CHAPTER V

RESULTS AND DISCUSSION

The results obtained are analysed and correlated as follows:

5.1 Influence of Reynolds Number, $Re_p = d_p T 2\pi N \rho_l / 60\mu$

Under isothermal condition for any particular solid - liquid system, μ, ρ and D_v are constant. In each solid - liquid system density difference ($\Delta\rho$) is constant. The value of Reynolds number depends on the rotation speeds of the agitator, N.

Tables 5.1 to 5.5 show the values of Re_p and Sh of benzoic acid coated on various materials and water, 13 wt %, 20 wt % and 40 wt % sucrose solution respectively at the temperature 30 °C or 35 °C and data are plotted on logarithmic scales. (see Figures 5.1-5.6).

Figures 5.1- 5.5 show that the data obtained for benzoic acid coated on various materials at various temperatures lie approximately in a straight line having the same slope. Figure 5.6 combines Figures 5.1-5.5. It can be seen that benzoic acid coated on any types of materials could be used as a representative of the group. Thus benzoic acid coated on glass beads is chosen for further studies.

Table 5.1 Re_p vs Sh_p of Benzoic Acid Coated on Various Materials - Water at 35 °C (Sc = 677), T = 20 cm

Materials	Rotation speed (rpm)	$Re_p \times 10^{-4}$	Mv	Sh_p					
				1	2	3	4	5	Average
Glass beads	400	5.1058	0.4104	244	230	250	235	241	240
	450	5.7440		257	258	268	270	257	262
	500	6.3822		340	310	330	320	300	320
	550	7.0204		405	402	414	410	379	402
Polystyrene shperes	275	3.5102	0.2441	137	140	140	158	150	145
	300	3.8292		190	180	175	193	192	186
	350	4.4675		210	208	229	215	238	220
	400	5.1058		240	230	220	215	220	225
	450	5.7440		280	290	295	275	295	287
	500	6.3822		293	282	302	280	293	290
Plastic particles type 1	275	3.5102	0.1937	133	130	132	140	150	137
	300	3.8293		160	180	170	171	159	168
	350	4.4675		220	210	212	225	228	219
	400	5.1058		260	270	272	261	262	265
	450	5.7440		250	280	260	278	282	270
	500	6.3822		291	303	295	305	306	300
Plastic particles type 2	270	3.5088	0.1306	158	174	175	178	155	168
	300	3.8278		180	190	201	201	173	189
	350	4.4657		210	200	195	215	220	208
	400	5.1037		240	250	259	230	231	242
	450	5.7417		273	288	268	281	290	280
	500	6.3796		300	320	325	301	304	310

Table 5.2 Re_p vs Sh_p of Benzoic Acid Coated on Various Materials - 13 wt % Sucrose in Water at 35 °C (Sc = 1,210), T = 20 cm

Materials	Rotation speed (rpm)	$Re_p \times 10^{-4}$	Mv	Sh_p					
				1	2	3	4	5	Average
Glass beads	350	3.4525	0.3520	290	310	300	288	307	299
	400	3.9458		380	381	370	365	368	373
	450	4.4390		425	440	430	415	450	432
	500	4.9322		477	480	499	508	526	498
Plastic particles type 1	300	2.9593	0.1358	230	200	210	195	195	206
	350	3.4525		319	350	330	361	350	342
	400	3.9458		385	390	420	395	410	400
	450	4.4390		477	470	480	490	458	475
	500	4.9322		510	520	507	495	533	513
Plastic particles type 2	300	2.9593	0.0758	270	290	300	268	292	284
	350	3.4525		299	308	340	310	343	320
	400	3.9458		399	392	370	378	386	385
	450	4.4390		408	367	390	360	380	381
	500	4.9332		410	445	440	428	452	435

Table 5.3 Re_p vs Sh_p of Benzoic Acid Coated on Various Materials - 20 wt % Sucrose in Water at 30 °C (Sc = 2,355), T_c = 20 cm

Materials	Rotation speed (rpm)	$Re_p \times 10^{-4}$	Mv	Sh_p					
				1	2	3	4	5	Average
Glass beads	350	2.5194	0.3009	358	380	385	350	392	373
	400	2.8794		399	445	450	431	465	438
	450	3.2395		520	510	500	550	590	534
	500	3.5992		599	591	605	573	587	591
Polystyrene spheres	300	2.1595	0.1475	322	329	300	340	334	325
	350	2.5194		371	360	330	320	344	345
	400	2.8794		430	435	440	470	480	451
	450	3.2393		511	491	497	531	570	520
	500	3.5992		608	678	655	609	600	630
Plastic particles type 1	300	2.1595	0.1010	300	315	320	309	296	308
	350	2.5194		380	360	340	365	370	363
	400	2.8794		400	420	405	398	432	411
	450	3.2393		471	473	435	446	475	460
	500	3.5992		590	550	560	545	560	561
Plastic particles type 2	300	2.1595	0.0492	270	290	280	279	301	284
	350	2.5194		357	337	381	367	363	361
	400	2.8794		447	426	450	420	412	431
	450	3.2393		440	478	430	422	435	441
	500	3.5992		566	520	532	550	560	542

Table 5.4 Re_p vs Sh_p of Benzoic Acid Coated on Various Materials - 35.5 wt % Sucrose in Water at 30 °C (Sc = 10,764), T = 20 cm

Materials	Rotation speed (rpm)	$Re_p \times 10^{-4}$	Mv	Sh_p					
				1	2	3	4	5	Average
Glass beads	400	1.3671	0.2181	640	656	601	610	673	636
	450	1.5380		740	790	756	785	825	780
	500	1.7089		875	890	866	897	872	880
	550	1.8778		958	940	997	990	950	967
Polystyrene spheres	300	1.0253	0.0745	460	480	470	476	504	478
	350	1.1962		600	580	590	545	545	572
	400	1.3671		701	711	681	695	712	700
	450	1.5380		793	820	821	780	836	810
	500	1.7089		940	950	900	911	899	920
Plastic particles type 1	300	1.0253	0.0309	433	459	475	465	464	460
	350	1.1962		593	573	603	600	581	590
	400	1.3671		697	660	633	655	600	649
	450	1.5380		806	793	789	759	753	780
	500	1.7089		951	930	961	980	903	945
Plastic particles type 2	300	1.0253	-0.0235	494	511	500	520	510	507
	350	1.1962		602	627	631	640	600	620
	400	1.3671		690	680	666	650	679	673
	450	1.5380		750	733	761	771	730	749
	500	1.7089		862	800	811	831	801	821

Table 5.5 Re_P vs Sh_P of Benzoic Acid Coated on Various Materials - 35.5 wt % Sucrose in Water at 35 °C (Sc = 8,469), T = 20 cm

Materials	Rotation speed (rpm)	$Re_P \times 10^{-4}$	Mv	Sh_P					
				1	2	3	4	5	Average
Glass beads	400	1.5050	0.2201	650	670	681	712	739	690
	450	1.6931		800	812	832	830	866	828
	500	1.8812		896	901	899	859	879	894
	550	2.0693		950	998	988	989	975	980
Polystyrene spheres	300	1.1287	0.0762	448	459	473	411	459	450
	350	1.3168		547	505	577	568	553	550
	400	1.5050		735	705	730	719	711	720
	450	1.6931		769	784	764	745	788	770
	500	1.8812		901	915	900	898	936	910
Plastic particles type 1	300	1.1287	0.0326	468	471	453	447	471	462
	350	1.3168		599	578	588	571	614	590
	400	1.5050		713	693	700	711	708	705
	450	1.6931		725	760	743	749	743	744
	500	1.8812		818	895	890	909	888	880
Plastic particles type 2	300	1.1287	-0.0219	458	489	465	470	488	474
	350	1.3168		508	521	541	500	535	519
	400	1.5050		671	689	659	705	726	690
	450	1.6931		795	800	800	807	813	800
	500	1.8812		845	874	861	859	861	860

