CHAPTER V

RESULTS AND DISCUSSION

5.1 Reactivity of Alcohols (C_1^{OH}-C_4^{OH})

From experimental results shown in Table 5.1-5.11 for case of the use of mordenite (HM-10) at various space velocities and temperatures, and in Table 5.12-5.22 for case of the use of Y-type (HY-5.6), the percentage conversion of alcohols from methanol to n-butanol at any temperature and space velocity trend to increase which respect to Mr.Yue's research saying that the dehydration reaction increased on the chain length of molecule of alcohols (62). For the percentage selectivity of ethylene from ethanol would have trend higher than other alcohols at any temperature and space velocity. thus, because of Mr.Costa's research found that mechanism of the conversion of ethanol to hydrocarbons has this pattern : (10)

$$CH_3CH_2OH \rightleftharpoons CH_2{=}CH_2 + H_2O \rightarrow \begin{cases} \text{Paraffins} \\ \text{Aromatics} \end{cases}$$

And, ethylene molecule in above reaction is vary stable,that's why, it has the percentage selectivity of ethylene more than other alcohols. In the similar way the percentage selectivity of ethylene from methanol will have trend higher than n-propanol and n-butanol,because of mechanism of reaction occuring on methanol to light olefins by giving the carbene groups ($\ddot{C}H_2$) which is finally changed to be C_2H_4, but in case of n-propanol and n-butanol, the mechanism of reaction would directly occure to be C_3H_6 and C_4H_8 previously. For the percentage selectivity of propylene of n-propanol would have trend higher than other alcohols at any temperatures and space velocities. The percentage selectivity of propylene of methanol would have trend higher than n-butanol and ethanol respectively at any temperatures and space velocities. Because of mechanism of dehydration of n-propanol would occur to be propylene and water more than occuring to be ethylene and water, which respect to basic concept of thermodynamics, which calculated in Appendix E said that $\Delta G_{f,r}$ for conversion n-propanol to propylene and water less than value of $\Delta G_{f,r}$ for conversion of n-propanol to ethylene and water at any temperatures. For percentage selectivity of propylene of methanol would have trend higher than ethanol and n-butanol, because of mechanism in occuring reaction of methanol to light olefins which occur to be the carbene groups ($\ddot{C}H_2$) that has the excess activation energy to change to ethylene and they continue to occur in chain reaction from ethylene to propylene, but in case of ethanol and n-butanol, the mechanism of reactions occuring to ethylene and butene previously which are rather stable molecules.

5.2 Effect of Reaction Temperature

From experimental result shown in Figure 5.1-5.3 for the case of mordenite catalyst (HM-10) at various space velocity and Figure 5.17-5.19 for Y-type catalyst (HY-5.6) which the result showed that when the reaction temperature increased from 200 to 350°C, the trend of alcohols conversion would increased for all of methanol, ethanol, n-propanol, and n-butanol at any space velocity. That's why, because of conversion of alcohols to light olefins, that is endothermic reaction. So, this research result is like to the basic theory; when the reaction temperature increased, the endothermic reactions was better to occur. And, this result is like to basic concept of thermodynamics which caculated in Appendix E said that the $\Delta G_{f,r}$'s methanol conversion to light olefins ($C_2H_4+C_3H_6$) and water at T= 200°C were equal to -85.75 and -157.15 kJ/g-mol when the reaction temperature increased to be 350°C, the $\Delta G_{f,r}$ value decreased to be -104.85 and -176.40 kJ/g-mol for product to be C_2H_4 and C_3H_6, respectively which shown that when temperature incrased, the trend of dehydration of methanol was favorable to occur. In the same way, the $\Delta G_{f,r}$ of alcohols (C_2^{OH} to C_4^{OH}) for conversion of the alcohols to ethylene and water at T = 200°C were equal to -14.64, +4.55, and +11.65 kJ/g-mol, respectively. And, for conversion of alcohols to propylene and water, the $\Delta G_{f,r}$ were equal to -100.97, -26.65, -79.15 kJ/g-mol, respectively. When the temperature increased to be 350°C, the $\Delta G_{f,r}$ of the alcohols were equal to -33.98, -54.31, -28.27 kJ/g-mol for the formation of ethylene, and the formation of propylene, the $\Delta G_{f,r}$ to be -140.19, -46.28, -161.37 kJ/g-mol in case of ethanol, n-propanol, n-butanol respectively. As that said, thermodynamically the dehydration of alcohols to light olefins would increase, when the temperature increasing.

From experimental results shown in Figure 5.7 for HM-10 at space velocity = 1500 hr^{-1}, The result shown that percentage selectivity of ethylene from methanol conversion was rather constant between 200 to 350°C. But, the percentage selectivity of ethylene increased with increasing temperature for both n-propanol and n-butanol, because of the higher temperature, propylene and butene from the dehydration of n-propanol and n-butanol occured to crack to ethylene. In case of ethanol, the selectivity of ethylene had a maximum value at optimum temperature = 300°C and decreased with increasing temperature. Because ethylene was changed to be continued to form others hydrocarbons. Figure 5.9 for mordenite (HM-10) at space velocity 1500 hr^{-1} shown the effect of temperature on percentage selectivity of propylene. The result showed that the trend of selectivity of propylene from methanal, ethanol, n-butanol increased with increasing temperature between 200 to 350°C. The reason of this results was because of the dehydration of alcohols (methanol, ethanol, n-butanol) were increased. In case of n-Propanol, the selectivity of propylene decreased with increasing temperature. The reason of this results because of propylene converted to higher olefins. Figure 5.23 and Figure 5.25 for Y-type catalyst (HY-5.6) showed the ethylene selectivity and propylene selectivity from alcohols (C_1^{OH} - C_4^{OH}) at space velocity 1500 hr^{-1}. The trend of ethylene selectivity and the trend of propylene selectivity were like with the case of using HM-10 catalyst. Owing to the reaction mechanism of olefin formation from alcohols were the same pattern.

Table 5.1 The effect of reaction temperature on activity and selectivity of HM-10 Zeolite (SV=1500 hr^{-1})

Reaction Temperature (°C)	200				250			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	17.35	33.28	40.92	74.22	49.59	72.0	93.3	93.7
%Yield of C_{2-3}	4.92	19.90	24.61	0.57	12.19	33.62	55.31	2.46
%Selectivity C_2H_4	16.02	59.78	0.10	0.05	8.22	46.69	0.15	0.12
%Selectivity C_3H_6	12.24	0	60.05	0.71	16.33	0	59.14	2.51

Reaction Temperature (°C)	300				350			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	54.45	75.19	92.13	94.0	72.08	84.25	94.03	94.19
%Yield of C_{2-3}	18.03	60.12	50.71	4.83	21.57	64.94	35.4	9.36
%Selectivity C_2H_4	13.56	74.49	0.28	0.27	15.24	65.48	1.0	1.04
%Selectivity C_3H_6	19.56	5.46	54.77	5.13	14.69	11.60	50.0	8.89

Table 5.2 The effect of reaction temperature on activity and selectivity of HM-10 Zeolite (SV=3000 hr^{-1})

Reaction Temperature (°C)	200				250			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	5.12	16.53	38.04	45.29	40.66	42.5	50.04	50.14
%Yield of C_{2-3}	1.82	9.89	26.52	0.16	14.62	36.06	33.75	0.48
%Selectivity C_2H_4	16.07	59.83	0.14	0	18.64	84.85	0.03	0.06
%Selectivity C_3H_6	19.67	0	69.58	3.39	17.34	0	67.41	0.89

Reaction Temperature (°C)	300				350			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	45.36	54.36	60.44	70.36	60.0	72.45	80.0	90.24
%Yield of C_{2-3}	12.88	37.25	35.36	3.17	20.83	67.46	31.83	4.80
%Selectivity C_2H_4	15.07	68.52	0.08	0.49	20.21	91.09	0.37	0.69
%Selectivity C_3H_6	13.34	0	58.41	4.02	14.52	2.01	39.41	4.63

Table 5.3 The effect of reaction temperature on activity and selectivity of HM-10 Zeolite (SV=5000 hr^{-1})

Reaction Temperature (°C)	200				250			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	2.63	12.43	17.5	24.94	22.58	30.27	35.0	38.0
%Yield of C_{2-3}	1.05	3.51	7.06	1.56	7.86	23.45	12.41	1.21
%Selectivity C_2H_4	22.83	28.25	0.22	0.52	21.82	76.36	0.31	1.25
%Selectivity C_3H_6	17.12	0	40.12	5.74	12.98	1.11	35.13	12.3

Reaction Temperature (°C)	300				350			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	31.4	40.0	49.24	67.01	55.0	60.14	64.12	72.06
%Yield of C_{2-3}	11.87	35.63	15.35	13.93	22.25	20.4	24.49	19.68
%Selectivity C_2H_4	22.91	71.67	1.01	2.33	30.41	17.6	3.88	4.55
%Selectivity C_3H_6	14.89	17.4	30.19	18.46	10.05	16.31	34.31	22.76

Table 5.4 The effect of space velocity on activity and selectivity of HM-10 Zeolite (C_1OH)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, ^{o}C	200	300	200	300	200	300
$\%C_1OH$ Conversion	17.35	54.45	5.12	45.36	2.63	31.4
%Yield of C_{2-3}	4.92	18.03	1.82	12.88	1.05	11.87
%Selectivity C_2H_4	16.02	13.56	16.07	15.07	22.83	22.91
%Selectivity C_3H_6	12.24	19.56	19.67	13.34	17.12	14.89

Table 5.5 The effect of space velocity on activity and selectivity of HM-10 Zeolite (C_2OH)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, ^{o}C	200	300	200	300	200	300
$\%C_2OH$ Conversion	33.28	75.19	16.53	54.36	12.43	40.0
%Yield of C_{2-3}	19.90	60.12	9.89	37.25	3.51	35.63
%Selectivity C_2H_4	59.78	74.49	59.83	68.52	28.25	71.67
%Selectivity C_3H_6	0	5.46	0	0	0	17.4

Table 5.6 The effect of space velocity on activity and selectivity of HM-10 Zeolite (n-C_3OH)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, ^oC	200	300	200	300	200	300
%n-C_3OH Conversion	40.92	92.13	38.04	60.44	17.5	49.2
%Yield of C_{2-3}	24.61	50.71	26.52	35.36	7.06	15.35
%Selectivity C_2H_4	0.1	0.28	0.14	0.08	0.22	1.01
%Selectivity C_3H_6	60.05	54.77	69.58	58.41	40.12	30.19

Table 5.7 The effect of space velocity on activity and selectivity of HM-10 Zeolite (n-C_4OH)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, ^oC	200	300	200	300	200	300
%n-C_4OH Conversion	74.22	94.09	45.29	70.36	24.94	67.01
%Yield of C_{2-3}	0.57	4.83	0.16	3.17	1.56	13.93
%Selectivity C_2H_4	0.05	0.27	0	0.49	0.52	2.33
%Selectivity C_3H_6	0.71	5.13	3.39	4.02	5.74	18.46

Table 5.8 The effect of space velocity on activity and selectivity of HM-10 Zeolite (C_1^{OH})

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, °C	250	350	250	350	250	350
%C_1^{OH} Conversion	49.59	72.08	40.66	60.0	22.58	55.0
%Yield of C_{2-3}	12.19	21.57	14.62	20.83	7.86	22.25
%Selectivity C_2H_4	8.22	15.24	18.64	20.21	21.82	30.41
%Selectivity C_3H_6	16.33	14.69	17.34	14.52	12.98	10.05

Table 5.9 The effect of space velocity on activity and selectivity of HM-10 Zeolite (C_2^{OH})

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, °C	250	350	250	350	250	350
%C_2^{OH} Conversion	72.0	84.25	42.5	72.45	30.27	60.14
%Yield of C_{2-3}	33.62	64.94	36.06	67.46	23.45	20.4
%Selectivity C_2H_4	46.69	65.48	84.85	91.09	76.36	17.6
%Selectivity C_3H_6	0	11.60	0	2.01	1.11	16.31

Table 5.10 The effect of space velocity on activity and selectivity of HM-10 Zeolite (n-C_3OH)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, °C	250	350	250	350	250	350
%n-C_3OH Conversion	93.3	94.03	50.04	80.0	35.0	64.12
%Yield of C_{2-3}	55.31	35.4	33.75	31.83	12.41	24.49
%Selectivity C_2H_4	0.15	1.0	0.03	0.37	0.31	3.88
%Selectivity C_3H_6	59.14	50.0	67.41	39.41	35.13	34.31

Table 5.11 The effect of space velocity on activity and selectivity of HM-10 Zeolite (n-C_4OH)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, °C	250	350	250	350	250	350
%n-C_4OH Conversion	93.7	94.19	50.14	90.24	38.0	72.06
%Yield of C_{2-3}	2.46	9.36	0.48	4.80	1.21	19.68
%Selectivity C_2H_4	0.12	1.04	0.06	0.69	1.25	4.55
%Selectivity C_3H_6	2.51	8.89	0.89	4.63	12.3	22.76

Table 5.12 The effect of reaction temperature on activity and selectivity of HY-5.6 Zeolite (SV=1500 hr^{-1})

Reaction Temperature (°C)	200				250			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	10.08	16.17	24.22	27.88	15.72	31.5	51.34	71.24
%Yield of C_{2-3}	0.02	9.87	15.81	0.63	0.28	19.36	34.25	2.73
%Selectivity C_2H_4	0.15	60.99	0	0.35	0.88	61.45	0.1	0.12
%Selectivity C_3H_6	0	0	65.25	1.91	0.93	0	66.62	3.71

Reaction Temperature (°C)	300				350			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	22.63	50.42	73.16	87.76	50.50	77.31	95.62	96.39
%Yield of C_{2-3}	1.56	30.71	45.91	4.47	7.45	47.16	51.44	6.92
%Selectivity C_2H_4	2.98	60.9	0.12	0.18	5.47	60.99	0.32	0.49
%Selectivity C_3H_6	3.92	0	62.63	4.92	9.29	0	53.47	6.69

Table 5.13 The effect of reaction temperature on activity and selectivity of HY-5.6 Zeolite ($SV=3000\ hr^{-1}$)

Reaction Temperature (°C)	200				250			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	3.21	6.63	10.51	16.5	5.5	13.75	25.24	39.24
%Yield of C_{2-3}	0.01	4.08	6.65	1.09	0.22	8.39	16.58	1.70
%Selectivity C_2H_4	0.26	60.92	0.11	0.56	0.72	60.94	0.06	0.42
%Selectivity C_3H_6	0	0.55	63.18	6.03	1.6	0.38	65.58	3.92

Reaction Temperature (°C)	300				350			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	10.63	20.0	40.0	62.40	21.31	29.26	55.62	75.95
%Yield of C_{2-3}	0.19	8.42	24.22	3.96	1.79	17.85	28.14	6.28
%Selectivity C_2H_4	0.80	42.04	0.13	0.36	2.27	60.62	0.29	0.46
%Selectivity C_3H_6	0.94	0.43	60.41	5.99	6.13	0.39	50.33	7.81

Table 5.14 The effect of reaction temperature on activity and selectivity of HY-5.6 Zeolite (SV=5000 hr^{-1})

Reaction Temperature (°C)	200				250			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	0.1	3.54	5.14	5.82	0.45	8.19	20.0	38.61
%Yield of C_{2-3}	0	1.6	3.15	0.08	0.05	4.99	10.23	0.36
%Selectivity C_2H_4	0	45.3	0	0.47	5.28	60.95	0	0.04
%Selectivity C_3H_6	0	0	61.33	0.96	5.57	0	51.15	0.87

Reaction Temperature (°C)	300				350			
Alcohols	C_1OH	C_2OH	C_3OH	C_4OH	C_1OH	C_2OH	C_3OH	C_4OH
%Conversion	1.39	13.28	32.48	50.5	5.19	24.37	39.5	48.42
%Yield of C_{2-3}	0.34	8.09	22.56	1.16	1.28	14.77	17.87	1.88
%Selectivity C_2H_4	11.76	60.94	0	0.09	12.15	60.48	0.09	0.13
%Selectivity C_3H_6	12.66	0	69.71	2.21	12.61	0.04	45.15	3.74

Table 5.15 The effect of space velocity on activity and selectivity of HY-5.6 Zeolite (C_1^{OH})

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, °C	200	300	200	300	200	300
% C_1^{OH} Conversion	10.08	22.63	3.21	10.63	0.1	1.39
%Yield of C_{2-3}	0.02	1.56	0.01	0.19	0	0.34
%Selectivity C_2H_4	0.15	2.98	0.26	0.80	0	11.76
%Selectivity C_3H_6	0	3.92	0	0.94	0	12.66

Table 5.16 The effect of space velocity on activity and selectivity of HY-5.6 Zeolite (C_2^{OH})

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, °C	200	300	200	300	200	300
% C_2^{OH} Conversion	16.17	50.42	6.63	20.0	3.54	13.28
%Yield of C_{2-3}	9.87	30.71	4.08	8.42	1.6	8.09
%Selectivity C_2H_4	60.99	60.9	60.92	42.04	45.3	60.94
%Selectivity C_3H_6	0	0	0.53	0.43	0	0

Table 5.17 The effect of space velocity on activity and selectivity of HY-5.6 Zeolites (n-C_3OH)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, °C	200	300	200	300	200	300
%n-C_3OH Conversion	24.22	73.16	10.51	40.0	5.14	32.48
%Yield of C_{2-3}	15.81	45.91	6.65	24.22	3.15	22.56
%Selectivity C_2H_4	0	0.12	0.11	0.13	0	0
%Selectivity C_3H_6	65.25	62.63	63.18	60.41	61.33	69.71

Table 5.18 The effect of space velolcity on activity and selectivity of HY-5.6 Zeolites (n-C_4OH)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, °C	200	300	200	300	200	300
%n-C_4OH Conversion	27.88	87.76	16.5	62.40	5.82	50.5
%Yield of C_{2-3}	0.63	4.47	1.09	3.96	0.08	1.16
%Selectivity C_2H_4	0.35	0.18	0.56	0.36	0.47	0.09
%Selectivity C_3H_6	1.91	4.92	6.03	5.99	0.96	2.21

Table 5.19 The effect of space velocity on activity and selectivity of HY-5.6 Zeolite (C_1^{OH})

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, ^oC	250	350	250	350	250	350
%C_1^{OH} Conversion	15.72	50.50	5.5	21.31	0.45	5.19
%Yield of C_{2-3}	0.28	7.45	0.22	1.79	0.05	1.28
%Selectivity C_2H_4	0.88	5.47	0.72	2.27	5.28	12.15
%Selectivity C_3H_6	0.93	9.29	1.6	6.13	5.57	12.61

Table 5.20 The effect of space velocity on activity and selectivity of HY-5.6 Zeolite (C_2^{OH})

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, ^oC	250	350	250	350	250	350
%C_2^{OH} Conversion	31.5	77.31	13.75	29.26	8.19	24.37
%Yield of C_{2-3}	19.36	47.16	8.39	17.85	4.99	14.77
%Selectivity C_2H_4	61.45	60.99	60.94	60.62	60.95	60.48
%Selectivity C_3H_6	0	0	0.38	0	0	0.04

