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Appendix

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Appendix A

Thermocouple calibration



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

| T(C) | mV | T/1000 | (T/1000)^2 | CHECK | |
|------|--------|--------|------------|-------|--------------|
| 1000 | 41.269 | 1.0000 | 1.0000 | 1000 | a = -4.61920 |
| 1010 | 41.657 | 1.0100 | 1.0201 | 1010 | b = 52.60911 |
| 1020 | 42.045 | 1.0200 | 1.0404 | 1020 | c = -6.72698 |
| 1030 | 42.432 | 1.0300 | 1.0609 | 1030 | |
| 1040 | 42.817 | 1.0400 | 1.0816 | 1040 | |
| 1050 | 43.202 | 1.0500 | 1.1025 | 1050 | |
| 1060 | 43.585 | 1.0600 | 1.1236 | 1060 | |
| 1070 | 43.968 | 1.0700 | 1.1449 | 1070 | |
| 1080 | 44.349 | 1.0800 | 1.1664 | 1080 | |
| 1090 | 44.729 | 1.0900 | 1.1881 | 1090 | |
| 1100 | 45.108 | 1.1000 | 1.2100 | 1100 | |
| 1110 | 45.486 | 1.1100 | 1.2321 | 1110 | |
| 1120 | 45.863 | 1.1200 | 1.2544 | 1120 | |
| 1130 | 46.238 | 1.1300 | 1.2769 | 1130 | |
| 1140 | 46.612 | 1.1400 | 1.2996 | 1140 | |
| 1150 | 46.985 | 1.1500 | 1.3225 | 1150 | |
| 1160 | 47.356 | 1.1600 | 1.3456 | 1160 | |
| 1170 | 47.726 | 1.1700 | 1.3689 | 1170 | |
| 1180 | 48.095 | 1.1800 | 1.3924 | 1180 | |
| 1190 | 48.462 | 1.1900 | 1.4161 | 1190 | |
| 1200 | 48.828 | 1.2000 | 1.4400 | 1200 | |
| 1210 | 49.192 | 1.2100 | 1.4641 | 1210 | |
| 1220 | 49.555 | 1.2200 | 1.4884 | 1220 | |
| 1230 | 49.916 | 1.2300 | 1.5129 | 1230 | |
| 1240 | 50.276 | 1.2400 | 1.5376 | 1240 | |
| 1250 | 50.633 | 1.2500 | 1.5625 | 1250 | |
| 1260 | 50.990 | 1.2600 | 1.5876 | 1260 | |
| 1270 | 51.344 | 1.2700 | 1.6129 | 1270 | |
| 1280 | 51.697 | 1.2800 | 1.6384 | 1280 | |
| 1290 | 52.049 | 1.2900 | 1.6641 | 1290 | |
| 1300 | 52.398 | 1.3000 | 1.6900 | 1300 | |



Regression Output:

| | |
|---------------------|--------------------|
| Constant | -4.61920 |
| Std Err of Y Est | 0.002918 |
| R Squared | 0.999999 |
| No. of Observations | 31 |
| Degrees of Freedom | 28 |
| X Coefficient(s) | 52.609115 -6.72698 |
| Std Err of Coef. | 0.1688357 0.073362 |

Equation

$$mV = a + bT + cT^2$$

$$T = (b/2c) \left((1 + 4c(mV - a)/b^2)^{0.5} - 1 \right)$$

Appendix B

Heating characteristic before batch charging



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Heating characteristic before
batch charging (P1-P5 in C)

| t(min) | P1 | P2 | P3 | P4 | P5 |
|--------|------|------|------|------|------|
| 0 | 30 | 30 | 32 | 31 | 114 |
| 5 | 351 | 321 | 354 | 325 | 423 |
| 10 | 454 | 437 | 455 | 442 | 533 |
| 15 | 528 | 507 | 523 | 516 | 594 |
| 20 | 585 | 565 | 578 | 574 | 649 |
| 25 | 624 | 612 | 616 | 619 | 689 |
| 30 | 657 | 648 | 649 | 652 | 715 |
| 35 | 674 | 669 | 667 | 671 | 734 |
| 40 | 714 | 712 | 704 | 714 | 770 |
| 45 | 731 | 732 | 724 | 733 | 788 |
| 50 | 754 | 754 | 745 | 752 | 808 |
| 55 | 776 | 777 | 767 | 775 | 829 |
| 60 | 796 | 799 | 788 | 796 | 843 |
| 65 | 814 | 817 | 805 | 813 | 856 |
| 70 | 831 | 834 | 820 | 829 | 870 |
| 75 | 841 | 851 | 837 | 845 | 879 |
| 80 | 864 | 868 | 854 | 862 | 889 |
| 85 | 876 | 881 | 866 | 875 | 898 |
| 90 | 890 | 894 | 880 | 887 | 903 |
| 95 | 904 | 910 | 894 | 902 | 918 |
| 100 | 916 | 922 | 906 | 913 | 927 |
| 105 | 1042 | 1051 | 1027 | 1039 | 1033 |
| 110 | 1054 | 1052 | 1048 | 1049 | 1065 |
| 115 | 1091 | 1088 | 1083 | 1084 | 1090 |
| 120 | 1119 | 1116 | 1110 | 1109 | 1109 |
| 125 | 1139 | 1139 | 1132 | 1132 | 1129 |
| 130 | 1164 | 1164 | 1156 | 1156 | 1144 |
| 135 | 1179 | 1179 | 1170 | 1169 | 1154 |
| 140 | 1198 | 1198 | 1185 | 1186 | 1160 |
| 145 | 1200 | 1211 | 1197 | 1198 | 1183 |

Appendix C

Individual batch composition



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

GLASS LABEL >>>>>Batch 01

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|----------------------------|------|-------|------------|
| number of species: | 3 | batch | sand glass |

| | | | | |
|------------|--------|--------|--------|--------|
| Si: sand | 621.95 | 621.95 | 200.00 | 740.98 |
| Ca: CaCO3 | 150.03 | 150.03 | 48.25 | 178.74 |
| Na: Na2CO3 | 228.02 | 228.02 | 73.32 | 271.66 |

| | | | | |
|----------------|---------|---------|--------|---------|
| TOTAL BATCH | 1000.00 | 1000.00 | 321.57 | 1191.39 |
| TOTAL GLASS | 839.36 | 839.36 | 269.91 | 1000.00 |
| TOTAL GAS | 160.64 | 160.64 | 51.66 | 191.39 |
| redox number R | | | | |
| Fe2+/Fe tot | 0.400 | | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | |
|------------|-------|--------|---------|------------|------------|
| Batch 01 | wt. % | REST % | | (Fe2+) | 0.400 |
| SiO2 = | 74.10 | Tg | C | 541.1 | wt(FeO) |
| TiO2 = | | T(7.6) | C | 706.5 | |
| ZrO2 = | | T(6.0) | C | 801.5 | |
| Al2O3 = | | T(4.0) | C | 998.7 | |
| B2O3 = | | T(3.0) | C | 1163.7 | |
| Fe2O3 = | | T(2.0) | C | 1424.3 | |
| Cr2O3 = | | T(1.5) | C | 1620.6 | Fe BALANCE |
| P2O5 = | | | | | sand |
| MgO = | | | | | cullet |
| CaO = | 10.02 | | | | feldspars |
| BaO = | | | | | slag |
| MnO = | | | | | dolomite |
| ZnO = | | | | | limestone |
| PbO = | | | | | Fe carrier |
| Li2O = | | | | | CaF2 |
| Na2O = | 15.89 | | | | add 1-4 |
| K2O = | | | | | others |
| SO3 = | | | | | SUM |

GLASS LABEL >>>>>Batch 02

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|----------------------------|------|-------|------------|
| number of species: | 5 | batch | sand glass |

| | | | | |
|-------------------------------------|--------|--------|--------|--------|
| Si: sand | 573.89 | 573.76 | 200.00 | 687.22 |
| Al: feldspar | 54.52 | 54.51 | 19.00 | 65.29 |
| Mg: dolomite | 150.65 | 150.62 | 52.50 | 180.40 |
| Ca: CaCO ₃ | 34.65 | 34.64 | 12.08 | 41.49 |
| Na: Na ₂ CO ₃ | 186.51 | 186.47 | 65.00 | 223.34 |

| | | | | |
|--------------------------|---------|---------|--------|---------|
| TOTAL BATCH | 1000.22 | 1000.00 | 348.58 | 1197.73 |
| TOTAL GLASS | 835.09 | 834.91 | 291.03 | 1000.00 |
| TOTAL GAS | 164.58 | 165.09 | 57.55 | 197.73 |
| redox number R | | | | |
| Fe ²⁺ /Fe tot | 0.400 | | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | |
|----------------------------------|-------|--------|---------|---------------------|------------------|
| Batch 02 | wt. % | REST % | | (Fe ²⁺) | 0.400 |
| SiO ₂ = | 73.16 | Tg | C | 548.9 | wt(FeO) 0.003 |
| TiO ₂ = | | T(7.6) | C | 731.4 | |
| ZrO ₂ = | | T(6.0) | C | 834.1 | |
| Al ₂ O ₃ = | 1.24 | T(4.0) | C | 1042.5 | |
| B ₂ O ₃ = | | T(3.0) | C | 1212.1 | |
| Fe ₂ O ₃ = | 0.01 | T(2.0) | C | 1471.5 | |
| Cr ₂ O ₃ = | | T(1.5) | C | 1660.6 | Fe BALANCE |
| P ₂ O ₅ = | | | | | sand |
| MgO = | 3.94 | | | | cullet |
| CaO = | 7.88 | | | | feldspars 0.007 |
| BaO = | | | | | slag |
| MnO = | | | | | dolomite |
| ZnO = | | | | | limestone |
| PbO = | | | | | Fe carrier |
| Li ₂ O = | | | | | CaF ₂ |
| Na ₂ O = | 13.69 | | | | add 1-4 |
| K ₂ O = | 0.08 | | | | others 0.000 |
| SO ₃ = | | | | | SUM 0.007 |

GLASS LABEL >>>>>Batch 03

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|----------------------------|---------|--------|---------|
| number of species: 7 | batch | sand | glass |
| Si: sand | 573.71 | 200.00 | 684.86 |
| Al: feldspar | 54.72 | 19.08 | 65.32 |
| Mg: dolomite | 150.21 | 52.36 | 179.31 |
| Ca: CaCO3 | 34.90 | 12.17 | 41.66 |
| Na: Na2CO3 | 173.55 | 60.50 | 207.17 |
| SO4: Na2SO4 | 8.61 | 3.00 | 10.28 |
| R: NaNO3 | 4.30 | 1.50 | 5.13 |
| TOTAL BATCH | 1000.00 | 348.61 | 1193.75 |
| TOTAL GLASS | 837.70 | 292.03 | 1000.00 |
| TOTAL GAS | 161.75 | 56.58 | 193.75 |
| redox number R | 24.91 | | |
| Fe2+/Fe tot | 0.026 | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | 24.91 |
|------------|-------|--------|----------|------------|-------|
| Batch 03 | wt. % | REST % | 0.000 | (Fe2+) | 0.026 |
| SiO2 = | 72.93 | Tg | C 550.2 | wt(FeO) | 0.000 |
| TiO2 = | | T(7.6) | C 733.5 | | |
| ZrO2 = | | T(6.0) | C 836.6 | | |
| Al2O3 = | 1.24 | T(4.0) | C 1045.8 | | |
| B2O3 = | | T(3.0) | C 1215.9 | | |
| Fe2O3 = | 0.01 | T(2.0) | C 1476.1 | | |
| Cr2O3 = | | T(1.5) | C 1665.6 | Fe BALANCE | |
| P2O5 = | | | | sand | |
| MgO = | 3.92 | | | cullet | |
| CaO = | 7.85 | | | feldspars | 0.007 |
| BaO = | | | | slag | |
| MnO = | | | | dolomite | |
| ZnO = | | | | limestone | |
| PbO = | | | | Fe carrier | |
| Li2O = | | | | CaF2 | |
| Na2O = | 13.39 | | | add 1-4 | |
| K2O = | 0.08 | | | others | 0.000 |
| SO3 = | 0.58 | | | SUM | 0.007 |

GLASS LABEL >>>>>Batch 04

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|----------------------------|---------|---------|---------|
| number of species: 7 | batch | sand | glass |
| Si: sand | 571.58 | 571.57 | 682.79 |
| Al: feldspar | 54.52 | 54.52 | 65.13 |
| Mg: dolomite | 149.66 | 149.66 | 178.78 |
| Ca: CaCO3 | 34.77 | 34.77 | 41.53 |
| Na: Na2CO3 | 180.05 | 180.05 | 215.08 |
| SO4: Na2SO4 | 8.57 | 8.57 | 10.24 |
| coal | 0.86 | 0.86 | 1.03 |
| TOTAL BATCH | 1000.01 | 1000.00 | 1194.57 |
| TOTAL GLASS | 837.13 | 837.12 | 1000.00 |
| TOTAL GAS | 162.34 | 162.88 | 194.57 |
| redox number R | -0.07 | | |
| Fe2+/Fe tot | 0.401 | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | -0.07 |
|------------|-------|--------|---------|------------|-------|
| Batch 04 | wt. % | REST % | | (Fe2+) | 0.401 |
| SiO2 = | 72.71 | Tg | C | wt(FeO) | 0.003 |
| TiO2 = | | T(7.6) | C | | |
| ZrO2 = | | T(6.0) | C | | |
| Al2O3 = | 1.24 | T(4.0) | C | | |
| B2O3 = | | T(3.0) | C | | |
| Fe2O3 = | 0.01 | T(2.0) | C | | |
| Cr2O3 = | | T(1.5) | C | Fe BALANCE | |
| P2O5 = | | | | sand | |
| MgO = | 3.91 | | | cullet | |
| CaO = | 7.83 | | | feldspars | 0.007 |
| BaO = | | | | slag | |
| MnO = | | | | dolomite | |
| ZnO = | | | | limestone | |
| PbO = | | | | Fe carrier | |
| Li2O = | | | | CaF2 | |
| Na2O = | 13.66 | | | add 1-4 | |
| K2O = | 0.08 | | | others | 0.000 |
| SO3 = | 0.58 | | | SUM | 0.007 |

GLASS LABEL >>>>>Batch 05

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|---|---------|---------|---------|
| number of species: 7 | batch | sand | glass |
| Si: sand | 573.61 | 572.47 | 683.43 |
| Al: feldspar | 54.52 | 54.41 | 64.96 |
| Mg: dolomite | 149.66 | 149.36 | 178.31 |
| Ca: CaCO ₃ | 34.77 | 34.70 | 41.43 |
| Na: Na ₂ CO ₃ | 180.06 | 179.70 | 214.53 |
| SO ₄ : Na ₂ SO ₄ | 8.72 | 8.70 | 10.39 |
| coal | 0.66 | 0.66 | 0.79 |
| TOTAL BATCH | 1002.00 | 1000.00 | 1193.83 |
| TOTAL GLASS | 839.31 | 837.64 | 1000.00 |
| TOTAL GAS | 162.14 | 162.36 | 193.83 |
| redox number R | 4.95 | | |
| Fe ²⁺ /Fe tot | 0.326 | | |



| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | 4.95 |
|----------------------------------|-------|--------|----------|---------------------|-------|
| Batch 05 | wt. % | REST % | 0.000 | (Fe ²⁺) | 0.326 |
| SiO ₂ = | 72.76 | Tg | C 548.8 | wt(FeO) | 0.002 |
| TiO ₂ = | | T(7.6) | C 731.3 | | |
| ZrO ₂ = | | T(6.0) | C 834.0 | | |
| Al ₂ O ₃ = | 1.23 | T(4.0) | C 1042.5 | | |
| B ₂ O ₃ = | | T(3.0) | C 1212.3 | | |
| Fe ₂ O ₃ = | 0.01 | T(2.0) | C 1471.9 | | |
| Cr ₂ O ₃ = | | T(1.5) | C 1661.2 | Fe BALANCE | |
| P ₂ O ₅ = | | | | sand | |
| MgO = | 3.90 | | | cullet | |
| CaO = | 7.81 | | | feldspars | 0.006 |
| BaO = | | | | slag | |
| MnO = | | | | dolomite | |
| ZnO = | | | | limestone | |
| PbO = | | | | Fe carrier | |
| Li ₂ O = | | | | CaF ₂ | |
| Na ₂ O = | 13.63 | | | add 1-4 | |
| K ₂ O = | 0.08 | | | others | 0.000 |
| SO ₃ = | 0.59 | | | SUM | 0.006 |

GLASS LABEL >>>>>Batch 06

| raw materials (kg) per | --> | 1000 | 200 | 1000 |
|------------------------|--------|---------|--------|---------|
| number of species: | 7 | batch | sand | glass |
| Si: sand | 572.64 | 572.65 | 200.00 | 683.47 |
| Al: feldspar | 54.62 | 54.62 | 19.08 | 65.19 |
| Mg: dolomite | 149.93 | 149.93 | 52.36 | 178.95 |
| Ca: CaCO3 | 34.83 | 34.83 | 12.16 | 41.57 |
| Na: Na2CO3 | 178.95 | 178.95 | 62.50 | 213.59 |
| SO4: Na2SO4 | 8.59 | 8.59 | 3.00 | 10.25 |
| coal | 0.43 | 0.43 | 0.15 | 0.51 |
| TOTAL BATCH | 999.99 | 1000.00 | 349.26 | 1193.54 |
| TOTAL GLASS | 837.84 | 837.85 | 292.62 | 1000.00 |
| TOTAL GAS | 161.61 | 162.15 | 56.63 | 193.54 |
| redox number R | 10.04 | | | |
| Fe2+/Fe tot | 0.249 | | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | 10.04 |
|------------|-------|--------|---------|------------|-----------------|
| Batch 06 | wt. % | REST % | 0.000 | (Fe2+) | 0.249 |
| SiO2 = | 72.78 | Tg | C | 549.2 | wt(FeO) 0.002 |
| TiO2 = | | T(7.6) | C | 731.8 | |
| ZrO2 = | | T(6.0) | C | 834.6 | |
| Al2O3 = | 1.24 | T(4.0) | C | 1043.2 | |
| B2O3 = | | T(3.0) | C | 1213.0 | |
| Fe2O3 = | 0.01 | T(2.0) | C | 1472.6 | |
| Cr2O3 = | | T(1.5) | C | 1661.8 | Fe BALANCE |
| P2O5 = | | | | | sand |
| MgO = | 3.91 | | | | cullet |
| CaO = | 7.84 | | | | feldspars 0.007 |
| BaO = | | | | | slag |
| MnO = | | | | | dolomite |
| ZnO = | | | | | limestone |
| PbO = | | | | | Fe carrier |
| Li2O = | | | | | CaF2 |
| Na2O = | 13.57 | | | | add 1-4 |
| K2O = | 0.08 | | | | others 0.000 |
| SO3 = | 0.58 | | | | SUM 0.007 |

GLASS LABEL >>>>>Batch 07

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|----------------------------|------|-------|------------|
| number of species: | 7 | batch | sand glass |

| | | | | |
|--------------|--------|--------|--------|--------|
| Si: sand | 573.51 | 573.51 | 200.00 | 684.06 |
| Al: feldspar | 54.70 | 54.70 | 19.08 | 65.24 |
| Mg: dolomite | 150.16 | 150.16 | 52.37 | 179.10 |
| Ca: CaCO3 | 34.89 | 34.89 | 12.17 | 41.62 |
| Na: Na2CO3 | 177.79 | 177.79 | 62.00 | 212.06 |
| SO4: Na2SO4 | 8.72 | 8.72 | 3.04 | 10.40 |
| coal | 0.23 | 0.23 | 0.08 | 0.27 |

| | | | | |
|----------------|---------|---------|--------|---------|
| TOTAL BATCH | 1000.00 | 1000.00 | 348.73 | 1192.76 |
| TOTAL GLASS | 838.39 | 838.39 | 292.37 | 1000.00 |
| TOTAL GAS | 161.06 | 161.61 | 56.36 | 192.76 |
| redox number R | 15.00 | | | |
| Fe2+/Fe tot | 0.175 | | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | 15.00 | |
|------------|-------|--------|---------|------------|------------|-------|
| Batch 07 | wt. % | REST % | 0.000 | (Fe2+) | 0.175 | |
| SiO2 = | 72.84 | Tg | C | 549.7 | wt(FeO) | 0.001 |
| TiO2 = | | T(7.6) | C | 732.6 | | |
| ZrO2 = | | T(6.0) | C | 835.5 | | |
| Al2O3 = | 1.24 | T(4.0) | C | 1044.4 | | |
| B2O3 = | | T(3.0) | C | 1214.3 | | |
| Fe2O3 = | 0.01 | T(2.0) | C | 1474.2 | | |
| Cr2O3 = | | T(1.5) | C | 1663.5 | Fe BALANCE | |
| P2O5 = | | | | | sand | |
| MgO = | 3.92 | | | | cullet | |
| CaO = | 7.84 | | | | feldspars | 0.007 |
| BaO = | | | | | slag | |
| MnO = | | | | | dolomite | |
| ZnO = | | | | | limestone | |
| PbO = | | | | | Fe carrier | |
| Li2O = | | | | | CaF2 | |
| Na2O = | 13.49 | | | | add 1-4 | |
| K2O = | 0.08 | | | | others | 0.000 |
| SO3 = | 0.59 | | | | SUM | 0.007 |

GLASS LABEL >>>>>Batch 08

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|----------------------------|---------|---------|---------|
| number of species: 6 | batch | sand | glass |
| Si: sand | 574.53 | 574.53 | 684.84 |
| Al: feldspar | 54.80 | 54.80 | 65.32 |
| Mg: dolomite | 150.43 | 150.43 | 179.31 |
| Ca: CaCO3 | 34.95 | 34.95 | 41.66 |
| Na: Na2CO3 | 176.67 | 176.67 | 210.59 |
| SO4: Na2SO4 | 8.62 | 8.62 | 10.27 |
| TOTAL BATCH | 1000.00 | 1000.00 | 1191.99 |
| TOTAL GLASS | 838.93 | 838.93 | 1000.00 |
| TOTAL GAS | 160.52 | 161.07 | 191.99 |
| redox number R | 20.10 | | |
| Fe2+/Fe tot | 0.098 | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | 20.10 |
|------------|-------|----------|---------|------------|-------|
| Batch 08 | wt. % | REST % | | (Fe2+) | 0.098 |
| SiO2 = | 72.93 | Tg C | 550.2 | wt(FeO) | 0.001 |
| TiO2 = | | T(7.6) C | 733.4 | | |
| ZrO2 = | | T(6.0) C | 836.6 | | |
| Al2O3 = | 1.24 | T(4.0) C | 1045.7 | | |
| B2O3 = | | T(3.0) C | 1215.9 | | |
| Fe2O3 = | 0.01 | T(2.0) C | 1476.0 | | |
| Cr2O3 = | | T(1.5) C | 1665.5 | Fe BALANCE | |
| P2O5 = | | | | sand | |
| MgO = | 3.92 | | | cullet | |
| CaO = | 7.85 | | | feldspars | 0.007 |
| BaO = | | | | slag | |
| MnO = | | | | dolomite | |
| ZnO = | | | | limestone | |
| PbO = | | | | Fe carrier | |
| Li2O = | | | | CaF2 | |
| Na2O = | 13.40 | | | add 1-4 | |
| K2O = | 0.08 | | | others | 0.000 |
| SO3 = | 0.58 | | | SUM | 0.007 |

