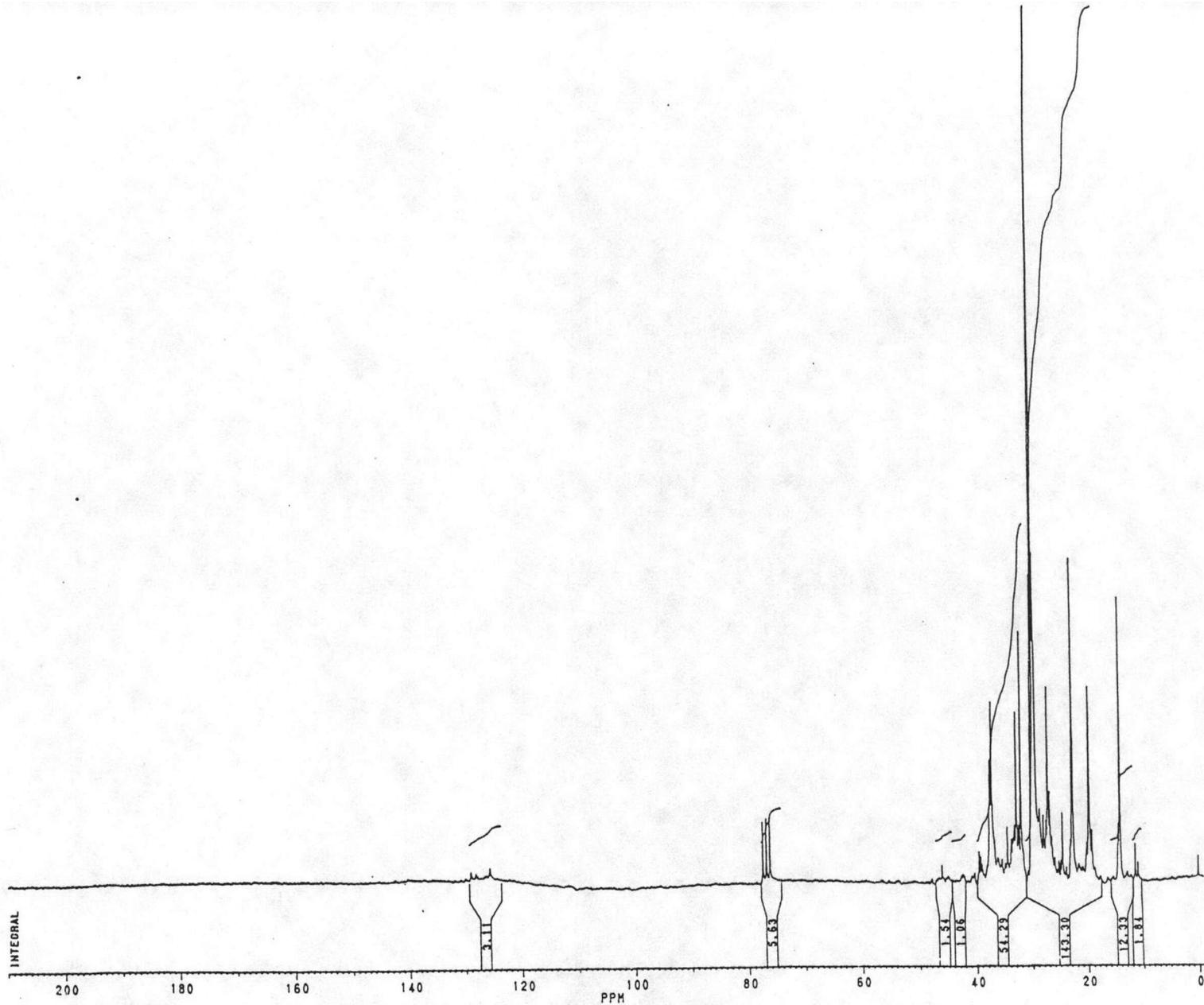


Figure B4 ^{13}C -NMR spectrum of oil obtained from hydrogenation of acid-clay treated oil by using 4% $\text{NiO}/\text{MoO}_3/\text{Al}_2\text{O}_3$ catalyst