Table 5.21 The effect of space velocity on activity and selectivity of HY-5.6 Zeolites ($n\text{-}C_3OH$)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, ^oC	250	350	250	350	250	350
%$n\text{-}C_3OH$ Conversion	51.34	95.62	25.24	55.62	20.0	39.5
%Yield of C_{2-3}	34.25	51.44	16.58	28.14	10.23	17.87
%Selectivity C_2H_4	0.1	0.32	0.06	0.29	0	0.09
%Selectivity C_3H_6	66.62	53.47	65.58	50.33	51.15	45.15

Table 5.22 The effect of space velocity on activity and selectivity of HY-5.6 Zeolites ($n\text{-}C_4OH$)

Space Velocity, hr^{-1}	1500		3000		5000	
Reaction Temp, ^oC	250	350	250	350	250	350
%$n\text{-}C_4OH$ Conversion	71.24	96.39	39.24	75.95	38.61	48.42
%Yield of C_{2-3}	2.73	6.92	1.7	6.28	0.36	1.88
%Selectivity C_2H_4	0.12	0.49	0.42	0.46	0.04	0.13
%Selectivity C_3H_6	3.71	6.69	3.92	7.81	0.87	3.74

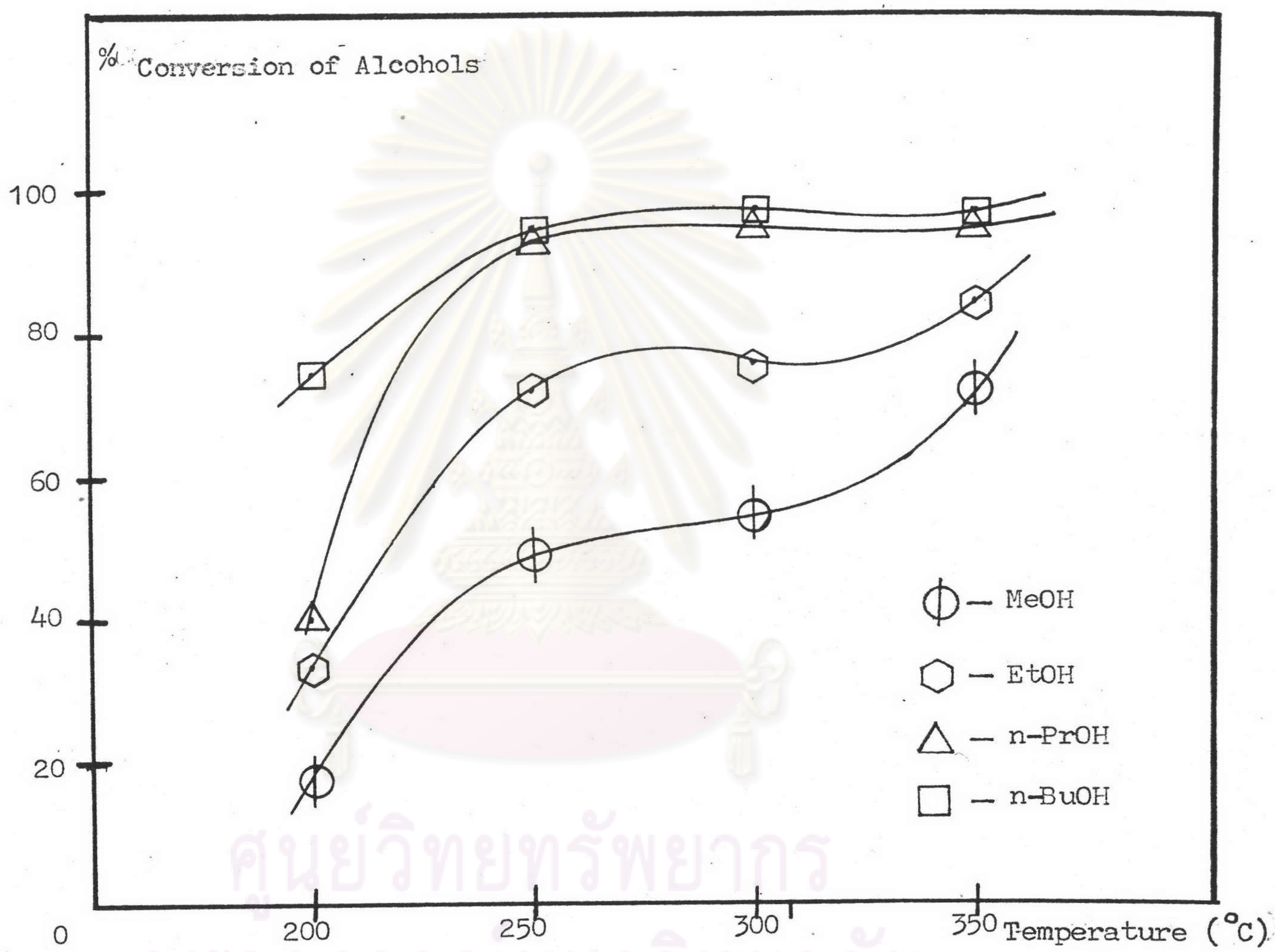

Figure 5.1 Effect of Temperature (200-350°C) on Alcohols (C_1OH-C_4OH) Conversion at S.V.=1500 hr^{-1} for HM-10 zeolite

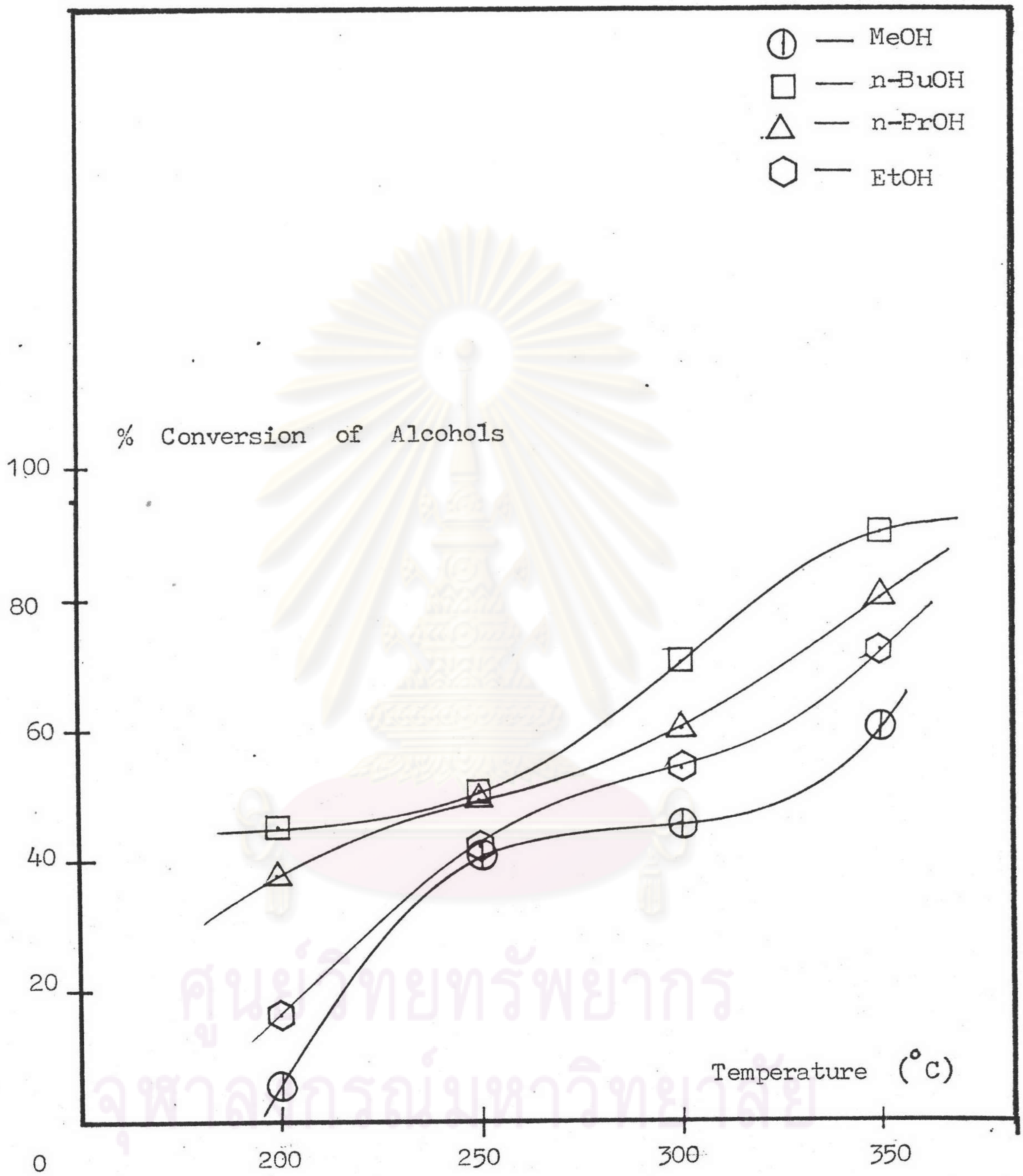

Figure 5.2 Effect of Temperature (200-350°C) on Alcohols (C_1OH-C_4OH) Conversion at S.V.= 3000hr^{-1} for HM-10 zeolite

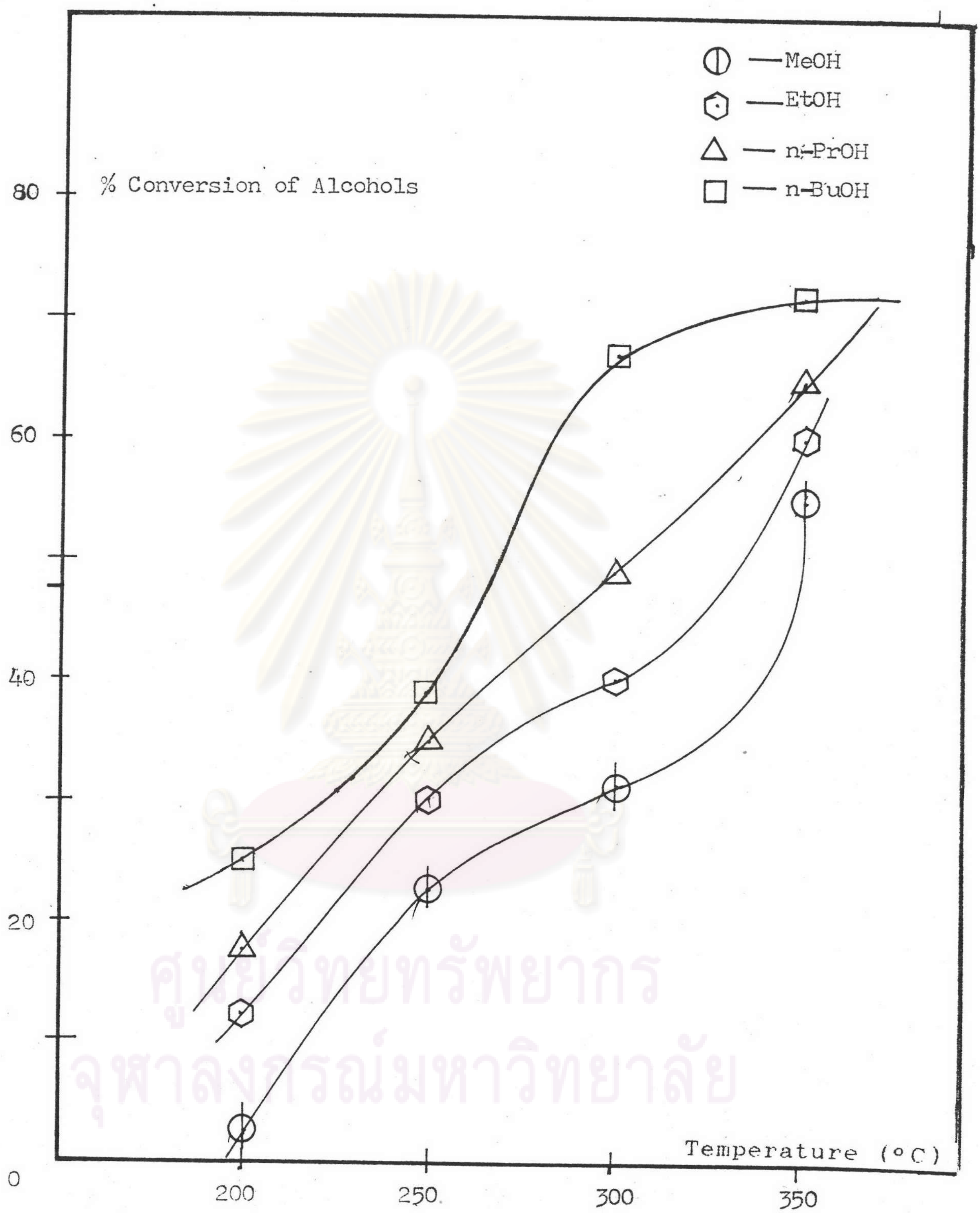

Figure 5.3 Effect of Temperature (200-350°C) on Alcohols (C_1^{OH}-C_4^{OH}) Conversion at S.V.=5000 hr^{-1} for HM-10 zeolite

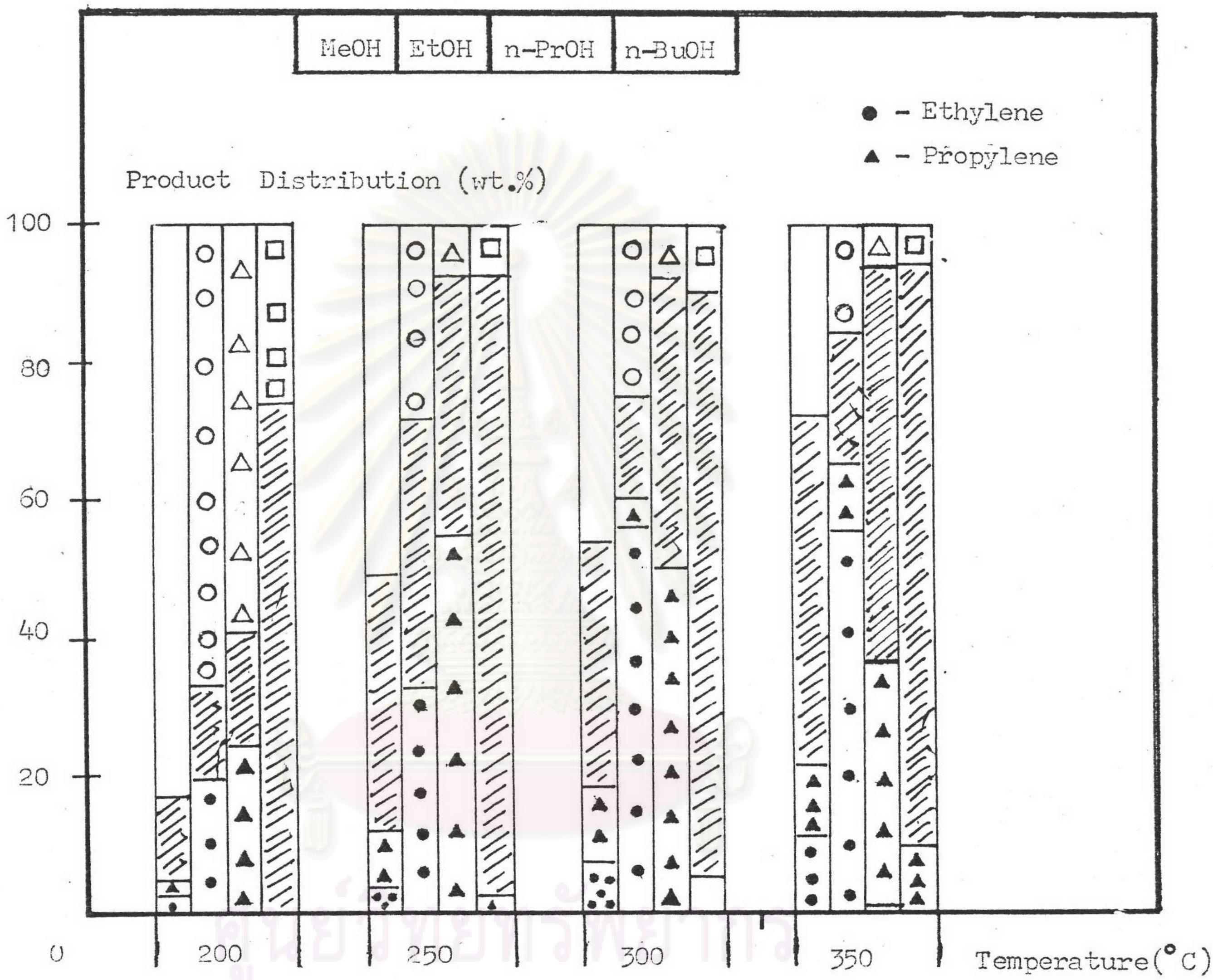

Figure 5.4 Effect of Temperature (200-350°C) on Product Distribution (wt.%) from Alcohols (C_1OH-C_4OH) at S.V.=1500 hr^{-1} for HM-10 zeolite

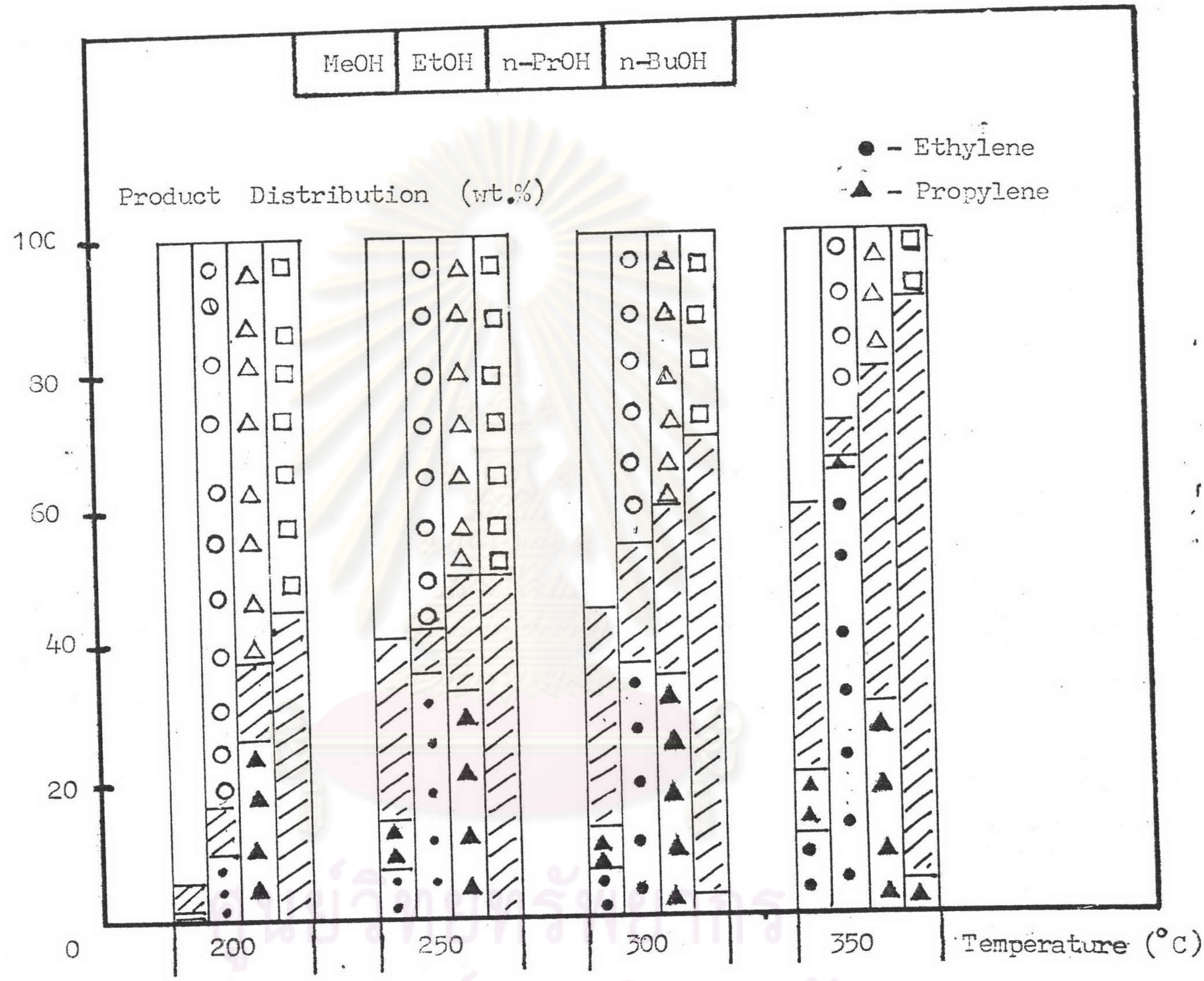

Figure 5.5 Effect of Temperature (200-350°C) on Product Distribution (wt.%) from Alcohols (C_1OH-C_4OH) at S.V.=3000 hr^{-1} for HM-10 zeolite

