Lampiran 1.

Material Factor and Properties

Lampiran 1. Material Factor (MF)

Compound	MF	Hc BTU/lb. x10[-3]	NFPA Classification			Flash Point ° F	Boiling Point ° F
			N_h	N_f	N_r		
Acetaldehyde	24	10.5	2	4	2	-38	70
Acetic Acid	14	5.6	2	2	1	103	245
Acetic Anhydride	24	7.1	2	2	1	129	284
Acetone	16	12.3	1	3	0	-4	133
Acetone Cyanohydrin	24	11.2	4	1	2	165	248
Acetonitrile	24	12.6	2	3	0	42	179
Acetyl Chloride	24	2.5	3	3	2	40	124
Acetylene	40	20.7	1	4	3	Gas	-118
Acetyl Ethanolamine	14	9.4	1	1	1	355	305
Acetyl Peroxide	40	8.4	1	2	4	—	[4]
Acetyl Salicylic Acid	—	8.9	1	1	0	—	—
Acetyl Tributyl Citrate	4	10.9	—	1	0	400	343[5]
Acrolein	24	11.8	3	3	2	-15	125
Acrylamide	14	9.5	2	1	1	—	257[5]
Acrylic Acid	24	7.6	3	2	2	122	287
Acrylonitrile	24	13.7	4	3	2	32	171
Allyl Alcohol	16	13.7	3	3	0	70	206
Allylamine	16	15.4	3	3	1	-20	128
Allyl Bromide	16	5.9	3	3	1	30	160
Allyl Chloride	29	9.7	3	3	1	-25	113
Allyl Ether	24	16.0	3	3	2	20	203
Aluminum Chloride	24	[2]	3	0	2	—	[3]
Ammonia	4	8.0	3	1	0	Gas	-28
Ammonium Nitrate	29	12.4[7]	2	0	3	—	410
Amyl Acetate	16	14.6	1	3	0	60	300
Amylacetate	16	14.4	1	3	0	77	300
Amyl Nitrate	24	11.5	2	2	0	118	306-315
Aniline	14	15.0	3	2	0	158	364
Barium Chlorate	24	[2]	0	1	2	—	—
Barium Stearate	4	8.9	0	1	0	—	—
Benzaldehyde	24	13.7	2	2	0	145	355
Benzene	16	17.3	2	3	0	12	176
Benzoic Acid	4	11.0	2	1	0	250	482
Benzyl Acetate	4	12.3	1	1	0	196	417
Benzyl Alcohol	4	13.6	2	1	0	200	403
Benzyl Chloride	14	12.6	2	2	1	153	354
Benzyl Peroxide	40	12.0	1	3	4	—	—
Bisphenol A	14	14.1	2	1	1	175	428
Bromine	1	0.0	4	0	0	—	—
Bromobenzene	14	8.1	2	2	0	124	313
o-Bromotoluene	10	8.5	2	2	0	174	359
1,3-Butadiene	24	19.2	2	4	2	Gas	24
Butane	21	19.7	1	4	0	Gas	31
Butanol (n-butyl alcohol)	16	14.3	1	3	0	84	243
1-Butene	21	19.5	1	4	0	Gas	21
Butyl Acetate	16	12.2	1	3	0	72	260
Butyl Acrylate	24	14.2	2	2	2	118	293
n-Butylamine	16	16.3	2	3	0	10	172
Butyl Bromide	16	7.6	2	3	0	65	215
Butyl Chloride	16	11.4	2	3	0	15	170

Compound	MF	Hc BTU/lb. x10⁻³	NFPA Classification			Flash Point ° F	Boiling Point ° F
			N_h	N_f	N_r		
2,3-Butylene Oxide	24	14.3	2	3	2	5	149
Butyl Ether	16	16.3	2	3	0	77	286
t-Butyl Hydroperoxide	40	11.9	1	4	4	80	—
Butyl Nitrate	29	11.1	1	3	3	97	277
t-Butyl Peracetate	40	10.6	2	3	4	<80	[4]
t-Butyl Perbenzoate	40	12.2	1	3	4	>190	[4]
t-Butyl Peroxide	29	14.5	1	3	3	64	176
Calcium Carbide	24	9.1	1	1	2	—	—
Calcium-Stearate[6]	4	—	0	1	0	—	—
Carbon Disulfide	16	6.1	2	3	0	-22	115
Carbon Monoxide	16	4.3	2	4	0	Gas	-314
Chlorine	1	0.0	3	0	0	—	—
Chlorine Dioxide	40	0.7	3	1	4	—	—
Chloroacetyl Chloride	14	2.5	3	0	1	—	222
Chlorobenzene	16	10.9	2	3	0	82	270
Chloroform	1	1.5	2	0	0	—	142
Chloro Methyl Ethyl Ether	14	5.7	2	1	1	—	—
1-Chloro 1-Nitroethane	40	3.53	—	2	3	133	344
o-Chlorophenol	10	9.2	3	2	0	147	347
Chloropicrin	29	5.8[7]	4	0	3	—	234
Chloropropane	21	10.1	2	4	0	-26	95
Chlorostyrene	24	12.5	2	1	2	—	—
Coumarin	24	12.0	2	1	2	—	554
Cumene	10	18.0	2	3	0	96	306
Cumene Hydroperoxide	40	13.7	1	2	4	175	[4]
Cyanamide	29	7.0	4	1	3	286	500
Cyclobutane	21	19.1	1	4	0	Gas	55
Cyclohexane	16	18.7	1	3	0	-4	179
Cyclohexanol	4	15.0	1	2	0	154	322
Cyclopropane	21	21.3	1	4	0	Gas	-29
DER[7] 331	14	13.7	—	—	—	485	878
Dichlorobenzene	14	8.1	2	2	0	151	356
1,2-Dichloroethylene	24	6.9	2	3	2	36	119
1,3-Dichloropropene	16	6.0	2	3	0	95	219
2,3-Dichloropropene	16	5.9	3	3	0	59	201
3,5-Dichloro Salicylic Acid	24	5.3	0	1	2	—	—
Dichlorostyrene	24	9.3	2	1	2	225	—
Dicumyl Peroxide	29	15.4	0	1	3	—	—
Dicyclopentadiene	24	17.9	1	3	2	90	342
Diesel Fuel	10	18.7	0	2	0	100-130	315
Diethanolamine	14	10.0	1	1	0	342	514
Diethylamine	16	16.5	2	3	0	-9	134
m-Diethyl Benzene	10	18.0	2	2	0	133	358
Diethyl Carbonate	16	9.1	2	3	1	77	259
Diethylene Glycol	4	8.7	1	1	0	255	472
Diethyl Ether	21	14.5	2	4	1	-49	95
Diethyl Peroxide	40	12.2	—	4	4	[4]	[4]
Diisobutylene	16	19.0	1	3	0	23	214
Diisopropyl Benzene	4	17.9	0	2	0	170	401
Dimethyl Amine	21	15.2	3	4	0	Gas	45

