

References

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APPENDICES

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Appendix A

Identification of anhydrous beclomethasone dipropionate form of the product of Sigma Aldrich and V&S Chemi Group in DSC thermograms and patterns of XRPD

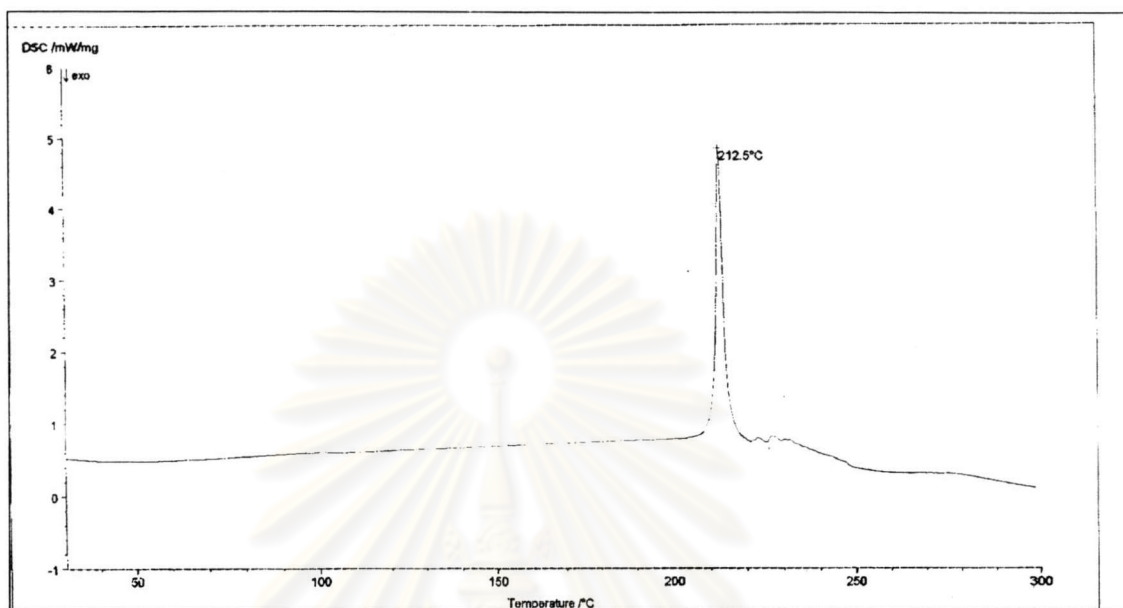


Figure 32 The DSC curve of anhydrous beclomethasone dipropionate of U&V Chemi Group at scanning rate 10°C/min

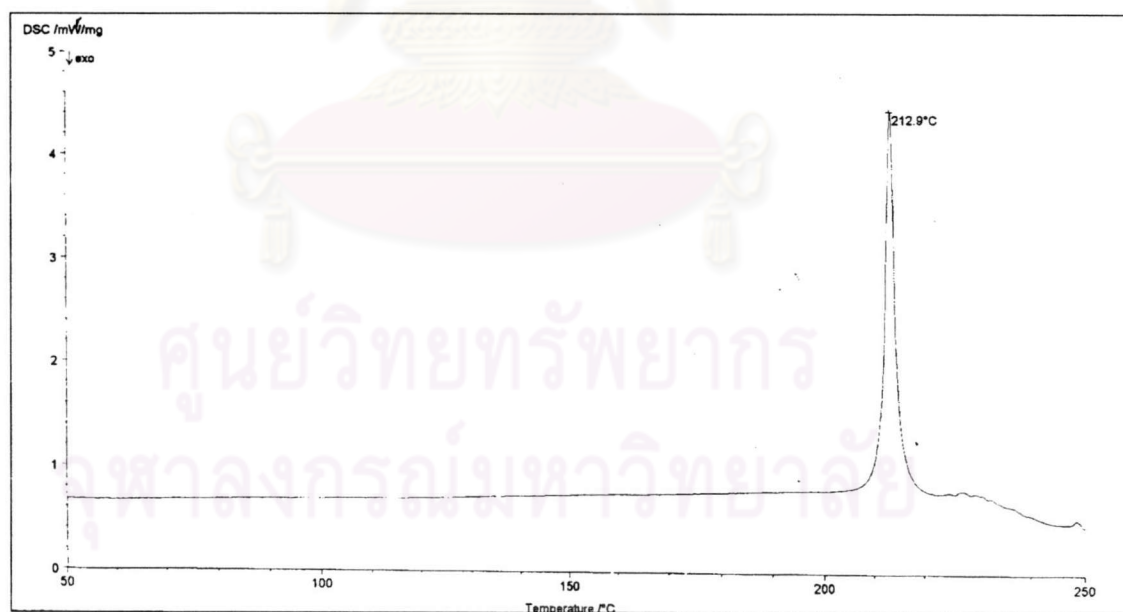


Figure 33 The DSC curve of anhydrous beclomethasone dipropionate of Sigma Aldrich at scanning rate 10°C/min

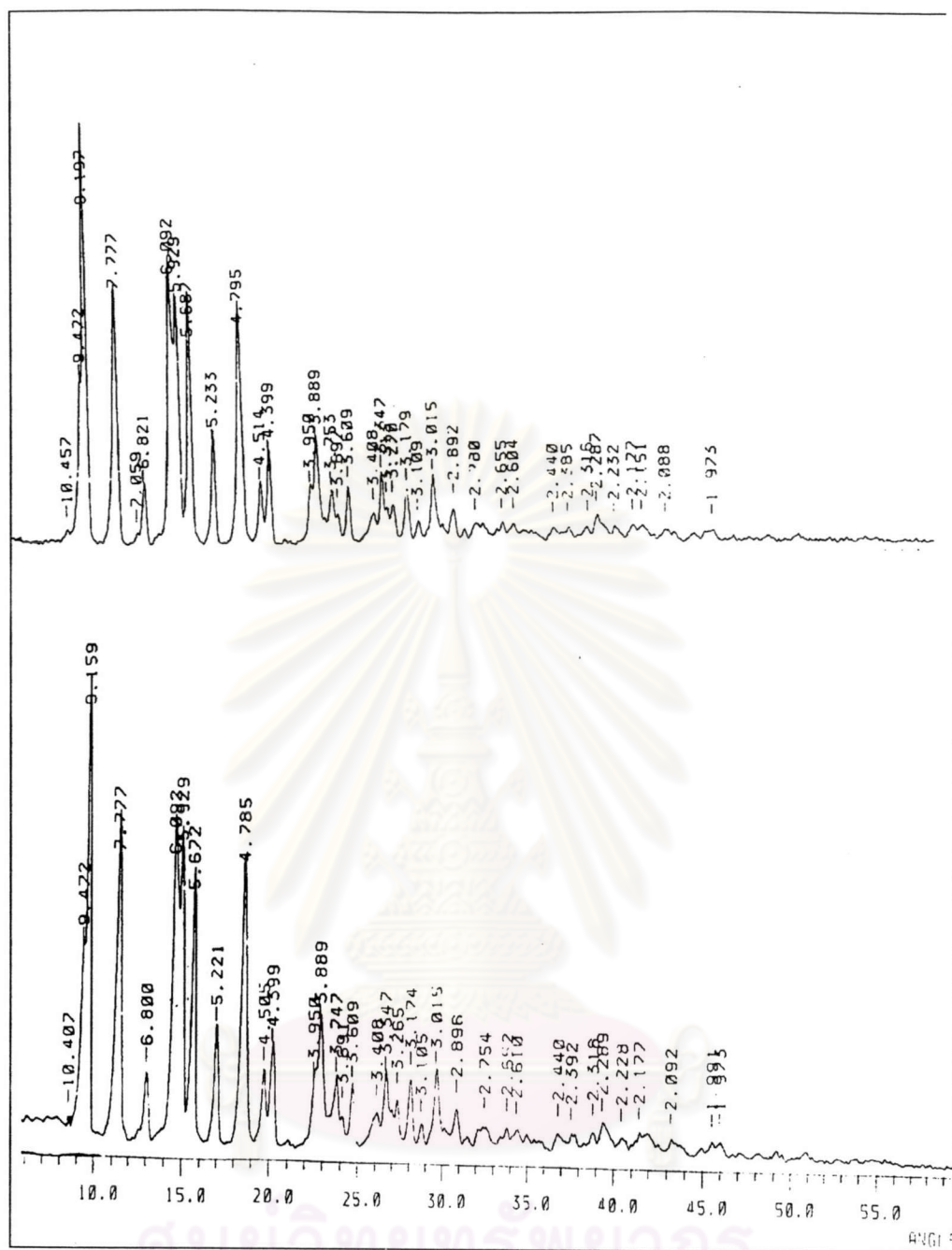


Figure 34 The comparison of x-ray pattern of anhydrous beclomethasone dipropionate

Top: The product of U&V Chemi Group; Bottom: The product of Sigma Aldrich

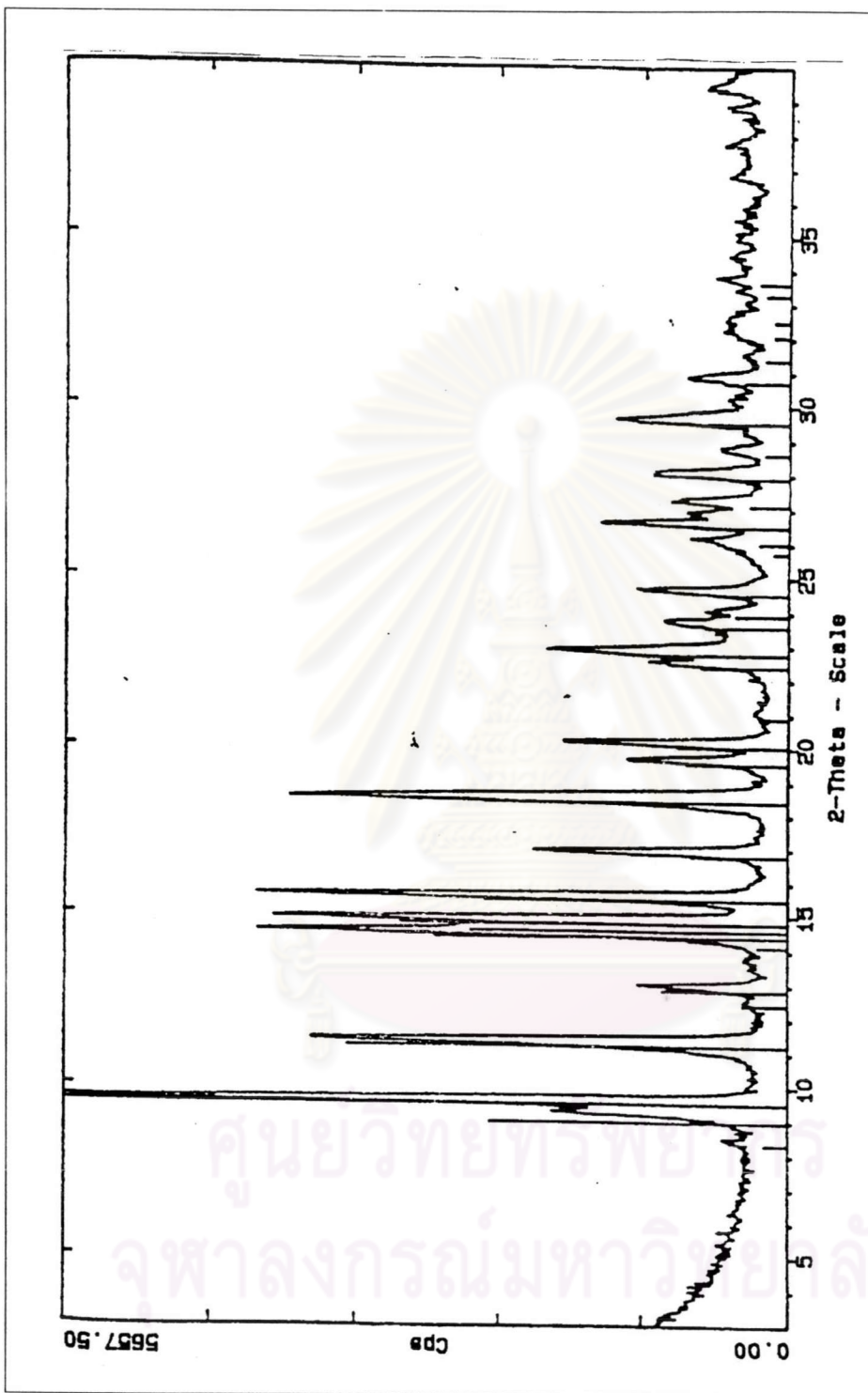


Figure 35 The x-ray pattern of anhydrous beclomethasone dipropionate from PDF standard

Appendix B

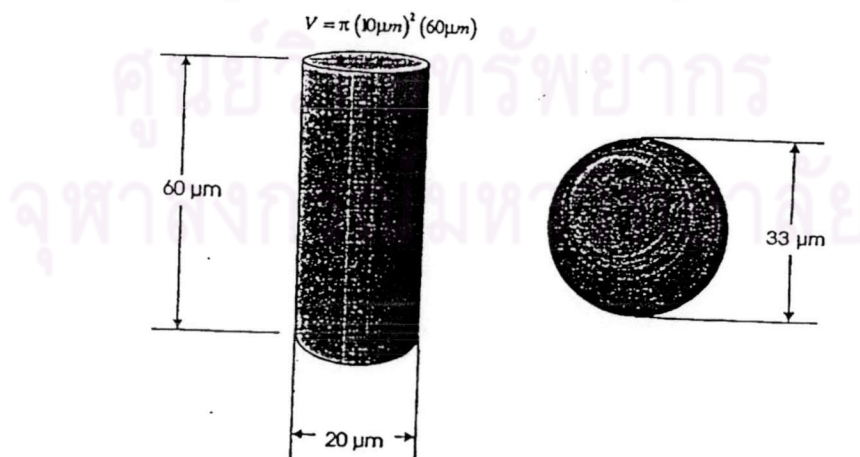
Particle size determination of beclomethasone dipropionate

The particle size of beclomethasone dipropionate was determined by Mastersizer S. It is a range of laser light scattering based particle sizers (Mastersizer particle size analyzer, Instrumental manual). The results reported by them are a number of fundamental concepts as follows:

- The result is volume based.
- The result is expressed in terms of equivalent spheres.
- The derivation of distribution parameters.