GLASS LABEL >>>>>Batch 09

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|---|---------|---------|---------|
| number of species: 7 | batch | sand | glass |
| Si: sand | 571.37 | 571.36 | 682.67 |
| Al: feldspar | 54.50 | 54.50 | 65.12 |
| Mg: dolomite | 149.60 | 149.60 | 178.74 |
| Ca: CaCO ₃ | 34.76 | 34.76 | 41.53 |
| Na: Na ₂ CO ₃ | 179.98 | 179.98 | 215.04 |
| SO ₄ : Na ₂ SO ₄ | 8.71 | 8.71 | 10.41 |
| coal | 1.09 | 1.09 | 1.30 |
| TOTAL BATCH | 1000.01 | 1000.00 | 1194.81 |
| TOTAL GLASS | 836.96 | 836.95 | 1000.00 |
| TOTAL GAS | 162.51 | 163.05 | 194.81 |
| redox number R | -5.14 | | |
| Fe ²⁺ /Fe tot | 0.477 | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | -5.14 | |
|----------------------------------|-------|--------|---------|---------------------|------------------|-------|
| Batch 09 | wt. % | REST % | | (Fe ²⁺) | 0.477 | |
| SiO ₂ = | 72.70 | Tg | C | 548.7 | wt(FeO) | 0.003 |
| TiO ₂ = | | T(7.6) | C | 731.0 | | |
| ZrO ₂ = | | T(6.0) | C | 833.6 | | |
| Al ₂ O ₃ = | 1.24 | T(4.0) | C | 1041.8 | | |
| B ₂ O ₃ = | | T(3.0) | C | 1211.4 | | |
| Fe ₂ O ₃ = | 0.01 | T(2.0) | C | 1470.7 | | |
| Cr ₂ O ₃ = | | T(1.5) | C | 1659.7 | Fe BALANCE | |
| P ₂ O ₅ = | | | | | sand | |
| MgO = | 3.91 | | | | cullet | |
| CaO = | 7.83 | | | | feldspars | 0.007 |
| BaO = | | | | | slag | |
| MnO = | | | | | dolomite | |
| ZnO = | | | | | limestone | |
| PbO = | | | | | Fe carrier | |
| Li ₂ O = | | | | | CaF ₂ | |
| Na ₂ O = | 13.66 | | | | add 1-4 | |
| K ₂ O = | 0.08 | | | | others | 0.000 |
| SO ₃ = | 0.59 | | | | SUM | 0.007 |

GLASS LABEL >>>>>Batch 10

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|----------------------------|------|-------|------------|
| number of species: | 7 | batch | sand glass |

| | | | | |
|--------------|--------|--------|--------|--------|
| Si: sand | 572.15 | 572.15 | 200.00 | 683.47 |
| Al: feldspar | 54.57 | 54.57 | 19.08 | 65.19 |
| Mg: dolomite | 149.81 | 149.81 | 52.37 | 178.96 |
| Ca: CaCO3 | 34.80 | 34.80 | 12.16 | 41.57 |
| Na: Na2CO3 | 178.80 | 178.80 | 62.50 | 213.59 |
| SO4: Na2SO4 | 8.58 | 8.58 | 3.00 | 10.25 |
| coal | 1.29 | 1.29 | 0.45 | 1.54 |

| | | | | |
|----------------|---------|---------|--------|---------|
| TOTAL BATCH | 1000.00 | 1000.00 | 349.56 | 1194.57 |
| TOTAL GLASS | 837.12 | 837.12 | 292.62 | 1000.00 |
| TOTAL GAS | 162.33 | 162.88 | 56.94 | 194.57 |
| redox number R | -10.12 | | | |
| Fe2+/Fe tot | 0.552 | | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | -10.12 | |
|------------|-------|--------|---------|------------|------------|-------|
| Batch 10 | wt. % | REST % | | (Fe2+) | 0.552 | |
| SiO2 = | 72.78 | Tg | C | 549.2 | wt(FeO) | 0.004 |
| TiO2 = | | T(7.6) | C | 731.8 | | |
| ZrO2 = | | T(6.0) | C | 834.6 | | |
| Al2O3 = | 1.24 | T(4.0) | C | 1043.2 | | |
| B2O3 = | | T(3.0) | C | 1212.9 | | |
| Fe2O3 = | 0.01 | T(2.0) | C | 1472.6 | | |
| Cr2O3 = | | T(1.5) | C | 1661.8 | Fe BALANCE | |
| P2O5 = | | | | | sand | |
| MgO = | 3.91 | | | | cullet | |
| CaO = | 7.84 | | | | feldspars | 0.007 |
| BaO = | | | | | slag | |
| MnO = | | | | | dolomite | |
| ZnO = | | | | | limestone | |
| PbO = | | | | | Fe carrier | |
| Li2O = | | | | | CaF2 | |
| Na2O = | 13.57 | | | | add 1-4 | |
| K2O = | 0.08 | | | | others | 0.000 |
| SO3 = | 0.58 | | | | SUM | 0.007 |

GLASS LABEL >>>>>Batch 11

| raw materials (kg) per --> | 1000 | 200 | 1000 |
|----------------------------|------|-------|------------|
| number of species: | 7 | batch | sand glass |

| | | | | |
|---|--------|--------|--------|--------|
| Si: sand | 571.11 | 571.11 | 200.00 | 682.65 |
| Al: feldspar | 54.47 | 54.47 | 19.08 | 65.11 |
| Mg: dolomite | 149.53 | 149.53 | 52.36 | 178.73 |
| Ca: CaCO ₃ | 34.74 | 34.74 | 12.17 | 41.52 |
| Na: Na ₂ CO ₃ | 179.90 | 179.90 | 63.00 | 215.04 |
| SO ₄ : Na ₂ SO ₄ | 8.74 | 8.74 | 3.06 | 10.45 |
| coal | 1.51 | 1.51 | 0.53 | 1.80 |

| | | | | |
|--------------------------|---------|---------|--------|---------|
| TOTAL BATCH | 1000.00 | 1000.00 | 350.20 | 1195.31 |
| TOTAL GLASS | 836.60 | 836.60 | 292.98 | 1000.00 |
| TOTAL GAS | 162.85 | 163.40 | 57.22 | 195.31 |
| redox number R | -14.92 | | | |
| Fe ²⁺ /Fe tot | 0.624 | | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | -14.92 | |
|----------------------------------|-------|--------|---------|---------------------|------------------|-------|
| Batch 11 | wt. % | REST % | | (Fe ²⁺) | 0.624 | |
| SiO ₂ = | 72.69 | Tg | C | 548.7 | wt(FeO) | 0.004 |
| TiO ₂ = | | T(7.6) | C | 730.9 | | |
| ZrO ₂ = | | T(6.0) | C | 833.6 | | |
| Al ₂ O ₃ = | 1.24 | T(4.0) | C | 1041.8 | | |
| B ₂ O ₃ = | | T(3.0) | C | 1211.3 | | |
| Fe ₂ O ₃ = | 0.01 | T(2.0) | C | 1470.7 | | |
| Cr ₂ O ₃ = | | T(1.5) | C | 1659.7 | Fe BALANCE | |
| P ₂ O ₅ = | | | | 182 | sand | |
| MgO = | 3.91 | | | 8.220 | cullet | |
| CaO = | 7.83 | | | 7.255 | feldspars | 0.007 |
| BaO = | | | | 6.460 | slag | |
| MnO = | | | | 5.793 | dolomite | |
| ZnO = | | | | 5.227 | limestone | |
| PbO = | | | | 66 | Fe carrier | |
| Li ₂ O = | | | | 27343 | CaF ₂ | |
| Na ₂ O = | 13.66 | | | 0.246 | add 1-4 | |
| K ₂ O = | 0.08 | | | 0.372 | others | 0.000 |
| SO ₃ = | 0.59 | | | 20 | SUM | 0.007 |

GLASS LABEL >>>>>Batch 12

| raw materials (kg) per | --> | 1000 | 200 | 1000 |
|---|---------|---------|--------|---------|
| number of species: | 7 | batch | sand | glass |
| Si: sand | 571.91 | 571.85 | 200.00 | 683.42 |
| Al: feldspar | 54.55 | 54.54 | 19.08 | 65.19 |
| Mg: dolomite | 149.74 | 149.72 | 52.36 | 178.94 |
| Ca: CaCO ₃ | 34.79 | 34.79 | 12.17 | 41.57 |
| Na: Na ₂ CO ₃ | 178.82 | 178.80 | 62.53 | 213.69 |
| SO ₄ : Na ₂ SO ₄ | 8.58 | 8.58 | 3.00 | 10.25 |
| coal | 1.72 | 1.72 | 0.60 | 2.06 |
| TOTAL BATCH | 1000.11 | 1000.00 | 349.74 | 1195.12 |
| TOTAL GLASS | 836.83 | 836.74 | 292.64 | 1000.00 |
| TOTAL GAS | 162.73 | 163.26 | 57.10 | 195.12 |
| redox number R | -20.20 | | | |
| Fe ²⁺ /Fe tot | 0.703 | | | |

| COMPONENTS | INPUT | SUM % | 100.000 | redox. no. | -20.20 | |
|----------------------------------|-------|--------|---------|---------------------|------------------|-------|
| Batch 12 | wt. % | REST % | | (Fe ²⁺) | 0.703 | |
| SiO ₂ = | 72.78 | Tg | C | 549.2 | wt(FeO) | 0.005 |
| TiO ₂ = | | T(7.6) | C | 731.8 | | |
| ZrO ₂ = | | T(6.0) | C | 834.6 | | |
| Al ₂ O ₃ = | 1.24 | T(4.0) | C | 1043.1 | | |
| B ₂ O ₃ = | | T(3.0) | C | 1212.8 | | |
| Fe ₂ O ₃ = | 0.01 | T(2.0) | C | 1472.4 | | |
| Cr ₂ O ₃ = | | T(1.5) | C | 1661.6 | Fe BALANCE | |
| P ₂ O ₅ = | | | | | sand | |
| MgO = | 3.91 | | | | cullet | |
| CaO = | 7.84 | | | | feldspars | 0.007 |
| BaO = | | | | | slag | |
| MnO = | | | | | dolomite | |
| ZnO = | | | | | limestone | |
| PbO = | | | | | Fe carrier | |
| Li ₂ O = | | | | | CaF ₂ | |
| Na ₂ O = | 13.58 | | | | add 1-4 | |
| K ₂ O = | 0.08 | | | | others | 0.000 |
| SO ₃ = | 0.58 | | | | SUM | 0.007 |

Appendix D

Time, Resistivity, and Temperature data



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Appendix D

The data of time (t), resistivity (R) in terms of voltage, and temperature (T) at different positions in the batch blanket; the unit of t, R, and T is given in min, mV, and C respectively.

Batch 01

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|--------|--------|---------|---------|------|------|------|------|------|
| 0 | 433.40 | 268.30 | 6975.00 | 7631.00 | 860 | 923 | 821 | 954 | 1081 |
| 1 | 453.50 | 241.10 | 4654.00 | 8994.00 | 869 | 938 | 834 | 1004 | 1119 |
| 2 | 317.80 | 239.40 | 1721.00 | 7517.00 | 879 | 943 | 858 | 1058 | 1135 |
| 3 | 91.13 | 156.41 | 298.30 | 6845.00 | 892 | 946 | 893 | 1094 | 1153 |
| 4 | 9.96 | 184.81 | 16.56 | 6648.00 | 905 | 956 | 923 | 1110 | 1150 |
| 5 | 62.26 | 143.78 | 1.90 | 6118.00 | 922 | 956 | 951 | 1113 | 1157 |
| 6 | 54.49 | 129.32 | 96.35 | 6341.00 | 937 | 964 | 973 | 1108 | 1150 |
| 7 | 12.83 | 260.70 | 94.90 | 54.52 | 948 | 969 | 984 | 1110 | 1132 |
| 8 | 68.87 | 164.59 | 50.30 | 25.27 | 959 | 976 | 1000 | 1127 | 1164 |
| 9 | 53.08 | 148.62 | 48.70 | 23.66 | 971 | 982 | 1015 | 1131 | 1157 |
| 10 | 10.95 | 167.13 | 4.53 | 26.47 | 982 | 989 | 1033 | 1139 | 1163 |
| 11 | 58.09 | 219.90 | 86.24 | 49.58 | 998 | 995 | 1054 | 1152 | 1179 |
| 12 | 101.85 | 258.40 | 97.47 | 24.08 | 1012 | 1002 | 1064 | 1161 | 1166 |
| 13 | 24.86 | 170.05 | 4.41 | 56.74 | 1022 | 1008 | 1080 | 1167 | 1170 |
| 14 | 36.11 | 168.38 | 6.50 | 132.70 | 1030 | 1013 | 1087 | 1164 | 1174 |
| 15 | 95.89 | 175.32 | 45.52 | 33.09 | 1040 | 1018 | 1093 | 1174 | 1179 |
| 16 | 22.70 | 0.25 | 99.88 | 119.98 | 1049 | 1025 | 1102 | 1175 | 1177 |
| 17 | 9.67 | 0.20 | 7.57 | 141.95 | 1058 | 1030 | 1104 | 1178 | 1180 |
| 18 | 66.60 | 0.24 | 101.98 | 50.79 | 1060 | 1037 | 1114 | 1185 | 1186 |
| 19 | 82.91 | 0.26 | 2.07 | 56.08 | 1070 | 1043 | 1116 | 1189 | 1195 |
| 20 | 31.71 | 0.28 | 3.59 | 51.10 | 1078 | 1049 | 1125 | 1191 | 1195 |
| 21 | 33.25 | 0.29 | 6.76 | 127.39 | 1088 | 1059 | 1135 | 1191 | 1179 |
| 22 | 31.60 | 0.23 | 7.13 | 16.16 | 1093 | 1065 | 1137 | 1200 | 1201 |
| 23 | 18.52 | 0.28 | 12.21 | 95.85 | 1100 | 1072 | 1144 | 1202 | 1185 |

batch 02

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|------|------|------|------|------|
| 0 | 1864.00 | 6678.00 | 6115.00 | 4068.00 | 806 | 569 | 689 | 938 | 1099 |
| 1 | 188.30 | 6073.00 | 5635.00 | 3322.00 | 810 | 563 | 682 | 1003 | 1124 |
| 2 | 117.41 | 6035.00 | 4814.00 | 1078.00 | 814 | 567 | 698 | 1033 | 1117 |
| 3 | 229.30 | 6003.00 | 3443.00 | 552.60 | 818 | 578 | 727 | 1052 | 1135 |
| 4 | 57.94 | 5452.00 | 4083.00 | 53.66 | 820 | 591 | 759 | 1067 | 1133 |
| 5 | 52.66 | 5289.00 | 679.50 | 15.18 | 823 | 603 | 782 | 1076 | 1141 |
| 6 | 191.27 | 5135.00 | 4398.00 | 45.23 | 826 | 619 | 803 | 1090 | 1138 |
| 7 | 87.79 | 5299.00 | 2995.00 | 51.86 | 829 | 634 | 823 | 1098 | 1150 |
| 8 | 165.80 | 5162.00 | 3706.00 | 58.95 | 834 | 654 | 847 | 1102 | 1150 |
| 9 | 69.08 | 4886.00 | 47.31 | 34.06 | 839 | 672 | 867 | 1107 | 1147 |
| 10 | 38.32 | 4782.00 | 107.12 | 19.30 | 844 | 693 | 888 | 1114 | 1150 |
| 11 | 126.77 | 4927.00 | 52.74 | 77.88 | 850 | 713 | 906 | 1123 | 1162 |
| 12 | 111.05 | 4805.00 | 96.50 | 41.80 | 855 | 732 | 921 | 1121 | 1151 |
| 13 | 61.06 | 4262.00 | 2069.00 | 45.92 | 860 | 750 | 935 | 1130 | 1147 |
| 14 | 50.87 | 3650.00 | 538.50 | 64.50 | 866 | 768 | 951 | 1134 | 1166 |
| 15 | 85.70 | 1841.00 | 191.90 | 77.62 | 872 | 786 | 966 | 1133 | 1161 |
| 16 | 44.28 | 1090.00 | 64.76 | 17.59 | 879 | 803 | 974 | 1136 | 1156 |
| 17 | 67.04 | 497.80 | 22.95 | 15.75 | 886 | 822 | 990 | 1135 | 1174 |
| 18 | 75.90 | 226.00 | 117.93 | 76.51 | 893 | 840 | 1005 | 1144 | 1184 |
| 19 | 67.19 | 88.03 | 27.44 | 33.82 | 900 | 860 | 1023 | 1146 | 1176 |
| 20 | 53.38 | 111.04 | 24.79 | 71.68 | 908 | 878 | 1034 | 1147 | 1174 |
| 21 | 189.45 | 122.58 | 31.42 | 5.59 | 919 | 899 | 1044 | 1156 | 1189 |
| 22 | 89.61 | 65.60 | 9.87 | 4.05 | 934 | 918 | 1053 | 1162 | 1183 |
| 23 | 2678.00 | 51.90 | 113.28 | 58.83 | 951 | 934 | 1065 | 1157 | 1190 |
| 24 | 1861.00 | 46.03 | 93.19 | 88.81 | 968 | 953 | 1070 | 1166 | 1182 |
| 25 | 2391.00 | 36.12 | 81.00 | 92.59 | 988 | 978 | 1076 | 1167 | 1197 |
| 26 | 2161.00 | 76.90 | 56.82 | 67.44 | 1004 | 996 | 1092 | 1167 | 1200 |
| 27 | 1903.00 | 36.69 | 91.42 | 64.93 | 1017 | 1022 | 1099 | 1166 | 1195 |
| 28 | 1933.00 | 80.00 | 177.25 | 107.23 | 1039 | 1040 | 1113 | 1175 | 1202 |
| 29 | 53.41 | 93.24 | 135.13 | 111.40 | 1051 | 1050 | 1115 | 1176 | 1198 |
| 30 | 185.47 | 96.38 | 97.38 | 41.83 | 1063 | 1063 | 1123 | 1180 | 1199 |
| 31 | 66.92 | 74.09 | 203.40 | 109.40 | 1074 | 1075 | 1126 | 1181 | 1193 |
| 32 | 55.87 | 88.35 | 167.74 | 112.31 | 1086 | 1082 | 1141 | 1191 | 1195 |
| 33 | 115.51 | 107.98 | 105.54 | 74.95 | 1094 | 1087 | 1144 | 1192 | 1197 |
| 34 | 151.60 | 61.79 | 116.52 | 112.54 | 1102 | 1099 | 1158 | 1199 | 1185 |
| 35 | 104.27 | 24.64 | 224.70 | 72.09 | 1111 | 1109 | 1163 | 1200 | 1202 |
| 36 | 172.56 | 196.00 | 44.99 | 11.67 | 1117 | 1115 | 1162 | 1197 | 1201 |

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|--------|---------|---------|---------|------|------|------|------|------|
| 0 | 779.60 | 8804.00 | 9312.00 | 4414.00 | 774 | 381 | 646 | 819 | 1094 |
| 1 | 551.30 | 7761.00 | 8947.00 | 4615.00 | 786 | 402 | 653 | 914 | 1111 |
| 2 | 445.30 | 7800.00 | 8448.00 | 4947.00 | 800 | 436 | 689 | 989 | 1133 |
| 3 | 296.70 | 7790.00 | 7930.00 | 75.84 | 815 | 475 | 726 | 1031 | 1138 |
| 4 | 281.70 | 7185.00 | 7756.00 | 62.36 | 833 | 525 | 782 | 1064 | 1151 |
| 5 | 204.90 | 7008.00 | 5641.00 | 95.17 | 839 | 544 | 805 | 1073 | 1152 |
| 6 | 244.40 | 7707.00 | 3360.00 | 30.34 | 846 | 569 | 840 | 1085 | 1156 |
| 7 | 188.00 | 6780.00 | 1567.00 | 66.83 | 853 | 592 | 869 | 1095 | 1160 |
| 8 | 86.47 | 7168.00 | 550.00 | 87.97 | 860 | 617 | 894 | 1111 | 1159 |
| 9 | 30.88 | 7065.00 | 537.40 | 29.68 | 865 | 634 | 914 | 1116 | 1161 |
| 10 | 74.35 | 6792.00 | 288.60 | 62.06 | 873 | 660 | 941 | 1123 | 1174 |
| 11 | 30.24 | 6877.00 | 338.50 | 63.52 | 878 | 677 | 957 | 1130 | 1171 |
| 12 | 29.95 | 6733.00 | 231.10 | 39.56 | 883 | 700 | 975 | 1133 | 1174 |
| 13 | 27.55 | 6351.00 | 212.90 | 56.05 | 891 | 725 | 997 | 1138 | 1179 |
| 14 | 37.24 | 6035.00 | 87.95 | 35.01 | 897 | 749 | 1017 | 1140 | 1179 |
| 15 | 53.09 | 5570.00 | 64.58 | 44.51 | 905 | 776 | 1039 | 1151 | 1179 |
| 16 | 221.30 | 5268.00 | 22.03 | 13.70 | 912 | 794 | 1057 | 1159 | 1184 |
| 17 | 219.50 | 4395.00 | 75.14 | 44.95 | 919 | 816 | 1069 | 1166 | 1186 |
| 18 | 147.29 | 3792.00 | 35.30 | 73.75 | 927 | 838 | 1075 | 1172 | 1192 |
| 19 | 215.80 | 2271.00 | 40.06 | 42.36 | 935 | 858 | 1096 | 1178 | 1186 |
| 20 | 236.50 | 1055.00 | 18.74 | 30.70 | 945 | 876 | 1095 | 1182 | 1189 |
| 21 | 204.80 | 421.40 | 98.02 | 20.92 | 952 | 892 | 1104 | 1183 | 1193 |
| 22 | 200.10 | 210.60 | 36.67 | 35.40 | 963 | 903 | 1112 | 1186 | 1196 |
| 23 | 187.14 | 119.84 | 34.41 | 41.66 | 976 | 921 | 1123 | 1189 | 1186 |
| 24 | 124.53 | 53.94 | 6.56 | 91.25 | 991 | 943 | 1134 | 1194 | 1194 |
| 25 | 10.84 | 52.60 | 12.71 | 40.32 | 1004 | 958 | 1143 | 1195 | 1193 |
| 26 | 20.62 | 75.62 | 80.77 | 42.85 | 1018 | 981 | 1150 | 1199 | 1197 |
| 27 | 12.01 | 16.38 | 62.16 | 11.19 | 1035 | 1004 | 1159 | 1203 | 1192 |
| 28 | 56.72 | 8.77 | 24.42 | 10.73 | 1052 | 1034 | 1170 | 1209 | 1200 |

