

CHAPTER 4

RESULTS

4.1 Results of Determination of NCO/OH Ratio

The experimental results of this study are shown in Table 4.1 and Figures 4.1-4.4 in which is variation of the NCO/OH ratio from 0.9 to 1.15. Both tensile strength and hardness increase to maximum values as the NCO/OH ratio increases. After that, begin to drop while NCO/OH ratio increases further. The maximum tensile strength and hardness are obtained at NCO/OH ratio = 1.09 but the maximum value of percentage elongation at break is obtained at NCO/OH ratio = 0.95.

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Table 4.1: Mechanical properties of unfilled polyurethane for various NCO/OH ratio

NCO/OH ratio	Tensile strength (N/mm ²)	Elongation at break (%)	Hardness (Shore A)
0.9	0.9605	145.033	32
0.95	3.8554	154.03	59
1	6.23	138.5	61
1.03	10.5691	144.967	67.67
1.06	11.3089	138.4	74
1.0897	15.49735	126.8	83.67
1.12	15.0358	126.775	80.33
1.15	12.39605	120.8825	80.17

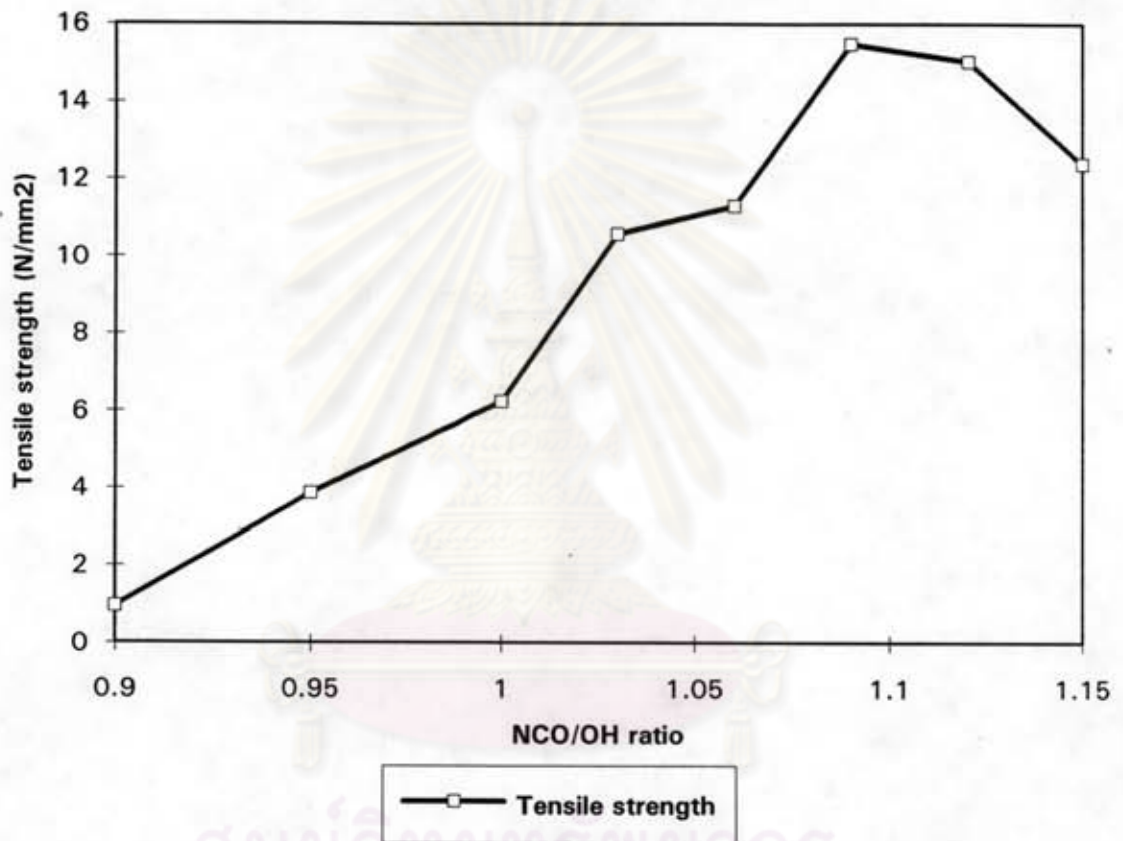


Figure 4.1 Effect of NCO/OH ratio on tensile strength of unfilled-polyurethane

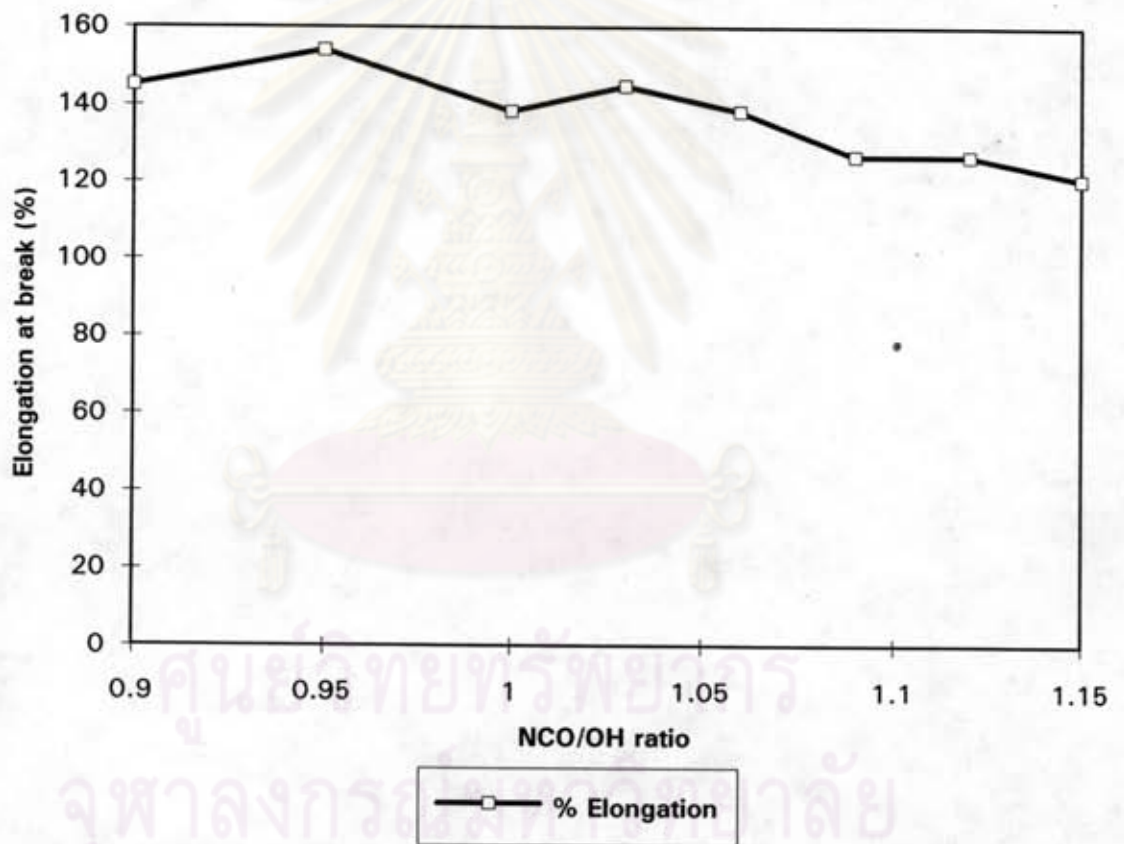


Figure 4.2 Effect of NCO/OH Ratio on %Elongation at break of unfilled-polyurethane