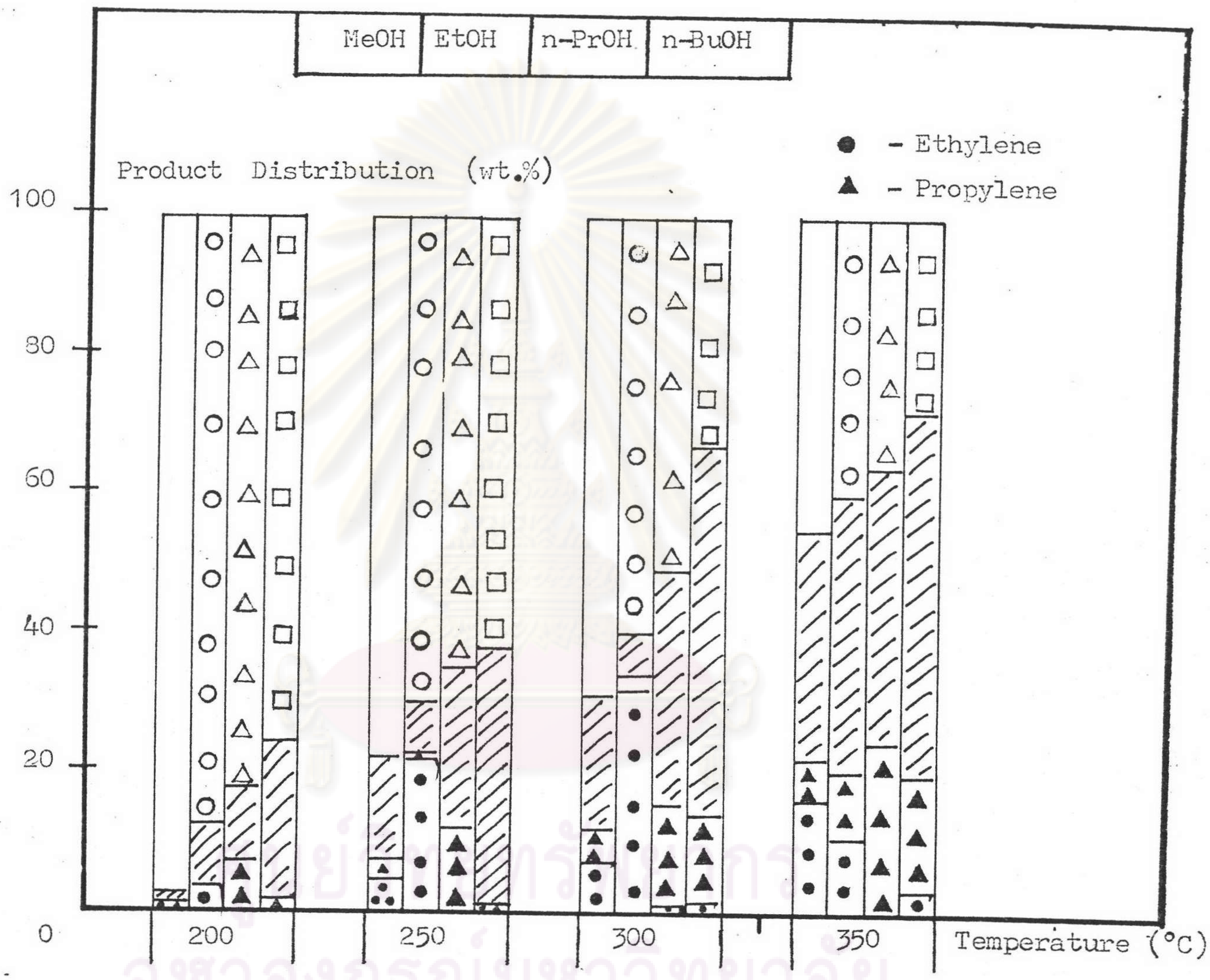

Figure 5.6 Effect of Temperature (200-350°C) on Product Distribution (wt.%) from Alcohols (C_1OH-C_4OH) at S.V.=5000 hr^{-1} for HM-10 zeolite

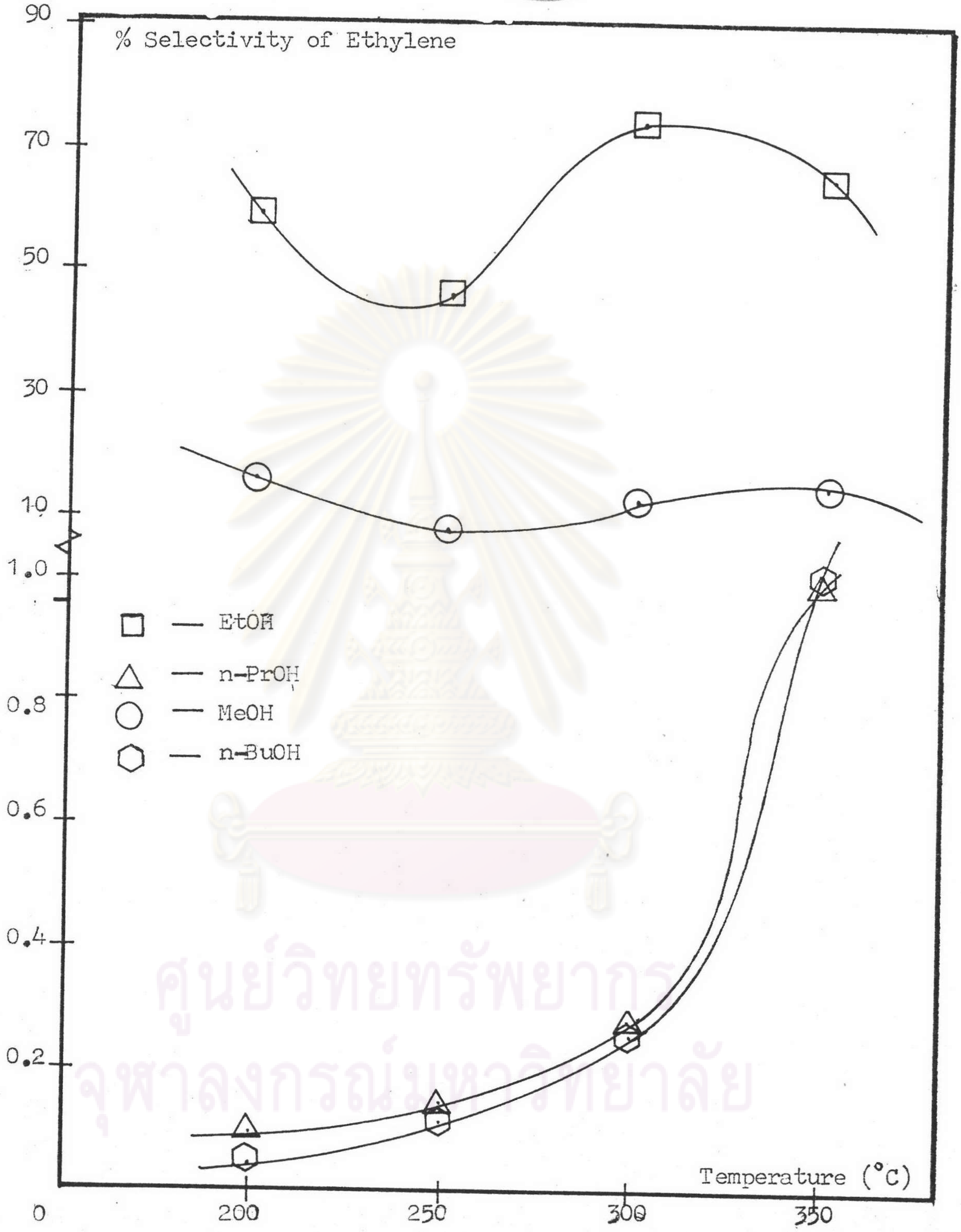

Figure 5.7 Effect of Temperature (200-350°C) on Selectivity of Ethylene from Alcohols (C_1OH-C_4OH) at S.V.=1500 hr^{-1} for HM-10 Zeolite

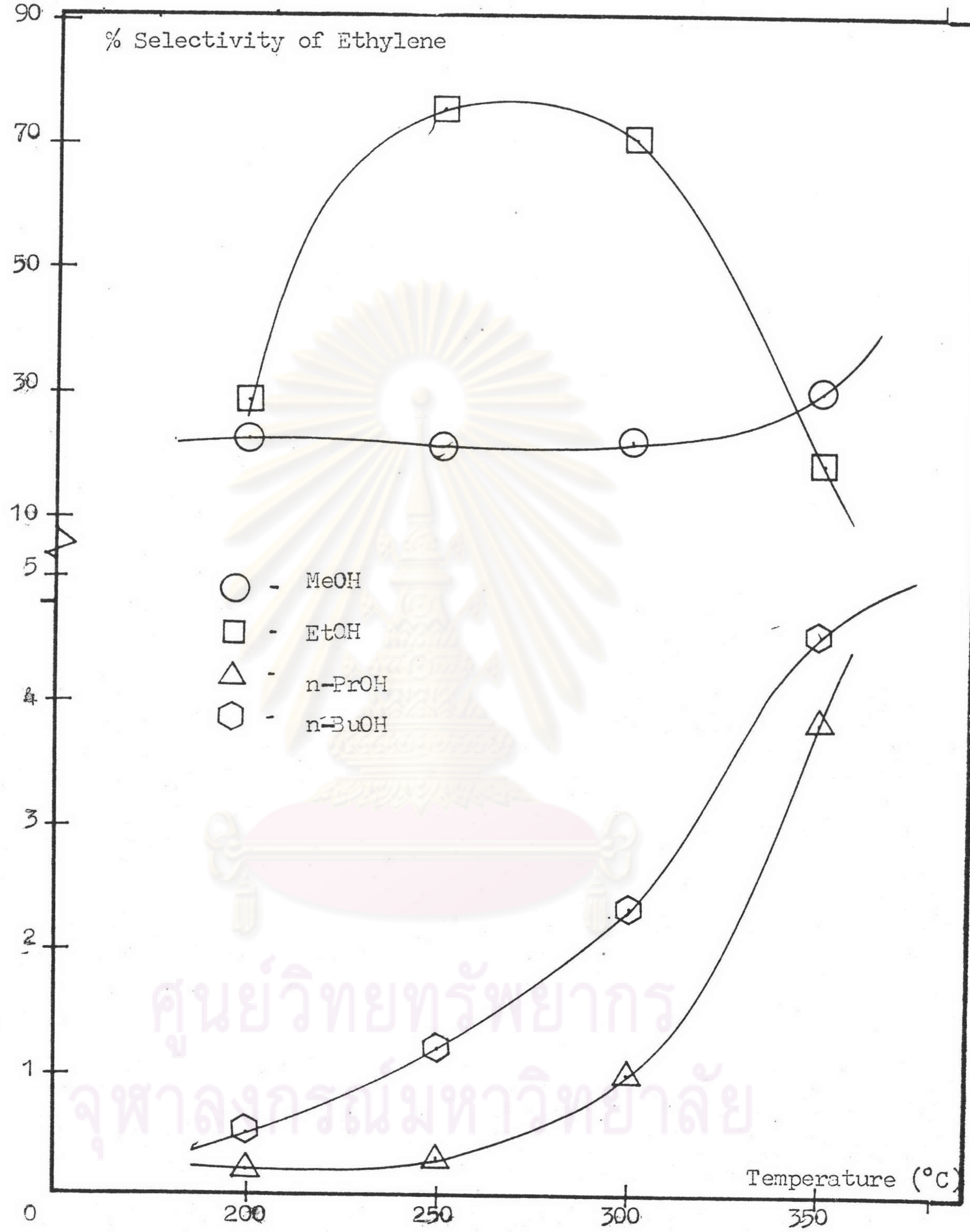

Figure 5.8 Effect of Temperature (200-350°C) on Selectivity of Ethylene from Alcohols (C_1OH-C_4OH) at S.V.=5000 hr^{-1} for HM-10 Zeolite

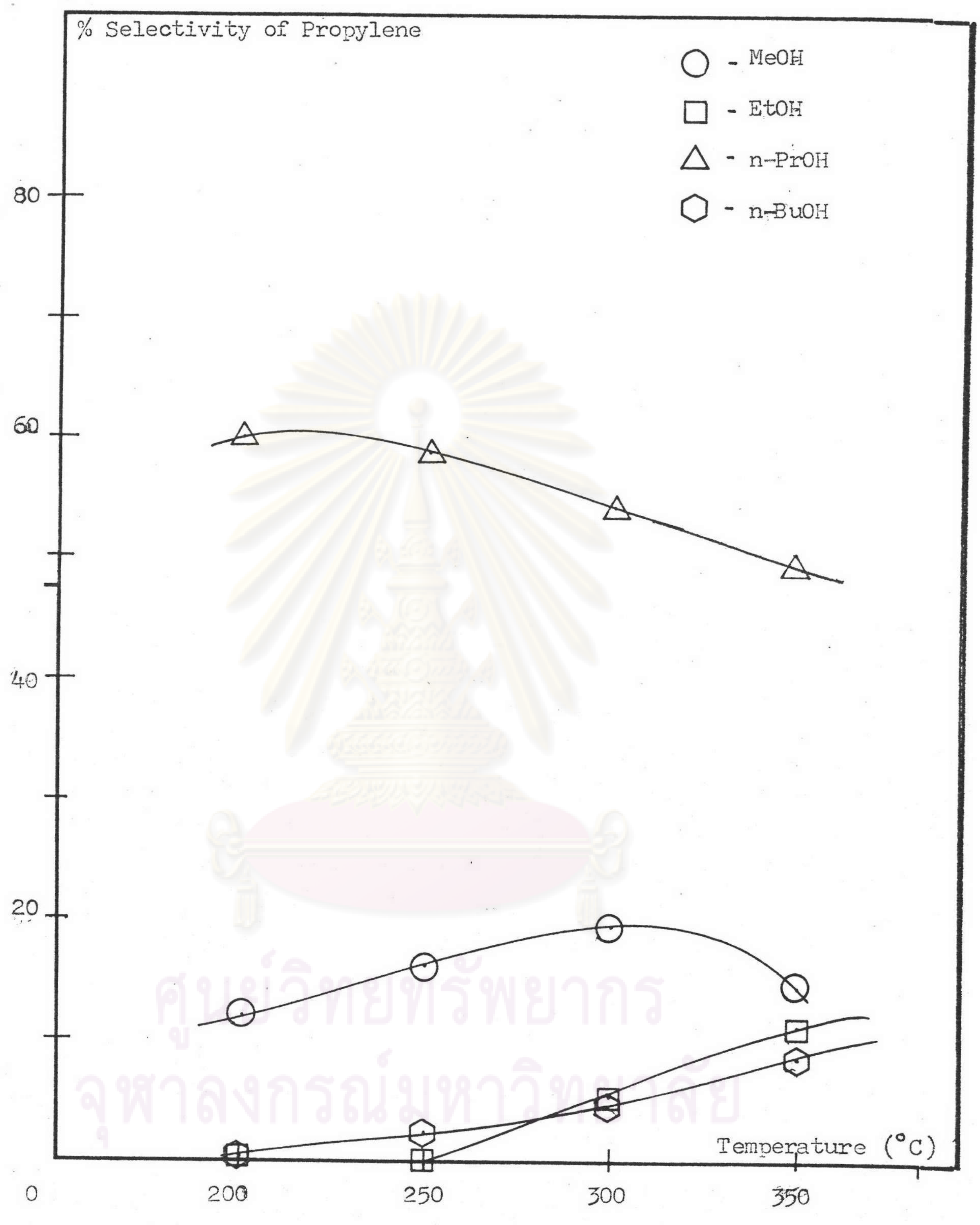

Figure 5.9 Effect of Temperature (200-350°C) on Selectivity of Propylene from Alcohols ($C_1{}^{OH}$-$C_4{}^{OH}$) at S.V.=1500 hr^{-1} for HM-10 Zeolite

