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APPENDICES

Appendix A

Impact Assessment Analysis of Wood-Plastic Composites

Table A.1 Characterization of environmental impacts of wood – plastic composites using Eco-Indicator 95

Impact category	Unit	WPC-PP/Sawdust	WPC-PP/Sawdust
greenhouse	kg CO2	2.08	2.1
ozone layer	kg CFC11	9.63E-07	5.42E-07
acidification	kg SO2	0.0207	0.0187
eutrophication	kg PO4	0.00141	0.00174
heavy metals	kg Pb	2.73E-05	5.01E-05
carcinogens	kg B(a)P	9.86E-08	1.02E-07
winter smog	kg SPM	0.0148	0.0138
summer smog	kg C2H4	0.00183	0.00303
energy resources	MJ LHV	85.7	68.6

Table A.2 Single score of environmental impacts of wood – plastic composites using Eco-Indicator 95

Impact category	Unit	WPC-PP/Sawdust	WPC-PP/Sawdust
Total	Pt	0.00617	0.0082
greenhouse	Pt	0.000398	0.000401
ozone layer	Pt	0.000104	5.85E-05
acidification	Pt	0.00184	0.00166
eutrophication	Pt	0.000184	0.000228
heavy metals	Pt	0.00252	0.00461
carcinogens	Pt	9.07E-05	9.37E-05
winter smog	Pt	0.000783	0.000731
summer smog	Pt	0.000256	0.000422
energy resources	Pt	0	0

Table A.3 Single score in each phase of environmental impacts of wood – plastic composites using Eco-Indicator 95

Impact category	WPC-PP/Sawdust			WPC-PP/Sawdust		
	Material	**Trans**	**Production**	**Material**	**Trans**	**Production**
greenhouse	0.000168	5.31E-05	0.000177	0.000174	4.98E-05	0.000177
ozone layer	4.34E-05	5.49E-05	5.66E-06	1.29E-06	5.15E-05	5.66E-06
acidification	0.00123	0.000146	0.000462	0.00106	0.000137	0.000462
eutrophication	0.000119	2.65E-05	3.85E-05	0.000164	2.49E-05	3.85E-05
heavy metals	0.000852	0.000718	0.000945	0.00299	0.000674	0.000945
carcinogens	9.58E-06	1.78E-05	6.33E-05	1.37E-05	1.67E-05	6.33E-05
winter smog	0.000522	3.58E-05	0.000226	0.000471	3.36E-05	0.000226
summer smog	0.00014	9.89E-05	1.75E-05	0.000312	9.28E-05	1.75E-05
Total	0.00309	0.00115	0.00193	0.00519	0.00108	0.00193

Table A.4 Damage assessment of wood – plastic composites using Eco-Indicator 99

Damage category	Unit	WPC-PP/Sawdust	WPC-PP/Sawdust
Total	Pt	0.14642	0.185
Human Health	Pt	0.0995	0.125
Ecosystem Quality	Pt	0.00582	0.00751
Resources	Pt	0.0411	0.0528

Table A.5 Single score in each phase of wood – plastic composites using Eco-Indicator 99

Damage category	WPC-PP/Sawdust			WPC-PP/Sawdust		
	Material	**Trans**	**Production**	**Material**	**Trans**	**Production**
Human health	0.0544	0.00786	0.0373	0.0802	0.00737	0.0373
Ecosystem	0.00282	0.00102	0.00198	0.00457	0.000959	0.00198
Resource	0.00556	0.00877	0.0268	0.0178	0.00822	0.0268
Total	0.0628	0.0176	0.066	0.103	0.0166	0.066

Table A.6 Impact category of environmental impacts of wood – plastic composites using Eco-Indicator 99

Impact category	Unit	WPC-PP/Sawdust	WPC-PP/Sawdust
Total	Pt	0.14652	0.185147
Carcinogens	Pt	0.00297	0.00367
Resp. organics	Pt	0.000335	0.000491
Resp. inorganics	Pt	0.0673	0.0913
Climate change	Pt	0.0289	0.0293
Radiation	Pt	5.79E-05	5.65E-05
Ozone layer	Pt	4.15E-05	2.37E-05
Ecotoxicity	Pt	0.000426	0.000416
Acidification	Pt	0.00394	0.00394
Land use	Pt	0.00145	0.00315
Minerals	Pt	0.0411	0.0528

Table A.7 Impact category in each phase of environmental impacts of wood – plastic composites using Eco-Indicator 99

Impact category	WPC-PP/Sawdust			WPC-PP/Sawdust		
	Material	Trans	Production	Material	Trans	Production
Carcinogens	0.000455	0.000507	0.00201	0.00119	0.000476	0.00201
Resp. organics	0.000186	0.000126	2.27E-05	0.00035	0.000118	2.27E-05
Resp. inorganics	0.0414	0.0033	0.0226	0.0656	0.0031	0.0226
Climate change	0.0124	0.0039	0.0126	0.0131	0.00366	0.0126
Radiation	6.20E-06	3.97E-06	4.77E-05	5.02E-06	3.72E-06	4.77E-05
Ozone layer	1.72E-05	2.17E-05	2.71E-06	6.33E-07	2.03E-05	2.71E-06
Ecotoxicity	3.85E-05	0.000277	0.000111	4.53E-05	0.00026	0.000111
Acidification	0. 261	0.00051	0.000823	0.00264	0.000478	0.000823
Land use	0.0166	0.000236	0.00104	0.00189	0.000221	0.00104
Minerals	0.00556	0.00877	0.0268	0.0178	0.00822	0.0268
Total	0.0628	0.0176	0.066	0.103	0.0166	0.066