[7] TRADEMARK OF THE DOW CHEMICAL COMPANY

Compound	MF	Hc BTU/lb. x10^{-3}	NFPA Classification			Flash Point ° F	Boiling Point ° F
			N_h	N_f	N_r		
2,2-Dimethyl Propanol	16	14.8	2	3	0	98	237
Dinitrobenzene	40	7.2	3	1	4	302	604
2,4-Dinitro Phenol	40	6.1	3	1	4	—	—
1,4-Dioxane	16	10.5	2	3	1	54	214
Dioxolane	24	9.1	2	3	2	35	165
Diphenyl Oxide	14	14.9	1	1	0	259	449
Dipropylene Glycol	4	10.8	0	1	0	280	449
Di-tert-Butyl Peroxide	40	14.5	3	2	4	70	—
Divinyl Acetylene	29	18.2	—	3	3	-4	183
Divinylbenzene	24	17.4	2	2	2	169	392
Divinyl Ether	24	14.5	2	3	2	-22	102
DOWANOL* PM	16	11.1	0	3	0	94	248
DOWICIL* 75	24	7.0	2	2	2	—	—
DOWICIL 200	24	9.3	2	2	2	—	—
DOWTHERM* A	4	15.5	1	1	0	255	495
DOWTHERM G	4	15.5	1	1	0	305	575
DOWTHERM J	10	17.6	1	2	0	145	358
DOWTHERM HT	4	—	1	1	0	355	650
DOWTHERM LF	4	16.0	1	1	0	260	507
DURSBAN*	14	19.8	1	2	1	81-110	—
Epichlorohydrin	24	7.2	3	2	2	88	239
Ethane	21	20.4	1	4	0	Gas	-128
Ethanolamine	4	9.5	2	2	0	185	342
Ethyl Acetate	16	10.1	1	3	0	24	171
Ethyl Acrylate	24	11.0	2	3	2	50	211
Ethyl Alcohol	16	11.5	0	3	0	55	173
Ethylamine	21	16.3	3	4	0	0	62
Ethyl Benzene	16	17.6	2	3	0	70	277
Ethyl Benzoate	4	12.2	1	1	0	190	414
Ethyl Bromide	21	5.6	2	1	0	—	100
Ethylbutylamine	16	17.0	3	3	0	64	232
Ethyl Butylcarbonate	14	10.6	2	2	1	122	275
Ethyl Butyrate	16	12.2	0	3	0	75	248
Ethyl Chloride	21	8.2	2	4	0	-58	54
Ethyl Chloroformate	16	5.2	1	3	1	61	201
Ethylene	24	20.8	1	4	2	Gas	-155
Ethylene Carbonate	14	5.3	2	1	1	290	351
Ethylenediamine	10	12.4	3	2	0	104	241
Ethylene Dichloride	16	4.6	2	3	0	56	183
Ethylene Glycol	4	7.3	1	1	0	232	387
Ethlene Glycol Dimethyl Ether	16	11.6	2	3	0	29	174
Ethylene Glycol Monoacetate	4	8.0	0	1	0	215	357
Ethylenimine	29	13.0	3	3	2	-20	132
Ethylene Oxide	29	11.7	2	4	3	0	51
Ethyl Ether	21	14.4	2	4	1	-49	95
Ethyl Formate	16	8.7	2	3	0	-4	130
2-Ethylhexanal	14	16.2	2	2	1	112	325
1,1-Ethylidene Dichloride	16	4.5	2	3	0	22	138
Ethyl Mercaptan	21	12.7	2	4	0	0	95
Ethyl Nitrate	40	6.4	2	3	4	50	190

*TRADEMARK OF THE DOW CHEMICAL COMPANY

Compound	MF	Hc BTU/lb. x10⁻³	NFPA Classification			Flash Point ° F	Boiling Point ° F
			N_h	N_f	N_r		
Ethyl Propyl Ether	16	15.2	1	3	0	< -4	147
p-Ethyl Toluene	10	17.7	—	2	0	108	324
Fluorine	29	—	4	0	3	—	-310
Fluorobenzene	24	13.4	—	3	0	5	185
Formaldehyde	24	8.0	2	4	0	Gas	-3
Formic Acid	4	3.0	3	2	0	156	213
Fuel Oil #1 to #6	10	18.7	0	2	0	100-150	304-574
Furan	21	12.6	1	4	1	32	88
Gasoline	16	18.8	1	3	0	-45	100-400
Glycerine	4	6.9	1	1	0	390	554
Glycolonitrile	14	7.6	1	1	1	—	—
Heptane	16	19.2	1	3	0	25	209
Hexachlorobutadiene	14	2.0	2	1	1	—	410
Hexachloro Diphenyl Oxide	29	5.5	2	1	1	—	446°
Hexanal	16	15.5	2	3	1	90	268
Hexane	16	19.2	1	3	0	-7	156
Hydrazine (anhydrous)	24	7.7	3	3	2	100	236
Hydrogen	21	51.6	0	4	0	Gas	-422
Hydrogen Cyanide	29	10.3	4	4	2	0	79
Hydrogen Peroxide (35%)	24	⁴	2	0	2	—	—
Hydrogen Sulfide	21	6.5	3	4	0	Gas	-76
Hydroxylamine	29	3.2	1	3	3	⁴	158
Hydroxy Ethyl Acrylate	14	8.9	2	1	2	154	375
Hydroxy Propyl Acrylate	14	10.4	2	1	2	149	375
Isobutane	21	19.4	1	4	0	Gas	11
Isobutyl Alcohol	16	14.2	1	3	0	82	225
Isobutylamine	16	16.2	2	3	0	15	150
Isobutylchloride	16	11.4	2	3	0	< 70	156
Isopentane	21	21.0	1	4	0	< -60	82
Isoprene	21	18.9	2	4	1	-65	93
Isopropanol	16	13.1	1	3	0	53	181
Isopropenyl Acetylene	24	—	2	4	2	< 19	92
Isopropyl Acetate	16	11.2	1	3	0	35	194
Isopropylamine	21	15.5	3	4	0	-35	89
Isopropyl Chloride	21	10.0	2	4	0	-28	95
Isopropyl Ether	16	15.6	2	3	1	-18	156
Jet Fuel A & A-1	10	21.7	0	2	0	110-150	—
Jet Fuel B	16	21.7	1	3	0	-10 to + 30	—
Kerosene	10	19.8	0	2	0	100-162	304-574
Lauryl Bromide	4	12.9	1	1	0	291	356
Lauryl Mercaptan	4	16.8	2	1	0	262	289
LORSBAN* 4E	14	3.0	1	2	1	85	165
Lauryl Peroxide	40	15.0	0	1	4	—	—
Lube Oil	4	19.0	0	1	0	350-400	—
Magnesium	14	10.6	0	1	1	—	—
Maleic Anhydride	14	5.9	3	1	1	218	396
Methacrylic Acid	24	9.3	3	2	2	171	316
Methane	21	21.5	1	4	0	Gas	-259
Methyl Acetate	16	8.5	1	3	0	14	140
Methylacetylene	40	20.0	2	4	2	Gas	-10