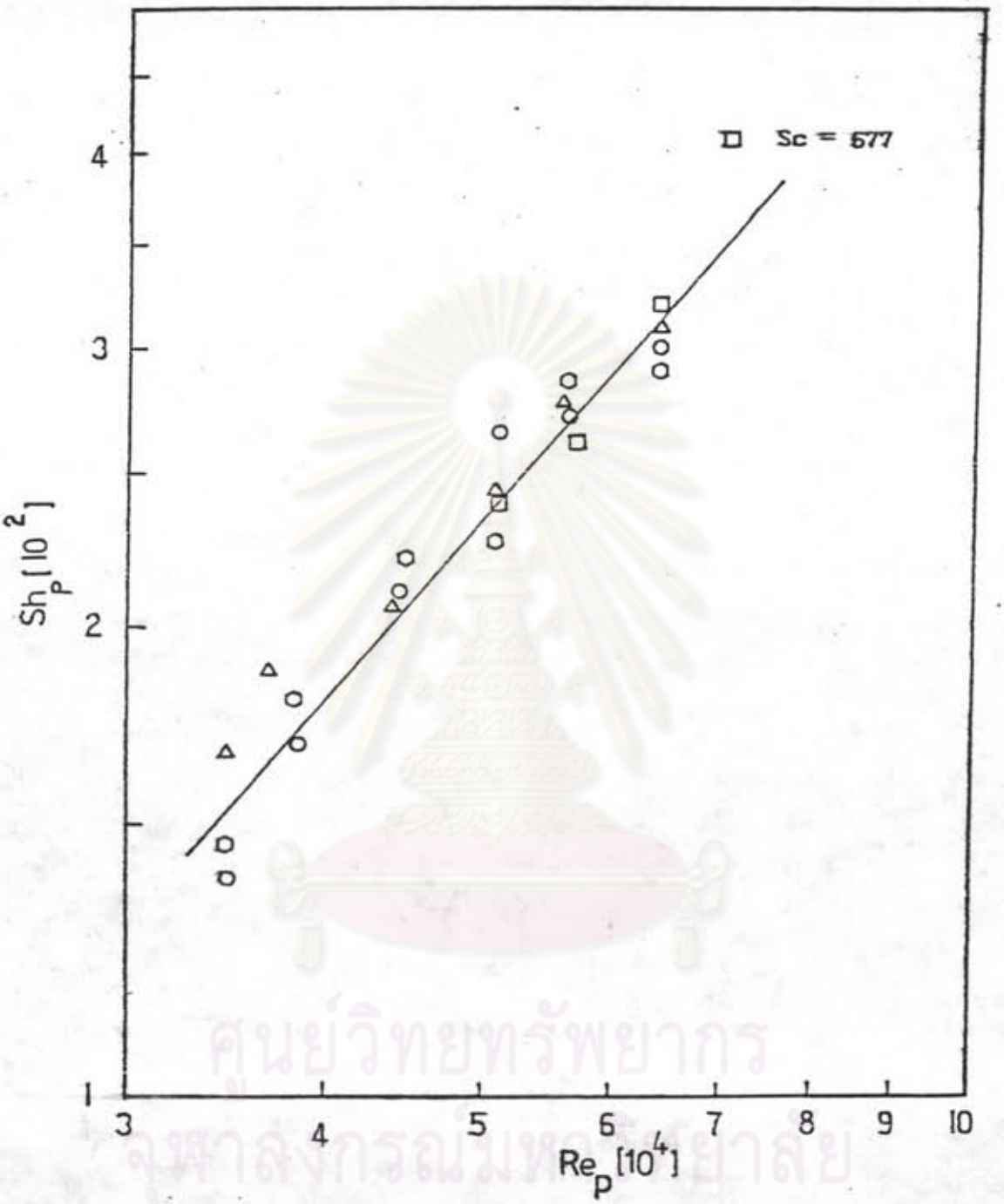

Figure 5.1 Re_p vs Sh_p of benzoic acid coated on various materials - water

□ Glass beads

○ Polystyrene spheres

○ Plastic particles type 1

△ Plastic particles type 2

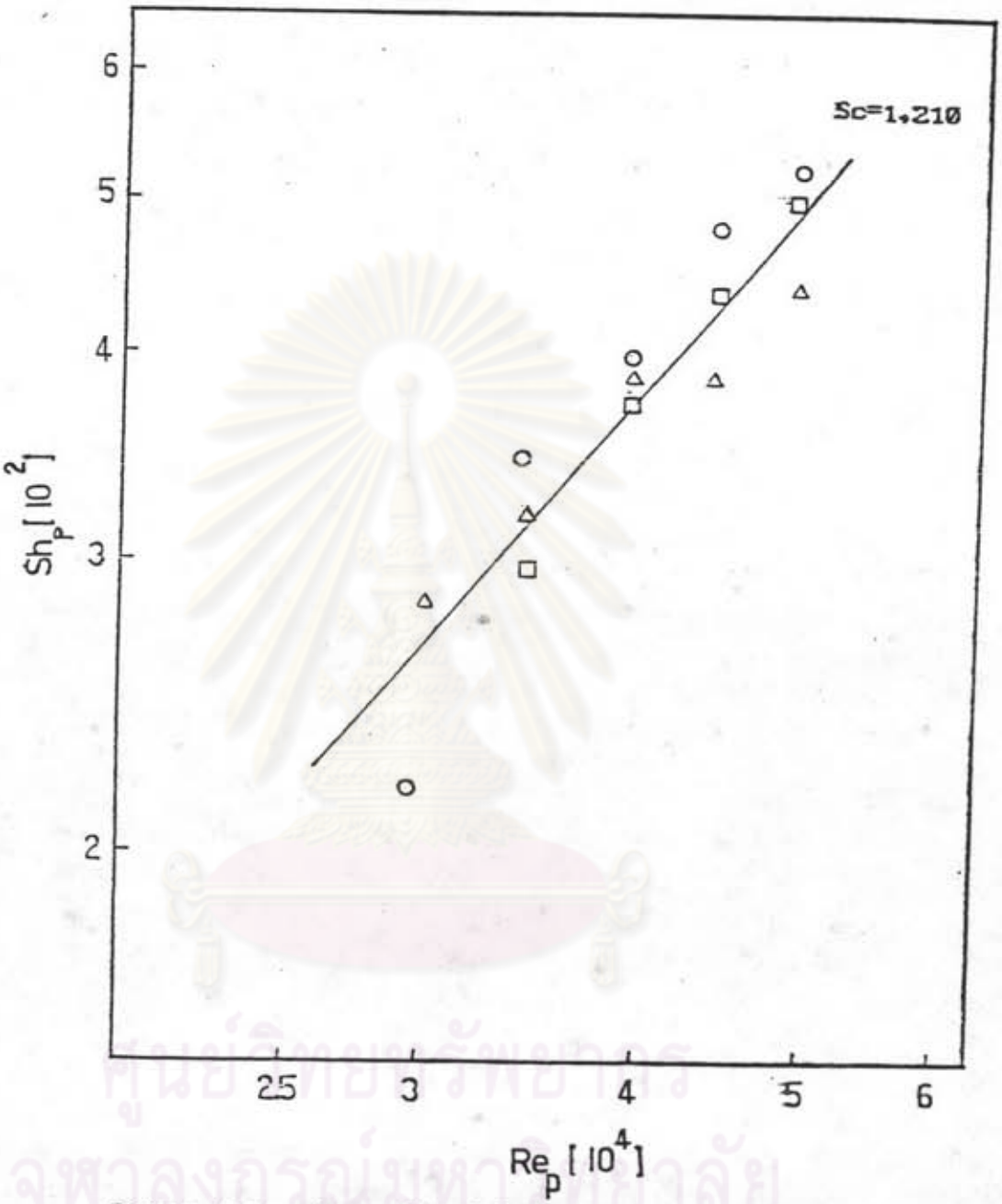

Figure 5.2 Re_p vs Sh_p of benzoic acid coated on various materials - 13 wt % sucrose in water

□ Glass beads

○ Plastic particles type 1

△ Plastic particles type 2

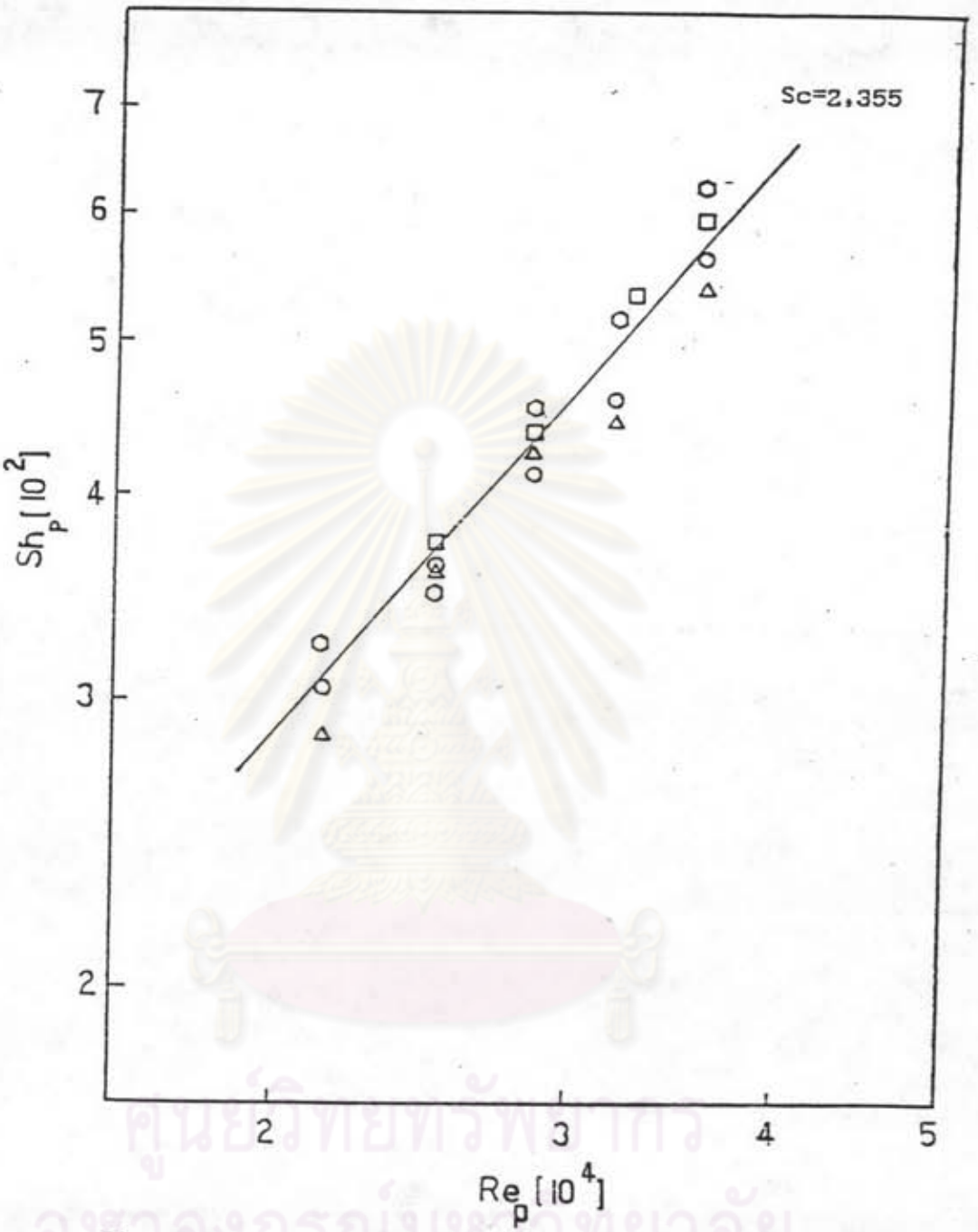

Figure 5.3 Re_p vs Sh_p of benzoic acid coated on various materials – 20 wt % sucrose in water

□ Glass beads

○ Polystyrene spheres

○ Plastic particles type 1

△ Plastic particles type 2

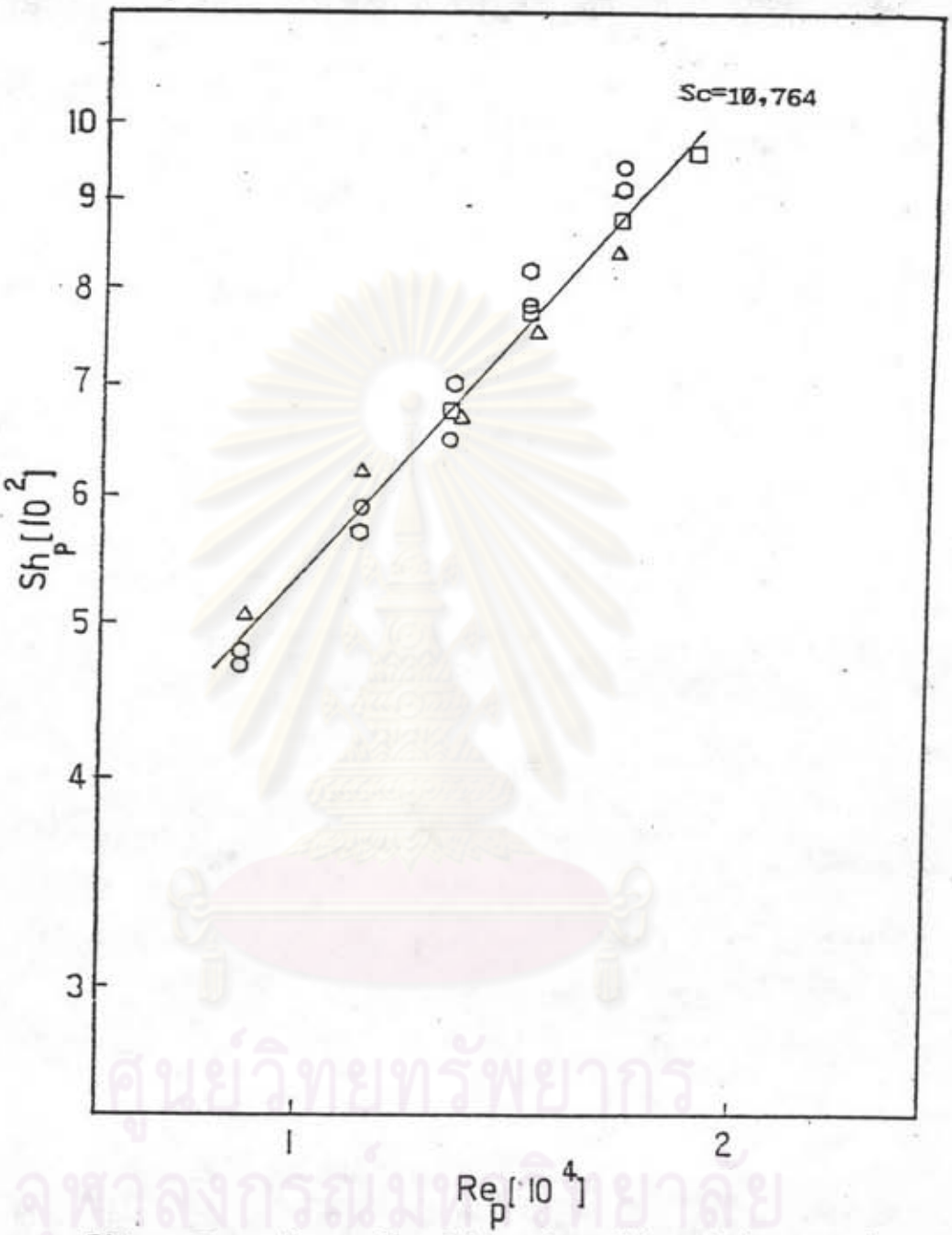

Figure 5.4 Re_p vs Sh_p of benzoic acid coated on various materials – 35.5 wt % sucrose in water

- □ Glass beads
- ○ Polystyrene
- ○ Plastic particles type 1
- △ Plastic particles type 2

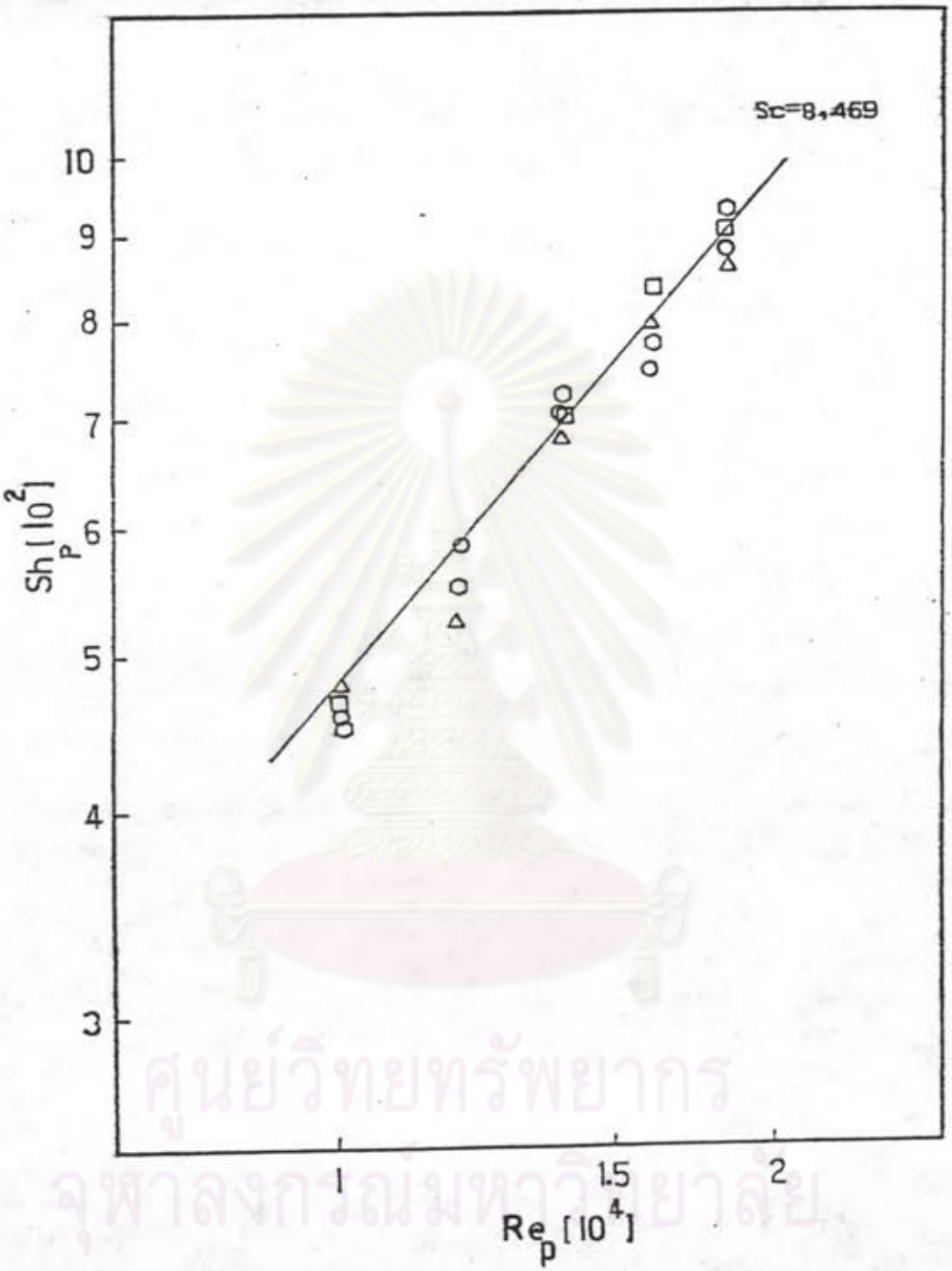

Figure 5.5 Re_p vs Sh_p of benzoic acid coated on various materials – 35.5 wt % sucrose in water

