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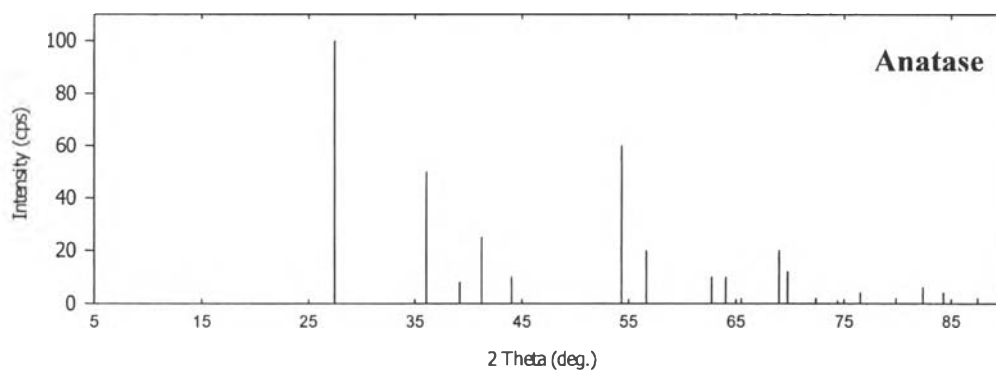
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## **APPENDICES**

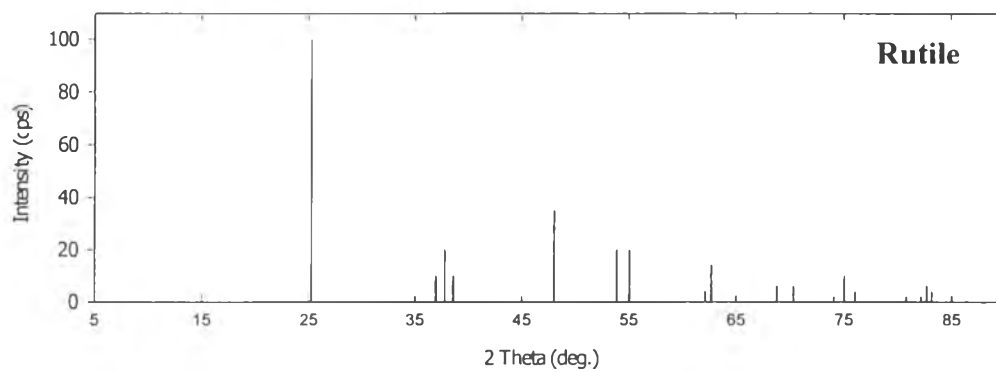
## Appendix A

### Standard TiO<sub>2</sub> XRD Patterns and Calculation of Crystalite Size of TiO<sub>2</sub> Catalysts

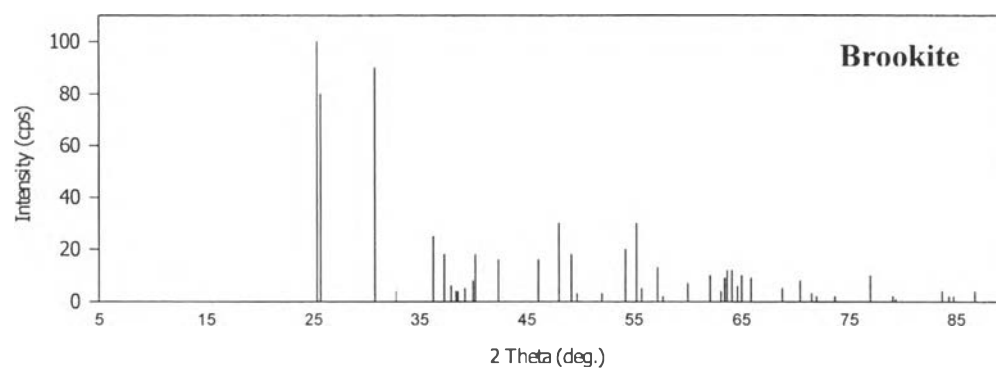
#### A.1 XRD patterns of TiO<sub>2</sub> reference



(a)



(b)



(c)

## A.2 Calculated crystallite size

X-ray diffraction patterns were used for the crystallite size ( $d$ ) estimation. The crystallite sizes of the catalysts can be determined from the broadening of the anatase main peak by Debye-Scherrer equation:

$$d = k\lambda / b\cos\theta \quad (3.1)$$

where

- $\lambda$  = the wave length (nm)
- $k$  = the Debye-Scherrer constant (assume equal to 1.0)
- $b$  = the full width at half maximum (FWHM) of the broadened peak
- $\theta$  = the Bragg angle of the reflection (deg.)
- $d$  = the crystallite size (nm)