*TRADEMARK OF THE DOW CHEMICAL COMPANY

Compound	MF	Hc BTU/lb. x10³	NFPA Classification			Flash Point ° F	Boiling Point ° F
			N_h	N_f	N_r		
Methyl Acrylate	24	18.7	2	3	2	27	176
Methyl Alcohol	16	8.6	1	3	0	52	147
Methylamine	21	13.2	3	4	0	Gas	21
Methyl Amyl Ketone	10	15.4	1	2	0	102	302
Methyl Borate	16	—	2	3	1	<80	156
Methyl Carbonate	16	6.2	2	3	1	66	192
Methylcellulose (bag storage)	10	6.5	0	1	0	—	—
Methyl Chloride	21	5.5	2	4	0	-50	-11
Methyl Chloroacetate	14	5.1	2	2	1	135	266
Methylcyclohexane	16	19.0	2	3	0	25	214
Methyl Cyclopentadiene	14	17.4	1	2	1	120	163
Methylene Chloride	4	2.3	2	1	0	—	104
Methyl Ether	21	12.4	2	4	1	Gas	-11
Methyl Ethyl Ketone	16	13.5	1	3	0	16	176
Methyl Formate	21	6.4	2	4	0	-2	90
Methylhydrazine	24	10.9	3	3	2	17	190
Methyl Isobutyl Ketone	16	16.6	2	3	0	64	244
Methyl Mercaptan	21	10.0	2	4	0	—	42
Methyl Methacrylate	24	11.9	2	3	2	50	212
2-Methylpropenal	24	15.4	3	3	2	35	154
Methyl Vinyl Ketone	24	13.4	3	3	2	20	177
Mineral Oil	4	17.0	0	1	0	380	680
Mineral Seal Oil	4	17.6	0	1	0	275	480-680
Monethanolamine	4	9.6	2	1	0	200	338
Monochlorobenzene	16	11.3	2	3	0	82	270
Naphtha, V.M. & P, Regular	16	18.0	1	3	0	28-85	212-320
Naphthalene	14	16.7	2	2	0	174	424
Nitrobenzene	24	10.4	3	2	0	190	412
Nitrobiphenyl	14	12.7	2	1	0	290	626
Nitrichlorobenzene	29	7.8	3	1	1	261	457
Nitroethane	29	7.7	1	3	3	82	237
Nitroglycerine	40	7.8	2	2	4	a	a
Nitromethane	40	5.0	1	3	3	95	214
1-Nitropropane	29	9.7	1	3	1	96	268
p-Nitrotoluene	29	11.2	3	1	0	223	461
N-SERV*	10	15.0	2	2	1	102	300
Octane	16	20.5	0	3	0	56	258
t-Octyl Mercaptan	10	16.5	2	2	0	115	329
Oleic Acid	4	16.8	0	1	0	372	547
Pentamethylene Oxide	16	13.7	2	3	1	-4	178
Pentane	21	19.4	1	4	0	-40	97
Peracetic Acid	40	4.8	3	2	4	105	221
Perchloric Acid	29	a	3	0	3	—	397
Petroleum - Crude	16	21.3	1	3	0	20-90	—
Phenol	4	13.4	3	2	0	175	358
2-Picoline	14	15.0	2	2	0	102	262
Polyethylene	18	18.7	—	—	—	NA	NA
Polystyrene Foam	16	17.1	—	—	—	NA	NA
Polystyrene Pellets	10	—	—	—	—	NA	NA
Potassium	24	—	3	1	2	—	1418

*TRADEMARK OF THE DOW CHEMICAL COMPANY

Compound	MF	Hc BTU/lb. x10⁻³	NFPA Classification			Flash Point ° F	Boiling Point ° F
			N_h	N_f	N_r		
Potassium Chlorate	29	*	2	0	3	—	752
Potassium Nitrate	29	*	1	0	3	—	752
Potassium Perchlorate	24	*	1	0	2	—	—
Potassium Peroxide	24	*	3	0	2	—	—
Propanal	16	12.5	2	3	1	22	120
Propane	21	19.9	1	4	0	Gas	-44
1,3-Propanediamine	16	13.6	2	3	0	75	276
Propargyl Alcohol	29	12.6	3	3	3	97	239
Propargyl Bromide	40	13.6†	4	3	4	64	192
Proprionic Nitrile	16	15.0	4	3	1	36	207
Propyl Acetate	16	11.2	1	3	0	55	215
Propyl Alcohol	16	12.4	1	3	0	74	207
Propylamine	16	15.8	3	3	0	-35	120
Propylbenzene	16	17.3	2	3	0	86	319
Propylchloride	16	10.0	2	3	0	0	115
Propylene	21	19.7	1	4	1	Gas	-53
Propylene Dichloride	16	6.3	2	3	0	60	205
Propylene Glycol	4	9.3	0	1	0	210	370
Propylene Oxide	24	13.2	2	4	2	-35	94
Propyl Ether	16	15.7	1	3	0	70	194
Propyl Nitrate	29	7.4	2	4	3	68	231
Pyridine	24	5.9	2	3	0	68	239
Sodium	24	—	3	1	2	—	—
Sodium Chlorate	24	—	1	0	2	—	‡
Sodium Dichromate	14	—	1	0	1	—	‡
Sodium Hydride	24	—	3	3	2	—	‡
Sodium Hydrosulfite	24	—	3	1	2	—	‡
Sodium Perchlorate	24	—	2	0	2	—	‡
Sodium Peroxide	24	—	3	0	2	—	‡
Stearic Acid	4	15.9	1	1	0	385	726
Styrene	24	17.4	2	3	2	88	295
Sulfur	4	4.0	2	1	0	—	—
Sulfur Chloride	24	1.8	2	1	2§	245	280
Sulfur Dioxide	1	0.0	2	0	0	Gas	12
Tetrachlorobenzene	4	4.7	0	1	0	311	475
TELONE*II	16	3.2	2	3	0	83	220
TELONE* C-17	16	2.7	3	3	1	79	200
Toluene	16	17.4	2	3	0	40	231
Tributylamine	4	17.8	2	2	0	187	417
Trichlorobenzene	29	6.2	2	1	3	210	413
1,1,1-Trichloroethane	14	3.1	3	1	1	None	165
Trichloroethylene	4	2.7	2	1	0	None	188
1,2,3-Trichloropropane	10	4.3	3	2	0	180	313
Triethanolimine	14	10.1	2	1	1	385	650
Triethylaluminum	29	16.9	3	3	3	-63	381
Triethylamine	16	17.8	2	3	0	16	193
Triethylene Glycol	4	9.3	1	1	0	350	546
Triisobutylaluminum	29	18.9	—	3	3	32	238
Triisopropylbenzene	16	18.1	0	1	0	207	495
Trimethylaluminum	29	16.5	—	3	3	32	259

*TRADEMARK OF THE DOW CHEMICAL COMPANY

Compound	MF	Hc BTU/lb. x10[-3]	NFPA Classification			Flash Point ° F	Boiling Point ° F
			N_h	N_f	N_r		
Trimethylamine	21	10.1	2	4	0	Gas	38
Tripropylamine	10	17.8	2	2	0	105	313
Vinyl Acetate	24	9.7	2	3	2	18	161
Vinyl Acetylene	40	19.5	—	4	3	—	41
Vinyl Allyl Ether	24	15.5	2	3	2	68	153
Vinyl Butyl Ether	24	15.4	2	3	2	15	202
Vinyl Chloride	21	8.0	2	4	1	Gas	7
Vinyl Cyclohexene	24	19.0	0	3	2	61	266
Vinyl Ethyl Ether	24	14.0	2	4	2	-50	96
Vinylidene Chloride	24	4.2	2	4	2	-19	89
Vinyl Toluene	14	17.5	2	2	1	120	334
Xylene	16	17.6	2	3	0	81	292
Zinc Chlorate	24	[8]	2	1	2	—	—
Zinc Stearate[9]	—	10.1	0	1	0	530	—

Footnotes:

The net Heat of Combustion (H_c) is the value obtained when the water formed in the combustion is considered to be in the vapor state. When H_c is given in Kcal/gm mole it can be converted to Btu/lb by multiplying by 1800 and dividing by molecular weight.