□ Glass beads

○ Polystyrene spheres

○ Plastic particles type 1

△ Plastic particles type 2

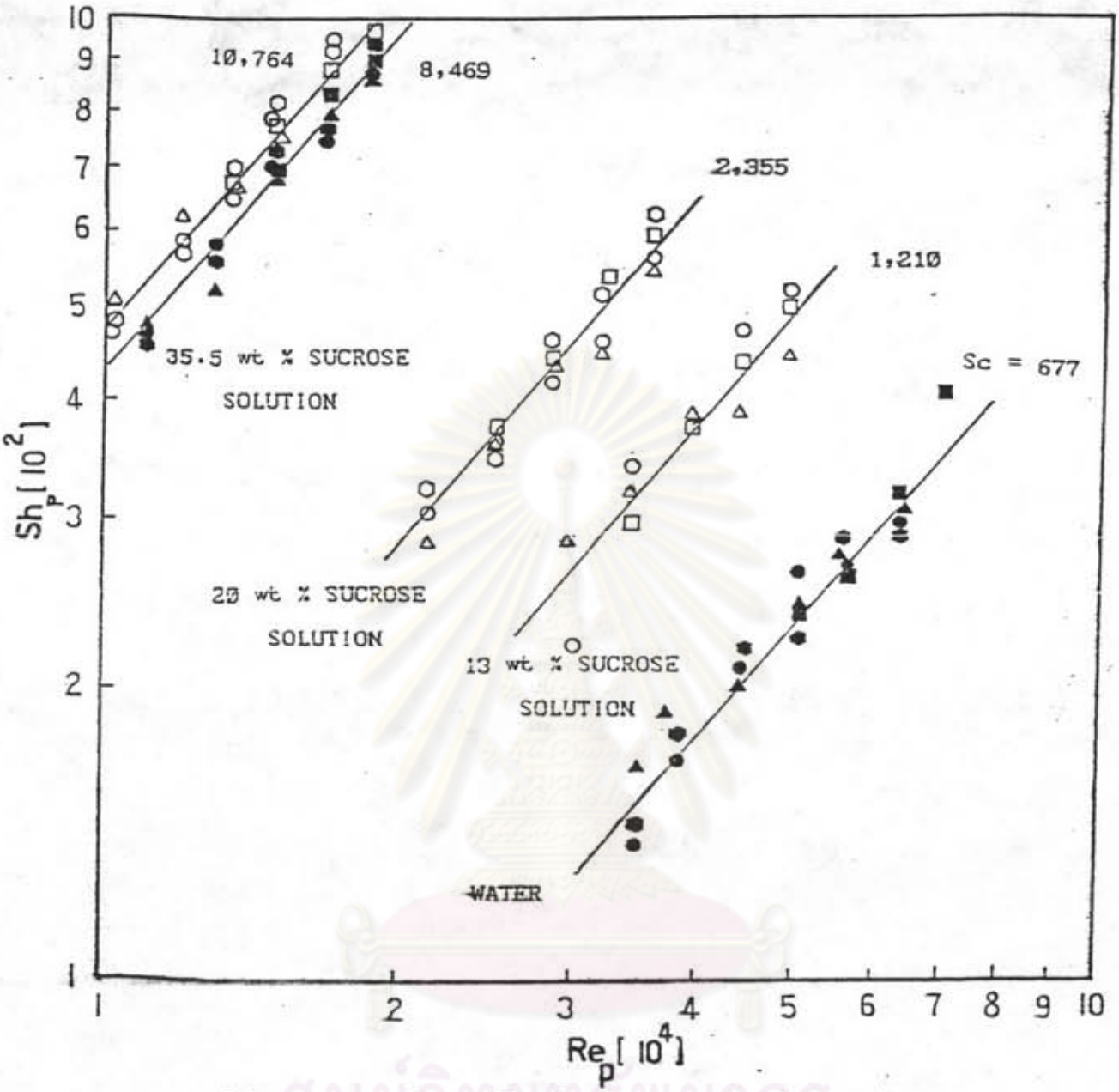

Figure 5.6 Re_p vs Sh_p of some experimental systems

- ■] Glass beads
- ●] Polystyrene spheres
- ●] Plastic particles type 1
- ▲] Plastic particles type 2

Benzoic acid coated on glass beads are used to check the influence of Reynolds number again at different temperatures with various liquids. Density difference between benzoic acid coated on glass beads and various liquids is constant for each pair. Data are shown in Tables 5.6-5.9 and are plotted in Figures 5.7-5.11. Each line represents constant temperature. Figure 5.11 combines Figures 5.7-5.10.

From Figures 5.1-5.11 the lines are parallel having a slope of 1.21, which is the exponent of the Reynolds number in the correlation.

5.2 Influence of Schmidt Number, $Sc = \mu/\rho_1 D_v$

To determine the influence of the Schmidt number on mass transfer the temperatures are varied while Reynolds number and density group are kept constant. From Figure 5.11 Reynolds number are read at 5.5×10^4, 3.8×10^4, 3.0×10^4, 1.5×10^4 respectively at various temperatures to determine Sherwood numbers for each solution. Data are shown in Tables 5.10-5.13 and are plotted in Figures 5.12-5.15. Figure 5.16 combines Figures 5.12-5.15. From Figure 5.16, it is found that the lines are parallel, having a slope of 0.50 which is the exponent of Schmidt number in the correlation.

5.3 Influence of Density Group, $Mv = (\rho_s-\rho_1)/\rho_1$

To determine the influence of density group on mass transfer the temperatures and Reynolds numbers are kept constant. The Reynolds numbers are 5.1×10^4, 3.95×10^4, 2.87×10^4, 1.53×10^4 and

Table 5.6 Re_p vs Sh_p of Benzoic Acid Coated on Glass Beads - Water, T = 20 cm

T (°C)	Sc	Rotation speed (rpm)	$Re_p \times 10^{-4}$	Mv	Sh_p					
					1	2	3	4	5	Average
25	1,033	400	4.2143	0.4061	226	238	242	240	239	237
		450	4.7411		280	259	290	280	286	279
		500	5.2679		321	330	311	325	328	323
		550	5.7947		367	389	391	391	397	387
30	842	400	4.6559	0.4081	254	260	229	235	247	245
		450	5.2379		270	281	295	270	274	278
		500	5.8199		300	319	320	305	316	312
		550	6.4019		328	344	369	355	344	349
35	677	400	5.1058	0.4104	235	229	244	258	234	240
		450	5.7440		244	270	255	269	272	262
		500	6.3822		311	318	320	321	330	320
		550	7.0204		414	400	395	390	411	402
40	533	400	5.5656	0.4130	241	238	259	235	262	247
		450	6.2613		249	241	278	268	249	257
		500	6.9570		333	311	345	337	319	329
		550	7.6527		351	331	377	333	323	343
45	411	225	3.8545	0.4159	129	151	147	142	131	140
		300	4.5347		174	171	151	158	171	165
		350	5.2905		185	188	199	200	203	195
		400	6.0462		218	225	239	212	236	226
		500	7.5578		301	321	300	307	296	305

Table 5.7 Re_P vs Sh_P of Benzoic Acid Coated on Glass Beads - 13 wt % Sucrose in Water, T = 20 cm

T (°C)	Sc	Rotation speed (rpm)	$Re_P \times 10^{-4}$	Mv	Sh_P				
					1	2	3	4	Average
30	1,516	350	3.0883	0.3395	353	322	366	351	348
		400	3.5295		371	395	377	381	386
		450	3.9707		502	485	478	491	489
		500	4.4118		524	565	538	493	530
35	1,210	350	3.4525	0.3420	291	298	309	298	299
		400	3.9458		383	364	359	386	373
		450	4.4390		420	418	440	450	432
		500	4.9322		501	521	500	470	498

Table 5.8 Re_P vs Sh_P of Benzoic Acid Coated on Glass Beads - 20 wt % Sucrose in Water, T = 20 cm

T (°C)	Sc	Rotation speed (rpm)	$Re_P \times 10^{-4}$	Mv	Sh_P			
					1	2	3	Average
25	3,043	350	2.2192	0.3004	340	369	374	361
		400	2.5362		415	400	403	406
		450	2.8533		517	544	538	533
		500	3.1703		519	510	516	515
30	2,355	350	2.5194	0.3009	387	365	367	373
		400	2.8794		436	424	445	438
		450	3.2393		526	524	516	534
		500	3.5992		605	612	556	591
35	1,868	350	2.8319	0.3016	361	389	390	380
		400	3.2365		429	444	480	451
		450	3.6411		475	438	500	471
		500	4.0457		543	580	605	576
40	1,539	350	3.1604	0.3055	387	366	414	389
		400	3.6119		444	471	438	451
		450	4.0634		525	547	503	525
		500	4.5149		578	565	591	578

Table 5.9 Re_p vs Sh_p of Benzoic Acid Coated on Glass Beads - 35.5 wt % Sucrose in Water, T = 20 cm

T (°C)	Sc	Rotation speed (rpm)	$Re_p \times 10^{-4}$	Mv	Sh_p			
					1	2	3	Average
25	14,318	350	1.0488	0.2166	559	539	525	541
		400	1.1987		739	648	671	686
		450	1.3485		722	712	741	725
		500	1.4983		874	895	871	880
30	10,764	400	1.3671	0.2181	638	623	647	636
		450	1.5380		814	797	729	780
		500	1.7089		871	891	878	880
		550	1.8798		944	987	970	967
35	8,469	400	1.5050	0.2201	694	705	671	690
		450	1.6931		833	830	821	828
		500	1.8812		914	896	876	894
		550	2.0693		964	978	998	980
40	7,072	400	1.5750	0.2227	715	727	700	714
		450	1.7718		783	800	787	790
		500	1.9687		840	826	815	827
		550	2.1650		960	991	965	972