The first, this means that when the result lists, for example 11% of the distribution in the size category 6.97 – 7.75 microns this means that the total volume of all particles with diameters in this range represents 11% of the total volume of all particles in the distribution. The result performed as the peak of frequency curve.

The second point is that the distribution is expressed in terms of the volumes of equivalent spheres. Consider a cylindrical particle of diameter 20 microns and length 60 microns. The volume of the cylinder is:



The sphere of equivalent volume would have a diameter center on:

$$\sqrt[3]{\frac{6V}{\pi}} = 33\mu m$$

With a spread from 20 to 60 microns.

It is interesting to compare this with other techniques. Sieving would pass the particles through a 20 microns aperture and classify them as 20 microns. Sedimentation would give a result related to the total surface area, in this case reporting a diameter of around 40 microns.

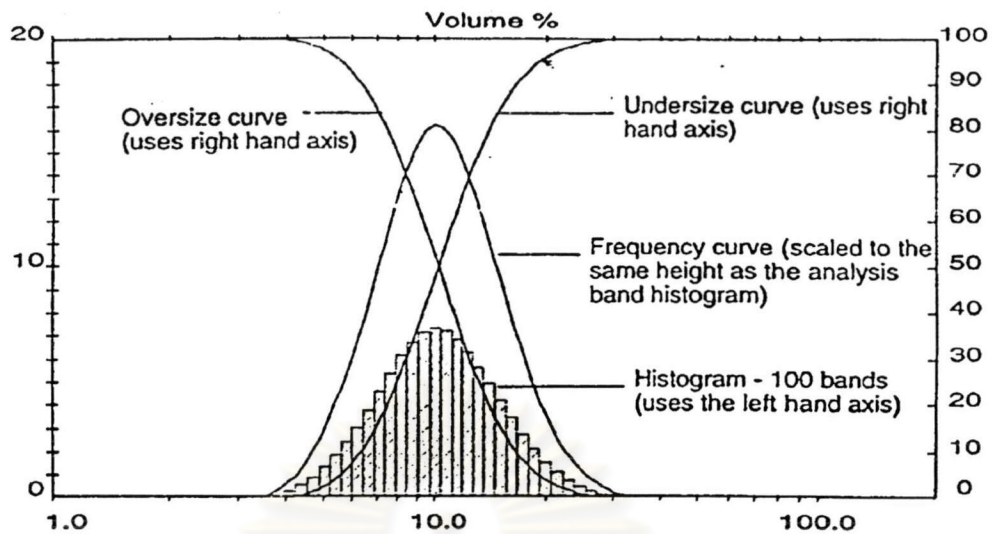
If wishing to correlate laser diffraction results with values from some other techniques, it might consider applying a shape correction using the result modification procedure built into the Malvern program.

The third point is that the analyzed distribution is a set of size classes, which the representative diameter for each class is taken to be the geometric mean of the size band limits:

The frequency curve is obtained by differentiating the cumulative undersize curve. The peak of the frequency curve gives the modal diameter - the most commonly occurring refer the particle diameter.

The figure below shows examples of the result graph types.

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The result from the analysis is the relative distribution of volume of particles in the range of size classes. From this basic result the statistics of the distribution are calculated. Moreover, the span and uniformity are calculated for described the distribution of the particles. The span gives a description of the width of the distribution which is independent of the median size. The uniformity is a measure of the absolute deviations from the median.

The interpolated results allow the cumulative undersize result to be determined for any size or the size can be determined for any percent of the total result under that size. This latter is known as percentile. The result tables have listed the percentile size for 10%, 50%, 90%.

The 50% volume percentile, expressed as $d(v,0.5)$ is also known as the median of the volume distribution. The v in the expression shows that this refers to the volume distribution. There are the 10% and 90% cutoffs respectively for the distribution. i.e.,

$d(v,0.9)$ – 90% of the distribution is below this value

$d(v,0.1)$ – 10% of the distribution is below this value

The span of the distribution is defined as :

$$Span = \frac{d(v,0.9) - d(v,0.1)}{d(v,0.5)}$$

The uniformity of the distribution is defined as:

$$Uniformity = \frac{\sum X_i (d(v,0.5) - d_i)}{d(v,0.5) \sum X_i}$$

where : $d(v,0.5)$ is the median size of the distribution.

d_i and X_i are respectively the mean diameter of, and result in size class i

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Table 15 Particle size of beclomethasone dipropionate monohydrate at various rate of adding water conditions

Particle size of beclomethasone dipropionate monohydrate at various rate of adding water conditions										
Rate	D(v,0.1)	Ave.	D(v,0.5)	Ave.	D(v,0.9)	Ave.	Span	Ave.	Uniformity	Ave.
7 ml/hr	131.65	127.25	444.38	431.07	780.56	753.74	1.88	1.89	0.58	0.58
	128.43		433.73		796.88		2.00		0.63	
	121.67		415.10		683.79		1.78		0.55	
23 ml/hr	89.90	85.36	268.98	261.67	664.04	694.84	2.14	2.23	0.66	0.73
	84.59		261.32		702.31		2.36		0.72	
	81.59		254.70		718.16		2.20		0.79	
60 ml/hr	66.85	65.36	221.66	208.30	527.73	474.83	2.19	2.22	0.66	0.61
	61.27		203.67		455.47		2.34		0.58	
	67.95		199.56		441.29		2.12		0.59	
120 ml/hr	43.66	39.12	179.03	159.07	618.39	570.26	3.21	3.35	0.95	1.00
	37.91		152.78		572.29		3.50		1.02	
	35.79		145.40		520.11		3.33		1.02	
300ml/hr	10.97	10.69	65.81	64.98	253.33	249.79	3.68	3.68	1.10	1.10
	10.66		64.67		250.20		3.70		1.11	
	10.45		64.46		245.84		3.65		1.10	