[1]Vacuum distillation [2]Material oxidized to higher level of oxidation

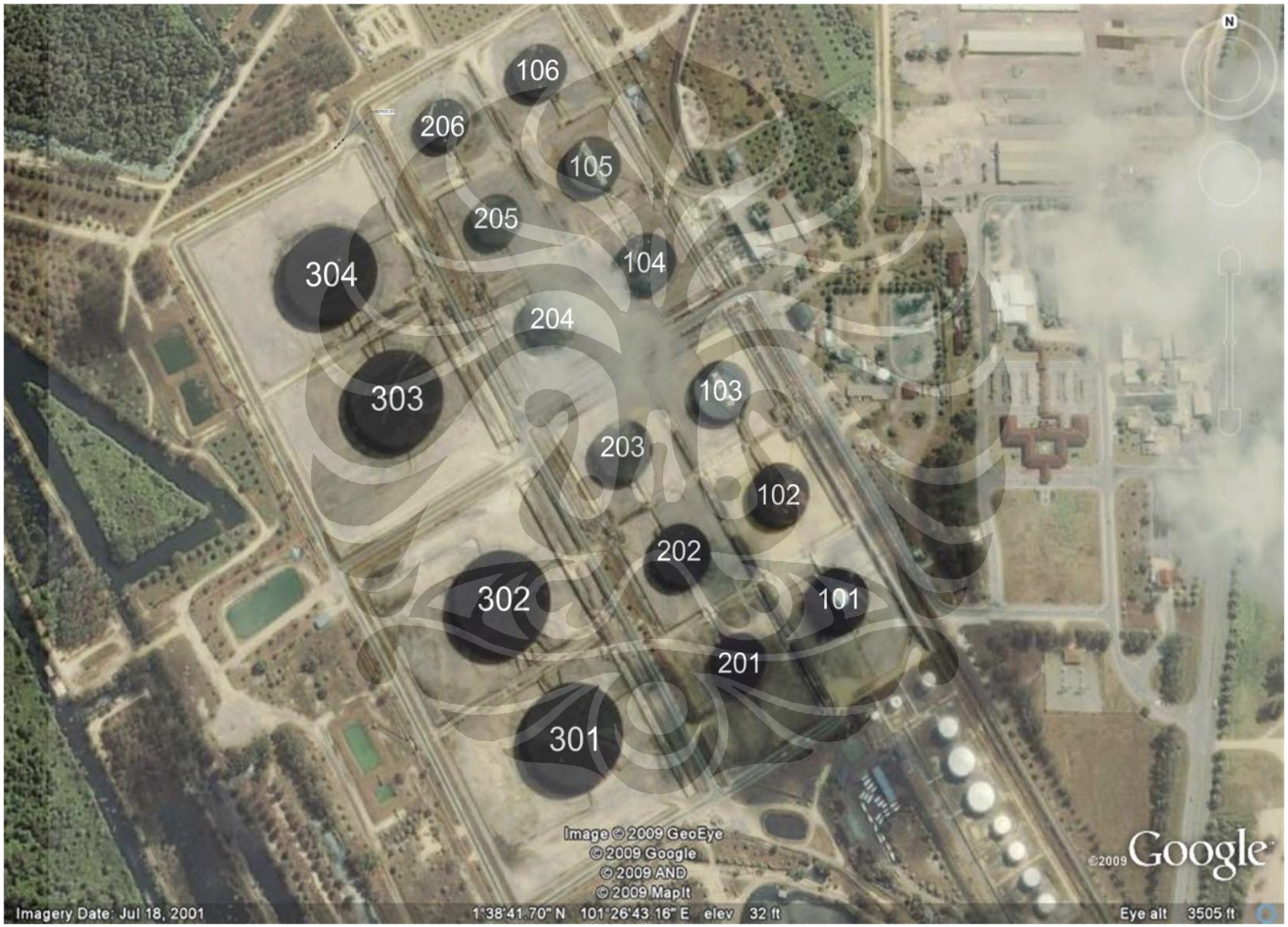
[3]Sublimes [4]Explodes on heating [5]Decomposes in water [6]MF is packaged material

[7]Hc equivalent to six times the heat of decomposition (Hd) [8]Evaluate as a DUST

Lampiran 2.

Lay Out Dumai Tank Farm

Lampiran 2. Lay Out Dumai Tank Farm (pada ketinggian 4833 ft)

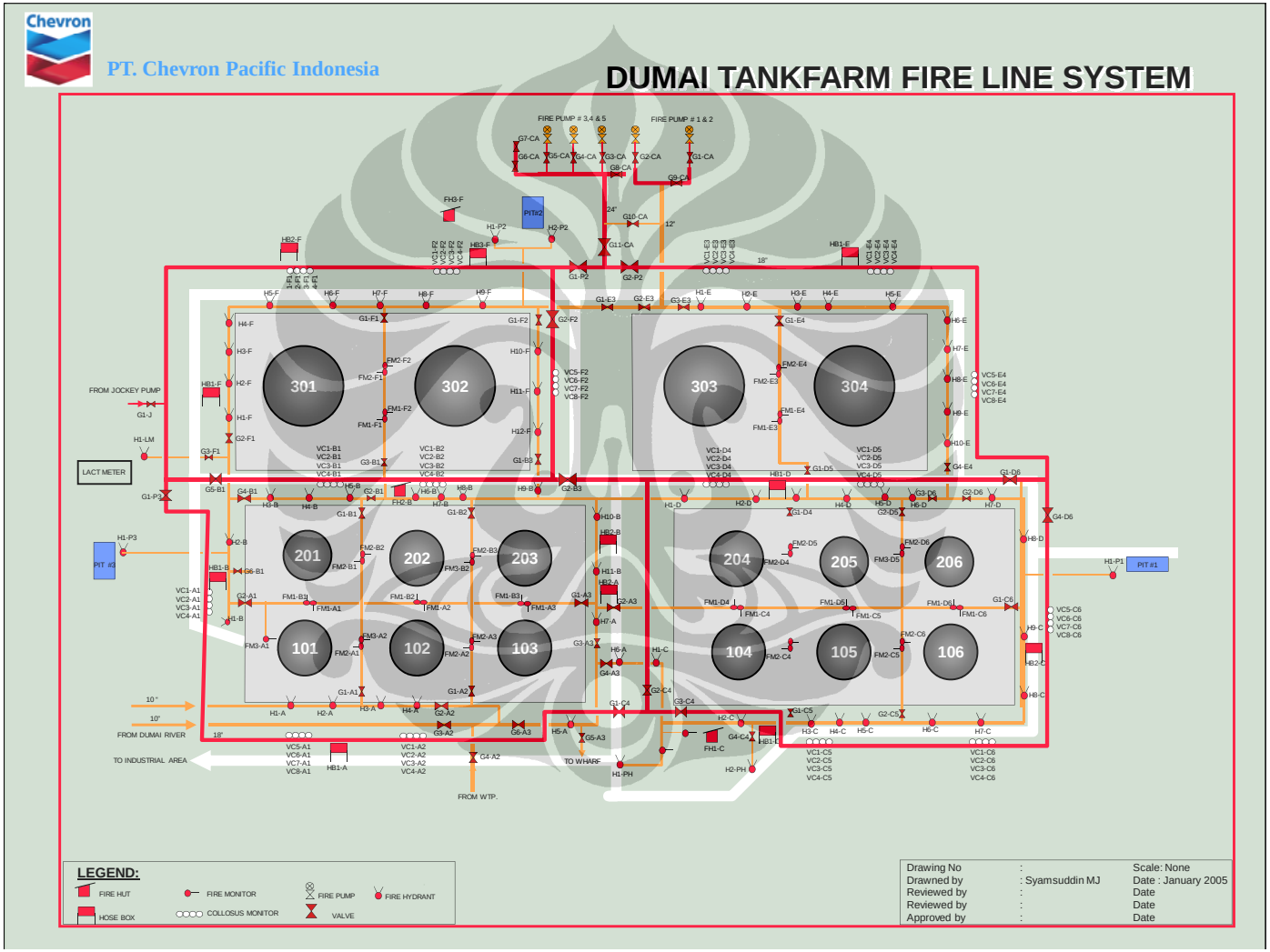


Sumber: (EuropaTechnologies, 2009)

Lampiran 3.

Lay Out Sistem Fire Line Dumai Tank Farm

Lampiran 3. Fire Line System Dumai Tank Farm



Oleh : Adis Arodiza Lanin (1305003025)

Lampiran 4.