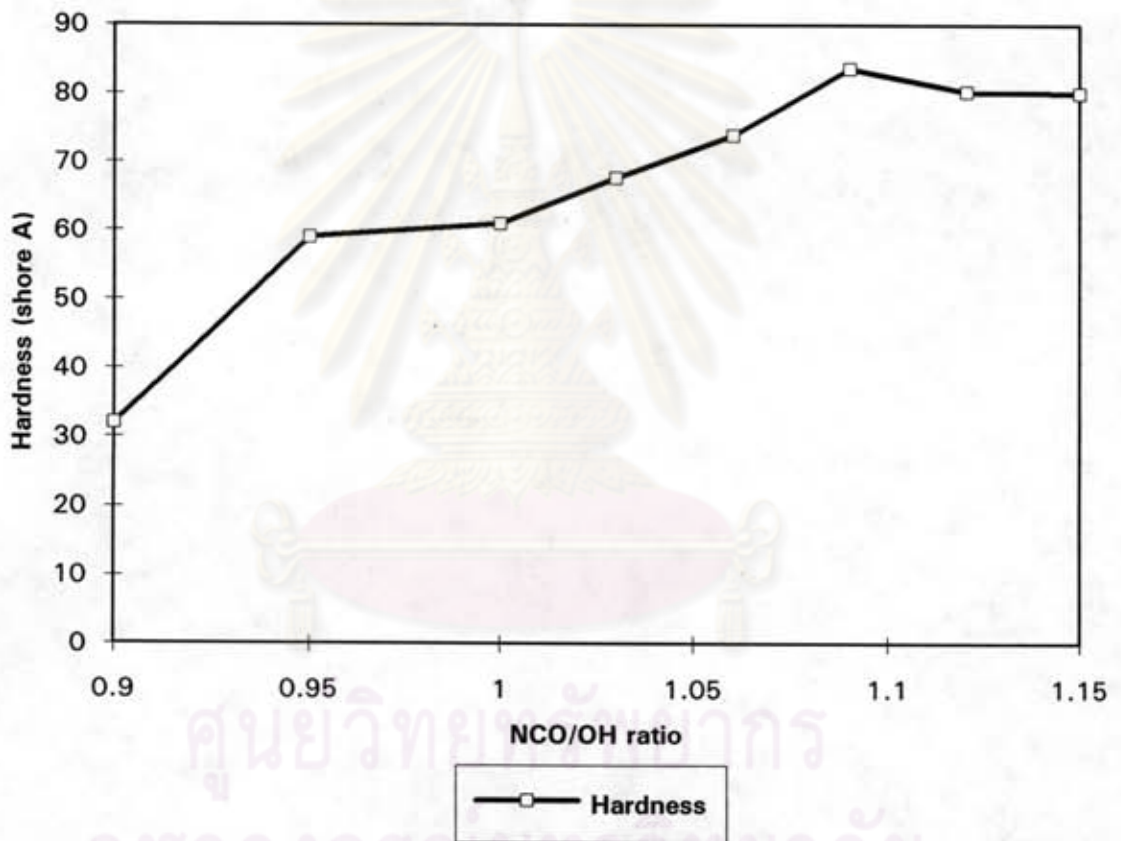


Figure 4.3 Effect of NCO/OH Ratio on hardness of unfilled-polyurethane

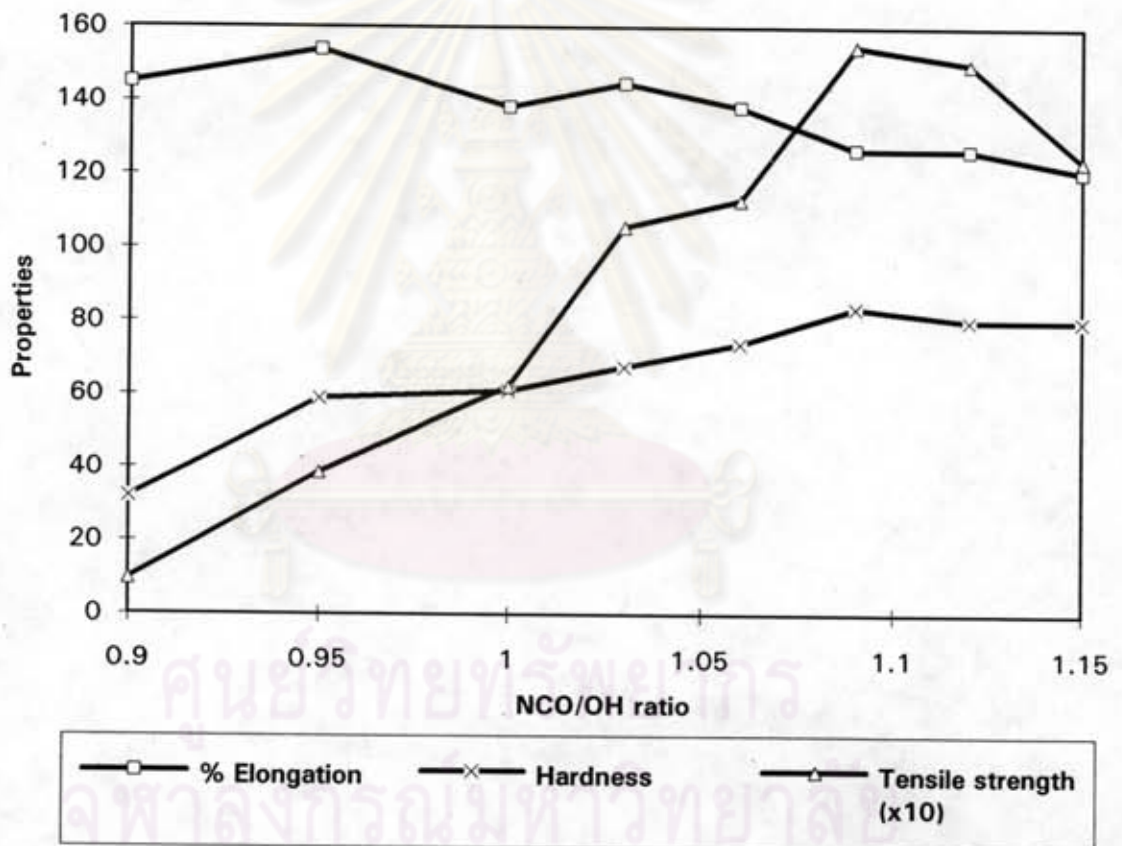


Figure 4.4 Effect of NCO/OH Ratio on mechanical properties of unfilled-polyurethane

4.2 Results of Determination of molar ratio

The results of experiments are shown in Table 4.2 and Figures 4.5-4.8. Molar ratio of polyester polyol : MDI : BDO varies from 1 : 2 : 1 to 1 : 5 : 4.

From Table 4.2 and Figures 4.5 - 4.8, the maximum values of tensile strength and percentage elongation at break are obtained at molar ratio of polyol : MDI : BDO = 1 : 4 : 3.

4.3 Results of Determination the type of filler

The results of this experiment are shown in Tables 4.3 - 4.4 and Figures 4.9 - 4.12. In Table 4.3 and Figure 4.9, the first set of samples with fixed NCO/OH ratio at 1.09 is obtained. The results of the second set of samples with NCO/OH ratio at 1.03 are shown in Table 4.4 and Figures 3.10 - 3.12.

All the fillers render the same effect on the mechanical properties of polyurethane. They increase hardness while decrease tensile strength and elongation at break. The magnitudes of their effect are not much different.

4.4 Results of Determination of Quantity of Brick

From the results of study in section 4.3, brick powder was chosen as the most suitable filler. So further study on this filler is carried out on the section 4.4. The results of this experiment are shown in Tables 4.5-4.6 and Figures 4.13-4.19. In Table 4.5 and Figures 4.13 - 4.16, the results of various weight percentage bricks at a fixed molar ratio of polyol : MDI : BDO of 1 : 4 : 3 and a fixed NCO/OH ratio at 1.09 is obtained. For the same molar ratio, another results in the case of a fixed NCO/OH ratio at 1.03 is obtained in Table 4.6. and Figures 4.17 - 4.19.

As the percentage of brick content increases, the hardness of the product increases while the tensile strength and elongation at break decrease.

Table 4.2 :Mechanical properties of unfilled polyurethane for various molar ratio

molar ratio	Tensile strength (N/mm ²)	Elongation at break (%)	Hardness (Shore A)
1:2:1	2.76	70.64	65.67
1:3:2	4.18	116.70	66.00
1:4:3	17.64	118.57	78.00
1:5:4	14.49	85.40	85.57