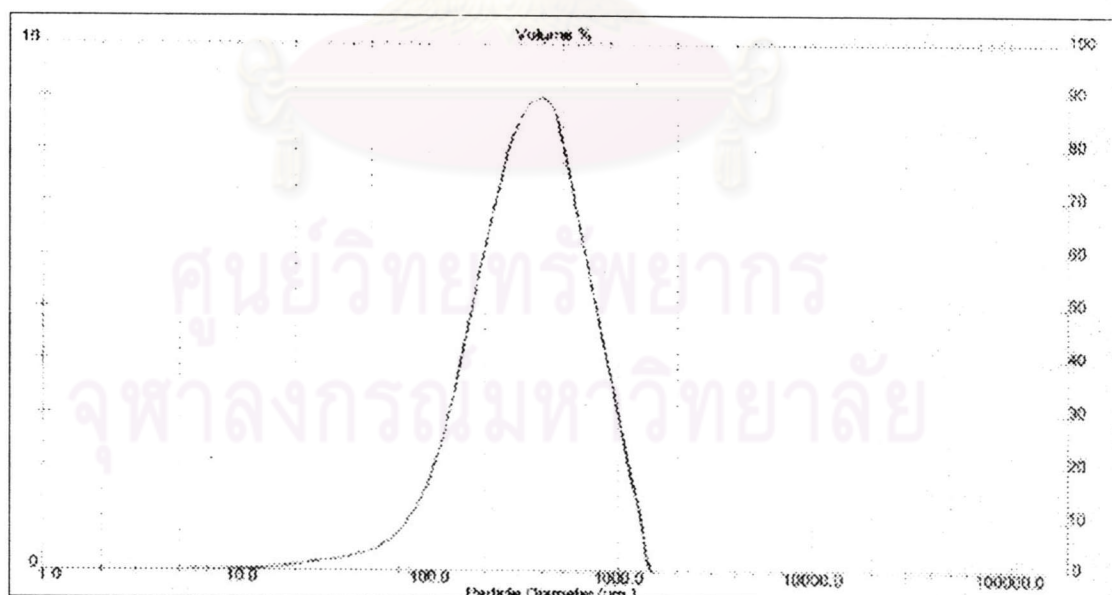


Figure 36 The example of size distribution curve of adding rate at 7 ml/hr

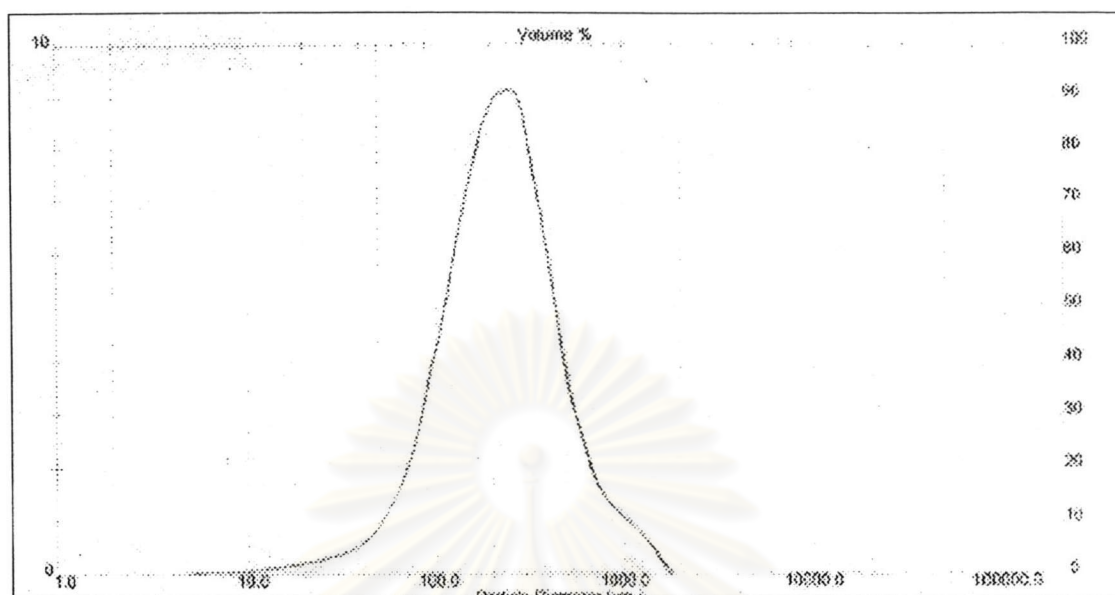


Figure 37 The example of size distribution curve of adding rate at 23 ml/hr

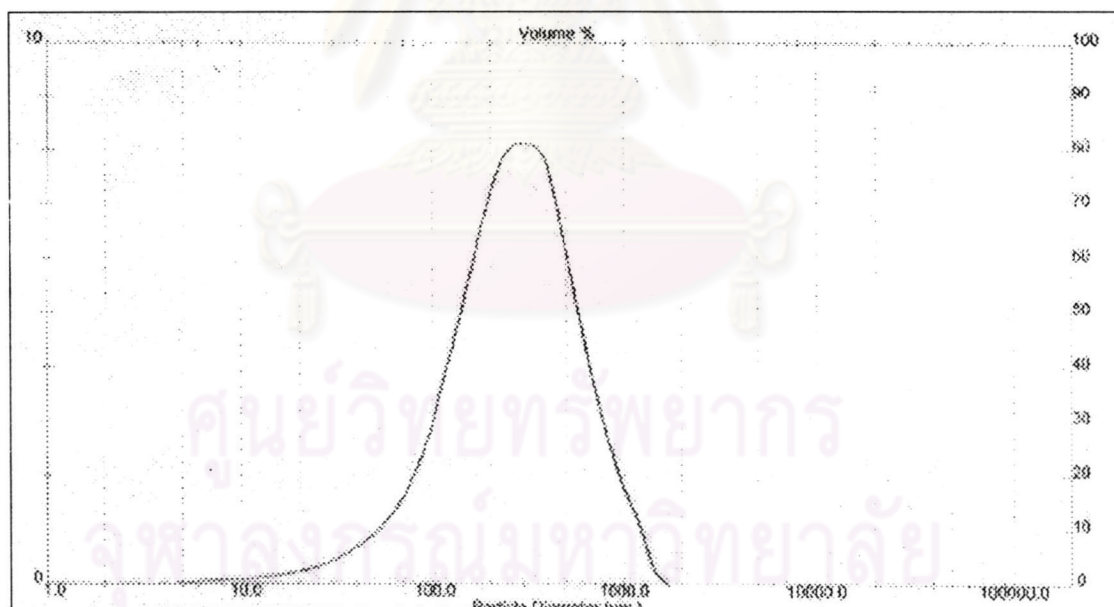


Figure 38 The example of size distribution curve of adding rate at 60 ml/hr

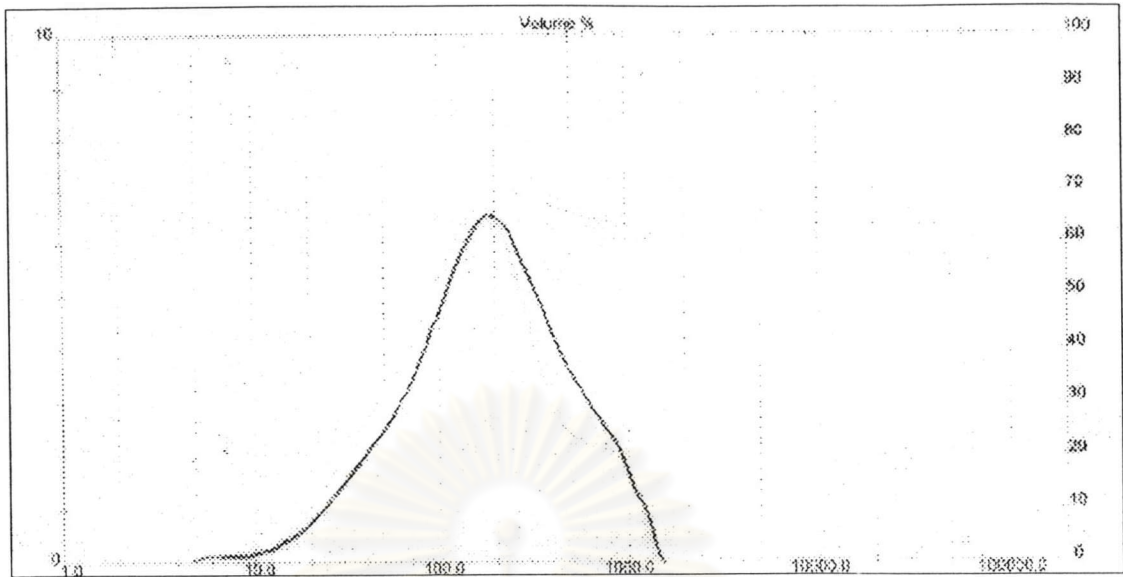


Figure 39 The example of size distribution curve of adding rate at 120 ml/hr

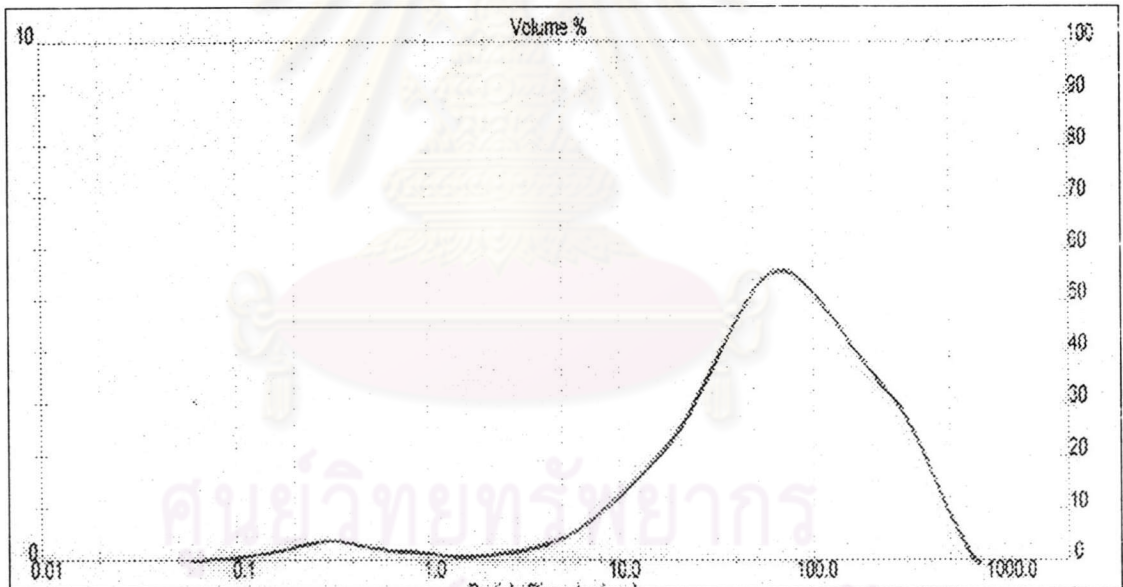


Figure 40 The example of size distribution curve of adding rate at 300 ml/hr

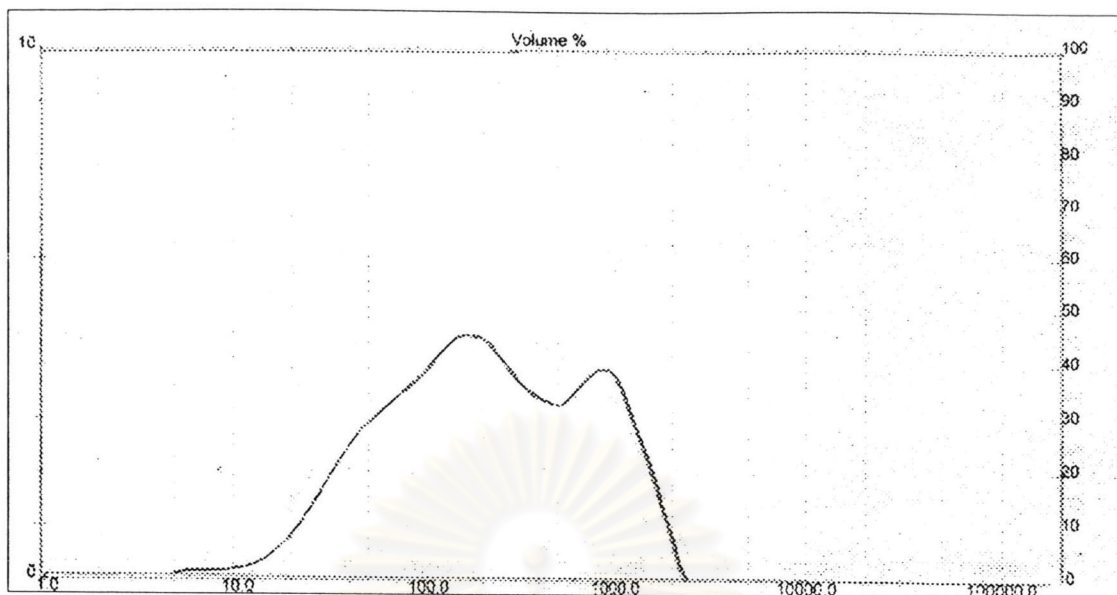


Figure 41 The example of size distribution curve of adding rate at 7 ml/hr (without paddle stir)

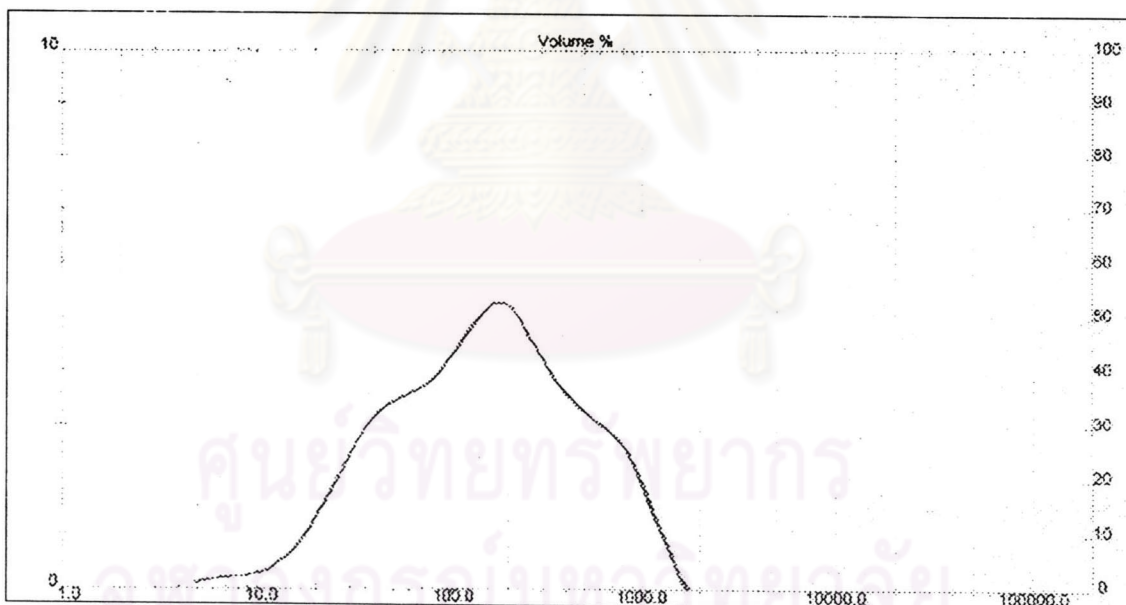


Figure 42 The example of size distribution curve of adding rate at 23 ml/hr (without paddle stir)

Table 16 Particle size of beclomethasone dipropionate monohydrate after sieve fractions

Particle size of beclomethasone dipropionate monohydrate after sieves fraction										
samples	D(v,0.1)	Ave.	D (v,0.5)	Ave.	D(v,0.9)	Ave.	Span	Ave.	Uniformity	Ave.
large (Intact)	223.62		441.10		764.28		1.23		0.38	
	210.49	213.93	429.41	429.89	773.53	758.79	1.31	1.27	0.41	0.39
	207.69		419.17		738.55		1.27		0.39	
medium	83.44		150.37		260.01		1.17		0.37	
	84.05	83.80	151.21	150.80	258.47	259.39	1.15	1.16	0.36	0.37
	83.92		150.83		259.68		1.17		0.37	
small	7.49		75.12		123.71		1.55		0.41	
	2.96	4.24	52.62	63.88	115.54	123.13	2.14	1.90	0.69	0.58
	2.28		63.90		130.15		2.00		0.63	

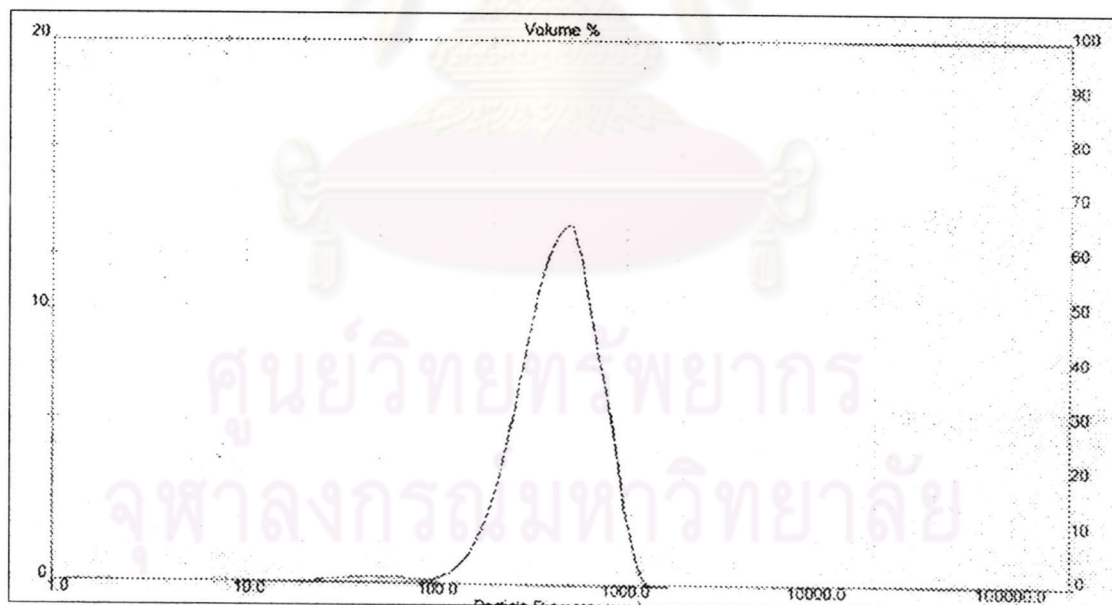


Figure 43 The example of size distribution curve of large crystal (intact)