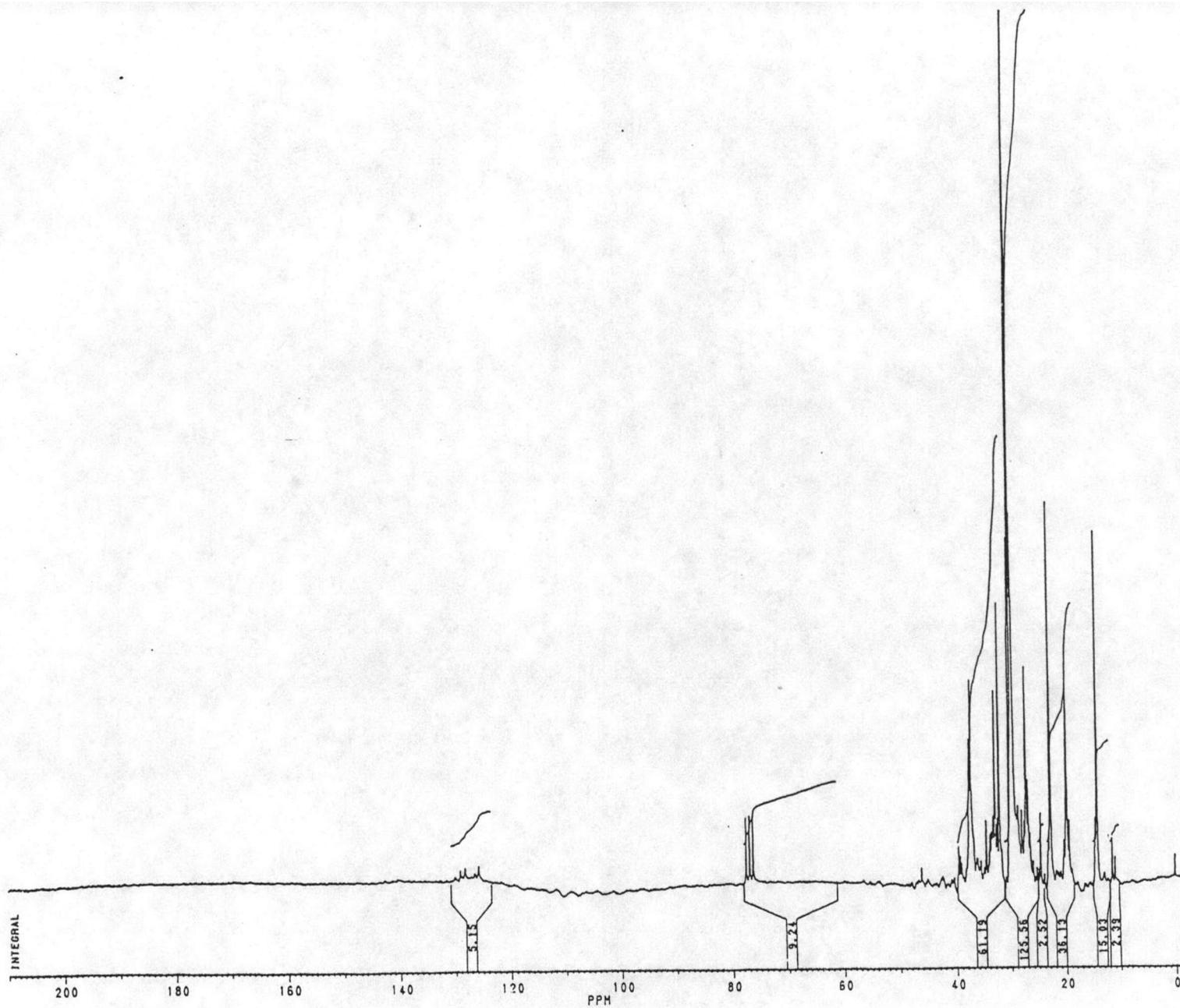


Figure B5 ^{13}C -NMR spectrum of oil obtained from hydrogenation of acid-clay treated oil by using 4% $\text{NiO}/\text{WO}_3/\text{Al}_2\text{O}_3$ catalyst

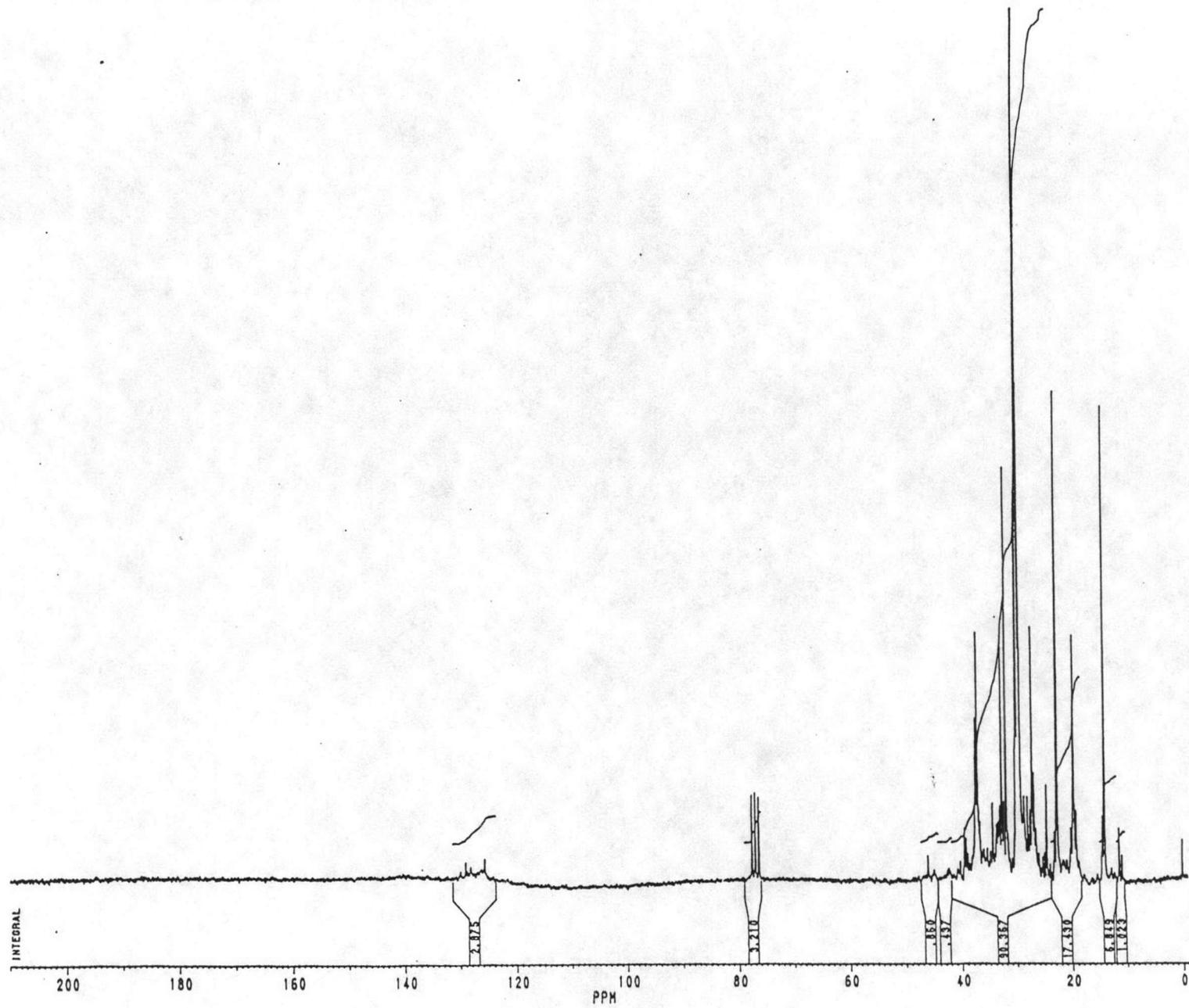


Figure B6 ^{13}C -NMR spectrum of oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst