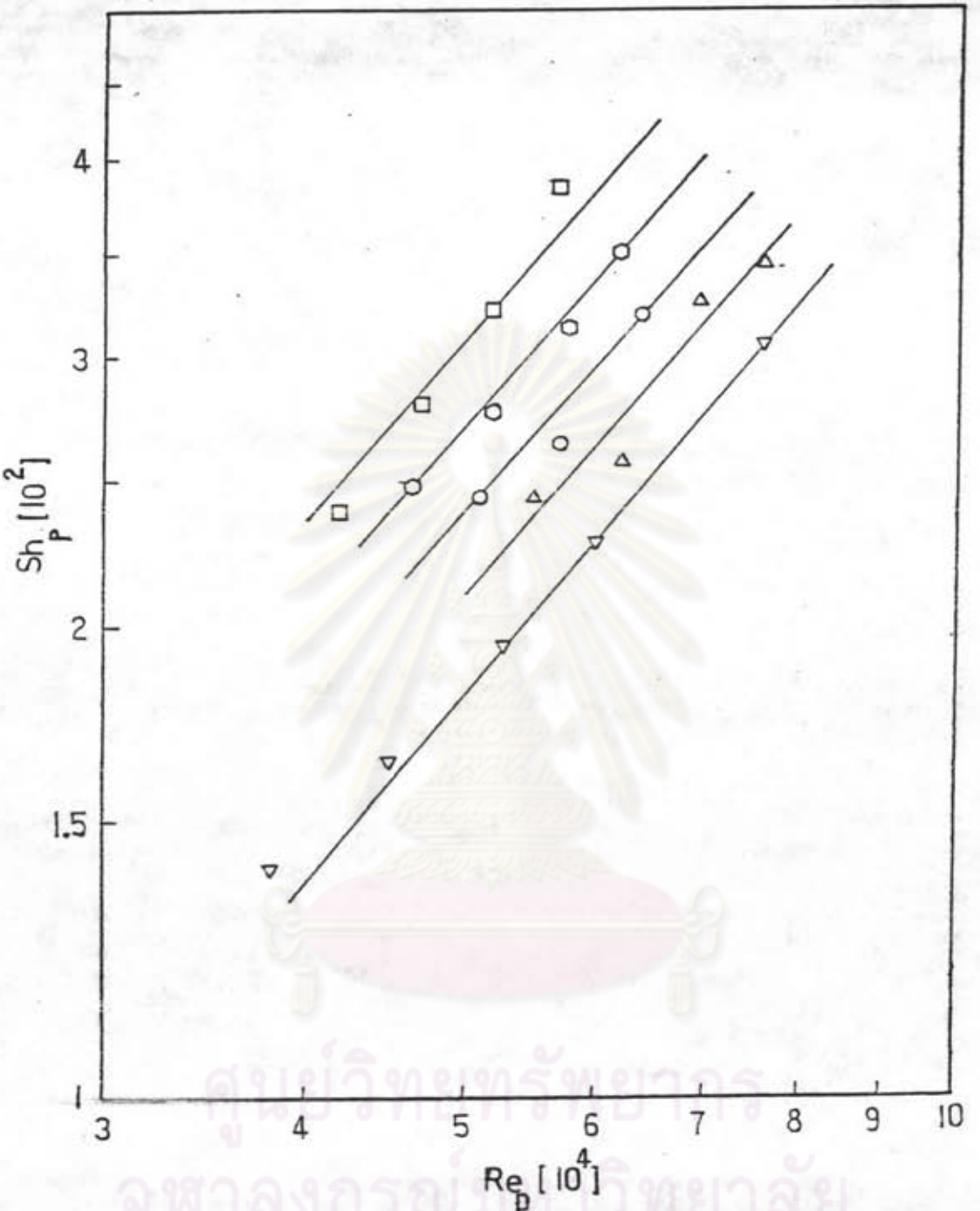

Figure 5.7 Re_p vs Sh_p of benzoic acid coated on glass beads – water

□ 25 °C, Sc = 1,032

○ 30 °C, Sc = 842

○ 35 °C, Sc = 677

△ 40 °C, Sc = 533

▽ 45 °C, Sc = 411

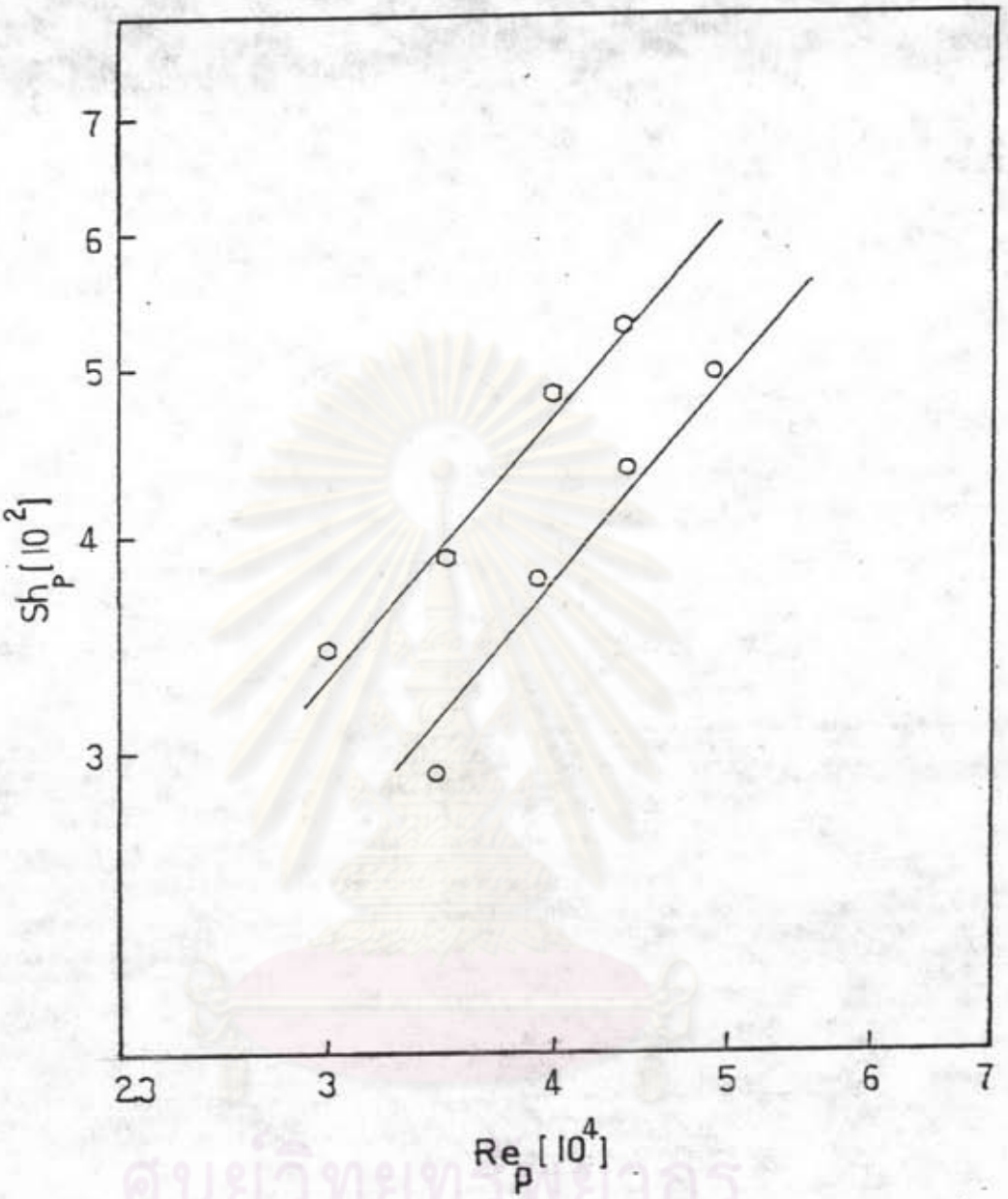

Figure 5.8 Re_p vs Sh_p of benzoic acid coated on glass beeds—
13 wt % sucrose in water
○ 30 °C, Sc = 1,516
○ 35 °C, Sc = 1,210

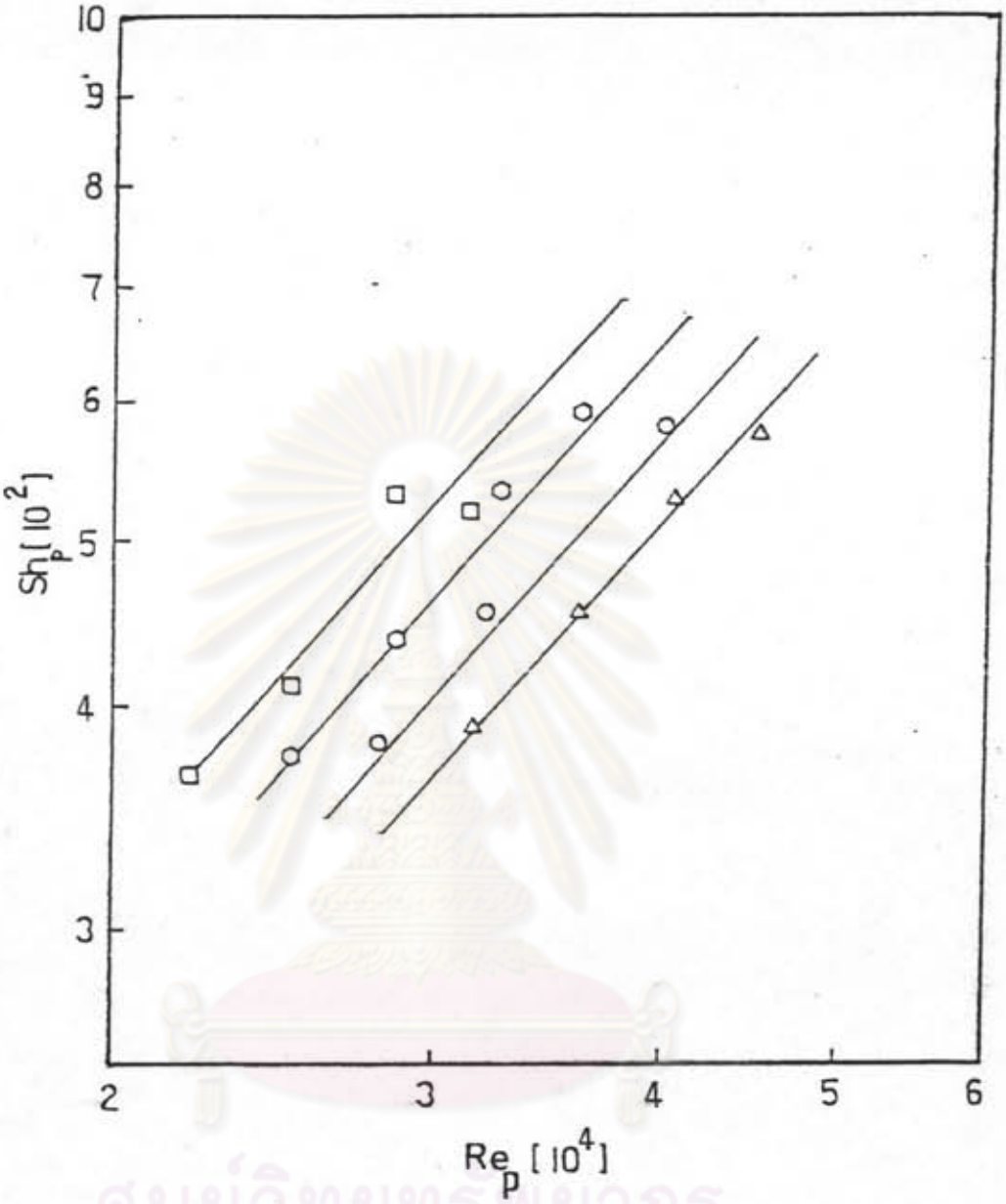

Figure 5.9 Re_p vs Sh_p of benzoic acid coated on glass beads–20 wt % sucrose in water

□ 25 °C, Sc = 3,043

○ 30 °C, Sc = 2,355

○ 35 °C, Sc = 1,868

△ 40 °C, Sc = 1,539

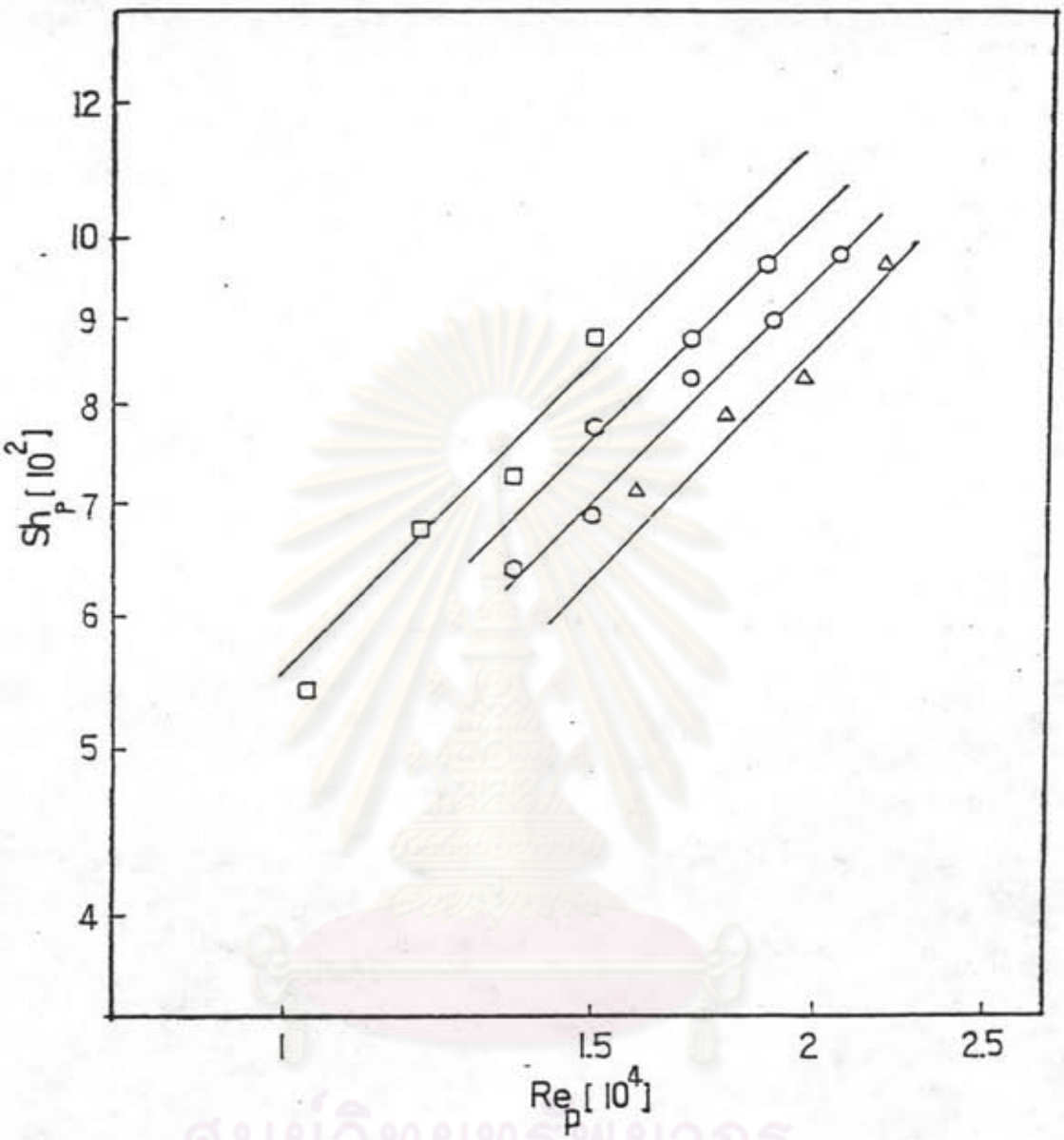

Figure 5.10 Re_p vs Sh_p of benzoic acid coated on glass beads-35.5 wt % sucrose in water

