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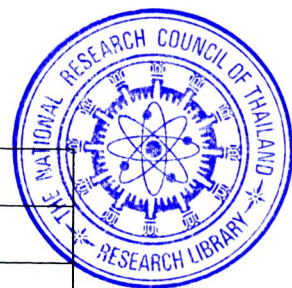
## **APPENDIX A**

Performance of batch experiment

## A.1 Heat treated inoculums

**Table A.1** sCOD removal in each type of treated inoculums in reactor with time

| Time<br>(day) | 1A     |       | 2A     |       | 3A    |       | 4A    |       |
|---------------|--------|-------|--------|-------|-------|-------|-------|-------|
|               | mg/L   | %     | mg/L   | %     | mg/L  | %     | mg/L  | %     |
| 3             | 5158.2 | 48.42 | 6184.0 | 38.16 | 648.6 | 40.00 | 680.6 | 31.94 |
| 6             | 4578.5 | 54.22 | 6000.0 | 40.00 | 640.0 | 41.46 | 590.8 | 40.92 |
| 10            | 4509.1 | 54.91 | 5853.7 | 41.46 | 585.4 | 41.46 | 581.8 | 41.82 |
| 15            | 3750.0 | 62.50 | 5508.2 | 40.98 | 615.4 | 40.98 | 562.5 | 43.75 |
| 17            | 3249.2 | 67.51 | 5419.4 | 41.94 | 464.5 | 41.94 | 590.8 | 40.92 |
| 23            | 3249.2 | 67.51 | 4645.2 | 41.94 | 387.1 | 41.94 | 480.0 | 52.00 |
| 31            | 2700.0 | 73.00 | 4400.0 | 52.00 | 400.0 | 60.00 | 412.5 | 58.75 |
| 36            | 2720.0 | 72.80 | 3692.3 | 63.08 | 375.0 | 63.08 | 320.0 | 68.00 |
| 38            | 2658.5 | 73.42 | 3456.0 | 65.44 | 307.2 | 61.60 | 332.3 | 66.77 |
| 43            | 2240.0 | 77.60 | 3072.0 | 69.28 | 300.0 | 62.50 | 280.0 | 72.00 |
| 51            | 1772.3 | 82.28 | 2709.7 | 72.90 | 271.0 | 72.90 | 266.7 | 73.33 |
| 55            | 1676.2 | 83.24 | 2181.8 | 78.18 | 232.3 | 76.77 | 258.5 | 74.15 |

**Table A.2** SS of microorganism in each type of inoculums with time

| Time<br>(day) | SS (g/L) |       |       |       |
|---------------|----------|-------|-------|-------|
|               | 1A       | 2A    | 3A    | 4A    |
| 1             | 5.067    | 4.900 | 4.833 | 4.900 |
| 6             | 5.133    | 5.033 | 4.867 | 4.933 |
| 10            | 5.267    | 5.633 | 5.000 | 5.100 |
| 16            | 6.133    | 5.967 | 5.167 | 5.333 |
| 20            | 6.067    | 6.833 | 4.933 | 5.200 |
| 28            | 6.133    | 6.933 | 5.400 | 5.533 |
| 35            | 6.933    | 6.867 | 5.300 | 5.333 |
| 42            | 6.933    | 7.200 | 5.733 | 5.867 |
| 49            | 7.400    | 7.267 | 5.900 | 5.833 |
| 52            | 7.500    | 7.667 | 5.967 | 5.900 |
| 55            | 7.733    | 7.767 | 6.000 | 5.933 |

**Table A.3** VSS of microorganism in each type of inoculums with time

| Time<br>(day) | VSS (g/L) |       |       |       |
|---------------|-----------|-------|-------|-------|
|               | 1A        | 2A    | 3A    | 4A    |
| 1             | 3.933     | 3.467 | 3.700 | 3.567 |
| 6             | 3.967     | 3.567 | 3.667 | 3.633 |
| 10            | 4.133     | 3.967 | 3.800 | 3.667 |
| 16            | 4.467     | 4.100 | 3.933 | 3.800 |
| 20            | 4.967     | 4.867 | 3.733 | 4.000 |
| 28            | 4.567     | 5.033 | 4.300 | 4.233 |
| 35            | 5.567     | 4.900 | 4.167 | 4.000 |
| 42            | 5.567     | 5.333 | 4.833 | 4.300 |
| 49            | 5.933     | 5.500 | 4.767 | 4.467 |
| 52            | 6.333     | 5.633 | 4.800 | 4.533 |
| 55            | 6.567     | 5.867 | 4.800 | 4.633 |

