TABLE 135

Storage Data For Fuels Used For Navy-CRC Storage Program
Soluble Gum, mg/100 ml.

Condition And Duration Of Storage	70% WMC SR[1] 30% WMC CC	70% WMC SR[1] 30% WMC CC 0.01% Add #2	50% WMC SR 50% WMC CC	50% WMC SR 50% WMC CC 0.01% Add. #2	50% WT SR 50% WT CC	50% WT SR 50% WT CC	50% EMC SR 50% EMC CC	50% EMC SR 50% EMC CC	50% EMC SR 50% EMC CC 0.02% Add. #1	50% EMC SR 50% EMC CC 0.02% Add #1	100% RM SR	100% RM SR
Barge Storage, Ambient Temp.												
0 Months	2.8	6.0	4.6	5.0	3.6	4.4	3.4	5.3	7.3	5.6	1.3	2.9
6 Months	3.8	7.1	6.3	7.9	13.4	10.6	8.4	7.7	10.3	10.9	1.2	1.5
9 Months	5.3	6.4	7.3	8.5	17.5	16.6	9.6	9.6	14.0	12.1	1.4	1.4
12 Months	4.7	6.5	5.1	7.0	17.4	17.3	11.0	12.0	13.9	12.4	1.7	2.1
18 Months	5.6	6.4	7.3	10.7	25.7	23.3	15.2	15.4	15.1	14.6	2.1	1.8
24 Months	5.8	8.3	7.9	13.4	34.6	33.4	18.4	19.4	20.7	19.8	2.1	2.6
Drum Storage, Ambient Temp.												
0 Months	6.2	6.6	5.2	6.4	5.0	5.6	7.2	5.6	6.6	5.5	2.4	0.4
3 Months	4.2	5.6	4.2	7.6	4.8	5.4	5.8	5.6	9.6	10.6	2.6	2.6
6 Months	3.2	5.5	4.3	7.4	12.3	10.0	7.2	12.0	9.4	13.5	1.8	1.4
9 Months	2.0	5.8	4.4	7.4	16.2	17.2	10.4	11.0	15.4	16.0	1.2	1.8
12 Months	4.3	6.5	16.2	14.1	18.7	16.3	11.1	11.6	15.9	17.1	3.6	3.3
15 Months	3.6	6.2	6.3	8.7	36.0	30.2	19.7	18.6	18.9	20.6	2.1	2.1
18 Months	7.9	11.8	8.7	12.5	31.3	28.0	18.0	22.6	22.3	25.6	1.1	2.2
24 Months	10.1	11.8	13.7	17.9	37.5	38.7	24.7	30.4	27.7	30.1	0.7	1.2
Bottle Storage, Ambient Temp.												
0 Months	6.2	6.6	6.2	6.4	5.0	5.6	6.6	5.0	6.6	5.0	2.4	0.4
3 Months	3.7	5.6	4.4	6.4	6.7	5.1	4.4	4.4	9.0	9.9	2.8	2.6
6 Months	4.8	6.9	6.5	10.1	11.3	14.5	9.0	9.8	12.5	14.0	0.2	1.2
9 Months	5.0	6.2	6.5	8.5	14.8	13.8	10.6	12.4	16.1	16.2	0.9	1.2
12 Months	7.1	6.2	5.4	8.3	20.2	16.7	19.5	20.9	21.9	16.6	1.0	1.1
15 Months	6.2	7.9	12.3	18.4	21.3	19.2	20.1	23.8	21.3	19.2	2.2	4.0
18 Months	6.8	7.1	9.3	11.2	33.7	30.4	19.2	23.3	23.0	22.8	1.2	1.1

Table 135 Continued on next page

[1] Fuel Abbreviations: WMC -- Western Midcontinent
EMC -- Eastern Midcontinent
WT -- West Texas
RM -- Rocky Mountain
SR -- Straight Run
CC -- Catalytically Cracked

Taken from Reference No. 27

TABLE 135

Storage Data For Fuels Used For Navy-CRC Storage Program
Soluble Gum, mg/100 ml. -- Continued

Condition And Duration Of Storage	70% WMC SR[1] 30% WMC CC	70% WMC SR[1] 30% WMC CC 0.01% Add #2	50% WMC SR 50% WMC CC	50% WMC SR 50% WMC CC 0.01% Add. #2	50% WT SR 50% WT CC	50% WT SR 50% WT CC	50% EMC SR 50% EMC CC	50% EMC SR 50% EMC CC	50% EMC SR 50% EMC CC 0.02% Add. #1	50% EMC SR 50% EMC CC 0.02% Add #1	100% RM SR	100% RM SR
Glass Pipe Storage, 24 Months	10.8	28.0	12.3	18.8	46.7	-	36.5	-	33.4	-	3.8	-
Bottle Storage, 80 ° F												
0 Months	0.8	1.3	0.4	1.1	1.7	1.4	2.2	2.4	2.6	2.7	0.0	0.7
3 Months	2.8	3.4	4.1	3.9	6.5	7.4	2.9	3.2	6.9	5.9	0.0	1.0
6 Months	2.7	4.4	3.5	5.4	9.3	8.0	4.7	5.5	8.1	8.4	0.6	1.4
Bottle Storage, 90 ° F												
0 Months	1.1	1.2	2.7	3.4	4.1	1.3	2.4	2.6	5.5	3.4	0.3	0.4
6 Months	5.9	7.2	8.1	6.8	17.1	14.9	11.8	13.8	15.6	10.1	1.6	1.5
12 Months	4.8	5.2	7.2	9.3	29.3	27.5	14.8	19.7	18.7	19.0	0.8	0.9
Bottle Storage, 110 ° F												
0 Weeks	5.8	6.0	6.2	6.4	5.4	4.4	6.4	7.8	6.0	5.0	2.4	2.4
13 Weeks	8.0	10.7	10.0	13.2	25.0	23.1	18.4	18.6	16.8	16.9	1.9	2.4
26 Weeks	7.6	13.2	11.0	17.5	33.9	36.0	28.5	30.1	25.5	25.4	3.0	4.0
39 Weeks	8.2	13.3	9.2	16.3	37.3	35.9	26.2	30.4	26.1	24.8	4.1	4.2
52 Weeks	11.0	12.6	11.4	12.9	37.4	34.6	23.0	27.0	25.2	24.3	2.1	2.9
65 Weeks	8.4	13.2	14.4	20.9	46.4	43.7	29.9	36.0	28.5	28.1	3.9	4.9