□ 25 °C, Sc = 14,138

○ 30 °C, Sc = 10,764

○ 35 °C, Sc = 8,469

△ 40 °C, Sc = 7,072

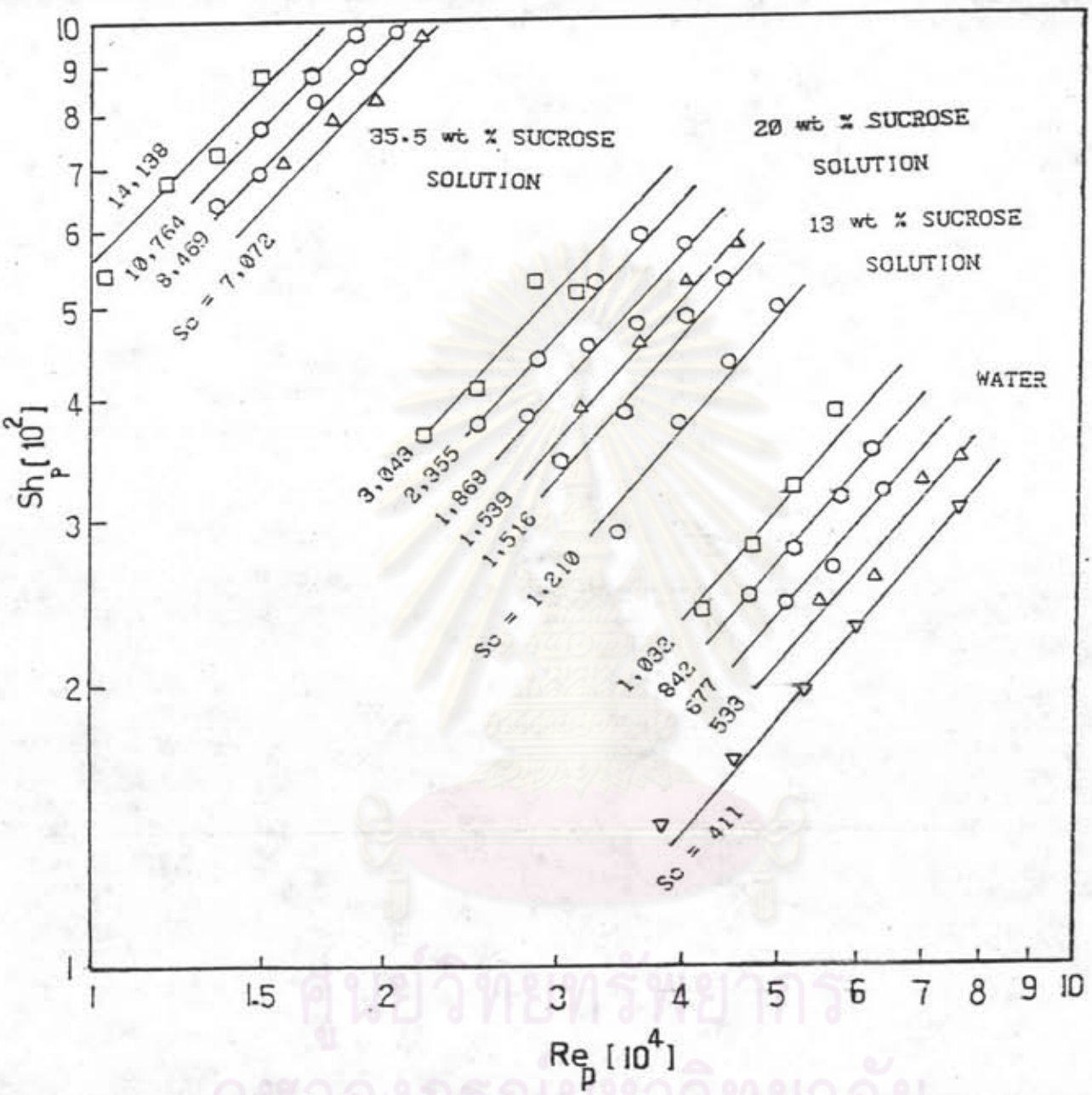

Figure 5.11 Re_p vs Sh_p of benzoic acid coated on glass beads - water, 13 wt %, 20 wt % and 35.5 wt % sucrose in water

□ 25 °C
○ 30 °C
○ 35 °C
△ 40 °C
▽ 45 °C

Table 5.10 Sc vs Sh_p of Benzoic Acid Coated on Glass Beads - Water, Re_p = 55,000, T = 20 cm

T (°C)	Sc	Sh_p
25	1,032	345
30	842	302
35	677	270
40	533	235
45	411	205

Table 5.11 Sc vs Sh_p of Benzoic Acid Coated on Glass Beads - 13 wt % Sucrose in Water, Re_p = 38,000, T = 20 cm

T (°C)	Sc	Sh_p
30	1,516	440
35	1,210	350

Table 5.12 Sc vs Sh_P of Benzoic Acid Coated on Glass Beads - 20 wt % Sucrose in Water, Re_P = 30,000, T = 20 cm

T (°C)	Sc	Sh_P
25	3,043	525
30	2,355	465
35	1,868	408
40	1,539	365

Table 5.13 Sc vs Sh_P of Benzoic Acid Coated on Glass Beads - 35.5 wt % Sucrose in Water, Re_P = 15,000, T = 20 cm

T (°C)	Sc	Sh_P
25	14,318	850
30	10,764	780
35	8,469	700
40	7,072	635

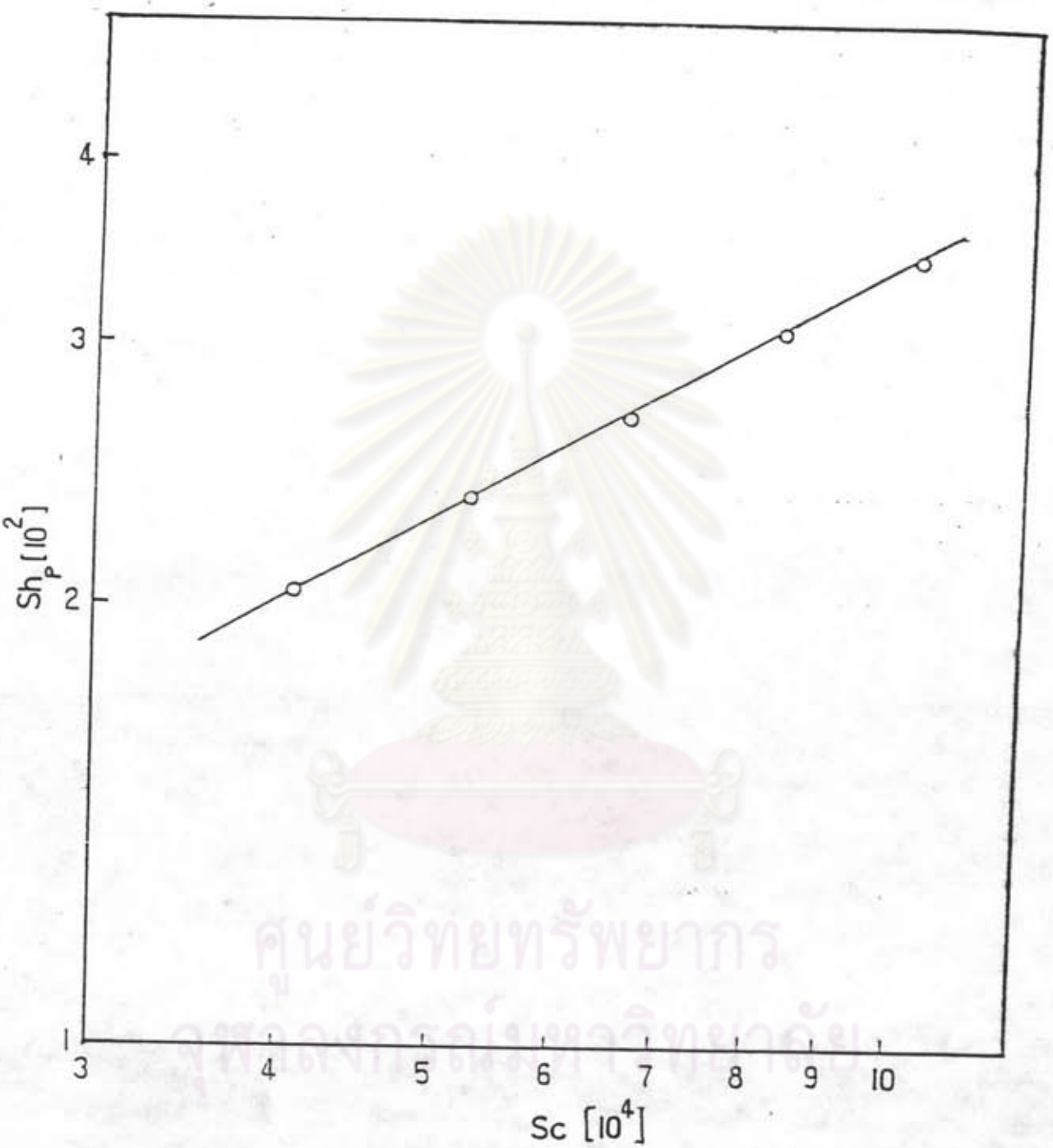

Figure 5.12 Sc vs Sh_p of benzoic acid coated on glass beads – water, $Re_p = 5.5 \times 10^{+}$

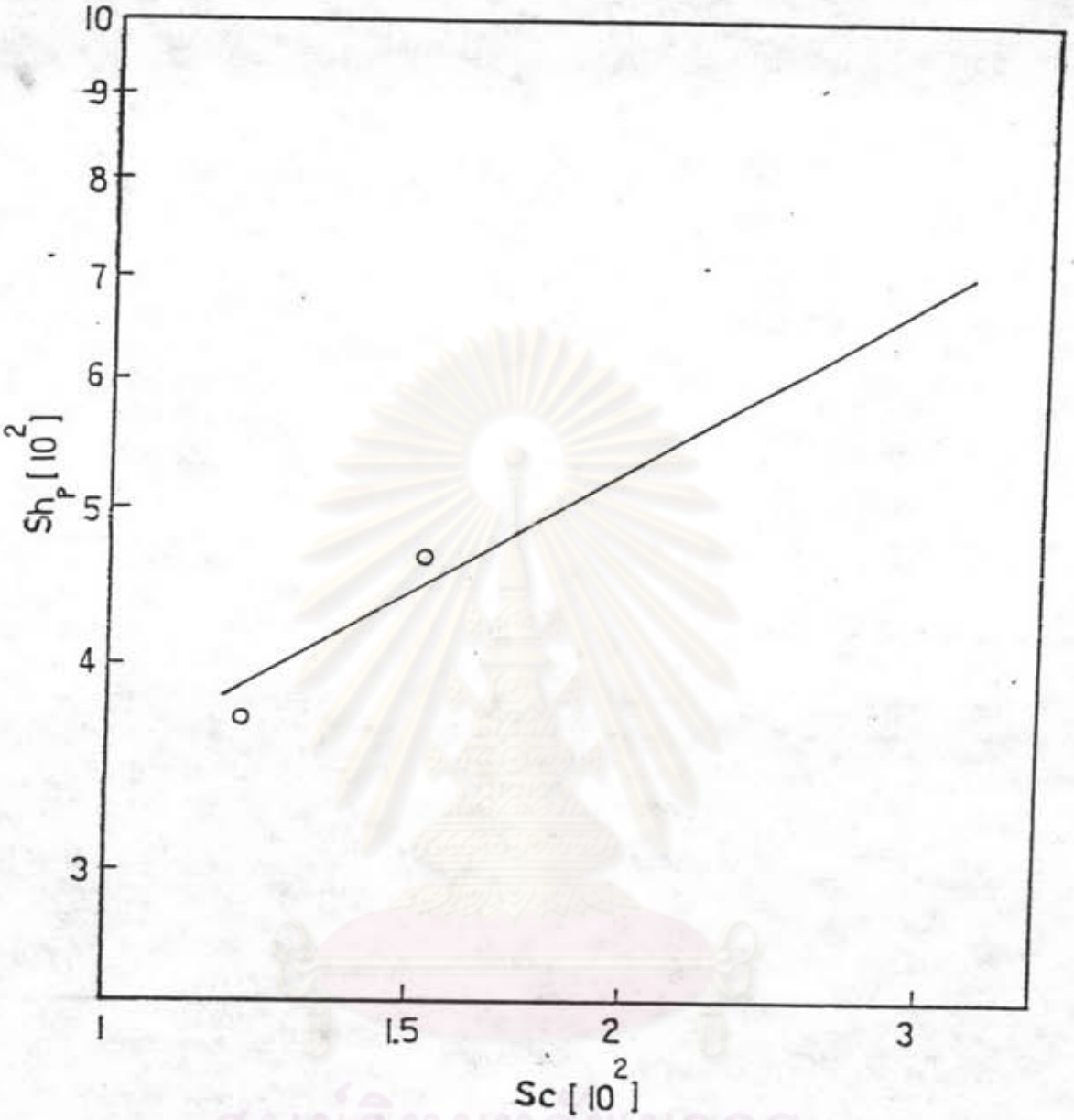

Figure 5.13 Sc vs Sh_p of benzoic acid coated on glass beads - 13 wt % sucrose in water, $Re_p = 4 \times 10^4$