**Table A.4** sCOD removal in each type of treated inoculums in reactor with time

| Time<br>(day) | 1AA    |       | 2AA    |       | 3AA    |       | 4AA    |       |
|---------------|--------|-------|--------|-------|--------|-------|--------|-------|
|               | mg/L   | %     | mg/L   | %     | mg/L   | %     | mg/L   | %     |
| 3             | 4871.6 | 40.59 | 5300.6 | 35.36 | 1766.9 | 36.90 | 1862.7 | 33.48 |
| 6             | 4430.8 | 45.97 | 4829.3 | 41.11 | 1609.8 | 42.51 | 1698.5 | 39.34 |
| 10            | 4072.7 | 50.33 | 4682.9 | 42.89 | 1609.8 | 42.51 | 1600.0 | 42.86 |
| 15            | 3600.0 | 56.10 | 4327.9 | 47.22 | 1573.8 | 43.79 | 1425.0 | 49.11 |
| 17            | 3249.2 | 60.38 | 3871.0 | 52.79 | 1548.4 | 44.70 | 1255.4 | 55.16 |
| 23            | 3101.5 | 62.18 | 3871.0 | 52.79 | 1548.4 | 44.70 | 1107.7 | 60.44 |
| 31            | 3000.0 | 63.41 | 3600.0 | 56.10 | 1200.0 | 57.14 | 1125.0 | 59.82 |
| 36            | 2880.0 | 64.88 | 3323.1 | 59.47 | 1292.3 | 53.85 | 1040.0 | 62.86 |
| 38            | 2436.9 | 70.28 | 2688.0 | 67.22 | 960.0  | 65.71 | 960.0  | 65.71 |
| 43            | 2240.0 | 72.68 | 2304.0 | 71.90 | 768.0  | 72.57 | 880.0  | 68.57 |
| 51            | 1920.0 | 76.59 | 2322.6 | 71.68 | 786.9  | 71.90 | 812.3  | 70.99 |
| 55            | 1523.8 | 81.42 | 2181.8 | 73.39 | 750.0  | 73.21 | 761.9  | 72.79 |

**Table A.5** SS of microorganism in each type of inoculums with time

| Time<br>(day) | SS (g/L) |       |       |       |
|---------------|----------|-------|-------|-------|
|               | 1AA      | 2AA   | 3AA   | 4AA   |
| 1             | 4.900    | 4.867 | 4.800 | 4.867 |
| 6             | 5.233    | 4.900 | 4.867 | 4.900 |
| 10            | 5.033    | 5.000 | 4.667 | 5.033 |
| 16            | 5.267    | 4.900 | 4.833 | 4.867 |
| 20            | 5.767    | 5.667 | 5.233 | 5.333 |
| 28            | 5.833    | 5.733 | 5.067 | 5.367 |
| 35            | 6.000    | 5.700 | 5.733 | 5.433 |
| 42            | 6.467    | 6.200 | 5.600 | 5.633 |
| 49            | 6.600    | 6.300 | 6.033 | 6.133 |
| 52            | 6.767    | 6.533 | 6.200 | 6.033 |
| 55            | 6.933    | 6.733 | 6.133 | 6.100 |

**Table A.6** VSS of microorganism in each type of inoculums with time

| Time<br>(day) | VSS (g/L) |       |       |       |
|---------------|-----------|-------|-------|-------|
|               | 1AA       | 2AA   | 3AA   | 4AA   |
| 1             | 3.633     | 3.433 | 3.667 | 3.700 |
| 6             | 3.767     | 3.500 | 3.733 | 3.833 |
| 10            | 3.533     | 3.600 | 3.633 | 3.900 |
| 16            | 3.733     | 3.300 | 4.033 | 3.600 |
| 20            | 4.567     | 4.033 | 4.200 | 4.000 |
| 28            | 4.667     | 4.067 | 3.767 | 4.100 |
| 35            | 4.567     | 3.900 | 4.300 | 4.067 |
| 42            | 5.100     | 4.733 | 4.467 | 4.300 |
| 49            | 5.167     | 5.000 | 4.933 | 4.700 |
| 52            | 5.233     | 4.867 | 5.133 | 4.533 |
| 55            | 5.367     | 4.967 | 5.233 | 4.667 |