Batch 04

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|-----|------|------|------|------|
| 0 | 9722.00 | 4002.00 | 9835.00 | 7678.00 | 585 | 883 | 529 | 723 | 1081 |
| 1 | 9566.00 | 4783.00 | 9496.00 | 4727.00 | 601 | 879 | 541 | 768 | 1103 |
| 2 | 9292.00 | 198.20 | 9413.00 | 428.50 | 623 | 881 | 567 | 830 | 1116 |
| 3 | 9005.00 | 265.90 | 9274.00 | 309.80 | 636 | 883 | 585 | 864 | 1122 |
| 4 | 9211.00 | 258.20 | 9343.00 | 227.10 | 646 | 884 | 600 | 889 | 1130 |
| 5 | 9072.00 | 184.70 | 9297.00 | 167.18 | 659 | 886 | 618 | 912 | 1133 |
| 6 | 9106.00 | 264.80 | 9271.00 | 144.09 | 672 | 888 | 637 | 938 | 1141 |
| 7 | 9034.00 | 255.10 | 9179.00 | 122.76 | 685 | 890 | 658 | 962 | 1140 |
| 8 | 8856.00 | 234.50 | 8985.00 | 119.57 | 704 | 893 | 688 | 989 | 1141 |
| 9 | 8712.00 | 212.40 | 8781.00 | 78.74 | 714 | 895 | 705 | 1003 | 1144 |
| 10 | 8602.00 | 168.41 | 8753.00 | 85.30 | 724 | 897 | 723 | 1016 | 1145 |
| 11 | 8561.00 | 133.19 | 8139.00 | 75.01 | 730 | 898 | 733 | 1022 | 1147 |
| 12 | 8331.00 | 211.40 | 6668.00 | 69.74 | 752 | 903 | 771 | 1042 | 1158 |
| 13 | 8160.00 | 138.21 | 3337.00 | 83.98 | 765 | 906 | 791 | 1052 | 1155 |
| 14 | 8051.00 | 142.43 | 1346.00 | 49.14 | 779 | 910 | 814 | 1060 | 1162 |
| 15 | 7608.00 | 100.23 | 594.20 | 66.24 | 794 | 913 | 838 | 1068 | 1168 |
| 16 | 7138.00 | 72.25 | 404.30 | 74.45 | 809 | 918 | 862 | 1074 | 1171 |
| 17 | 6874.00 | 222.10 | 245.60 | 98.65 | 823 | 923 | 882 | 1081 | 1173 |
| 18 | 6281.00 | 216.20 | 103.65 | 194.40 | 835 | 928 | 899 | 1084 | 1175 |
| 19 | 5876.00 | 208.00 | 154.29 | 202.90 | 849 | 935 | 919 | 1091 | 1179 |
| 20 | 5211.00 | 234.30 | 130.69 | 209.70 | 863 | 941 | 936 | 1100 | 1181 |
| 21 | 4197.00 | 192.00 | 112.36 | 262.40 | 875 | 947 | 949 | 1107 | 1185 |
| 22 | 3204.00 | 240.40 | 103.64 | 234.10 | 887 | 953 | 961 | 1106 | 1185 |
| 23 | 1786.00 | 233.40 | 168.71 | 224.50 | 901 | 961 | 976 | 1107 | 1187 |
| 24 | 995.50 | 195.30 | 105.93 | 202.70 | 913 | 968 | 989 | 1111 | 1189 |
| 25 | 669.70 | 180.30 | 97.71 | 200.80 | 930 | 978 | 1003 | 1118 | 1189 |
| 26 | 289.20 | 269.40 | 105.54 | 262.40 | 943 | 986 | 1015 | 1116 | 1189 |
| 27 | 288.50 | 202.80 | 153.39 | 273.20 | 959 | 992 | 1026 | 1119 | 1193 |
| 28 | 287.10 | 240.40 | 62.30 | 263.20 | 972 | 1002 | 1034 | 1125 | 1197 |
| 29 | 264.60 | 288.30 | 58.71 | 252.90 | 995 | 1009 | 1043 | 1129 | 1199 |
| 30 | 211.50 | 212.30 | 42.15 | 258.20 | 997 | 1017 | 1053 | 1134 | 1201 |

Batch 05

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|------|------|------|------|------|
| 0 | 9386.00 | 8478.00 | 9144.00 | 7860.00 | 564 | 372 | 419 | 576 | 1087 |
| 1 | 9104.00 | 8319.00 | 8613.00 | 1176.00 | 590 | 366 | 422 | 662 | 1096 |
| 2 | 8971.00 | 7858.00 | 8442.00 | 202.40 | 613 | 367 | 434 | 722 | 1111 |
| 3 | 8894.00 | 7753.00 | 8139.00 | 216.80 | 636 | 375 | 451 | 777 | 1113 |
| 4 | 8831.00 | 7745.00 | 8012.00 | 186.97 | 657 | 385 | 471 | 820 | 1118 |
| 5 | 8715.00 | 7684.00 | 7970.00 | 154.52 | 678 | 399 | 492 | 860 | 1126 |
| 6 | 8689.00 | 7671.00 | 7879.00 | 121.80 | 697 | 413 | 513 | 889 | 1132 |
| 7 | 8685.00 | 7351.00 | 7740.00 | 82.46 | 718 | 432 | 539 | 922 | 1133 |
| 8 | 8573.00 | 7201.00 | 7623.00 | 64.64 | 732 | 446 | 559 | 950 | 1140 |
| 9 | 8495.00 | 7073.00 | 7357.00 | 66.11 | 749 | 465 | 585 | 970 | 1141 |
| 10 | 8372.00 | 7007.00 | 7351.00 | 55.68 | 770 | 490 | 617 | 1001 | 1145 |
| 11 | 7938.00 | 6998.00 | 7031.00 | 42.42 | 783 | 511 | 643 | 1021 | 1151 |
| 12 | 8099.00 | 6982.00 | 6920.00 | 22.72 | 798 | 536 | 673 | 1040 | 1153 |
| 13 | 7997.00 | 6893.00 | 6403.00 | 45.64 | 807 | 552 | 694 | 1050 | 1153 |
| 14 | 7474.00 | 6853.00 | 6027.00 | 68.78 | 820 | 577 | 720 | 1065 | 1155 |
| 15 | 7164.00 | 6854.00 | 4313.00 | 68.26 | 832 | 598 | 745 | 1073 | 1159 |
| 16 | 6513.00 | 6641.00 | 2893.00 | 63.62 | 844 | 621 | 769 | 1077 | 1163 |
| 17 | 6032.00 | 6821.00 | 2446.00 | 64.77 | 857 | 646 | 795 | 1075 | 1166 |
| 18 | 6252.00 | 6672.00 | 1750.00 | 66.90 | 866 | 666 | 810 | 1060 | 1170 |
| 19 | 4778.00 | 6642.00 | 761.90 | 64.63 | 876 | 688 | 833 | 1075 | 1171 |
| 20 | 4437.00 | 6538.00 | 291.50 | 54.96 | 886 | 710 | 861 | 1096 | 1169 |
| 21 | 2483.00 | 6324.00 | 121.31 | 39.94 | 895 | 734 | 885 | 1108 | 1166 |
| 22 | 2138.00 | 6290.00 | 65.13 | 57.93 | 906 | 758 | 913 | 1115 | 1167 |
| 23 | 1425.00 | 6351.00 | 61.97 | 66.33 | 914 | 776 | 930 | 1122 | 1172 |
| 24 | 711.90 | 5891.00 | 101.93 | 45.59 | 921 | 792 | 941 | 1127 | 1171 |
| 25 | 514.90 | 5700.00 | 77.94 | 54.17 | 928 | 806 | 956 | 1132 | 1172 |
| 26 | 270.80 | 5785.00 | 79.30 | 75.68 | 936 | 824 | 968 | 1137 | 1176 |
| 27 | 250.10 | 5336.00 | 75.30 | 72.14 | 942 | 843 | 982 | 1141 | 1178 |
| 28 | 198.86 | 3517.00 | 44.93 | 66.81 | 952 | 858 | 996 | 1144 | 1181 |
| 29 | 156.70 | 1740.00 | 64.39 | 41.87 | 960 | 866 | 1007 | 1149 | 1182 |
| 30 | 142.08 | 858.60 | 55.49 | 76.13 | 969 | 881 | 1017 | 1140 | 1183 |
| 31 | 139.73 | 503.80 | 47.62 | 50.78 | 978 | 896 | 1021 | 1146 | 1185 |
| 32 | 63.02 | 310.60 | 52.73 | 56.99 | 983 | 915 | 1041 | 1161 | 1187 |
| 33 | 62.28 | 175.58 | 56.32 | 33.51 | 998 | 935 | 1051 | 1160 | 1194 |
| 34 | 46.80 | 149.59 | 37.71 | 34.90 | 1008 | 947 | 1063 | 1170 | 1191 |
| 35 | 54.97 | 102.00 | 46.44 | 33.20 | 1020 | 971 | 1073 | 1173 | 1193 |
| 36 | 40.47 | 67.67 | 37.90 | 41.83 | 1041 | 1012 | 1092 | 1181 | 1190 |

Batch 06

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|------|------|------|------|------|
| 0 | 9628.00 | 9096.00 | 8807.00 | 9268.00 | 520 | 372 | 504 | 573 | 1091 |
| 1 | 9210.00 | 8870.00 | 8589.00 | 9027.00 | 544 | 375 | 512 | 621 | 1106 |
| 2 | 8999.00 | 8431.00 | 8314.00 | 5464.00 | 575 | 392 | 526 | 675 | 1119 |
| 3 | 8944.00 | 8232.00 | 8274.00 | 696.60 | 599 | 406 | 538 | 709 | 1119 |
| 4 | 8826.00 | 8191.00 | 8269.00 | 445.90 | 626 | 425 | 554 | 744 | 1122 |
| 5 | 8794.00 | 7978.00 | 8052.00 | 319.90 | 645 | 440 | 566 | 767 | 1134 |
| 6 | 8774.00 | 7876.00 | 8218.00 | 307.60 | 670 | 466 | 587 | 809 | 1138 |
| 7 | 8687.00 | 7814.00 | 8102.00 | 283.50 | 689 | 488 | 604 | 848 | 1139 |
| 8 | 8578.00 | 7784.00 | 8116.00 | 281.70 | 709 | 511 | 625 | 885 | 1142 |
| 9 | 8400.00 | 7756.00 | 8173.00 | 225.30 | 726 | 535 | 645 | 917 | 1148 |
| 10 | 8082.00 | 7607.00 | 8092.00 | 180.48 | 745 | 559 | 669 | 949 | 1152 |
| 11 | 8069.00 | 7544.00 | 8093.00 | 137.36 | 763 | 582 | 690 | 967 | 1157 |
| 12 | 7898.00 | 7600.00 | 8143.00 | 111.59 | 780 | 607 | 715 | 982 | 1159 |
| 13 | 7653.00 | 7490.00 | 7850.00 | 109.92 | 794 | 626 | 735 | 986 | 1156 |
| 14 | 7542.00 | 7454.00 | 7444.00 | 93.11 | 807 | 644 | 752 | 999 | 1158 |
| 15 | 7385.00 | 7411.00 | 7183.00 | 78.51 | 822 | 668 | 777 | 1016 | 1159 |
| 16 | 7043.00 | 7489.00 | 6944.00 | 77.83 | 835 | 689 | 800 | 1031 | 1160 |
| 17 | 6870.00 | 7416.00 | 5931.00 | 67.72 | 847 | 715 | 823 | 1051 | 1166 |
| 18 | 6709.00 | 7545.00 | 4689.00 | 64.44 | 861 | 738 | 848 | 1072 | 1165 |
| 19 | 6680.00 | 7462.00 | 3032.00 | 66.76 | 871 | 760 | 871 | 1082 | 1170 |
| 20 | 6138.00 | 7347.00 | 839.70 | 72.73 | 888 | 791 | 901 | 1092 | 1169 |
| 21 | 5303.00 | 7338.00 | 624.60 | 57.06 | 895 | 803 | 914 | 1091 | 1166 |
| 22 | 4150.00 | 7191.00 | 461.20 | 69.86 | 906 | 816 | 930 | 1092 | 1171 |
| 23 | 2641.00 | 6986.00 | 239.00 | 61.24 | 915 | 832 | 951 | 1106 | 1176 |
| 24 | 2071.00 | 6903.00 | 234.10 | 60.44 | 930 | 848 | 968 | 1110 | 1175 |
| 25 | 1423.00 | 6617.00 | 203.50 | 75.15 | 945 | 866 | 985 | 1120 | 1178 |
| 26 | 801.70 | 6416.00 | 182.00 | 71.51 | 956 | 879 | 996 | 1123 | 1181 |
| 27 | 468.40 | 5902.00 | 140.52 | 76.91 | 970 | 895 | 1011 | 1130 | 1177 |
| 28 | 336.30 | 5723.00 | 121.77 | 63.20 | 980 | 908 | 1025 | 1134 | 1184 |
| 29 | 285.30 | 5332.00 | 136.01 | 71.05 | 993 | 921 | 1045 | 1140 | 1185 |
| 30 | 206.00 | 4120.00 | 96.56 | 57.75 | 1002 | 935 | 1058 | 1150 | 1190 |
| 31 | 228.10 | 2323.00 | 85.80 | 69.86 | 1016 | 954 | 1068 | 1152 | 1184 |
| 32 | 215.80 | 952.20 | 73.91 | 77.53 | 1033 | 975 | 1081 | 1159 | 1188 |
| 33 | 91.74 | 432.90 | 51.49 | 52.25 | 1043 | 999 | 1094 | 1160 | 1192 |
| 34 | 84.87 | 245.30 | 44.06 | 43.08 | 1057 | 1037 | 1113 | 1169 | 1195 |
| 35 | 76.61 | 199.50 | 48.65 | 46.48 | 1069 | 1064 | 1124 | 1178 | 1195 |
| 36 | 51.78 | 181.70 | 55.37 | 42.70 | 1079 | 1085 | 1140 | 1185 | 1195 |
| 37 | 63.30 | 185.80 | 54.88 | 38.02 | 1094 | 1110 | 1149 | 1193 | 1195 |
| 38 | 62.22 | 140.18 | 50.82 | 23.04 | 1103 | 1127 | 1163 | 1200 | 1196 |
| 39 | 64.46 | 60.52 | 32.86 | 30.31 | 1111 | 1139 | 1174 | 1206 | 1193 |



Batch 07

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|------|------|------|------|------|
| 0 | 9729.00 | 9342.00 | 8972.00 | 9155.00 | 723 | 376 | 447 | 531 | 1095 |
| 1 | 9549.00 | 9165.00 | 8730.00 | 9087.00 | 739 | 383 | 443 | 592 | 1112 |
| 2 | 9354.00 | 8938.00 | 8600.00 | 8670.00 | 750 | 391 | 446 | 645 | 1120 |
| 3 | 9289.00 | 8838.00 | 8471.00 | 7881.00 | 764 | 404 | 455 | 699 | 1129 |
| 4 | 9665.00 | 8772.00 | 8400.00 | 699.50 | 780 | 421 | 469 | 758 | 1137 |
| 5 | 9609.00 | 8725.00 | 8404.00 | 368.40 | 789 | 432 | 480 | 784 | 1144 |
| 6 | 9713.00 | 8529.00 | 8469.00 | 83.84 | 802 | 449 | 496 | 829 | 1150 |
| 7 | 9710.00 | 8444.00 | 8637.00 | 62.21 | 810 | 460 | 510 | 855 | 1152 |
| 8 | 9492.00 | 8354.00 | 8621.00 | 82.21 | 819 | 473 | 524 | 879 | 1153 |
| 9 | 9305.00 | 8221.00 | 7968.00 | 59.39 | 829 | 490 | 544 | 911 | 1155 |
| 10 | 9352.00 | 8254.00 | 7527.00 | 55.57 | 840 | 511 | 569 | 943 | 1161 |
| 11 | 9279.00 | 8251.00 | 7446.00 | 74.02 | 846 | 525 | 587 | 965 | 1166 |
| 12 | 9363.00 | 8118.00 | 7255.00 | 51.19 | 853 | 539 | 605 | 984 | 1169 |
| 13 | 9200.00 | 7975.00 | 7215.00 | 68.82 | 858 | 552 | 619 | 995 | 1169 |
| 14 | 9122.00 | 7656.00 | 6803.00 | 87.31 | 865 | 569 | 641 | 1015 | 1175 |
| 15 | 9077.00 | 7595.00 | 6786.00 | 47.85 | 872 | 587 | 665 | 1031 | 1175 |
| 16 | 8798.00 | 7495.00 | 6486.00 | 80.27 | 876 | 602 | 682 | 1041 | 1174 |
| 17 | 8732.00 | 7344.00 | 5734.00 | 78.06 | 882 | 622 | 710 | 1061 | 1179 |
| 18 | 8561.00 | 7248.00 | 5295.00 | 93.43 | 886 | 636 | 726 | 1066 | 1182 |
| 19 | 8310.00 | 7266.00 | 4731.00 | 61.51 | 893 | 657 | 751 | 1079 | 1180 |
| 20 | 8038.00 | 7218.00 | 2631.00 | 62.92 | 899 | 675 | 774 | 1093 | 1180 |
| 21 | 7515.00 | 6820.00 | 1616.60 | 95.05 | 905 | 697 | 805 | 1101 | 1184 |
| 22 | 7158.00 | 6724.00 | 560.50 | 88.15 | 909 | 705 | 818 | 1107 | 1184 |
| 23 | 6703.00 | 6502.00 | 166.31 | 84.45 | 916 | 728 | 838 | 1114 | 1188 |
| 24 | 6243.00 | 6111.00 | 112.84 | 66.48 | 922 | 742 | 856 | 1118 | 1189 |
| 25 | 5474.00 | 5767.00 | 82.11 | 79.68 | 929 | 759 | 876 | 1132 | 1195 |
| 26 | 4826.00 | 5644.00 | 84.05 | 53.80 | 935 | 775 | 894 | 1139 | 1196 |
| 27 | 4111.00 | 5576.00 | 83.32 | 69.56 | 942 | 790 | 914 | 1146 | 1195 |
| 28 | 3245.00 | 5570.00 | 79.24 | 75.75 | 949 | 806 | 932 | 1153 | 1196 |
| 29 | 2349.00 | 4948.00 | 62.20 | 55.53 | 956 | 824 | 951 | 1161 | 1197 |
| 30 | 1389.00 | 4642.00 | 59.06 | 50.44 | 964 | 840 | 967 | 1166 | 1201 |
| 31 | 834.60 | 4418.00 | 58.05 | 37.48 | 974 | 857 | 984 | 1172 | 1203 |
| 32 | 489.20 | 3574.00 | 69.44 | 45.12 | 982 | 868 | 995 | 1176 | 1202 |
| 33 | 192.00 | 2340.00 | 72.51 | 37.83 | 991 | 881 | 1011 | 1187 | 1202 |
| 34 | 223.30 | 1169.00 | 69.92 | 35.44 | 1006 | 912 | 1031 | 1198 | 1197 |
| 35 | 168.06 | 654.90 | 58.87 | 20.74 | 1016 | 932 | 1046 | 1199 | 1204 |
| 36 | 108.37 | 135.86 | 51.50 | 32.69 | 1026 | 954 | 1063 | 1207 | 1206 |
| 37 | 89.16 | 75.24 | 70.60 | 24.98 | 1042 | 997 | 1082 | 1221 | 1211 |
| 38 | 69.29 | 54.75 | 54.07 | 14.05 | 1058 | 1031 | 1096 | 1230 | 1214 |

Batch 08

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|------|-----|------|------|------|
| 0 | 9825.00 | 8916.00 | 9155.00 | 7315.00 | 484 | 336 | 482 | 642 | 1065 |
| 1 | 9352.00 | 8528.00 | 8720.00 | 6686.00 | 490 | 338 | 484 | 713 | 1076 |
| 2 | 9341.00 | 8400.00 | 8434.00 | 461.10 | 505 | 349 | 505 | 809 | 1108 |
| 3 | 9231.00 | 8376.00 | 8514.00 | 196.13 | 524 | 367 | 535 | 879 | 1115 |
| 4 | 9089.00 | 8095.00 | 8228.00 | 116.80 | 536 | 379 | 553 | 916 | 1126 |
| 5 | 8826.00 | 8187.00 | 8200.00 | 130.97 | 547 | 389 | 569 | 938 | 1127 |
| 6 | 8725.00 | 7977.00 | 8245.00 | 74.65 | 562 | 406 | 594 | 973 | 1137 |
| 7 | 8624.00 | 7889.00 | 7673.00 | 60.63 | 578 | 425 | 623 | 1003 | 1135 |
| 8 | 8557.00 | 7912.00 | 7423.00 | 42.16 | 600 | 453 | 663 | 1036 | 1139 |
| 9 | 8479.00 | 7944.00 | 7351.00 | 50.32 | 615 | 472 | 689 | 1054 | 1138 |
| 10 | 8448.00 | 7922.00 | 7135.00 | 57.53 | 633 | 498 | 721 | 1070 | 1146 |
| 11 | 8530.00 | 7831.00 | 6583.00 | 62.54 | 648 | 518 | 748 | 1087 | 1149 |
| 12 | 8535.00 | 7985.00 | 5628.00 | 44.21 | 667 | 547 | 783 | 1101 | 1145 |
| 13 | 8392.00 | 7894.00 | 1949.00 | 50.64 | 683 | 571 | 813 | 1111 | 1146 |
| 14 | 8124.00 | 7929.00 | 631.00 | 48.81 | 698 | 597 | 844 | 1123 | 1154 |
| 15 | 7910.00 | 7849.00 | 253.20 | 58.99 | 719 | 626 | 871 | 1135 | 1155 |
| 16 | 7826.00 | 7518.00 | 149.87 | 43.81 | 730 | 644 | 888 | 1141 | 1157 |
| 17 | 7825.00 | 7626.00 | 73.10 | 49.08 | 745 | 669 | 911 | 1144 | 1160 |
| 18 | 7560.00 | 7592.00 | 62.92 | 43.76 | 763 | 696 | 932 | 1153 | 1161 |
| 19 | 7471.00 | 7536.00 | 42.79 | 32.77 | 783 | 723 | 957 | 1161 | 1164 |
| 20 | 7283.00 | 7243.00 | 43.21 | 39.13 | 800 | 746 | 975 | 1167 | 1163 |
| 21 | 7034.00 | 7152.00 | 27.92 | 31.59 | 818 | 774 | 991 | 1179 | 1164 |
| 22 | 6804.00 | 6655.00 | 25.13 | 40.96 | 833 | 793 | 1004 | 1179 | 1166 |
| 23 | 6192.00 | 6182.00 | 19.14 | 32.27 | 850 | 816 | 1022 | 1183 | 1172 |
| 24 | 5514.00 | 5527.00 | 22.44 | 29.46 | 862 | 833 | 1034 | 1185 | 1172 |
| 25 | 4960.00 | 4158.00 | 24.13 | 24.77 | 880 | 861 | 1058 | 1200 | 1176 |
| 26 | 4168.00 | 2088.00 | 19.77 | 18.87 | 898 | 885 | 1076 | 1215 | 1178 |
| 27 | 3423.00 | 1031.00 | 19.17 | 16.13 | 913 | 899 | 1086 | 1219 | 1178 |
| 28 | 2434.00 | 485.30 | 19.77 | 17.54 | 935 | 914 | 1102 | 1225 | 1176 |
| 29 | 862.30 | 122.55 | 22.77 | 16.49 | 953 | 930 | 1116 | 1228 | 1176 |
| 30 | 301.30 | 61.48 | 20.39 | 27.15 | 977 | 945 | 1129 | 1236 | 1179 |
| 31 | 155.59 | 32.92 | 23.26 | 28.83 | 1005 | 965 | 1139 | 1237 | 1182 |
| 32 | 48.76 | 43.83 | 11.60 | 17.24 | 1032 | 986 | 1156 | 1241 | 1182 |