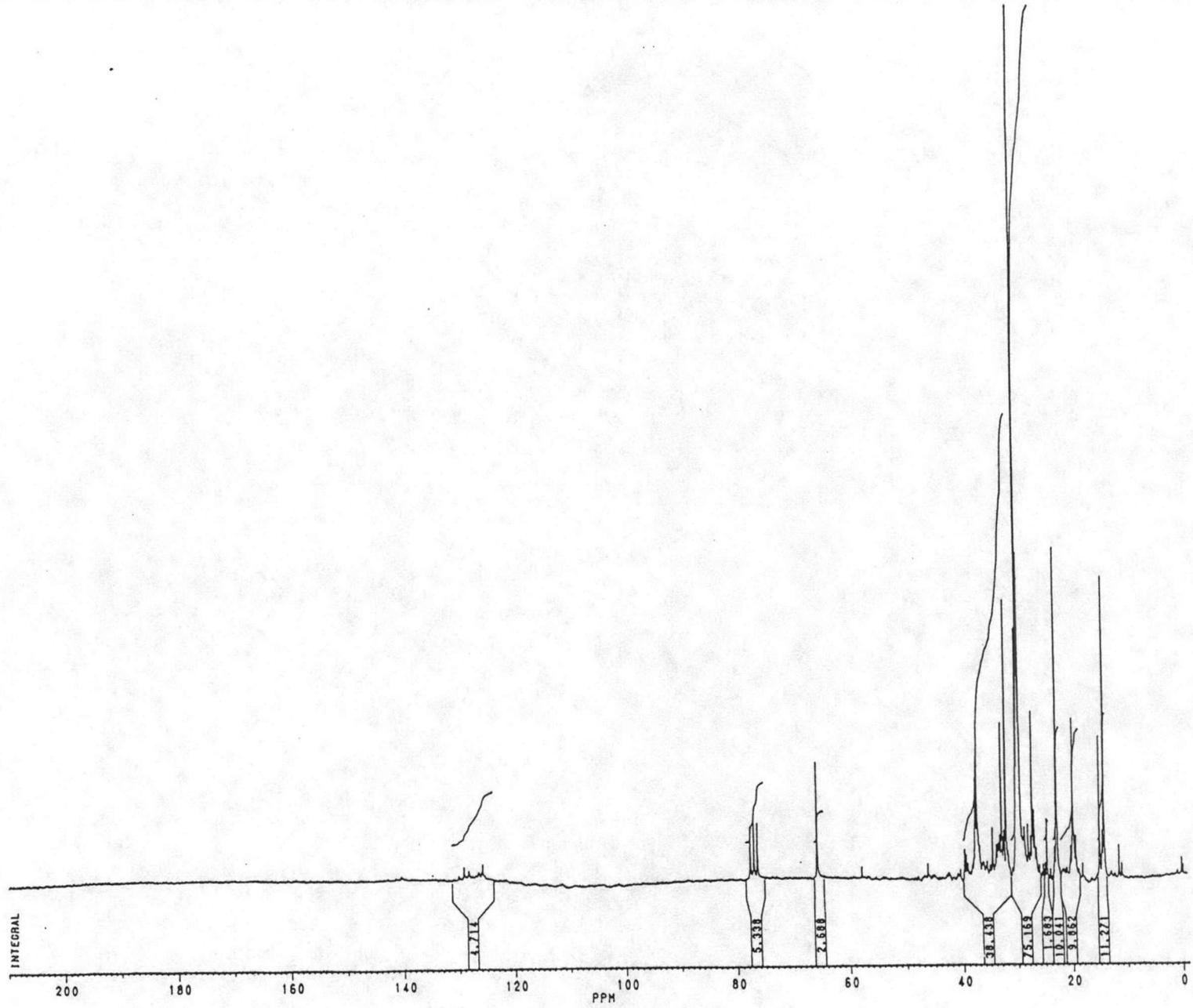


Figure B7 ^{13}C -NMR spectrum of oil obtained from hydrogenation of used oil by using 4% $\text{NiO}/\text{MoO}_3/\text{Al}_2\text{O}_3$ catalyst