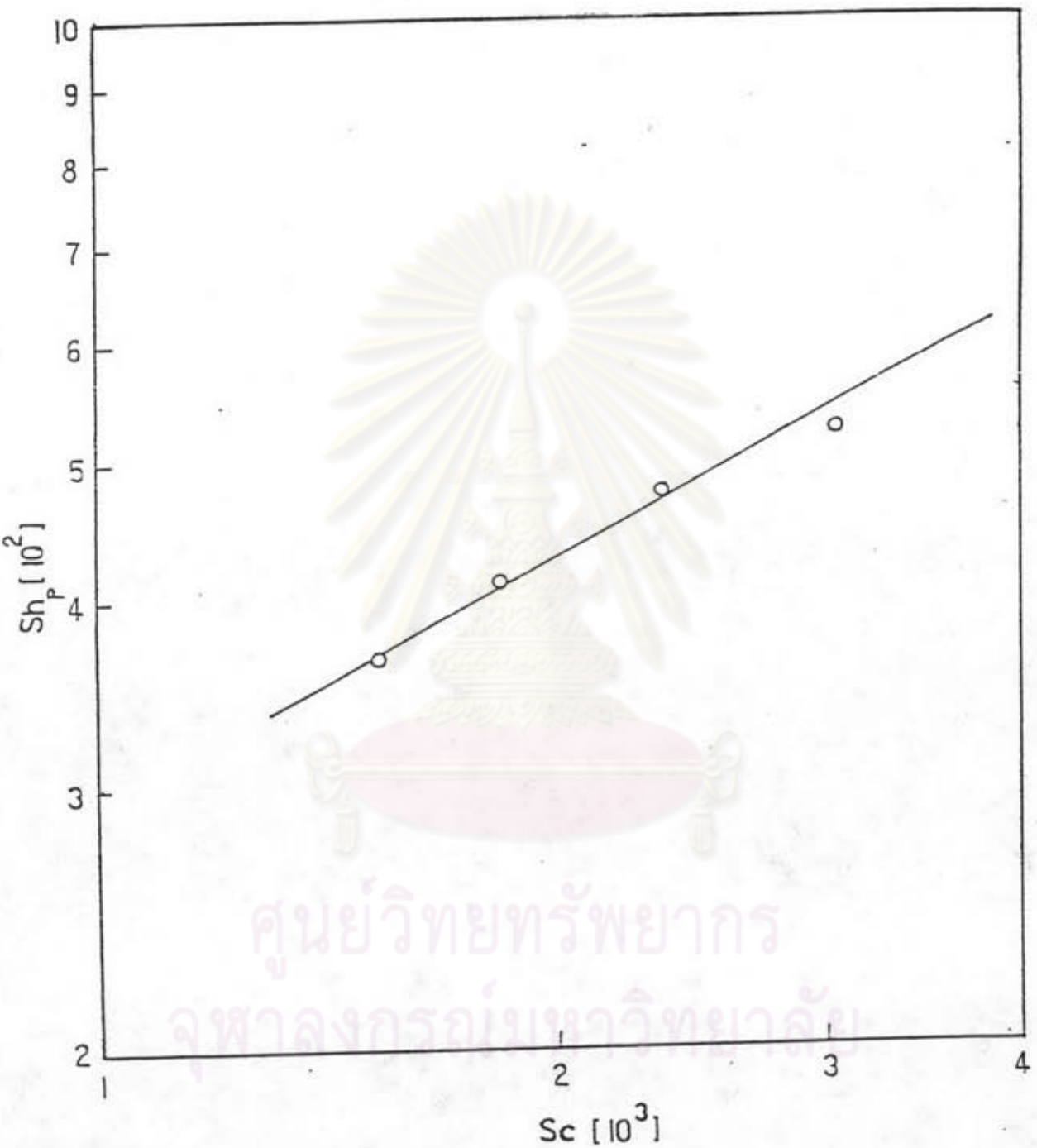

Figure 5.14 Sc vs Sh_p of benzoic acid coated on glass beads - 20 wt % sucrose in water, $Re_p = 3 \times 10^4$

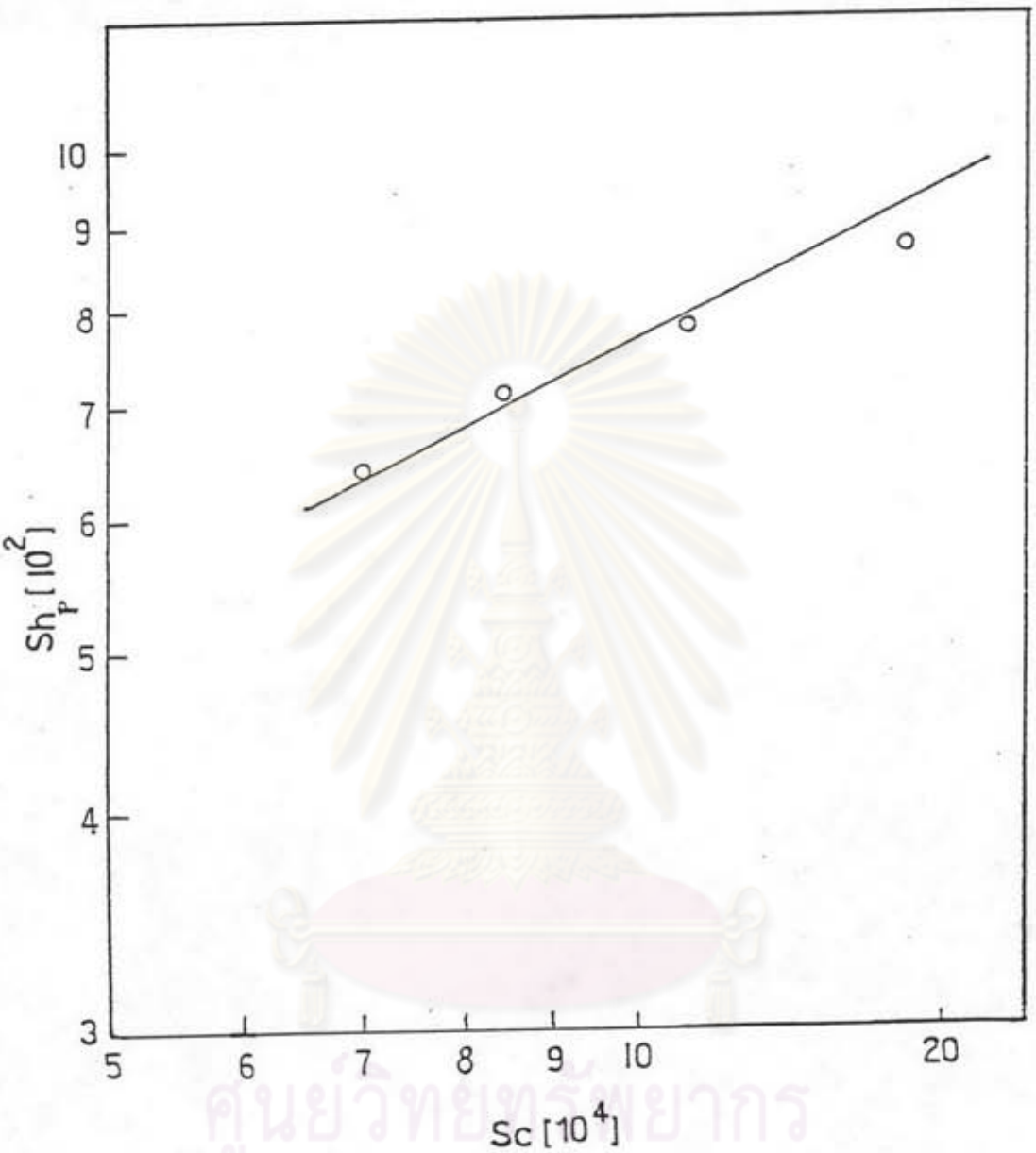

Figure 5.15 Sc vs Sh_p of benzoic acid coated on glass beads– 35.5 wt % sucrose in water, Re_p = 1.5×10^4

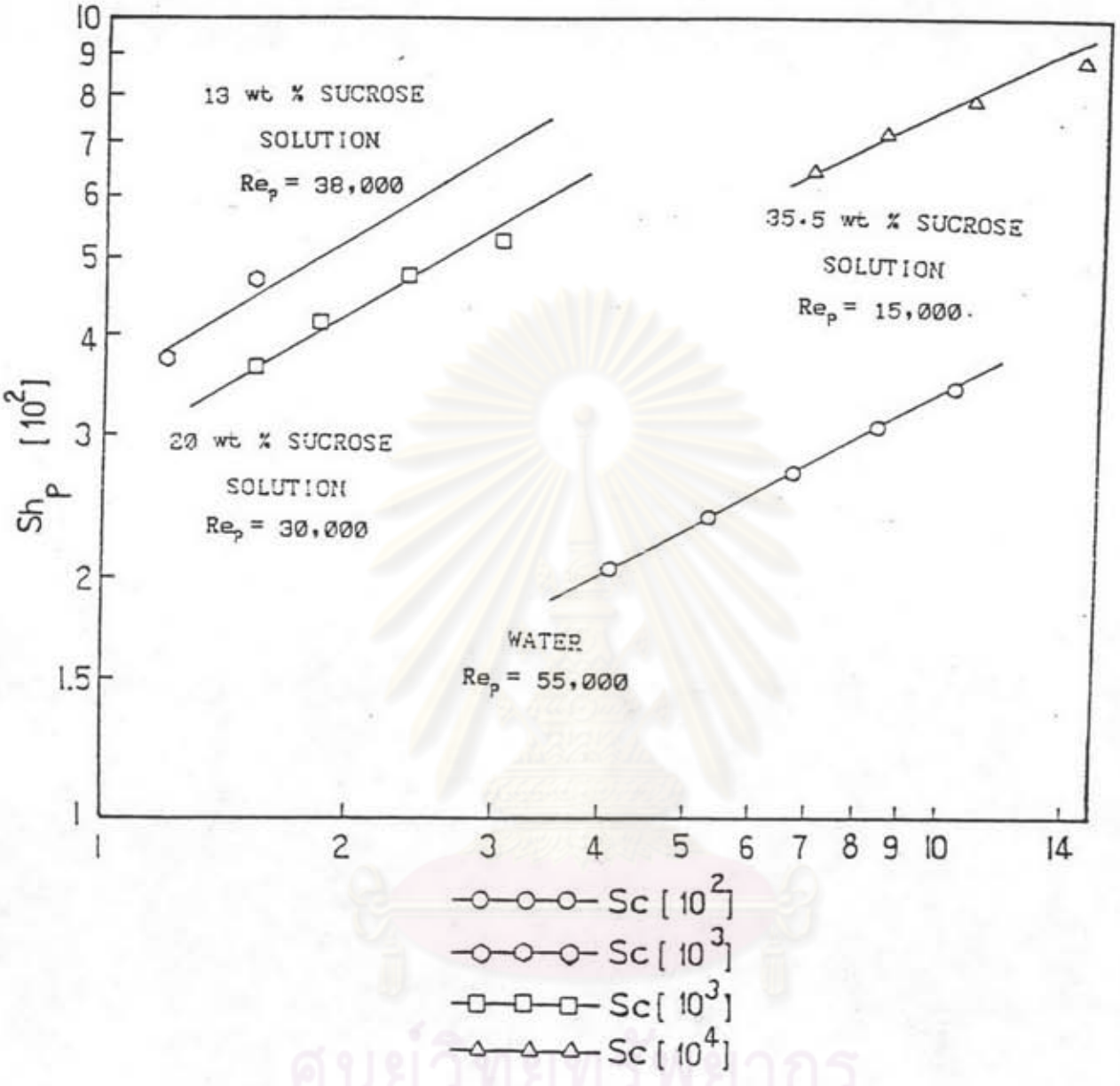

Figure 5.16 Sc vs Sh_p for systems of benzoic acid coated on glass beads and water, 13 wt %, 20 wt % and 35.5 wt % sucrose in water

$1.5x10^{4}$ and the temperatures are kept constant at 35 °C, 35 °C, 30 °C, 30 °C and 35 °C respectively. Data are shown in Tables 5.14-5.18 and are plotted in Figure 5.17.