Appendix B

Characterization Factor of Eco-Indicator 95

Table B.1 Characterization Factor of greenhouse gas (kg CO2 Equivalent) in Eco-Indicator 95

Component	Substance	Factor	Unit
Airborne emission	1,1,1-trichloroethane	100	kg
Airborne emission	CFC-11	3400	kg
Airborne emission	CFC-113	4500	kg
Airborne emission	CFC-114	7000	kg
Airborne emission	CFC-115	7000	kg
Airborne emission	CFC-116	6200	kg
Airborne emission	CFC-12	7100	kg
Airborne emission	CFC-13	13000	kg
Airborne emission	CFC-14	4500	kg
Airborne emission	CFC (hard)	7100	kg
Airborne emission	CFC (soft)	1600	kg
Airborne emission	CO2	1	kg
Airborne emission	CO2 (soft)	1	kg
Airborne emission	Dichloriomethane	15	kg
Airborne emission	HALON-1211	4900	kg
Airborne emission	HALON-1301	4900	kg
Airborne emission	HCFC-123	90	kg
Airborne emission	HCFC-141b	440	kg
Airborne emission	HCFC-141b	580	kg
Airborne emission	HCFC-142b	1800	kg
Airborne emission	HCFC-22	1600	kg
Airborne emission	HFC-125	3400	kg
Airborne emission	HFC-134a	1200	kg
Airborne emission	HFC-143a	3800	kg
Airborne emission	HFC-152a	150	kg
Airborne emission	Methane	11	kg
Airborne emission	N2O	270	kg
Airborne emission	Tetrachloromethane	1300	kg

Compartment	Substance	Factor	Unit
Airborne emission	Trichloromethane	25	kg

Table B.2 Characterization Factor of ozone layer depletion (kg CFC Equivalent) in Eco-Indicator 95

Component	Substance	Factor	Unit
Airborne emission	1,1,1-trichloroethane	0.12	kg
Airborne emission	CFC-11	1	kg
Airborne emission	CFC-113	1.07	kg
Airborne emission	CFC-114	0.8	kg
Airborne emission	CFC-115	0.5	kg
Airborne emission	CFC-12	1	kg
Airborne emission	CFC-13	1	kg
Airborne emission	CFC (hard)	1	kg
Airborne emission	CFC (soft)	0.055	kg
Airborne emission	HALON-1201	1.4	kg
Airborne emission	HALON-1202	1.25	kg
Airborne emission	HALON-1211	4	kg
Airborne emission	HALON-1301	16	kg
Airborne emission	HALON-2311	0.14	kg
Airborne emission	HALON-2401	0.25	kg
Airborne emission	HALON-2402	7	kg
Airborne emission	HCFC-123	0.02	kg
Airborne emission	HCFC-124	0.022	kg
Airborne emission	HCFC-141b	0.11	kg
Airborne emission	HCFC-142b	0.065	kg
Airborne emission	HCFC-22	0.055	kg
Airborne emission	HCFC-225ca	0.025	kg
Airborne emission	HCFC-225cb	0.033	kg
Airborne emission	Methyl bormide	0.6	kg
Airborne emission	Tetrachloromethane	1.08	kg

Table B.3 Characterization Factor of acidification (kg SO2 Equivalent) in Eco-Indicator 95

Component	Substance	Factor	Unit
Airborne emission	Ammonia	1.88	kg
Airborne emission	HCl	0.88	kg
Airborne emission	HF	1.6	kg
Airborne emission	NOx	0.7	kg
Airborne emission	Nox (as NO2)	0.7	kg
Airborne emission	SO2	1	kg
Airborne emission	SOx	1	kg
Airborne emission	NO	1.07	kg
Airborne emission	NO2	0.7	kg

Table B.4 Characterization Factor of carcinogen (kg B(a) Equivalent) in Eco-Indicator 95

Component	Substance	Factor	Unit
Airborne emission	Benzene	0.000044	kg
Airborne emission	CxHy aromatic	0.000044	kg
Airborne emission	Metals	0.0001786	kg
Airborne emission	Ni	0.0044	kg
Airborne emission	PAH's	0.4792	kg
Airborne emission	Acrylonitrile	0.00022	kg
Airborne emission	As	0.044	kg
Airborne emission	Bebzo(a)pyrene	1	kg
Airborne emission	Cr(VI)	0.44	kg
Airborne emission	Ethylbenzene	0.000044	kg
Airborne emission	Floranthene	1	kg
Airborne emission	Tar	0.000044	kg
Airborne emission	Vinyl chloride	0.000011	kg

Table B.5 Characterization Factor of enerygy resources deletion (MJ LHV) in Eco-Indicator 95

Component	Substance	Factor	Unit
Raw Material	Coal ETH	18	kg
Raw Material	Crude oil ETH	42.6	kg
Raw Material	Lignite ETH	8	kg
Raw Material	Natural gas (vol)	36.6	M3
Raw Material	Natural gas ETH	35	M3
Raw Material	Pot.energy hydropower	1	MJ
Raw Material	Unspecfied energy	1	MJ
Raw Material	Uranium (in ore)	45100	kg
Raw Material	Wood	15.3	kg
Raw Material	Wood (feed stock)	15.3	kg
Raw Material	Crude oil (feed stock)	41	kg
Raw Material	Energy (undef.)	1	MJ
Raw Material	Energy from hydro power	1	MJ
Raw Material	Natural gas (feed stock)	35	kg
Raw Material	Steam from waste incineration	1	MJ
Raw Material	Barrange water	0.01	kg
Raw Material	Biomass (feed stock)	1	MJ
Raw Material	Energy from coal	1	MJ
Raw Material	Energy from lignite	1	MJ
Raw Material	Energy from natural gas	1	MJ
Raw Material	Energy from oil	1	MJ
Raw Material	Energy from uranium	1	MJ
Raw Material	Energy from wood	1	MJ
Raw Material	Energy recovery	1	MJ
Raw Material	Gas from oil production	1	M3
Raw Material	Lignite	10	kg
Raw Material	Methane	35.9	kg
Raw Material	Natural gas	30.3	kg