Table 135 Continued on next page

[1] Fuel Abbreviations: WMC – Western Midcontinent
EMC -- Eastern Midcontinent
WT – West Texas
RM -- Rocky Mountain
SR -- Straight Run
CC -- Catalytically Cracked

Taken from Reference No. 27

TABLE 135

Storage Data For Fuels Used For Navy-CRC Storage Program

Soluble Gum, mg/100 ml. -- Continued

Condition And Duration Of Storage	70% WMC SR[1] 30% WMC CC	70% WMC SR[1] 30% WMC CC 0.01% Add #2	50% WMC SR 50% WMC CC	50% WMC SR 50% WMC CC 0.01% Add. #2	50% WT SR 50% WT CC	50% WT SR 50% WT CC	50% EMC SR 50% EMC CC	50% EMC SR 50% EMC CC	50% EMC SR 50% EMC CC 0.02% Add. #1	50% EMC SR 50% EMC CC 0.02% Add #1	100% RM SR	100% RM SR
Bottle Storage 110 ° F												
0 Weeks	0.8	1.3	0.4	1.1	1.7	1.42.2	2.4	2.6	2.7	0.0	0.7	
6 Weeks	-	-	-	-	-	-	-	-	-	-	-	-
12 Weeks	10.4	12.8	10.7	8.8	17.7	26.9	12.3	16.7	17.8	16.5	2.1	1.3
Bottle Storage 110 ° F												
0 Weeks	1.1	1.2	2.7	3.4	4.1	1.3	2.4	2.6	5.5	3.4	0.3	0.4
6 Weeks	4.2	4.9	5.6	7.8	12.1	15.0	9.5	7.5	10.2	10.9	0.3	0.7
12 Weeks	1.9	1.9	3.6	6.0	19.5	14.2	10.5	12.0	13.7	15.0	0.7	1.0
18 Weeks	5.2	5.4	9.2	10.1	28.5	15.3	15.3	16.8	17.5	24.3	0.4	0.8
24 Weeks	5.9	5.5	9.4	10.6	31.3	34.4	21.7	21.6	22.9	22.6	0.9	1.1
Bottle Storage 110 ° F												
0 Weeks	3.0	9.8	-	16.8	5.9	-	9.6	-	13.0	-	3.6	-
3 Weeks	4.8	7.6	4.4	12.4	-	-	-	-	10.4	-	-	-
6 Weeks	8.4	17.2	11.6	11.8	20.8	-	11.6	-	15.6	-	TR	-
9 Weeks	9.4	12.8	9.0	13.0	30.8	-	23.0	-	22.2	-	2.8	-
12 Weeks	7.6	11.8	8.2	15.8	28.4	-	20.8	-	27.4	-	0.4	-
Bottle Storage 110 ° F												
0 Weeks	1.5	5.1	1.4	3.5	1.7	-	3.2	-	6.4	-	0.2	-
6 Weeks	2.2	3.0	6.5	6.5	10.8	-	4.5	-	6.6	-	0.3	-
12 Weeks	2.0	5.0	4.2	5.3	15.7	-	10.6	-	12.9	-	0.4	-
18 Weeks	3.9	5.8	6.7	7.0	19.0	-	14.5	-	13.5	-	0.5	-
24 Weeks	3.9	7.6	8.4	9.4	24.5		15.8	-	16.3	-	0.8	-

[1] Fuel Abbreviations: WMC – Western Midcontinent
EMC – Eastern Midcontinent
WT – West Texas
RM – Rocky Mountain
SR – Straight Run
CC – Catalytically Cracked

Taken from Reference No. 27

TABLE 136

Analyses of Stored Blends of an Unstable Petroleum Distillate Fuel[1]