Catalyst	FWHM (deg.)	b	$2\theta$ (deg.)	$\cos\theta$	d (nm)
TiO <sub>2</sub> (Degussa P25)	0.376	0.0066	25.38	0.9755	24
TiO <sub>2</sub> (sol-gel-1)	0.706	0.0123	25.30	0.9757	13
TiO <sub>2</sub> (sol-gel-2)	0.800	0.0139	25.34	0.9756	11
1.0% Pt/TiO <sub>2</sub>	0.353	0.0062	25.34	0.9756	26
0.2% Ag/TiO <sub>2</sub>	0.965	0.0168	25.46	0.9754	9
0.5% Ag/TiO <sub>2</sub>	0.847	0.0148	25.46	0.9754	11
1.0% Ag/TiO <sub>2</sub>	0.612	0.0106	25.36	0.9756	15
1.5% Ag/TiO <sub>2</sub>	0.918	0.0160	25.38	0.9755	10

## Appendix B

### Experimental Data from Photocatalytic Degradation of 4-Chlorophenol

#### B.1 Photocatalytic degradation of HQ

Time (min)	Concentration (mM)		Remaining fraction	
	HQ	HHQ	HQ	TOC
0	0.4642	0	1	1
30	0.2163	0.0045	0.47	0.68
60	0.1839	0.0232	0.40	0.59
90	0.1528	0.0559	0.33	0.56
120	0.1244	0.0782	0.27	0.54
150	0.0854	0.0755	0.18	0.51
180	0.0656	0.0793	0.14	0.49
210	0.0488	0.0716	0.11	0.47
270	0.0280	0.0754	0.06	0.44
300	0.0253	0.0594	0.05	0.40
360	0.0123	0.0584	0.03	0.36



## B.2 Photocatalytic degradation of 4-CP without catalyst

### B.2.1 With oxygen aeration

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4741	0.0000	0.0000	1.00	1.00
30	0.1438	0.1337	0.1254	0.30	0.78
60	0.0542	0.2049	0.1744	0.11	0.72
90	0.0211	0.1872	0.1742	0.04	0.72
120	0.0000	0.1885	0.2149	0.00	0.71
150	0.0000	0.1725	0.2503	0.00	0.70
180	0.0000	0.1580	0.2484	0.00	0.69
210	0.0000	0.1531	0.2459	0.00	0.70
240	0.0000	0.1270	0.2351	0.00	0.66
270	0.0000	0.1207	0.2083	0.00	0.65
300	0.0000	0.1072	0.2047	0.00	0.65
330	0.0000	0.0940	0.1842	0.00	0.63
360	0.0000	0.0805	0.1836	0.00	0.62

### B.2.2 With nitrogen aeration

Time (min)	Concentration (mM)				Remaining fraction	
	4-CP	HQ	HHQ	BQ	4-CP	TOC
0	0.4935	0.0000	0.0000	0.0000	1.00	1.00
30	0.1954	0.1610	0.1584	0.0597	0.40	0.81
60	0.1305	0.2195	0.1991	0.1208	0.26	0.81
90	0.0787	0.2329	0.2189	0.1344	0.16	0.82
120	0.0132	0.2496	0.2457	0.1431	0.03	0.79
150		0.2546	0.2550	0.1329		0.81
180		0.2641	0.2717	0.1268		0.75
210		0.2168	0.2715	0.1211		0.76
240		0.2172	0.2709	0.1159		0.77
270		0.2149	0.2712	0.1103		0.74
300		0.2129	0.2815	0.1041		0.76
330		0.2085	0.2945	0.0975		0.75
360		0.2047	0.3050	0.0740		0.76

### B.3 Photocatalytic degradation of 4-CP with TiO<sub>2</sub> (Degussa P25)

#### B.3.1 With oxygen aeration

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4569	0.000	0.000	1.00	1.00
30	0.3514	0.0381	0.0152	0.77	0.89
60	0.2259	0.0410	0.228	0.49	0.63
90	0.1648	0.0484	0.0340	0.36	0.54
120	0.0990	0.0461	0.0523	0.22	0.43
150	0.0697	0.0407	0.0547	0.15	0.36
180	0.0546	0.0404	0.0471	0.12	0.31
210	0.0245	0.0234	0.0449	0.05	0.20
240	0.0247	0.0258	0.0321	0.05	0.18
270	0.0216	0.0178	0.0246	0.05	0.14
300	0.0165	0.0123	0.0233	0.04	0.11
330	0.0108	0.0077	0.0212	0.02	0.09
360	0.00056	0.0058	0.0197	0.01	0.07