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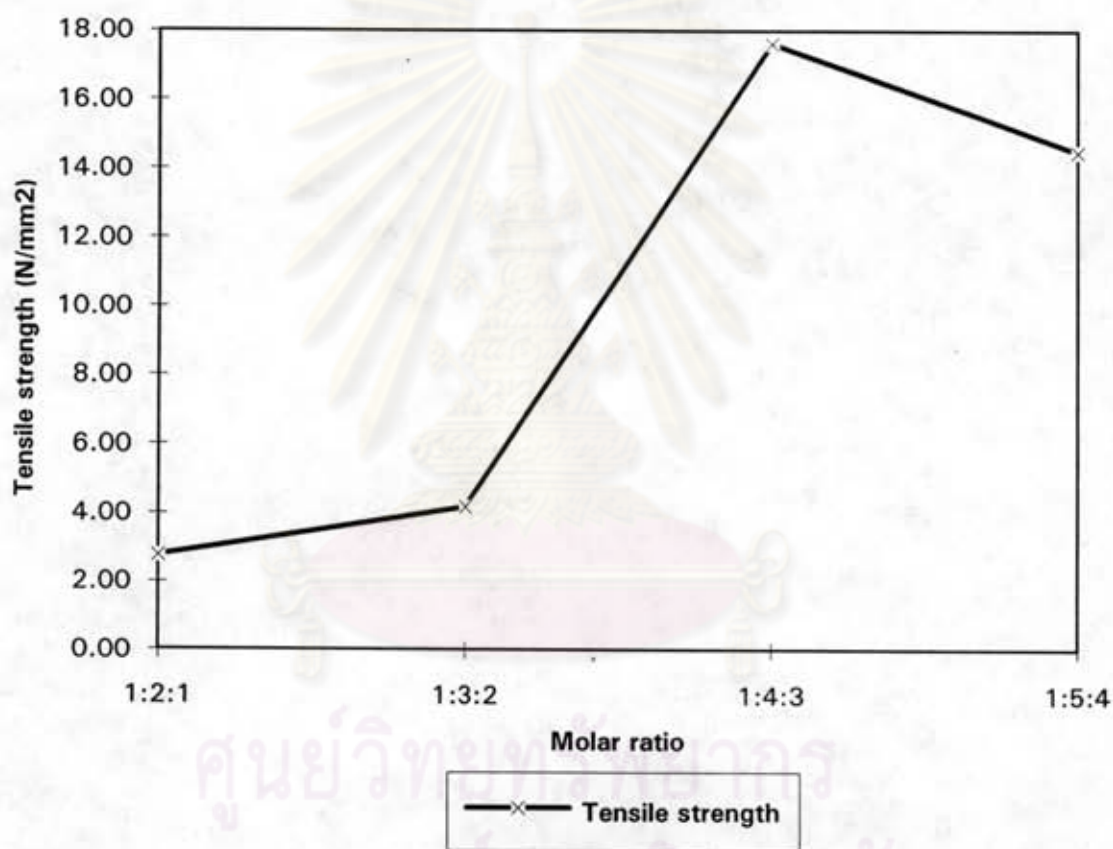


Figure 4.5 Effect of molar ratio on tensile strength of unfilled-polyurethane

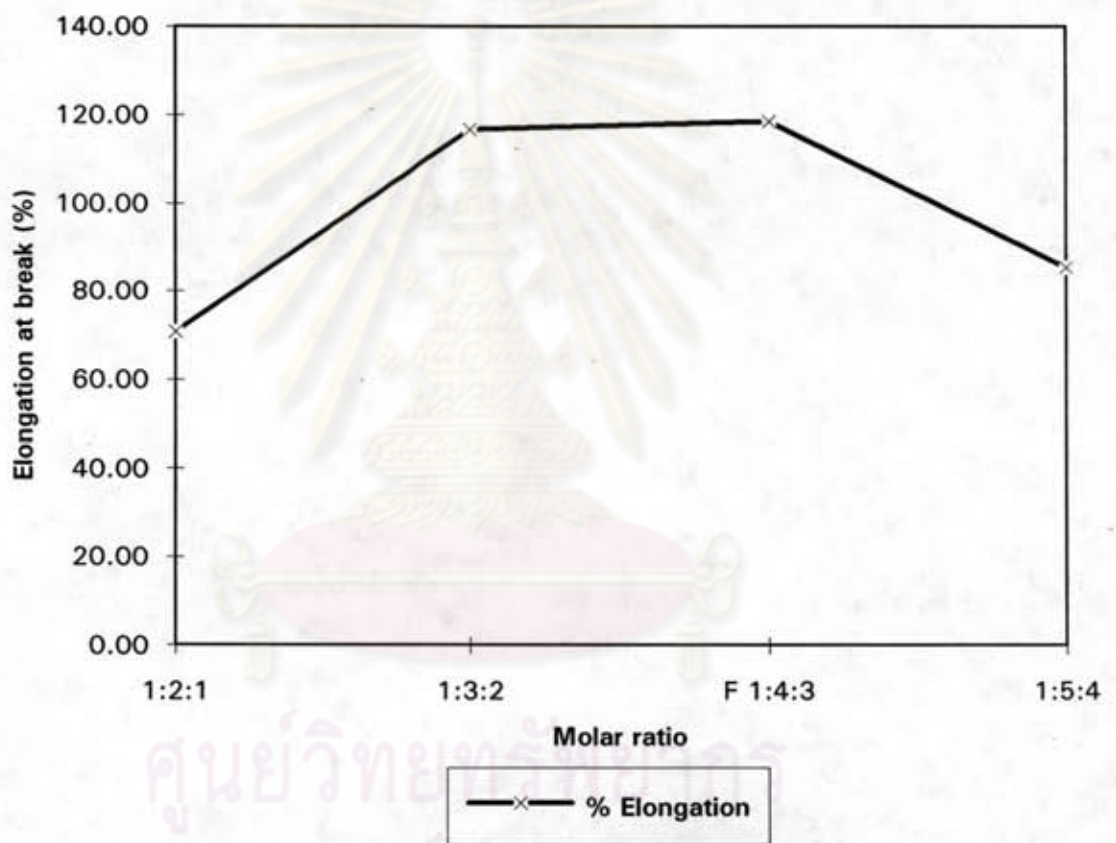


Figure 4.6 Effect of molar ratio on % elongation at break of unfilled-polyurethane