Blend description[2]	Hydroperoxides, equivalents of oxygen per liter, weeks of storage				Insoluble gum, mg/100 ml weeks of storage				Soluble gum, mg/100 ml weeks of storage			
	0	13	26	39	0	13	26	39	0	13	26	39
Distillate fuel ;												
As received	4.4	6.6	8.6	7.1	1.3	6.8	8.8	14.9	5.7	19.9	27.7	33.9
+ 1 Vol. Benzene extract[3]	4.7	.6	7.9	8.1	4.3	6.0	12.6	16.2	6.9	22.5	27.7	37.5
+ 2 Vol. Benzene extracts	4.4	.6	8.3	8.3	3.0	8.4	11.3	18.0	16.3	27.1	30.2	39.0
+ 1 Vol. Ether extracts	5.2	5.6	8.5	9.0	3.2	8.9	13.3	17.7	10.1	25.2	31.3	41.3
+ 2 Vol. Ether extracts	7.4	6.6	10.0	10.6	2.7	12.5	14.5	20.6	8.9	34.6	39.4	44.6
+ 1 Vol. Alcohol extract	5.2	8.6	8.5	8.4	27.1	39.5	40.9	46.3	32.4	57.2	49.4	66.9
+ 2 Vol. Alcohol extracts	7.3	7.0	9.8	10.2	71.9	101.7	116.6	131.7	47.7	74.2	86.2	113.4
Depolarized	3.6	3.6	7.3	15.2	0.2	0.3	0.3	1.9	0.2	0.2	2.6	28.8
+ 1 Vol. Benzene extract	3.4	6.5	6.5	8.8	2.2	.9	1.0	1.5	1.5	4.8	4.3	17.5
+ 2 Vol. Benzene extracts	4.4	6.5	6.3	8.8	3.2	1.7	1.6	3.6	5.2	6.4	7.2	20.6
+ 3 Vol. Benzene extracts	4.5	6.3	6.1	8.2	22.1	2.1	2.4	3.4	3.8	8.3	8.9	25.4
+ 1 Vol. Ether extract	5.0	10.8	9.2	10.3	1.8	1.1	1.2	3.3	5.7	8.0	7.3	23.4
+ 2 Vol. Ether extracts	-	6.5	10.0	9.9	-	1.7	2.0	6.3	-	8.8	12.5	25.4
+ 3 Vol.Ether extracts	8.4	7.3	7.6	8.2	3.8	2.8	2.4	5.7	8.2	12.1	14.9	26.5
+ 1 Vol. Alcohol extract	4.7	4.7	6.1	6.3	31.1	30.6	28.0	29.8	21.6	31.6	23.7	39.8
+ 2 Vol. Alcohol extracts	6.7	7.0	7.5	7.5	80.4	90.5	98.5	89.8	33.6	66.0	61.4	74.1

[1] Stored at 43 ° C

[2] Blends of fuel with polar compounds separated from the fuel on a silica gel column and eluted from the column with the indicated solvent.

[3] One volume extract = amount originally present in fuel.

Taken from Reference No. 31

TABLE 137

Stability of Gas Oils A, C[1] and Their Blends Stored in Metal Containers.[2]

	3 Months								6 Months								9 Months							
			Percent C in A								Percent C in A								Percent C in A					
	A	C	4	8	12	16	20	50	A	C	4	8	12	16	20	50	A	C	4	8	12	16	20	50
Union-color	1.25	6.50	4.25	4.25	4.25	4.25	4.25	4.75	2.50	1.25	4.50	4.50	4.50	4.75	5.00	6.25	2.50	7.50	4.25	4.50	4.75	5.00	5.00	6.50
Carbon residue %									0.13	0.35	0.13	0.15	0.17	0.18	0.23	0.23	0.13	0.36	0.15	0.15	0.16	0.17	0.20	0.22
Total Sulphur %									0.95	1.13						1.04	0.88	1.12						1.06
Total acidity																								
mg KOH/g									0.05	0.09	0.05	0.06	0.06	0.08	0.11	0.11	0.08	0.14	0.10	0.11	0.14	0.14	0.14	0.15
Copper corrosion	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a
Bromine No.	2.8	23.6	3.9	4.6	5.0	5.9	6.5	13	1.4	18.3	1.7	2.3	2.8	3.5	4.2	9.9	1.9	21.1	2.7	3.0	3.5	3.8	4.3	10.0
Aniline point °C																	73.4	65.8	73.0	72.8	72.8	72.2	71.6	69.4
Diesel index																	58	51	58	57	57	56	55	54
Distillation range																								
I.B.P. °C									178	183	176	179	172	173	175	176	174	176	176	174	172	174	174	176
10%									228	213	229	222	223	223	224	224	224	219	225	224	227	227	224	224
50%									297	284	295	295	294	295	290	290	293	296	295	294	294	296	296	294
90%									351	350	350	351	350	350	350	350	350	350	350	350	350	350	350	350
Gum after filtration																								
Total mg/100 ml	1.0	5.3	2.2	2.4	2.9	3.1	3.4	4.6	2.3	5.8	2.6	2.1	6.7	3.6	3.7	5.1	3.2	7.3	3.1	3.3	6.0	4.5	4.8	5.6
Soluble in																								
acetone-methanol	0.4	2.7	1.2	1.6	2.0	2.0	2.2	2.2	1.4	3.2	1.5	1.7	1.8	1.9	1.9	2.0	1.9	4.8	1.9	2.1	2.3	2.5	2.8	3.0
Soluble in pyridine	0.2	1.0	0.2	0.2	0.2	0.2	0.2	0.6	0.3	1.5	0.1	0.2	0.2	0.3	0.4	1.0	0.3	1.7	0.2	0.2	0.3	0.4	0.5	0.6
Insoluble	0.5	1.6	0.8	0.6	0.7	1.9	1.0	1.8	0.6	0.1	1.0	0.2	4.7	1.4	1.4	2.1	1.0	1.0	1.0	1.0	3.4	1.5	1.5	2.0

[1] Oil A was a straight-run gas oil; oil C was a catalytically-cracked gas oil.

[2] Stored at ambient temperature.

Taken from Reference No. 8

TABLE 138

Stability of Blends of Gas Oils A and D[1] Stored in Glass Containers[2]

Storage time	3 months				6 months				9 months			
Concentration of D in A,%	4	8	12	16	4	8	12	16	4	8	12	16
Union-color	2.75	2.75	3.25	3.25	3.25	3.25	4.00	4.25	4.00	4.25	4.5	4.75
Total acidity mgKOH/g	0.03	0.04	0.05.	0.05	0.06	0.08	0.09	0.09	0.09	0.10	0.10	0.10
Total sulphur %	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.95
Copper corrosion	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a
Aniline point °C	-	-	-	-	74.0	73.6	73.2	72.8	72.2	71.8	71.6	71.4
Diesel index	-	-	-	-	58	58	57	57	56	55	55	55
Gum after filtration												
Total insolubles, mg/100 ml.	0.60	0.60	0.60	0.65	0.78	0.84	0.99	1.16	1.0	1.3	1.7	2.1
Soluble in acetone-methanol	0.50	0.50	0.50	0.55	0.68	0.74	0.89	1.06	0.9	1.2	1.6	2.0
Insoluble	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

[1] Oil A was a straight-run gas oil; oil D was a catalytically-cracked gas oil.