Component	Substance	Factor	Unit
Raw Material	Natural gas FAL	46.8	kg
Raw Material	Uranium (ore)	1110	kg
Raw Material	Uranium FAL	2291	g
Raw Material	Wood and wood waste FAL	9.5	kg
Raw Material	Petroleum gas ETH	35	m3

Table B.6 Normalization and weighting factor of Eco-Indicator 95

Impact category	Normailization	Weighting
Greenhouse	0.0000765	2.5
Ozone layer	1.08	100
Acidification	0.00888	10
Eutrophication	0.0262	5
Heavy metal	18.4	5
Carcinogens	92	10
Winter smog	0.0106	5
Summer smog	0.0558	2.5
Pesticides	1.04	25
Energy resource	0.00000629	0
Solid waste	0	0

Table B.7 Correlated effect to type of damage of Eco-Indicator 95

Type of Damage	Effect Contributing to this Damage
Factor of fatalites as a consequence of the effect	Ozone Layer Airborne Heavy Metal Pesticides Carcinogenic Substance
Nuisance and number of non-fatal casualties as a result of occurrence of smog period	Winter Smog Summer Smog
Damage to parts of ecosystem	Greenhouse Effect Acidification Eutrophication Waterborne Heavy Metals Pesticides

Appendix C

Characterization Factor of Eco-Indicator 99

Table C.1 Characterization Factor of climate change (DALYs) in Eco-Indicator 99

Compartment	Substance	Factor	Unit
Airborne emission	CO2	2.1E-7	kg
Airborne emission	CO2 (non-fossil)	2.1E-7	kg
Airborne emission	HOLON-1301	-0.0071	kg
Airborne emission	Methane	4.4E-6	kg
Airborne emission	N2O	6.9E-5	kg
Airborne emission	CFC-14	1.4E-3	kg
Airborne emission	1,1,1-trichloroethane	-0.000043	kg
Airborne emission	CF31	2.1E-7	kg
Airborne emission	CFC-11	2.2E-4	kg
Airborne emission	CFC-113	6.3E-4	kg
Airborne emission	CFC-116	2.0E-3	kg
Airborne emission	CFC-12	1.4E-3	kg
Airborne emission	CO2 (fossil)	2.1E-7	kg
Airborne emission	dichloromethane	1.9E-6	kg
Airborne emission	HCFC-123	6.6E-6	kg
Airborne emission	HCFC-124	8.5E-5	kg
Airborne emission	HCFC-141a	5.2E-5	kg
Airborne emission	HCFC-142b	3.4E-4	kg
Airborne emission	HCFC-22	2.8E-4	kg
Airborne emission	HFC-125	5.7E-4	kg
Airborne emission	HFC-134	2.1E-4	kg
Airborne emission	HFC-134a	2.7E-4	kg
Airborne emission	HFC-143	6.3E-5	kg
Airborne emission	HFC-143a	7.5E-4	kg
Airborne emission	HFC-152a	2.9E-5	kg
Airborne emission	HFC-227ea	5.9E-4	kg
Airborne emission	HFC-23	2.6E-3	kg
Airborne emission	HFC-236fa	1.4E-3	kg
Airborne emission	HFC-245ca	1.2E-4	kg

Compartment	Substance	Factor	Unit
Airborne emission	HFC-32	1.4E-4	kg
Airborne emission	HFC-41	3.1E-5	kg
Airborne emission	HFC-4310 mee	2.7E-4	kg
Airborne emission	Perfluorbutane	1.5E-3	kg
Airborne emission	Perfluorcyclobutane	1.9E-3	kg
Airborne emission	Perfluorhexane	1.6E-3	kg
Airborne emission	Perfluorpropane	1.7E-3	kg
Airborne emission	Perfluorpentane	1.5E-3	kg
Airborne emission	SF6	5.3E-3	kg
Airborne emission	Tetrachloromethane	-0.00026	kg
Airborne emission	trichloromethane	8.3E-7	kg

Table C.2 Characterization Factor of ozone layer (DALYs) in Eco-Indicator 99

Compartment	Substance	Factor	Unit
Airborne emission	CO2	2.1E-7	kg
Airborne emission	CO2 (non-fossil)	2.1E-7	kg
Airborne emission	HOLON-1301	-0.0071	kg
Airborne emission	Methane	4.4E-6	kg
Airborne emission	N2O	6.9E-5	kg
Airborne emission	CFC-14	1.4E-3	kg
Airborne emission	1,1,1-trichloroethane	-0.000043	kg
Airborne emission	CF31	2.1E-7	kg
Airborne emission	CFC-11	2.2E-4	kg
Airborne emission	CFC-113	6.3E-4	kg
Airborne emission	CFC-116	2.0E-3	kg
Airborne emission	CFC-12	1.4E-3	kg
Airborne emission	CO2 (fossil)	2.1E-7	kg
Airborne emission	dichloromethane	1.9E-6	kg
Airborne emission	HCFC-123	6.6E-6	kg
Airborne emission	HCFC-124	8.5E-5	kg