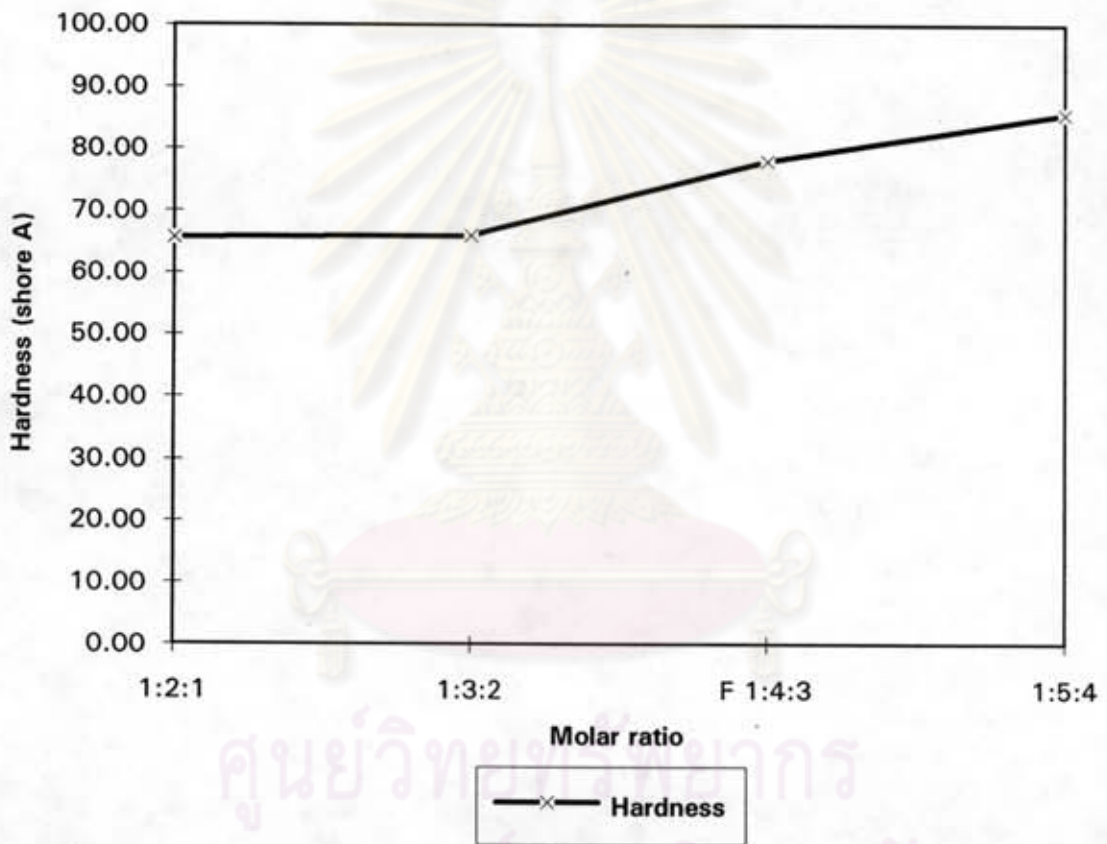


Figure 4.7 Effect of molar ratio on hardness of unfilled-polyurethane

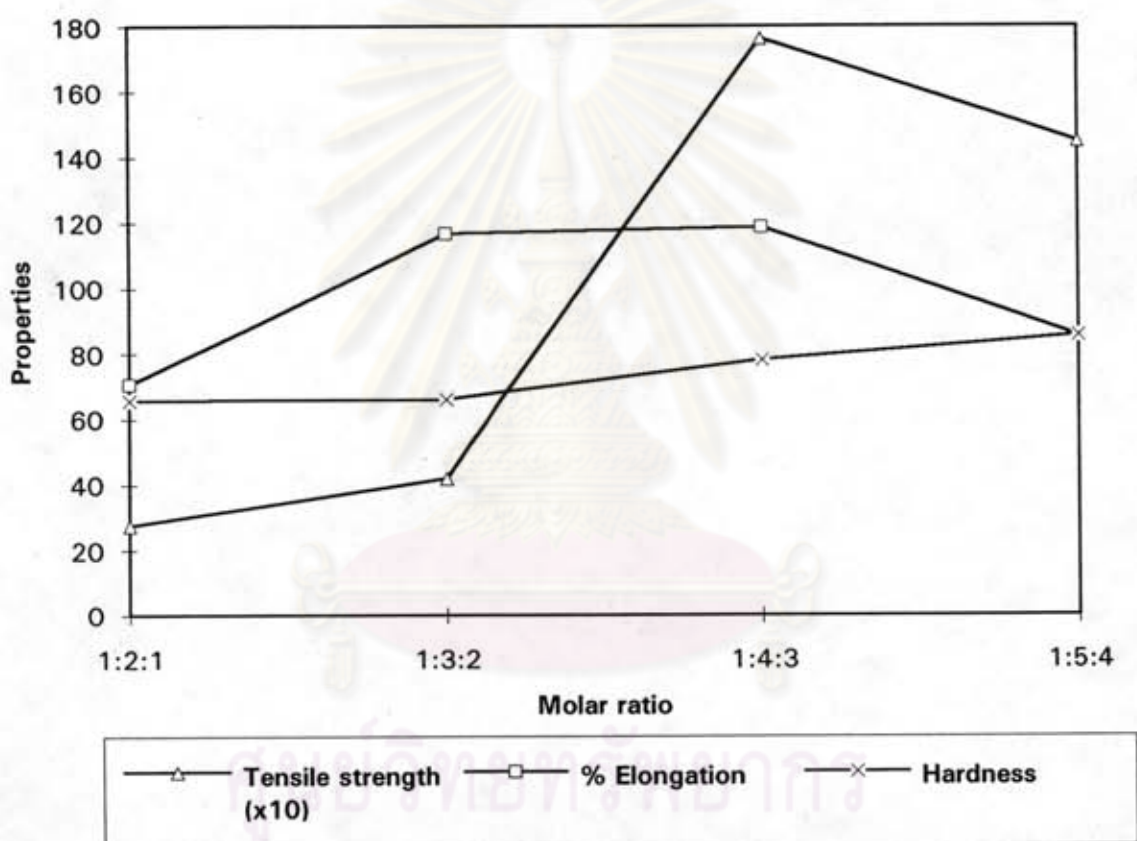


Figure 4.8 Effect of molar ratio on mechanical properties of unfilled-polyurethane

Table 4.3 :Mechanical properties for various kinds of filler with a fixed NCO/OH ratio at 1.09

Type of filler	Tensile strength (N/mm ²)	Elongation at break (%)	Hardness (Shore A)
Brick 5%	12.0494	109.9	78.9167
CaCO ₃ 5%	14.0189	118.9	76.25
Silica 5%	14.5996	114.3	77.1667

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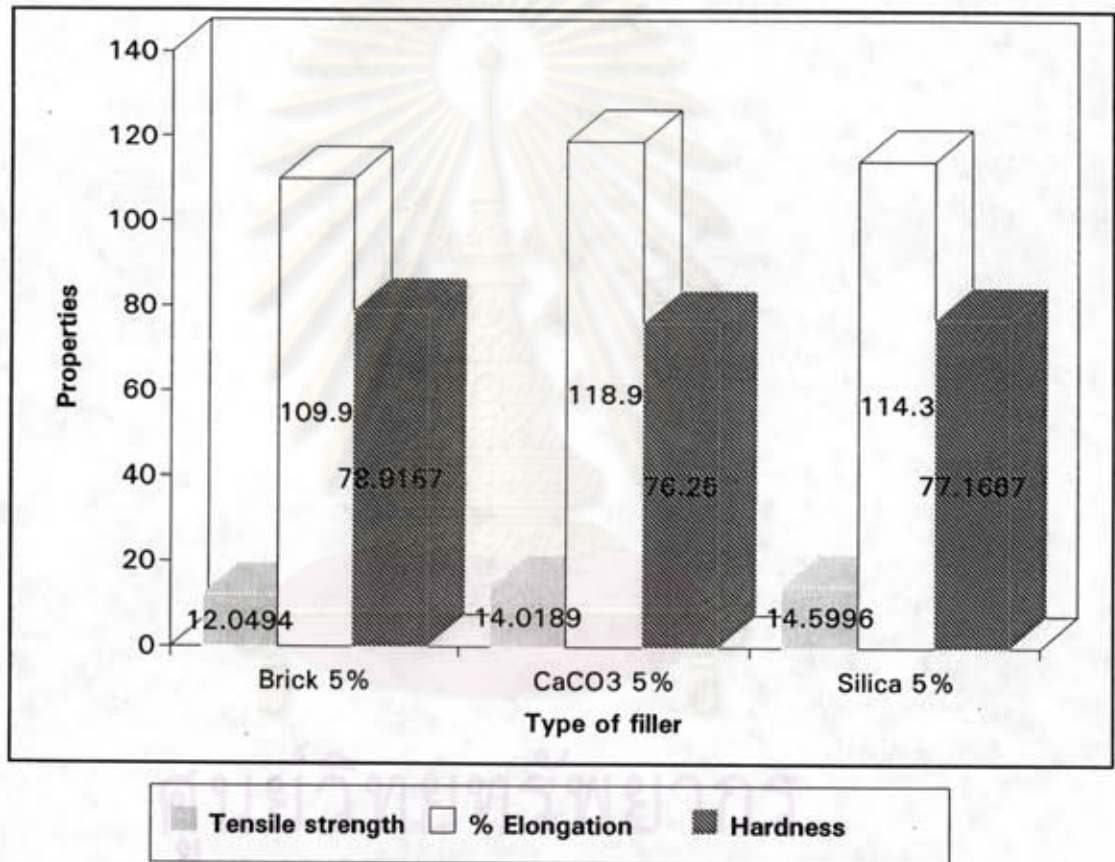


Figure 4.9 Effect of various kind of filler (5%) on mechanical properties with a fixed

NCO/OH ratio at 1.09

Table 4.4 Mechanical properties for various kinds of filler with a fixed NCO/OH ratio at 1.03

Type of filler	Tensile strength (N/mm ²)	Elongation at break (%)	Hardness (Shore A)
Brick 5%	11.0099	112.5	76
10%	10.4832	100.67	80.39
20%	7.2364	79.71	81
CaCO 5%	10.7616	114.3	77
10%	8.8143	88.73	79
20%	6.4215	66.16	80
Silica 5%	12.1932	118.9	65.5
10%	10.33	103.58	76.8
20%	10.2588	84.98	83.5