[2] Stored at ambient temperature.

Taken from Reference No. 8

Analytical Data on Navy Dist[illegible]e Fuel A[1] Bottle Storage Samples.

Storage Time months	Physical Properties: Gravity, deg API 60/60 °F	Viscosity, cSt at 100 °F	Interfacial Tension, dyne / cm at 77 °F	Total Gum mg / 100 ml	Neutralization No., mg KOH/g	Emulsibility, 30 min. 77 °F, ml: Oil	Water	Emulsion
Fuel as Received								
0	29.2	6.1	20.0	—	1.4	35	0	45
Fuel From Bottle Storage in Florida								
3	29.2	6.1	16.3	0.9	NA[3]	26	8	46
6	29.1	6.1	15.9	1.8	NA	32	4	44
12	28.9	6.1	13.9	3.7	1.6	39	7	34
18	29.5	6.1	12.5	5.2	1.7	30	8	42
24	29.2	6.0	12.5	3.4	1.6	35	30	15
30	28.6	6.2	NC[2]	9.6	1.4	37	22	21
Fuel From Bottle Storage at Annapolis								
3	28.9	6.1	16.4	0.8	NA	28	0	52
6	29.0	6.1	16.3	0.9	NA	28	3	49
12	29.2	6.1	15.9	0.6	1.7	37	15	28
18	29.3	6.1	14.5	4.4	1.9	35	10	35
24	29.1	6.1	14.5	3.5	1.6	28	8	44
30	29.1	6.1	NC	3.5	1.5	33	15	32
Fuel From Bottle Storage in Maine								
3	29.0	6.1	16.5	1.2	NA	28	8	44
6	29.4	6.0	16.7	1.2	1.5	32	3	45
12	29.3	6.1	16.5	0.8	1.5	38	12	30
18	29.4	6.1	13.9	3.6	1.5	30	10	40
24	NA[3]	6.1	14.6	1.0	1.5	38	12	30
30	29.4	6.1	15.0	2.9	1.4	33	12	35

[1] Fuel meeting Military Specifications MIL-F-24376 or MIL-F-24397
[2] NC = not completed.
[3] NA = not available.

Taken from Reference No. 140

TABLE 140

Analytical Data on Fuel B[1] Bottle Storage Samples.

Storage Time months	Physical Properties: Gravity, deg API 60/60 °F	Physical Properties: Viscosity, cSt at 100 °F	Physical Properties: Interfacial Tension, dyne / cm at 77 °F	Total Gum mg / 100 ml	Neutralization No., mg KOH/g	Emulsibility, 30 min., 77 °F, ml: Oil	Emulsibility, 30 min., 77 °F, ml: Water	Emulsibility, 30 min., 77 °F, ml: Emulsion
				Fuel as Received				
0	21.5	2.8	31.3	---	0.03	41	39	0
				Fuel From Bottle Storage in Florida				
3	21.4	2.8	31.0	1.1	NA[3]	38	42	0
6	21.6	2.8	29.5	1.9	0.02	41	38	1
12	21.5	2.8	28.0	2.5	0.01	40	39	1
18	21.3	2.8	24.4	2.8	0.06	41	39	0
24	21.4	2.8	24.3	3.0	0.03	40	40	0
30	21.7	2.8	NC[2]	4.0	0.00	41	39	0
				Fuel From Bottle Storage at Annapolis				
3	21.0	2.8	29.3	2.8	NA	41	39	0
6	21.4	2.8	30.4	1.7	NA	41	32	7
12	21.5	2.8	30.2	1.2	0.02	41	39	0
18	21.3	2.8	26.9	2.2	0.06	41	39	0
24	21.3	2.8	27.3	2.0	0.01	40	33	7
30	21.2	2.8	NC	2.2	0.03	43	37	0
				Fuel From Bottle Storage in Maine				
3	21.4	2.8	31.1	0.9	NA	41	39	0
6	21.6	2.8	30.9	1.3	0.02	42	34	4
12	21.6	2.8	30.6	1.4	0.02	41	39	0
18	21.7	2.8	27.6	1.9	0.02	41	39	0
24	21.1	2.8	30.9	2.4	0.02	40	40	0
30	21.2	2.8	26.5	2.3	0.00	42	38	0

[1] Light catalytic cycle stock.
[2] NC = not completed.
[3] NA = not available.

Take m Reference No. 140

TABLE 141

Analytical Data on Navy Distillate Fuel C[1] Bottle Storage Samples.