Batch 09

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|-----|-----|-----|------|------|
| 0 | 9504.00 | 8520.00 | 8593.00 | 9357.00 | 475 | 373 | 409 | 543 | 1069 |
| 1 | 9348.00 | 7021.00 | 8351.00 | 9187.00 | 489 | 375 | 408 | 619 | 1085 |
| 2 | 9306.00 | 5529.00 | 8229.00 | 8704.00 | 511 | 378 | 426 | 709 | 1092 |
| 3 | 9234.00 | 650.47 | 8066.00 | 7701.00 | 522 | 383 | 411 | 756 | 1102 |
| 4 | 9278.00 | 315.84 | 7886.00 | 932.20 | 539 | 395 | 468 | 821 | 1109 |
| 5 | 9105.00 | 189.21 | 7554.00 | 228.00 | 553 | 407 | 493 | 867 | 1109 |
| 6 | 9007.00 | 116.50 | 7528.00 | 145.14 | 570 | 421 | 518 | 904 | 1112 |
| 7 | 9003.00 | 98.89 | 7482.00 | 112.58 | 585 | 434 | 542 | 933 | 1114 |
| 8 | 8844.00 | 66.78 | 7314.00 | 110.90 | 600 | 451 | 571 | 960 | 1117 |
| 9 | 8753.00 | 62.21 | 6973.00 | 105.50 | 612 | 467 | 592 | 982 | 1116 |
| 10 | 8571.00 | 68.29 | 6750.00 | 104.65 | 625 | 484 | 616 | 999 | 1121 |
| 11 | 8411.00 | 61.16 | 6817.00 | 82.91 | 637 | 502 | 641 | 1017 | 1124 |
| 12 | 8304.00 | 77.75 | 6764.00 | 81.80 | 649 | 519 | 664 | 1026 | 1126 |
| 13 | 8189.00 | 79.58 | 6815.00 | 76.55 | 659 | 536 | 688 | 1036 | 1132 |
| 14 | 8203.00 | 69.25 | 6812.00 | 64.08 | 671 | 555 | 710 | 1048 | 1130 |
| 15 | 8181.00 | 72.12 | 6898.00 | 70.67 | 684 | 576 | 727 | 1052 | 1133 |
| 16 | 7848.00 | 60.65 | 6276.00 | 54.45 | 694 | 590 | 749 | 1064 | 1131 |
| 17 | 7839.00 | 63.35 | 3604.00 | 55.26 | 711 | 618 | 777 | 1070 | 1133 |
| 18 | 7899.00 | 66.14 | 1925.70 | 34.11 | 719 | 630 | 790 | 1070 | 1133 |
| 19 | 8051.00 | 67.58 | 691.60 | 23.34 | 725 | 648 | 806 | 1076 | 1138 |
| 20 | 8041.00 | 50.32 | 247.40 | 29.51 | 733 | 664 | 820 | 1078 | 1139 |
| 21 | 8083.00 | 55.23 | 120.75 | 32.05 | 741 | 679 | 836 | 1077 | 1138 |
| 22 | 7925.00 | 58.78 | 123.27 | 30.66 | 750 | 696 | 851 | 1076 | 1135 |
| 23 | 7894.00 | 47.47 | 104.89 | 22.76 | 758 | 716 | 865 | 1078 | 1134 |
| 24 | 7712.00 | 52.69 | 79.17 | 23.43 | 772 | 739 | 887 | 1085 | 1136 |
| 25 | 7824.00 | 55.29 | 78.13 | 27.30 | 784 | 757 | 906 | 1089 | 1132 |
| 26 | 7831.00 | 47.15 | 68.22 | 30.48 | 788 | 764 | 911 | 1086 | 1133 |
| 27 | 7594.00 | 50.55 | 62.66 | 23.21 | 796 | 774 | 919 | 1086 | 1136 |
| 28 | 7508.00 | 41.14 | 43.89 | 22.37 | 806 | 787 | 930 | 1087 | 1132 |
| 29 | 7360.00 | 38.98 | 49.45 | 28.27 | 811 | 798 | 940 | 1089 | 1131 |
| 30 | 6951.00 | 37.62 | 58.28 | 33.09 | 815 | 807 | 944 | 1087 | 1132 |
| 31 | 6876.00 | 33.21 | 37.21 | 32.21 | 824 | 817 | 949 | 1086 | 1133 |
| 32 | 6327.00 | 42.19 | 34.25 | 23.49 | 829 | 830 | 957 | 1090 | 1128 |
| 33 | 5960.00 | 47.25 | 21.05 | 28.36 | 836 | 844 | 964 | 1090 | 1129 |
| 34 | 6309.00 | 34.34 | 19.20 | 27.60 | 843 | 854 | 970 | 1090 | 1122 |
| 35 | 5211.00 | 35.56 | 13.25 | 24.02 | 848 | 865 | 976 | 1093 | 1127 |
| 36 | 4852.00 | 30.01 | 16.27 | 13.37 | 852 | 868 | 980 | 1097 | 1128 |
| 37 | 3893.00 | 35.44 | 15.35 | 11.00 | 857 | 872 | 981 | 1093 | 1128 |
| 38 | 3327.00 | 32.67 | 15.52 | 11.65 | 865 | 887 | 985 | 1091 | 1127 |

Batch 09 (continue)

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|-------|-------|-------|-----|-----|------|------|------|
| 39 | 1693.70 | 28.47 | 9.98 | 8.78 | 877 | 909 | 999 | 1096 | 1125 |
| 40 | 890.90 | 24.56 | 10.42 | 12.14 | 883 | 918 | 1005 | 1096 | 1127 |
| 41 | 377.20 | 20.19 | 10.41 | 9.32 | 893 | 926 | 1007 | 1097 | 1127 |
| 42 | 98.79 | 18.98 | 9.85 | 9.03 | 904 | 941 | 1014 | 1094 | 1130 |



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| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|------|-----|------|------|------|
| 0 | 9027.00 | 9412.00 | 8539.00 | 8114.00 | 821 | 403 | 402 | 553 | 1152 |
| 1 | 8846.00 | 9198.00 | 7824.00 | 7313.00 | 853 | 409 | 417 | 591 | 1165 |
| 2 | 8449.00 | 8999.00 | 7479.00 | 5815.00 | 875 | 423 | 436 | 643 | 1174 |
| 3 | 8532.00 | 8885.00 | 7181.00 | 1070.70 | 893 | 442 | 460 | 701 | 1183 |
| 4 | 8468.00 | 8749.00 | 7170.00 | 238.10 | 900 | 453 | 476 | 733 | 1153 |
| 5 | 8459.00 | 8560.00 | 7251.00 | 73.58 | 909 | 469 | 498 | 773 | 1153 |
| 6 | 8539.00 | 8618.00 | 7259.00 | 49.54 | 917 | 483 | 512 | 801 | 1159 |
| 7 | 8267.00 | 8297.00 | 6863.00 | 38.33 | 921 | 498 | 534 | 830 | 1160 |
| 8 | 7838.00 | 7306.00 | 6833.00 | 26.36 | 923 | 515 | 561 | 863 | 1165 |
| 9 | 7780.00 | 6642.00 | 6636.00 | 28.30 | 927 | 532 | 585 | 889 | 1172 |
| 10 | 7320.00 | 6578.00 | 6568.00 | 10.67 | 931 | 551 | 613 | 913 | 1175 |
| 11 | 7021.00 | 6236.00 | 6500.00 | 14.24 | 931 | 566 | 634 | 935 | 1175 |
| 12 | 6982.00 | 6237.00 | 5772.00 | 20.44 | 932 | 599 | 681 | 965 | 1183 |
| 13 | 6565.00 | 6205.00 | 5329.00 | 12.87 | 931 | 615 | 703 | 974 | 1180 |
| 14 | 6134.00 | 6897.00 | 5030.00 | 7.35 | 930 | 634 | 725 | 979 | 1183 |
| 15 | 5844.00 | 6916.00 | 5429.00 | 20.80 | 929 | 651 | 740 | 976 | 1185 |
| 16 | 5488.00 | 7163.00 | 5247.00 | 20.82 | 933 | 674 | 761 | 981 | 1189 |
| 17 | 5127.00 | 7092.00 | 5027.00 | 20.83 | 931 | 686 | 778 | 986 | 1189 |
| 18 | 4698.00 | 7161.00 | 3224.00 | 7.74 | 933 | 702 | 796 | 997 | 1191 |
| 19 | 4639.00 | 6967.00 | 2003.00 | 12.28 | 935 | 719 | 815 | 1003 | 1192 |
| 20 | 4080.00 | 6999.00 | 995.20 | 20.54 | 935 | 733 | 829 | 1008 | 1194 |
| 21 | 4095.00 | 6875.00 | 320.50 | 16.49 | 938 | 747 | 848 | 1018 | 1197 |
| 22 | 3291.00 | 6684.00 | 134.56 | 9.35 | 940 | 761 | 864 | 1023 | 1200 |
| 23 | 2426.00 | 6503.00 | 68.30 | 16.63 | 944 | 778 | 883 | 1024 | 1203 |
| 24 | 1621.10 | 6159.00 | 75.11 | 12.02 | 946 | 789 | 895 | 1030 | 1201 |
| 25 | 1249.00 | 5742.00 | 61.05 | 15.96 | 942 | 800 | 908 | 1034 | 1198 |
| 26 | 1131.70 | 5153.00 | 44.30 | 17.06 | 943 | 813 | 920 | 1040 | 1200 |
| 27 | 759.90 | 4775.00 | 52.44 | 18.82 | 945 | 825 | 928 | 1037 | 1201 |
| 28 | 423.90 | 3517.00 | 21.66 | 10.24 | 949 | 840 | 939 | 1035 | 1203 |
| 29 | 328.60 | 1561.20 | 26.53 | 20.82 | 954 | 855 | 948 | 1033 | 1206 |
| 30 | 114.78 | 744.10 | 21.83 | 28.57 | 961 | 867 | 957 | 1046 | 1210 |
| 31 | 64.23 | 318.80 | 29.66 | 16.16 | 968 | 877 | 965 | 1050 | 1212 |
| 32 | 48.70 | 220.20 | 34.21 | 9.04 | 975 | 889 | 974 | 1049 | 1215 |
| 33 | 36.92 | 206.80 | 38.02 | 12.50 | 979 | 903 | 986 | 1056 | 1215 |
| 34 | 41.47 | 170.65 | 39.36 | 23.49 | 990 | 920 | 993 | 1058 | 1217 |
| 35 | 35.21 | 136.12 | 30.12 | 22.76 | 998 | 933 | 1001 | 1063 | 1220 |
| 36 | 26.50 | 46.70 | 36.98 | 22.72 | 1003 | 946 | 1004 | 1062 | 1217 |
| 37 | 35.07 | 44.45 | 23.80 | 28.29 | 1014 | 963 | 1007 | 1062 | 1219 |

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|------|------|------|------|------|
| 0 | 8476.00 | 8640.00 | 8145.00 | 7781.00 | 616 | 424 | 463 | 612 | 1077 |
| 1 | 7978.00 | 8201.00 | 7661.00 | 6545.00 | 630 | 418 | 458 | 638 | 1097 |
| 2 | 7952.00 | 8423.00 | 7223.00 | 2489.00 | 644 | 418 | 463 | 685 | 1110 |
| 3 | 7706.00 | 8582.00 | 6645.00 | 540.40 | 665 | 424 | 471 | 719 | 1113 |
| 4 | 7674.00 | 8498.00 | 5762.00 | 209.60 | 667 | 432 | 486 | 767 | 1126 |
| 5 | 7287.00 | 8214.00 | 5534.00 | 199.00 | 676 | 440 | 498 | 800 | 1132 |
| 6 | 7122.00 | 8198.00 | 5647.00 | 202.80 | 691 | 456 | 517 | 840 | 1139 |
| 7 | 6909.00 | 8004.00 | 5459.00 | 160.58 | 700 | 466 | 537 | 866 | 1145 |
| 8 | 6823.00 | 8088.00 | 5396.00 | 157.38 | 714 | 486 | 564 | 896 | 1150 |
| 9 | 6695.00 | 8079.00 | 5371.00 | 148.89 | 723 | 501 | 585 | 917 | 1156 |
| 10 | 6541.00 | 7976.00 | 5232.00 | 135.08 | 732 | 521 | 610 | 939 | 1155 |
| 11 | 6228.00 | 7897.00 | 4553.00 | 122.08 | 744 | 546 | 639 | 960 | 1160 |
| 12 | 6208.00 | 7834.00 | 4351.00 | 121.83 | 750 | 560 | 658 | 972 | 1160 |
| 13 | 6210.00 | 7963.00 | 3773.00 | 85.04 | 762 | 586 | 691 | 993 | 1160 |
| 14 | 6368.00 | 7779.00 | 3498.00 | 94.61 | 767 | 600 | 711 | 998 | 1158 |
| 15 | 6314.00 | 7772.00 | 1820.00 | 92.47 | 786 | 629 | 742 | 1013 | 1162 |
| 16 | 6196.00 | 7905.00 | 629.20 | 82.23 | 789 | 648 | 765 | 1030 | 1164 |
| 17 | 6098.00 | 7661.00 | 151.98 | 67.77 | 802 | 679 | 793 | 1045 | 1168 |
| 18 | 5958.00 | 7565.00 | 122.07 | 58.01 | 813 | 700 | 818 | 1053 | 1171 |
| 19 | 5821.00 | 7353.00 | 136.59 | 66.90 | 824 | 724 | 846 | 1064 | 1174 |
| 20 | 5726.00 | 7032.00 | 121.73 | 52.29 | 831 | 737 | 862 | 1067 | 1174 |
| 21 | 5874.00 | 6007.00 | 106.46 | 48.29 | 841 | 760 | 883 | 1071 | 1174 |
| 22 | 5260.00 | 5295.00 | 109.70 | 62.64 | 850 | 776 | 902 | 1074 | 1177 |
| 23 | 4891.00 | 2736.00 | 97.70 | 56.82 | 859 | 796 | 920 | 1077 | 1175 |
| 24 | 4377.00 | 880.20 | 107.30 | 71.53 | 872 | 815 | 935 | 1080 | 1175 |
| 25 | 3100.00 | 413.20 | 79.50 | 69.93 | 886 | 837 | 960 | 1083 | 1183 |
| 26 | 985.30 | 281.10 | 72.91 | 76.23 | 902 | 863 | 978 | 1086 | 1181 |
| 27 | 422.80 | 199.76 | 48.91 | 64.35 | 918 | 881 | 989 | 1090 | 1185 |
| 28 | 229.50 | 150.16 | 53.51 | 45.14 | 933 | 900 | 994 | 1093 | 1189 |
| 29 | 139.65 | 146.60 | 58.08 | 52.44 | 940 | 909 | 1004 | 1096 | 1185 |
| 30 | 89.30 | 137.16 | 49.72 | 56.20 | 953 | 928 | 1015 | 1098 | 1190 |
| 31 | 58.62 | 107.00 | 21.19 | 34.89 | 963 | 938 | 1024 | 1100 | 1187 |
| 32 | 37.39 | 56.30 | 18.50 | 35.68 | 974 | 960 | 1033 | 1103 | 1188 |
| 33 | 29.19 | 46.38 | 19.76 | 32.61 | 989 | 988 | 1045 | 1106 | 1196 |
| 34 | 34.66 | 58.21 | 10.62 | 26.57 | 1000 | 998 | 1049 | 1109 | 1197 |
| 35 | 27.31 | 30.66 | 7.43 | 19.48 | 1013 | 1019 | 1058 | 1112 | 1197 |

Batch 12

| t | R1 | R2 | R3 | R4 | T1 | T2 | T3 | T4 | T5 |
|----|---------|---------|---------|---------|-----|-----|------|------|------|
| 0 | 9284.00 | 9354.00 | 8442.00 | 8393.00 | 627 | 390 | 490 | 807 | 1063 |
| 1 | 9206.00 | 8881.00 | 8121.00 | 5147.00 | 647 | 399 | 504 | 875 | 1074 |
| 2 | 8789.00 | 8862.00 | 7992.00 | 141.08 | 667 | 414 | 533 | 918 | 1085 |
| 3 | 8748.00 | 8809.00 | 7729.00 | 129.56 | 684 | 431 | 567 | 968 | 1091 |
| 4 | 8617.00 | 8850.00 | 7511.00 | 127.70 | 705 | 456 | 610 | 1015 | 1101 |
| 5 | 8431.00 | 8933.00 | 6963.00 | 137.38 | 723 | 480 | 645 | 1036 | 1106 |
| 6 | 7950.00 | 8955.00 | 5692.00 | 106.63 | 740 | 502 | 676 | 1048 | 1110 |
| 7 | 7881.00 | 8918.00 | 3694.00 | 95.18 | 753 | 523 | 701 | 1058 | 1111 |
| 8 | 7683.00 | 8913.00 | 1369.70 | 91.38 | 767 | 548 | 734 | 1063 | 1118 |
| 9 | 7418.00 | 8864.00 | 455.30 | 103.60 | 778 | 574 | 761 | 1072 | 1119 |
| 10 | 7294.00 | 8837.00 | 291.70 | 95.13 | 789 | 598 | 787 | 1078 | 1118 |
| 11 | 7030.00 | 8861.00 | 227.20 | 84.96 | 801 | 623 | 813 | 1086 | 1118 |
| 12 | 6730.00 | 8761.00 | 186.00 | 91.45 | 811 | 648 | 835 | 1083 | 1118 |
| 13 | 6335.00 | 8684.00 | 149.64 | 73.51 | 819 | 666 | 853 | 1090 | 1117 |
| 14 | 6334.00 | 8624.00 | 172.26 | 76.62 | 830 | 693 | 872 | 1086 | 1118 |
| 15 | 5931.00 | 8254.00 | 120.98 | 82.06 | 841 | 719 | 888 | 1083 | 1114 |
| 16 | 5292.00 | 7986.00 | 145.44 | 64.21 | 848 | 736 | 901 | 1083 | 1115 |
| 17 | 5150.00 | 7849.00 | 127.63 | 59.48 | 854 | 752 | 909 | 1072 | 1114 |
| 18 | 4518.00 | 7580.00 | 107.28 | 50.19 | 862 | 769 | 922 | 1077 | 1114 |
| 19 | 4003.00 | 7128.00 | 91.76 | 64.02 | 870 | 786 | 934 | 1077 | 1111 |
| 20 | 3346.00 | 6447.00 | 75.60 | 54.29 | 877 | 802 | 946 | 1079 | 1106 |
| 21 | 2820.00 | 5462.00 | 52.81 | 54.41 | 883 | 817 | 955 | 1076 | 1110 |
| 22 | 1984.00 | 4092.00 | 55.95 | 49.01 | 890 | 832 | 963 | 1075 | 1111 |
| 23 | 1478.70 | 2369.00 | 48.17 | 45.21 | 898 | 844 | 966 | 1070 | 1108 |
| 24 | 1067.70 | 1160.90 | 46.93 | 36.09 | 906 | 858 | 975 | 1071 | 1104 |
| 25 | 583.60 | 799.20 | 39.26 | 37.47 | 911 | 867 | 979 | 1070 | 1106 |
| 26 | 207.90 | 425.50 | 36.67 | 27.78 | 922 | 881 | 984 | 1067 | 1104 |
| 27 | 93.18 | 293.10 | 26.77 | 26.08 | 930 | 892 | 988 | 1064 | 1101 |
| 28 | 42.41 | 217.40 | 12.64 | 16.48 | 941 | 908 | 995 | 1067 | 1098 |
| 29 | 49.76 | 198.20 | 15.33 | 16.74 | 950 | 919 | 1000 | 1064 | 1097 |
| 30 | 46.99 | 70.44 | 11.13 | 13.42 | 956 | 928 | 1005 | 1062 | 1096 |

Appendix E

Vairation of heating rate in the blanket



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Heating rate of all batches
(The unit is given in K/min)

| Batch no. | P1 | P2 | P3 | P4 |
|-----------|------|------|------|------|
| 01 | 13.1 | 7.4 | 26.3 | 52.0 |
| 02 | 5.4 | 17.3 | 21.1 | 47.5 |
| 03 | 7.8 | 23.1 | 31.6 | 85.0 |
| 04 | 13.5 | 3.1 | 20.9 | 35.4 |
| 05 | 13.6 | 18.9 | 23.6 | 44.9 |
| 06 | 16.3 | 20.3 | 20.5 | 36.7 |
| 07 | 7.4 | 16.2 | 18.9 | 40.2 |
| 08 | 16.4 | 22.4 | 27.2 | 61.7 |
| 09 | 9.7 | 14.7 | 19.3 | 55.9 |
| 10 | 2.7 | 15.7 | 20.2 | 34.8 |
| 11 | 10.6 | 18.8 | 22.2 | 34.1 |
| 12 | 10.2 | 19.1 | 23.9 | 55.5 |
| Min. | 2.7 | 3.1 | 18.9 | 34.1 |
| Max. | 16.4 | 23.1 | 31.6 | 85.0 |
| Ave. | 10.6 | 16.4 | 23.0 | 48.6 |