Figure 5.17 shows that the influence of the density group is not significant on mass transfer. The lines are parallel and horizontal.

For systems of benzoic acid coated on various materials and water, the values of Sherwood number are the average values of at least five identical experimental runs. For systems of benzoic acid coated on various materials and 13 wt %, 20 wt % and 35.5 wt %, the values of Sherwood number are the average values of at least three identical experimental runs.

This work is to find mass transfer correlation of solid - liquid systems in standard agitated vessel. The solubilities of benzoic acid into water and sucrose solution are low resulting in low flux mass transfer.

There are some important parameters on solid - liquid mass transfer in agitated vessel such as rotation speed, temperature, density difference between solid and liquid system, impeller type, level of agitation, particle size, shape of particles, ratio of turbine diameter to tank diameter, diffusivity, viscosity etc. In this work the important parameters that is the rotation speed, temperature and density difference between solid and liquid are varied. In order to obtain solid with different densities, benzoic acid is coated on various materials. To obtain different

Table 5.14 Mv vs Sh_p of Benzoic Acid Coated on Various Materials - Water at 35 °C, $Re_p = 5.1 \times 10^4$, Sc = 677, T = 20 cm, Liquid Density = 0.9940 g/cm³

Benzoic acid coated on	Density difference (g/cm³)	Mv = $\Delta\rho/\rho_1$	Sh_p
Glass beads	0.4079	0.4104	240
Polystyrene spheres	0.2426	0.2441	225
Plastic particles type 1	0.1925	0.1937	265
Plastic particles type 2	0.1298	0.1306	242

Table 5.15 Mv vs Sh_p of Benzoic Acid Coated on Various Materials - 13 wt % Sucrose in Water at 35 °C, $Re_p = 3.95 \times 10^4$, Sc = 2,355, T = 20 cm, Liquid Density = 1.0777 g/cm³

Benzoic acid coated on	Density difference (g/cm³)	Mv = $\Delta\rho/\rho_1$	Sh_p
Glass beads	0.3573	0.3420	373
Plastic particles type 1	0.1419	0.1358	400
Plastic particles type 2	0.0792	0.0758	385

Table 5.16 Mv vs Sh_p of Benzoic Acid Coated on Various Materials - 20 wt % Sucrose in Water at 30 °C, $Re_p = 2.87 \times 10^4$, Sc = 1,210, T = 20 cm, Liquid Density = 1.0472 g/cm³

Benzoic acid coated on	Density difference (g/cm³)	Mv = $\Delta\rho/\rho_1$	Sh_p
Glass beads	0.3243	0.3009	438
Polystyrene spheres	0.1589	0.1475	451
Plastic particles type 1	0.1088	0.1010	411
Plastic particles type 2	0.0462	0.0429	431

Table 5.17 Mv vs Sh_p of Benzoic Acid Coated on Various Materials - 35.5 wt % Sucrose in Water at 30 °C, $Re_p = 1.53 \times 10^4$, Sc = 10,764, T = 20 cm, Liquid Density = 1.1510 g/cm³

Benzoic acid coated on	Density difference (g/cm³)	Mv = $\Delta\rho/\rho_1$	Sh_p
Glass beads	0.2510	0.2181	780
Polystyrene spheres	0.0857	0.0745	810
Plastic particles type 1	0.0356	0.0309	780
Plastic particles type 2	-0.0253	-0.0235	749

Table 5.18 Mv vs Sh_p of Benzoic Acid Coated on Various Materials - 35.5 wt % Sucrose in Water at 35 °C, $Re_p = 1.5 \times 10^4$, Sc = 8,469, T = 20 cm, Liquid Density = 1.1491 g/cm³

Benzoic acid coated on	Density difference (g/cm³)	$Mv = \Delta\rho/\rho_1$	Sh_p
Glass beads	0.2529	0.2201	690
Polystyrene spheres	0.0876	0.0762	720
Plastic particles type 1	0.0375	0.0326	705
Plastic particles type 2	-0.0252	-0.0219	690

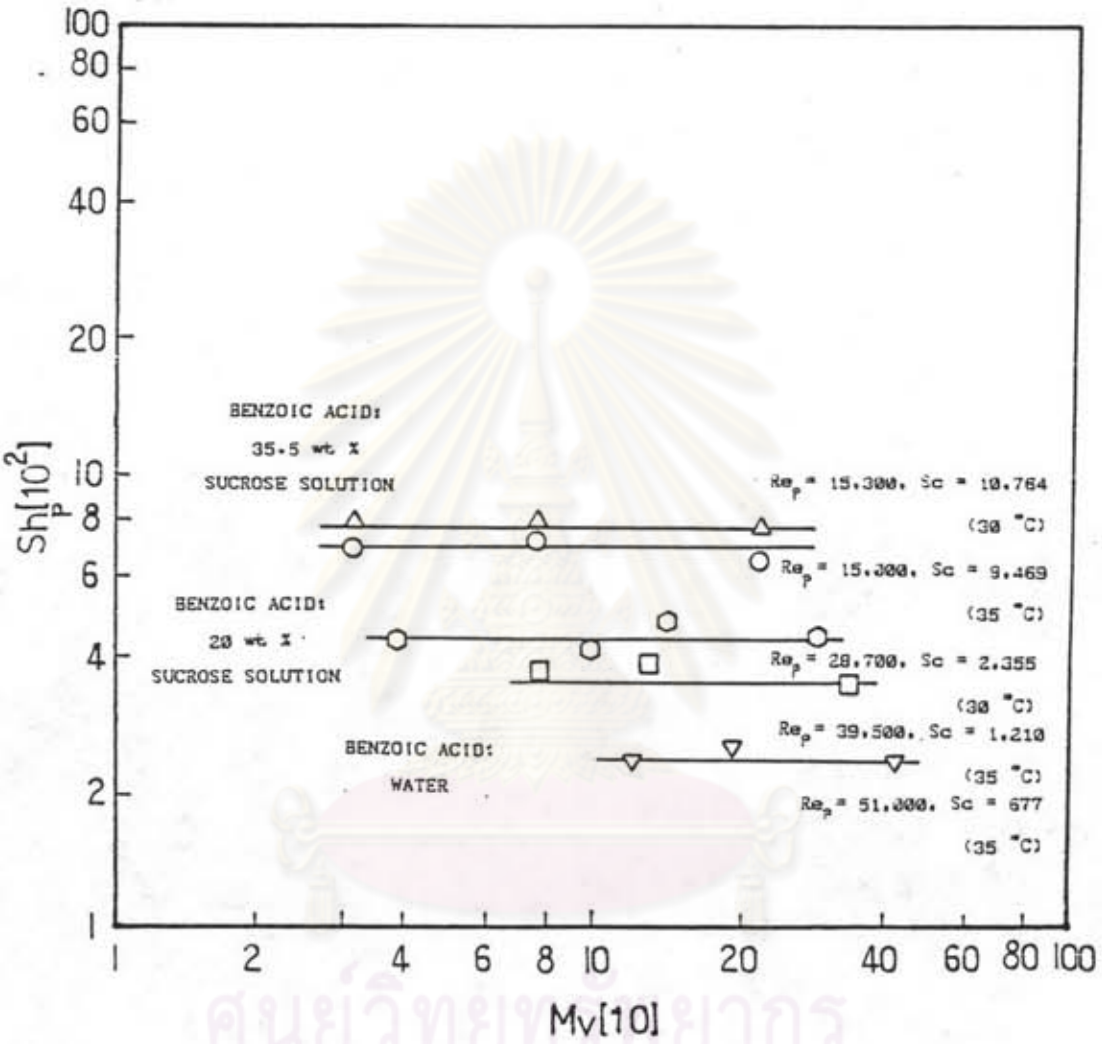

Figure 5.17 Mv vs Sh_p for the systems of benzoic acid coated on various materials and water: 13 wt %, 20 wt % and 35.5 wt % sucrose in water at the temperatures 30 °C or 35 °C

densities between solid and liquid, water, 13 wt %, 20 wt % and 35.5 wt % sucrose in water are used.

Figure 5.17 shows that the density group, Mv, is not a significant parameter of the systems used, that is benzoic acid coated on glass beads, polystyrene spheres, plastic particles type 1 and type 2 and water, 13 wt %, 20 wt % and 35.5 wt % sucrose in water. This result agrees with those of most investigators [6,18]. Harriott [18] shows that for density difference less than 0.4 g/cm^3 has insignificant influence, Figure 5.18.

In this work the limits of variation of various demensionless groups are

$$1.04 \times 10^{4} < Re_P < 7.7 \times 10^{4}$$

$$411 < Sc < 14,318$$

$$-0.0219 < Mv < 0.4104$$

Thus a general solid - liquid mass tranfer correlation in standard agitated vessel for above systems are conveniently expressed by the equation

$$Sh_P = rRe_P^{\alpha} Sc^{\gamma}$$

By analytical calculation technique r for each system is obtained, see Table 5.19

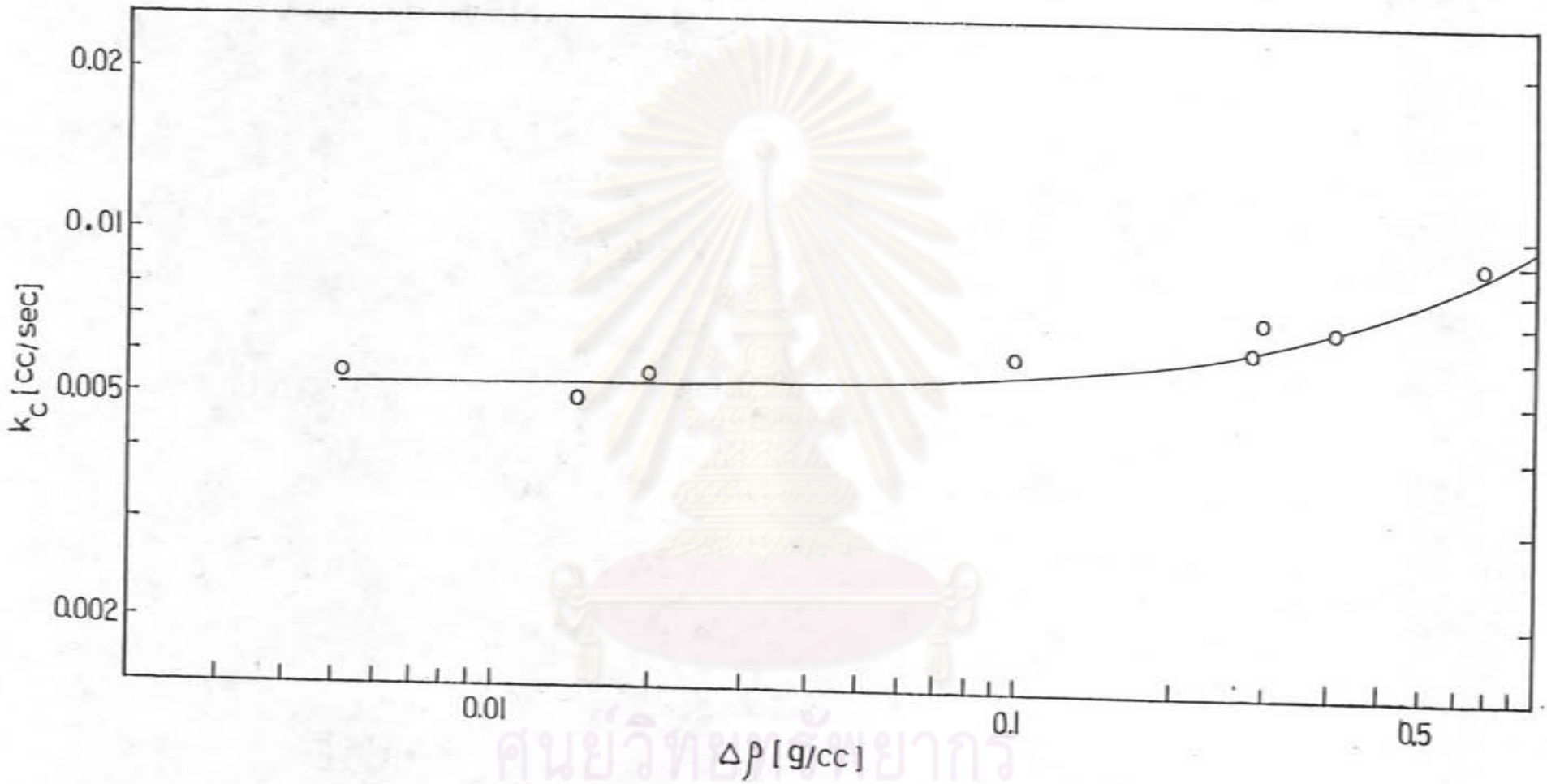

Figure 5.18 Effect of density difference on mass transfer coefficient [18]

Table 5.19 Values of r for this Experimental Systems

Experimental systems	r	Range of Re_p	Range of Sc
System I	1.90×10^{-5}	$4 \times 10^4 - 7.7 \times 10^4$	411 - 1,032
System II	3.00×10^{-5}	$3 \times 10^4 - 5 \times 10^4$	1,210 - 1,516
System III	3.57×10^{-5}	$2.2 \times 10^4 - 4.5 \times 10^4$	1,539 - 3,043
System IV	6.48×10^{-5}	$1.04 \times 10^4 - 2.2 \times 10^4$	7,072 - 14,318

where

System I is benzoic acid coated on various materials - water

System II is benzoic acid coated on various materials - 13 wt % sucrose in water

System III is benzoic acid coated on various materials - 20 wt % sucrose in water

System IV is benzoic acid coated on various materials - 35.5 wt % sucrose in water

In this work the correlations obtained are as follows, see Table 5.20.