Storage Time months	Physical Properties: Gravity, deg API 60/60 °F	Physical Properties: Viscosity, cSt at 100 °F	Physical Properties: Interfacial Tension, dyne / cm at 77 °F	Total Gum mg / 100 ml	Neutralization No., mg KOH/g	Emulsibility, 30 min., 77 °F, ml: Oil	Emulsibility, 30 min., 77 °F, ml: Water	Emulsibility, 30 min., 77 °F, ml: Emulsion
				Fuel as Received				
0	30.4	6.0	21.5	NA[4]	0.9	41	39	0
				Fuel From Bottle Storage in Florida				
3	31.1	6.1	20.0	1.7	0.9	40	40	0
6	30.7	6.1	16.5	1.0	NA[4]	40	40	0
12	30.9	6.1	17.6	2.4	0.9	41	39	0
18	31.0	6.1	16.9	7.4	0.9	40	40	0
24	30.8	6.2	NC[3]	4.6	0.8	40	40	0
				Fuel From Bottle Storage at Annapolis				
3	30.9	6.1	20.1	0.5	0.9	41	39	0
6	30.9	6.1	20.1	1.2	0.9	40	39	1
12	31.2	6.1	18.5	1.8	0.9	40	40	0
18	30.4	6.2	17.8	1.8	0.8	40	40	0
24	31.2	6.1	17.4	2.4	0.8	41	39	0
				Fuel From Bottle Storage in Maine				
3	31.2	6.1	20.1	1.2	1.0	40	40	0
6	31.1	6.1	17.7	0.8	0.9	NA[4]	NA[4]	NA[4]
12	SL[2]	---	---	---	---	---	---	---
18	SL	---	---	---	---	---	---	---
24	31.0	6.0	NC	2.0	0.8	40	40	0

[1] Fuel meeting Military Spec. MIL-F-24376 or MIL-F-24397.
[2] SL = sample lost in transit.
[3] NC = not yet completed.
[4] NA = not available.

Taken from Reference No. 140

TABLE 142

Analytical Data on Navy Distillate Fuel D[1] Bottle Storage Samples.

Storage Time months	Physical Properties: Gravity, deg API 60/60 °F	Physical Properties: Viscosity, cSt at 100 °F	Physical Properties: Interfacial Tension, dyne / cm at 77 °F	Total Gum, mg / 100 ml	Neutralization No., mg KOH/g	Emulsibility, 30 min., 77 °F, ml: Oil	Emulsibility, 30 min., 77 °F, ml: Water	Emulsibility, 30 min., 77 °F, ml: Emulsion
				Fuel as Received				
0	31.6	4.8	22.1	NA[4]	0.1	41	39	0
				Fuel From Bottle Storage in Florida				
3	32.0	4.8	21.1	0.8	0.1	39	41	0
6	32.0	4.8	18.6	1.9	NA[4]	40	40	0
12	31.8	4.8	21.0	0.4	0.1	40	40	0
18	31.7	4.7	20.2	0.6	0.1	40	40	0
24	32.1	4.8	NC[3]	1.0	0.1	41	39	0
				Fuel From Bottle Storage at Annapolis				
3	32.0	4.8	21.8	0.5	0.1	40	40	0
6	31.8	4.8	21.8	1.0	0.1	41	39	0
12	32.3	4.8	22.1	0.4	0.1	40	40	0
18	31.9	4.9	21.0	0.4	0.1	40	40	0
24	32.2	4.8	21.5	0.6	0.1	41	39	0
				Fuel From Bottle Storage in Maine				
3	31.7	4.8	22.1	0.3	0.1	41	39	0
6	31.8	4.8	20.7	0.8	0.1	NA[4]	NA[4]	NA[4]
12	32.0	4.8	NA[4]	0.8	0.1	41	39	0
18	SL[2]	---	---	---	---	---	---	---
24	32.1	4.9	NC	1.3	0.1	40	40	0

[1] Fuel meeting Military Spec. MIL-F-24376 or MIL-F-24397.
[2] SL = sample lost in transit.
[3] NC = not yet completed.
[4] NA = not available.

Taken from Reference No. 140

TABLE 143

Analytical Data on Navy Distillate Fuels from Can Storage

Storage Time months	Physical Properties: Gravity, deg API 60/60 °F	Viscosity, cSt at 100 °F	Interfacial Tension, dyne / cm at 77 °F	Total Gum mg / 100 ml	Neutralization No., mg KOH/g	Emulsibility, 30 min., 77 °F, ml: Fuel	Water	Emulsion
				Fuel A[1]				
6	29.0	6.1	16.1	2.8	NA[3]	36	5	39
12	29.3	6.1	16.2	2.0	1.6	36	1	43
24	28.9	6.1	13.6	1.9	1.5	38	3	39
				Fuel B[2]				
6	21.4	2.8	28.6	3.4	NA	41	39	0
12	21.3	2.8	28.5	4.1	0.02	41	39	0
24	21.6	2.8	27.7	1.8	0.05	41	38	1

[1] Navy distillate fuel meeting Military Spec. MIL-F-24376 or MIL-F-24397.
[2] Light catalytic cycle stock.
[3] NA = not available.

Taken from Reference No. 140

TABLE 144

Analytical Data on Navy Distillate Fuels from 43.3 °C (110 °F) Beaker Tests.

Storage Time months	Physical Properties: Gravity, deg API 60/60 °F	Physical Properties: Viscosity, cSt at 100 °F	Physical Properties: Interfacial Tension, dyne / cm at 77 °F	Total Gum mg / 100 ml	Neutralization No., mg KOH/g	Emulsibility, 30 min., 77 °F, ml: Oil	Emulsibility, 30 min., 77 °F, ml: Water	Emulsibility, 30 min., 77 °F, ml: Emulsion
				Fuel A[1]				
0	29.2	6.1	20.0	NA[3]	1.4	35	0	45
12	29.3	6.0	13.3	1.3	NA	40	5	35
24	28.5	7.3	12.1	1.7	NA	38	2	40
36	27.7	7.4	6.4	3.9	1.7	40	0	40
				Fuel B[2]				
0	21.5	2.8	31.3	NA	0.03	41	39	0
12	21.6	2.8	26.5	2.6	NA	40	39	1
24	21.4	2.8	23.6	4.4	NA	40	39	1
36	21.5	2.8	21.8	4.2	0.03	41	38	1
				Fuel C[1]				
0	30.4	6.0	21.5	NA	0.9	41	39	0
12	31.5	5.4	16.7	2.8	0.9	41	39	0
24	30.5	6.8	11.6	3.7	0.9	39	41	0
36	30.3	6.4	10.9	4.5	1.0	39	41	0
				Fuel D[1]				
0	31.6	4.8	22.1	NA	0.1	41	39	0
12	31.3	5.0	16.8	0.6	0.1	41	39	0
24	31.4	4.9	12.7	0.9	0.1	41	39	0
36	31.6	5.1	12.4	0.9	0.1	41	39	0