Compartment	Substance	Factor	Unit
Airborne emission	HCFC-141a	5.2E-5	kg
Airborne emission	HCFC-142b	3.4E-4	kg
Airborne emission	HCFC-22	2.8E-4	kg
Airborne emission	HFC-125	5.7E-4	kg
Airborne emission	HFC-134	2.1E-4	kg
Airborne emission	HFC-134a	2.7E-4	kg
Airborne emission	HFC-143	6.3E-5	kg
Airborne emission	HFC-143a	7.5E-4	kg
Airborne emission	HFC-152a	2.9E-5	kg

Table C.3 Characterization Factor of acidification effect (PDF*m) in Eco-Indicator 99

Compartment	Substance	Factor	Unit
Airborne emission	Ammonia	15.57	kg
Airborne emission	NOx	5.713	kg
Airborne emission	NOx (as NO2)	5.713	kg
Airborne emission	SO2	1.041	kg
Airborne emission	SOx (as SO2)	1.041	kg
Airborne emission	NO	8.789	kg
Airborne emission	NO2	5.713	kg
Airborne emission	SO3	0.8323	kg

Table C.4 Characterization Factor of carcinogen effect (DALYs) in Eco-Indicator 99

Compartment	Substance	Factor	Unit
Airborne emission	1,2-dibromoethane	2.6E-4	kg
Airborne emission	1,2-dichloroethane	2.9E-5	kg
Airborne emission	1,3-butadiene	1.58E-5	kg
Airborne emission	1,4-dioxane	1.39E-7	kg
Airborne emission	2,4,6-trichlorophenol	2.05E-6	kg
Airborne emission	Acetaldehyde	2.16E-7	kg

Compartment	Substance	Factor	Unit
Airborne emission	Acrylonitrile	1.69E-5	kg
Airborne emission	Alpha-HCH	3.00E-4	kg
Airborne emission	As	2.46E-2	kg
Airborne emission	BCME	7.48E-3	kg
Airborne emission	Benzene	2.50E-6	kg
Airborne emission	Benzo(a)anthracene	5.86E-2	kg
Airborne emission	Benzo(a)pyrene	3.98E-3	kg
Airborne emission	Benzotrichloride	6.6E-3	kg
Airborne emission	Benzylechloride	1.04E-5	kg
Airborne emission	Beta-HCH	9.99E-5	kg
Airborne emission	Bromodichloromethane	8.76E-6	kg
Airborne emission	Cd	1.35E-1	kg
Airborne emission	Cr(VI)	1.75	kg
Airborne emission	di(2-ethylehexyl)phthalate	3.38E-5	kg
Airborne emission	dibenz(a)anthracene	3.1E1	kg
Airborne emission	Dichlrvos	4.36E-7	kg
Airborne emission	Dioxin(TEQ)	3.15E-5	kg
Airborne emission	Epichlorohydrin	1.79E2	kg
Airborne emission	Ethylene oxide	3.02E-7	kg
Airborne emission	Formadehyde	1.83E-4	kg
Airborne emission	Gamma-HCH(Lindane)	9.91E-7	kg
Airborne emission	Heavy metals	0.0006969	kg
Airborne emission	Hexachlorobenzene	8.25E-2	kg
Airborne emission	Metals	0.0006969	kg
Airborne emission	Ni	2.35E-2	kg
Airborne emission	Ni-subsulfide	9.48E-2	kg
Airborne emission	PAH's	1.7E-4	kg
Airborne emission	Particle diesel soot	9.78E-6	kg
Airborne emission	PCB's	1.97E-3	kg
Airborne emission	Pentachlorophenol	7.21E-3	kg
Airborne emission	Propyleneoxide	1.17E-5	kg

Compartment	Substance	Factor	Unit
Airborne emission	Styrene	2.44E-8	kg
Airborne emission	Tetrachloroethane	4.82E-7	kg
Airborne emission	Tetrachloromethane	8.38E-4	kg
Airborne emission	Trichloromethane	2.63E-5	kg
Airborne emission	Vinyl chloride	2.09E-7	kg
Emission to soil	1,2-dibromoethane	3.81E-3	kg
Emission to soil	1,2-dichloroethane	4.58E-	kg
Emission to soil	1,3-butadiene	41.2E-5	kg
Emission to soil	1,4-dioxane	3.1E-7	kg
Emission to soil	2,4,6-trichlorophenol	2.71E-6	kg
Emission to soil	Acetaldehyde	4.77E-7	kg
Emission to soil	Acrylonitrile	7.01E-5	kg
Emission to soil	Alpha-HCH	2.32E-2	kg
Emission to soil	As	1.32E-2	kg
Emission to soil	BCME	1.68E-2	kg
Emission to soil	Benzene	1.33E-5	kg
Emission to soil	Benzo(a)anthracene	1.6E-1	kg
Emission to soil	Benzo(a)pyrene	2.06E-3	kg
Emission to soil	Benzotrichloride	1.32E-1	kg
Emission to soil	Benzylechloride	4.16E-5	kg
Emission to soil	Beta-HCH	7.36E-3	kg
Emission to soil	Bromodichloromethane	7.82E-5	kg
Emission to soil	Cd	3.98E-3	kg
Emission to soil	Cr(VI)	2.71E-1	kg
Emission to soil	di(2-ethylehexyl)phthalate	3.18E-7	kg
Emission to soil	dibenz(a)anthracene	2.44E1	kg
Emission to soil	Dichlrvos	2.25E-5	kg
Emission to soil	Dioxin(TEQ)	7.06	kg
Emission to soil	Epichlorohydrin	1.3E-6	kg
Emission to soil	Ethylene oxide	2.38E-3	kg
Emission to soil	Formadehyde	1.83E-6	kg