#### B.3.2 With nitrogen aeration

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4506	0.0000	0.0000	1.00	1.00
30	0.3436	0.0226	0.0000	0.76	0.81
60	0.2846	0.0353	0.0000	0.63	0.71
90	0.2385	0.0454	0.0000	0.53	0.63
120	0.2205	0.0485	0.0025	0.49	0.60
150	0.1949	0.0536	0.0037	0.43	0.56
180	0.1785	0.0563	0.0046	0.40	0.53
210	0.1633	0.0613	0.0039	0.36	0.51
240	0.1377	0.0642	0.0039	0.31	0.46
270	0.1339	0.0677	0.0037	0.30	0.46
300	0.1219	0.0695	0.0045	0.27	0.43
330	0.1142	0.0703	0.0048	0.25	0.42
360	0.1101	0.0703	0.0049	0.24	0.42

## B.4 Photocatalytic degradation of 4-CP with TiO<sub>2</sub> (sol-gel-1)

### B.4.1 With oxygen aeration

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4315	0.0000	0.0000	1.00	1.00
30	0.1326	0.1442	0.0530	0.31	0.76
60	0.0404	0.1782	0.0783	0.09	0.69
90	0.0068	0.1483	0.0906	0.02	0.57
120	0.0000	0.1476	0.1009		0.58
150	0.0000	0.1264	0.1037		0.53
180	0.0000	0.1024	0.0962		0.46
210	0.0000	0.0785	0.0886		0.39
240	0.0000	0.0617	0.0825		0.33
270	0.0000	0.0382	0.0689		0.25
300	0.0000	0.0222	0.0552		0.18
330	0.0000	0.0130	0.0419		0.13
360	0.0000	0.0152	0.0293		0.10

### B.4.2 With nitrogen aeration

Time (min)	Concentration (mM)				Remaining fraction	
	4-CP	HQ	HHQ	BQ	4-CP	TOC
0	0.4787	0.0000	0.0000	0.0000	1.00	1.00
30	0.1876	0.0589	0.0000	0.0449	0.39	0.61
60	0.1084	0.0766	0.0015	0.0725	0.23	0.57
90	0.0647	0.0821	0.0036	0.0305	0.14	0.55
120	0.0386	0.0806	0.0034	0.0371	0.08	0.53
150	0.0263	0.0901	0.0036	0.0398	0.05	0.51
180	0.0164	0.0926	0.0031	0.0409	0.03	0.51
210	0.0085	0.0949	0.0052	0.0419	0.02	0.47
240		0.1005	0.0058	0.0398		0.46
270		0.1049	0.0048	0.0444		0.45
300		0.1084	0.0053	0.0712		0.44
330		0.1091	0.0051	0.0720		0.41
360		0.1180	0.0048	0.0717		0.41

### B.5 Photocatalytic degradation of 4-CP with TiO<sub>2</sub> (sol-gel-2) under the presence of dissolved oxygen

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4626	0.000	0.000	1.00	1.00
30	0.0643	0.1876	0.0633	0.14	0.68
60	0.0418	0.1573	0.0729	0.09	0.59
90	0.0000	0.1730	0.1313	0.00	0.66
120		0.1451	0.1334		0.60
150		0.1075	0.1243		0.48
180		0.0947	0.1273		0.50
210		0.0882	0.1100		0.43
240		0.0690	0.1084		0.38
270		0.0231	0.0823		0.23
300		0.0091	0.0622		0.15
330		0.0097	0.0575		0.15
360		0.0000	0.0455		0.10

## B.6 Photocatalytic degradation of 4-CP with 1% Pt/TiO<sub>2</sub>

### B.6.1 With oxygen aeration

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4555	0.0000	0.0000	1.00	1.00
30	0.1892	0.0647	0.0708	0.42	0.71
60	0.0916	0.0697	0.1193	0.20	0.62
90	0.0479	0.0611	0.1599	0.11	0.59
120	0.0313	0.0752	0.1453	0.01	0.55
150	0.0184	0.0590	0.1283	0.04	0.45
180		0.0489	0.1220	0.00	0.38
210		0.0361	0.1212		0.35
240		0.0244	0.1185		0.31
270		0.0164	0.1137		0.29
300		0.0103	0.1044		0.25
330		0.0000	0.0914		0.20
360		0.0000	0.0902		0.20