[1] Navy distillate fuel meeting Military Spec. MIL-F-24376 or MIL-F-24397.
[2] Light catalytic cycle stock.
[3] NA = Not available.

Taken from Reference No. 140

TABLE 145

Effect of Storage On Thermal Oxidation Stability Of Coal Derived Fuels

Sample[1] Number	Constituent Added to fuel	Breakpoint temperature, °C (°F)[2] Before storage		After storage[3]	
1	-	257	(495)	282	(540)
	Black Iron	257	(495)	>277	(530)
	Oxidation Inhibitor	257	(495)	>277	(530)
	Oxidation Inhibitor/ Black Iron	257	(495)	>291	(555)
2	-	263	(505)	260	(500)
	Black Iron	263	(505)	263	(505)
	Oxidation Inhibitor	263	(505)	285	(545)
	Oxidation Inhibitor/ Black Iron	263	(505)	>288	(550)
3	-	>371	(700)	>371	(700)
	Black Iron	>371	(700)	>371	(700)
	Oxidation Inhibitor	>371	(700)	>371	(700)
	Oxidation Inhibitor/ Black Iron	>371	(700)	>371	(700)
4	-	368	(695)	>371	(700)
	Black Iron	368	(695)	371	(700)
	Oxidation Inhibitor	368	(695)	371	(700)
	Oxidation Inhibitor/ Black Iron	368	(695)	>366	(690)

[1]Liquids produced by COED process.
Sample 1: From Kentucky coal, high aromatic content
Sample 2: From Utah coal, high aromatic content
Sample 3: From Kentucky coal, low aromatic content
Sample 4: From Utah coal, low aromatic content
[2]JFTOT Test
[3]Stored 26 weeks at 43.3° C (110 °F)

Taken from Reference No. 82

TABLE 146

Effect of Storage on Existent Gum Formation of Coal Derived Fuels

Sample[1] Number	Constituent added to fuel	Gum, mg / 100 ml		
		Before Storage	After Storage[2]	Change
1	---	0.0	0.6	+ 0.6
	Black Iron	0.0	0.2	+ 0.2
	Oxidation Inhibitor	0.0	0.0	0.0
	Oxidation Inhibitor/Black Iron	0.0	0.4	+ 0.4
2	---	0.1	2.6	+ 2.5
	Black Iron	0.1	10.3	+ 10.2
	Oxidation Inhibitor	0.1	0.0	- 0.1
	Oxidation Inhibitor/Black Iron	1.0	0.8	+ 0.7
3	---	0.0	1.8	+ 1.8
	Black Iron	0.0	0.1	+ 0.1
	Oxidation Inhibitor	0.0	0.1	+ 0.1
	Oxidation Inhibitor/Black Iron	0.0	1.3	+ 1.3
4	---	0.1	1.2	+ 1.1
	Black Iron	0.1	0.9	+ 0.8
	Oxidation Inhibitor	0.1	0.0	-0.1
	Oxidation Inhibitor/Black Iron	0.1	1.6	+ 1.5

[1]Liquids produced by COED process.
Sample 1: From Kentucky coal, high aromatic content
Sample 2: From Utah coal, high aromatic content
Sample 3: From Kentucky coal, low aromatic content
Sample 4: From Utah coal, low aromatic content
[2]Stored 26 weeks at 43.3 °C (110 °F)

Taken from Reference No. 82

TABLE 147

Solvent Analysis of Aged SYNTHOIL Coal Liquids

	Yield, Percent by Weight			
	Oil	Asphaltene	Benzene Insol.	Ash
Original[1]	73	20	7	3
N_2 Storage[2]	75	18	7	3
O_2 Storage[3]	62	20	18	3

[1] Original unaged sample
[2] Aged in nitrogen atmosphere 35 days at 61 °C.
[3] Aged in oxygen atmosphere 28 days at 61 °C.

Taken from Reference No. 58

TABLE 148

Accelerated Storage Test of Petroleum and Alternative Fuels: 16 hours at 93.3° C (200° F)[1]

	SASOL gasoline	Tar Sands naphtha	Regular leaded gasoline	Unleaded gasoline	Petroleum JP-5	Shale JP-5	Tar Sands JP-5	COED JP-5	Shale Jet A #4	Shale Jet A #23	Shale Jet A #10
Soluble gum	37.6	13.6	9.8	10.0	0.6	3.6	2.0	1.8	1.8	0.6	1.2
Insoluble gum	0.4	0.4	0.6	0.6	0.4	1.3	0.7	0.4	0.2	0.9	1.4
Total gum	38.0	14.0	10.4	10.6	1.0	4.9	2.7	2.2	2.0	1.5	2.6
Inorganic residue	0.1	0.1	1.3	0.1	0.1	0	0.1	0.1	0.2	0.1	0.1
Oxygen, percent (in ullage)	20.9	21.0	18.7	18.3	20.2	19.9	20.2	13.7	20.6	20.8	20.2
Predicted gum after 32 weeks storage at 110° F	21.6	3.6	11.6	13.9	1.8	5.7	3.2	3.9	3.2	2.5	3.8
Measured gum after 32 weeks storage at 110° F	35.8	20.7	6.4	10.9	2.6	6.4	26.0	27.9	116.5	1.8	2.1

[1]Gum data presented as mg gum/100 ml fuel.