Compartment	Substance	Factor	Unit
Emission to soil	Gamma-HCH(Lindane)	8.64E-3	kg
Emission to soil	PCB's	2.04E-2	kg
Emission to soil	Pentachlorophenol	1.26E-5	kg
Emission to soil	Propyleneoxide	1.4E-4	kg
Emission to soil	Styrene	2.09E-8	kg
Emission to soil	Tetrachloroethane	6E-6	kg
Emission to soil	Tetrachloromethane	3.99E-2	kg
Emission to soil	Trichloromethane	4.12E-6	kg
Emission to soil	Vinyl chloride	7.67E-7	kg
Waterborne emission	1,2-dibromoethane	1.24E-3	kg
Waterborne emission	1,2-dichloroethane	2.98E-5	kg
Waterborne emission	1,3-butadiene	3.37E-4	kg
Waterborne emission	1,4-dioxane	9.21E-7	kg
Waterborne emission	2,4,6-trichlorophenol	1.05E-5	kg
Waterborne emission	Acetaldehyde	9.23E-7	kg
Waterborne emission	Acrylonitrile	4.16E-5	kg
Waterborne emission	Alpha-HCH	6.85E-3	kg
Waterborne emission	As	6.57E-2	kg
Waterborne emission	BCME	1.54E-2	kg
Waterborne emission	Benzene	4.12E-6	kg
Waterborne emission	Benzo(a)anthracene	6.58E-1	kg
Waterborne emission	Benzo(a)pyrene	2.99	kg
Waterborne emission	Benzotrichloride	9.46E-3	kg
Waterborne emission	Benzylechloride	1.98E-5	kg
Waterborne emission	Beta-HCH	5.75E-3	kg
Waterborne emission	Bromodichloromethane	9.36E-6	kg
Waterborne emission	Cd	7.12E-2	kg
Waterborne emission	Cr(VI)	3.43E-1	kg
Waterborne emission	di(2-ethylehexyl)phthalate	6.64E-4	kg
Waterborne emission	dibenz(a)anthracene	4.07E1	kg
Waterborne emission	Dichlrvos	1.17E-5	kg

Compartment	Substance	Factor	Unit
Waterborne emission	Dioxin(TEQ)	2.02E3	kg
Waterborne emission	Epichlorohydrin	9.9E-7	kg
Waterborne emission	Ethylene oxide	1.39E-4	kg
Waterborne emission	Formadehyde	4.97E-6	kg
Waterborne emission	Gamma-HCH(Lindane)	4.16E-3	kg
Waterborne emission	Ni	3.11E-2	kg
Waterborne emission	Ni-subsulfide	5.02E-3	kg
Waterborne emission	PAH's	1.00E-2	kg
Waterborne emission	PCB's	3.91E-2	kg
Waterborne emission	Pentachlorophenol	2.99E-2	kg
Waterborne emission	Propyleneoxide	1.74E-5	kg
Waterborne emission	Styrene	1.22E-6	kg
Waterborne emission	Tetrachloroethane	4.27E-7	kg
Waterborne emission	Tetrachloromethane	8.29E-4	kg
Waterborne emission	Trichloromethane	2.6E-5	kg
Waterborne emission	Vinyl chloride	2.84E-7	kg

Table C.5 Characterization Factor of energy resource depletion (MJ surplus) in Eco-Indicator 99

Compartment	Substance	Factor	Unit
Raw material	Coal ETH	0.155	kg
Raw material	Crude oil ETH	6.13	kg
Raw material	Natural gas (vol)	5.49	m3
Raw material	Naturl gas ETH	5.25	m3
Raw material	Crude oil (feed stock)	5.90	kg
Raw material	Natural gas (feed stock)	5.25	m3
Raw material	Coal	0.252	kg
Raw material	Coal FAL	0.227	kg
Raw material	Crude oil	5.90	kg
Raw material	Crude oil FAL	6.04	kg

Compartment	Substance	Factor	Unit
Raw material	Crude oil IDEMAT	6.15	kg
Raw material	Energy from coal	8.59E-3	MJ
Raw material	Energy from natural gas	1.50E-1	MJ
Raw material	Energy from coal	0.144	MJ
Raw material	Natural gas	4.55	kg
Raw material	Natural gas FAL	7.02	kg
Raw material	Natural gas (feed stock)	7.02	kg
Raw material	Crude oil (feed stock)	6.04	kg
Raw material	Coal FAL	0.227	kg

Table C.6 Normalization and Weighting of Eco-Indicator 99

Damage Category	Normalization	Weighting
Human Health	65.1	400
Ecosystem quality	1.95E-4	400
Resources	1.19E-4	200

Table C.7 Damage assessment factor of human health of Eco-Indicator 99

Impact Category	Unit	Factor
Carcinogens	DALY	1
Resp.organics	DALY	1
Resp.inorganics	DALY	1
Climate change	DALY	1
Radiation	DALY	1
Ozone layer	DALY	1

Table C.8 Damage assessment factor of ecosystem quality of Eco-Indicator 99

Impact Category	Unit	Factor
Ecotoxicity	PAF x m^2 x yr	0.1
Acidification/Eutrophication	PAF x m^2 x yr	1
Land use	PAF x m^2 x yr	1