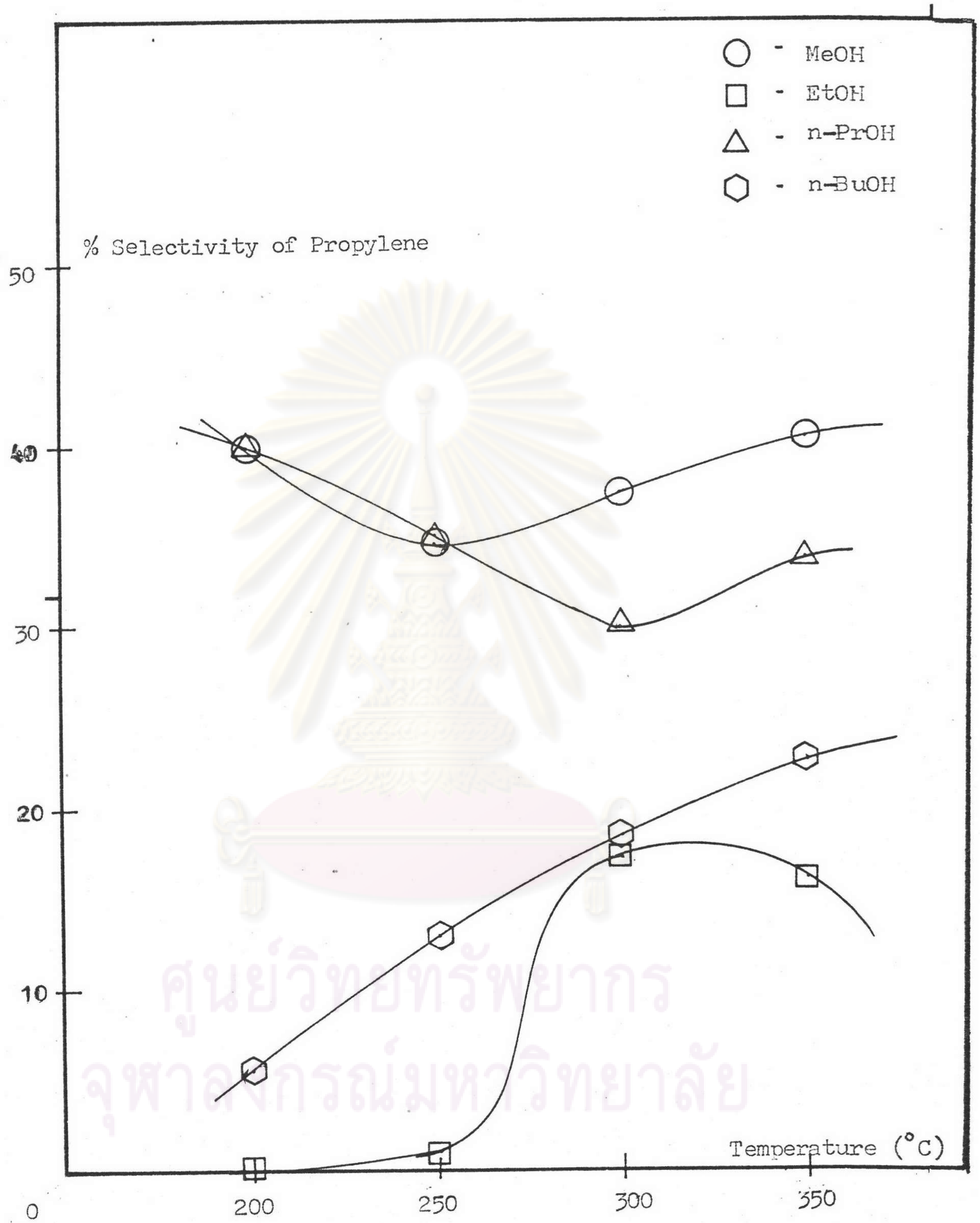

Figure 5.10 Effect of Temperature (200-350°C) on Selectivity of Propylene from Alcohols (C_1OH-C_4OH) at S.V.=5000 hr^{-1} for HM-10 Zeolite

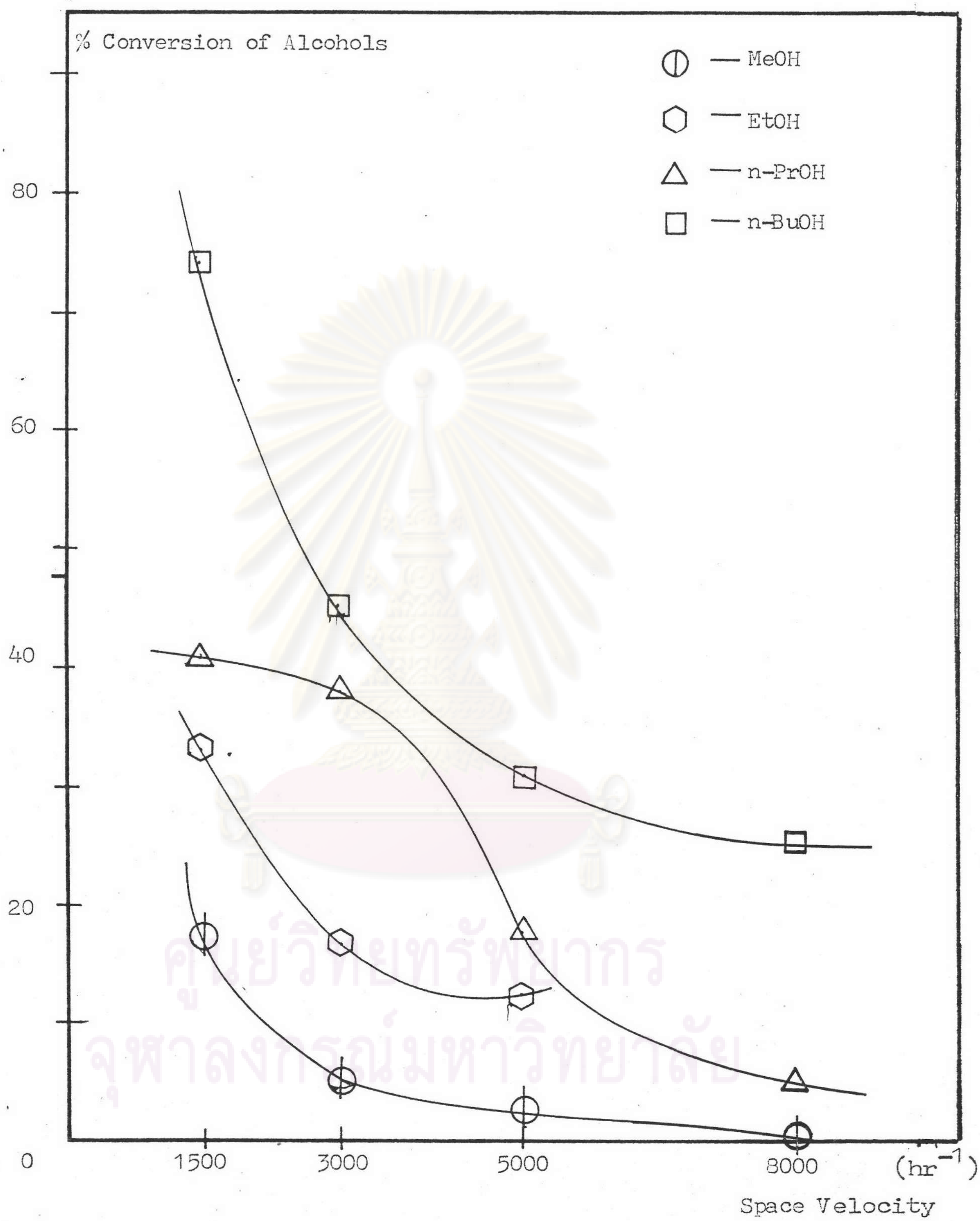

Figure 5.11 Effect of Space Velocity (1500-5000 hr^{-1}) on Alcohols (C_1OH-C_4OH) Conversion at T=200°C for HM-10 Zeolite

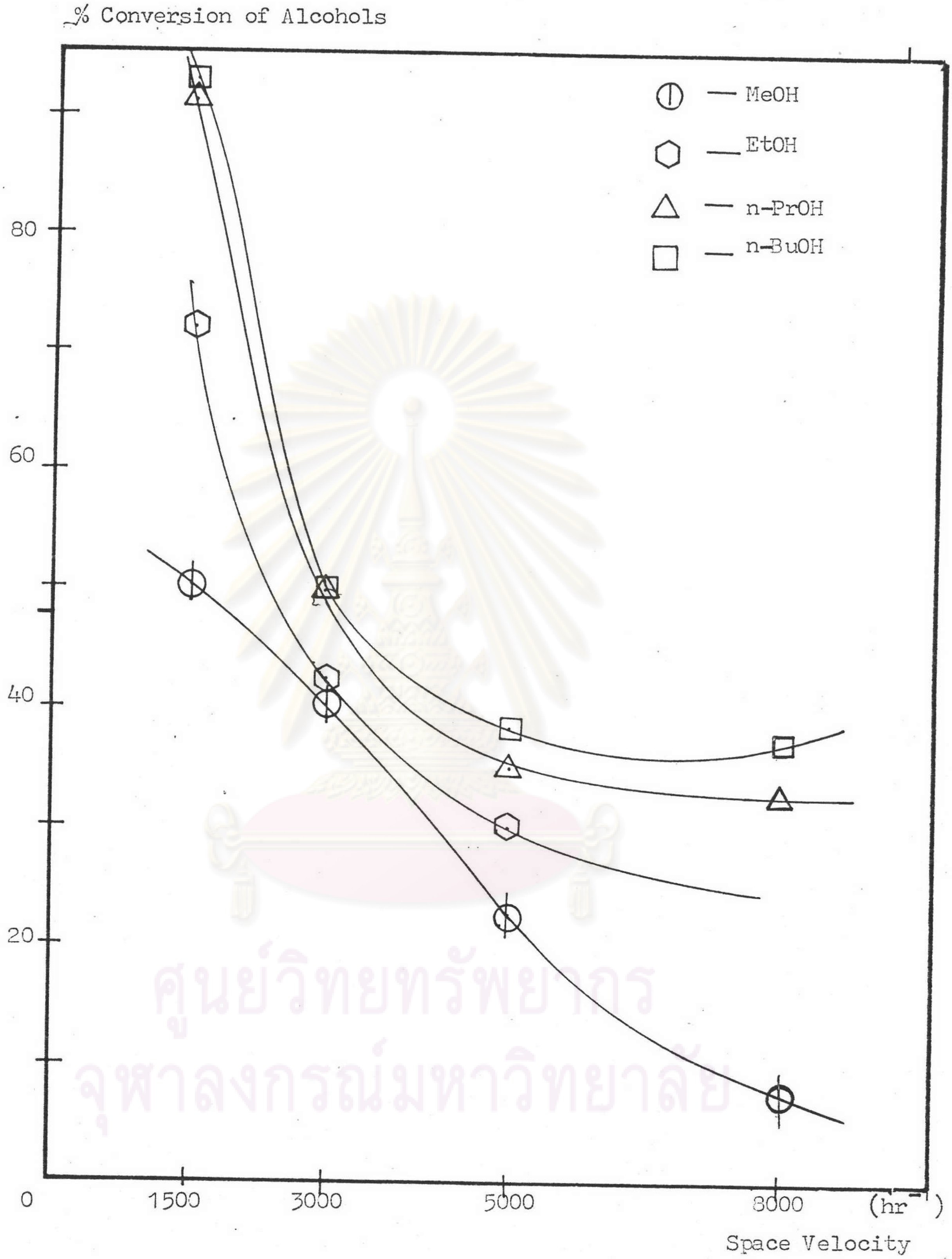

Figure 5.12 Effect of Space Velocity (1500-5000 hr^{-1}) on Alcohols (C_1OH-C_4OH) Conversion at T=250°C for HM-10 Zeolite

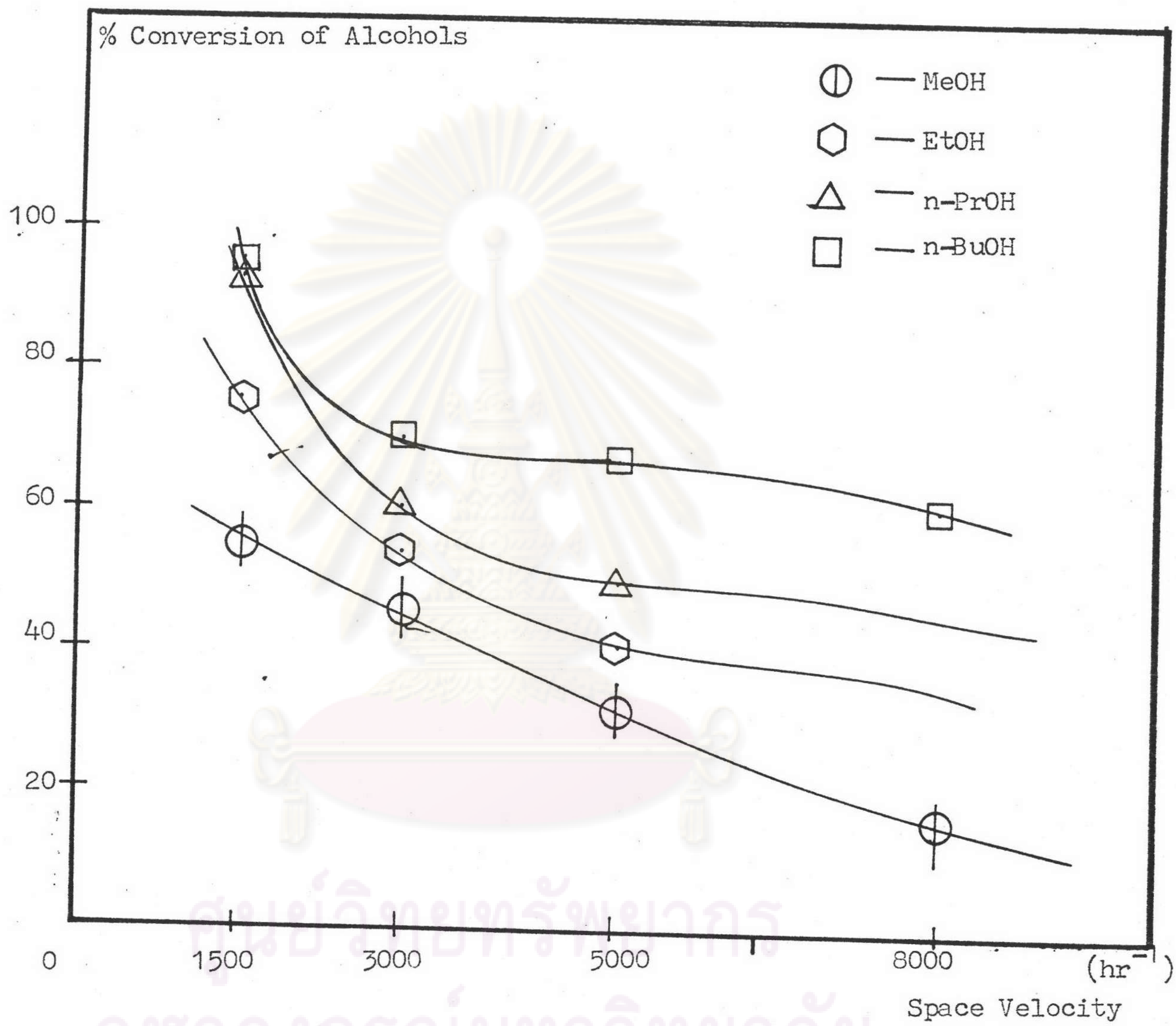

Figure 5.13 Effect on Space Velolcity (1500-5000 hr^{-1}) on Alcohols (C_1OH-C_4OH) Conversion at T=300°C for HM-10 Zeolite

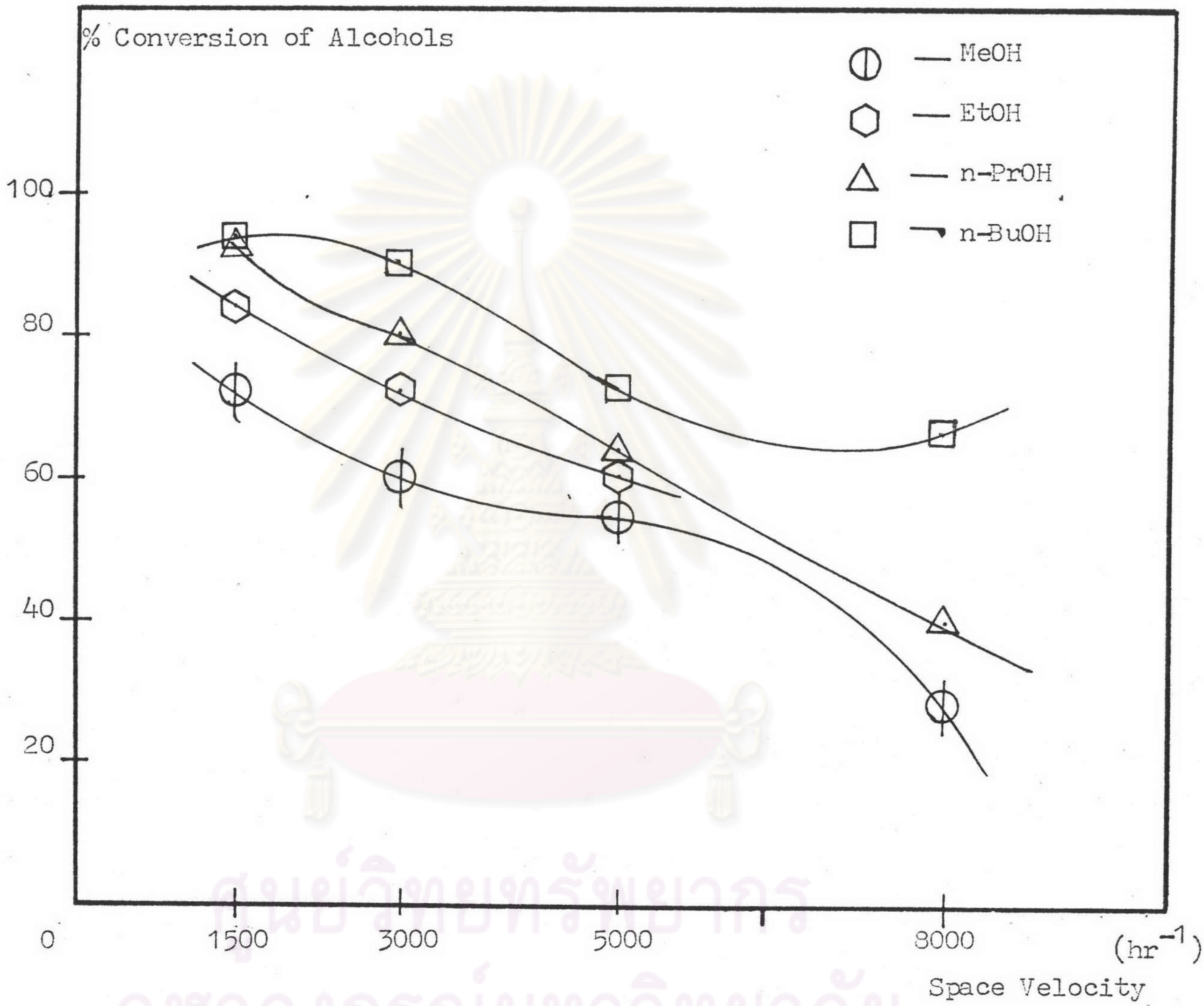

Figure 5.14 Effect of Space Velocity (1500-5000 hr^{-1}) on Alcohols (C_1OH-C_4OH) Conversion at T=350°C for HM-10 Zeolite