## A.2 Natural inoculums

**Table A.7** sCOD removal in each type of natural inoculums in reactor with time

| Time<br>(day) | 1B     |       | 2B     |       | 3B    |       | 4B    |       |
|---------------|--------|-------|--------|-------|-------|-------|-------|-------|
|               | mg/L   | %     | mg/L   | %     | mg/L  | %     | mg/L  | %     |
| 3             | 5874.6 | 41.25 | 6260.9 | 37.39 | 660.9 | 33.91 | 644.8 | 35.52 |
| 6             | 5464.6 | 45.35 | 6240.0 | 37.60 | 556.5 | 44.35 | 627.7 | 37.23 |
| 10            | 5090.9 | 49.09 | 5969.7 | 40.30 | 484.0 | 51.60 | 545.5 | 45.45 |
| 15            | 4200.0 | 58.00 | 5907.7 | 42.40 | 406.2 | 59.38 | 450.0 | 55.00 |
| 17            | 4135.4 | 58.65 | 5760.0 | 40.92 | 369.2 | 63.08 | 406.2 | 59.38 |
| 23            | 3840.0 | 61.60 | 4878.7 | 41.77 | 354.1 | 64.59 | 369.2 | 63.08 |
| 31            | 3750.0 | 62.50 | 3840.0 | 64.55 | 295.4 | 70.46 | 337.5 | 66.25 |
| 36            | 3040.0 | 69.60 | 3636.4 | 65.09 | 254.5 | 74.55 | 360.0 | 64.00 |
| 38            | 3692.3 | 63.08 | 3600.0 | 64.00 | 300.0 | 70.00 | 295.4 | 70.46 |
| 43            | 3040.0 | 69.60 | 3544.6 | 64.55 | 258.5 | 74.15 | 320.0 | 68.00 |
| 51            | 2953.8 | 70.46 | 3396.9 | 66.03 | 258.5 | 74.15 | 266.7 | 73.33 |
| 55            | 2880.0 | 71.20 | 3150.0 | 68.50 | 225.0 | 77.52 | 258.5 | 74.15 |

**Table A.8** SS of microorganism in each type of inoculums with time

| Time<br>(day) | SS (g/L) |       |       |       |
|---------------|----------|-------|-------|-------|
|               | 1B       | 2B    | 3B    | 4B    |
| 1             | 4.833    | 4.967 | 5.067 | 5.033 |
| 6             | 4.833    | 4.933 | 5.200 | 5.200 |
| 10            | 4.867    | 5.033 | 5.033 | 4.900 |
| 16            | 4.700    | 5.300 | 5.300 | 5.167 |
| 20            | 5.300    | 5.867 | 5.433 | 5.500 |
| 28            | 5.633    | 6.167 | 5.733 | 5.367 |
| 35            | 6.067    | 6.033 | 5.633 | 5.867 |
| 42            | 6.133    | 6.100 | 6.000 | 5.400 |
| 49            | 6.300    | 6.133 | 6.200 | 6.033 |
| 52            | 6.633    | 6.267 | 6.133 | 5.933 |
| 55            | 6.767    | 6.233 | 6.167 | 6.067 |

**Table A.9** VSS of microorganism in each type of inoculums with time

| Time<br>(day) | VSS (g/L) |       |       |       |
|---------------|-----------|-------|-------|-------|
|               | 1B        | 2B    | 3B    | 4B    |
| 1             | 3.300     | 3.933 | 3.500 | 3.900 |
| 6             | 3.367     | 3.900 | 3.600 | 4.067 |
| 10            | 3.533     | 4.067 | 3.533 | 4.000 |
| 16            | 3.367     | 4.500 | 3.900 | 4.200 |
| 20            | 4.033     | 4.733 | 4.067 | 4.467 |
| 28            | 4.533     | 5.100 | 4.333 | 4.433 |
| 35            | 5.100     | 5.000 | 4.367 | 4.867 |
| 42            | 4.967     | 5.333 | 5.000 | 4.667 |
| 49            | 5.367     | 5.167 | 5.133 | 5.100 |
| 52            | 5.667     | 5.400 | 4.967 | 5.000 |
| 55            | 5.833     | 5.367 | 5.100 | 5.033 |