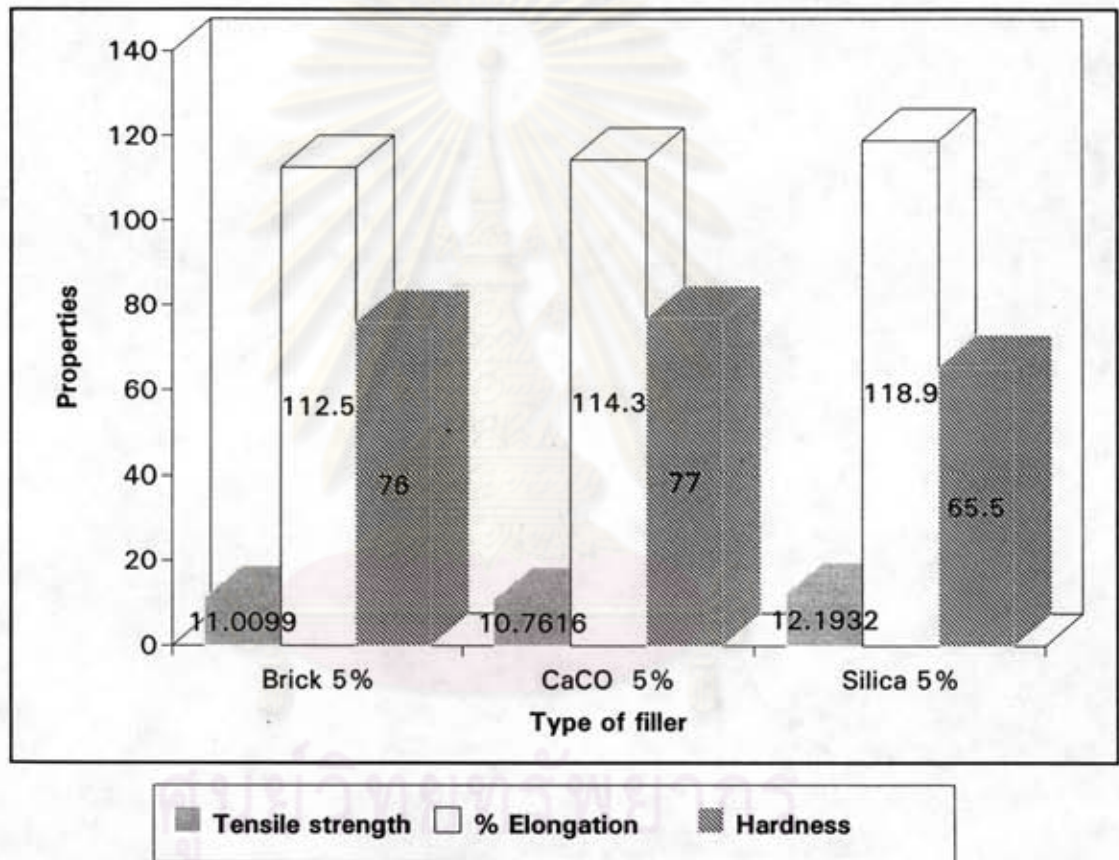
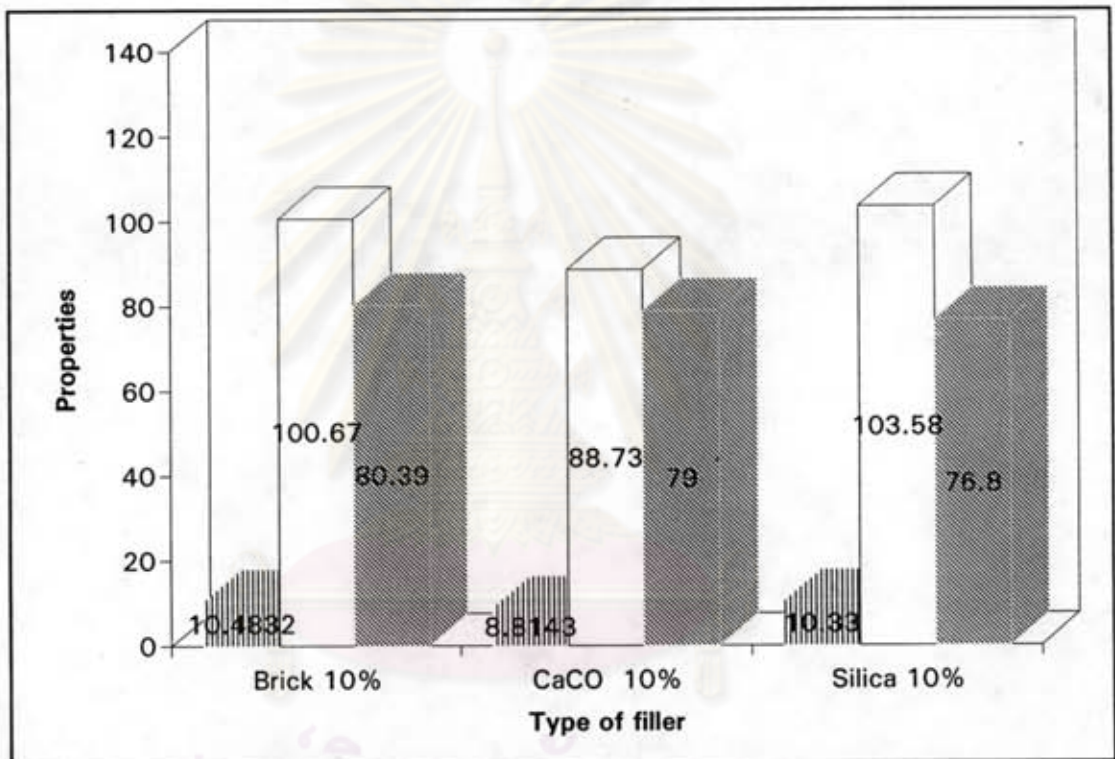


Figure 4.10 Effect of various kinds of filler (5%) on mechanical properties with a fixed NCO/OH ratio at 1.03



|||| Tensile strength □ % Elongation ■ Hardness
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Figure 4.11 Effect of various kinds of filler (10%) on mechanical properties with a fixed NCO/OH ratio at 1.03

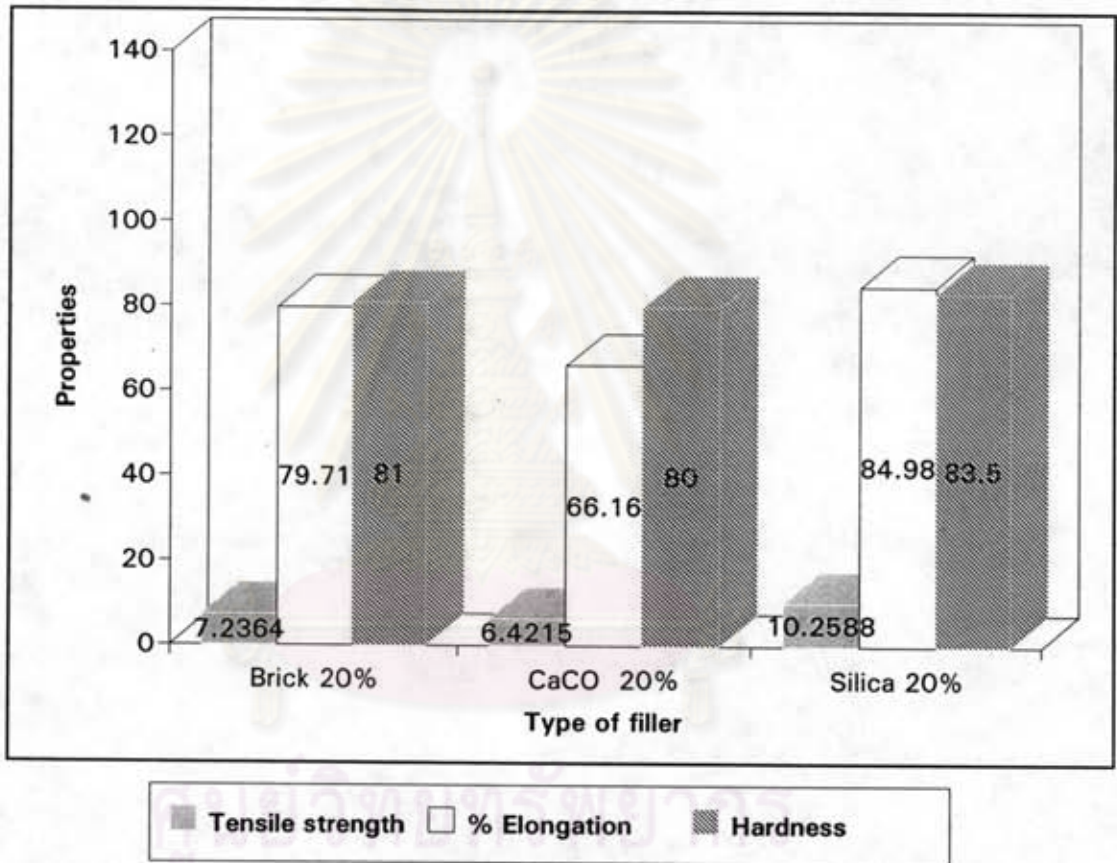


Figure 4.12 Effect of various kinds of filler (20%) on mechanical properties with a fixed NCO/OH ratio at 1.03

Table 4.5 :Mechanical properties of polyurethane of various weight percent brick and a fixed NCO/OH ratio at 1.09

% Brick	Tensile strength (N/mm ²)	Elongation at break (%)	Hardness (Shore A)
0	17.6353	118.567	78
5	12.0494	109.9	78
9	10.1815	90.8967	80
13	8.9827	81.7633	83
17	7.8466	80.32	81
20	7.2777	59.33	84
23	6.3514	54.68	84