Taken from Reference No. 20

TABLE 149

Storage Stability Test Results for Fuels from Petroleum, Coal, Shale, and Tar Sands[1]

		4 Weeks				8 Weeks				16 Weeks				32 Weeks			
Description	Initial Total gum	Inorg. residue	Fuel Insol. gum	Soluble gum	Total gum	Inorg. residue	Fuel Insol. gum	Soluble gum	Total gum	Inorg. residue	Fuel Insol. gum	Soluble gum	Total gum	Inorg. residue	Fuel Insol. gum	Soluble gum	Total gum
SASOL gasoline	19.6	0.1	0.3	19.0	19.3	0.1	0.5	19.2	19.7	0	0.2	21.2	21.4	2.5	2.2	33.6	35.8
Tar Sands naphtha	2.3	0.1	0.5	0.8	1.3	0.1	1.2	2.9	4.1	0.3	0.5	5.9	6.3	0.3	1.2	19.5	20.7
Commercial regular Gasoline - leaded	2.3	0	0.5	1.5	2.0	0	0.7	3.9	4.6	0.2	0.3	4.2	4.5	0.2	1.0	5.4	6.4
Commercial unleaded Gasoline	4.0	0	0.6	2.3	2.9	0.1	0.4	4.2	4.6	0.1	0.4	4.0	4.4	0	1.4	9.5	10.9
Petroleum based JP-5	0.3	0.1	1.4	0.6	2.0	0	0.5	1.7	2.2	0.02	0.7	0.5	1.2	0	0.9	1.7	2.6
Paraho Shale Oil JP-5	4.1	0	0.7	2.9	3.6	0	0.6	2.7	3.5	0.2	1.7	3.4	5.1	0	1.7	4.7	6.4
Tar Sands JP-5	1.6	0.1	0.1	0.9	1.0	0.2	0.3	1.9	2.2	0.1	1.8	7.3	8.3	0	1.8	25.0	26.0
COED coal liquid JP-5	2.0	0	0.4	2.4	2.8	0.1	0.4	1.6	2.0	0.2	0.9	2.6	3.5	0.3	2.9	25.0	27.9
Paraho Shale Oil Jet A #4	2.5	0.1	0.1	1.9	2.0	0.1	0.4	3.4	3.9	0.04	0.4	4.4	4.8	0	0.1	116.4	116.5
Paraho Shale Oil Jet A #23	2.7	0	0.6	3.3	3.9	0.04	0.2	4.4	4.6	0.04	0.4	1.8	2.2	0	0.2	1.6	1.8
Paraho Shale Oil Jet A#10	3.1	0.04	0.1	1.5	1.6	0.1	0.4	2.0	2.4	0.04	0.2	1.6	1.8	0	0.3	1.8	2.1

[1] Aged at 43.3 ° C (110 °F); Data presented as mg/100 ml fuel.

Taken from Reference No. 20

TABLE 150

Analysis of Aged CLP[1] Samples

Sample	Oil	Asphal.	Benzene Insol.	Total Oxygen, Wt. %	Phenolic Oxygen, Wt. %	Non-Phenolic Oxygen, Wt. % (By Difference)
CLP before aging	70	23	7	3.11	1.8	1.3
CLP after aging Under O_2 [2]	55	25	20	3.62	1.4	2.2
CLP after aging Under N_2 [3]	67	26	7	3.19	1.7	1.5

[1]Centrifuged liquid product from PETC coal liquefaction unit

[2]Aged 30 days at 90 °C in oxygen atmosphere

[3]Aged 30 days at 90 °C in nitrogen atmosphere

Taken from Reference No. 35

TABLE 151

ESR Analysis of Aged Coal Liquids

Sample	Spin Conc. (spins/g)	g-Value (gauss)
1. CLP Asphaltene[1] before aging	2.9×10^{18}	2.0032_2
CLP Asphaltene after O_2 aging	3.4×10^{18}	2.0033_4
CLP Asphaltene after N_2 aging	4.1×10^{18}	2.0032_2
11. Dialyzate[2] Asphaltene before aging	4.1×10^{19}	2.0029_3
Dialyzate Asphaltene after O_2 aging	6.1×10^{19}	2.0030_9
Dialyzate Benzene Insols after aging	3.3×10^{19}	2.0031_1

[1] Asphaltenes separated from the centrifuged liquids product produced in PETC coal liquefaction unit.

[2] A dialyzed heavy liquid which contained both oils and asphaltenes but was free of benzene insolubles.

Taken from Reference No. 35

TABLE 152

Storage Stability Tests on Alternative Fuels at 43.3 °C (110 °F)