**Table A.10** sCOD removal in each type of natural inoculums in reactor with time

| Time<br>(day) | 1BB    |       | 2BB    |       | 3BB    |       | 4BB    |       |
|---------------|--------|-------|--------|-------|--------|-------|--------|-------|
|               | mg/L   | %     | mg/L   | %     | mg/L   | %     | mg/L   | %     |
| 3             | 5301.5 | 35.35 | 5287.0 | 35.52 | 1808.7 | 35.40 | 1862.7 | 33.48 |
| 6             | 4578.5 | 44.17 | 4521.7 | 44.86 | 1704.3 | 39.13 | 1698.5 | 39.34 |
| 10            | 3927.3 | 52.11 | 4356.3 | 46.87 | 1573.1 | 43.82 | 1381.8 | 50.65 |
| 15            | 3450.0 | 57.93 | 4283.1 | 47.77 | 1440.0 | 48.57 | 1125.0 | 59.82 |
| 17            | 3396.9 | 58.57 | 3987.7 | 51.37 | 1255.4 | 55.16 | 1107.7 | 60.44 |
| 23            | 3249.2 | 60.38 | 3934.4 | 52.02 | 1141.0 | 59.25 | 1107.7 | 60.44 |
| 31            | 2850.0 | 65.24 | 3249.2 | 60.38 | 1107.7 | 60.44 | 1125.0 | 59.82 |
| 36            | 2560.0 | 68.78 | 2909.1 | 64.52 | 1090.9 | 61.04 | 1040.0 | 62.86 |
| 38            | 2658.5 | 67.58 | 2550.0 | 68.90 | 900.0  | 67.86 | 923.1  | 67.03 |
| 43            | 2720.0 | 66.83 | 2658.5 | 67.58 | 886.2  | 68.35 | 960.0  | 65.71 |
| 51            | 2510.8 | 69.38 | 2584.6 | 68.48 | 886.2  | 68.35 | 923.1  | 67.03 |
| 55            | 2438.1 | 70.27 | 2510.8 | 69.38 | 825.0  | 70.55 | 886.2  | 68.35 |

**Table A.11** SS of microorganism in each type of inoculums with time

| Time<br>(day) | SS (g/L) |       |       |       |
|---------------|----------|-------|-------|-------|
|               | 1BB      | 2BB   | 3BB   | 4BB   |
| 1             | 4.833    | 4.900 | 4.933 | 4.967 |
| 6             | 5.000    | 4.967 | 4.900 | 5.033 |
| 10            | 4.667    | 5.033 | 4.967 | 5.000 |
| 16            | 5.000    | 5.433 | 5.267 | 5.267 |
| 20            | 5.467    | 5.600 | 5.000 | 5.133 |
| 28            | 5.000    | 5.367 | 5.533 | 5.567 |
| 35            | 5.767    | 5.633 | 5.600 | 5.467 |
| 42            | 5.667    | 5.900 | 5.933 | 5.967 |
| 49            | 6.000    | 5.767 | 6.033 | 5.867 |
| 52            | 6.300    | 5.900 | 6.100 | 5.800 |
| 55            | 6.267    | 6.100 | 6.233 | 5.933 |

**Table A.12** VSS of microorganism in each type of inoculums with time

| Time<br>(day) | VSS (g/L) |       |       |       |
|---------------|-----------|-------|-------|-------|
|               | 1BB       | 2BB   | 3BB   | 4BB   |
| 1             | 3.600     | 3.333 | 3.433 | 3.900 |
| 6             | 3.600     | 3.400 | 3.467 | 3.933 |
| 10            | 3.333     | 3.600 | 3.767 | 4.000 |
| 16            | 3.667     | 4.033 | 4.267 | 4.367 |
| 20            | 4.133     | 4.400 | 4.133 | 4.100 |
| 28            | 4.067     | 4.233 | 4.567 | 4.700 |
| 35            | 4.567     | 4.533 | 4.533 | 4.533 |
| 42            | 4.333     | 4.833 | 4.900 | 4.900 |
| 49            | 4.900     | 4.667 | 4.833 | 4.700 |
| 52            | 5.133     | 4.767 | 5.200 | 4.950 |
| 55            | 5.267     | 5.033 | 5.267 | 4.967 |