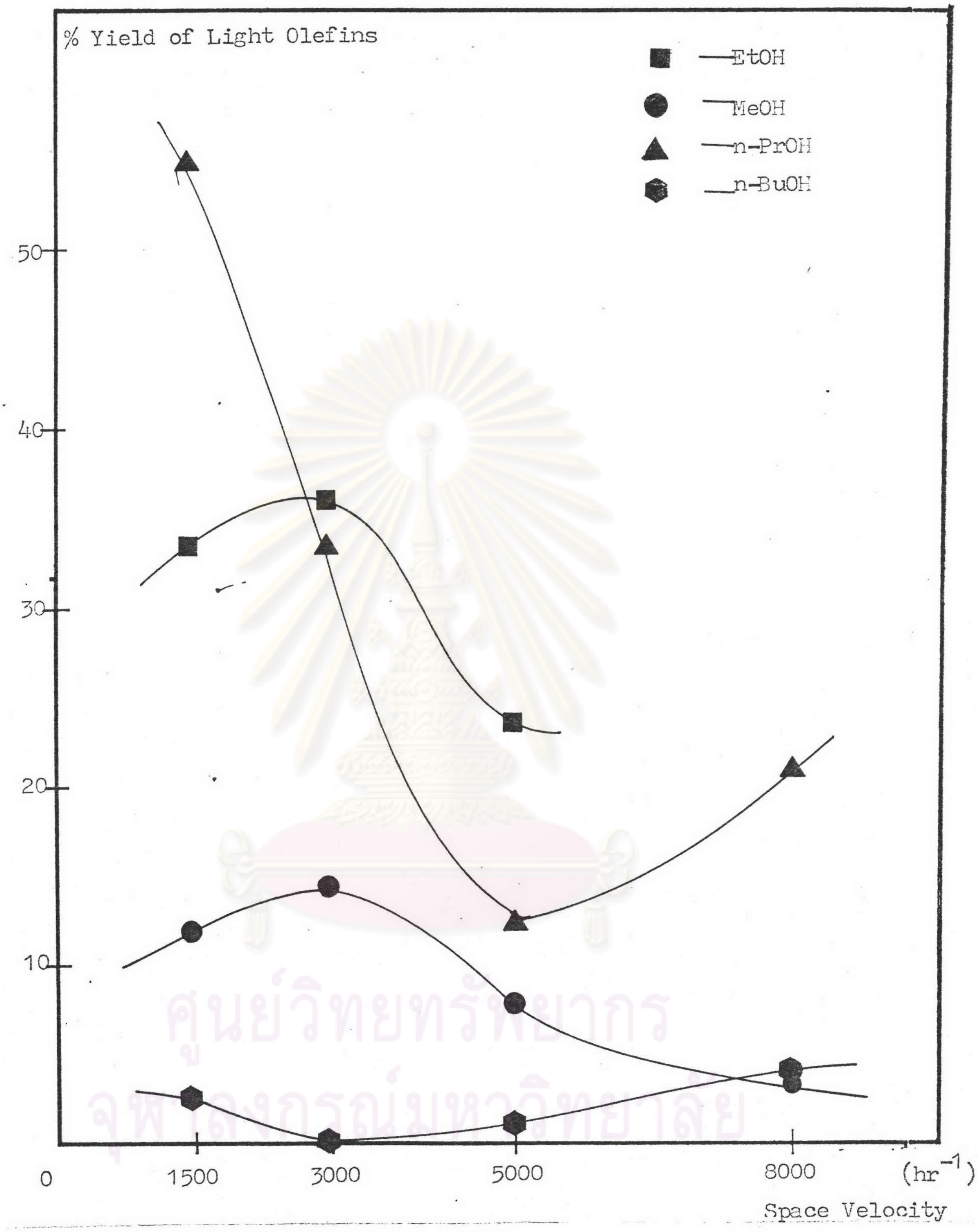

Figure 5.15 Effect of Space Velocity (1500-5000 hr^{-1}) on Percent Yield of Light Olefins (C_{2-3}) from Alcohols ($C_1{}^{OH}$-$C_4{}^{OH}$) at T=250°C for HM-10 Zeolite

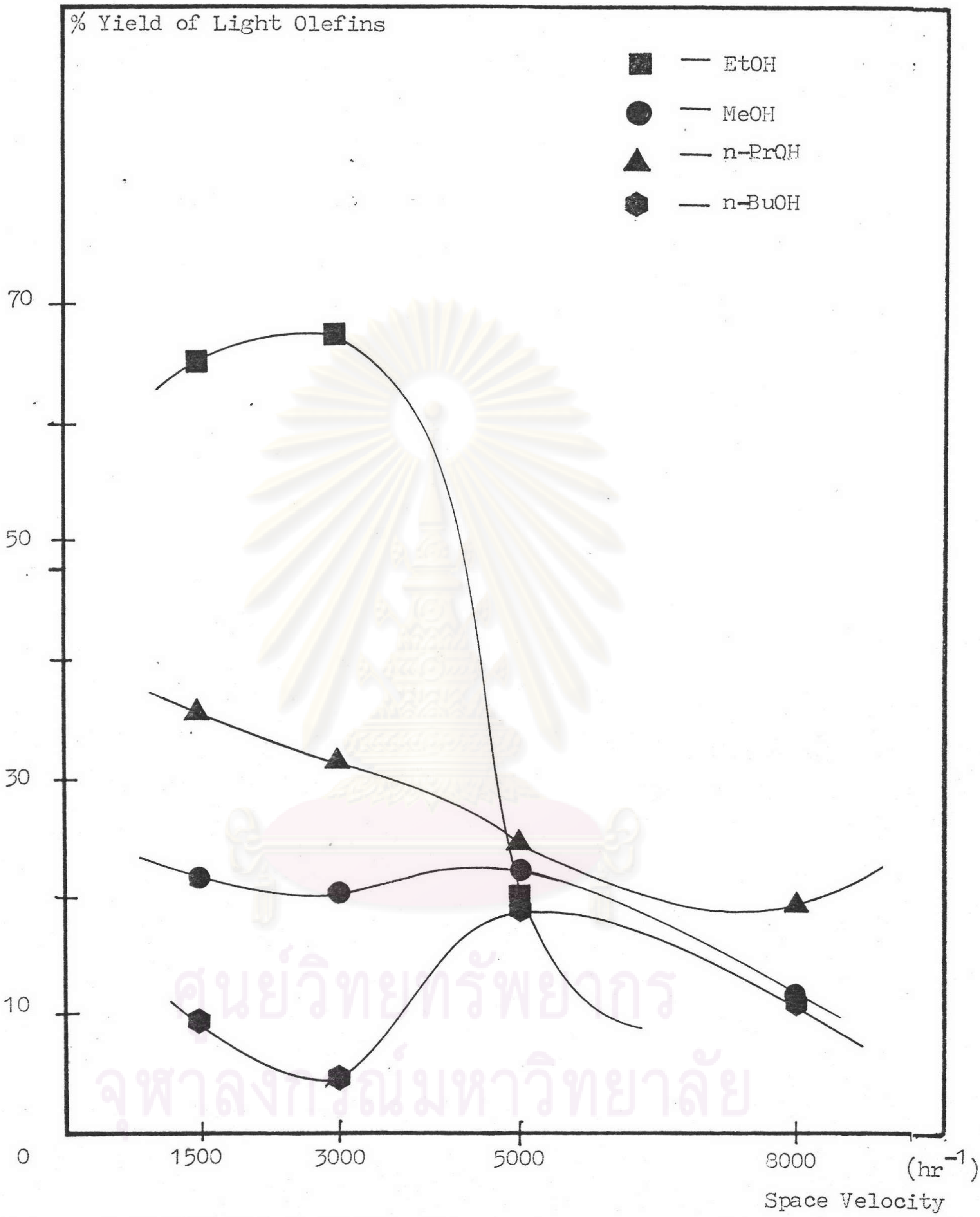

Figure 5.16 Effect of Space Velocity (1500-5000 hr^{-1}) on Percent Yield of Light Olefins (C_{2-3}) from Alcohols (C_1OH-C_4OH) at T=350°C for HM-10 Zeolite

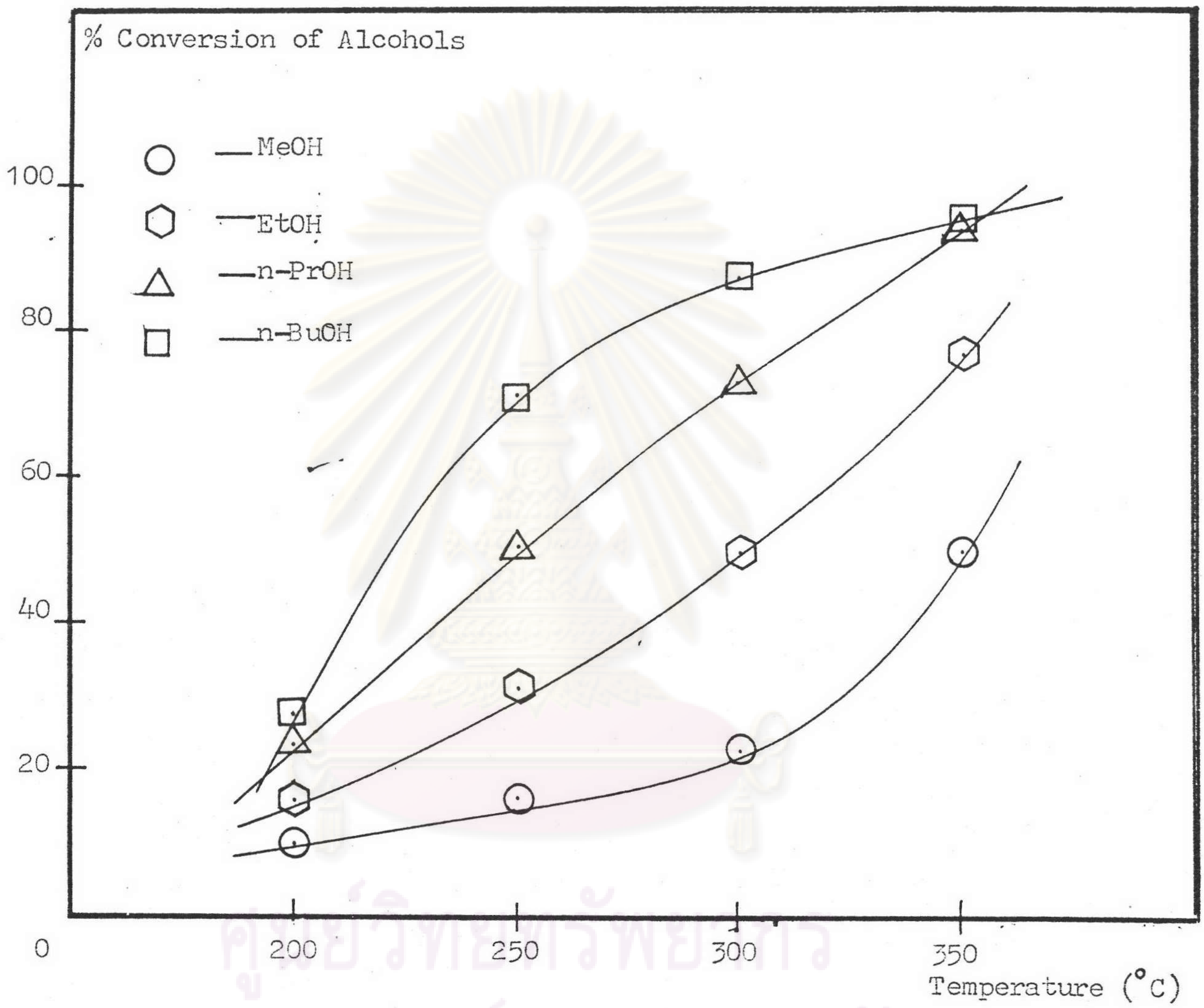

Figure 5.17 Effect of Temperature (200-350°C) on Alcohols (C_1OH-C_4OH) Conversion at S.V.=1500 hr^{-1} for HY-5.6 Zeolite

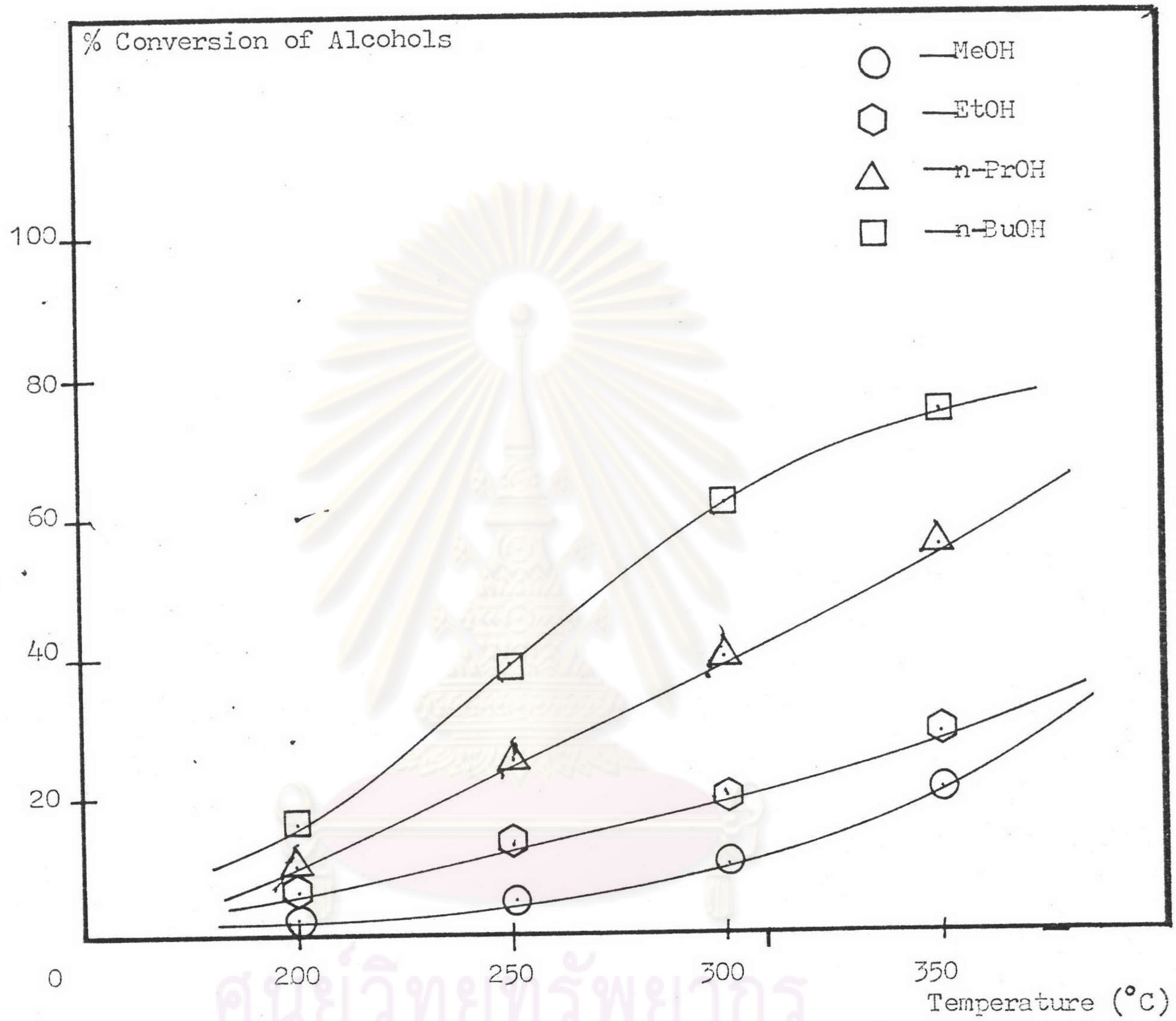

Figure 5.18 Effect of Temperature (200-350°C) on Alcohols ($C_1{}^{OH}$-$C_4{}^{OH}$) Conversion at S.V.3000 hr^{-1} for HY-5.6 Zeolite

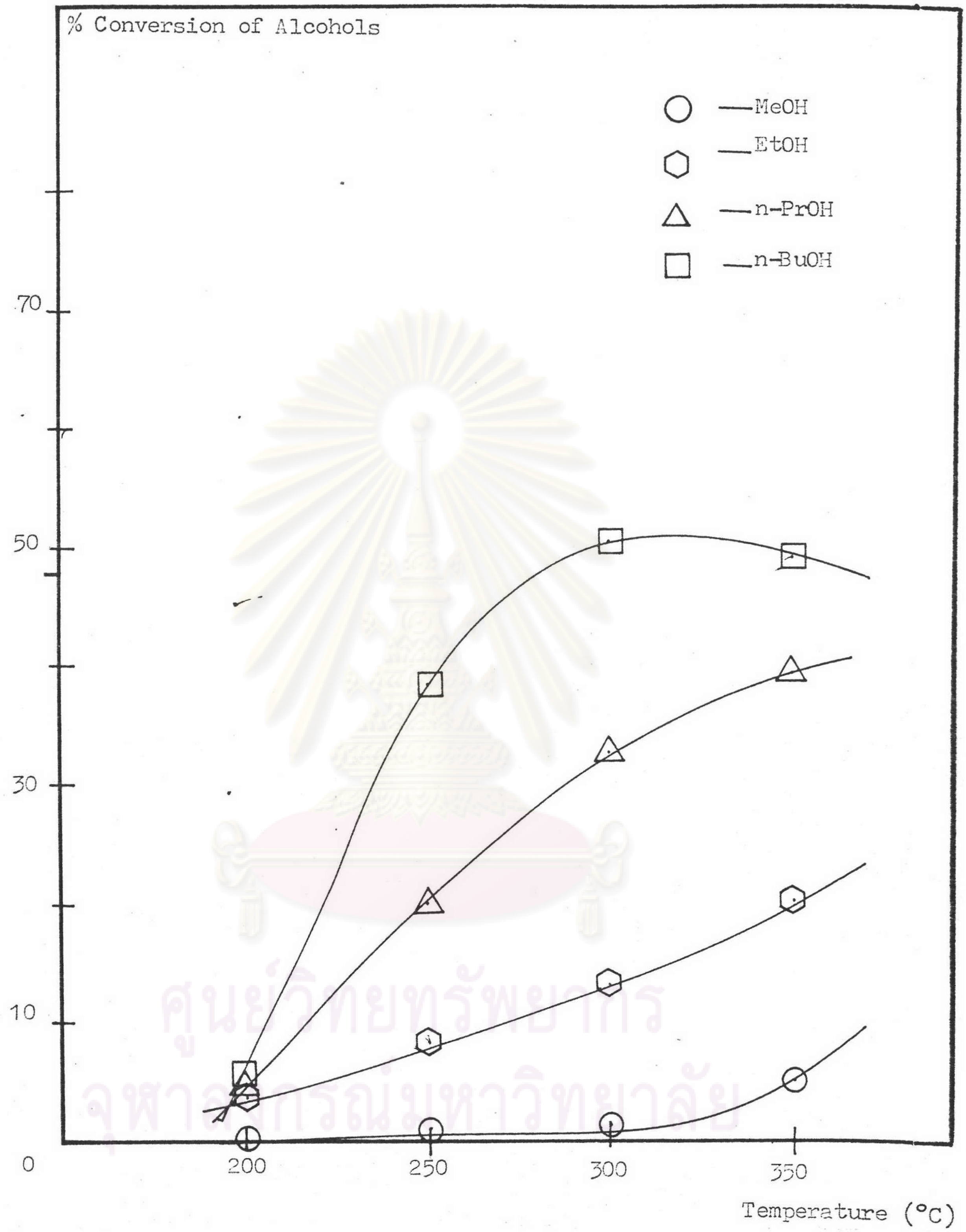

Figure 5.19 Effect of Temperature (200-350°C) on Alcohols (C_1OH-C_4OH) Conversion at S.V.=5000 hr^{-1} for HY-5.6 Zeolite