Description	Sediment, mg/100 ml											
		4 Weeks			8 Weeks			16 Weeks			32 Weeks		
	Initial	Soluble gum	Insol. gum	Prec.	Soluble gum	Insol. gum	Prec.	Soluble gum	Insol. gum	Prec.	Soluble gum	Insol. gum	Prec.
Illinois No. 6 Coal-Naphtha	145	A - 318[1] B - 314[1]	0.9	2.7	A - 602 B - 397	1.8	6.1	A - 663 B - 490	2.3	5.0	A - 913 B - 829	54.9	12.1
Wyodak Coal-Naphtha	258	A - 501 B - 509	1.2	3.4	A - 985 B - 616	5.8	5.4	A - 955 B - 989	7.0	4.0	A - 1044 B - 1025	35.6	6.4
JP-8 from Paraho II Shale Oil	0.4	A - 1.2 B - 1.2	0.7	0.1	A - 0.9 B - 0.9	0.6	0.1	A - 1.1 B - 1.0	1.0	0.2	A - 1.7 B - 1.7	2.3	0.3
JP-5 from Paraho II Shale Oil	0	A - 0 B - 0	0.5	0.1	A - 0 B - 0	0.4	0.1	A - 0 B - 0	0.7	0.6	A - 0 B - 0	0.8	0.2
DFM from Paraho II Shale Oil	0	A - 0 B - 0	0.6	0.6	A - 0.6 B - 0.5	0.9	1.0	A - 0 B - 0	0.9	1.0	A - 0.5 B - 1.2	1.4	1.0
Petroleum Based JP-5	0.3	0.6	1.4	0.1	1.7	0.5	0	0.5	0.7	0.02	2.6	1.7	0.9

[1] A and B are values obtained for duplicate bottles. The insoluble gum and precipitate values for bottles A and B are combined into one.

Taken from Reference No. 9

TABLE 153

Dissolved Oxygen and Peroxide Numbers in Fuels Stored at 43.3 °C (110 °F)

Description	Initial		4 Weeks		8 Weeks		16 Weeks		32 Weeks	
	Dissolved O_2, ppm	Peroxide Number[1]	Dissolved O_2, ppm	Peroxide Number[1]	Dissolved O_2, ppm	Peroxide Number[1]	Dissolved O_2, ppm	Peroxide Number[1]	Dissolved O_2, ppm	Peroxide Number[1]
Illinois No. 6 Coal - Naphtha	38	0.5	59	[2]	61	[2]	56	[2]	62	[2]
Wyodak Coal - Naphtha	40	1.3	51	[2]	60	[2]	63	[2]	52	[2]
JP-8 from Paraho II Shale Oil	69	0	67	0	67	0.14	[3]	[3]	45	0.24
JP-5 from Paraho II Shale Oil	72	0	69	0	60	0.06	85	0.12	42	0.16
DFM from Paraho II Shale Oil	54	0	52	0	52	0.33	46	0.35	34	0.39

[1] Peroxide number is defined as the gram-equivalent of active oxygen in 1000 liters of fuel.
[2] Too dark
[3] Sample lost

Taken from Reference No. 9

.BLE 154

Thermal Oxidation Stability (JFTOT) Data for Shale-Derived Fuels Before and After 32 Weeks of Storage at 43 °C (110 °F)

JFTOT at 260 °C	JP-8	JP-5	DFM
As Received			
ΔP, mm Hg	0	0	0
Tube rating, visual	2	1	3
Tube Deposit Rating, spun	10.0	2.0	11.5
Tube Deposit Rating, spot	12.0	8.0	14.0
After 32 weeks at 43 °C			
ΔP, mm Hg	0	0	0
Tube rating, visual	2	1	1
Tube Deposit Rating, spun	2	4	7
Tube Deposit Rating, spot	7.5	6	14

Taken from Reference No. 9

Table 155

Solvent Analysis Data for Coal-derived Liquids[1] Aged at 61 °C Under Different Gaseous Environments.

		Yield (wt %)				
Sample	Aging time (Days)	Oil	Asphaltenes	Organic benzene-insolubles	Increase in organic benzene-insolubles	Increase in viscosity
Unaged	0	73	20	4	---	---
N_2-aged	35	75	18	4	0	3x
Air-aged	35	67	21	11.5	7.5	6x
O_2-aged	28	62	19	15	11	120x

[1]Coal liquid produced from Kentucky coal in the process development unit at the DOE Pittsburgh Energy Technology Center.

Taken from Reference No. 22

TABLE 156

Results of Storage Stability Tests of Treated Shale-I JP-5[1]

Experiment No.	N-Additive, ppm[3]	Inhibitor,[2] ppm	Storage Results					
			Existent Gums, mg/100 ml		Peroxide, meq/kg		JFTOT 260 °C, Max TDR	
			Before	After	Before	After	Before	After
1	0	0	0	0	0.14	60	1	10
2	8.4	0	0	1.4	1.4	64.3	9	13
3	25	0	0	5.4	1.0	96.8	4	27
4	125	0	0	1.6	0.2	42.5	5	48
5	0[4]	25-DA	0	0	0	1.0	0	2
6	39[4]	25-DA	0	0	0	0.6	0	2
7	123[4]	25-DA	0	0	0.1	0.1	5	13
8	0	24-HP	0	0	0.7	0.7	4	9
9	5-ethyl-2-methylpyridine, 50	0	0	5	0.6	83	4	35
10	5-ethyl-2-methylpyridine, 50	24-HP	0	0	0.6	0.6	0	0
11	2,5-dimethylpyrrole, 50	0	0	0.4	0.09	4.2	25	25
12	2,5-dimethylpyrrole, 50	24-HP	0	0.6	0.07	0.5	26	25

[1] Shale-I JP-5 containing 976 ppm nitrogen was first acid extracted then treated with silica gel to yield a nitrogen-free fuel. Conditions of storage: temp = 60° C; time = 4 weeks; no agitation; air allowed to freely diffuse into fuel.

[2] Antioxidants used were commercial products qualified for Navy fuel use; DA=phenylene diamine (1,4-diamino benzene); HP = hindered phenol (2,6-di-tert-butyl-4-methylphenol).

[3] Acid extracted nitrogen compounds added to nitrogen-free Shale-I JP-5 to bring nitrogen content to designated level.

[4] Corrected for antioxidant nitrogen content.

Taken from Reference No. 84