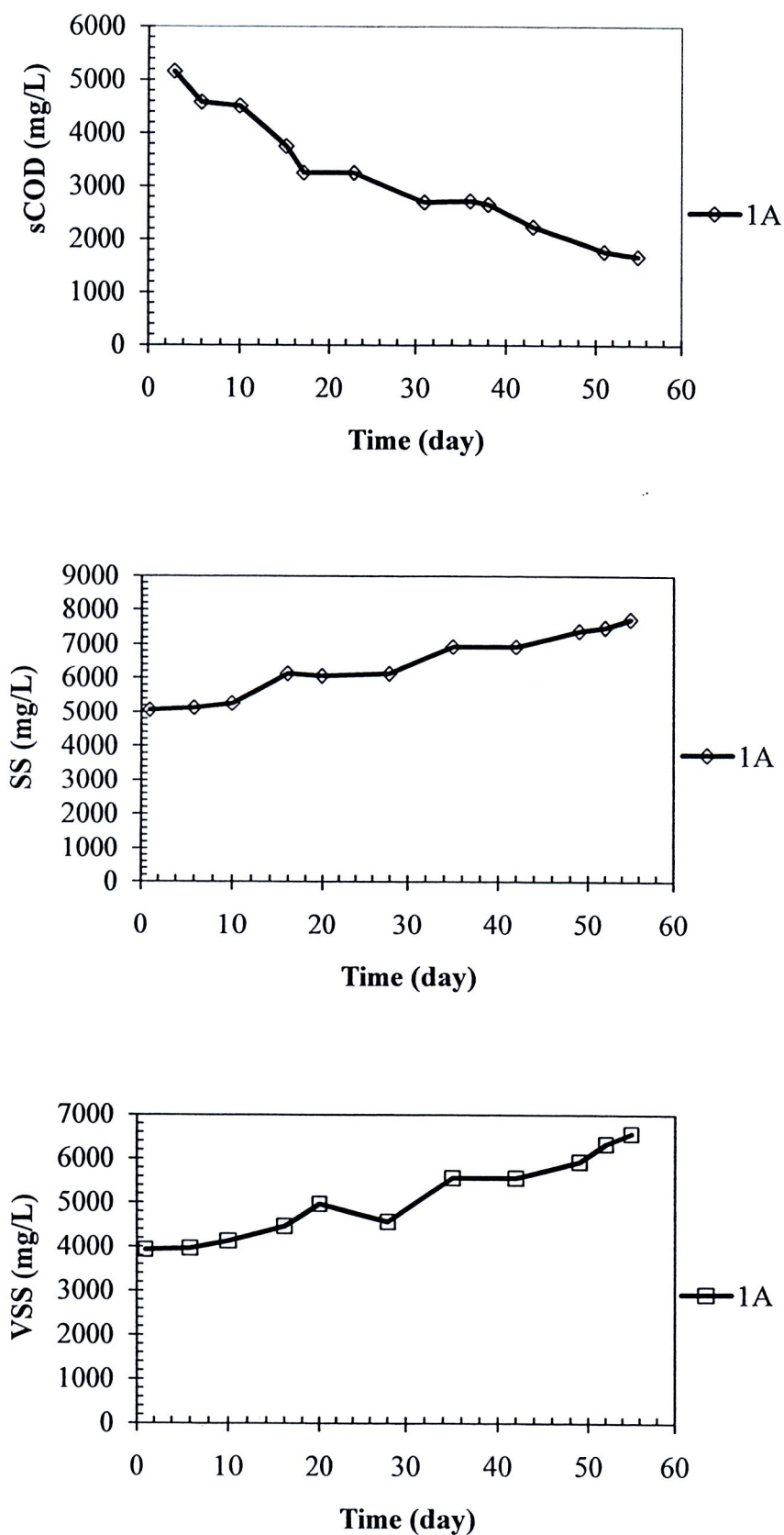
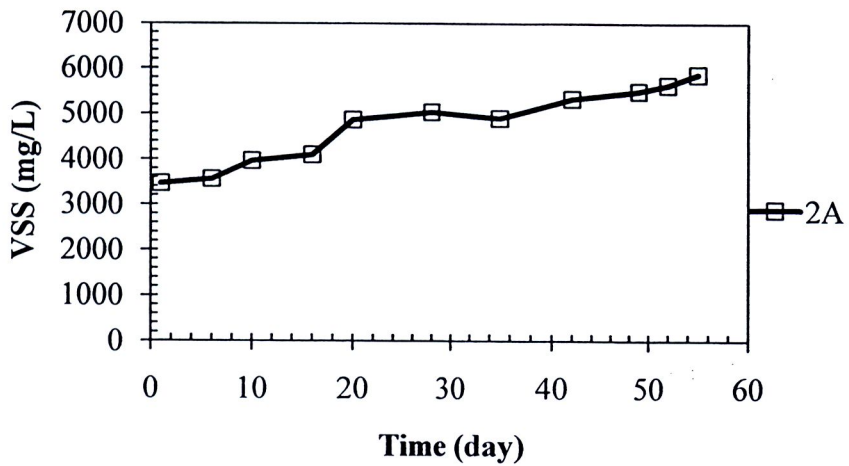