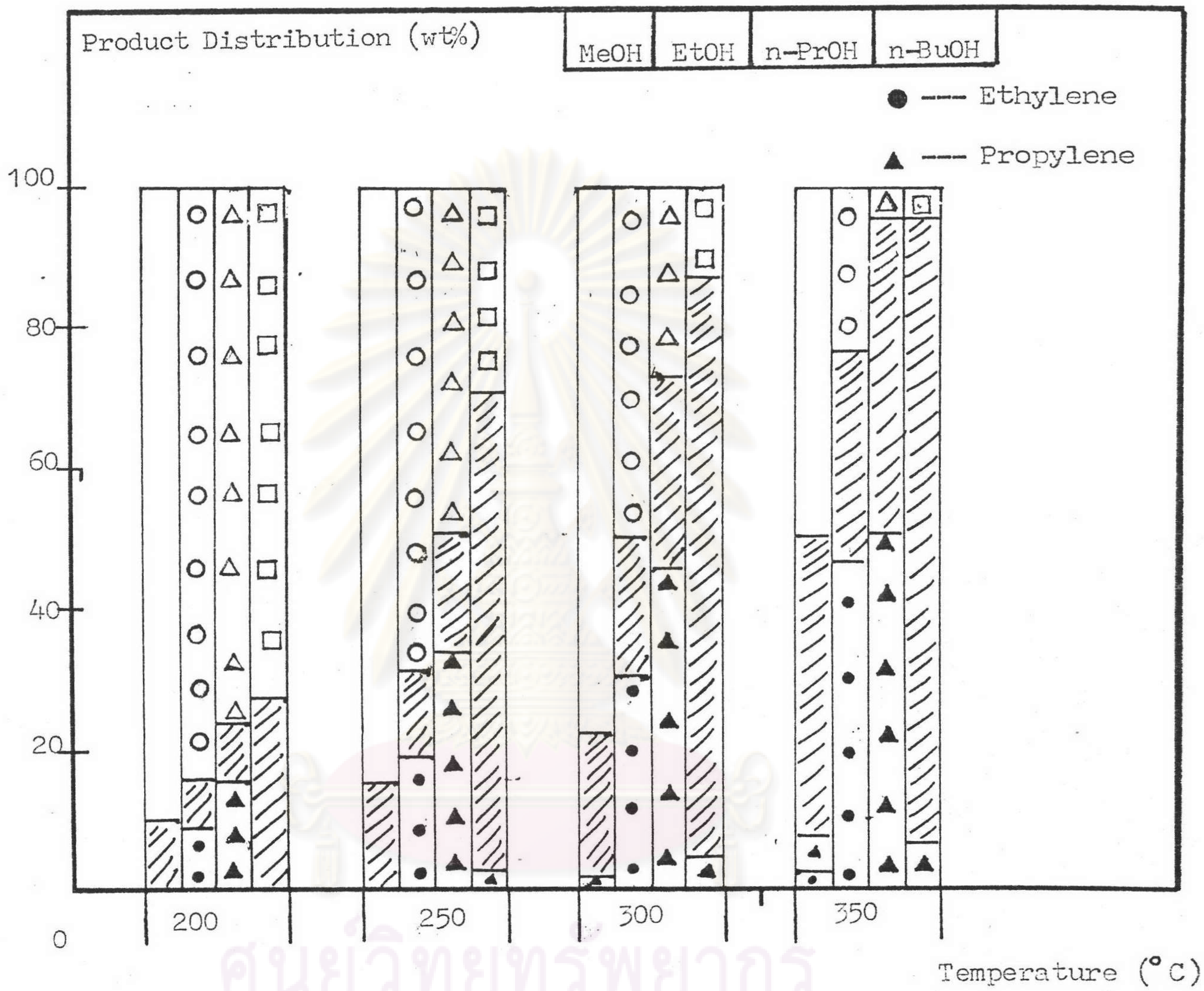

Figure 5.20 Effect of Temperature (200-350°C) on Product Distribution (wt.%) from Alcohols (C_1OH-C_4OH) at S.V.=1500 hr^{-1} for HY-5.6 Zeolite

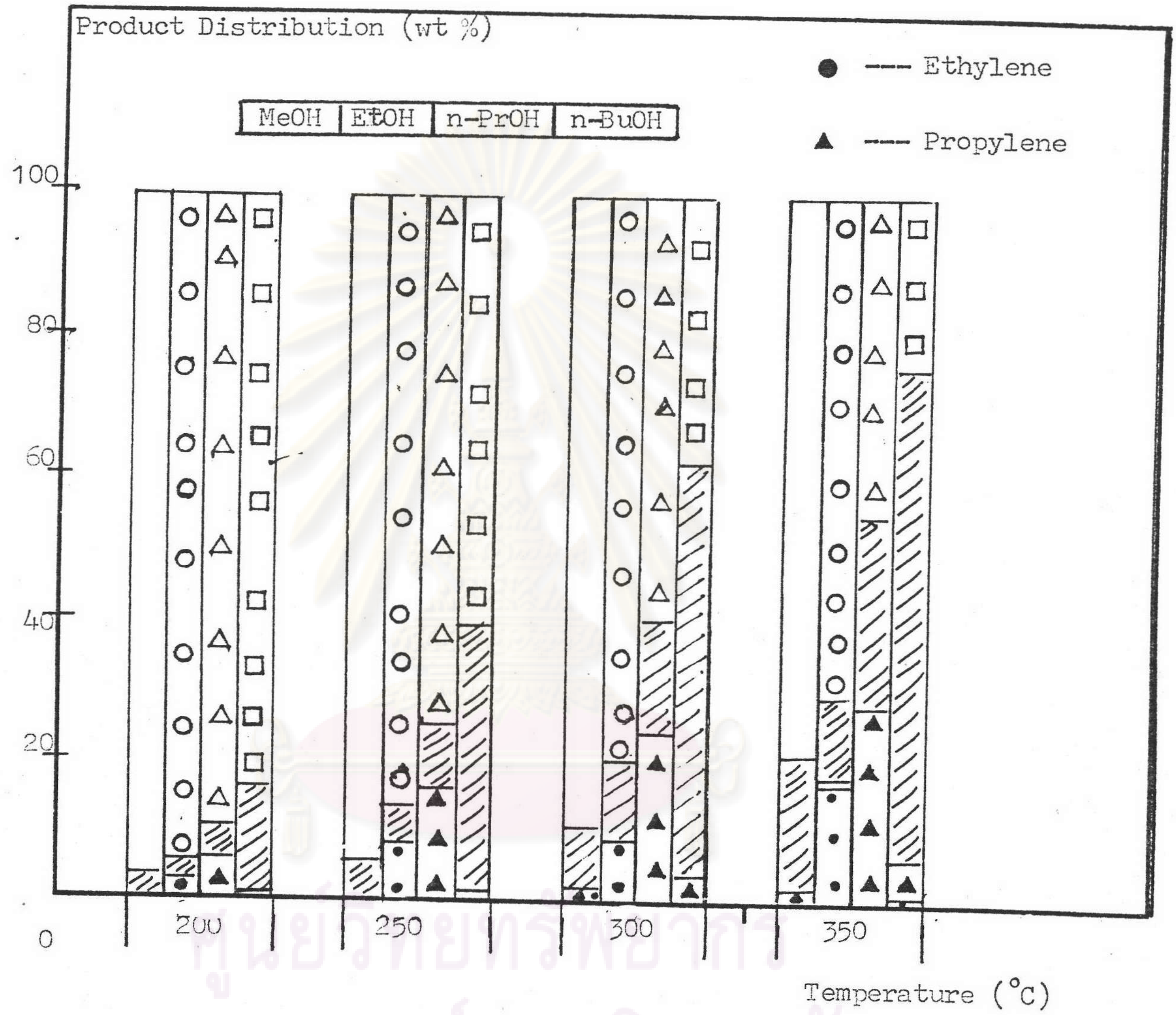

Figure 5.21 Effect of Temperature (200-350°C) on Product Distribution (wt.%) from Alcohols (C_1OH-C_4OH) at S.V.3000 hr^{-1} for HY-5.6 Zeolite

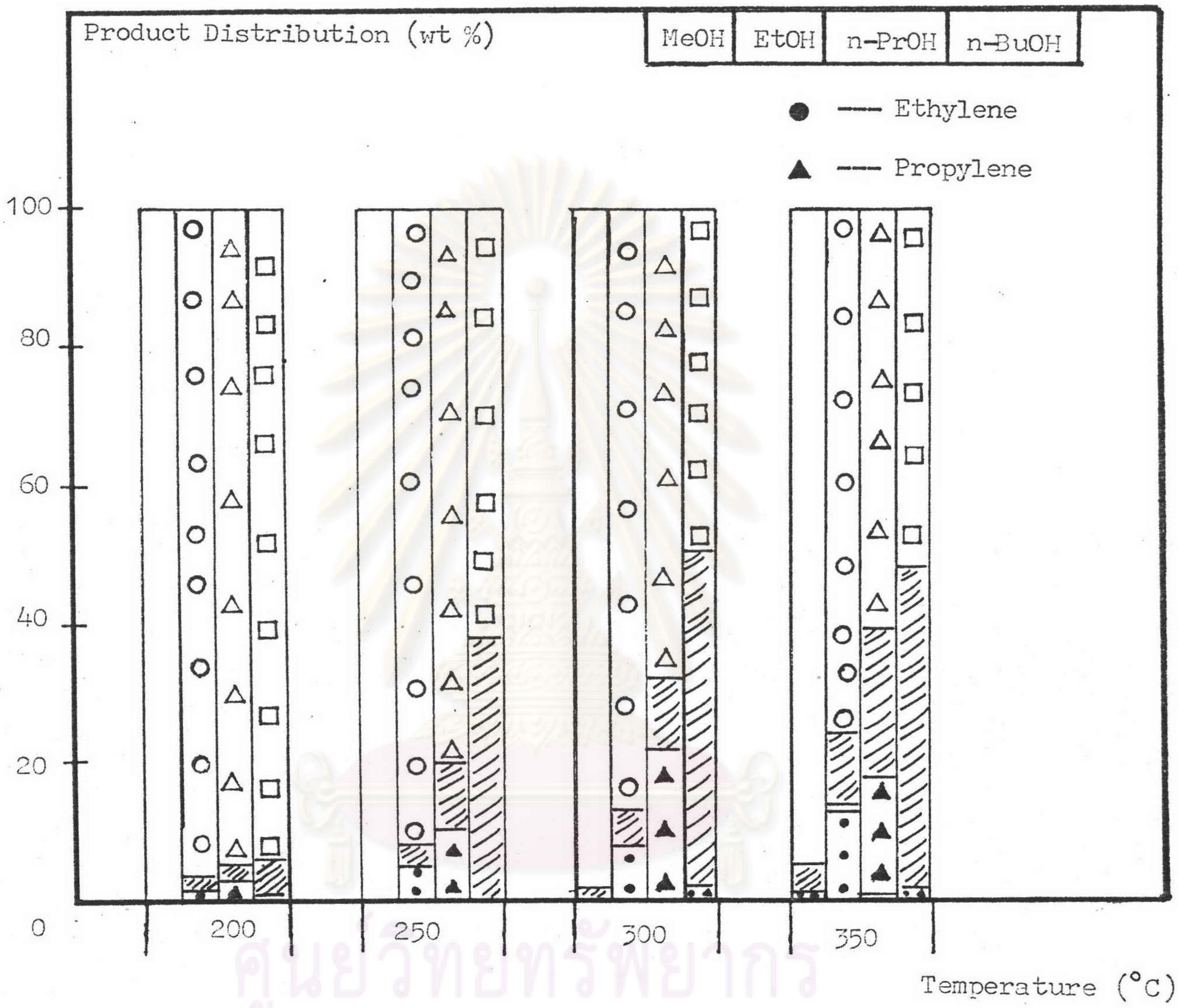

Figure 5.22 Effect of Temperature (200-350°C) on Product Distribution (wt.%) from Alcohols (C_1OH-C_4OH) at S.V.=5000 hr^{-1} for HY-5.6 Zeolite

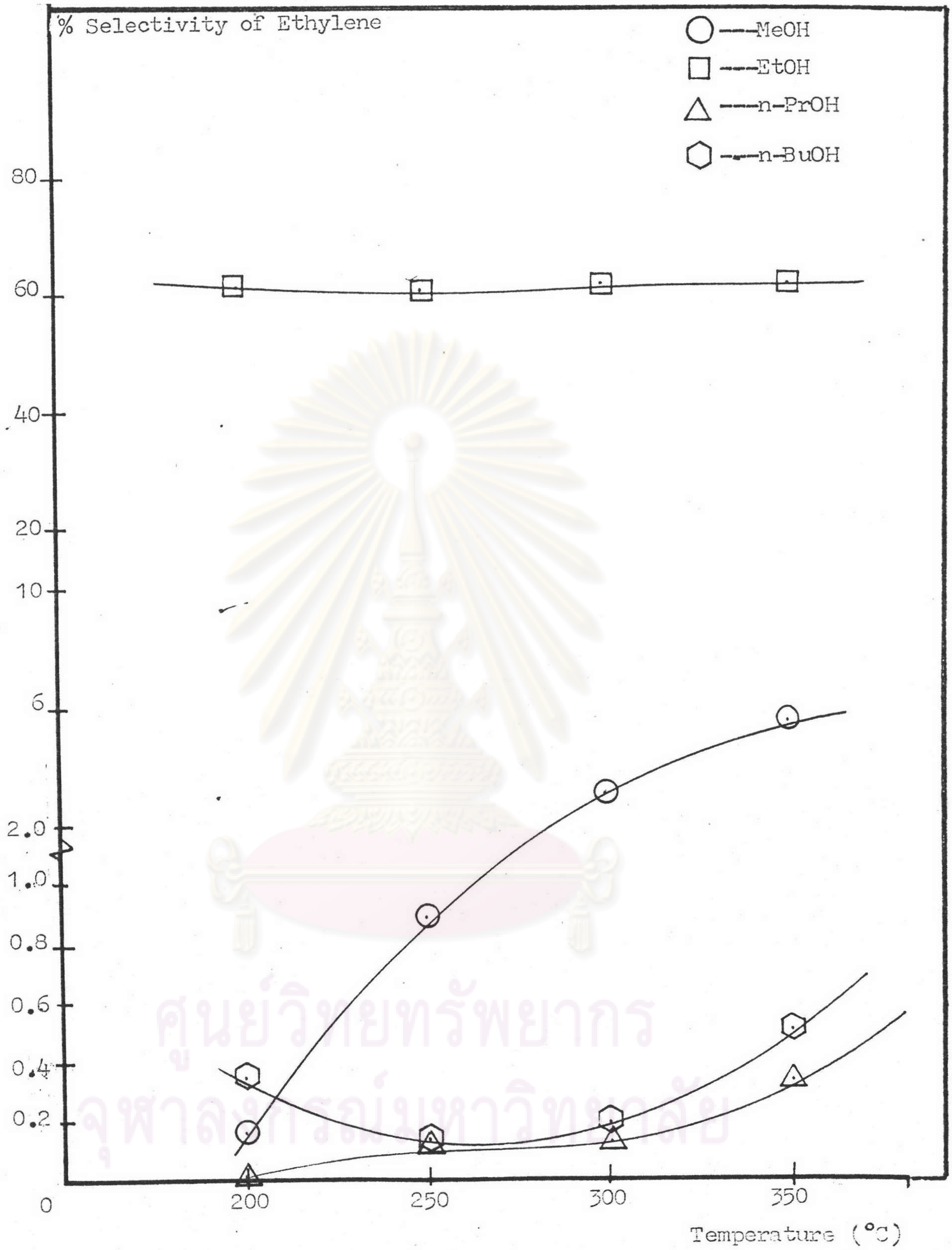

Figure 5.23 Effect of Temperature (200-350°C) on Selectivity of Ethylene from Alcohols (C_1OH-C_4OH) at S.V.=1500 hr^{-1} for HY-5.6 Zeolite

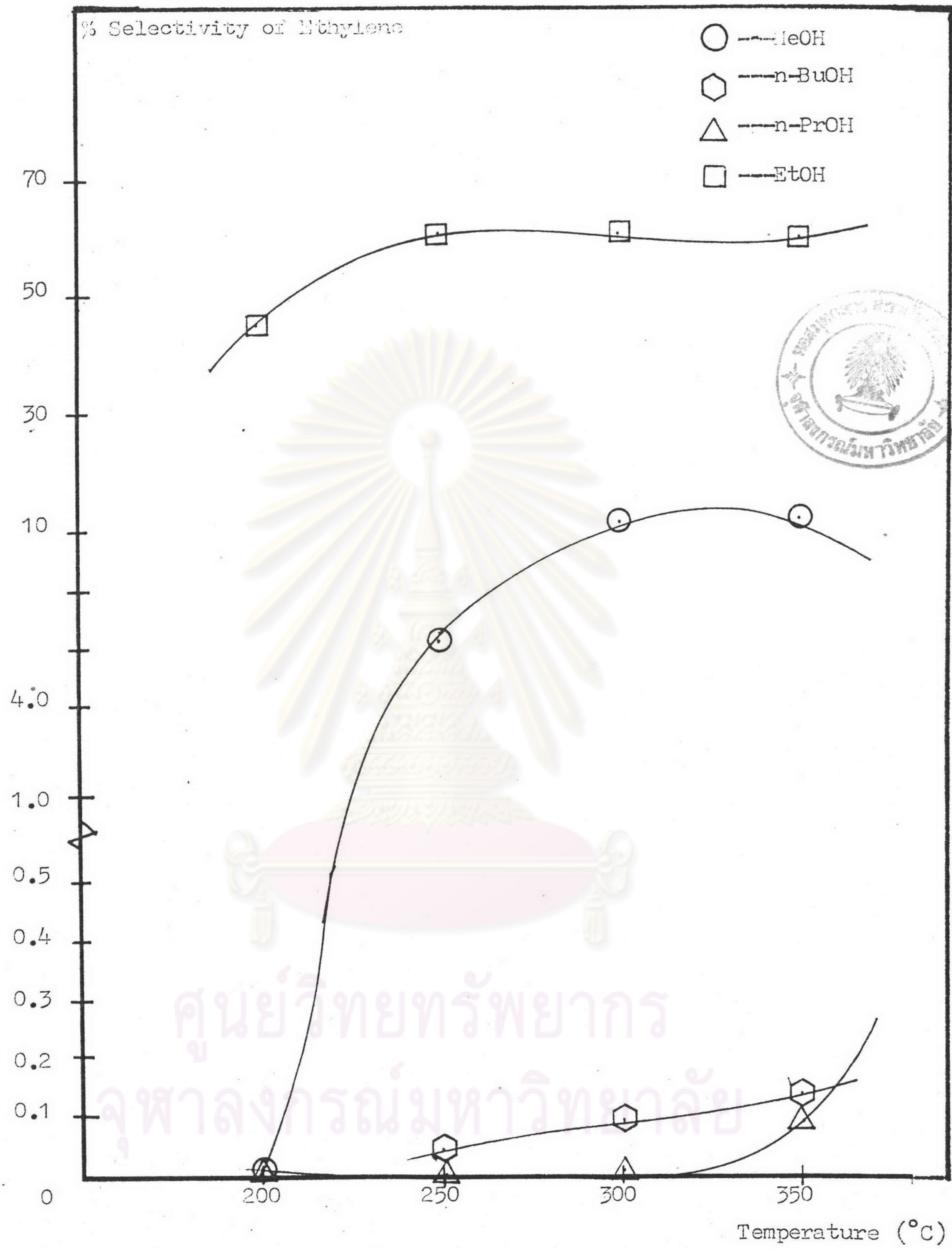

Figure 5.24 Effect of Temperature (200-350°C) on Selectivity of Ethylene from Alcohols (C_1OH-C_4OH) at S.V.=5000 hr^{-1} for HY-5.6 Zeolite