Hasil Pengumpulan Data

HASIL PENGUMPULAN DATA

PENILAIAN RISIKO BAHAYA KEBAKARAN DAN LEDAKAN PADA TANGKI TIMBUN CRUDE OIL DI DUMAI TANK FARM PT CHEVRON PACIFIC INDONESIA TAHUN 2009

Peneliti : Adis Ardiza Lanin

Pembimbing Akademik : Dra. Fatma Lestari, M.Si., Ph.D

GAMBAR HASIL PENGUMPULAN DATA

PENILAIAN RISIKO BAHAYA KEBAKARAN DAN LEDAKAN PADA TANGKI TIMBUN CRUDE OIL DI DUMAI TANK FARM PT CHEVRON PACIFIC INDONESIA TAHUN 2009

Peneliti : Adis Ardiza Lanin

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Gambar 2. Tanggul Konkrit dan Akses Tangga Mendekati Tangki

Gambar 3. Tanggul tidak Konkrit Antar Tangki

Gambar 4. Water Pump

Gambar 5. Water Pump dan Kanal

Gambar 6. Control Room Hydrocarbon Transport (HCT)

Gambar 7. Saluran Drainase

Gambar 8. Oil Catcher

Gambar 9. Fire Monitor

Gambar 10. APAR

Gambar 11. Kabel Ditanam Dalam Tanah

Gambar 12. Terminator

Gambar 13. Latihan Pemadaman Menggunakan Terminator

Gambar 14. Latihan Pemadaman Menggunakan Foam Solution

LAMPIRAN HASIL PENGUMPULAN DATA

PENILAIAN RISIKO BAHAYA KEBAKARAN DAN LEDAKAN PADA TANGKI TIMBUN CRUDE OIL DI DUMAI TANK FARM PT CHEVRON PACIFIC INDONESIA TAHUN 2009

Peneliti : Adis Ardiza Lanin

Pembimbing Akademik : Dra. Fatma Lestari, M.Si., Ph.D

Lampiran 1. Perhitungan Penilaian Risiko Bahaya Kebakaran dan Ledakan
Pada Tangki Timbun Crude Oil (T302) Tank Farm Dumai PT. Chevron Pacific Indonesia 2009

No.	Kategori	Tangki 302		
		Nilai	Catatan	
1	**Diameter Tangki** (m)	**90,65**	Diameter (ft)	**297,405**
2	**Jari - jari Tangki** (m)	**45,325**	Jari - jari (ft)	**148,702**
3	**Tinggi Tangki** (m)	**17,070**	Tinggi (ft)	**56,003**
4	**Biaya Pembuatan Tangki**	**724.054,00**		
5	**MATERIAL FACTOR**	**16**		
	General Process Hazards	**Penalti**		
6.a	Base Factor	1,00		
6.b	A. Reaksi Eksotermis	0,00		
6.c	B. Reaksi Endotermis	0,00		
6.d	C. Pemindahan dan Penanganan Material	0,00		
6.e	D. Unit Proses Tertutup	0,00		
6.f	E. Akses (Jalan)	0,00		
6.g	F. Saluran Pembuangan dan Pengendalian Tumpahan	0,50		
6	**GENERAL PROCESS HAZARDS FACTOR (F1)** (∑ 6.a-g)	**1,50**		
	Special Process Hazards	**Penalti**		
7.a	Base Factor	1,00		
7.b	A. Material Beracun	0,20		
7.c	B. Tekanan Bawah Atmosfir	0,00		
7.d	C. Temperatur Operasi Pada/Dekat Flammable Range	0,50		
7.e	D. Ledakan Debu	0,00		
7.f	E. Tekanan Pelepasan	0,16		
7.g	F. Temperatur Rendah	0,00		
7.h	G.Jumlah Material	0,42		
7.i	H. Korosi dan Erosi	0,20		

7.j	I. Kebocoran	0,10		
7.k	J. Penggunaan Alat Pembakar	0,00		
7.l	K.Sistem Pertukaran Minyak Panas	0,00		
7.m	L. Peralatan Berputar	0,00		
7	**SPECIAL PROCESS HAZARDS FACTOR (F2)** (∑ 7.a-m)	**2,58**		
8	**PROCESS UNIT HAZARDS FACTOR (F3)** (6 x 7)	**3,87**		
9	**FIRE AND EXPLOSION INDEX (F&EI)** (5 x 8)	**61,92**		
10	RADIUS OF EXPOSURE (ft) (0,84 x F&EI)	52,01	Radius (m)	**15,85**
11	**RADIUS OF EXPOSURE yang sesungguhnya (ft)** (10 + 2)	**200,72**	Radius sesungguhnya (m)	**61,18**
12	**AREA OF EXPOSURE** (Luas Daerah Pajanan (ft^2) = pR^2)	**126.499,72**	Luas (m^2)	**38.557,11**
13	**VALUE OF THE AREA OF EXPOSURE** (Biaya Asli x 0,82 x Faktor Eskalasi)	**2.740.112,39**	Nilai Daerah Pajanan(Rp)	**31.237.281.261,90**
14	**DAMAGE FACTOR**	**0,45**		
15	**BASE MAXIMUM PROBABLE PROPERTY DAMAGE** (13 x 14)	**1.233.050,58**	Nilai Kerugian Dasar (Rp)	**14.056.776.567,86**
	Process Control Credit Factor	**Kredit**		
16.a	1. *Emergency Power* (Pembangkit Listrik Darurat)	0,98		
16.b	2. *Cooling* (Pendingin)	0,97		
16.c	*3. Explosion Control* (Pengendalian Ledakan)	1,00		
16.d	*4. Emergency Shutdown* (Penghenti Darurat)	0,98		
16.e	*5. Computer Control* (Pengendalian Komputer)	0,97		
16.f	*6. Inert Gas*	1,00		
16.g	*7. Operating Instruction/Procedures* (Prosedur atau Intruksi Operasi)	0,93		
16.h	*8. Reactive Chemical Review* (Tinjauan Terhadap Bahan Kimia Reaktif)	0,98		
16.i	*9. Other Process Hazards Analysis* (Analisis Bahaya Proses yang Lain)	0,91		
16	**PROCESS CONTROL CREDIT FACTOR (C1)** (Hasil Perkalian 16.a-i)	**0,75**		
	Material Isolation Credit Factor	**Kredit**		
17.a	1. *Remote Control Valves* (Katup yang Dikendalikan Dari Jauh)	0,96		
17.b	*2. Dump/Blowdown* (Tangki Penampungan)	1,00		
17.c	*3. Drainage* (Drainase)	1,00		
17.d	*4. Interlock*	0,98		

17	**MATERIAL ISOLATION CREDIT FACTOR (C2)** (Hasil Perkalian 17.a-d)	**0,94**		
	Fire Protection Credit Factor	**Kredit**		
18.a	*1. Leak Detection* (Deteksi Kebocoran)	1,00		
18.b	*2. Structural Steel* (Baja Struktural)	1,00		
18.c	*3. Fire Water Supply* (Pasokan Air Pemadam)	0,94		
18.d	*4. Special Systems* (Sistem Khusus)	1,00		
18.e	*5. Sprinkler Systems* (Sistem Sprinkler)	1,00		
18.f	*6. Water Curtain* (Tabir Air)	1,00		
18.g	*7. Foam* (Busa)	1,00		
18.h	*8. Hand Extinguisher/Monitors* (APAR/Monitor)	0,97		
18.i	*9. Cable Protection* (Proteksi Kabel)	0,94		
18	**FIRE PROTECTION CREDIT FACTOR (C3)** (Hasil Perkalian 18.a-i)	**0,86**		
19	**LOSS CONTROL CREDIT FACTOR (LCCF)** (16 x 17 x 18)	**0,60**		
20	**ACTUAL MAXIMUM PROBABLE PROPERTY DAMAGE (MPPD)** (15 x 19)	**745.163,68**	Kerugian Sebenarnya (Rp)	**8.494.865.919,27**
21	**MAXIMUM PROBABLE DAYS OUTAGE (MPDO)**	**21**		
22	**BUSINESS INTERRUPTION** ($) (MPDO x Nilai Produksi/hari x 0,70)	**23.106.359,47**	Business Interruption (Rp.)	**263.412.497.926,91**
	Kapasitas SLC yang disalurkan T302 (barrel/hari)	38411,97		
	Harga (dollar/barrel)	40,00		
	Nilai Produksi (dollar/hari)	1.536.478,84		