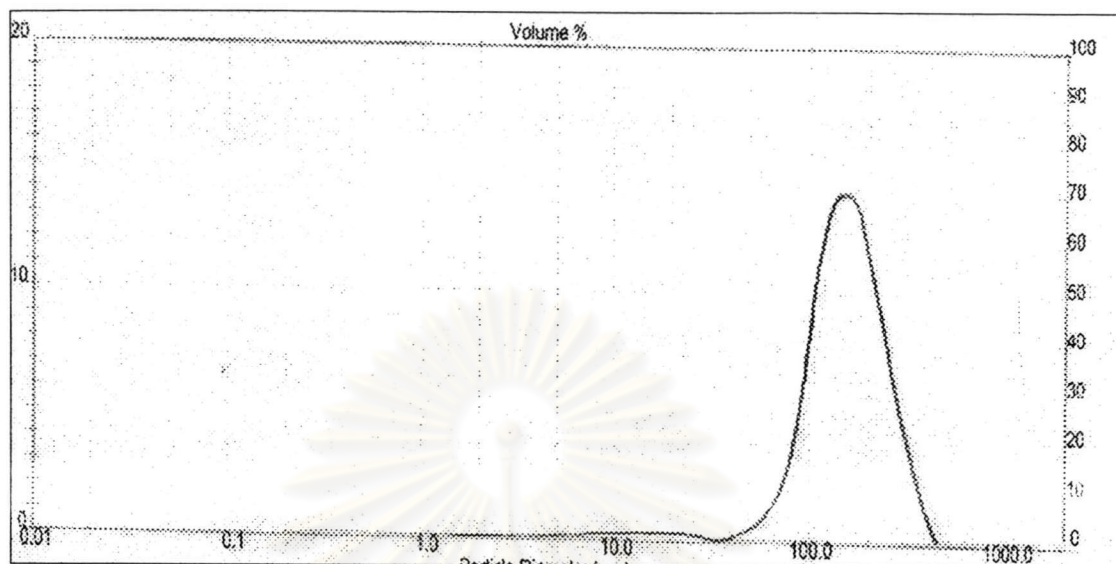


Figure 44 The example of size distribution curve of medium crystal

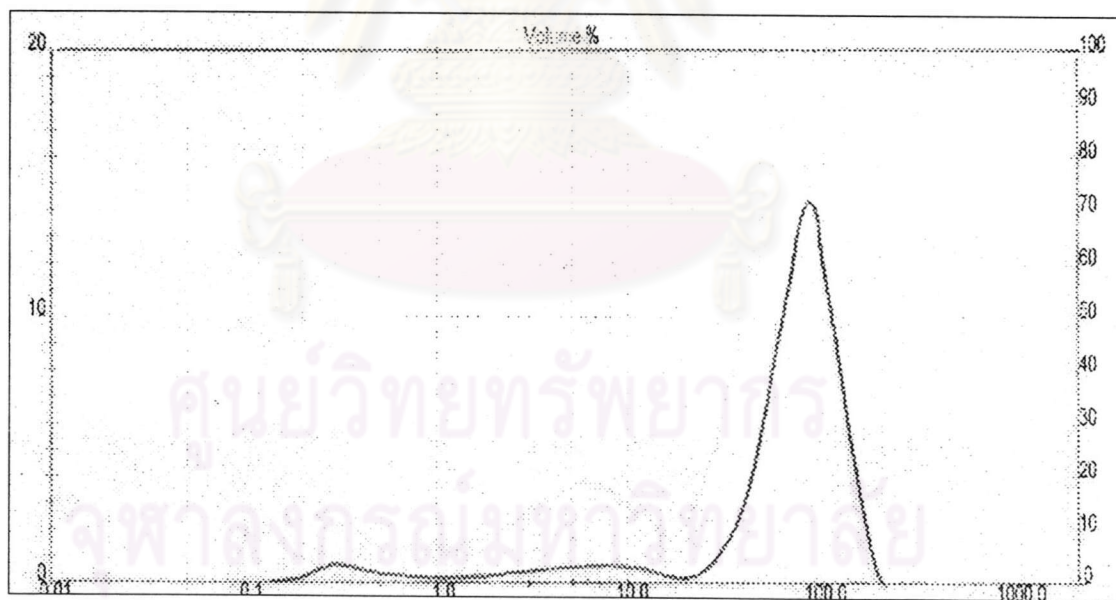


Figure 45 The size distribution curve of small crystal (n_1)

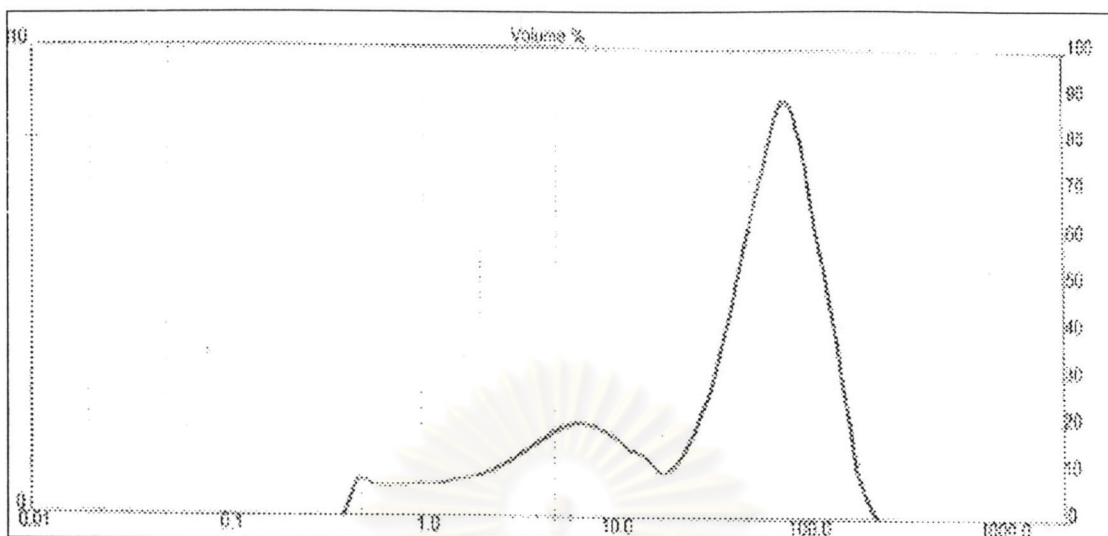


Figure 46 The size distribution curve of small crystal (n₂)

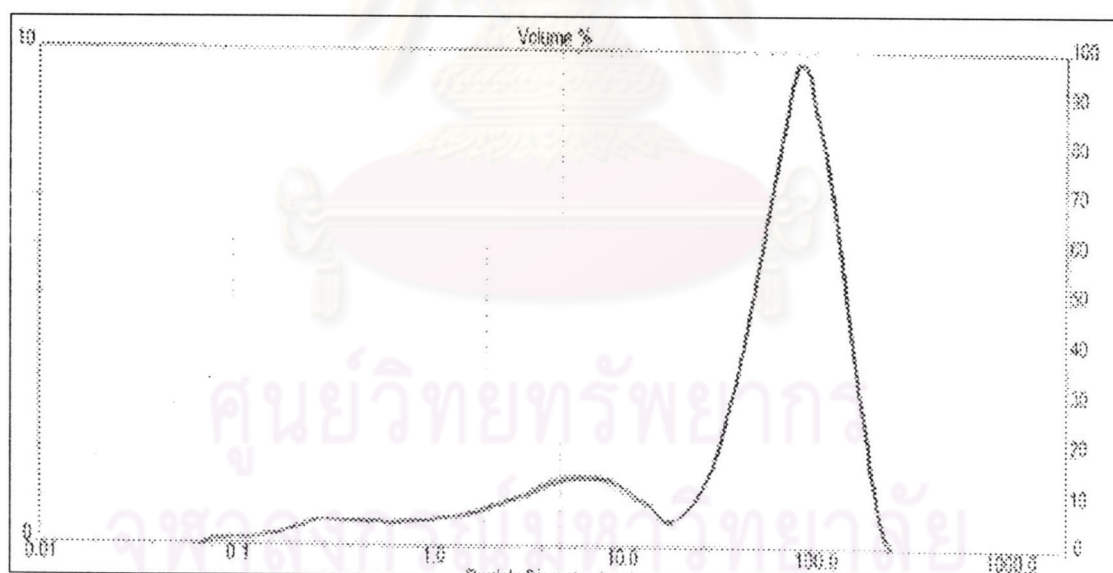


Figure 47 The size distribution curve of small crystal (n₃)

Table17 Particle size of large crystals (intact) of beclomethasone dipropionate monohydrate after dehydration

Particle size of large crystal of beclomethasone dipropionate monohydrate after dehydration										
Temp	D(v,0.1)	Ave.	D(v,0.5)	Ave.	D(v,0.9)	Ave.	Span	Ave.	Uniformity	Ave.
85.5 C	13.06		46.85		132.44		1.91		0.62	
	13.58	13.70	47.58	48.10	127.65	131.23	1.86	1.90	0.61	0.62
	14.45		49.88		133.59		1.92		0.62	
74.5 C	20.26		58.64		120.20		2.29		0.74	
	20.30	20.36	57.58	58.34	116.98	120.34	2.17	2.22	0.68	0.71
	20.51		58.79		123.85		2.19		0.71	
65.0 C	34.20		112.98		230.07		1.73		0.53	
	32.53	34.57	112.25	112.31	229.02	226.29	1.75	1.71	0.53	0.52
	36.99		111.71		219.78		1.64		0.50	
55.0 C	132.77		308.34		682.94		1.78		0.55	
	134.13	134.57	312.25	311.54	660.44	665.86	1.69	1.71	0.52	0.53
	136.82		314.04		654.20		1.65		0.51	

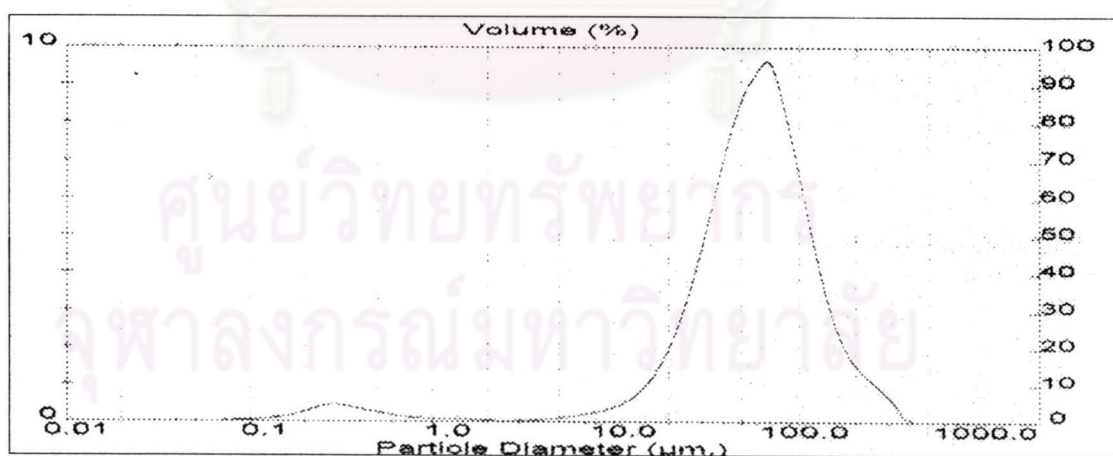


Figure 48 The example of size distribution curve of dehydrated large crystals at 85.5 °C

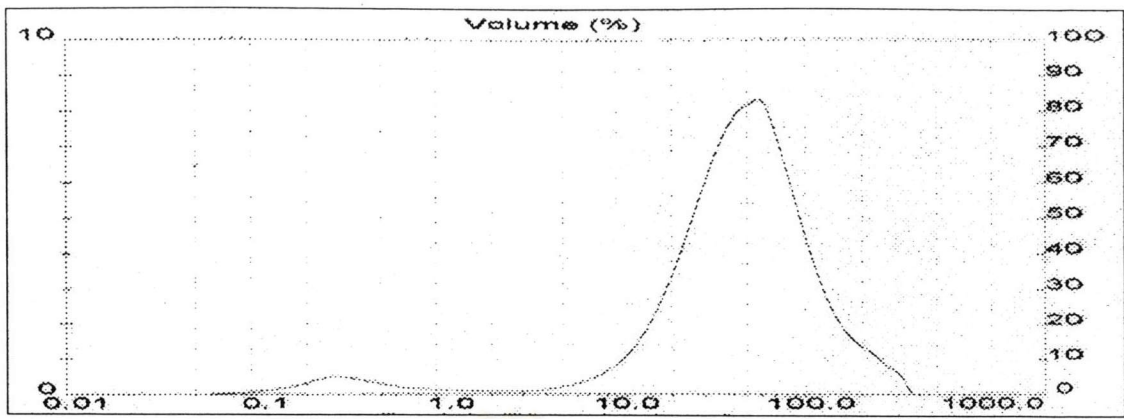


Figure 49 The example of size distribution curve of dehydrated large crystals at 74.5 °C