Table 5.20 General Solid - Liquid Mass Transfer Correlation in this Work

Experimental systems	Correlation
System I	$1.90\times10^{-6}\ Re_p^{1.21}\ Sc^{0.60}$ $4\times10^{4} < Re_p < 7.7\times10^{4}$ $411 < Sc < 1,032$
System II	$3.00\times10^{-6}\ Re_p^{1.21}\ Sc^{0.60}$ $3\times10^{4} < Re_p < 5\times10^{4}$ $1,210 < Sc < 1,516$
System III	$3.57\times10^{-6}\ Re_p^{1.21}\ Sc^{0.60}$ $2.2\times10^{4} < Re_p < 4.5\times10^{4}$ $1,539 < Sc < 3,043$
System IV	$6.48\times10^{-6}\ Re_p^{1.21}\ Sc^{0.60}$ $1.04\times10^{4} < Re_p < 2.2\times10^{4}$ $7,072 < Sc < 14,318$

5.4 Comparison of the Experimental Results with Others

In this present work, experimental mass transfer coefficients of benzoic acid coated on various materials in water, 13 wt %, 20 wt % and 35.5 wt % sucrose in water are obtained at serveral speeds of the agitator and temperatures. The exponents of Reynolds number and Schmidt number of this experiment are compared with other investigators, see Table 5.21.

Table 5.21 Comparison of the Exponents of Re and Sc of this Work with Other Investigators

Authors	Ref.	Exponent of Re	Exponent of Sc	System of agitator utilize
Hixson and Baum	[1]	0.62, 1.40	0.5	Turbine in curve with 45°, Marine propeller
Barker and Treybal	[6]	0.83	0.5	Standard 6-bladed turbine
Askew and Beckmann	[7]	0.55	0.30	6-bladed turbine
Humphrey and Van Ness	[14]	0.87	0.58	Standard 6-bladed turbine
Penkha Saetun	[25]	1.269	0.465	Standard 6-bladed turbine
Boon-Long	[28]	0.28	0.46	Standard 6-bladed turbine
Keey and Glen	[8]	0.8	0.5	Paddle
This work		1.21	0.5	Standard 6-bladed turbine

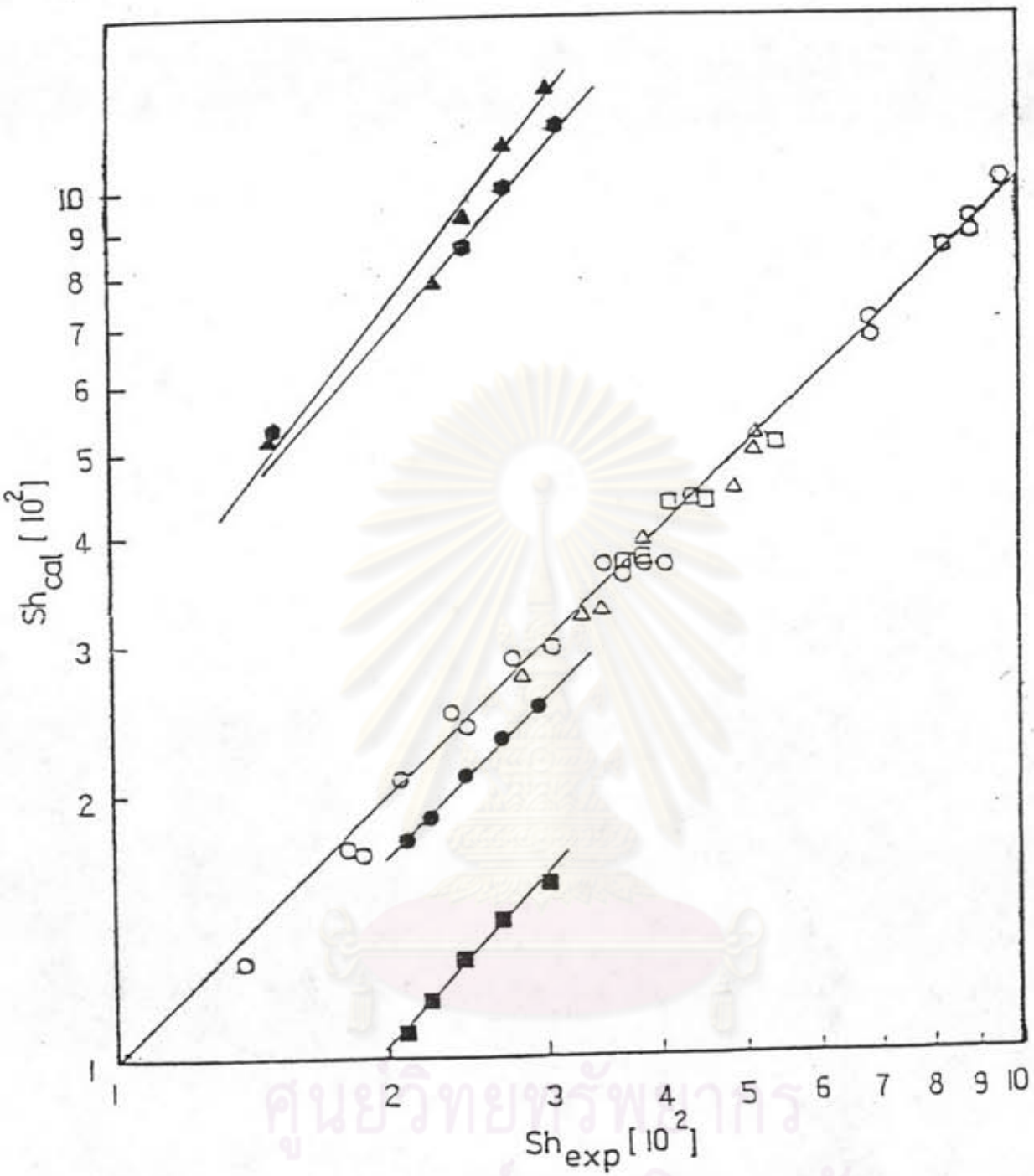

Figure 5.19 Comparison with other investigations
(Benzoic acid - water)

- ▲ Hixson & Baum [1]
- ● Barker & Treybal [6]
- ■ Humphrey & Vanness [14]
- ⬢ Saetun [25]
- ○ Benzoic acid - water
- △ Benzoic acid - 13 wt % sucrose
- □ Benzoic acid - 20 wt % sucrose
- ⬡ Benzoic acid - 35.5 wt % sucrose

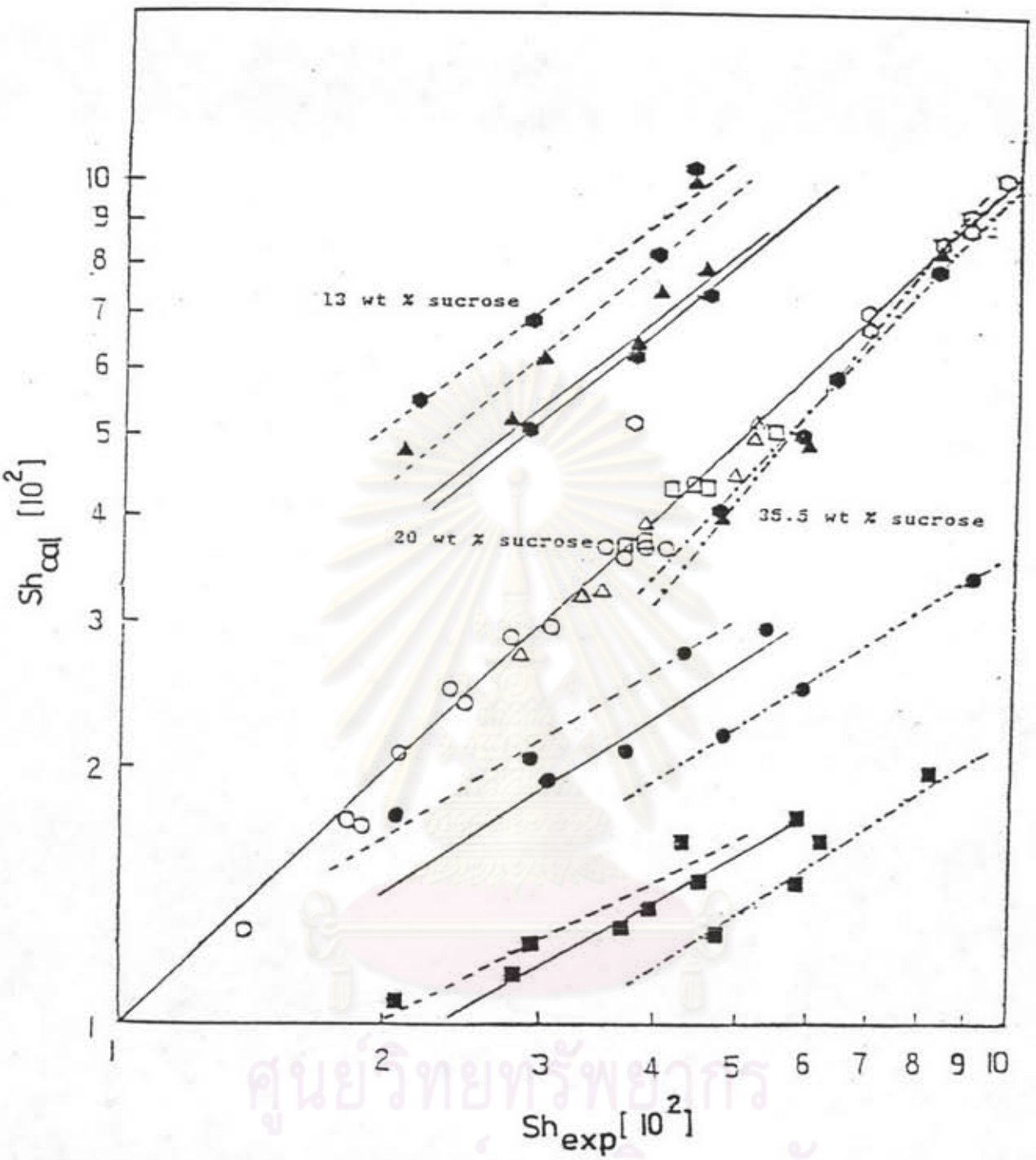

Figure 5.20 Comparison with other investigations
(Benzoic acid - sucrose solution)

- ▲ Hixson & Baum [1]
- ● Barker & Treybal [6]
- ■ Humphrey & Vanness [14]
- ⬣ Saetun [25]
- ○ Benzoic acid - water
- △ Benzoic acid - 13 wt % sucrose
- □ Benzoic acid - 20 wt % sucrose
- ○ Benzoic acid - 35.5 wt % sucrose

The results obtained in this work are compared with other correlations in term of experimental Sherwood number versus calculated Sherwood number, see Figure 5.19 and Figure 5.20.

The results of this work are shown in Table 5.21, Figures 5.19 and 5.20. The results have some differences with other investigators because the agitating system, the system of solid - liquid used and the experimental conditions are not the same. As seen from Figure 5.19, for the system of benzoic acid coated on various materials - water, the results of this work are in agreement with those of Barker and Treybal [6] and Humphrey and Van Ness [14]. For Figure 5.20, for the systems of benzoic acid coated on various materials - sucrose solutions, the results of this work are in agreement with these of Hixson and Baum [1], Saetun [25] and Barker and Treybal [6]. These investigators also studied low flux mass transfer systems as this work studied. For the agitation systems they used standard six bladed turbine and used the vessels with baffles as in this work. Especially Barker and Treybal used benzoic acid and other substances as solids and water and 45 wt % sucrose solution as liquids.

It shows that the correlation in this work is rather general because this work used four different types of solid - liquid systems. It can be seen that for each solid - liquid system, the exponent of Reynolds number and of Schmidt number is the same as the other workers.