Cat: 1 m = 3.2808 ft 1 ft = 0.3048 m US$1 = Rp114000,00

Lampiran 2. Perhitungan kapasitas air untuk fire fighting

tangki	tahun pembuatan	tinggi (m)	diameter (m)	luas permukaan atas (m2) (1)	volume (m3) (2)	luas permukaan dinding (m2) (3)	foam concentrate (utk 65 menit) (4)	foam solution (5)	kapasitas air untuk foam solution per menit (liter/menit) (5)	kapasitas air untuk cooling (liter/menit) (6)	total kapasitas air yang dibutuhkan (liter/menit) (7)	per 30 menit (8)
101	1957	14,62	54,89	2.365,14	34.578,29	2.519,82	45.100,90	1.501.859,86	22.412,37	3.593,55		
102	1957	14,62	54,89	2.365,14	34.578,29	2.519,82	45.100,90	1.501.859,86	22.412,37	3.593,55		
103	1957	14,64	54,86	2.362,55	34.587,75	2.521,89	45.051,61	1.500.218,63	22.387,88	3.596,50		
104	1951	14,64	54,91	2.366,86	34.650,83	2.524,19	45.133,77	1.502.954,51	22.428,71	3.599,77		
105	1957	14,64	54,86	2.362,55	34.587,75	2.521,89	45.051,61	1.500.218,63	22.387,88	3.596,50		
106	1957	14,64	54,86	2.362,55	34.587,75	2.521,89	45.051,61	1.500.218,63	22.387,88	3.596,50		
201	1958	14,50	48,75	1.865,60	27.051,22	2.219,59	35.575,25	1.184.655,81	17.678,71	3.165,38		
202	1960	14,64	54,95	2.370,31	34.701,33	2.526,03	45.199,55	1.505.145,00	22.461,39	3.602,40		
203	1960	14,63	54,93	2.368,58	34.652,39	2.523,39	45.166,65	1.504.049,56	22.445,05	3.598,63		
204	1961	14,64	54,85	2.361,69	34.575,14	2.521,43	45.035,19	1.499.671,75	22.379,72	3.595,84		
205	1963	14,61	48,85	1.873,26	27.368,37	2.241,01	35.721,35	1.189.520,92	17.751,31	3.195,93		
206	1963	14,58	48,78	1.867,90	27.233,96	2.233,21	35.619,05	1.186.114,29	17.700,47	3.184,80		
301	1969	17,07	90,65	6.450,68	110.113,05	4.858,82	123.008,28	4.096.175,58	61.127,54	6.929,21		
302	1969	17,07	90,65	6.450,68	110.113,05	4.858,82	123.008,28	4.096.175,58	61.127,54	6.929,21	78.579,77	2.357.393,22
303	1967	17,06	90,64	6.449,25	110.024,27	4.855,44	122.981,14	4.095.271,90	61.114,06	6.924,39		
304	1967	17,06	90,58	6.440,72	109.878,65	4.852,23	122.818,37	4.089.851,89	61.033,17	6.919,81		

Catatan:

fire monitor rate = 750 gpm (2838.75 liter/menit) , I gallon = 3.785 liter

foam application rate = 0.24 gpm per square feet (9.779 litter/min per square meter) per 65 minutes (williams inc)

foam concentrate = 3%

konstanta = 33,3

application rate untuk cooling = 0.1 gpm per sq feet (4.0746 litter/min per square meter)

I gpm per square feet = 40.746 liter/menit

Rumus:

1. Luas permukaan atas = (3,14*(D)^2/4)
2. Volume = (((3,14*(D)^2/4)*T)
3. Luas permukaan dinding = (3,14*D*T)
4. Foam concentrate (utk 65 menit) = 65*foam application rate*luas permukaan atas tangki*foam concentrate rate (williams.inc)
5. Foam solution = foam concentrate*konstanta
6. Kapasitas air untuk cooling = 35%*luas permukaan dinding tangki*application rate untuk cooling (williams.inc)
7. Total kapasitas air yang dibutuhkan = kapasitas air untuk foam solution per menit+ untuk cooling tangki terdekat
8. Untuk 30 menit (waktu yang ditentukan dalam Dow's Fire and Explosion Index)

jika tangki 302 terbakar tangki yang mengalami cooling = 301, 303, 203

Lampiran 3. Perhitungan penalti untuk jumlah material

tangki	volume bersih (bbl)	volume bersih (l)	massa jenis material (kg/liter)	massa material (kg)	massa material (lb)	Hc (BTU/lb)	total energi (BTU)	total energi (BTUx10^9) (X)	log X	log Y	penalti (Y)
302	673.840	107140560	0,87	93212287,2	205495808,4	21300	4,37706E+12	4377,06	3,641	-0,3818256	0,42

1 barrel = 159 L
1 kg = 2.2046 lb

tangki timbun berisi class I flammable liquids, sehingga penalti ditentukan dengan persamaan
log (Y) = -0.403115 + 0.378703 (log X) - 0,046402 (log X)^2 - 0.015379 (log X)^3
Y adalah penalti dan X adalah total energi dalam proses (BTU x 10^9)

Lampiran 4 Biaya Asli Tangki 302

Asset Number	Asset Description	Unit Number	Remarks Line 2	Loc.	Location Description	Asset Value	POP Year
132073	TANK CRUDE CONE #302 690000B	0001060158	#302 690000B	741	Dumai Industrial Area	$724.054,00	1969
204050	REPAIR TANK#302 EXCPI#060158	9915600008	TANK#302 EXCPI#	741	Dumai Industrial Area	$880.226,00	1994

POP = Put on Production/Services

Sumber : JDE Chevron Pacific Indonesia 2009

Lampiran 5. Perhitungan Penentuan Damage Factor

Keterangan	X = F3	MF = 1	MF = 4	MF = 10	MF = 14	**MF = 16**	MF = 21	MF = 24	MF = 29	MF = 40
		Y = Damage Factor								
	1	0,010605	0,044368	0,116974	0,230574	0,286802	0,420027	0,490468	0,576584	0,634839
	2	0,023625	0,063039	0,136906	0,267064	0,333693	0,503184	0,580201	0,662222	0,713527
	3,87	0,0589139	0,1042991	0,1780413	0,3552228	0,4482641	0,6527674	0,7267456	0,7993427	0,8462323
	3	0,041227	0,083570	0,1583	0,31197	0,392134	0,585405	0,662674	0,73982	0,787599
	4	0,061671	0,107701	0,181078	0,361872	0,456845	0,662310	0,735607	0,807518	0,854415
	5	0,083217	0,137172	0,205162	0,413350	0,522546	0,729519	0,796720	0,863456	0,911335
	6	0,104125	0,173723	0,230474	0,462984	0,583957	0,782652	0,843733	0,905774	0,955719

Damage Factor ditentukan dengan persamaan :

Material Factor of 1:

Y = 0.003907 + 0.002957 * X + 0.004031* X 2 - 0.00029* X 3

Material Factor of 4:

Y = 0.025817 + 0.019071* *X* - 0.00081* *X* 2 + 0.00029 * *X* 3

Material Factor of 10:

Y = 0.098582 + 0.017596* *X* + 0.000809* *X* 2 - 0.000013* *X* 3

Material Factor of 14:

Y = 0.20592 + 0.017596* *X* + 0.007628* *X* 2 - 0.00057 * *X* 3

Material Factor of 16:

Y = 0.256741+ 0.019886 * *X* + 0.011055* *X* 2 - 0.00088* *X* 3

Material Factor of 21:

Y = 0.340314 + 0.076531* *X* + 0.003912 * *X* 2 - 0.00073* *X* 3

Material Factor of 24:

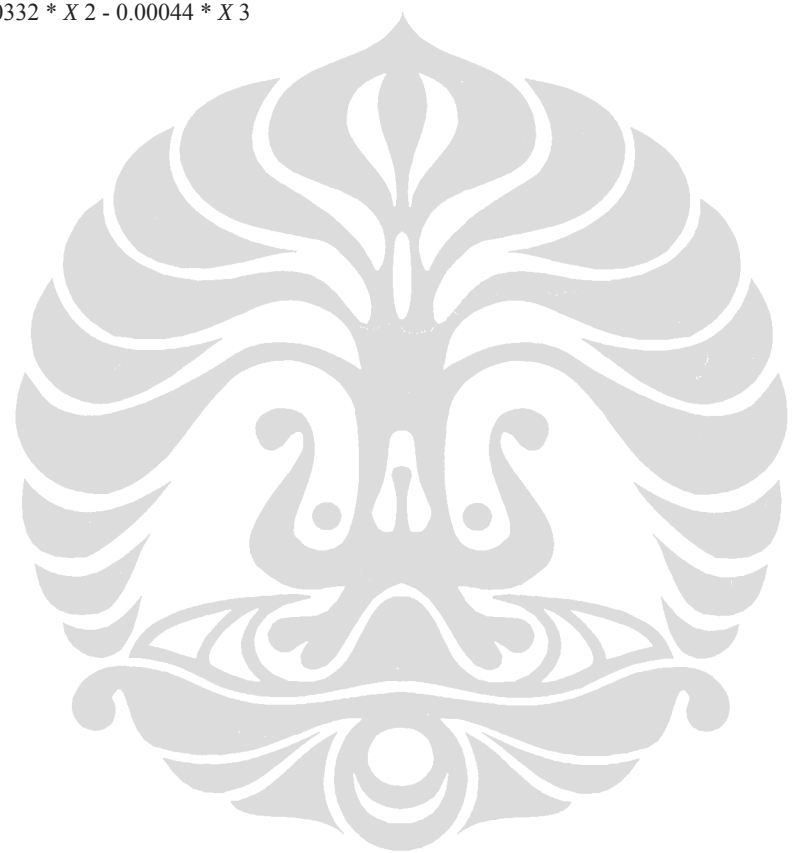
Y = 0.395755 + 0.096443* *X* - 0.00135* *X* 2 - 0.00038* *X* 3

Material Factor of 29:

Y = 0.484766 + 0.094288* *X* - 0.00216 * *X* 2 - 0.00031* *X* 3

Material Factor of 40:

$Y = 0.554175 + 0.080772 * X + 0.000332 * X\,2 - 0.00044 * X\,3$



Lampiran 6. Perhitungan Penentuan Hari Kerja yang Hilang

Hari kerja yang hilang atau MAXIMUM PROBABLE DAYS OUTAGE (MPDO) ditentukan dengan langkah sebagai berikut:

1. Untuk peralatan yang sulit didapat (the upper 70 % probability):

   Log (Y) = 1,550233 + + 0,598416 x Log (X/10^6)

2. Peralatan yang tidak sulit didapat dan tidak ada dalam stok (normal):

   Log ((Y) = 1,325132 + + 0,592471 x Log ((X/10^6)

3. Peralatan yang ada dalam stok (Lower 70 % probability Limit)

   Log (Y) = 1,045515 + + 0,610426 x Log ((X/10^6)

Dimana Y adalah hari kerja yang hilang dan X adalah nilai kerugian sebenarnya (Berdasarkan US Dollar Tahun 1986).

Catatan: CEPCI pada maret 2008 adalah sebesar 549,2 dan pada Tahun 1986 nilainya adalah 318,4.

Tangki	MPPD Tahun 2009	MPPD Tahun 1986	Log (Y)	MPDO
302	745.163,68	432.010,41	1,332	21,48

MPPD Tahun 1986 = MPPD Tahun 2009*(CEPCI 1986/CEPCI Agustus 2008)

Lampiran 7. Perhitungan *Fire Load*

tangki	volume bersih (bbl)	volume bersih (l)	volume bersih (ml)	volume yang terbakar (ml)	massa jenis material (g/ml)	massa material (g)	massa material (kg)	massa material (lb)	Hc (BRU/lb)	total energi (BTU)	luas permukaan tangki (ft2)	fire load (BTU/ft2)	fire load (BTU/ft2) x 1000
302	673,840	107140560	1.07141E+11	10714056000	0.87	9321228720	9321228.7	20549581	21300	4.37706E+11	190712.61	2295108.2	2295.1082

fire load
(BTU/ft2)

1 kg = 2,2046 lb

hanya 10 % bahan yang diperkirakan akan terbakar

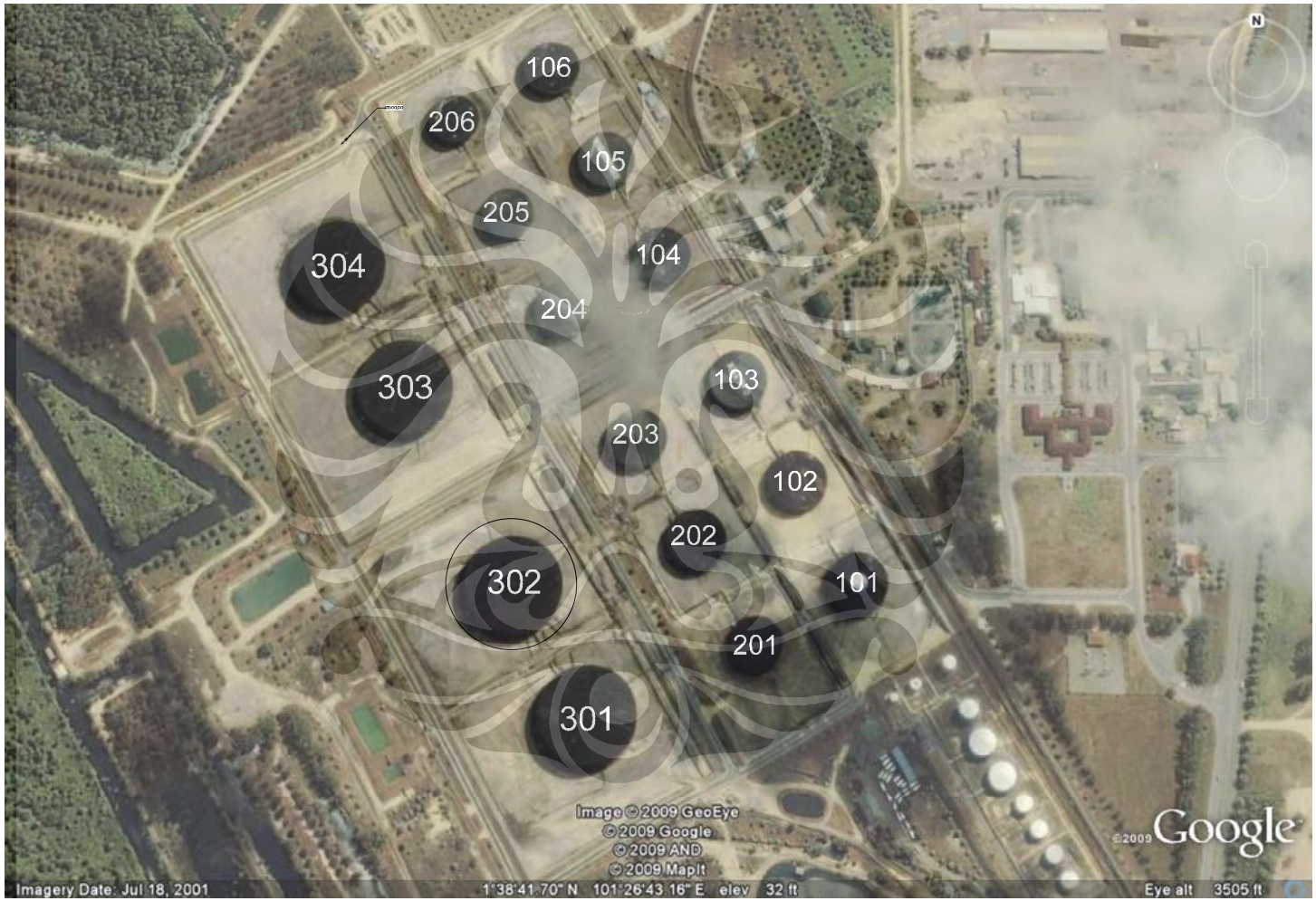
tangki	diameter (ft)	tinggi (ft)	luas permukaan atas/bawah (ft2)	luas permukaan dinding (ft2)	total luas permukaan (ft2)
302	297	56	69244.065	52224.48	190712.61

Lampiran 5.