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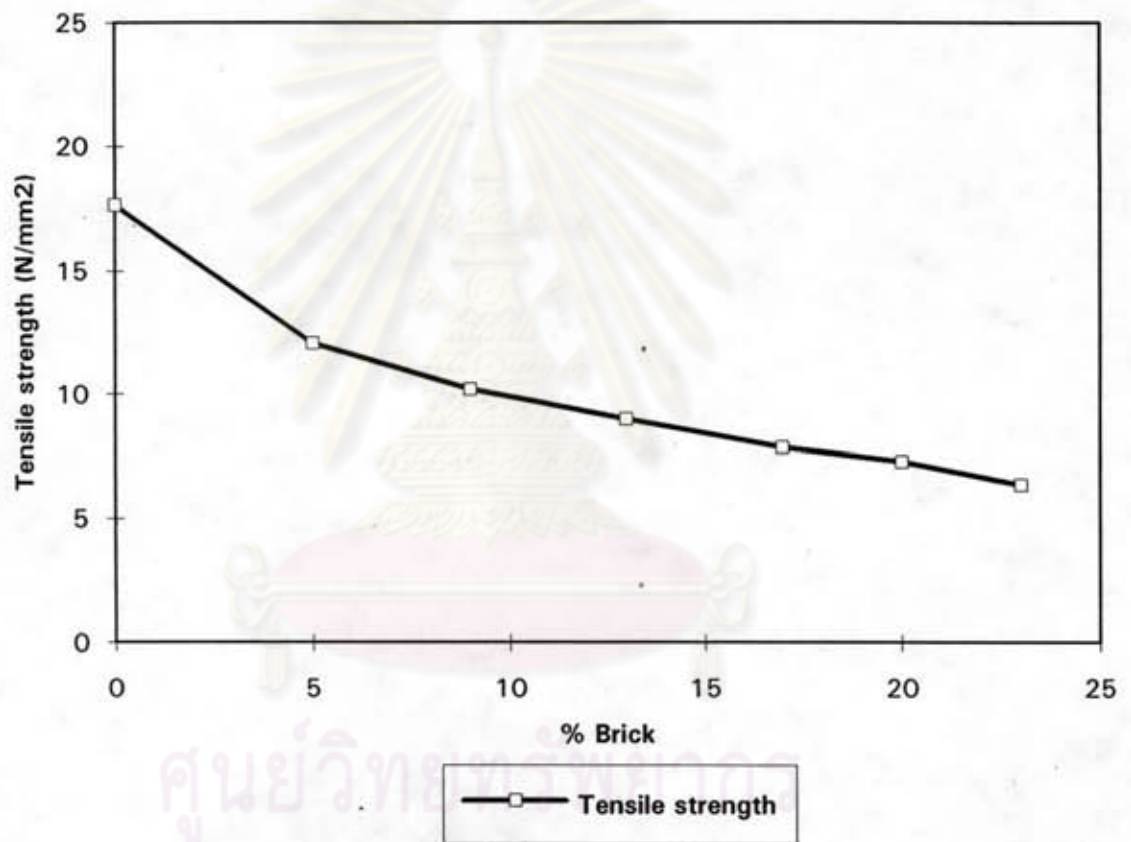


Figure 4.13 Effect of various weight %brick on tensile strength with a fixed NCO/OH ratio at 1.09

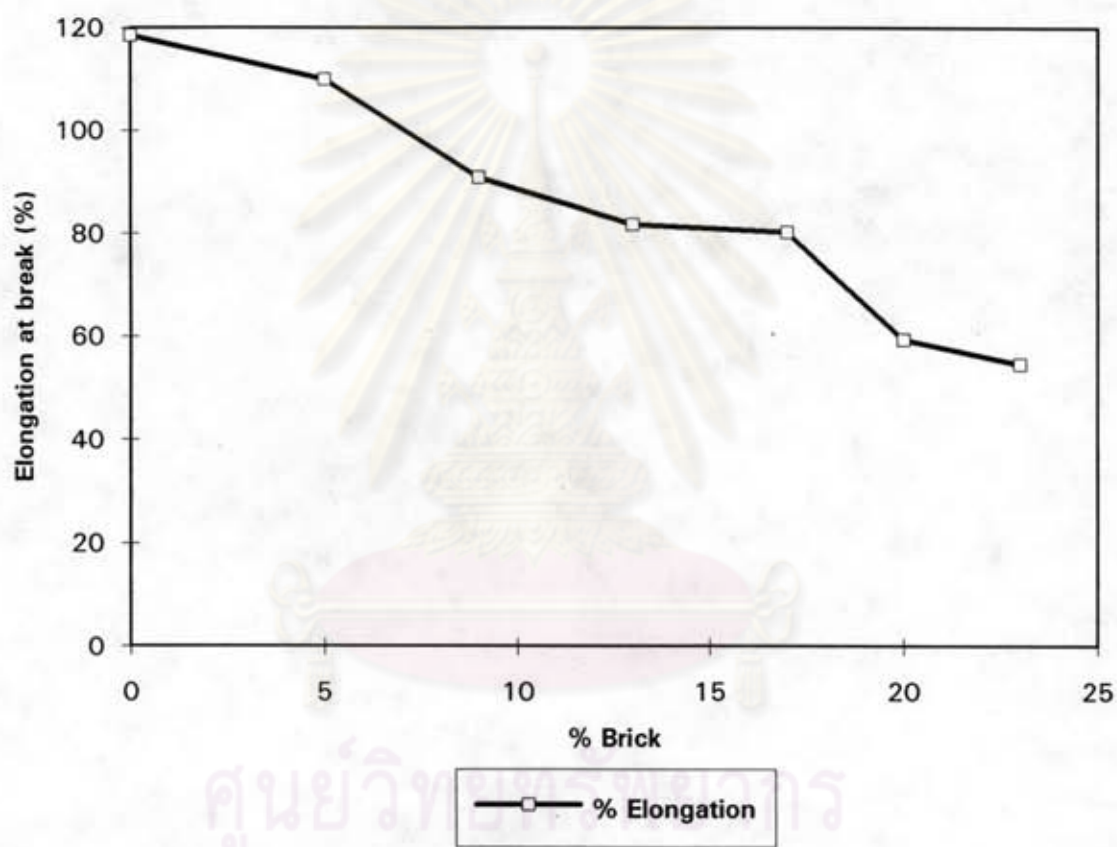


Figure 4.14 Effect of various weight %brick on elongation at break with a fixed NCO/OH ratio at 1.09

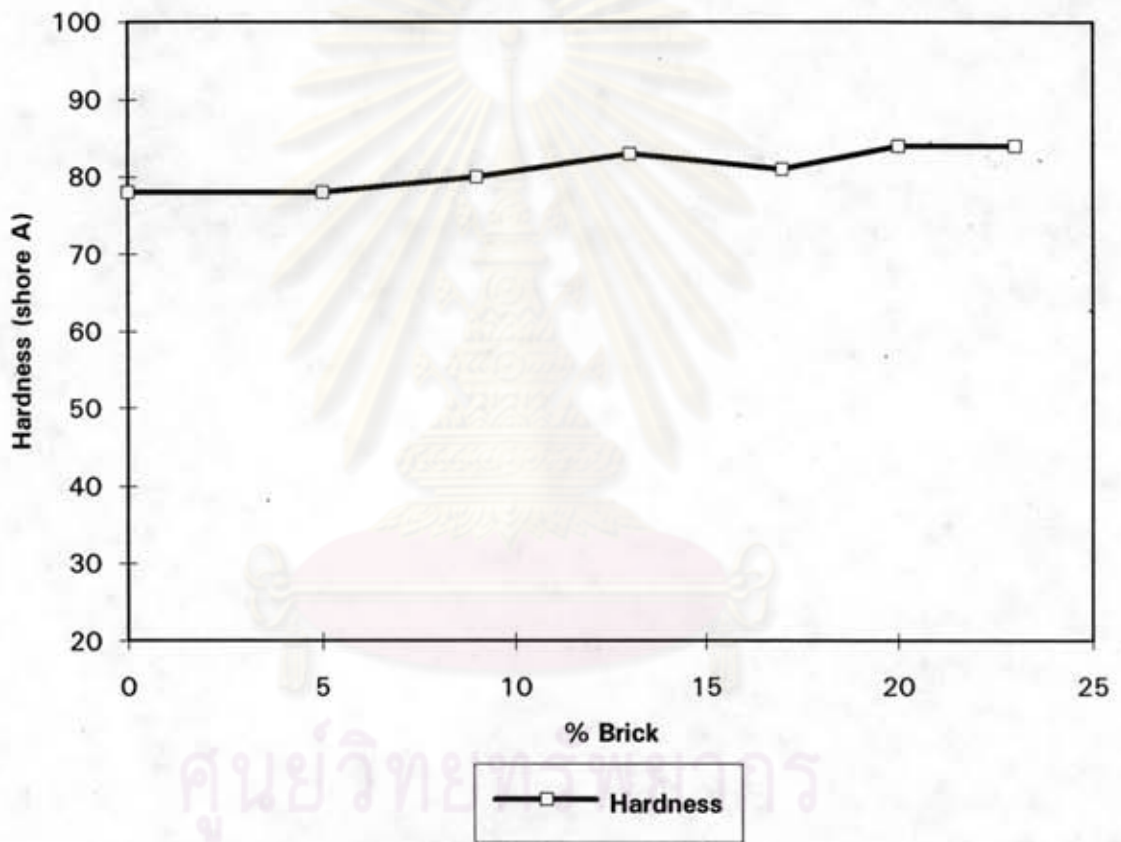


Figure 4.15 Effect of various weight %brick on hardness with a fixed NCO/OH ratio at 1.09