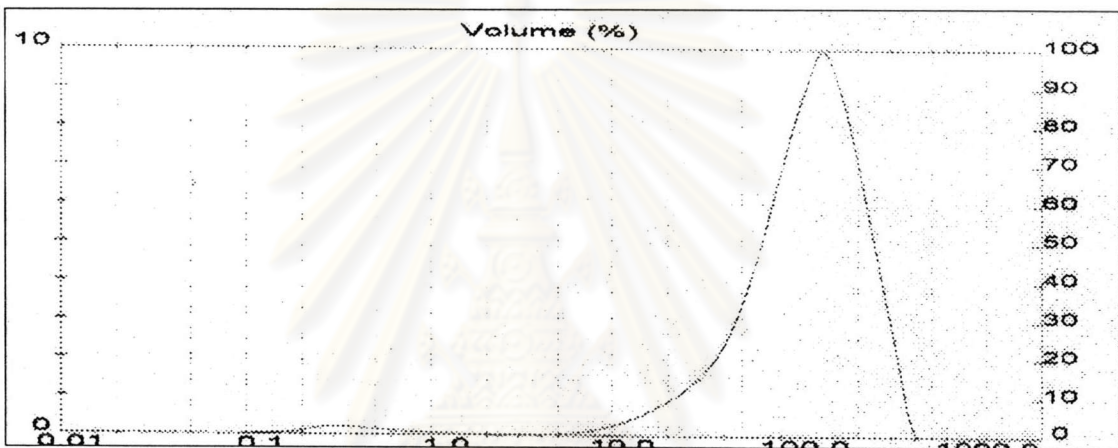


Figure 50 The example of size distribution curve of dehydrated large crystals at 65 °C

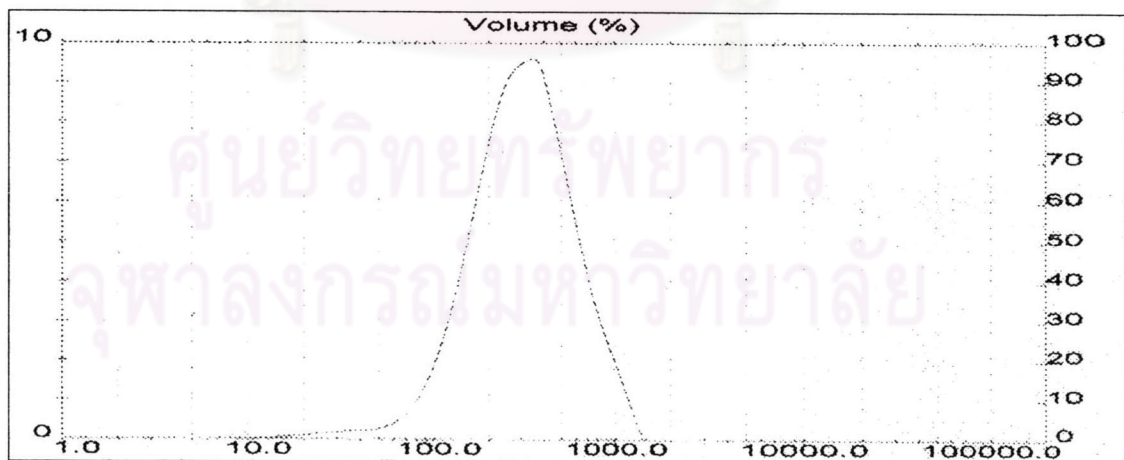


Figure 51 The example of size distribution curve of dehydrated large crystals at 56 °C

Table18 Particle size of medium crystals of beclomethasone dipropionate monohydrate after dehydration

Particle size of medium crystals of beclomethasone dipropionate monohydrate after dehydration										
Temp	D(v,0.1)	Ave.	D(v,0.5)	Ave.	D(v,0.9)	Ave.	Span	Ave.	Uniformity	Ave.
80.0 C	10.59		42.65		98.56		2.06		0.67	
	10.76	10.73	42.85	42.78	97.10	96.73	2.02	2.01	0.66	0.65
	10.83		42.85		94.52		1.95		0.61	
74.5 C	14.85		44.52		114.31		2.37		0.73	
	15.41	15.32	45.77	45.39	113.84	112.93	2.30	2.30	0.71	0.71
	15.69		45.89		110.64		2.24		0.69	
70.0 C	13.56		46.71		118.76		2.25		0.73	
	13.73	13.77	46.35	46.68	109.97	112.83	2.08	2.12	0.66	0.68
	14.03		46.97		109.76		2.04		0.65	

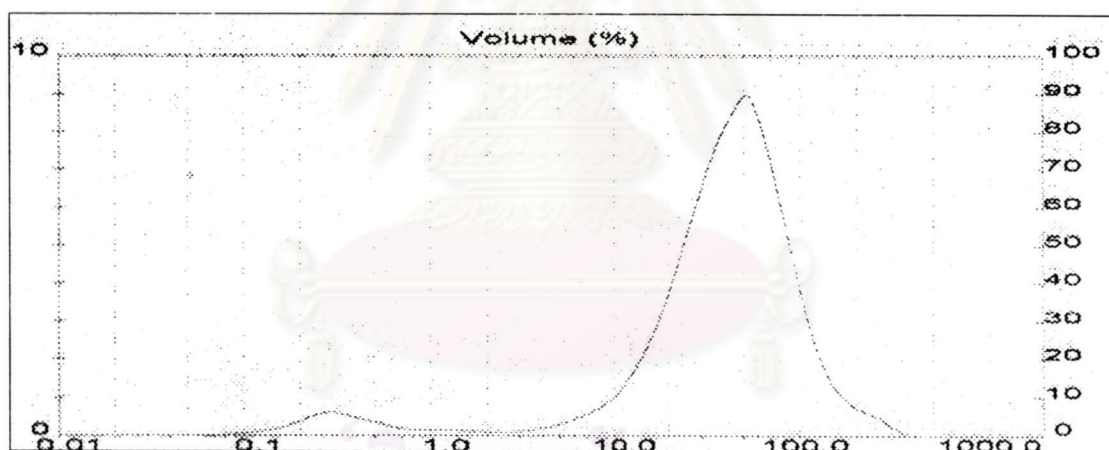


Figure 52 The example of size distribution curve of dehydrated medium crystals at 80 °C

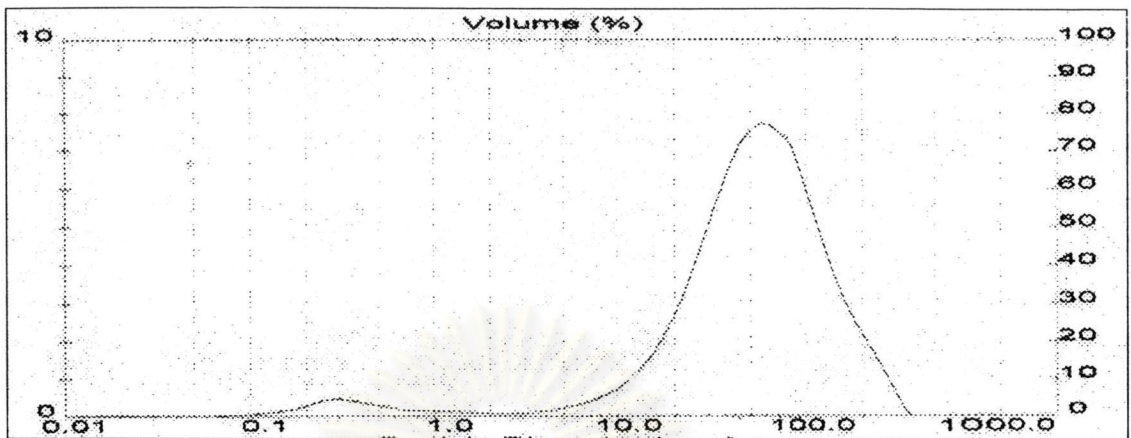


Figure 53 The example of size distribution curve of dehydrated medium crystals at 74.5 °C

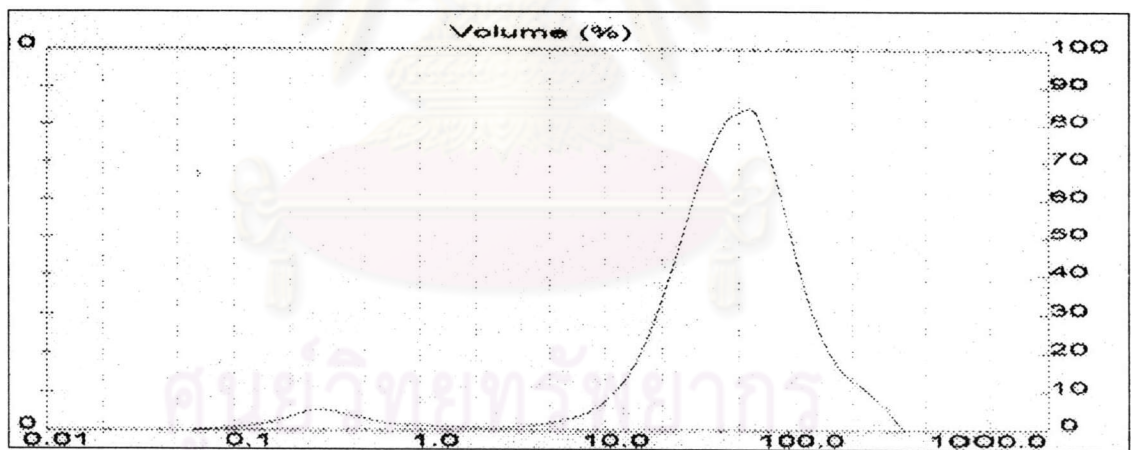


Figure 54 The example of size distribution curve of dehydrated medium crystals at 70 °C

Table 19 Particle size of small crystals of beclomethasone dipropionate monohydrate after dehydration

Particle size of small crystals of beclomethasone dipropionate monohydrate after dehydration										
Temp	D(v,0.1)	Ave.	D(v,0.5)	Ave.	D(v,0.9)	Ave.	Span	Ave.	Uniformity	Ave.
101.5 C	9.11		36.78		73.85		1.76		0.54	
	8.70	8.81	36.36	36.41	73.26	73.29	1.78	1.77	0.55	0.54
	8.63		36.09		72.77		1.78		0.55	
90.5 C	14.75		46.24		100.75		1.86		0.64	
	15.60	15.54	46.77	46.82	101.33	101.34	1.83	1.83	0.63	0.63
	16.28		47.44		101.95		1.81		0.61	
85.5 C	16.85		46.70		93.54		1.64		0.55	
	17.96	17.93	47.71	47.78	95.63	95.66	1.63	1.63	0.55	0.54
	18.97		48.94		97.81		1.61		0.54	
80.0 C	15.59		46.07		95.17		1.73		0.58	
	16.10	16.19	46.75	46.81	96.38	96.47	1.72	1.72	0.57	0.57
	16.87		47.60		97.87		1.70		0.57	

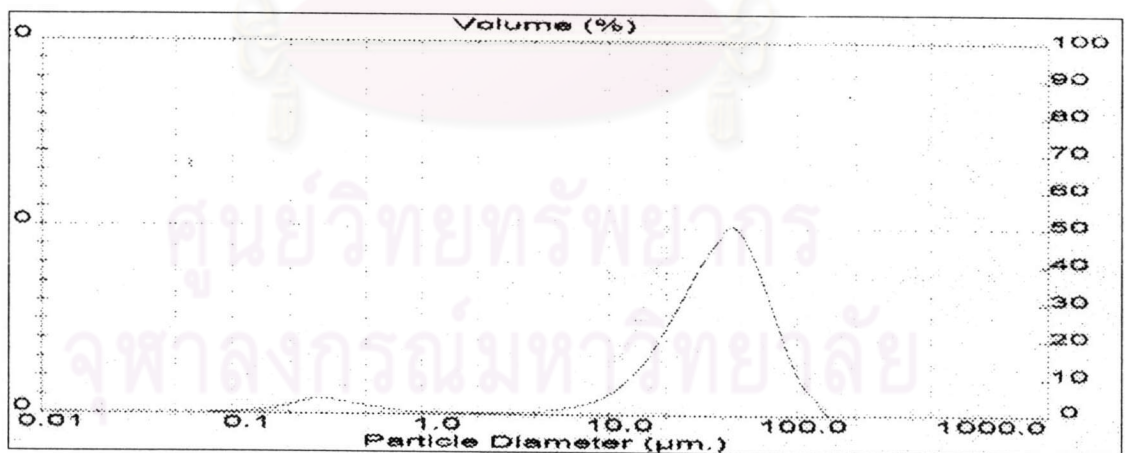


Figure 55 The example of size distribution curve of dehydrated small crystals at 101.5 °C