### B.6.2 With nitrogen aeration

Time (min)	Concentration (mM)				Remaining fraction	
	4-CP	HQ	HHQ	BQ	4-CP	TOC
0	0.4299	0.0000	0.0000	0.0000	1.00	1.00
30	0.2078	0.0651	0.0000	0.0177	0.48	0.44
60	0.1911	0.0530	0.0019	0.0189	0.44	0.62
90	0.0686	0.0735	0.0012	0.0210	0.16	0.38
120	0.0423	0.0788	0.0020	0.0213	0.10	0.34
150	0.0261	0.0811	0.0019	0.0244	0.06	0.31
180	0.0187	0.0829	0.0015	0.0259	0.04	0.30
210	0.0106	0.0888	0.0017	0.0206	0.02	0.28
240	0.0101	0.0884	0.0019	0.0221	0.02	0.29
270	0.0000	0.0854	0.0025	0.0240	0.00	0.26
300		0.0868	0.0023	0.0260	0.00	0.27
330		0.0867	0.0030	0.0271	0.00	0.27
360		0.0868	0.0023	0.0260	0.00	0.27

## B.7 Photocatalytic degradation of 4-CP with Ag/TiO<sub>2</sub> under the presence of dissolved oxygen

### B.7.1 With 0.2% Ag/TiO<sub>2</sub>

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4333	0.0000	0.0000	1.00	1.00
30	0.1557	0.1384	0.0617	0.36	0.82
60	0.0627	0.1790	0.0746	0.14	0.73
90	0.0318	0.1823	0.0817	0.07	0.68
120	0.0000	0.1437	0.0899	0.00	0.54
150		0.1245	0.0920		0.50
180		0.1044	0.1020		0.48
210		0.0894	0.1042		0.45
240		0.0967	0.0936		0.44
270		0.0824	0.0944		0.41
300		0.0696	0.0914		0.37
330		0.0519	0.0888		0.32
360		0.0183	0.0795		0.23

### B.7.2 With 0.5% Ag/TiO<sub>2</sub>

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4634	0.0000	0.0000	1.00	1.00
30	0.1449	0.1717	0.0482	0.31	0.79
60	0.0456	0.2002	0.0860	0.10	0.72
90	0.0000	0.1876	0.1008	0.00	0.62
120		0.1537	0.1163		0.58
150		0.1301	0.1414		0.59
180		0.0988	0.1486		0.53
210		0.0694	0.1400		0.45
240		0.0421	0.0955		0.30
270		0.0196	0.0757		0.21
300		0.0000	0.0532		0.11
330			0.0360		0.08
360			0.0180		0.04

B.7.3 With 1.0% Ag/TiO<sub>2</sub>

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4687	0.0000	0.0000	1.00	1.00
30	0.1533	0.1724	0.0991	0.33	0.91
60	0.1215	0.1290	0.0736	0.26	0.69
90	0.0000	0.1708	0.12611	0.00	0.63
120		0.1629	0.1340		0.63
150		0.1425	0.1394		0.60
180		0.11005	0.1219		0.47
210		0.0913	0.1265		0.46
240		0.0717	0.1098		0.39
270		0.0575	0.1021		0.34
300		0.0523	0.0969		0.32
330		0.0331	0.0913		0.27
360		0.0280	0.0855		0.24

B.7.4 With 1.5% Ag/TiO<sub>2</sub>

Time (min)	Concentration (mM)			Remaining fraction	
	4-CP	HQ	HHQ	4-CP	TOC
0	0.4023	0.0000	0.0000	1.00	1.00
30	0.1250	0.1145	0.0652	0.31	0.76
60	0.0343	0.1380	0.1130	0.09	0.71
90	0.0129	0.1337	0.1300	0.03	0.69
120	0.0000	0.1370	0.1438	0.00	0.70
150		0.1171	0.1462		0.65
180		0.1032	0.1392		0.60
210		0.0838	0.1305		0.53
240		0.0663	0.1217		0.47
270		0.0457	0.1065		0.38
300		0.0440	0.1071		0.38
330		0.0213	0.0907		0.28
360		0.0159	0.0872		0.26

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- 2000 Preliminary Study on Catalytic Pyrolysis and Degradation with Ethanol of PET
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- 1999 Student Trainee, Alliance Refining Co., Ltd., Map Ta Phut Industrial Estate, Rayong