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

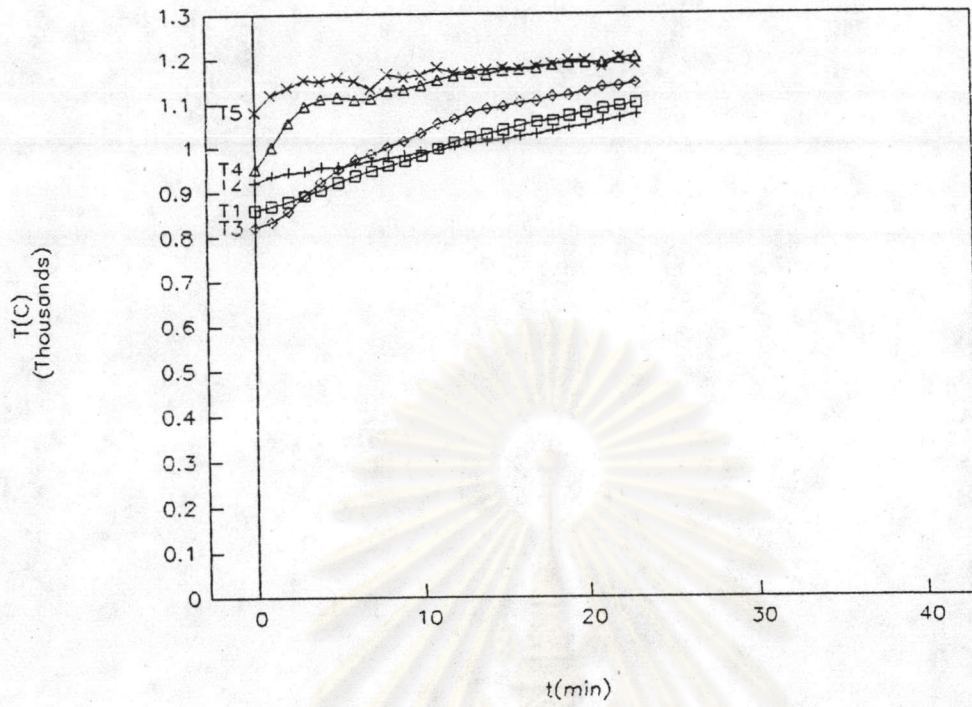
Appendix F

Temperature-time distribution curves

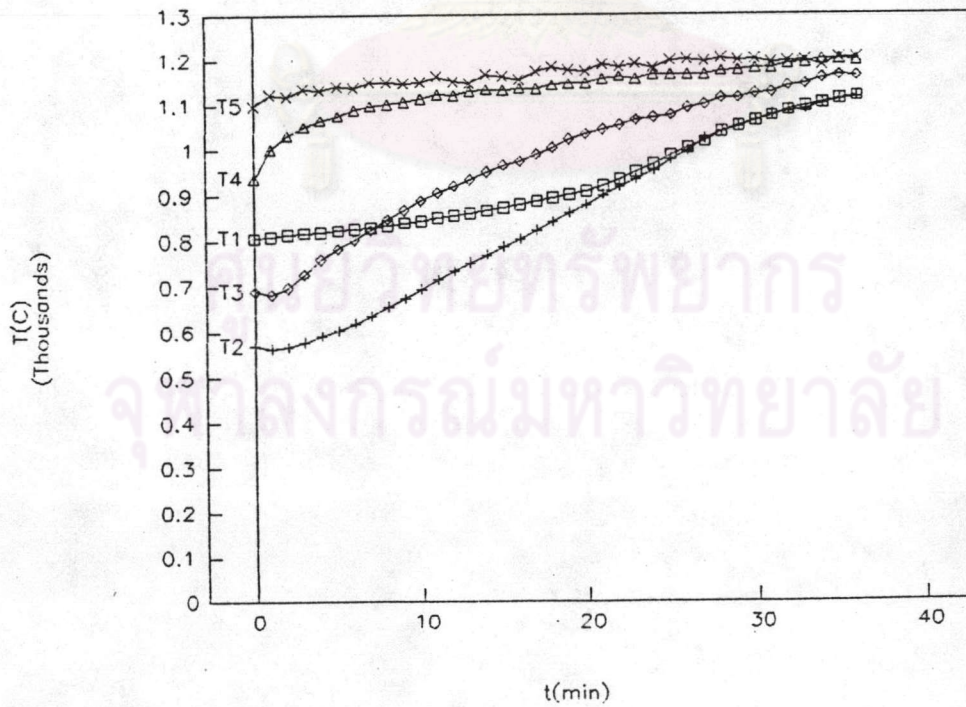


ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

TEMPERATURE DISTRIBUTION OF BATCH 01

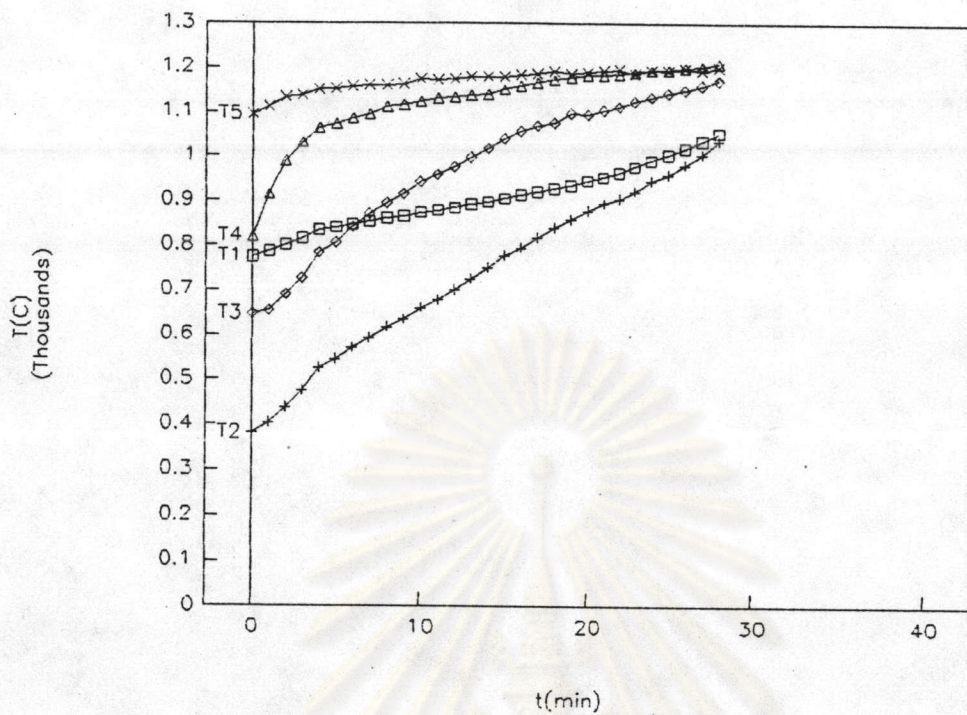


TEMPERATURE DISTRIBUTION OF BATCH 02

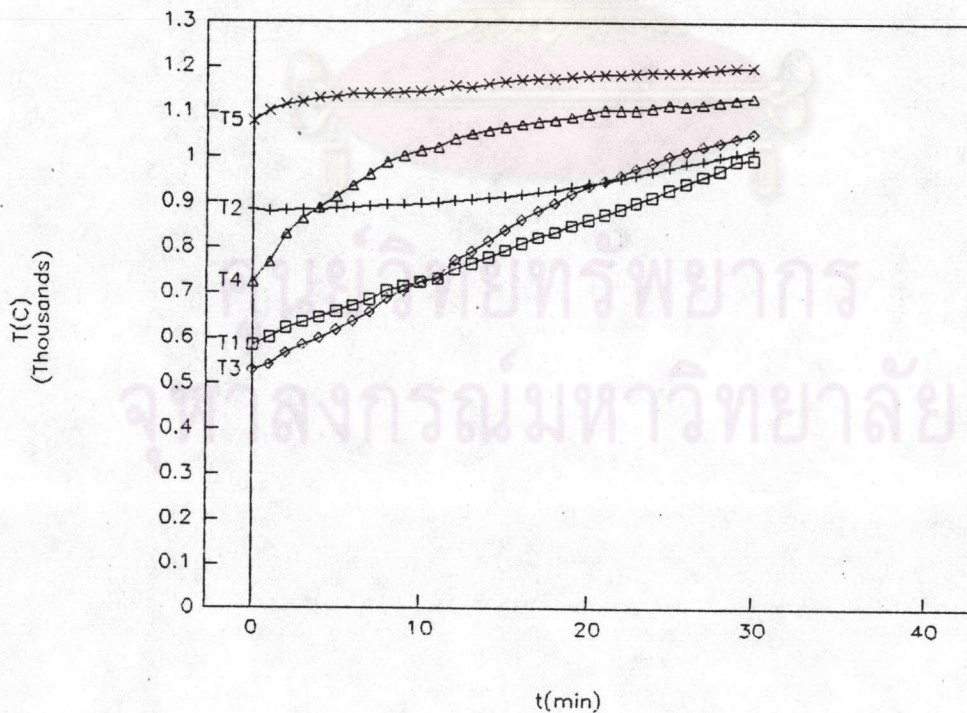


มหาวิทยาลัยศรีนครินทรวิโรฒ
คณะเภสัชศาสตร์
จุฬาลงกรณ์มหาวิทยาลัย

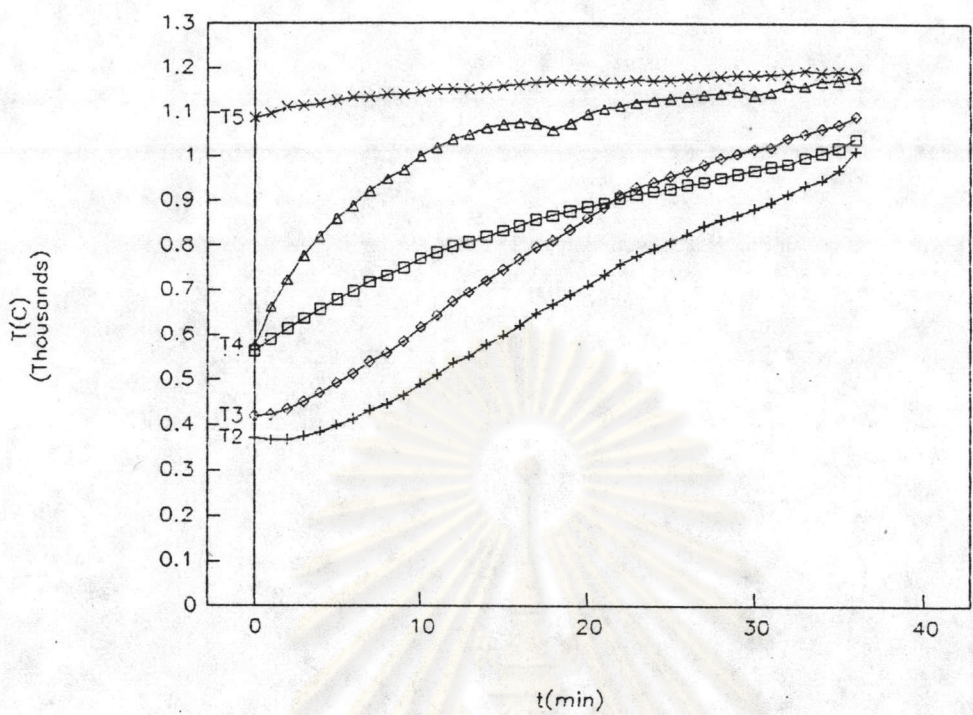
TEMPERATURE DISTRIBUTION OF BATCH 03



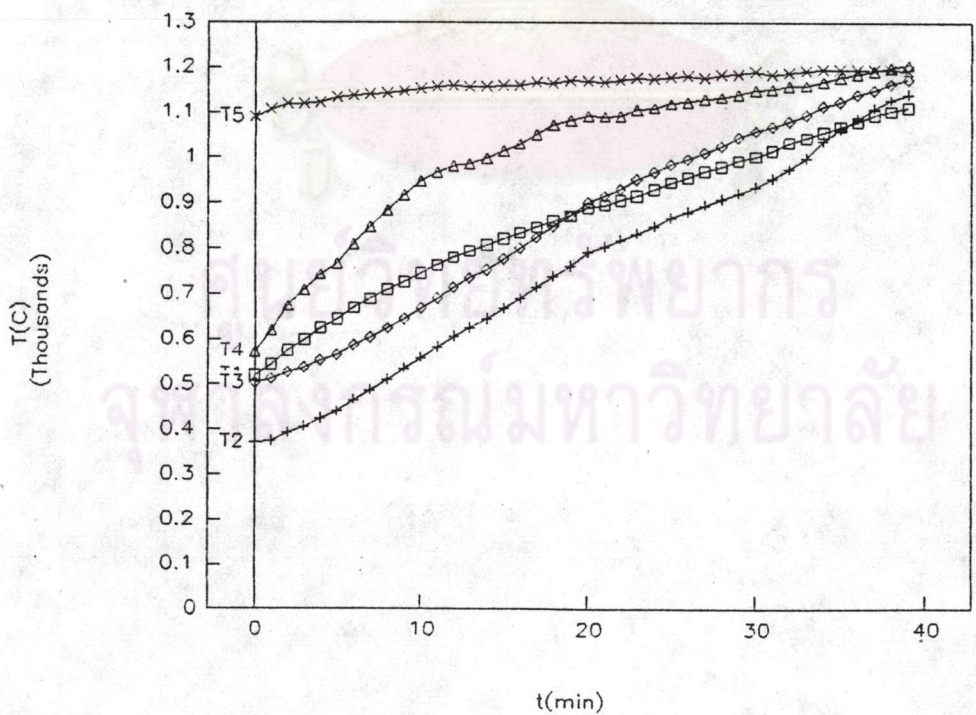
TEMPERATURE DISTRIBUTION OF BATCH 04



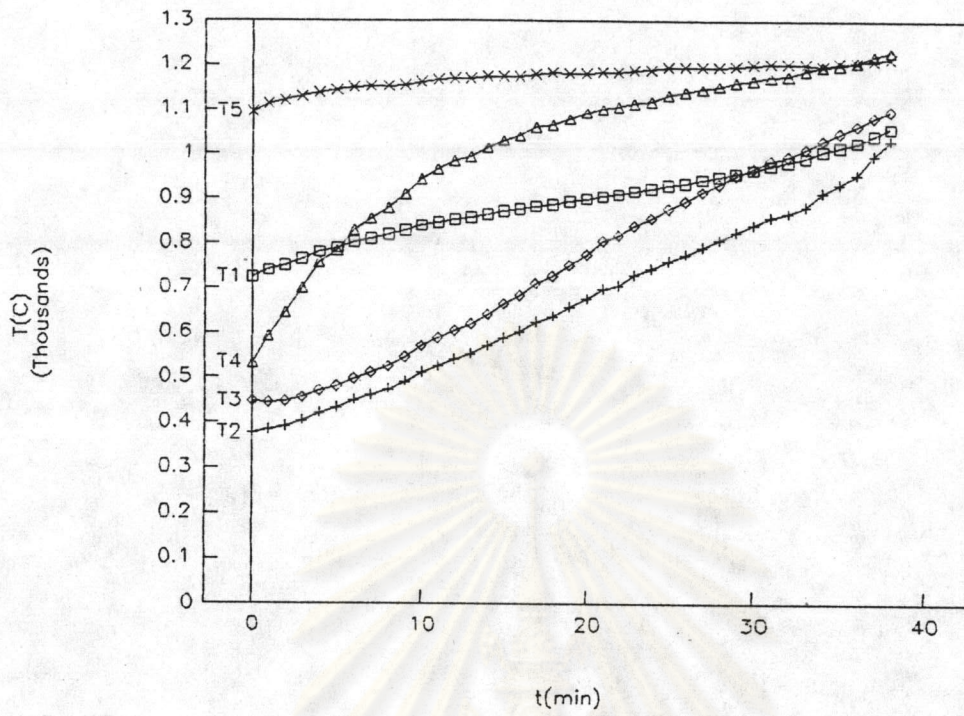
TEMPERATURE DISTRIBUTION OF BATCH 05



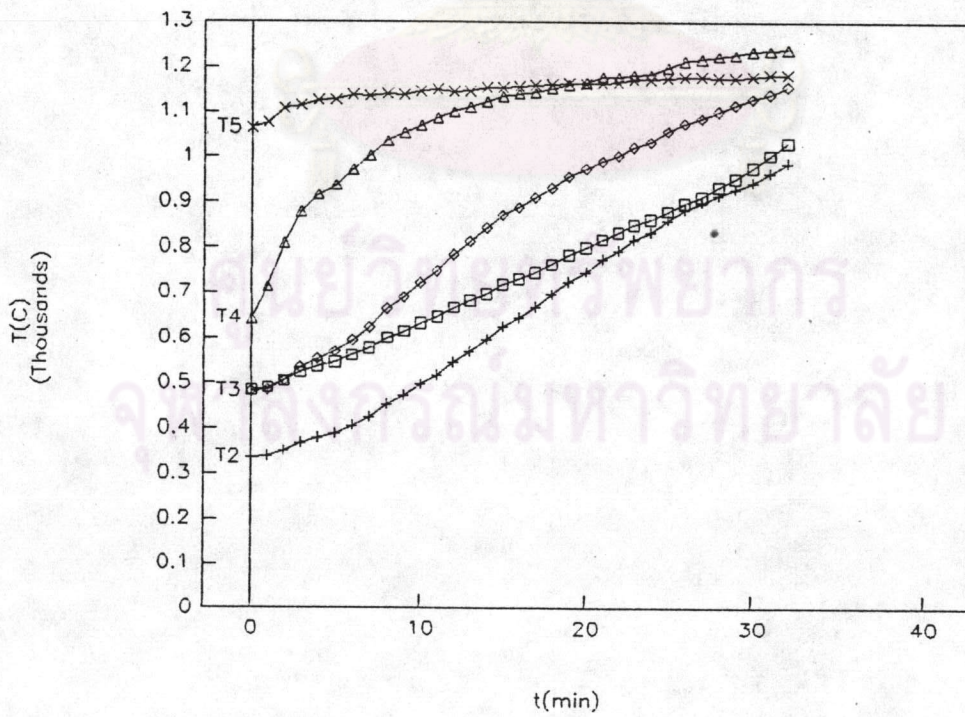
TEMPERATURE DISTRIBUTION OF BATCH 06



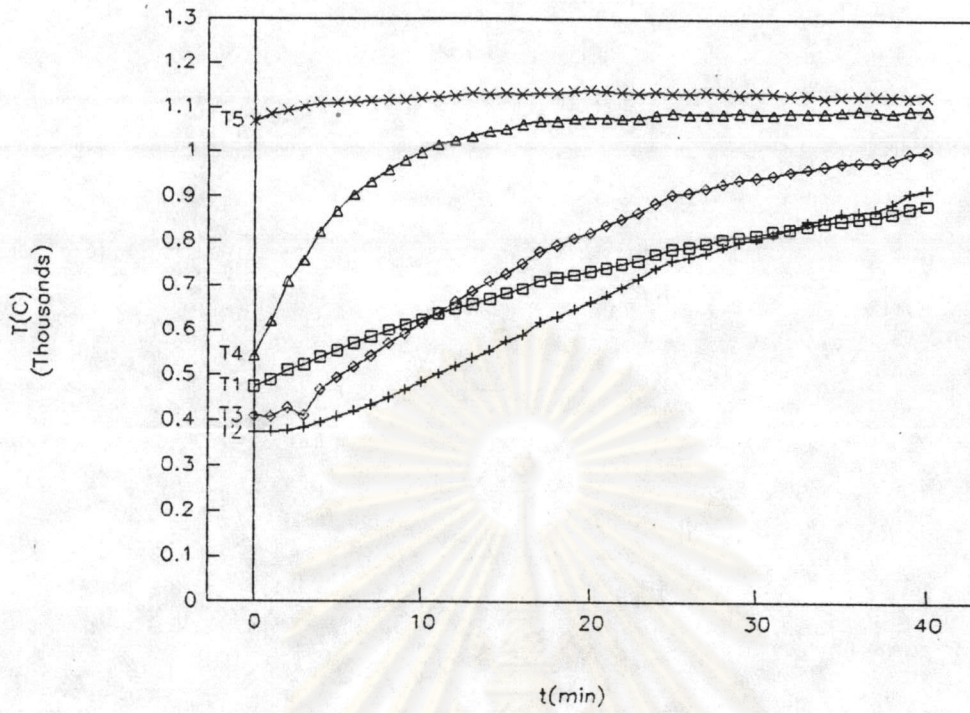
TEMPERATURE DISTRIBUTION OF BATCH 07



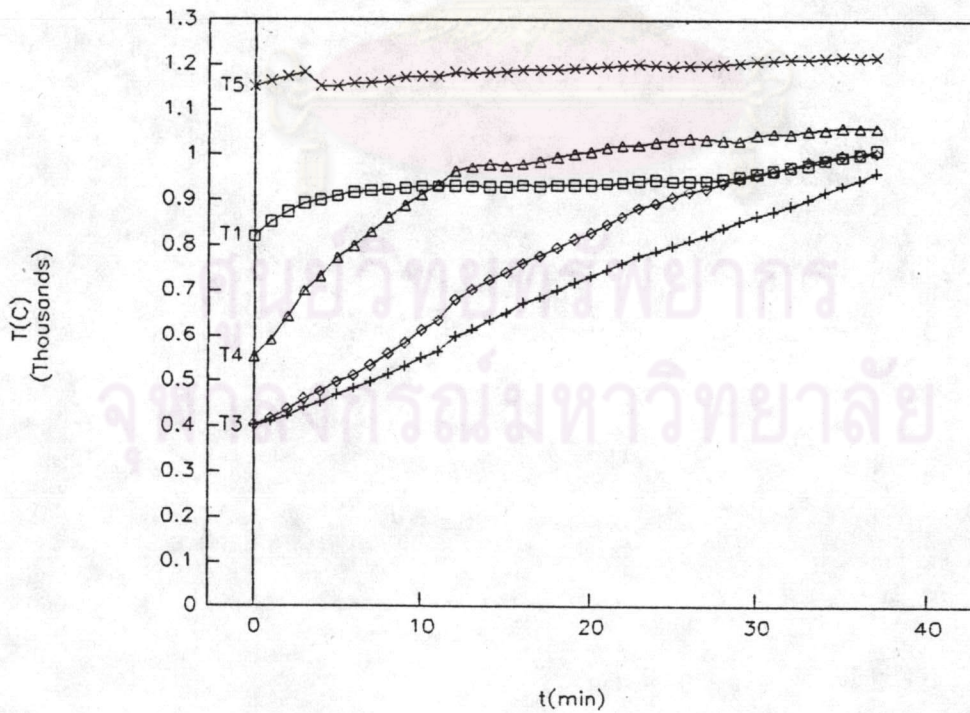
TEMPERATURE DISTRIBUTION OF BATCH 08



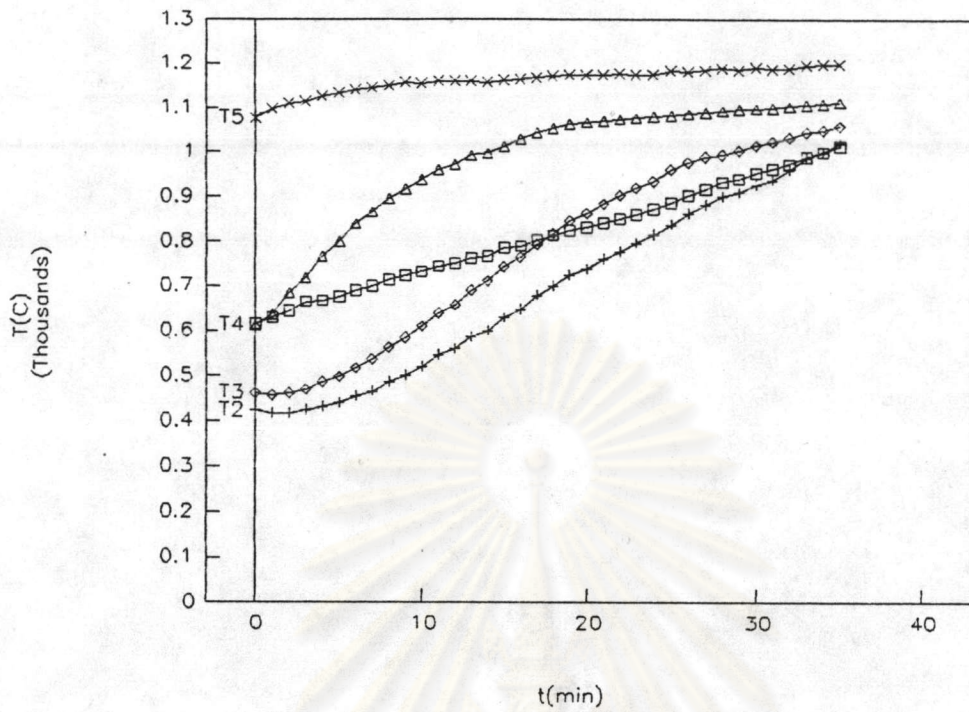
TEMPERATURE DISTRIBUTION OF BATCH 09



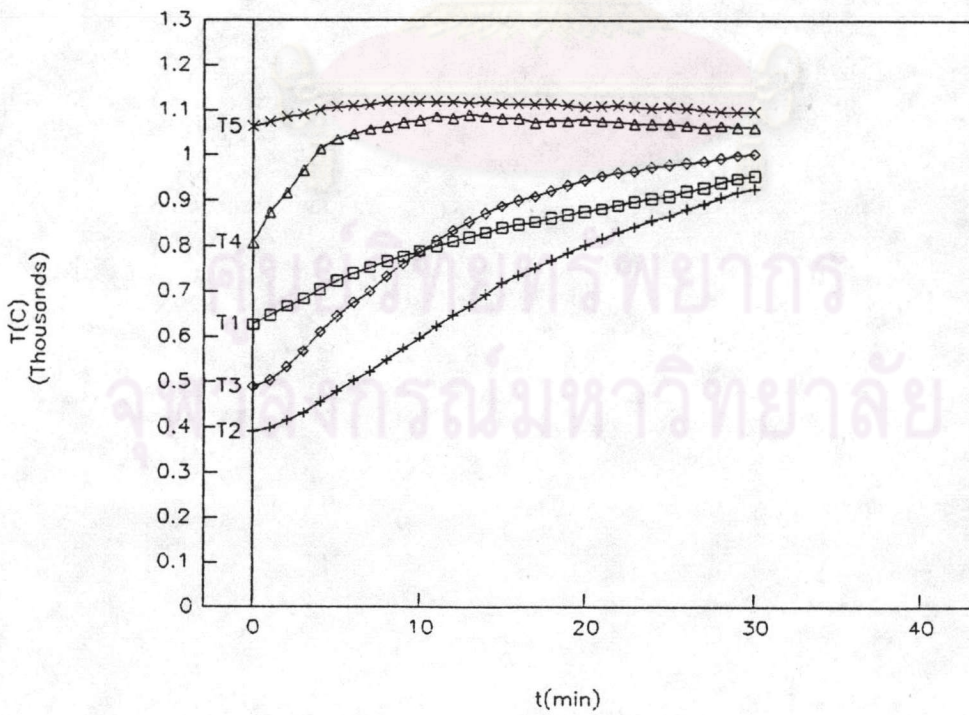
TEMPERATURE DISTRIBUTION OF BATCH 10



TEMPERATURE DISTRIBUTION OF BATCH 11



TEMPERATURE DISTRIBUTION OF BATCH 12



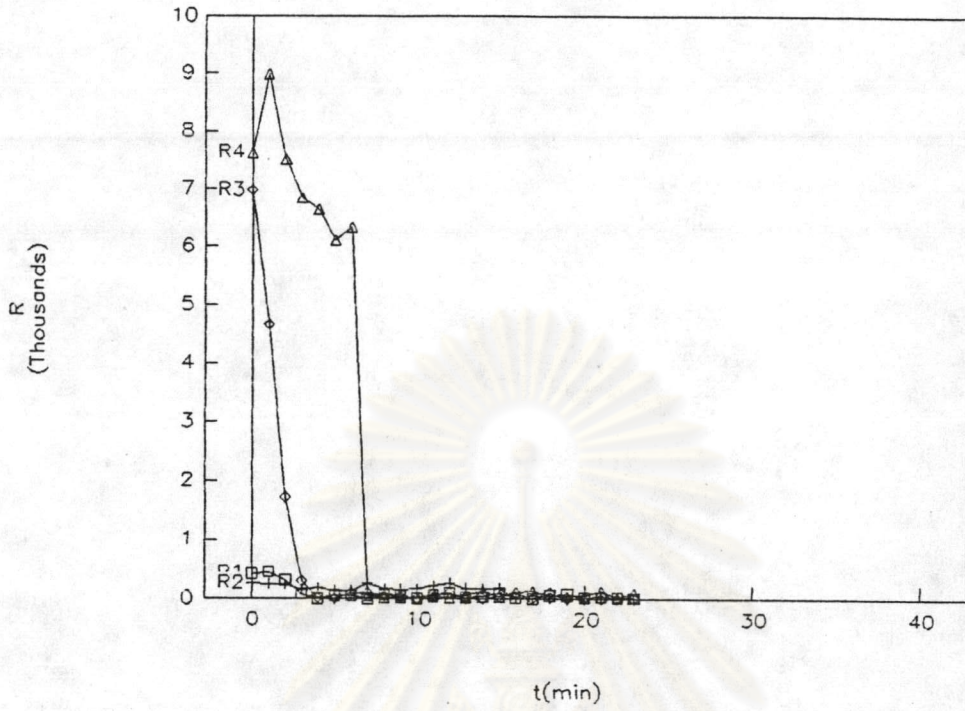
Appendix G

Resistivity-time distribution curves

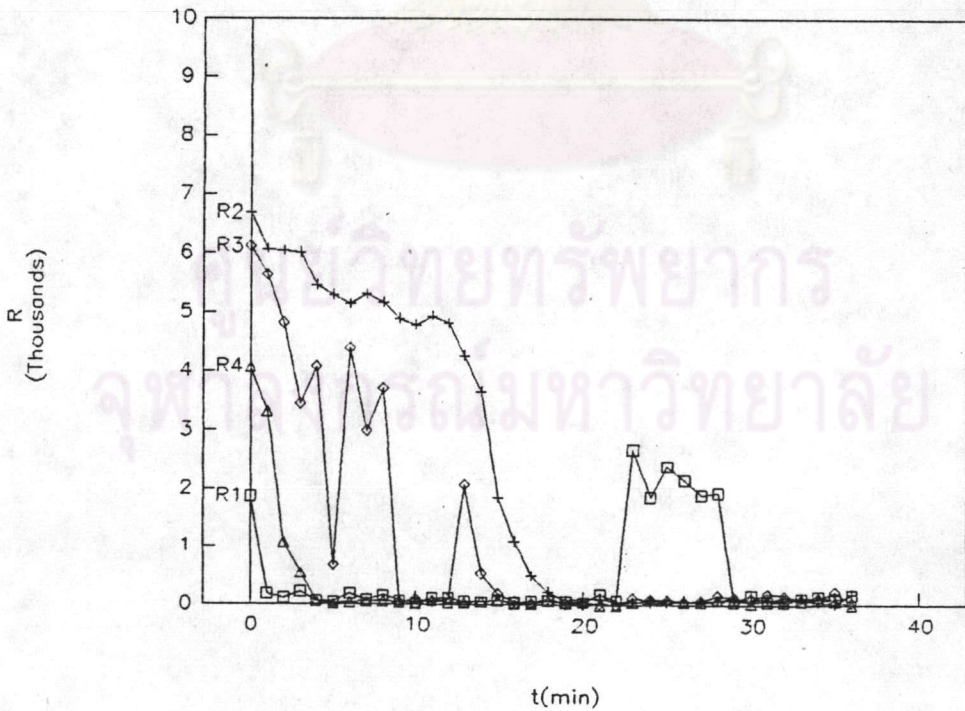


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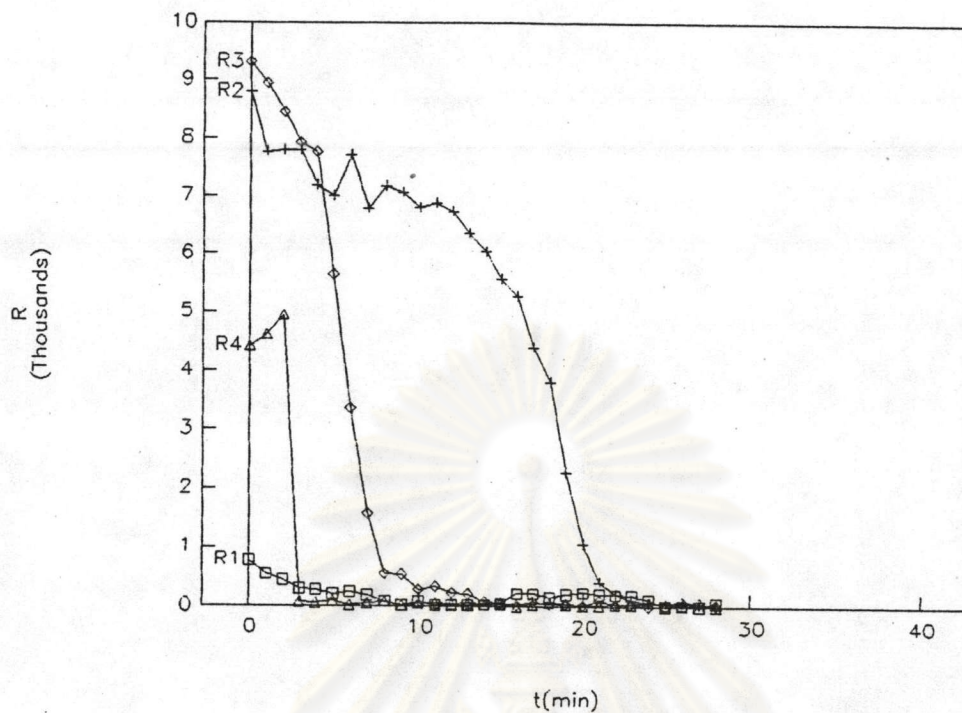
RESISTIVITY DISTRIBUTION OF BATCH 01