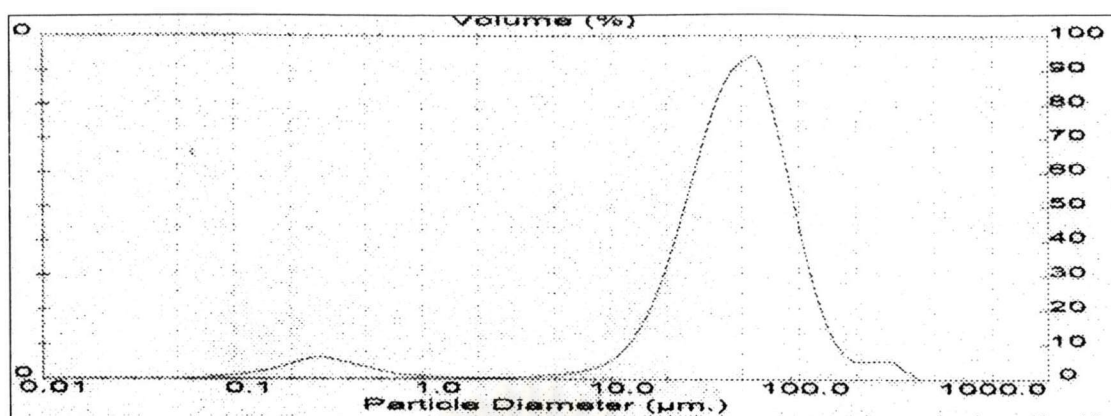


Figure 56 The example of size distribution curve of dehydrated small crystals at 90.5 °C

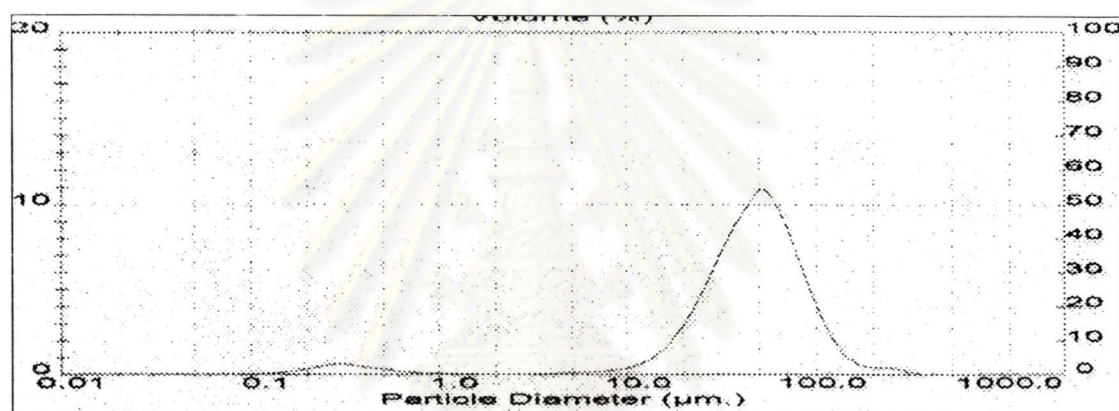


Figure 57 The example of size distribution curve of dehydrated small crystals at 85.5 °C

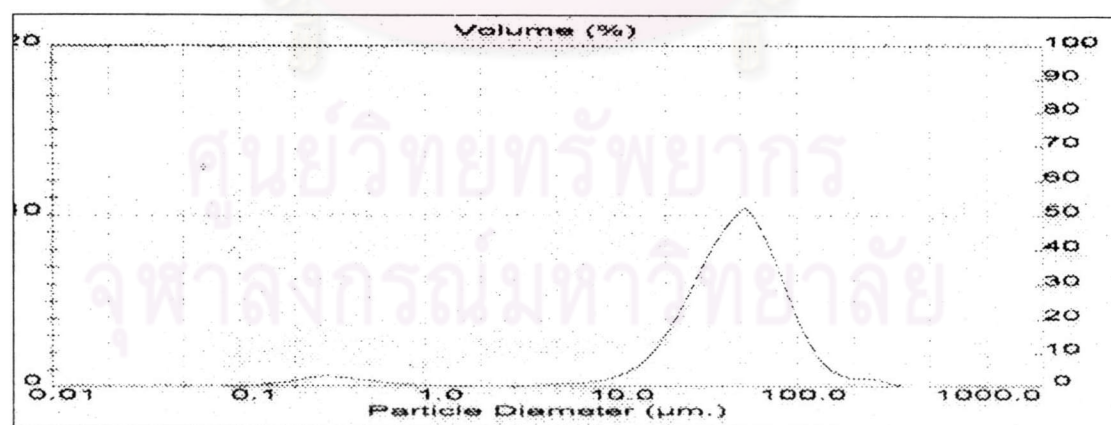


Figure 58 The example of size distribution curve of dehydrated small crystals at 80 °C

Appendix C

Table 20 Concentration and absorbance data for calibration curve of the beclomethasone dipropionate in water: alcohol = 8:2

Standard curve of BCP in water:alc 8:2 at 243 nm					
Conc. (mcg/ml)	Absorbance			Ave.	SD
	n ₁	n ₂	n ₃		
5	0.164	0.165	0.166	0.161	0.003
7.5	0.236	0.238	0.235	0.235	0.002
10	0.325	0.323	0.325	0.327	0.002
15	0.475	0.476	0.475	0.474	0.001
20	0.628	0.632	0.627	0.625	0.004

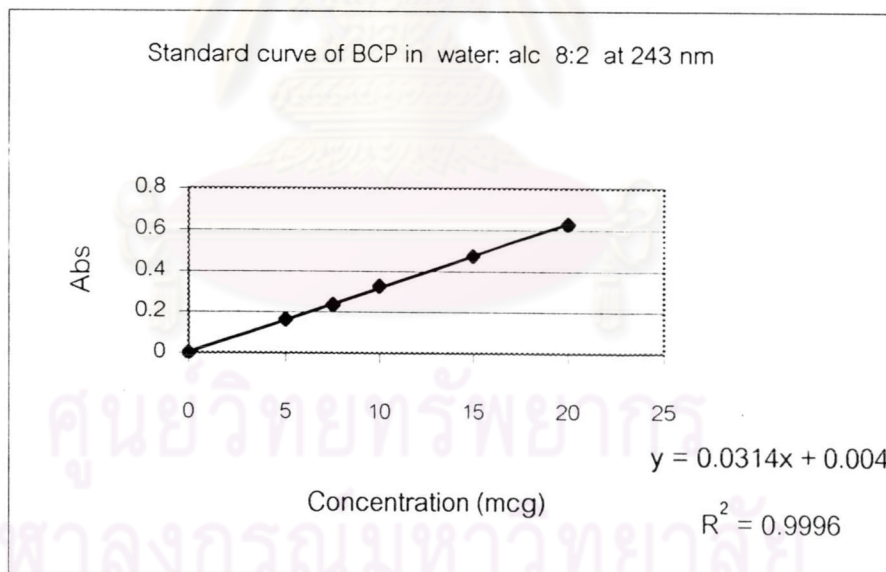


Figure 59 Calibration curve for the beclomethasone dipropionate in water:alcohol 8:2 using absorption spectroscopy at $\lambda = 243$ nm

Table 21 Concentration and absorbance data for calibration curve of the beclomethasone dipropionate in water: alcohol = 5:5

Standard curve of BCP in water:alc 5:5 at 241.5 nm					
Conc. (mcg/ml)	Absorbance			Ave.	SD
	n ₁	n ₂	n ₃		
5	0.166	0.163	0.167	0.168	0.003
10	0.321	0.322	0.320	0.321	0.001
15	0.477	0.474	0.475	0.482	0.004
20	0.648	0.65	0.649	0.645	0.003
30	0.938	0.939	0.939	0.936	0.002

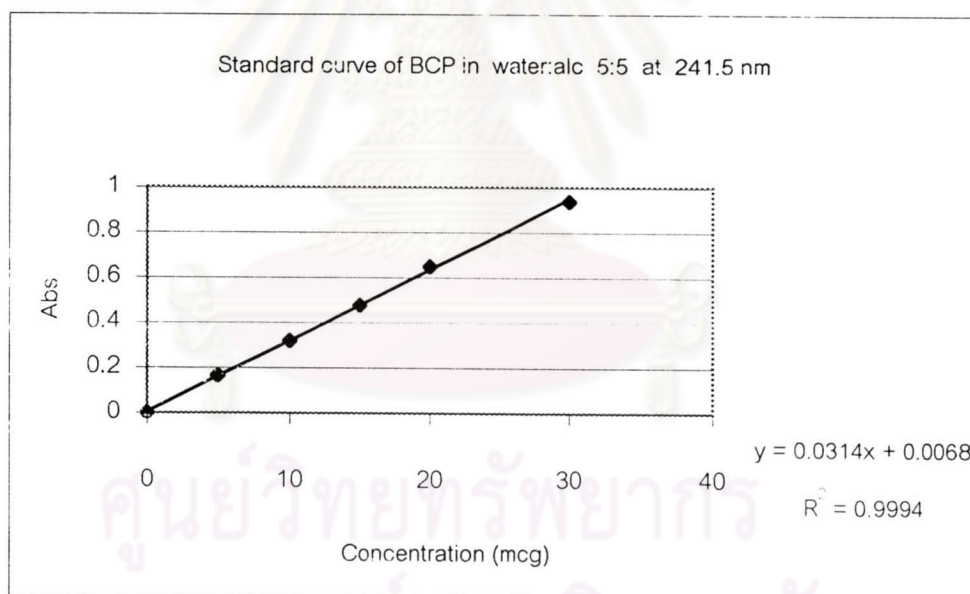


Figure 60 Calibration curve for the beclomethasone dipropionate in water:alcohol 5:5 using absorption spectroscopy at $\lambda = 241.5$ nm

Table 22 Concentration and absorbance data for calibration curve of the beclomethasone dipropionate in water: alcohol = 2:8

Standard curve of BCP in water:alc 2:8 at 242 nm					
Conc. (mcg/ml)	Absorbance			Ave.	SD
	n ₁	n ₂	n ₃		
5	0.16	0.159	0.162	0.159	0.002
10	0.322	0.321	0.322	0.323	0.001
15	0.479	0.474	0.488	0.475	0.008
20	0.651	0.653	0.651	0.649	0.002
30	0.942	0.941	0.938	0.947	0.005

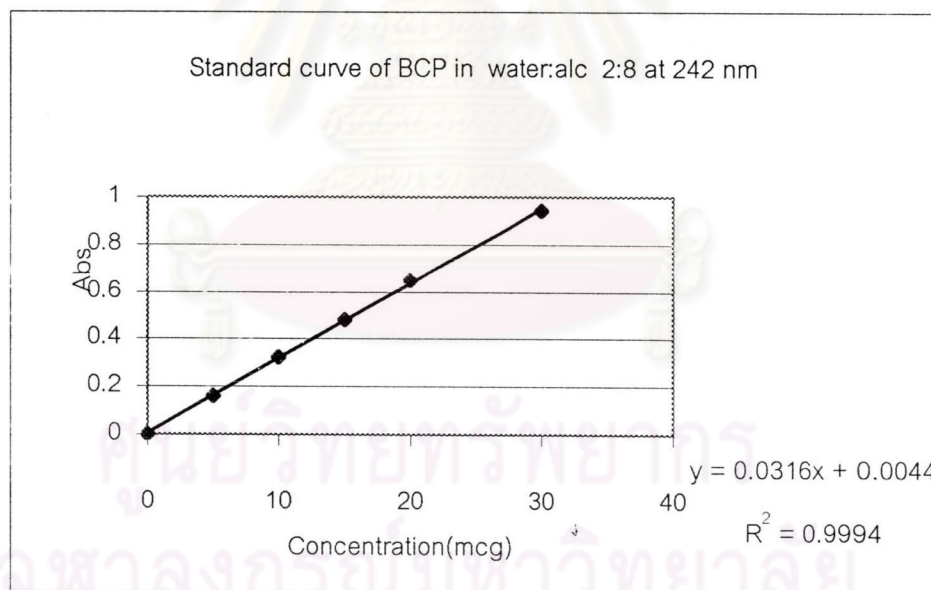


Figure 61 Calibration curve for the beclomethasone dipropionate in water:alcohol 2:8 using absorption spectroscopy at $\lambda = 242$ nm

Table 23 Solubility data of beclomethasone dipropionate in water:alcohol 8:2

Time (hr)	Abs. at $\lambda = 243$ nm			Conc. at $\lambda = 243$ nm			Ave Conc. (mcg/ml)	Conc. (mg/ml)	SD
	n_1	n_2	n_3	n_1	n_2	n_3			
1	0.038	0.038	0.035	1.083	1.083	0.987	1.051	0.0011	0.055
3	0.052	0.051	0.047	1.529	1.497	1.369	1.465	0.0015	0.084
7	0.124	0.058	0.058	3.822	1.720	1.720	2.420	0.0024	1.214
9	0.164	0.131	0.121	5.096	4.045	3.726	4.289	0.0043	0.717
12	0.088	0.049	0.051	2.675	1.433	1.497	1.868	0.0019	0.699
24	0.051	0.053	0.052	1.497	1.561	1.529	1.529	0.0015	0.032
30	0.055	0.048	0.049	1.624	1.401	1.433	1.486	0.0015	0.121
36	0.053	0.051	0.050	1.561	1.497	1.465	1.507	0.0015	0.049

