APPENDIX 1

Calculation percentage of tin

From 1 mL 0.1N of iodine solution = 0.005935 g of tin

$$\% Sn = \frac{0.05935 \times N \times V \times 100}{0.1 \times \text{wt.sample (g)}}$$

N = concentration of iodine solution (0.5033 N)

V = volume of iodine solution

$$\%Sn = \frac{0.005935 \times 0.5033 \times 56.90 \times 100}{0.1 \times 30.0}$$

$$= 5.67\ \%$$

In this experiment use 100 mL of sample from 900 mL of sample, so percentage of tin can calculate from this equation.

$$\% Sn = \frac{5.67 \times 900}{100}$$

$$= 51.03\ \%$$

In aqueous $SnCl_4$

$$N_1V_1 = N_2V_2$$

$$V_1 = \frac{0.5033 \times 56.90}{0.5}$$

$$= 286.38\ mL$$

From factor

1 mL 0.1N of I_2 solution = 0.005935 g of Sn

286.38 mL of 0.1N of I_2 solution = 0.005935 × 286.38

= 1.6997 g of Sn

Solution 100 mL = 1.6997 g of Sn

$$1000\ mL = \frac{1.6997 \times 1000}{100}$$

= 16.997 g Sn /1000 mL

From Sn × 2.1950 = $SnCl_4$

16.997 × 2.1950 = 37.3084 g $SnCl_4$/1000 mL

= 0.0373 g $SnCl_4$ /1 mL

There for aqueous $SnCl_4$ = 29.84 g / 800 mL

APPENDIX 2

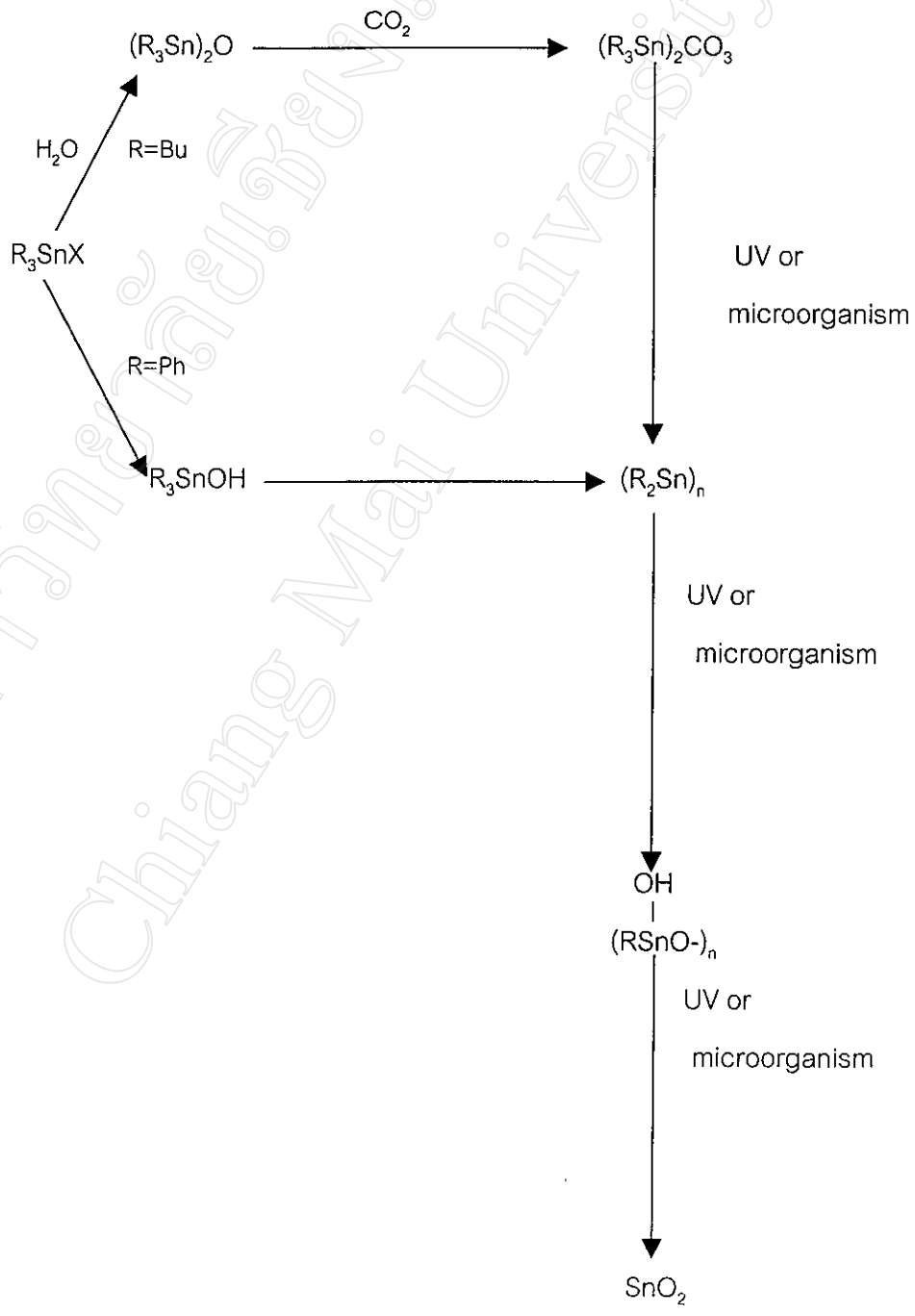

Figure A1 Environmental Degradation Scheme for Tributyl- and Triphenyl-tin compounds [19]

APPENDIX 3

Table A1 The Properties of Tin [5]

Valence electron configuration	$5S^2$ $5P^2$
Density (g/cm^3)	7.28
Melting point (^oC)	231.9
Boiling point (^oC)	2270
Atomic Radius (pm)	162
Ionic Radius (pm)[a]	112
First and second inization energies (kJ/mol)	709;1413
Electronegativity	1.8
Standard reduction potential (V)[b]	-0.14

a= refers to the cation Sn^{2+}

b= The half reaction is Sn^{2+} (aq) + $2e^-$ ⟶ Sn(s)

APPENDIX 4

Table A2 Infrared Spectra of Organotin Compounds [6]

Vibration	Range (cm-1) and intensity
ν(Sn-Me)	520-580 s-m
Sn-Me rock	720-791 m
ν(Sn-C_{alkyl})	480-600 variable
ν(Sn-Ph)	225-280 variable
ν(Sn-F)	328-372[a] s-m
ν(Sn-Cl)	318-385[a] s-m
ν(Sn-Br)	222-265[a] s-m
ν(Sn-I)	155-270[a] s-m
ν(Sn-H)	1790-1880[a] s-m
ν(Sn-O)	561-784[b] s