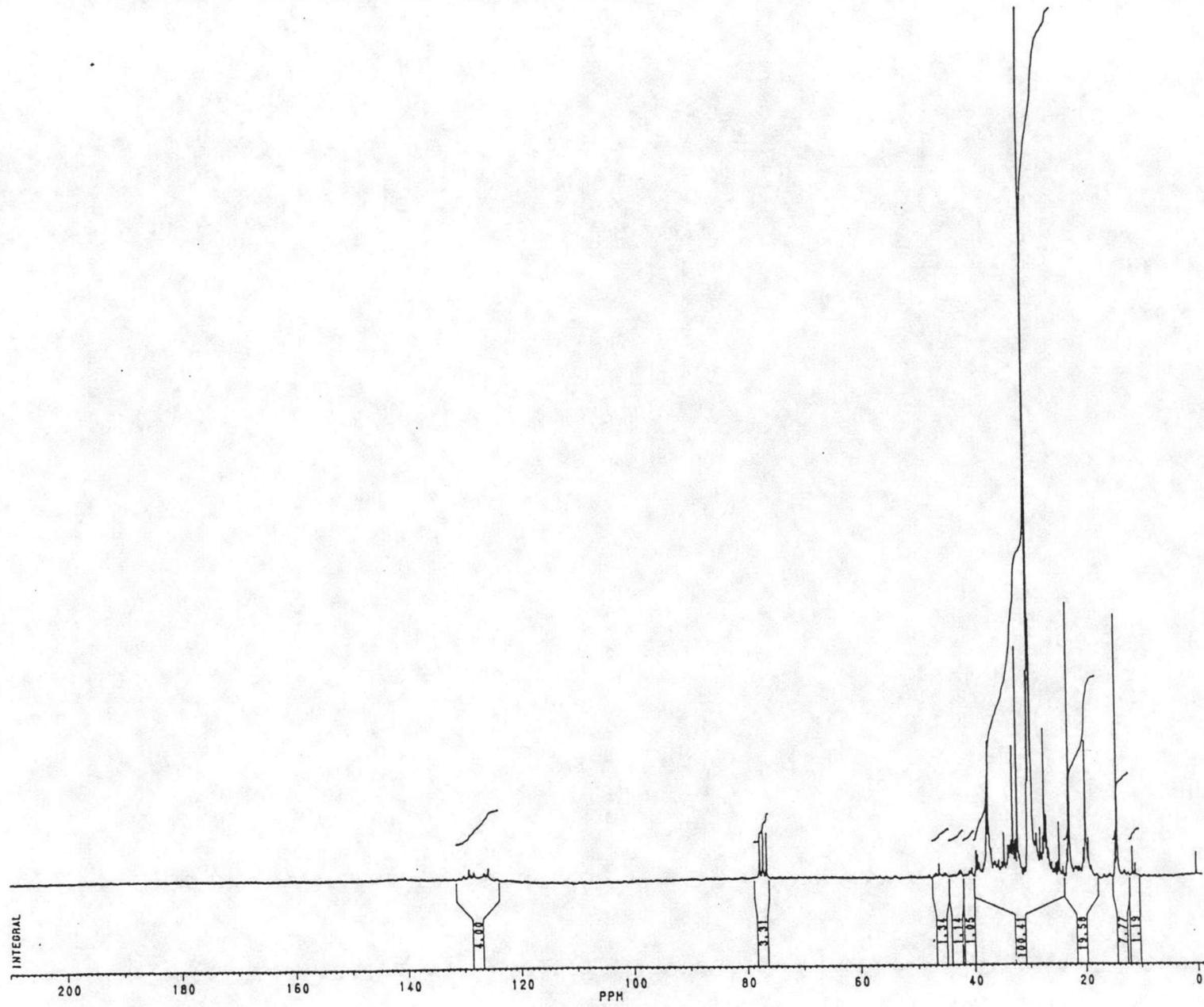


Figure B8 ^{13}C -NMR spectrum of oil obtained from hydrogenation of used oil by using 4% $\text{NiO}/\text{WO}_3/\text{Al}_2\text{O}_3$ catalyst

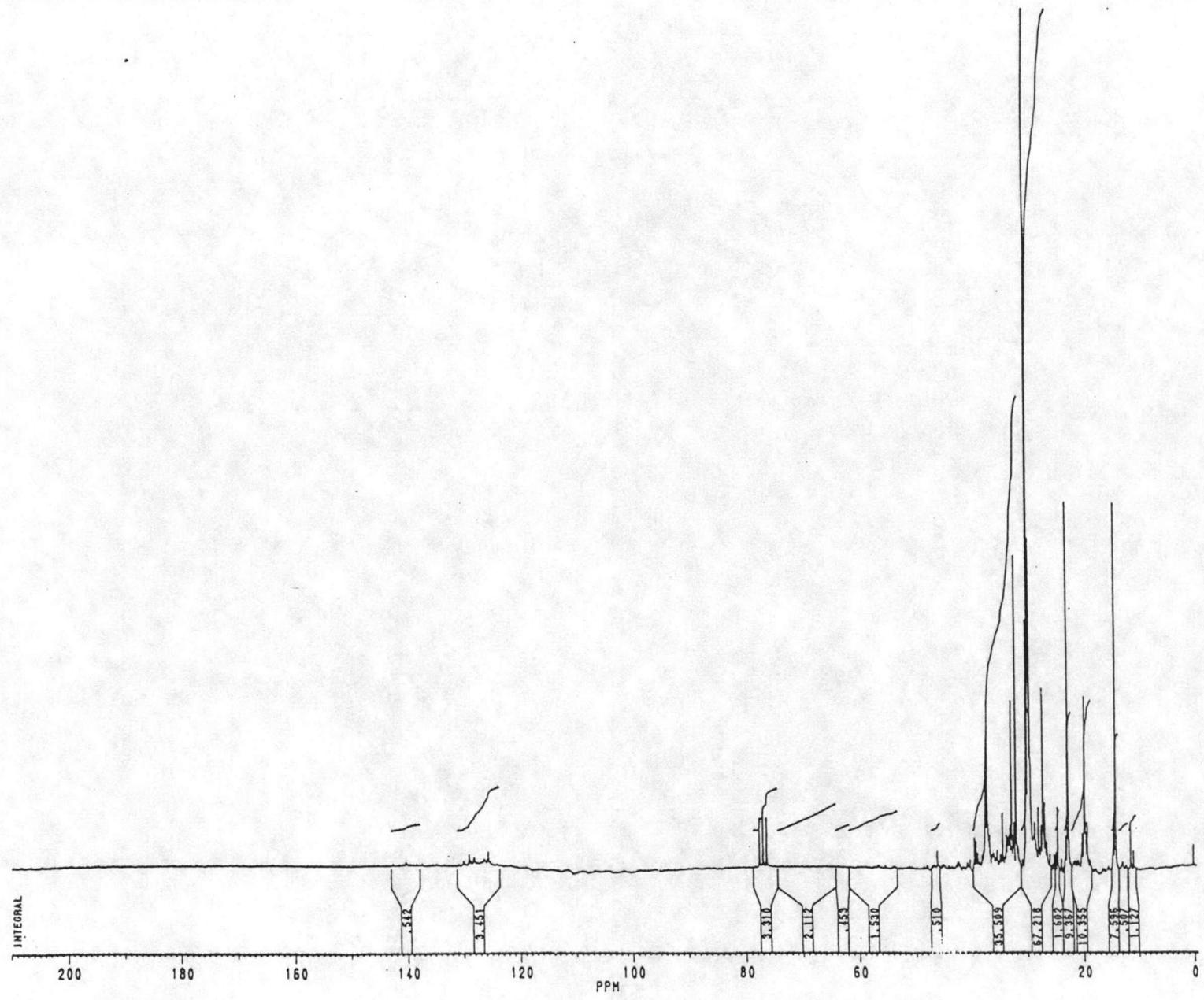


Figure B9 ^{13}C -NMR spectrum of oil obtained from hydrogenation of used oil by using 6% Raney nickel catalyst