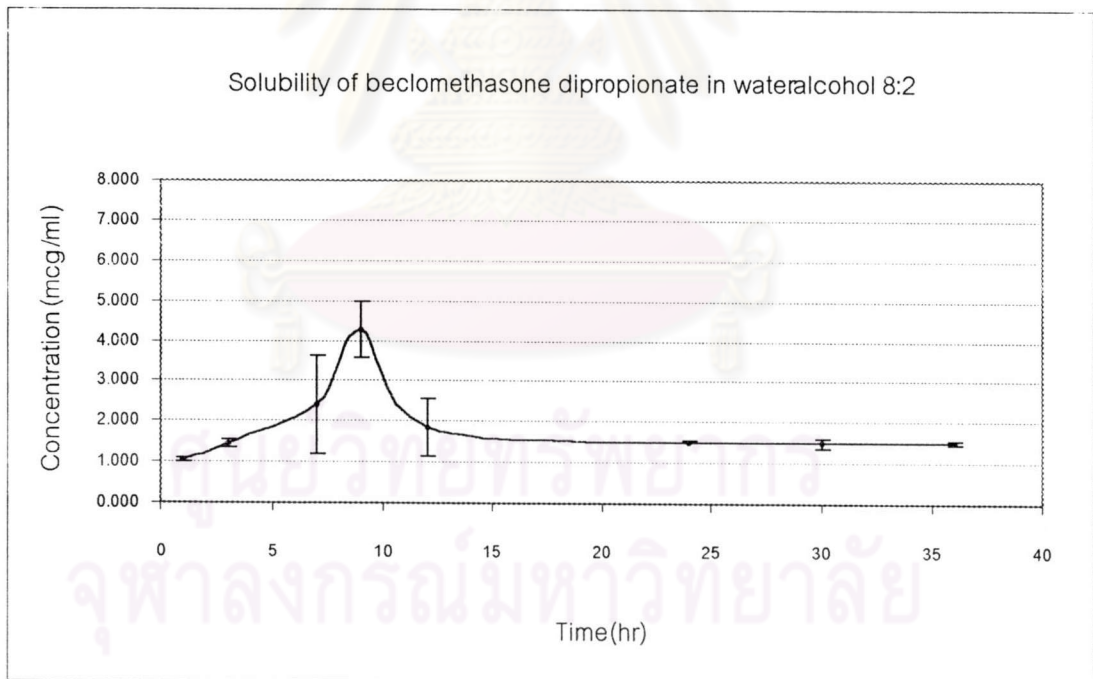


Figure 62 Solubility curve of beclomethasone dipropionate in water:alcohol 8:2

Table 24 Solubility data of beclomethasone dipropionate in water:alcohol 5:5

Time (hr)	Abs at $\lambda = 241.5$ nm			Conc. at $\lambda = 241.5$			Ave Conc. (mg/ml)	Dilution Factor	SD
	n_1	n_2	n_3	n_1	n_2	n_3			
1	0.348	0.352	0.310	0.217	0.220	0.193	0.210	20	0.015
3	0.605	0.535	0.559	0.381	0.336	0.352	0.356	20	0.023
7	0.626	0.554	0.557	0.394	0.349	0.350	0.364	20	0.026
9	0.564	0.628	0.662	0.355	0.396	0.417	0.389	20	0.032
12	0.666	0.758	0.686	0.420	0.478	0.433	0.444	20	0.031
24	0.712	0.509	0.666	0.449	0.320	0.420	0.396	20	0.068
30	0.616	0.612	0.603	0.388	0.385	0.380	0.384	20	0.004
36	0.615	0.614	0.610	0.387	0.387	0.384	0.386	20	0.002

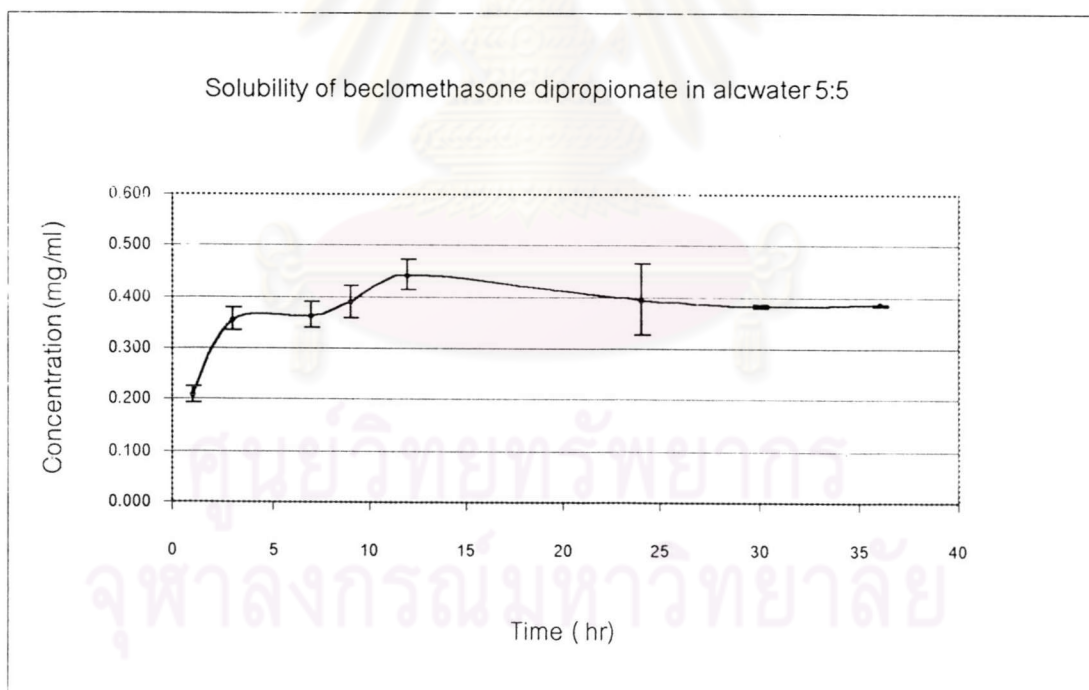


Figure63 Solubility curve of beclomethasone dipropionate in water:alcohol 5:5

Table 25 Solubility data of beclomethasone dipropionate in water:alcohol 2:8

Time (hr)	Abs. at $\lambda = 242$ nm			Conc. at $\lambda = 242$ nm			Ave (mg/ml)	Dilution Factor	SD
	n_1	n_2	n_3	n_1	n_2	n_3			
1	0.522	0.413	0.750	4.095	3.233	5.899	4.409	250	1.360
3	0.586	0.437	0.854	4.601	3.422	6.722	4.915	250	1.672
7	0.861	0.817	0.882	6.777	6.429	6.943	6.716	250	0.262
9	0.845	0.780	0.868	6.650	6.136	6.832	6.540	250	0.361
12	0.447	0.532	0.455	6.995	8.340	7.130	7.488	500	0.741
24	0.589	0.574	0.597	9.250	9.005	9.369	9.208	500	0.186
30	0.558	0.563	0.566	8.759	8.831	8.886	8.825	500	0.063
36	0.559	0.558	0.569	8.775	8.752	8.926	8.818	500	0.094

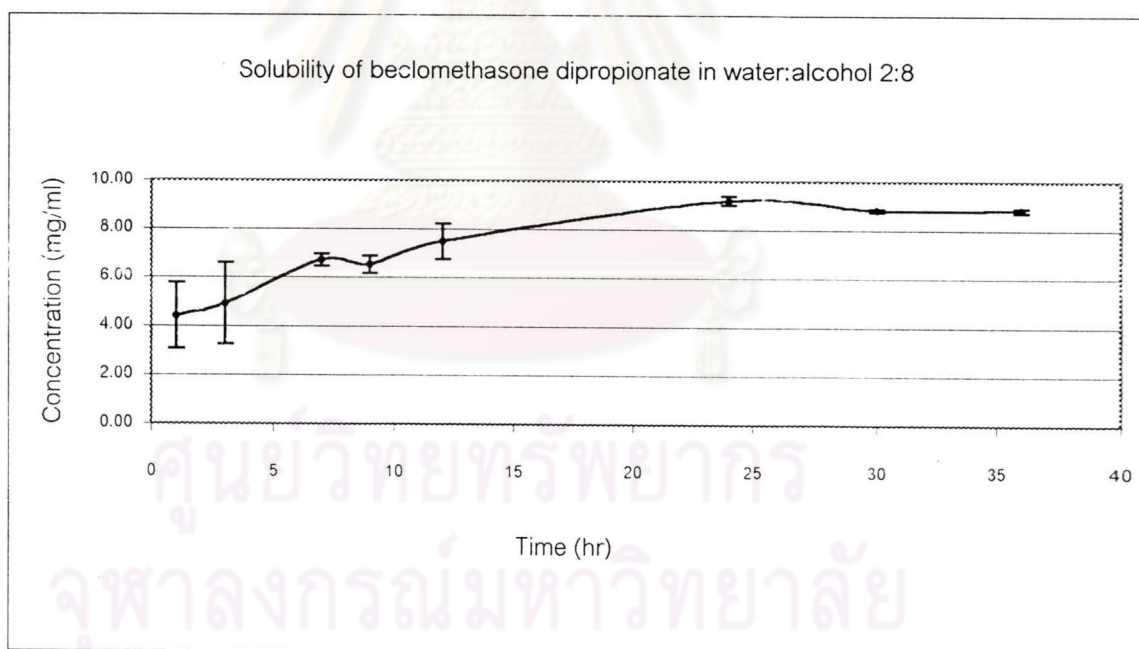


Figure 64 Solubility curve of beclomethasone dipropionate in water:alcohol 2:8

Table 26 The solubility data of stable form of beclomethasone dipropionate in % alcohol in solution

% alcohol in solution	Concentration (mg/ml)
0	0
0.2	0.002
0.5	0.386
0.8	8.818
1.0	22

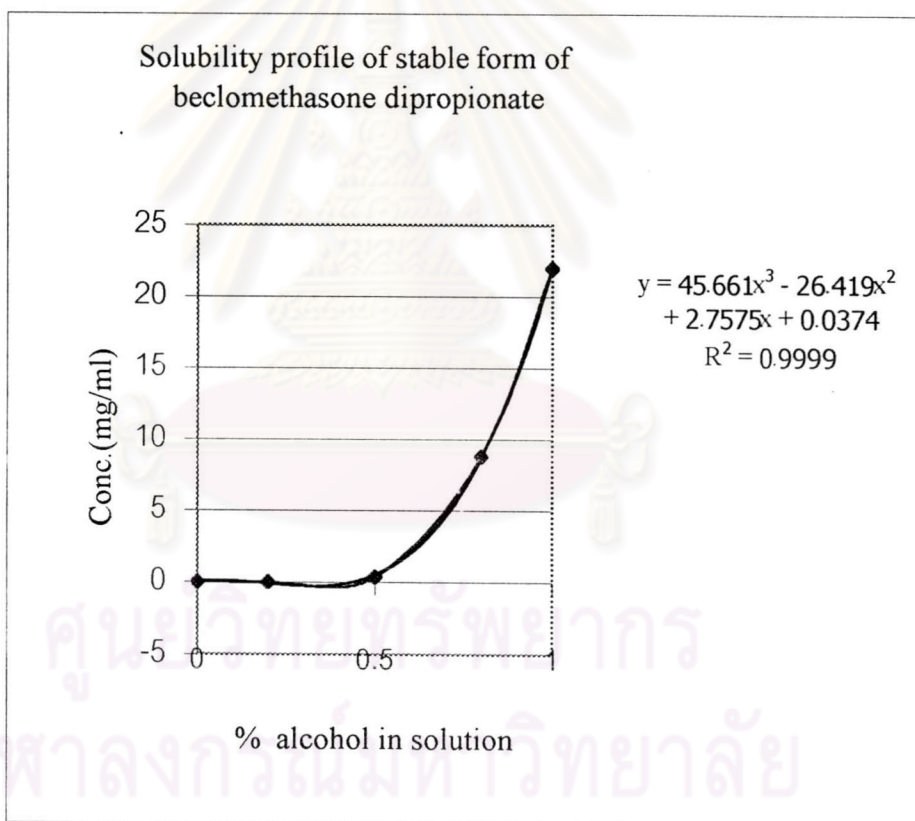


Figure 65 The solubility profile of stable form of beclomethasone dipropionate

The value of limit quantitative

The value of limit quantitative (BCP in water:alc 8:2 at 243 nm)								
Conc.	Absorbance					Ave.	SD	% CV
(mcg/ml)	n ₁	n ₂	n ₃	n ₄	n ₅	(Abs)		
0.5	0.018	0.018	0.018	0.018	0.018	0.018	0.0000	0.000
1	0.034	0.035	0.035	0.035	0.034	0.035	0.0005	1.583
2	0.062	0.063	0.063	0.063	0.062	0.063	0.0005	0.875
3	0.094	0.094	0.095	0.094	0.094	0.094	0.0004	0.475
4	0.128	0.128	0.129	0.128	0.128	0.128	0.0004	0.349

Conc.	Measurement					Ave.	SD	% CV
(mcg/ml)	n ₁	n ₂	n ₃	n ₄	n ₅	(Conc.)		
0.5	0.446	0.446	0.446	0.446	0.446	0.446	0.0000	0.000
1	0.955	0.987	0.987	0.987	0.955	0.975	0.0174	1.790
2	1.847	1.879	1.879	1.879	1.847	1.866	0.0174	0.935
3	2.866	2.866	2.898	2.866	2.866	2.873	0.0142	0.496
4	3.949	3.949	3.981	3.949	3.949	3.955	0.0142	0.360