Table C.9 Damage assessment factor of ecosystem quality of Eco-Indicator 99

Impact Category	Unit	Factor
Minerals	MJ surplus	1

Appendix D

Guidance for SimaPro®6.0 software

Guidance for SimaPro®6.0 software

1. Click Start then choose Program => SimaPro6.0 => SimaPro 6.0 Single User as shown in Figure D-1

Figure D-1 Opening SimaPro®6.0 software

2. Click New for create new project and type the name of project as shown in Figure D-2

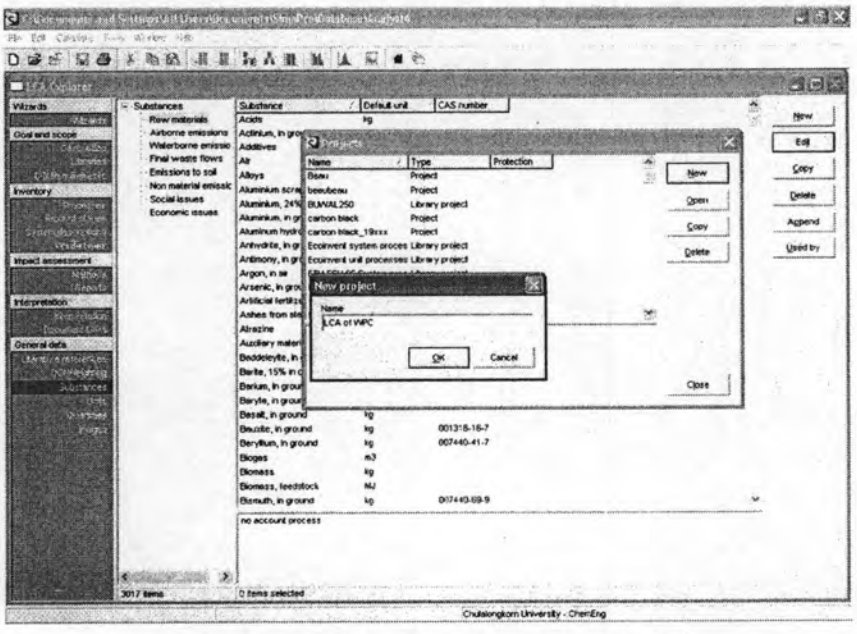

Figure D-2 Creating the new project

3. After opening SimaPro® 6.0, data requirement must be fulfilled by choose goal and scope => description and DQI Requirement. The program will save automatically when data was change as shown in Figure D-3 and Figure D-4

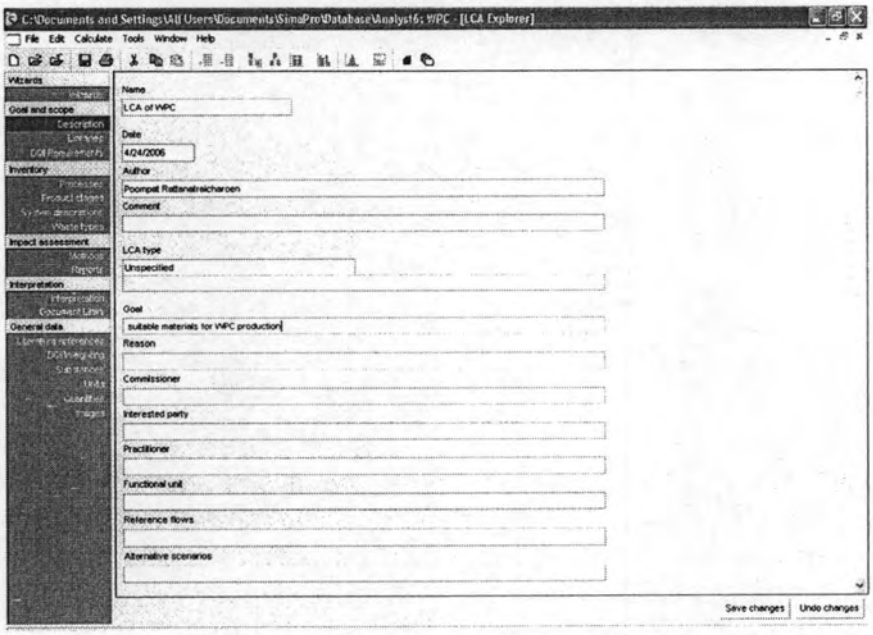

Figure D-3 Description of the LCA project

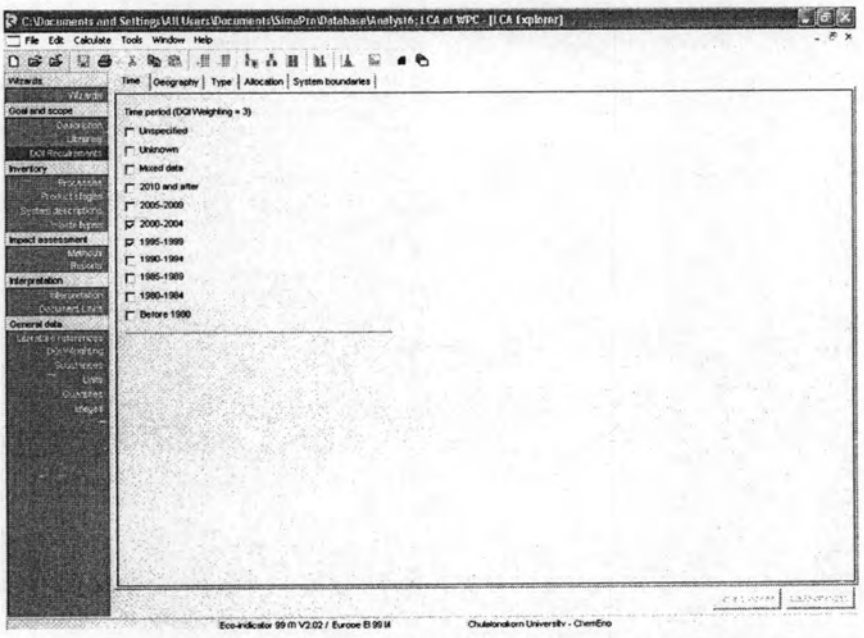

Figure D-4 Fulfillment of DOI Requirement of the project

4. If necessary, you can create a new database for the project by choose the appropriate category for the project in the process by choose inventory => process and then input the information for the new database as shown in Figure D-5