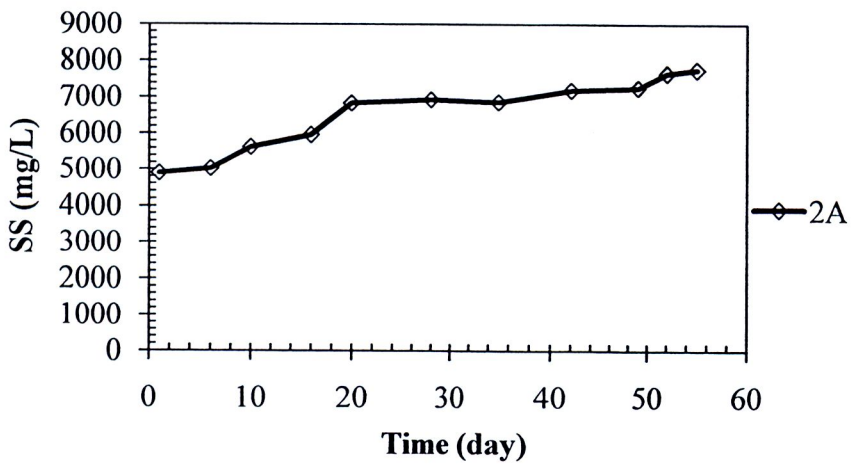
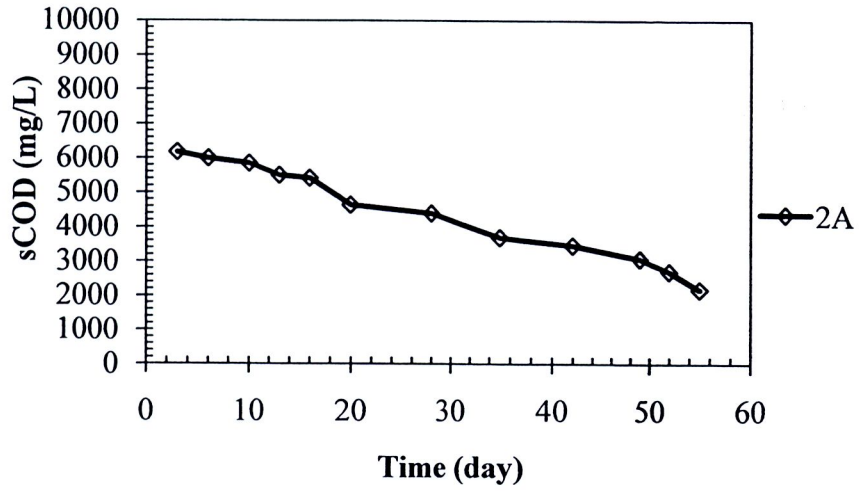