Daerah Pajanan Jika terjadi

Kebakaran dan Ledakan pada Tangki 302

Lampiran 5. Daerah Pajanan Jika terjadi Kebakaran pada Tangki 302



Keterangan : Daerah yang berwarna merah adalah daerah yang terpajanan

Lampiran 6.

Material Safety Data Sheet (MSDS)

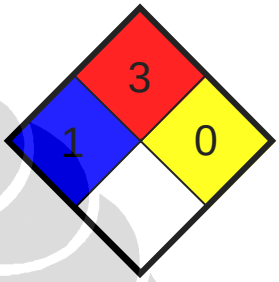
Duri Crude Oil dan Sumatra Light Crude

DURI CRUDE OIL & SUMATRAN LIGHT CRUDE OIL

From Dumai Tank Farm
Refer to samples received at TS Lab Duri in Jul 2007 – Jun 2008
Material Safety Data Sheet, Valid Jul 2008 – Jun 2009

Technology Support Laboratory
PT. Chevron Pacific Indonesia
PO. Box 423
Phone: 62-765-825685, 824951
Fax No: 62-765-826555
Duri 28884
Indonesia

Head Office: Gedung Sarana Jaya
Jl. Budi Kemuliaan I No. 1
Jakarta 10110, Indonesia
Phone 62-21-3512151 (Hunting)
Fax No. 62-21-3512064/3512065



General Information
Synonyms: Crude Petroleum
Composition: A mixture of hydrocarbons.

	DURI CRUDE OIL	SUMATRAN LIGHT CRUDE OIL
Density, at 60 ^{o} F :	0.92 – 0.94 gr/cc	0.85 – 0.87 gr/cc
Solid Point, ^{o} F :	45-55	85-95
Flash Point, ^{o} F :	145-165	5-70
Pour Point, ^{o} F :	50-60	90-100

Hazard Analysis
Fire Hazard: Moderate,when exposed to heat or flame.
Disaster Hazard: Moderately dangerous;when heated to decomposition,it emits toxic fumes; it can react with oxidizing materials.

Countermeasures

SECTION 1. - - - - - - - - - CHEMICAL IDENTIFICATION- - - - - - - - - -
CATALOG # : **16075 DCO** NAME : **DURI CRUDE OIL**
CATALOG #: **16076 SLCO** NAME: **SUMATRAN LIGHT CRUDE OIL**

SECTION 2. - - - - - COMPOSITION/INFORMATION ON INGREDIENTS - - - - - -
SYNONYMS: CRUDE PETROLEUM

SECTION 3. - - - - - - - - - - HAZARDS IDENTIFICATION - - - - - - - - -
LABEL PRECAUTIONARY STATEMENTS
IRRITANT
RISK OF SERIOUS DAMAGE TO EYES.
IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.
WEAR SUITABLE PROTECTIVE CLOTHING.

SECTION 4. - - - - - - - - - - FIRST-AID MEASURES- - - - - - - - - -
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES.
IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS AMOUNTS OF WATER.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION.
IF BREATHING IS DIFFICULT, GIVE OXYGEN.
IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED.
PERSON IS CONSCIOUS, CALL A PHYSICIAN.
WASH CONTAMINATED CLOTHING BEFORE REUSE.

SECTION 5. - - - - - - - - - FIRE FIGHTING MEASURES - - - - - - - - - -
EXTINGUISHING MEDIA, WATER SPRAY, CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM. SPECIAL FIREFIGHTING PROCEDURES, WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.

SECTION 6. - - - - - - - - ACCIDENTAL RELEASE MEASURES- - - - - - - - -
CHEMICAL SAFETY GOGGLES, RUBBER BOOTS AND HEAVY RUBBER GLOVES.
ABSORB ON SAND OR VERMICULITE AND PLACE IN CLOSED CONTAINERS FOR DISPOSAL.
WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

SECTION 7. - - - - - - - - - - HANDLING AND STORAGE- - - - - - - - - -
REFER TO SECTION 8.

SECTION 8. - - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION- - - - - -
CHEMICAL SAFETY GOGGLES, RUBBER GLOVES, SAFETY SHOWER AND EYE BATH.
MECHANICAL EXHAUST REQUIRED, AVOID CONTACT AND INHALATION.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
SEVERE EYE IRRITANT.
WASH THOROUGHLY AFTER HANDLING, KEEP TIGHTLY CLOSED, STORE IN A COOL DRY PLACE.

SECTION 9. - - - - - - - PHYSICAL AND CHEMICAL PROPERTIES - - - - - - -
APPEARANCE AND ODOR LIQUID.

SECTION 10. - - - - - - - - -STABILITY AND REACTIVITY - - - - - - - - -
INCOMPATIBILITIES, STRONG OXIDIZING AGENTS, HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
TOXIC FUMES OF: CARBON MONOXIDE, CARBON DIOXIDE

SECTION 11. - - - - - - - - - TOXICOLOGICAL INFORMATION - - - - - - - -
ACUTE EFFECTS MAY BE HARMFUL BY INGESTION OR SKIN ABSORPTION. CAUSES EYE IRRITATION.
MAY CAUSE SKIN IRRITATION, CHRONIC EFFECTS DERMATITIS, LUNG IRRITATION CHEMICAL PNEUMONITIS.
TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.
ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS) DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.

SECTION 12. - - - - - - - - - ECOLOGICAL INFORMATION - - - - - - - - - -
DATA NOT YET AVAILABLE.

SECTION 13. - - - - - - - - - DISPOSAL CONSIDERATIONS - - - - - - - - -

DISSOLVE OR MIX THE MATERIAL WITH A COMBUSTIBLE SOLVENT AND BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.
OBSERVE LOCAL ENVIRONMENTAL REGULATIONS.

SECTION 14. - - - - - - - - - - TRANSPORT INFORMATION - - - - - - - - -

PROPER SHIPPING NAME : PETROLEUM CRUDE OIL
HAZARD CLASS / PACKING GROUP: 3; DETERMINE FLASH POINT TO ACCURATELY CLASSIFY PACKING GROUP
DOT IDENTIFICATION NUMBER : UN 1267
DOT SHIPPING LABEL : FLAMMABLE LIQUID

SECTION 15. - - - - - - - - - REGULATORY INFORMATION - - - - - - - - - -

CUSTOM INFORMATION
IRRITANT
R 41
RISK OF SERIOUS DAMAGE TO EYES.
S 26
IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.
S 36
WEAR SUITABLE PROTECTIVE CLOTHING. REVIEWS, STANDARDS, AND REGULATIONS OEL=MAK
IARC CANCER REVIEW:ANIMAL INADEQUATE EVIDENCE IMEMDT 33,87,84
IARC CANCER REVIEW:GROUP 3 IMSUDL 7,252,87
NOES 1983: HZD X5299; NIS 200; TNF 29566; NOS 139; TNE 633350; TFE 249735
NOES 1983: HZD Y1079; NIS 36; TNF 3132; NOS 59; TNE 92890; TFE 61238
EPA TSCA SECTION 8(B) CHEMICAL INVENTORY
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, JULY 1996

SECTION 16. - - - - - - - - - - OTHER INFORMATION- - - - - - - - - - -

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