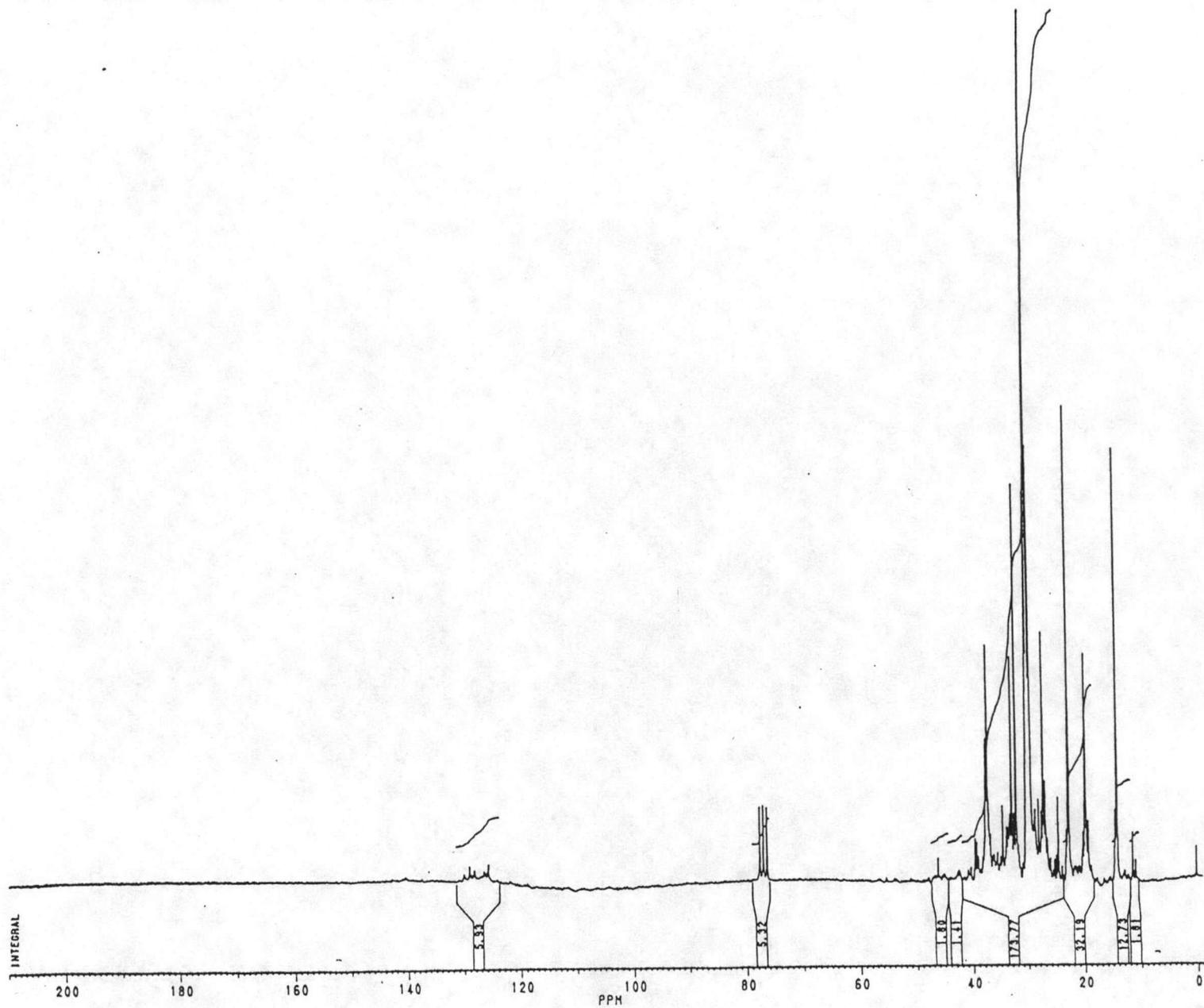


Figure B10 ^{13}C -NMR spectrum of oil obtained from hydrogenation of used oil by using 8% Raney nickel catalyst