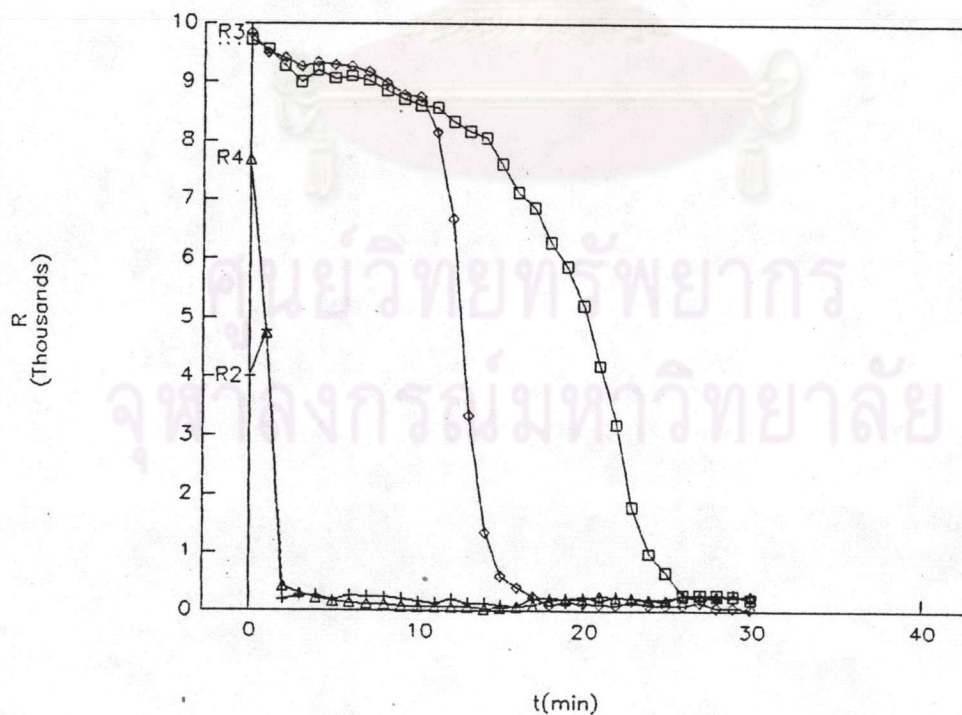
RESISTIVITY DISTRIBUTION OF BATCH 02



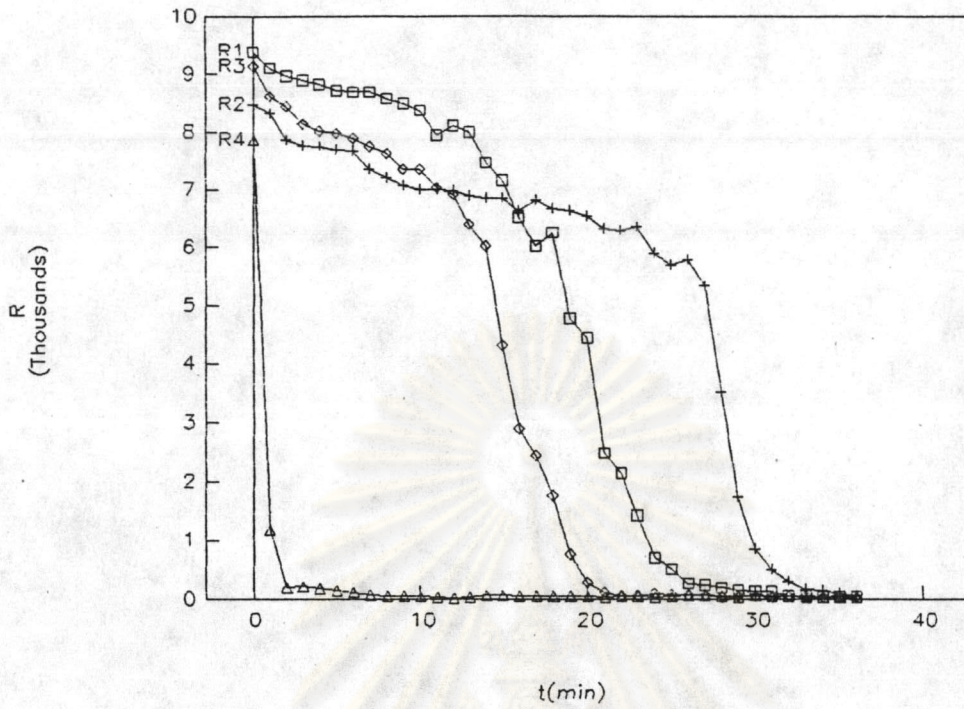
RESISTIVITY DISTRIBUTION OF BATCH 03



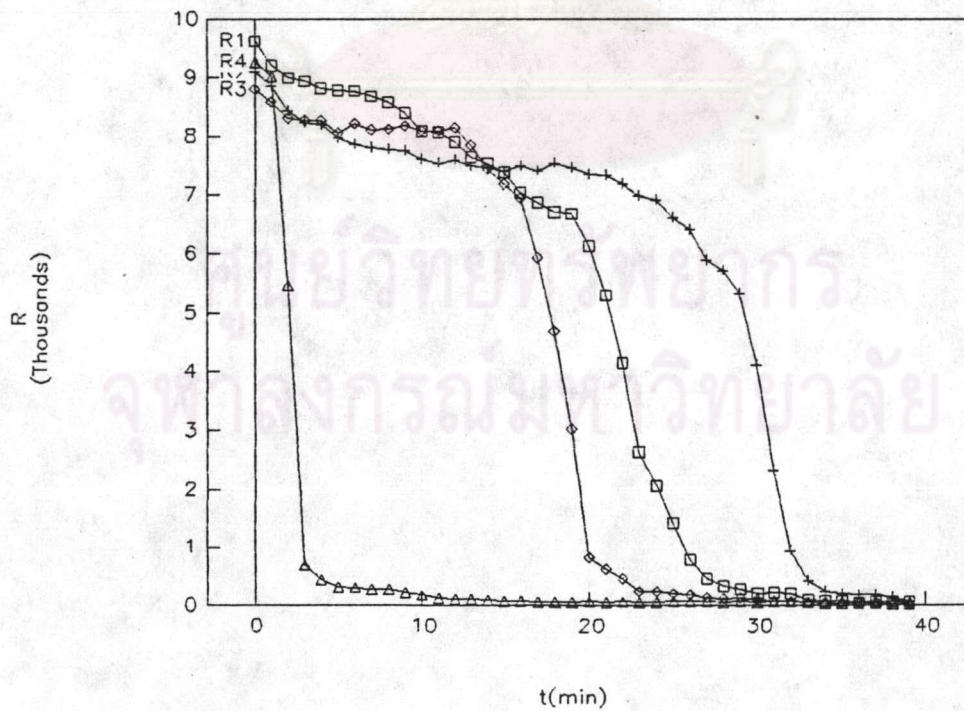
RESISTIVITY DISTRIBUTION OF BATCH 04



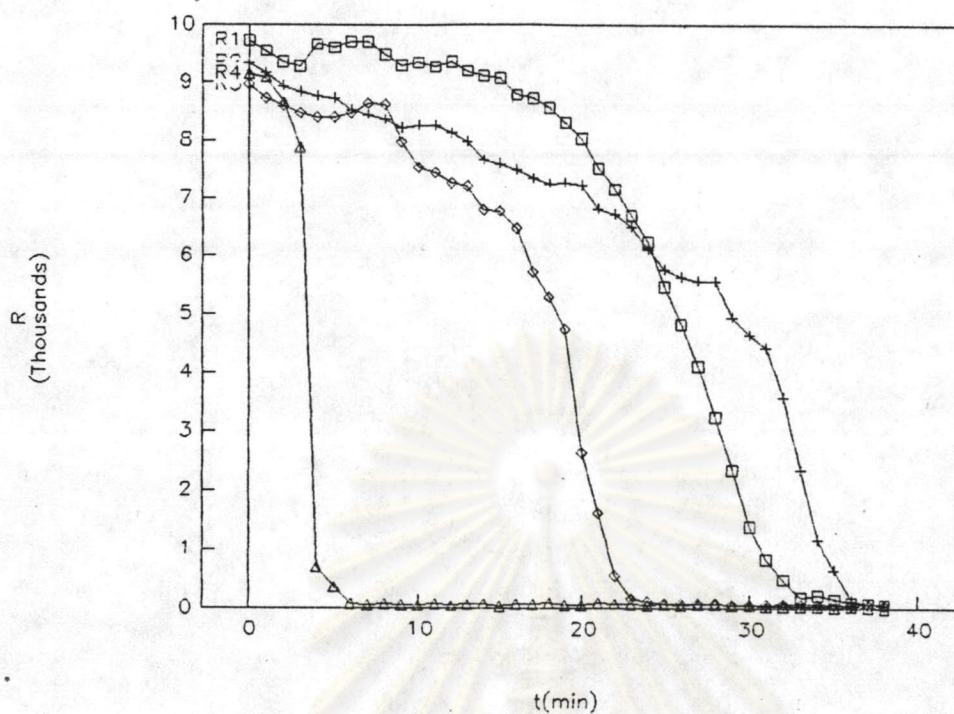
RESISTIVITY DISTRIBUTION OF BATCH 05



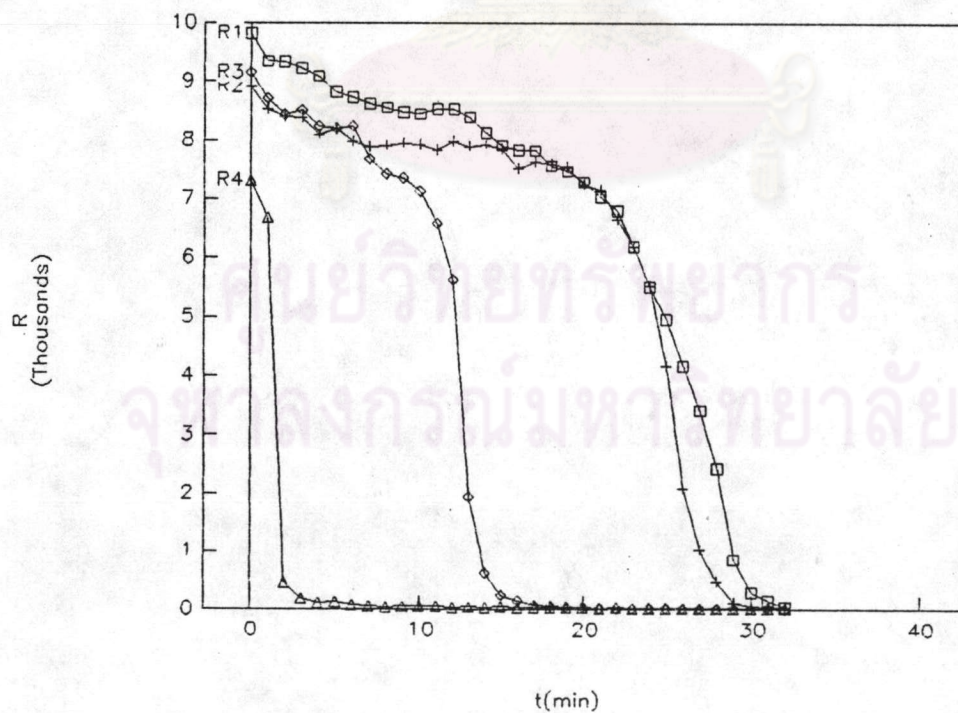
RESISTIVITY DISTRIBUTION OF BATCH 06



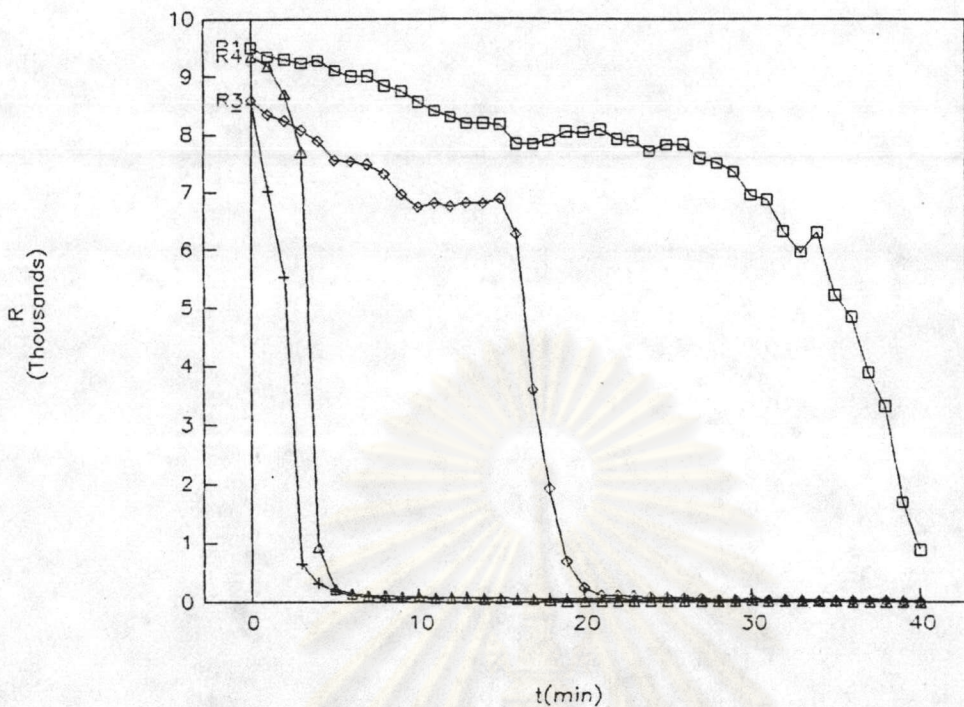
RESISTIVITY DISTRIBUTION OF BATCH 07



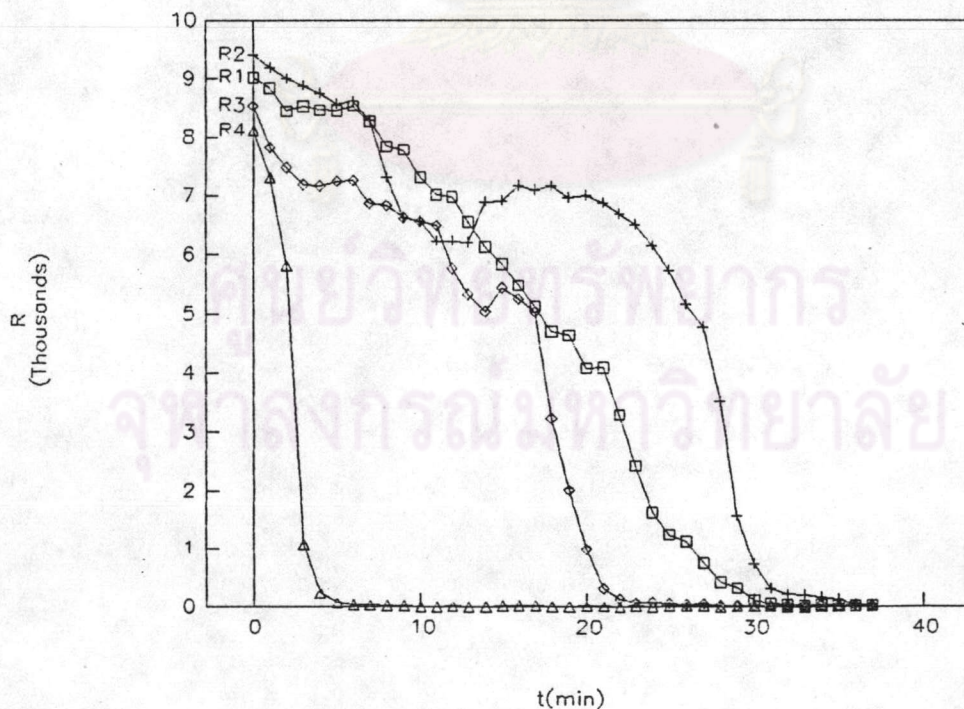
RESISTIVITY DISTRIBUTION OF BATCH 08



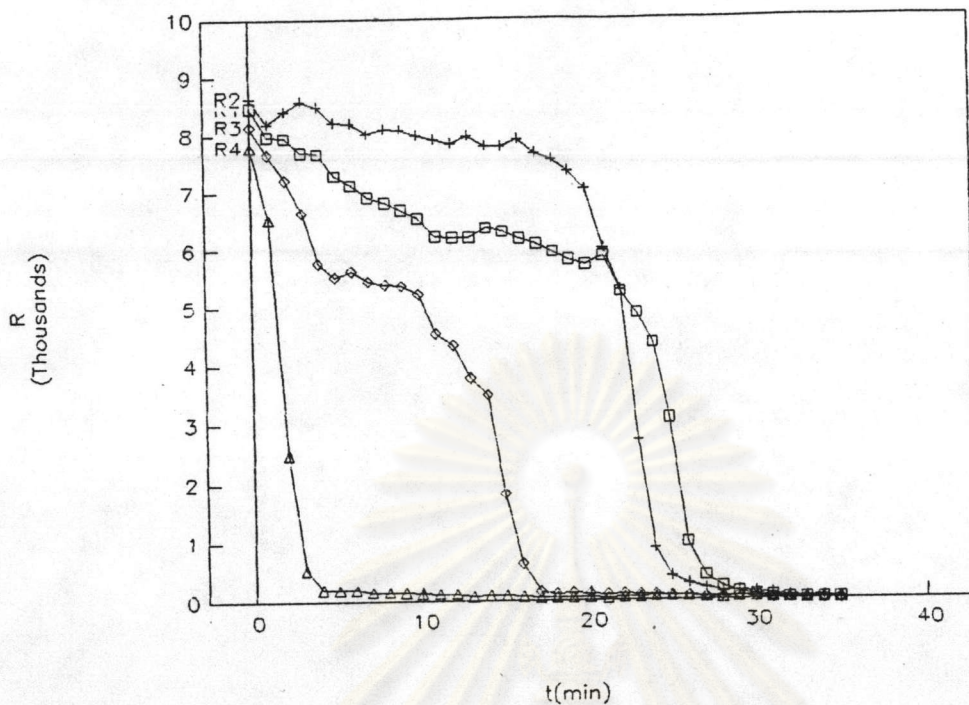
RESISTIVITY DISTRIBUTION OF BATCH 09



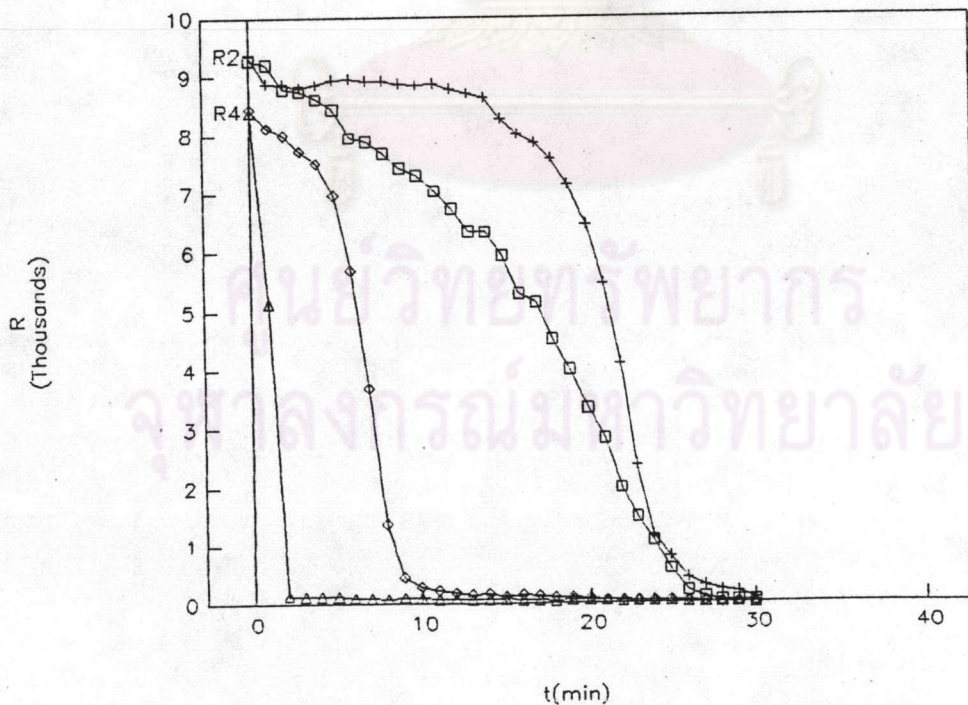
RESISTIVITY DISTRIBUTION OF BATCH 10



RESISTIVITY DISTRIBUTION OF BATCH 11



RESISTIVITY DISTRIBUTION OF BATCH 12



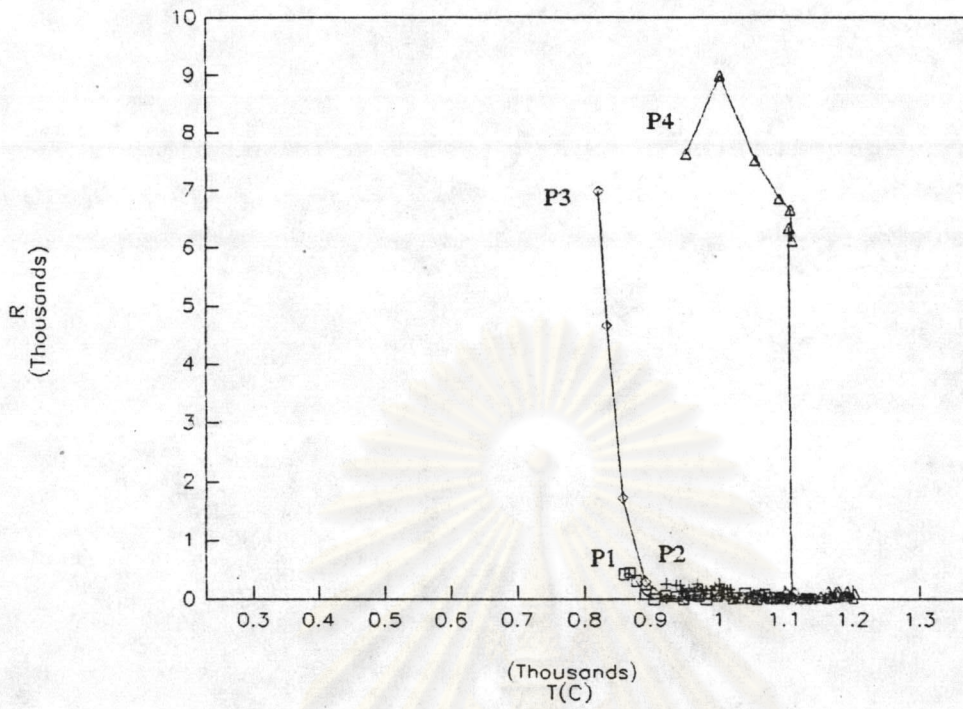
Appendix H

Resistivity-temperature distribution curves

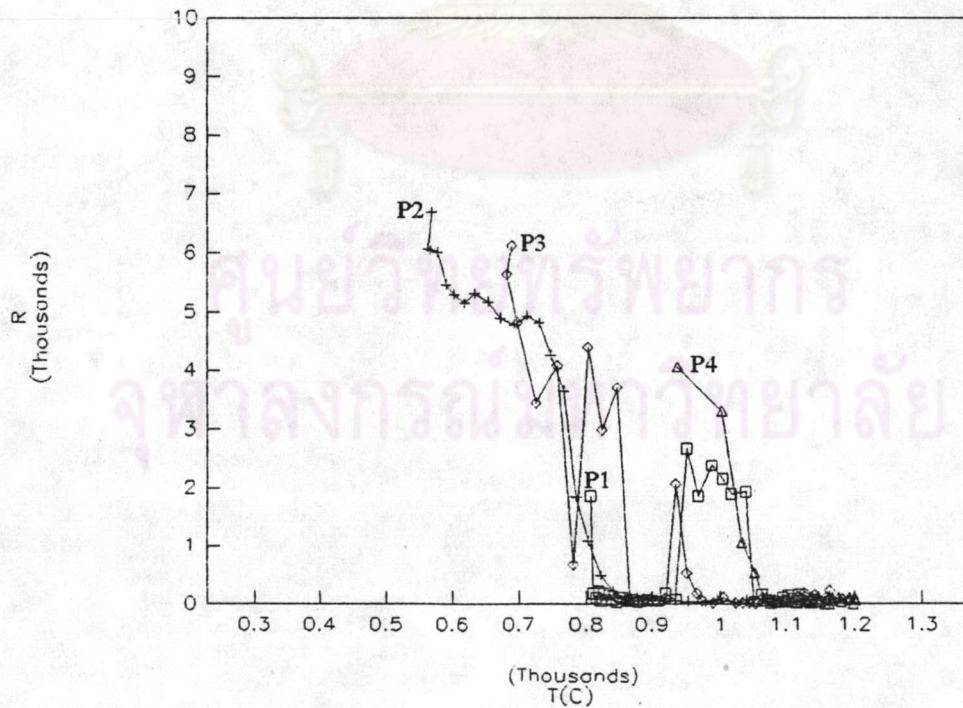


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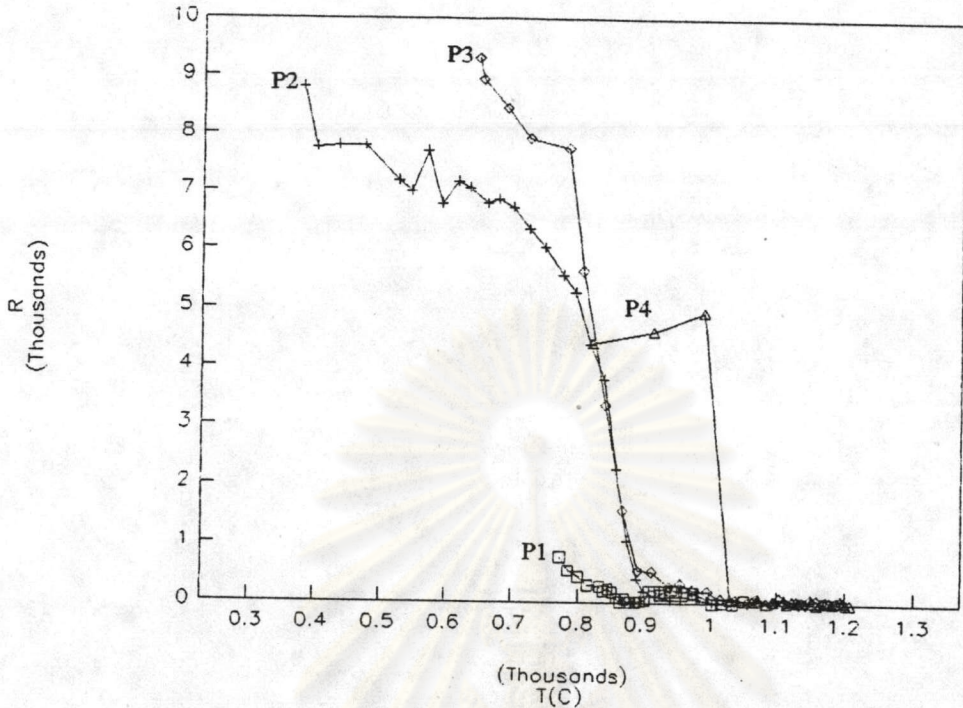
R-T PLOT OF BATCH 01