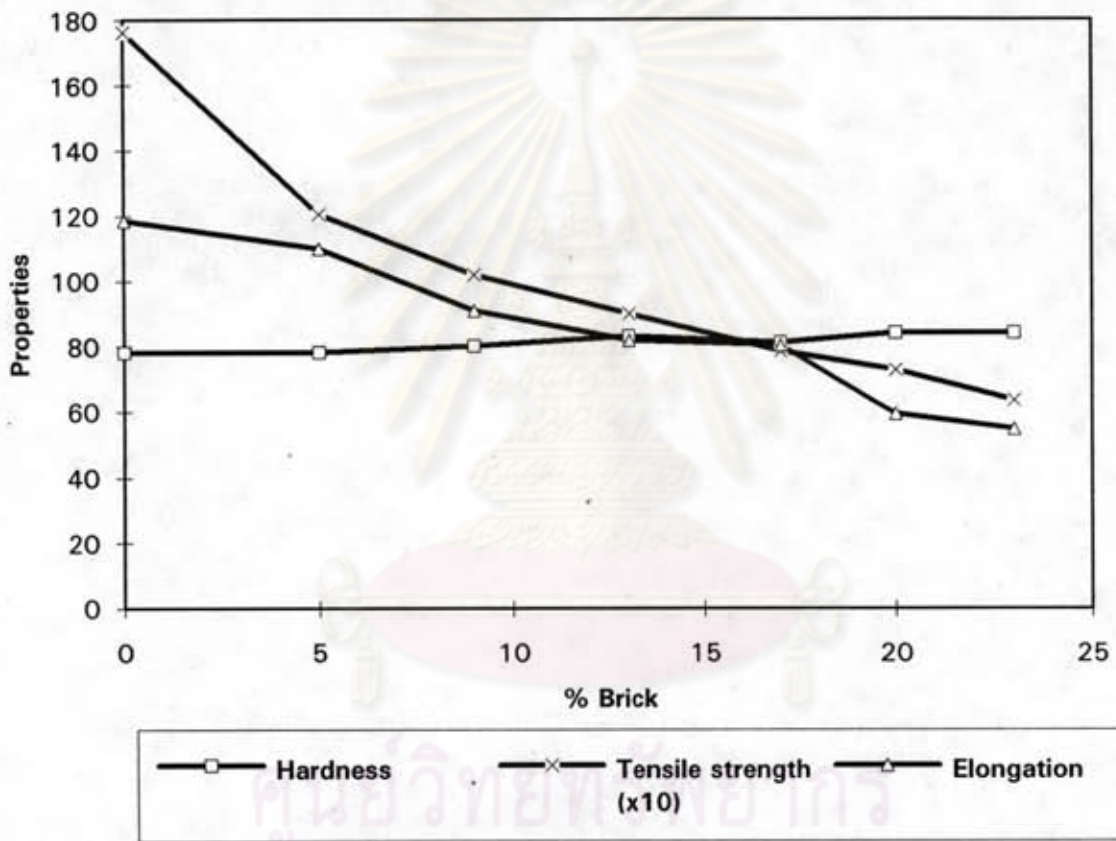


Figure 4.16 Effect of various weight %brick on mechanical properties with a fixed NCO/OH ratio at 1.09

Table 4.6 Mechanical properties on various weight percent brick and a fixed NCO/OH ratio at 1.03

% Brick	Tensile strength (N/mm ²)	Elongation at break (%)	Hardness (Shore A)
0	12.7117	144.97	67.67
5	11.0099	112.5	76
10	10.4832	100.67	80.34
15	9.0606	90.23	84.34
20	7.2364	79.71	81

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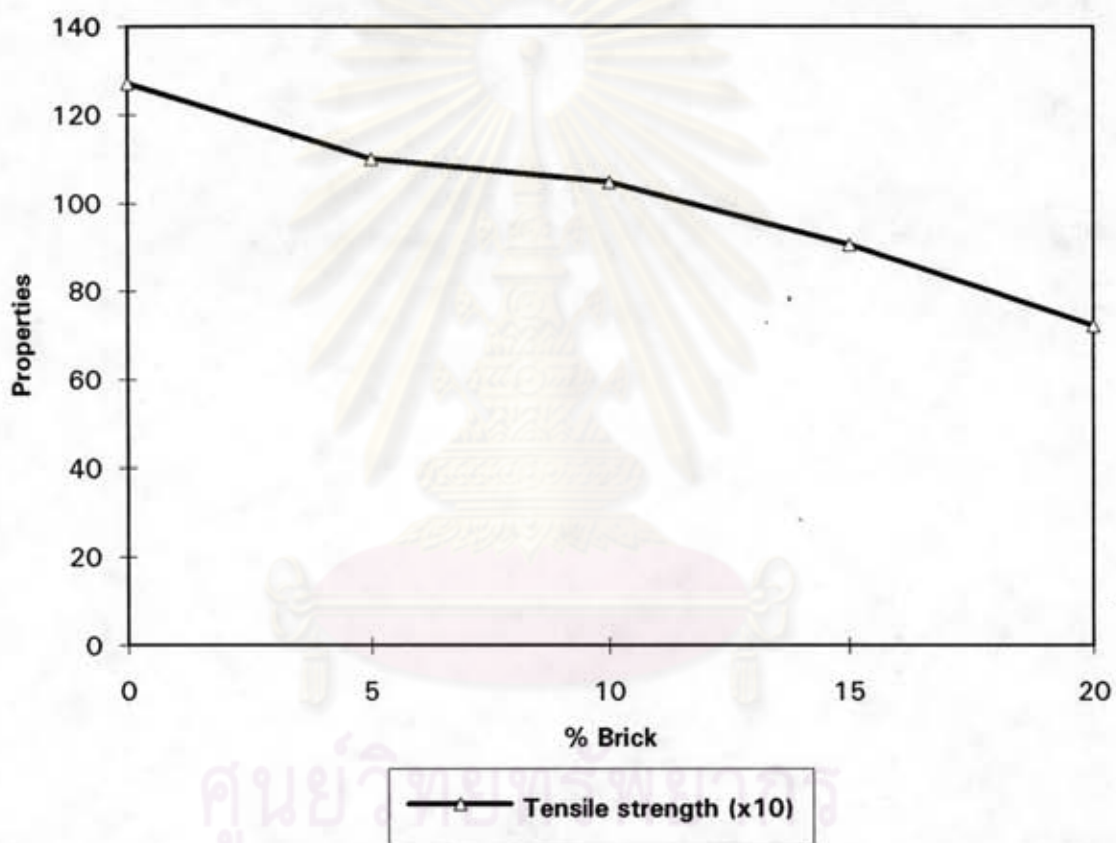


Figure 4.17 Effect of various weight %brick on tensile strength with a fixed NCO/OH ratio at 1.03