σ(Sn-OH)	885-917 s-m
ν(Sn-S)	327-376 s
ν(Sn-Sn)	194-208 [c]

a= These figures only apply to simple organotin halide of the general formula R_2SnX_{4-n}

b= This rang applies only oxide of type $(R_3Sn)_2O$

c= Raman band : only asymmetrical di-tins show this band in the infrared

APPENDIX 5

Table A3 Acute Toxicity of Tributyltin Compounds (rats)[19]

Tributyltin compound (TBT-X)	LD_{50}(mg/kg)	LD_{50}(mmol TBT/kg)
Fluoride	94	0.30
Chloride	122	0.38
Oxide	127	0.42
Benzoate	99/203	0.24/0.49
Linoleate	190	0.34
Abietate	158	0.27
Naphthenate	224	0.37

APPENDIX 6

Table A4 Triorganotin Compounds use as industrial biocides [20]

Compounds	Application
Triphenytin acetatat, Ph_3SnOAc	Agricultural chemicals, Fungicide
Triphenyltin hydroxide, Ph_3SnOH	Agricultural chemicals, Fungicide
Tricyclohexyltin hydroxide, $(C_6H_{11})_3SnOH$	Agricultural chemicals, Fungicide
Tributyltin bensoate, $Bu_3SnOCOPh$	Disinfection, Bacteriostat
Tributyltin Fluoride, Bu_3SnF	Biocides in Marine, Antifouling Paints
Triphenyltin X, Ph_3SnX (X=Cl,F,OH,OAc)	Biocides in Marine, Antifouling Paints
Bis(tributyltin) oxide, $(Bu_3Sn)_2O$	Wood Preservation, Stone Preservation, Textile Preservation, Slimicide in Paper Industry, Biocid in Antifouling Rubbers, In Can Fungicide for Paints

Table A5 Volatility of Tributyltin Compounds [1]

Compounds	Weight loss after 144 hour at 65 °C in dry air
T.B.T.O.	26
TBT benzoate	8.5
TBT linoleate	1.0
TBT naphthenate	6.0
TBT abitate	2.1

APPENDIX 7

Table A6 Tri-n-octylphosphine oxide (TOPO) extraction of the element [33]

VITAE

Name	Patchrapha Usit
Date of Birth	June 13, 1972
Place of Birth	Chiang Mai, Thailand
Education	High School Certificate holder from Doisaketwittayakom school, Chiang Mai (1990)
	Bachelor of Education, Science Teaching. Chiang Mai University, Thailand (1993)
	Master of Science, Chemistry Chiang Mai University, Thailand (1999)
Position Held & Office	Teacher Nernmapang Suksawittaya school, Phitsanuloke, Thailand