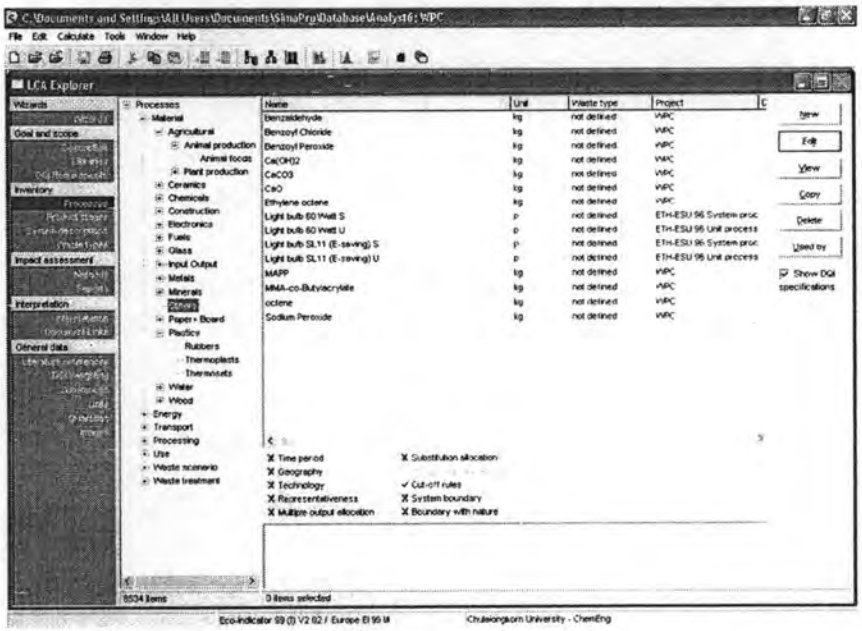

Figure D-5 Creating the new database for the project

5. Create new assembly by select product stage => assembly => others => new and then insert recorded data, which are materials and energy, into the blank as shown in Figure D-6

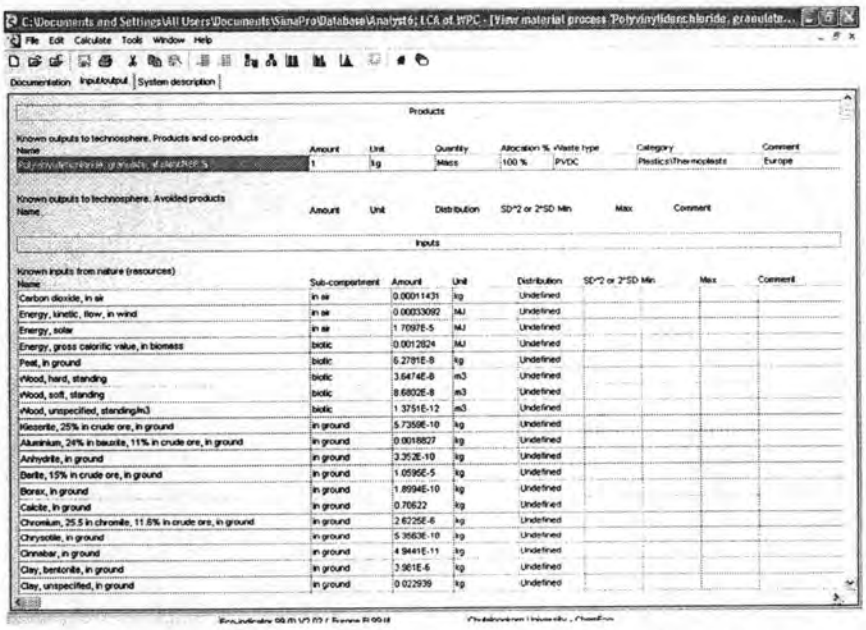

Figure D-6 Selecting the appropriate category for the project

6. Choose method for assessment of environmental impacts and then check select for choose the method as shown in Figure D-7