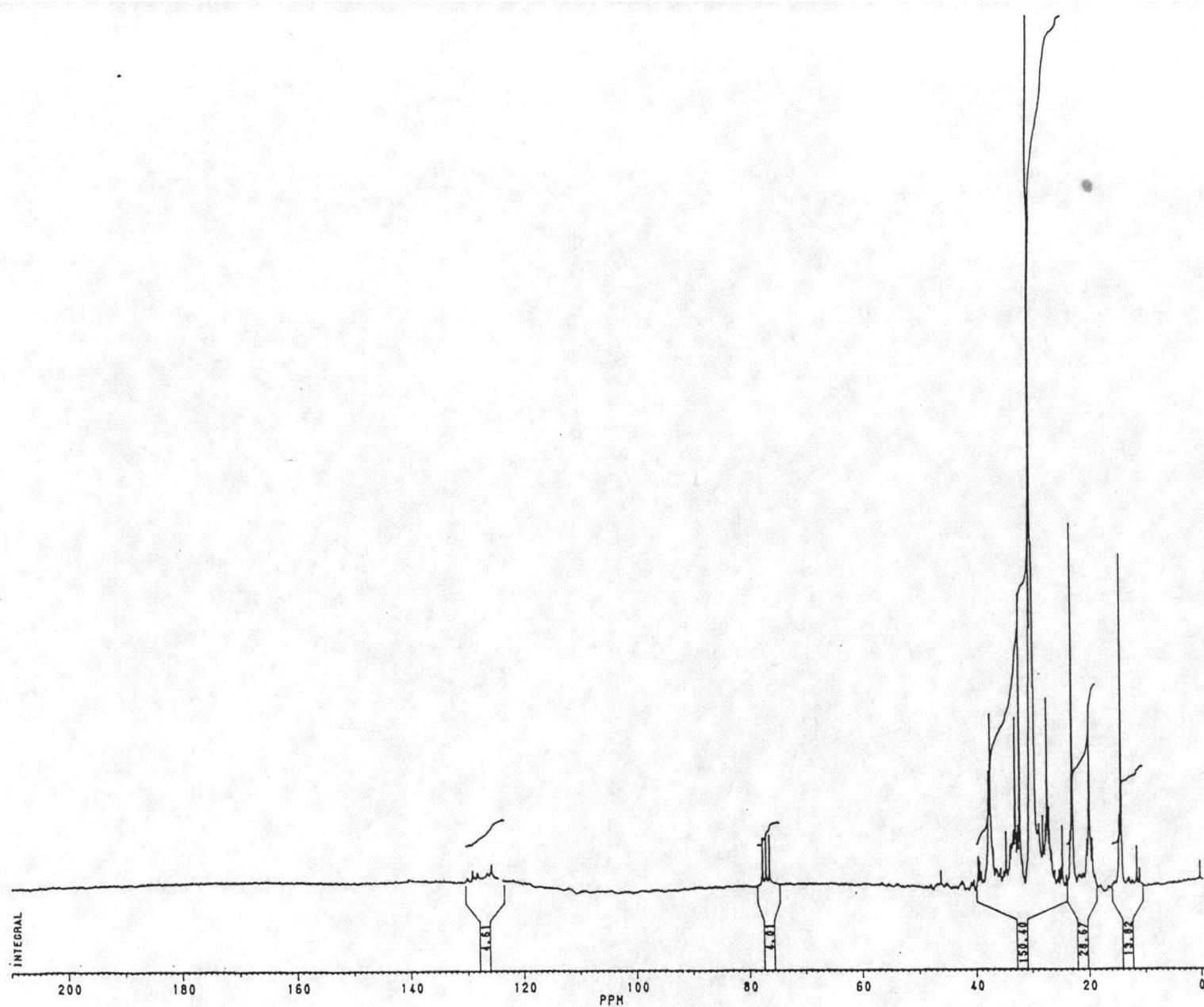


Figure B11 ^{13}C -NMR spectrum of oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst with 6 hours reaction time

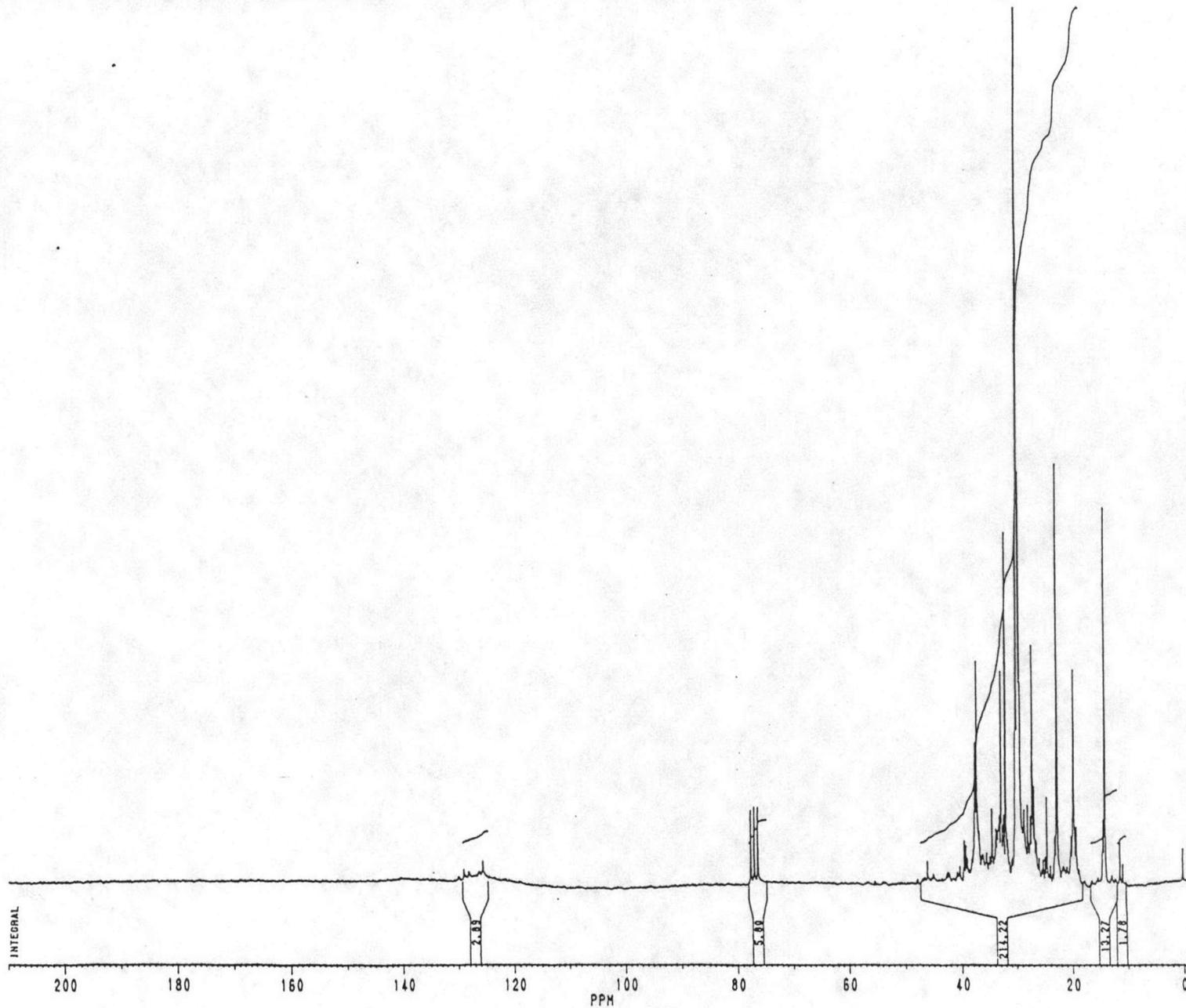


Figure B12 ^{13}C -NMR spectrum of oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst with 8 hours reaction time