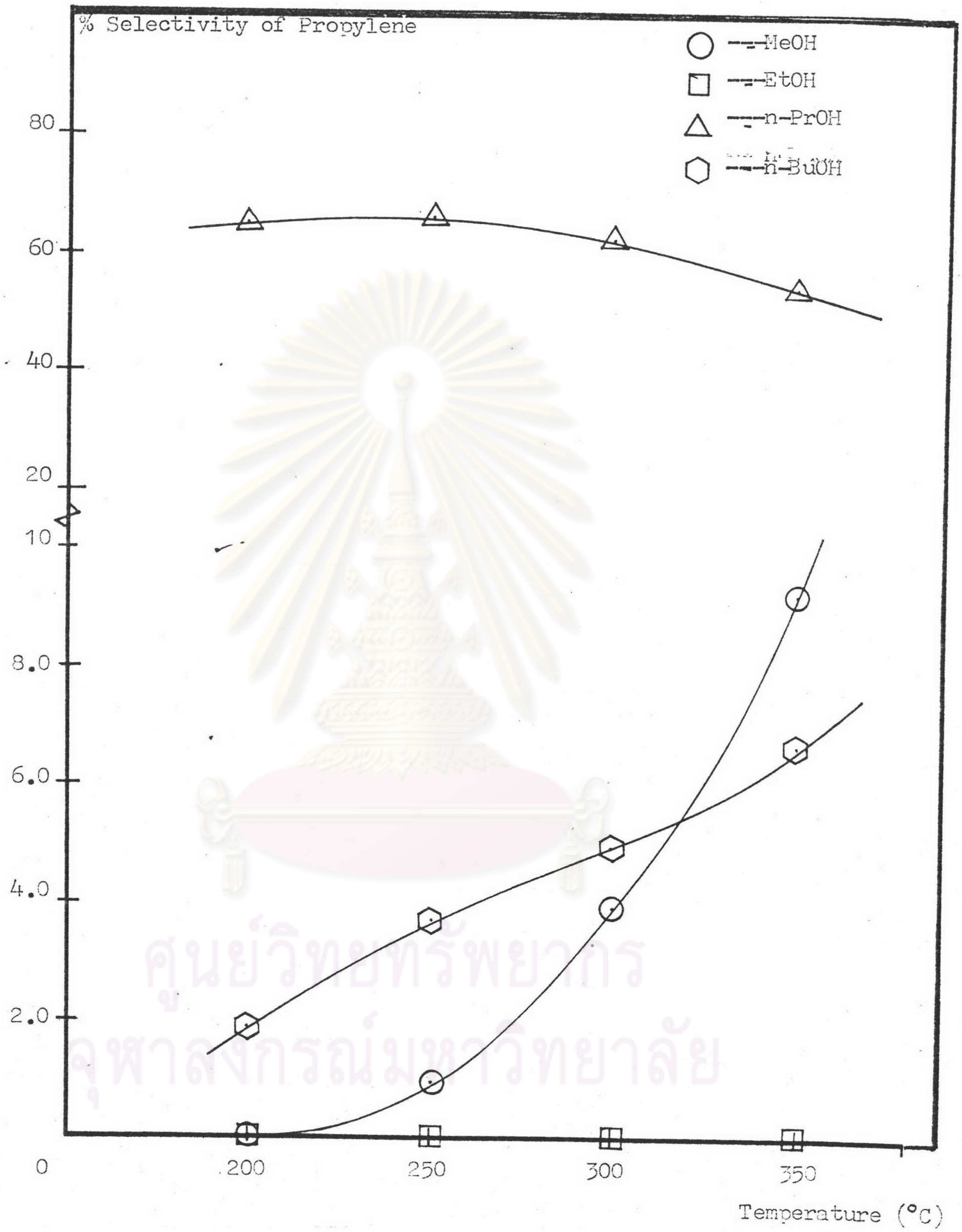

Figure 5.25 Effect of Temperature (200-350°C) on Selectivity of Propylene from Alcohols (C_1OH-C_4OH) at S.V.=1500 hr^{-1} for HY-5.6 Zeolite

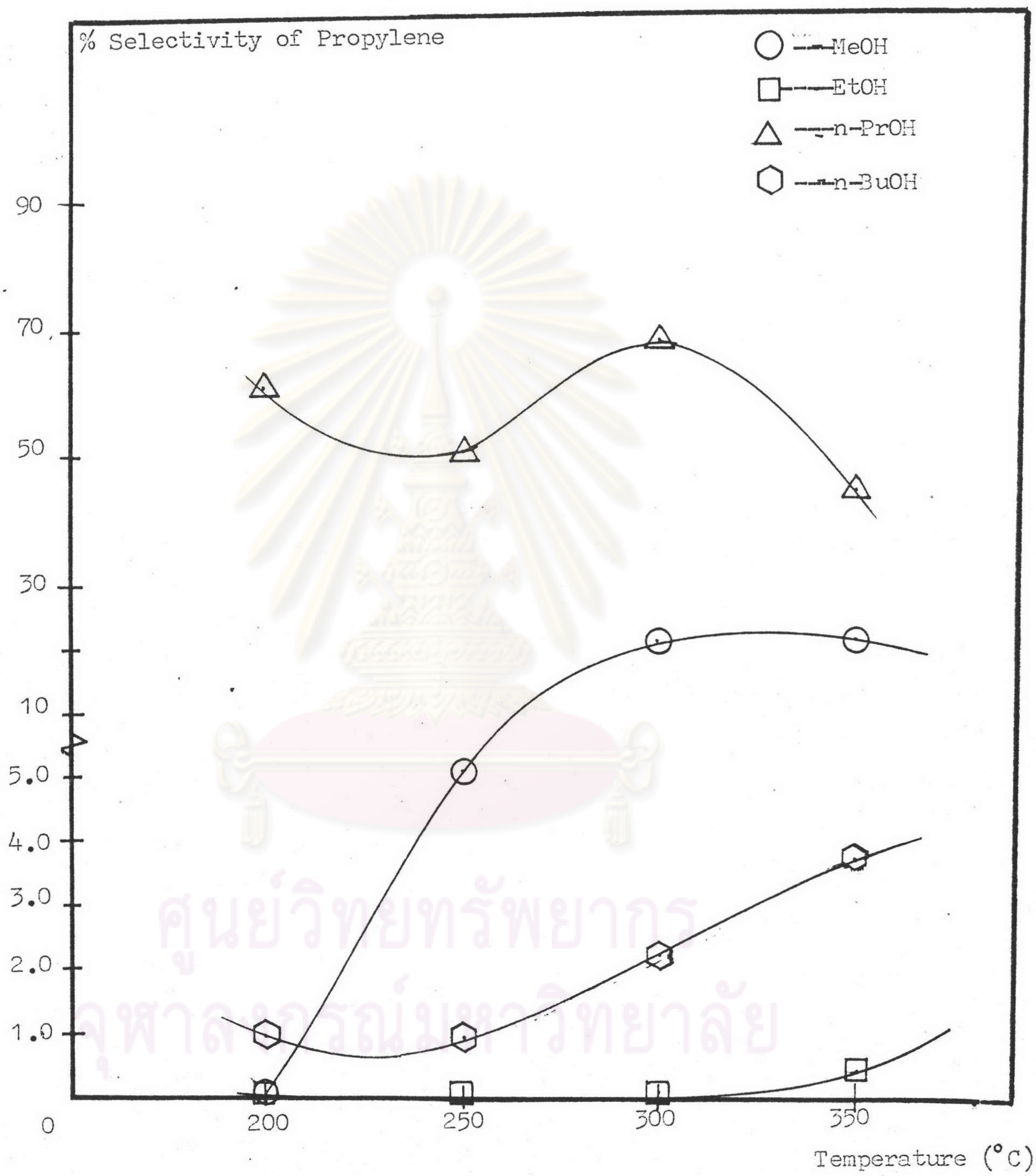

Figure 5.26 Effect of Temperature (200-350°C) on Selectivity of Propylene from Alcohols (C_1OH-C_4OH) at S.V. 5000 hr^{-1} for HY-5.6 Zeolite

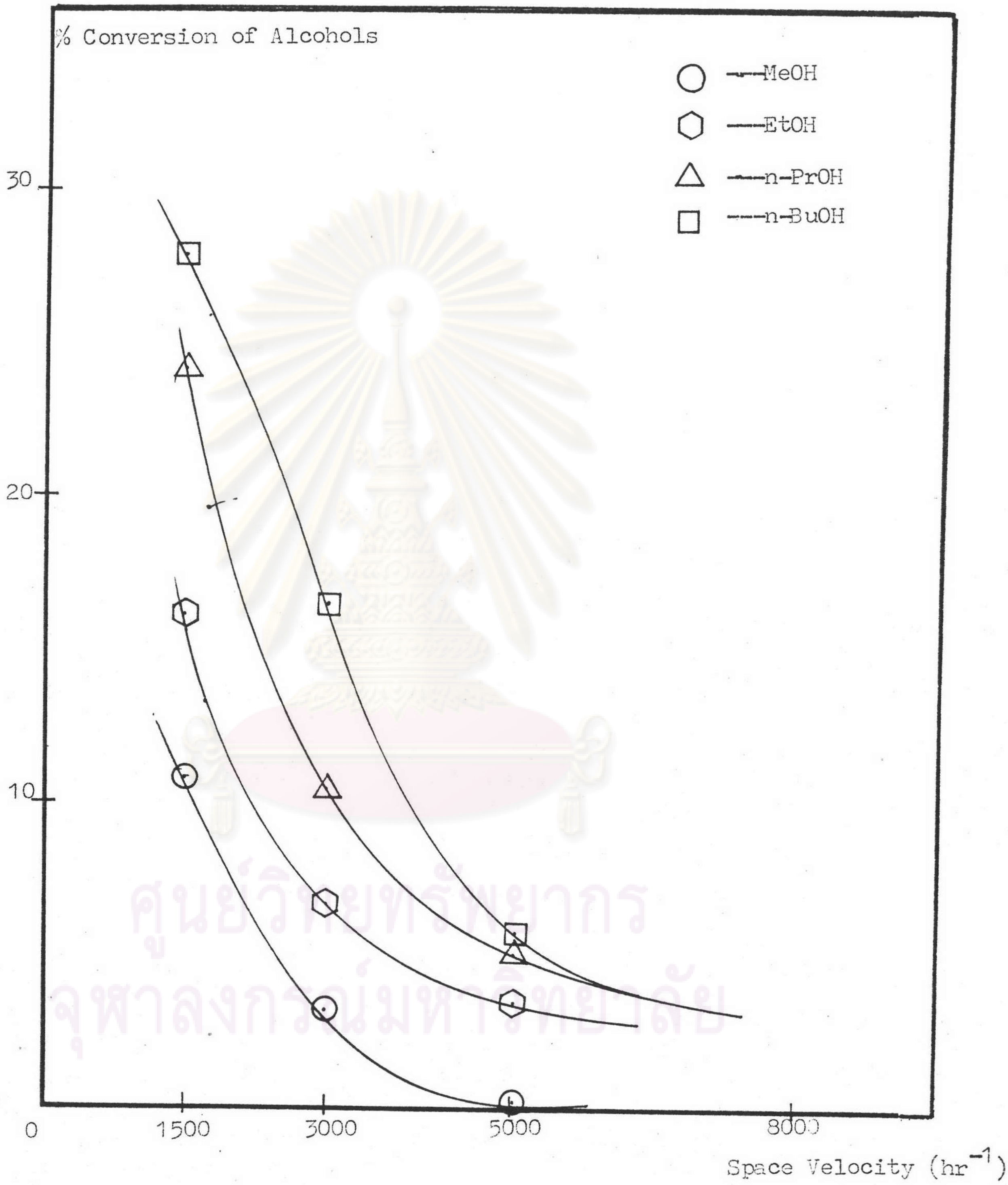

Figure 5.27 Effect of Space Velocity (1500-5000 hr^{-1}) on Alcohols (C_1OH-C_4OH) Conversion at T=200°C for HY-5.6 Zeolite

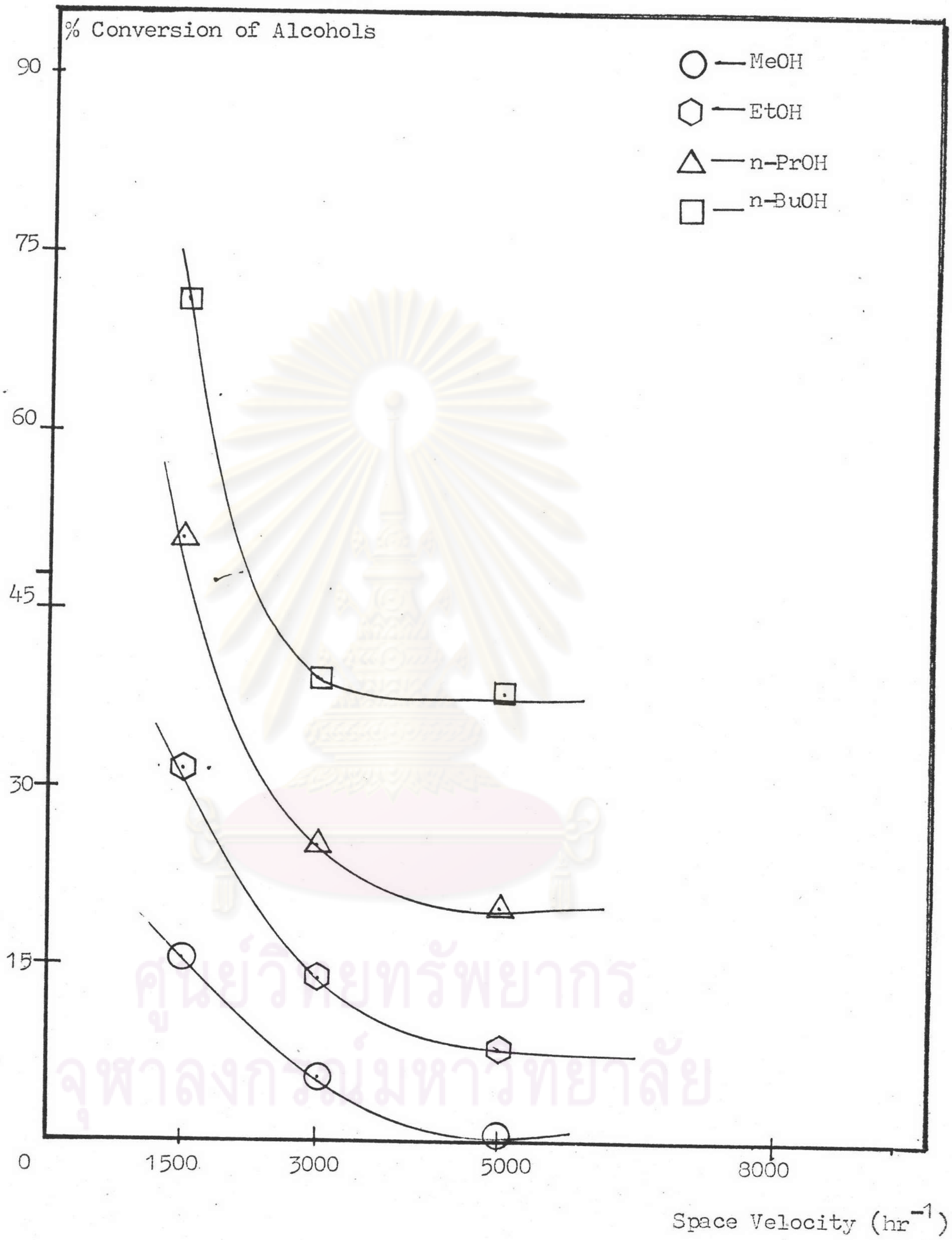

Figure 5.28 Effect of Space Velocity (1500-5000 hr^{-1}) on Alcohols (C_1OH-C_4OH) Conversion at T=250°C for HY-5.6 Zeolite

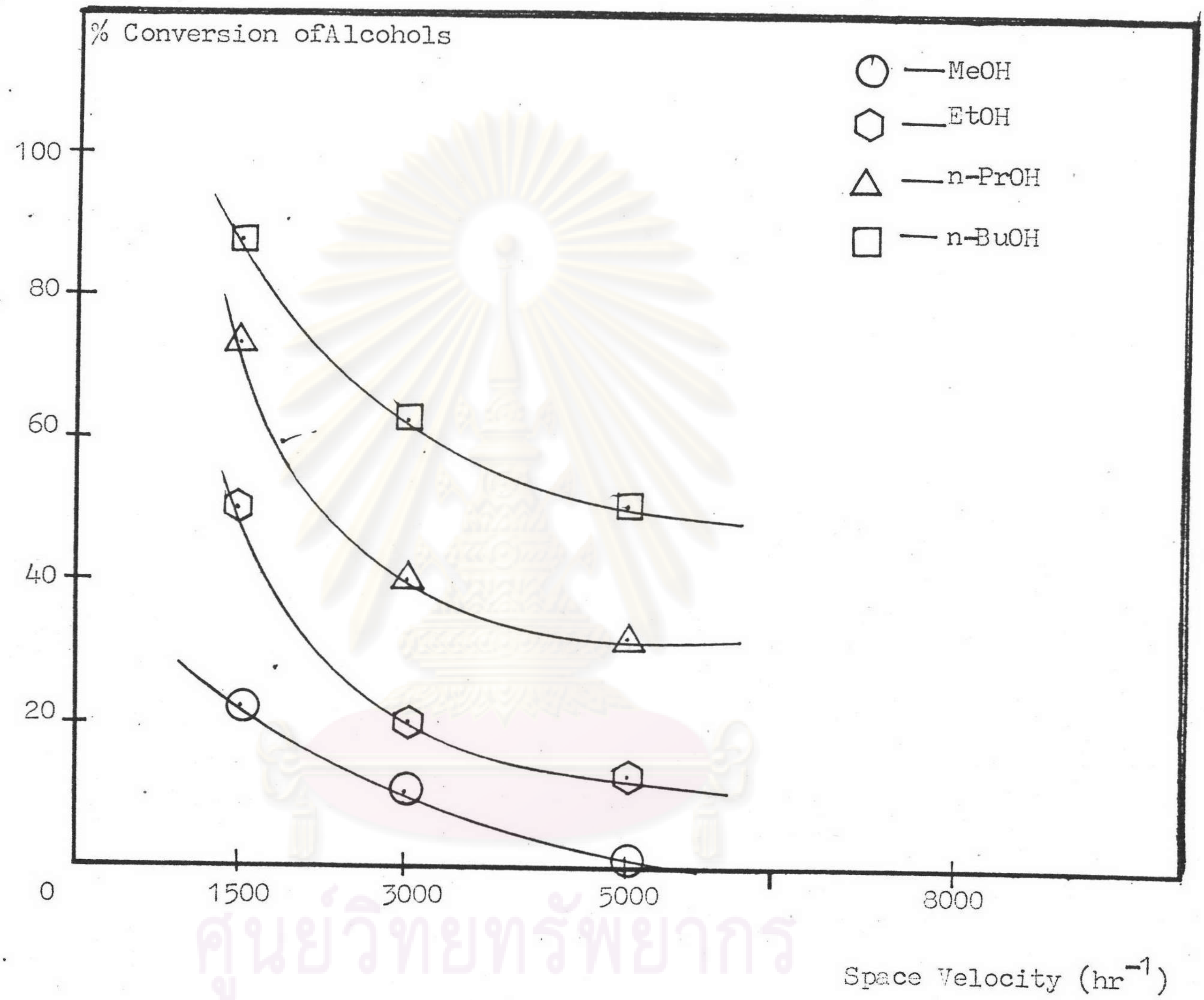

Figure 5.29 Effect of Space Velocity (1500-5000 hr^{-1}) on Alcohols (C_1OH-C_4OH) Conversion at T=300°C for HY-5.6 Zeolite