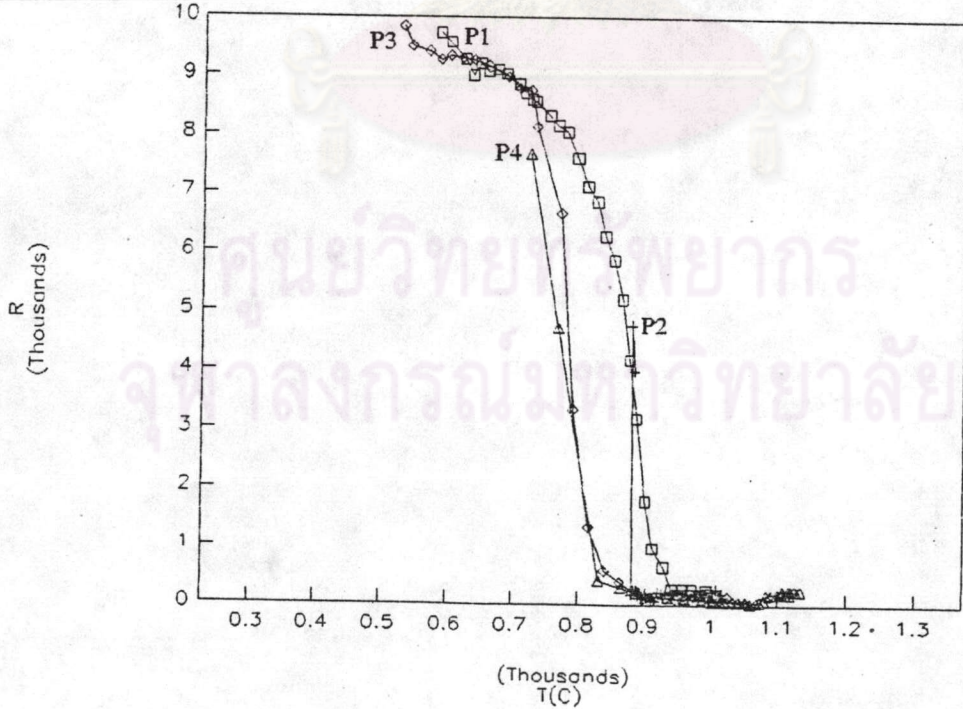
R-T PLOT OF BATCH 02



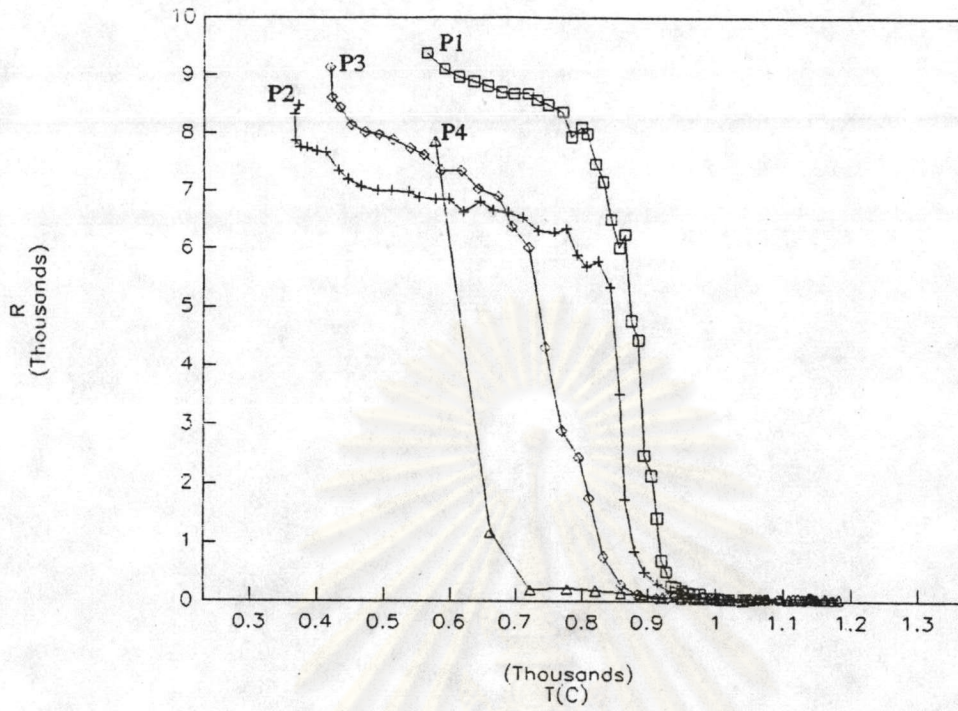
R-T PLOT OF BATCH 03



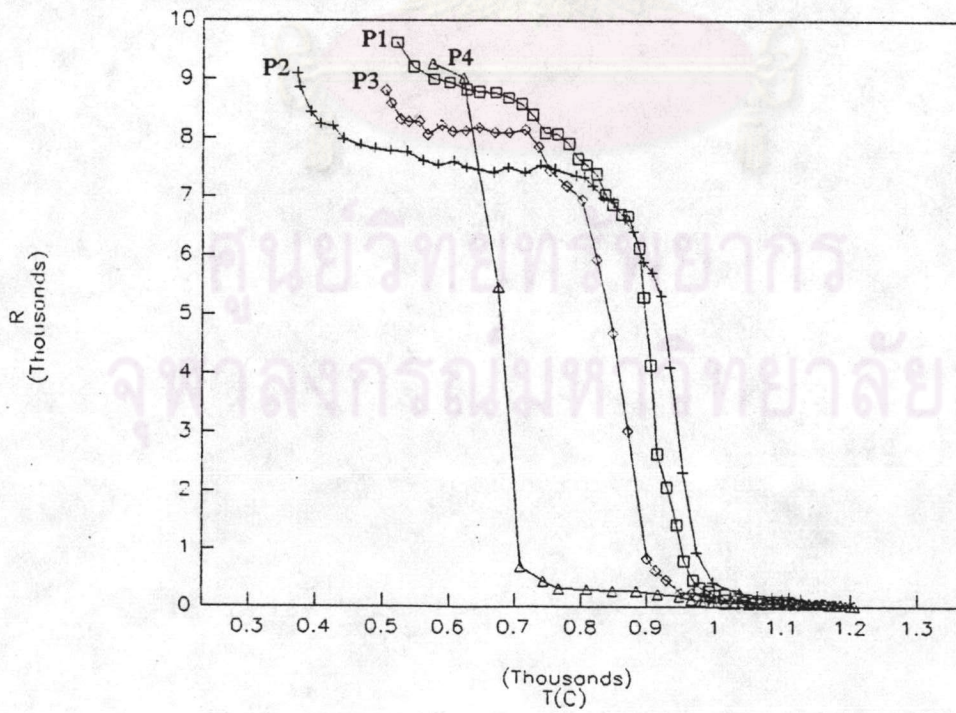
R-T PLOT OF BATCH 04



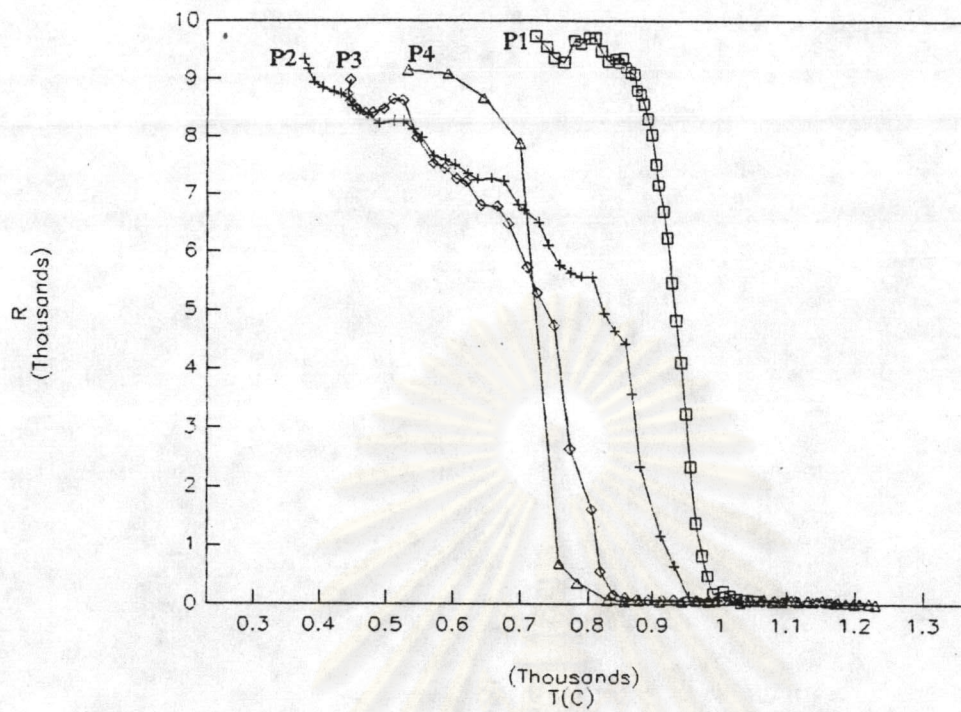
R-T PLOT OF BATCH 05



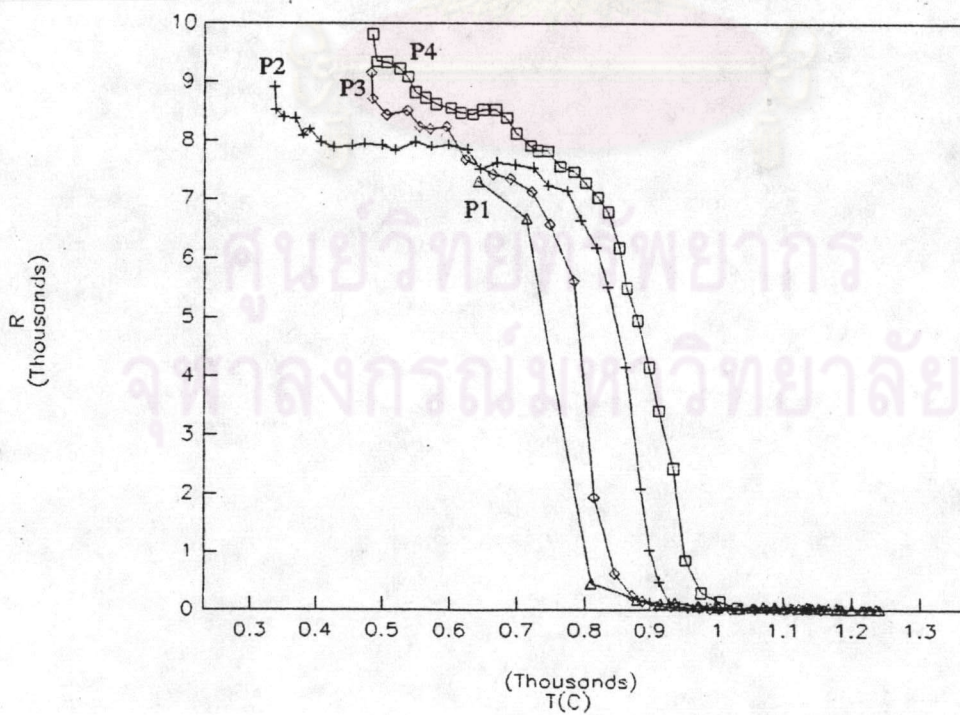
R-T PLOT OF BATCH 06



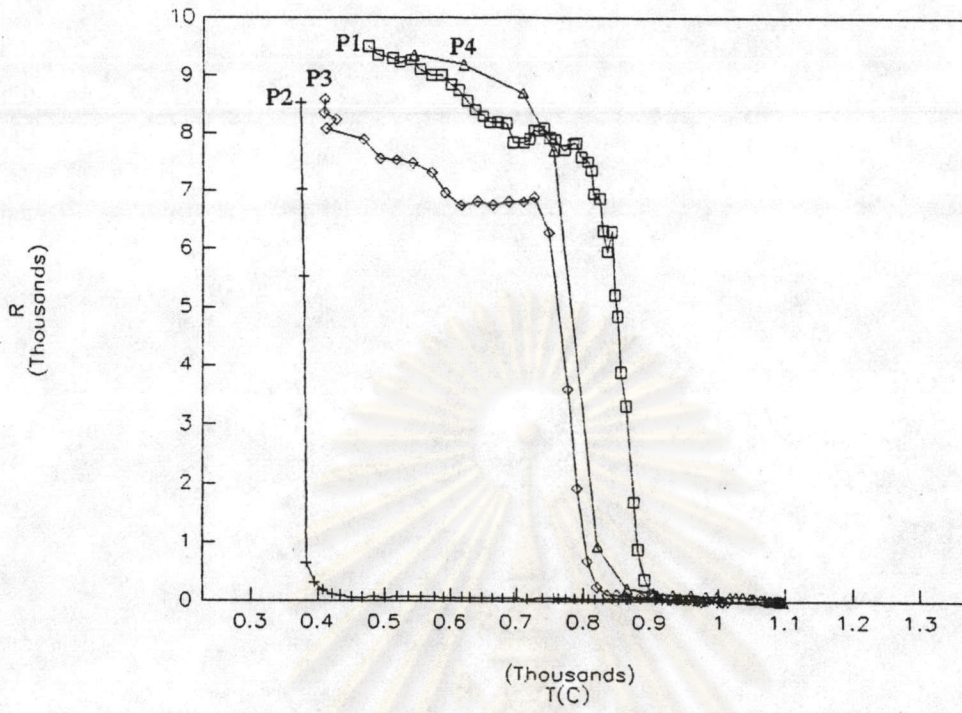
R-T PLOT OF BATCH 07



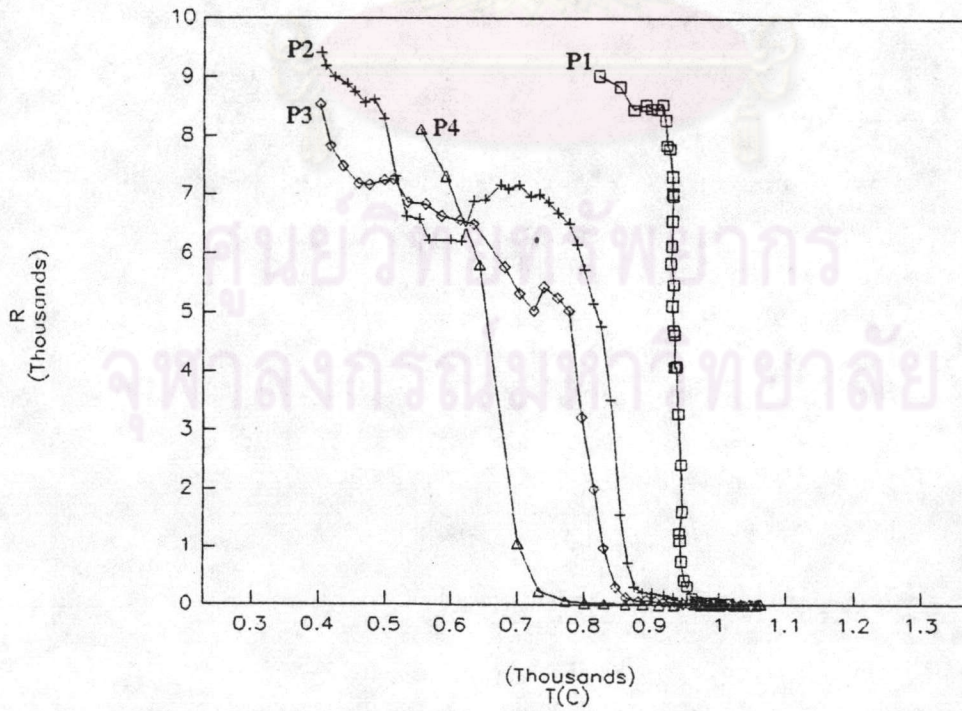
R-T PLOT OF BATCH 08



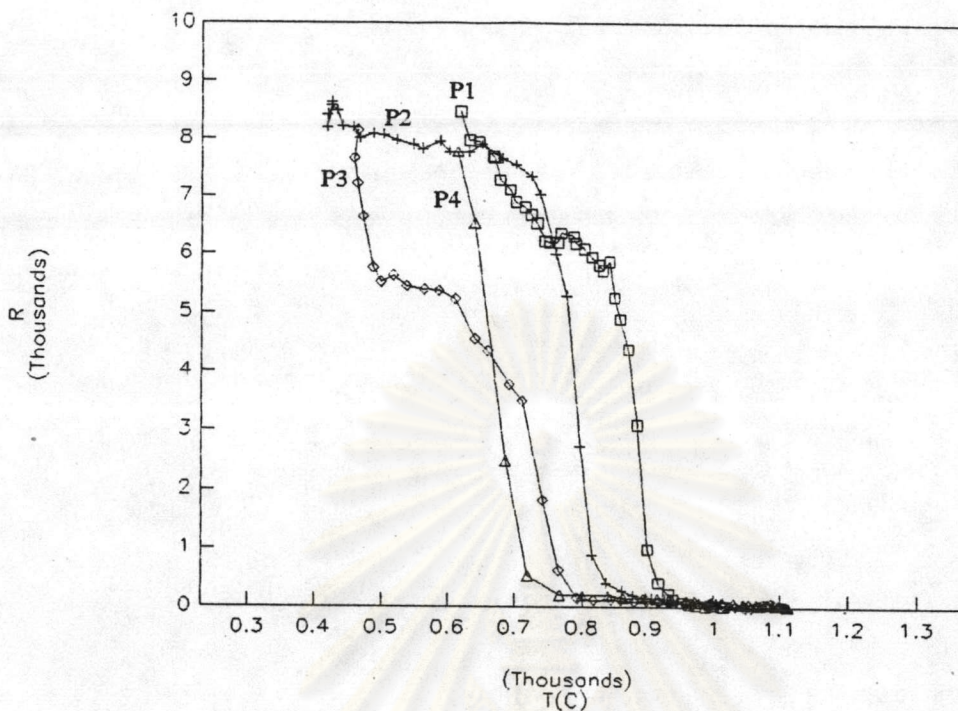
R-T PLOT OF BATCH 09



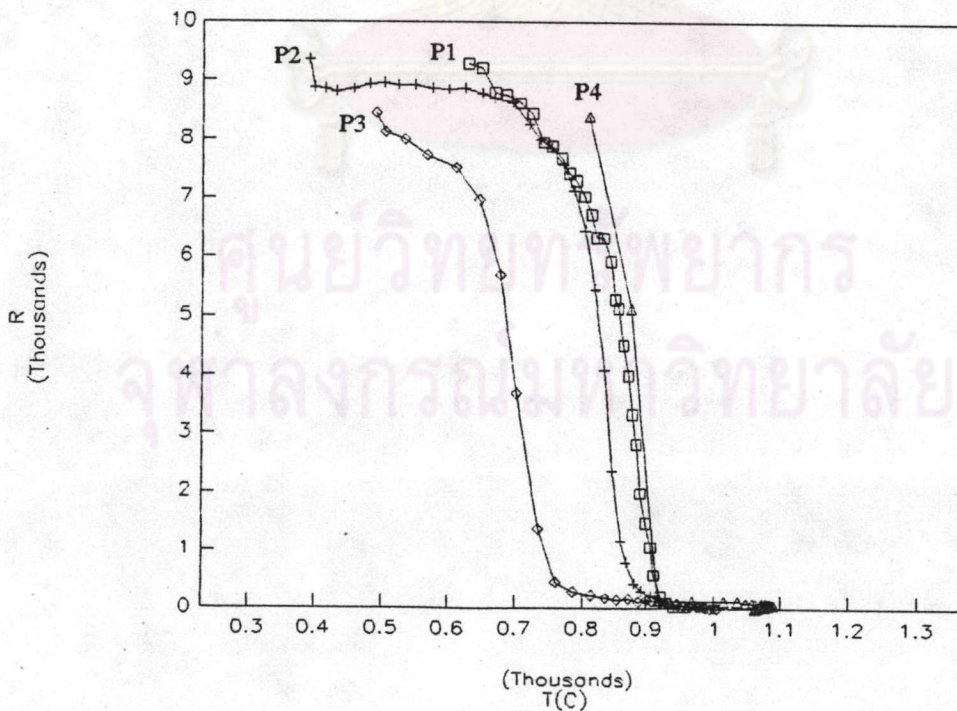
R-T PLOT OF BATCH 10



R-T PLOT OF BATCH 11



R-T PLOT OF BATCH 12



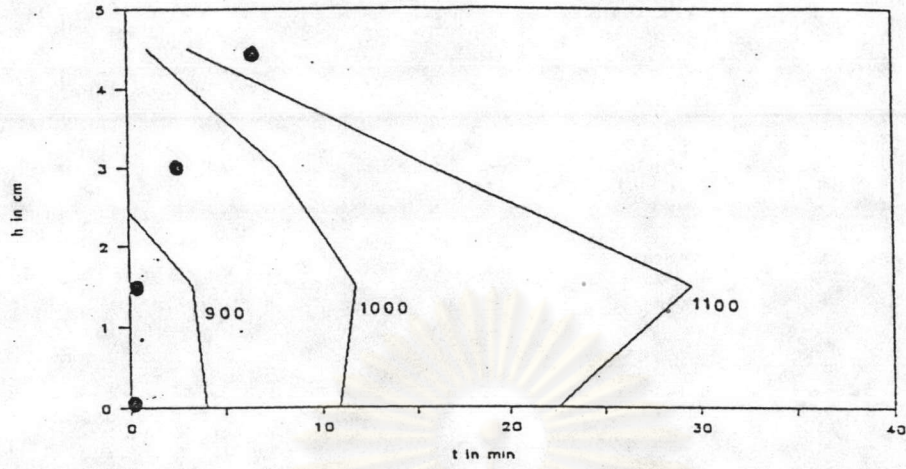
Appendix I

Isothermal and melting front diagrams

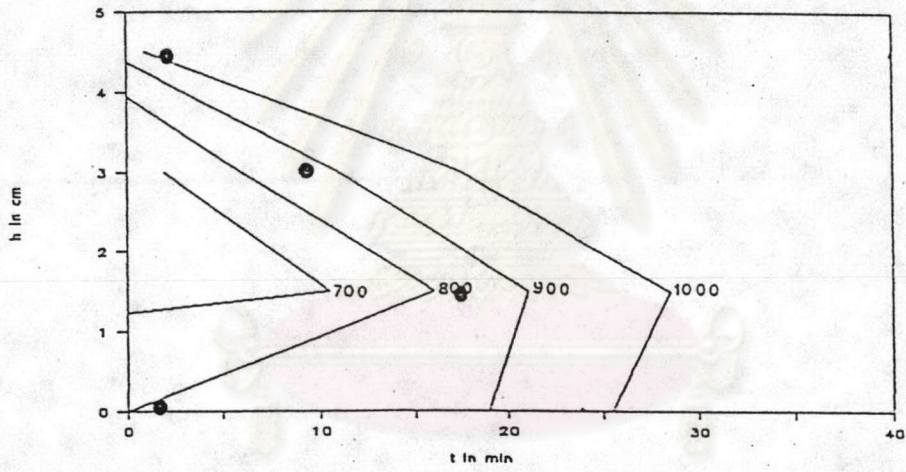


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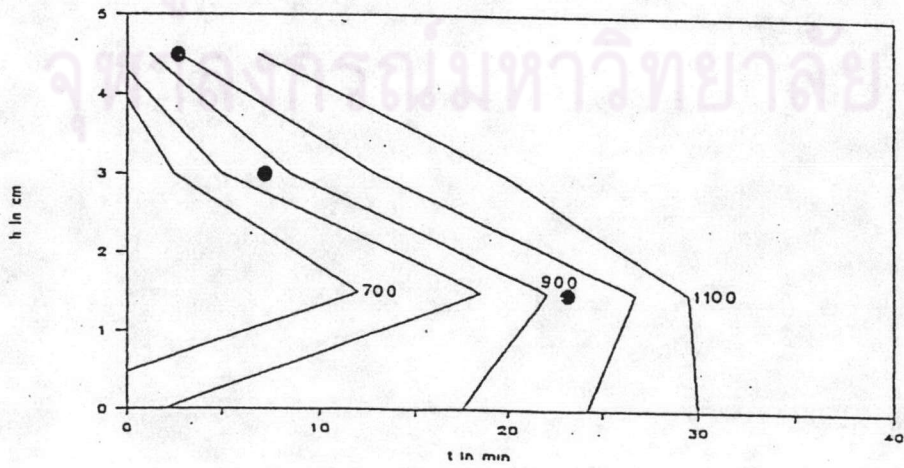
ISOTHERMS IN BATCH 01