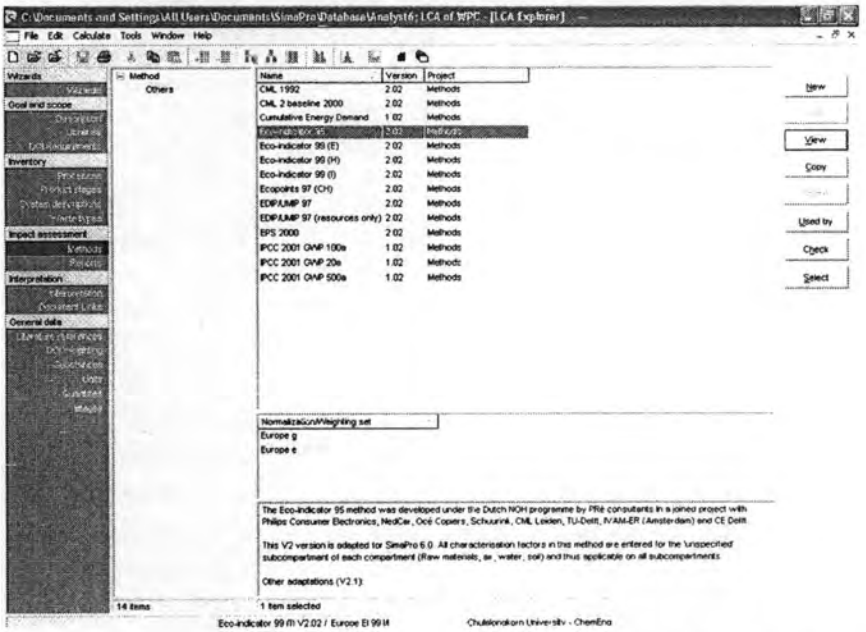

Figure C-7 Selecting the appropriate category for the project

7. The Software can be analyze environmental impacts of each products by check analyze and also can be compare impacts of the product by select compare. The software analyze the impact according to selected method which has 4 parts: Characterization, Damage assessment, Normalization, Weighting and Single score by checking as shown in Figure D-8 and Figure D-9

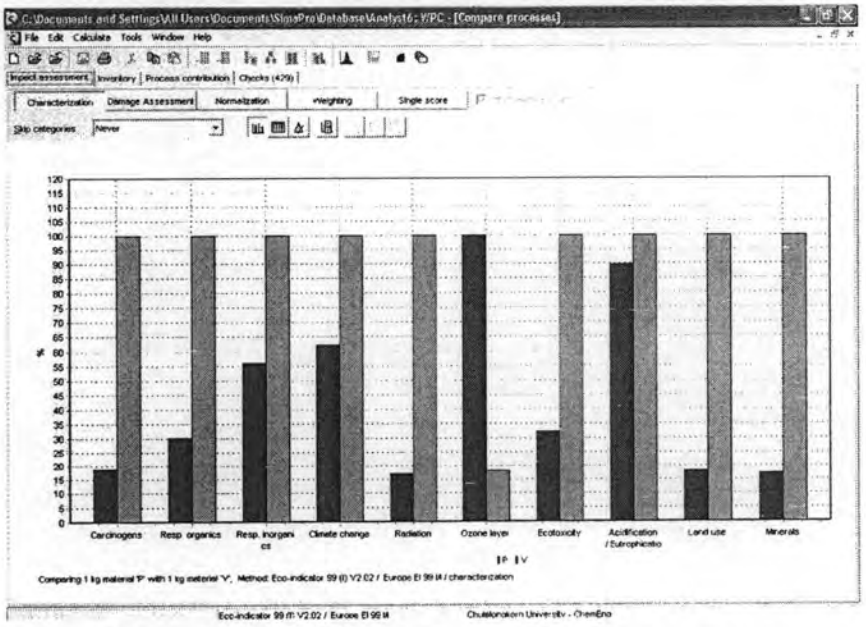

Figure D-8 Characterization of environmental impacts of the product

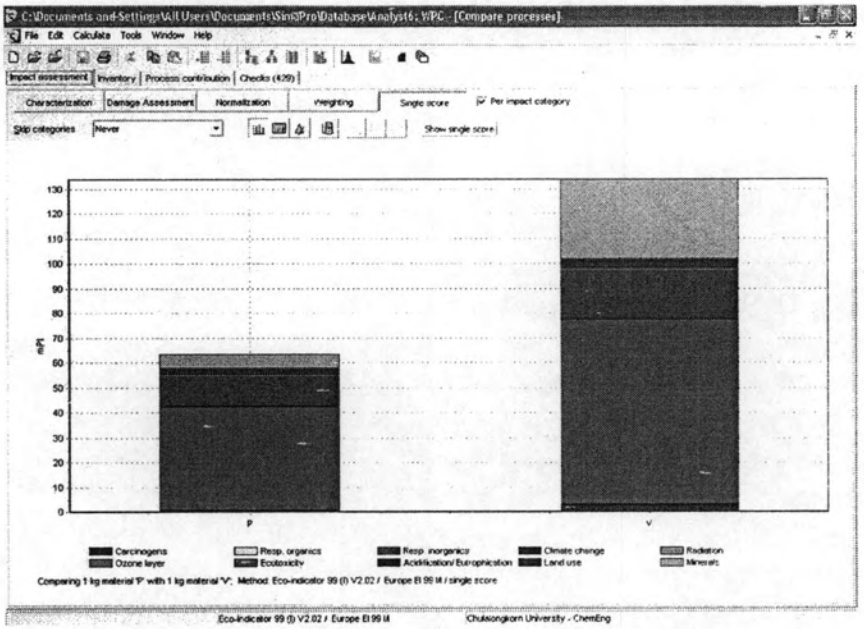

Figure D-9 Single score of environmental impacts of the product

BIOGRAPHY

Mr.Poompat Rattanatraicharoen, the second son of Praponkiat and Janjira Rattanatraicharoen, was born in Bangkok, Thailand on Friday 22nd April 1983. He graduated secondary school level from Dolvidthaya School in 1997 and received the Vocational Certificate in Technical Education (Printing) from Don Bosco School in 2001. In March and May 2005, he received the Bachelor of Engineering in Chemical Engineering and the Bachelor of Business Administration in Human Resource Management from Srinakharinwirot University and Ramkhamhaeng University, respectively. After graduation, he immediately pursues his graduate study for a Master Degree in Chemical Engineering. He graduated in May 2007 with the thesis entitled "Estimation of Environmental impacts of Wood-Plastic Composites (WPC)"