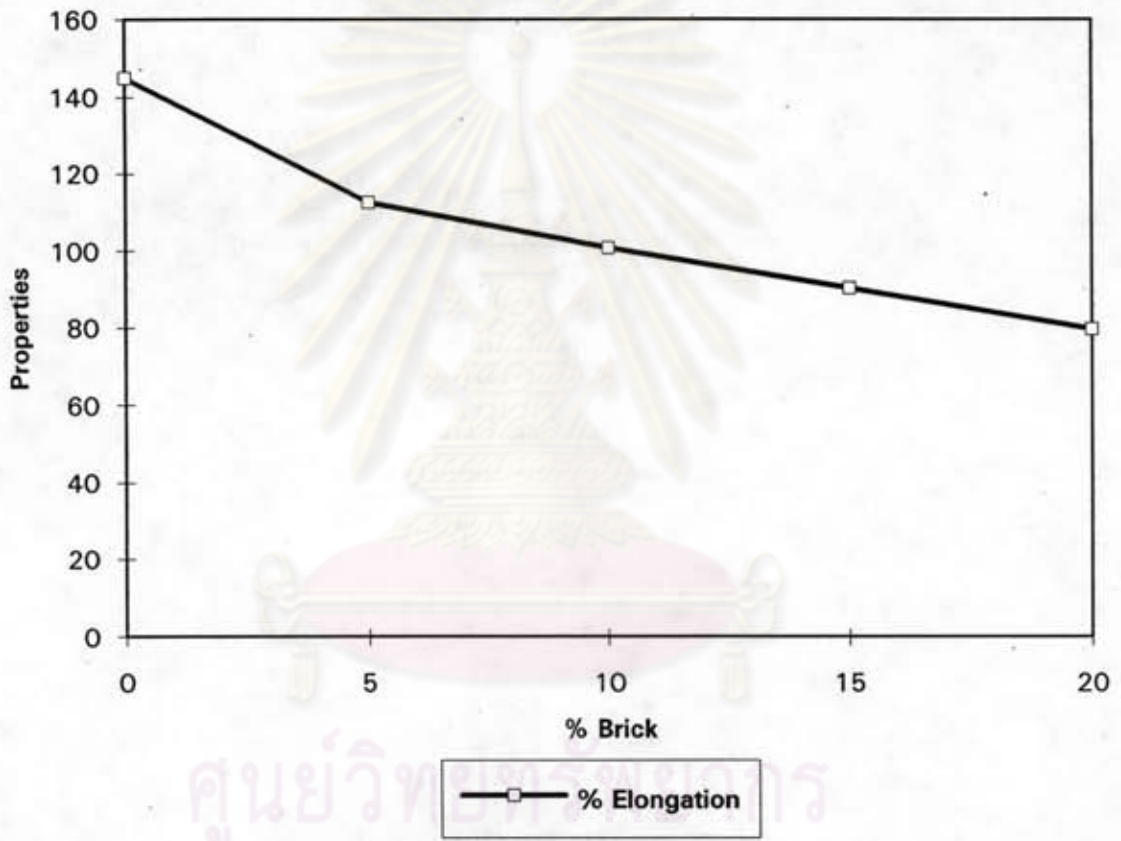


Figure 4.18 Effect of various weight %brick on elongation with a fixed NCO/OH ratio at 1.03

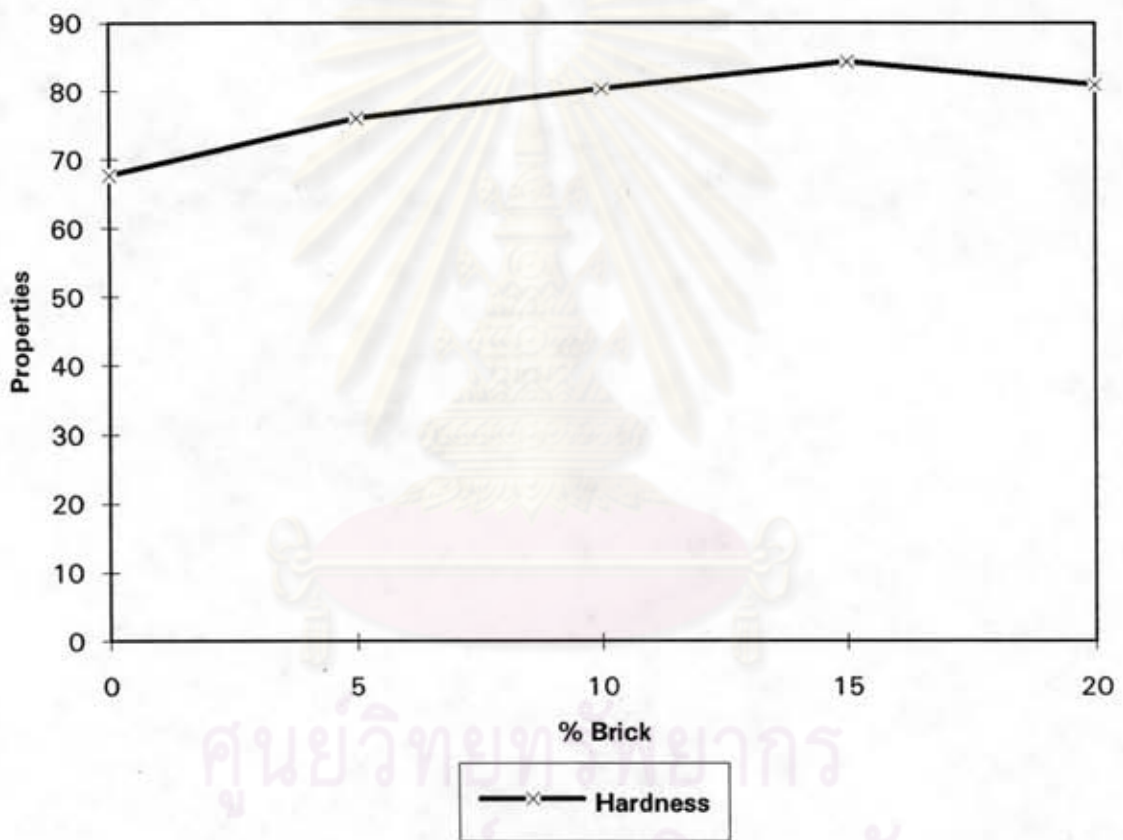


Figure 4.19 Effect of various weight %brick on hardness with a fixed NCO/OH ratio at 1.03

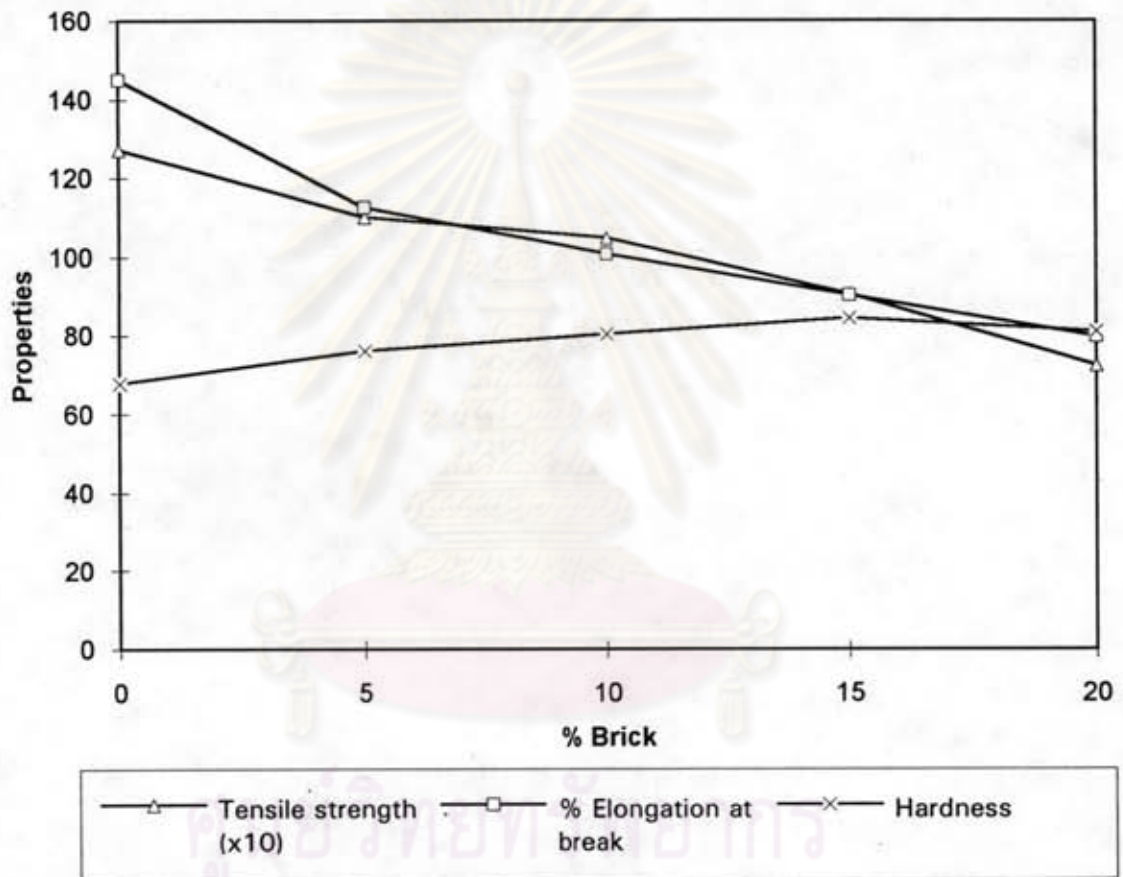


Figure 4.20 Effect of various weight %brick on mechanical properties with a fixed

NCO/OH ratio at 1.03