APPENDIX C

OIL FEATURES

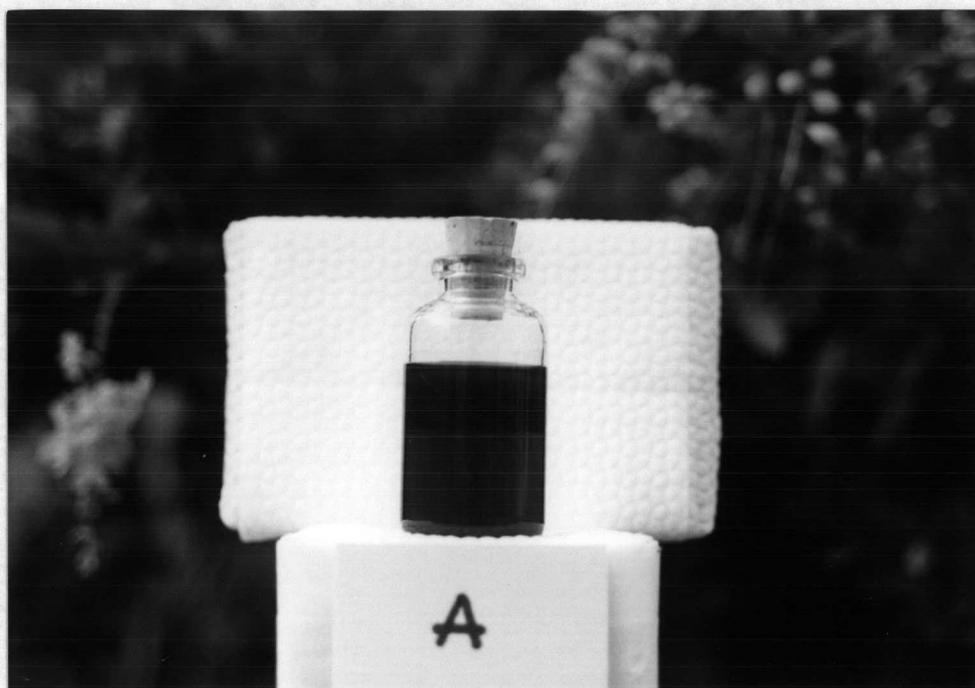


Figure C1 Used oil



Figure C2 Acid-clay treated oil

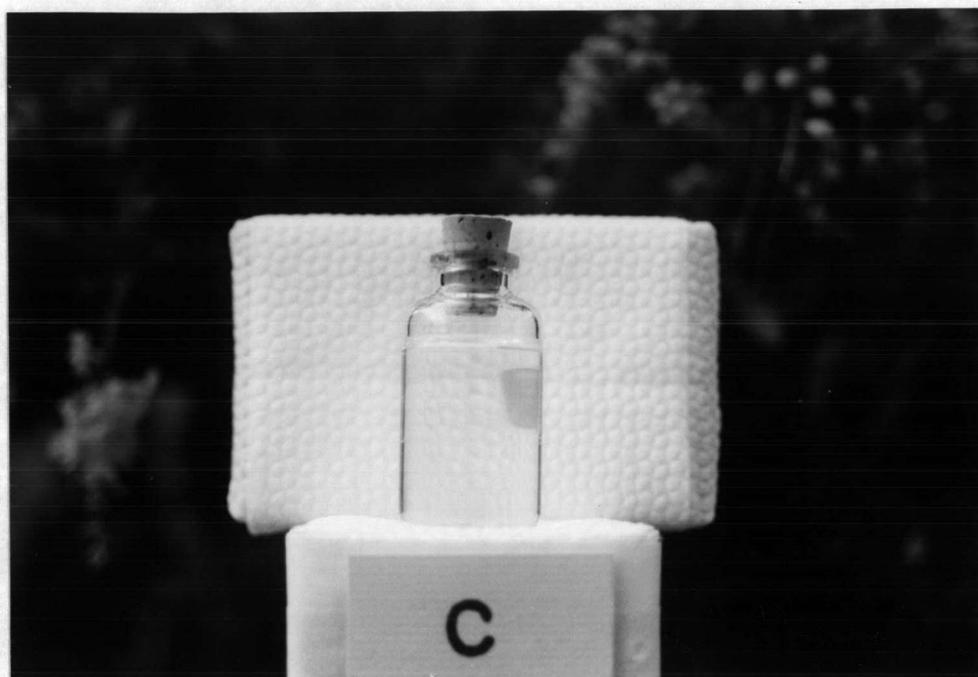


Figure C3 Oil obtained from hydrogenation of acid-clay treated oil by using 4% Raney nickel catalyst



Figure C4 Oil obtained from hydrogenation of acid-clay treated oil by using 4% NiO/MoO₃/Al₂O₃ catalyst



Figure C5 Oil obtained from hydrogenation of acid-clay treated oil by using 4% NiO/WO₃/Al₂O₃ catalyst



Figure C6 Oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst



Figure C7 Oil obtained from hydrogenation used oil by using 4% NiO/MoO₃/Al₂O₃ catalyst



Figure C8 Oil obtained from hydrogenation of used oil by using 4% NiO/WO₃/Al₂O₃ catalyst



Figure C9 Oil obtained from hydrogenation of used oil by using 6% Raney nickel catalyst



Figure C10 Oil obtained from hydrogenation of used oil by using 8% Raney nickel catalyst



Figure C11 Oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst with 6 hours reaction time



Figure C12 Oil obtained from hydrogenation of used oil by using 4% Raney nickel catalyst with 8 hours reaction time