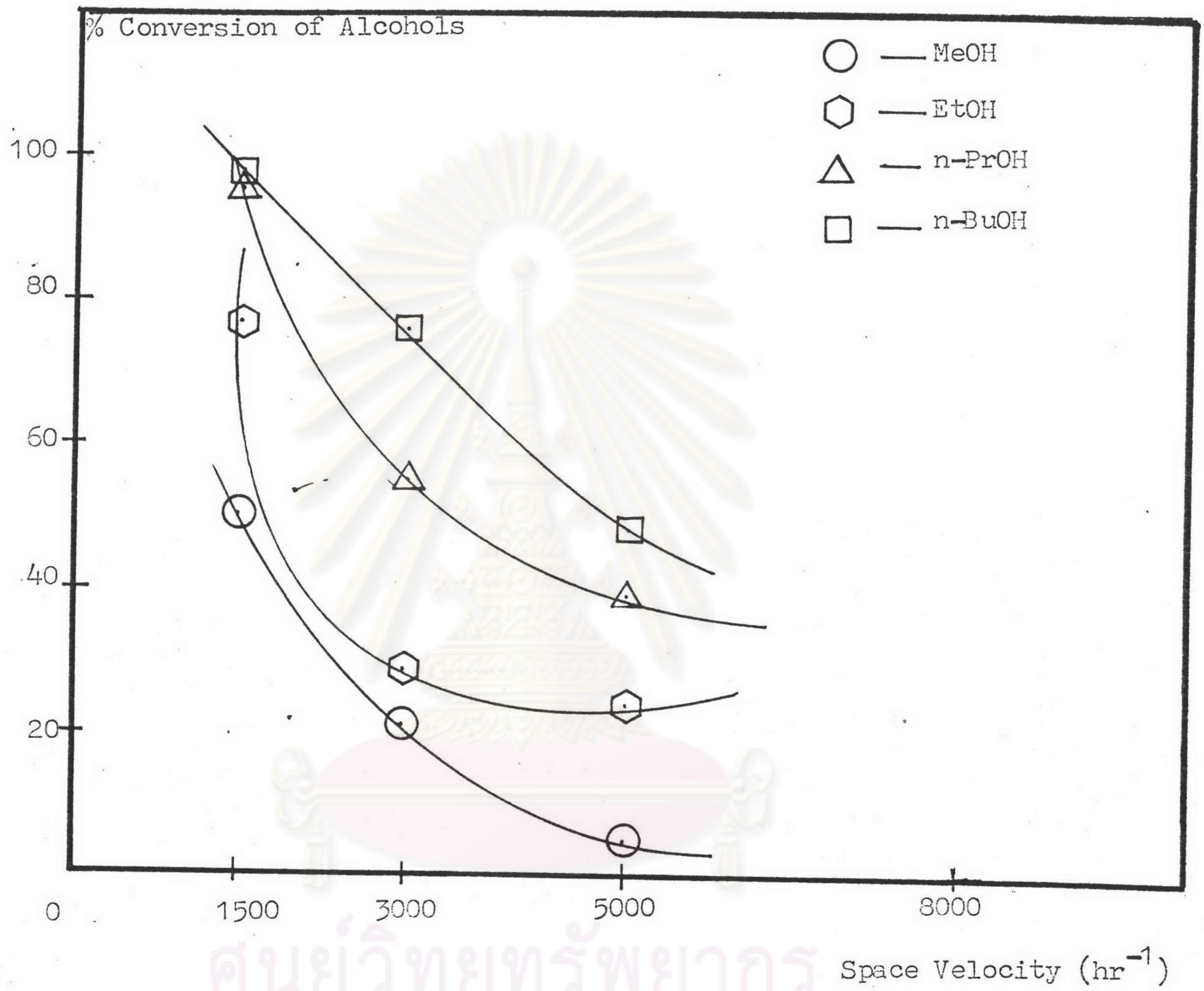

Figure 5.30 Effect of Space Velocity (1500-5000 hr^{-1}) on Alcohols (C_1OH-C_4OH) Conversion at T=350°C for HY-5.6 Zeolite

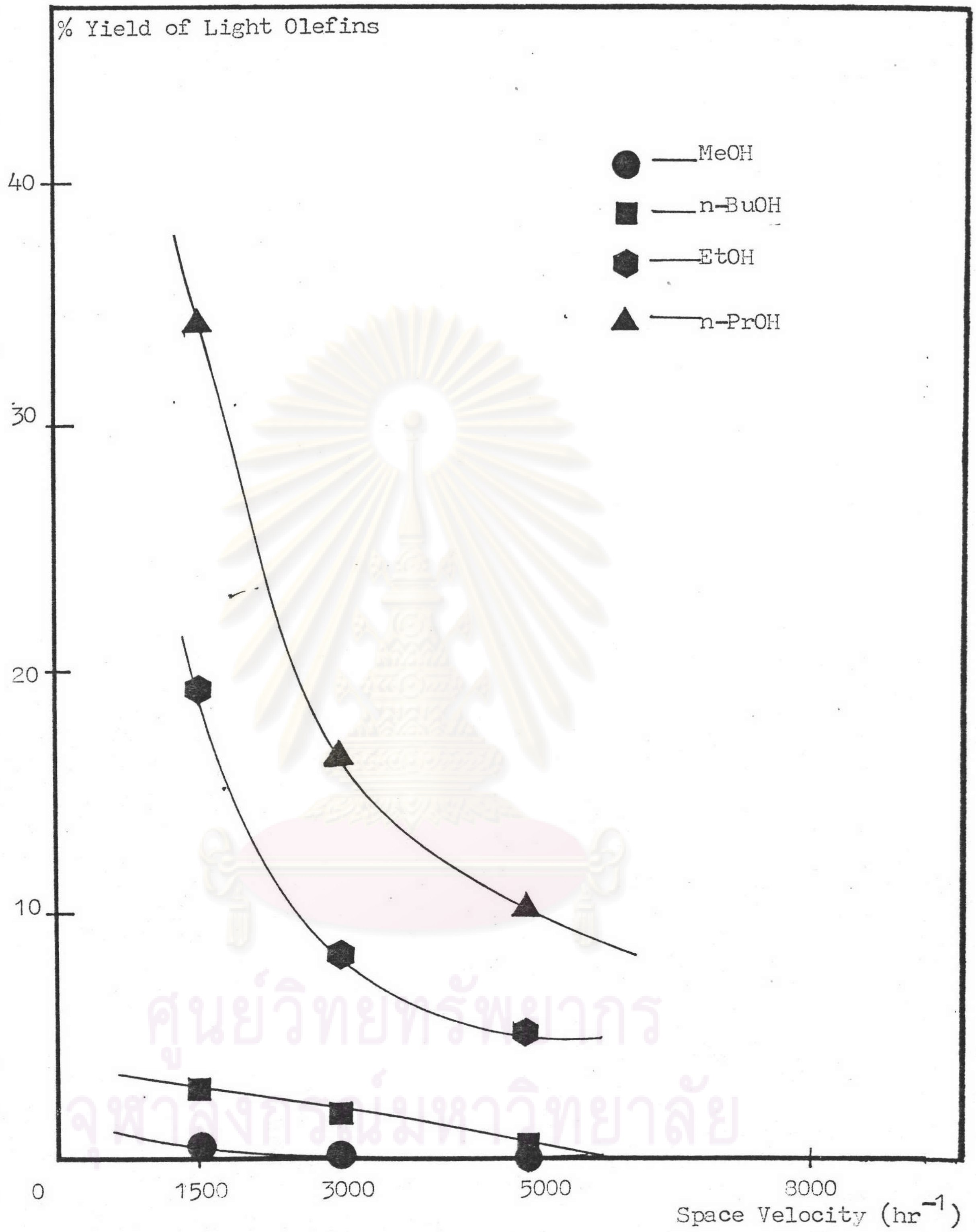

Figure 5.31 Effect of Space Velocity (1500-5000 hr^{-1}) on Percent Yield of Light Olefins (C_{2-3}) from Alcohols (C_1OH-C_4OH) at T=250°C for HY-5.6 Zeolite

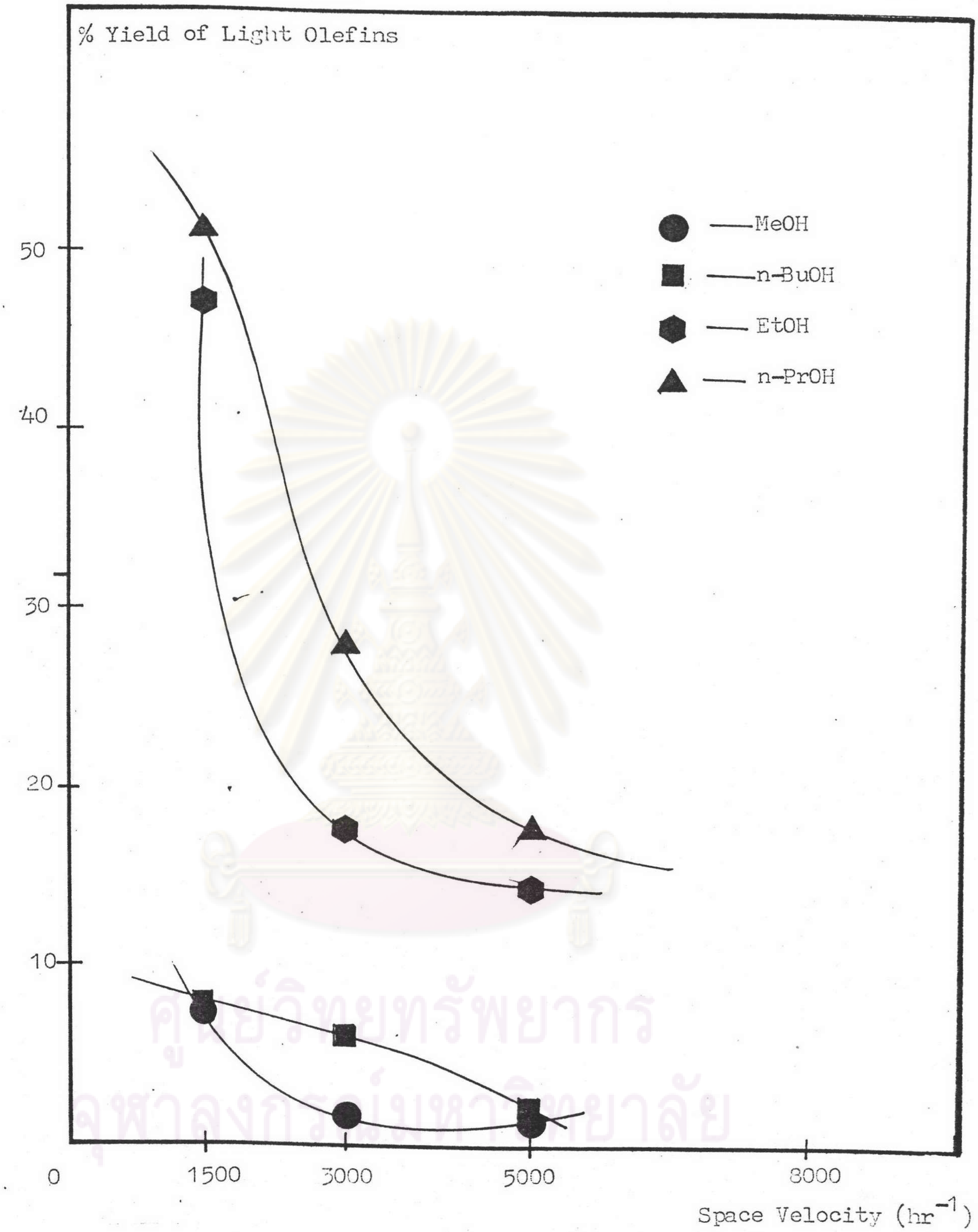

Figure 5.32 Effect of Space Velocity (1500-5000 hr^{-1}) on Percent Yield of Light Olefins (C_{2-3}) from Alcohols (C_1OH-C_4OH) at T=350°C for HY-5.6 Zeolite

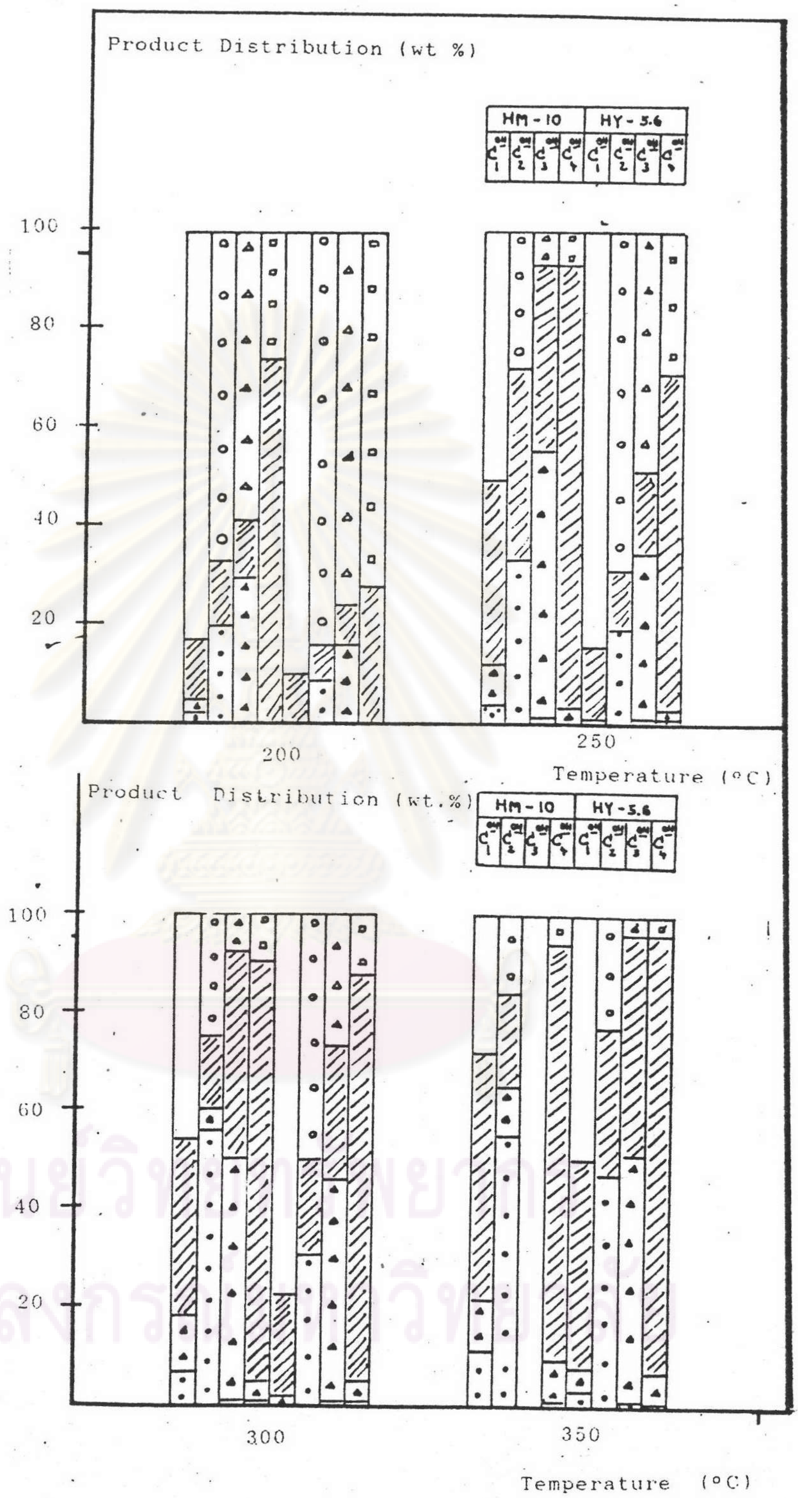

Figure 5.33 Influence of type of zeolite on Product Distribution (Wt.%) from Alcohols (C_1OH-C_4OH) at SV=1500 hr^{-1} and T = 200-350°C

5.3 Effect of Space Velocity

Figure 5.11-5.14 for HM-10 Zeolite and Figure 5.27-5.30 for HY-5.6 zeolite at reaction temperature 200,250,300,350°C, respectively, which the results shows that the percentage conversion profiles usually decreased with increasing space velocity between 1500 to 5000 hr^{-1} for the case of MeOH, EtOH, n-PrOH, and n-BuOH on both catalyst. The reason of this results may be because of the probability the dehydration of alcohols were decreased, since the contact time of the alcohol molecules on the active site in the surface area were reduced. Figure 5.15-5.16 for HM-10 zeolite and Figure 5.31-5.32 for HY-5.6 zeolite at reaction temperature 250,350°C, respectively, which the results shows that the percentage yield of olefin (C_2-C_3) usually decreased with increasing space velocity between 1500 to 5000 hr^{-1} in case of MeOH,EtOH,n-PrOH, and n-BuOH. The reason of this results may be because of the probability the dehydration of alcohols were decreased, since the contact time of the alcohol molecules on the active site in the surface area were reduced. Table 5.4-5.11 for HM-10 zeolite and Table 5.15-5.22 for HY-5.6 showed a summary of the effect of space velocity on conversion of alcohols (C_1OH-C_4OH) to light olefin process.

5.4 Influence of Type of Zeolite

To Consider the activity of the Zeolites in promoting the formation of light olefins, HM-10 and HY-5.6 have been examined at reaction temperature 200-350°C. Figure 5.33 shows the performance of the Zeolites on the dehydration of alcohols (C_1^{OH}-C_4^{OH}) to light olefins (C_2-C_3) at SV=1500 hr^{-1} The order of activity was found to be:HM-10 HY-5.6, the reason of this result may be because of the Si/Al ratio of HM-10 Zeolite has been higher than that of HY-5.6 Because, the mechanism of dehydration of alcohols occur on the position of Si as a active site on the catalyst surface [Mihail,R.et al (40)]. The trend of activity of zeolites observed here is similar to the speech's Stone [63] that the number of acid sites increase with the silica content in the zeolite, Thus the silicon to aluminium ratio in the skeleton of the zeolite will influence its activity.