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Appendix D

The thermograms of TGA from NETZSCH STA 409 C thermogravimetric analyzer of intact and ground beclomethasone dipropionate monohydrate

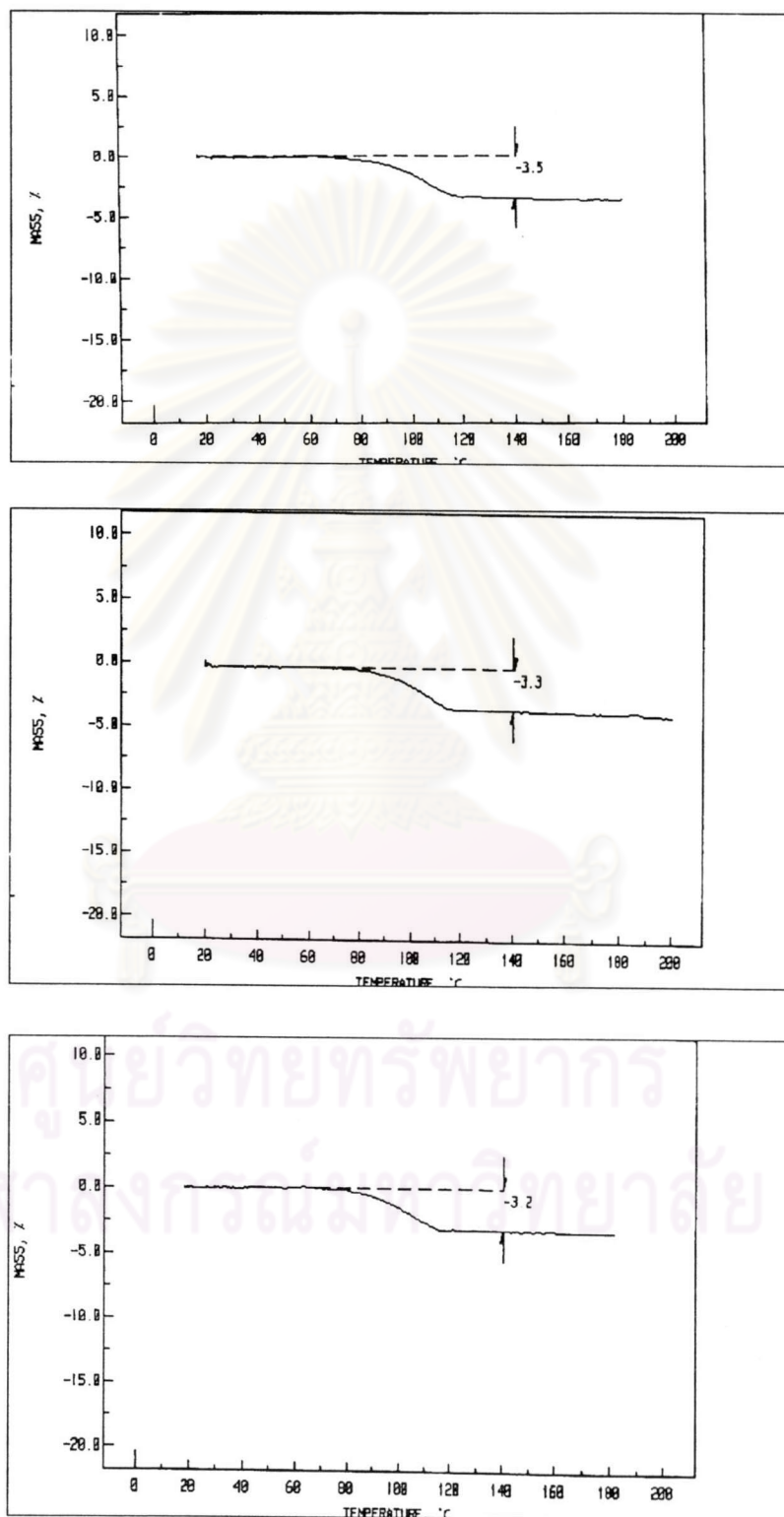


Figure 66 The TGA curves of intact crystals (n = 3)

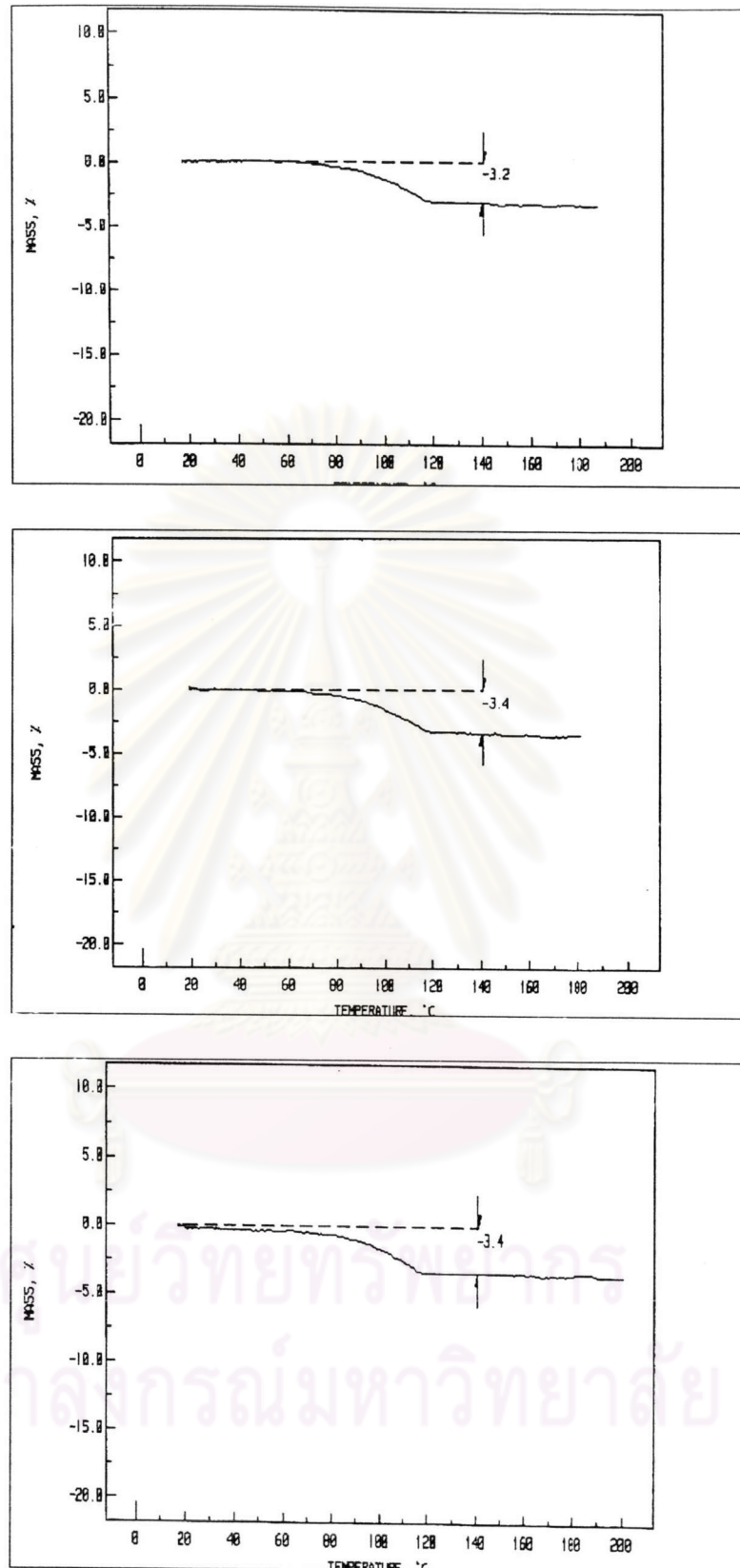


Figure 67 The TGA curves of ground crystals (n = 3)

Appendix E

Table 27 % Fraction dehydration of large particles (intact) at 85.5 °C in oven

Temp	min	gram	% fraction dehydration
85.5 °C	0	0.1995	0.00
	15	0.1989	9.00
	30	0.1957	57.03
	45	0.1929	99.05
	50	0.1922	109.56

Table 28 % Fraction dehydration of large particles (intact)at 74.5 °C in oven

Temp	min	gram	%fraction dehydration
74.5°C	0	0.2043	0
	15	0.2026	24.91
	30	0.1994	71.81
	45	0.1988	80.60
	65	0.1986	83.53
	95	0.1980	92.33
	120	0.1980	92.33

Table 29 % Fraction dehydration of large particles (intact) at 65 °C in oven

Temp	min	gram	%fraction dehydration
65°C	0	0.2048	0.00
	15	0.2036	17.54
	30	0.2036	17.54
	45	0.2035	19.00
	50	0.2032	23.39
	65	0.2033	21.93
	80	0.2028	29.24
	120	0.2024	35.09
	150	0.2010	55.55
	180	0.1994	78.94
	210	0.1984	93.56
	240	0.1984	93.56

Table 30 % Fraction dehydration of large particles (intact) at 56 °C in oven

Temp	min	gram	%fraction dehydration
56°C	0	0.2281	0.00
	30	0.2277	5.25
	60	0.2273	10.50
	120	0.2259	28.88
	180	0.2253	36.75
	240	0.2230	66.94
	300	0.2224	74.82
	540	0.2218	82.69
	720	0.2217	84.01
	750	0.2217	84.01

Table 31 % Fraction dehydration of medium particles at 80 °C in oven

Temp	min	gram	%fraction dehydration
80°C	0	0.2366	0.00
	10	0.2341	31.64
	30	0.2324	53.15
	45	0.2312	68.33
	60	0.2311	69.60
	75	0.2309	72.13
	90	0.2303	79.72
	120	0.2299	84.78
	150	0.2299	84.78

Table 32 % Fraction dehydration of medium particles at 74.5 °C in oven

Temp	min	gram	%fraction dehydration
74.5°C	0	0.2139	0.00
	30	0.2122	23.80
	60	0.2108	43.39
	90	0.2098	57.39
	120	0.2096	60.19
	150	0.2084	76.98
	180	0.2082	79.78
	220	0.2079	83.98
	250	0.2079	83.98

Table 33 % Fraction dehydration of medium particles at 70 °C in oven

Temp	min	gram	%fraction dehydration
70°C	0	0.1924	0.00
	30	0.1907	25.92
	60	0.1897	42.12
	90	0.1891	51.84
	120	0.1887	58.32
	150	0.1882	64.81
	180	0.1882	64.81
	210	0.1878	71.29
	240	0.1874	77.77
	270	0.1874	77.77
	300	0.1872	81.01
	330	0.1872	81.01

Table 34 % Fraction dehydration of small particles at 101.5 °C in oven

Temp	min	gram	%fraction dehydration
101.5°C	0	0.1948	0.00
	15	0.1921	41.06
	30	0.1909	60.01
	45	0.1895	82.11
	60	0.1888	91.59
	75	0.1888	91.59

Table 35 % Fraction dehydration of small particles at 90.5 °C in oven

Temp	min	gram	%fraction dehydration
90.5	0	0.1994	0.00
	30	0.1964	45.18
	60	0.1952	63.25
	120	0.1936	87.35
	150	0.1938	84.34
	180	0.1938	84.34

Table 36 % Fraction dehydration of small particles at 85.5 °C in oven

Temp	min	gram	%fraction dehydration
85.5°C	0	0.2073	0.00
	30	0.2042	44.65
	60	0.2032	58.60
	120	0.2025	69.76
	150	0.2017	80.92
	180	0.2015	83.71
	210	0.2015	83.71

Table 37 % Fraction dehydration of small particles at 80 °C in oven

Temp	min	gram	%fraction dehydration
80°C	0	0.2034	0.00
	30	0.2018	23.16
	60	0.2004	43.43
	90	0.2001	49.22
	120	0.2001	49.22
	180	0.1979	81.08
	240	0.1975	86.87
	300	0.1975	86.87

Appendix F

Table 38 The statistic test of the median size of ground samples (medium and small particles)

Descriptive
MEDIAN

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Medium particles	3	44.9500	1.9869	1.1471	40.0143	49.8857	42.78	46.68
Small particles	4	44.4550	5.3826	2.6913	35.8901	53.0199	36.41	47.78
Total	7	44.6671	3.9840	1.5058	40.9826	48.3517	36.41	47.78

ANOVA
MEDIAN

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.420	1	.420	.022	.888
Within Groups	94.812	5	18.962		
Total	95.232	6			

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VITA

Miss Amolwan Chinapak was born on October 9, 1975 in Bangkok, Thailand. She received her Bachelor of Science in Pharmacy from the Faculty of Pharmaceutical Sciences, Chulalongkorn University in 1998. After graduation, she has been employed by the Government Pharmaceutical Organization. In 2000, she entered the Master's Degree program in Manufacturing Pharmacy at Chulalongkorn University.



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