Figure C13 Commercial industrial lubricating oil :
Mobil hydraulic DTE oil 25



Figure C14 Commercial industrial lubricating oil :
Mobil hydraulic DTE oil 26



Figure C15 Commercial industrial lubricating oil :
Mobil hydraulic AW 46

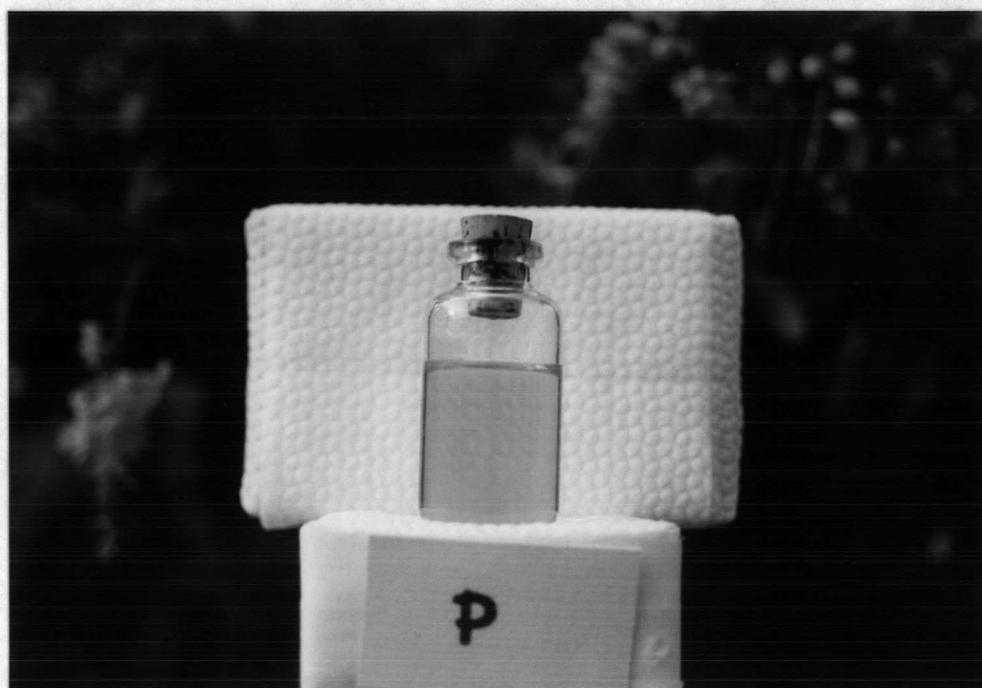


Figure C16 Commercial industrial lubricating oil :
Mobil gear 626



Figure C17 Commercial industrial lubricating oil :
Esso hydraulic NUTO 68



Figure C18 Commercial industrial lubricating oil :
Esso gear SPARTAN EP



Figure C19 Commercial industrial lubricating oil :
Esso Turbine TERESSO

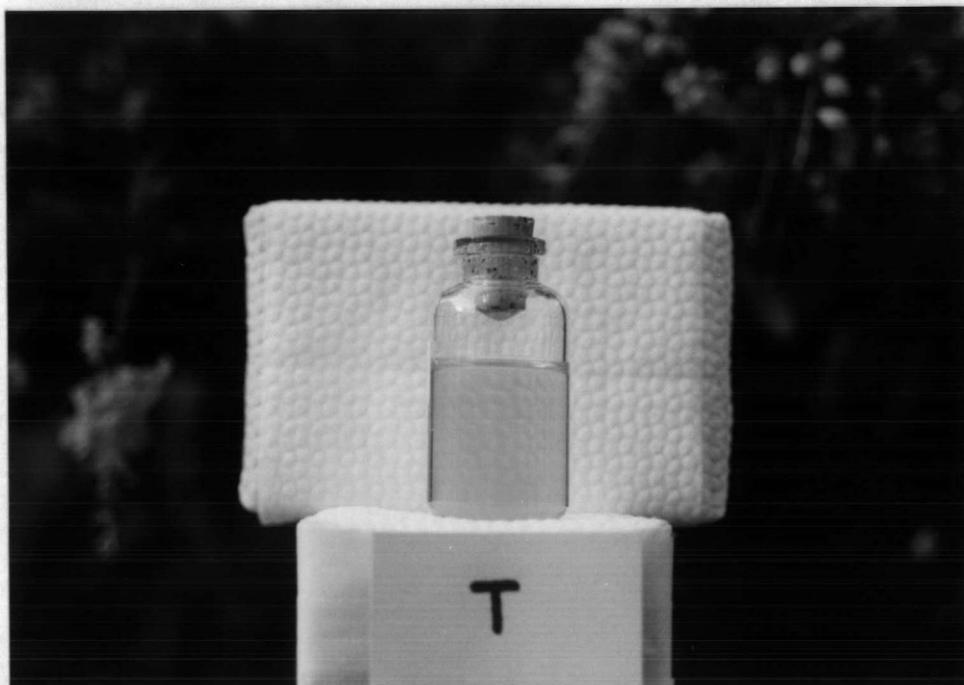


Figure C20 Commercial industrial lubricating oil :
Caltex hydraulic RANDO HD 46



Figure C21 Commercial industrial lubricating oil :
Caltex gear MEROPA 150

APPENDIX D

PHYSICAL PROPERTIES OF COMMERCIAL

INDUSTRIAL LUBRICATING OILS

Table D1 Physical properties of Caltex commercial industrial lubricating oils

Physical properties	RANDO HD 46	MEROPA 150
API Gravity @ 60°F	26.6	27.6
Colour,ASTM	2.0	L 3.0
VI	96	102
Sulfur Content,%	1.405	1.668

Table D2 Physical properties of Mobil commercial industrial lubricating oils

Physical properties	Gear 626	DTE 25	DTE 26	AW 46
API Gravity @ 60°F	27.6	29.2	28.1	28.7
Colour,ASTM	L 3.0	L 1.5	L 1.5	L 1.5
VI	102	107	101	99
Sulfur Content,%	1.668	0.935	0.974	1.086

Table D3 Physical properties of Esso commercial industrial lubricating oils

Physical properties	NUTO 68	SPARTAN	TERRESO
API Gravity @ 60°F	28.6	28.1	28.5
Colour,ASTM	1.5	1.5	1.5
VI	102	101	99
Sulfur Content,%	0.765	1.072	0.614

VITA

Mr. Kanit Rongsawat was born on July 24, 1964 in Songkla, Thailand. He received a Bachelor Degree of Science in Education (Chemistry) from Prince of Songkla University in 1987. His experiences before studying in Petrochemistry in Chulalongkorn University were a chemist at Kulthorn Kirby Co., Ltd. for two years, and worked as a instructor of Faculty of Science at Bangkok University for one year. Now, he works in Technical Supports position at Engineering and Science Associates in Bangkok.