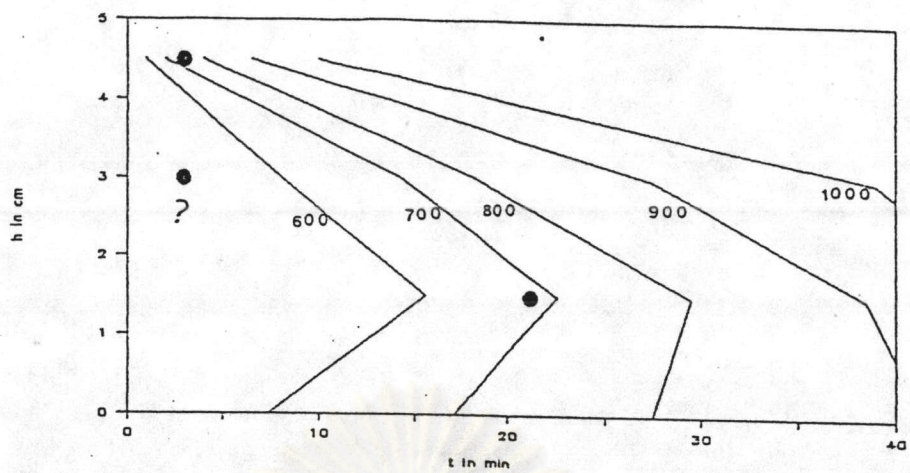
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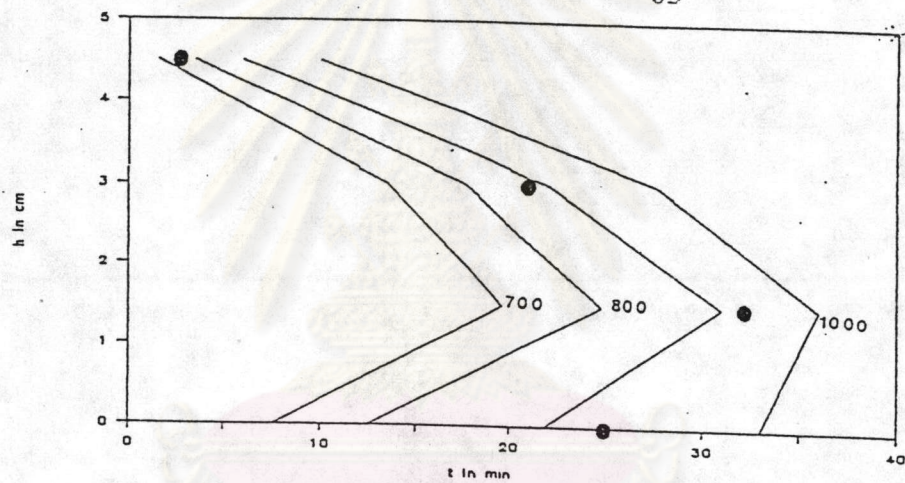
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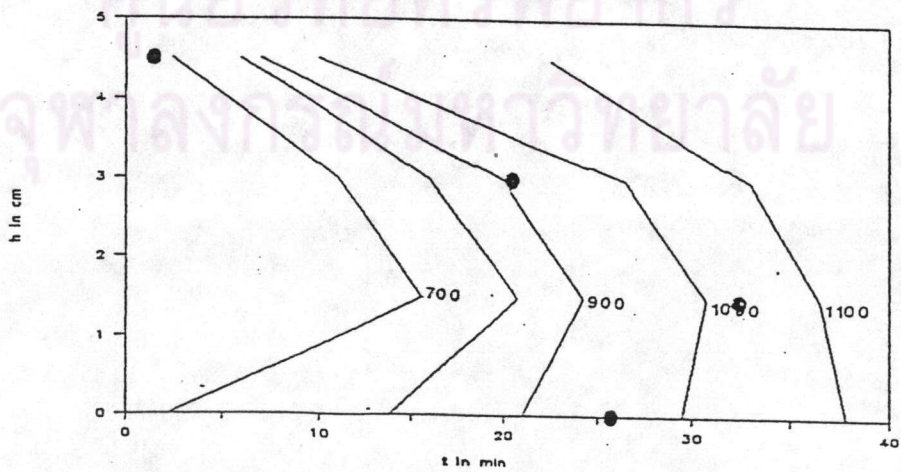
ISOTHERMS IN BATCH 04



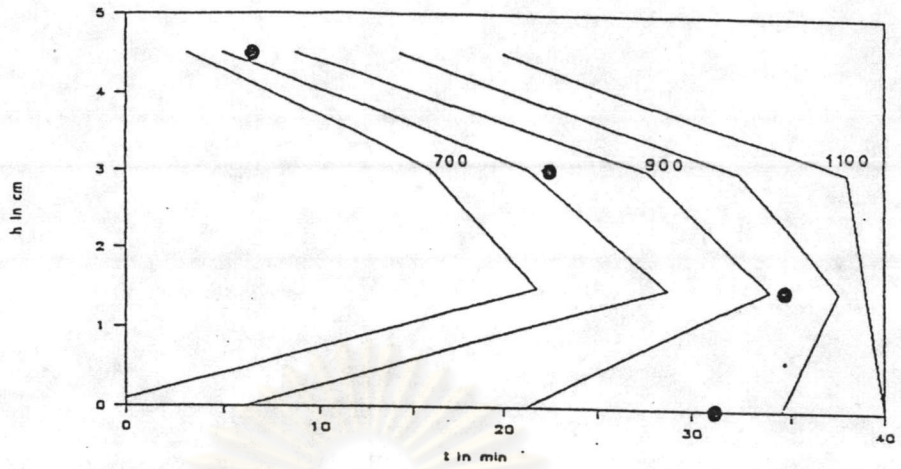
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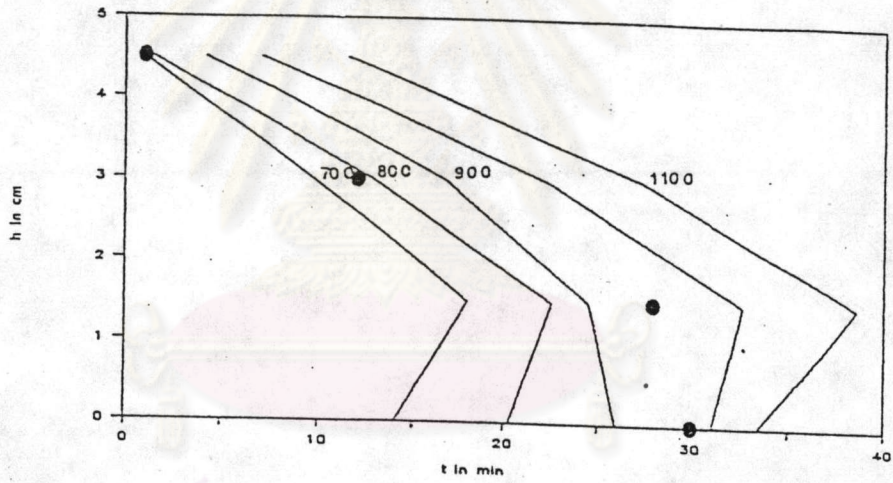
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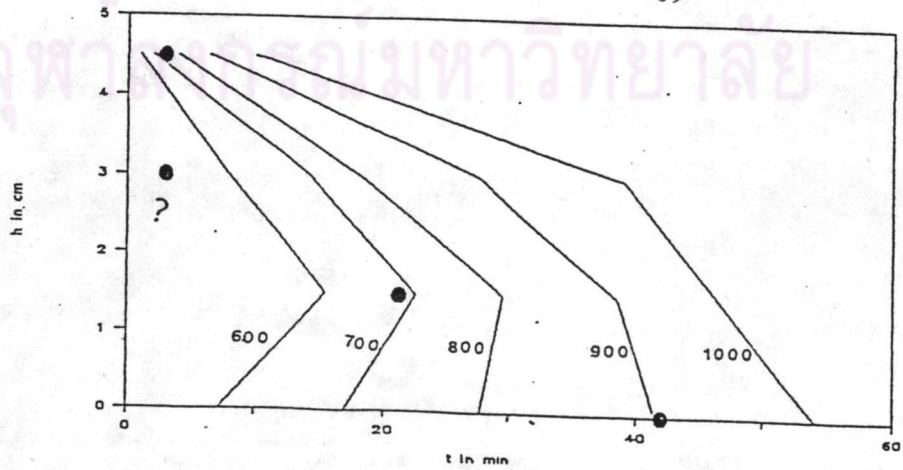
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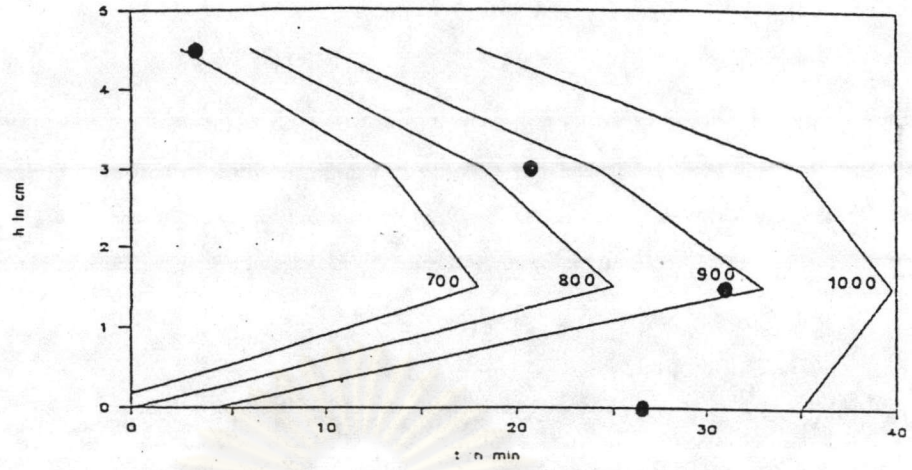
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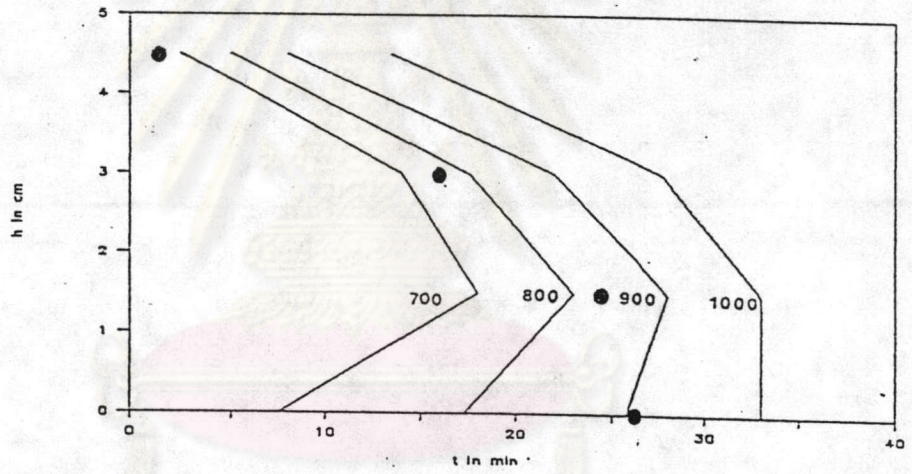
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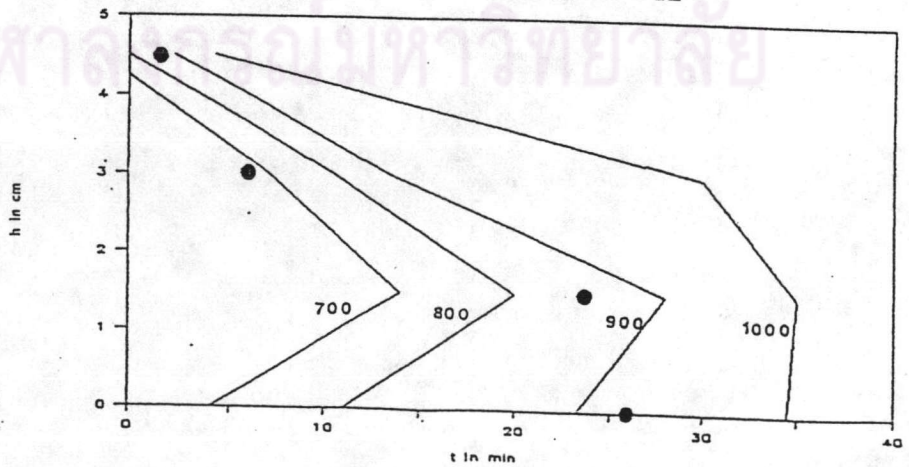
ISOTHERMS IN BATCH 10



ISOTHERMS IN BATCH 11



ISOTHERMS IN BATCH 12



Vita

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