Figure A.1 Profile of sCOD, SS and VSS of reactor 1A



**Figure A.2** Profile of sCOD, SS and VSS of reactor 2A

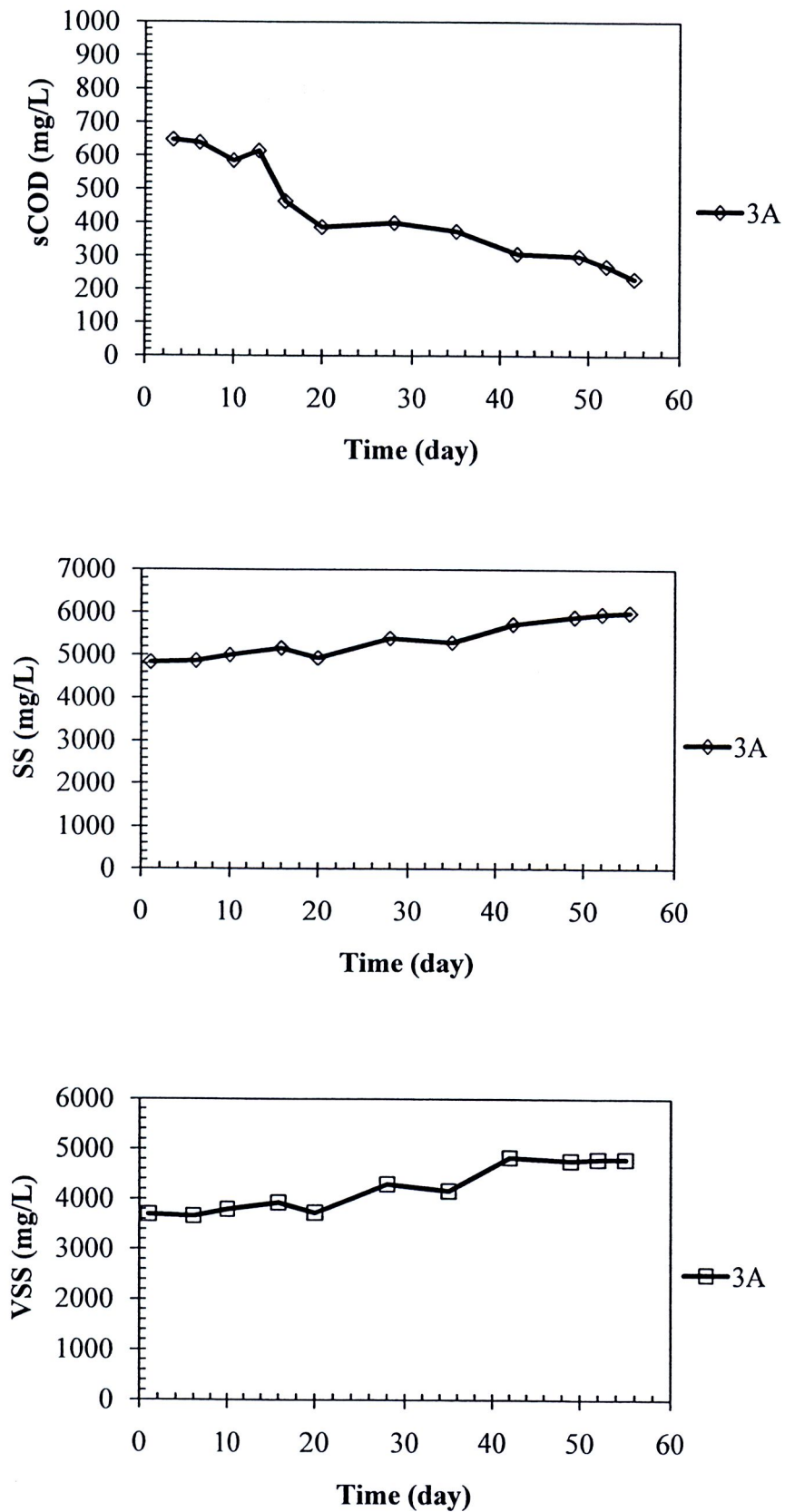


Figure A.3 Profile of sCOD, SS and VSS of reactor 3A

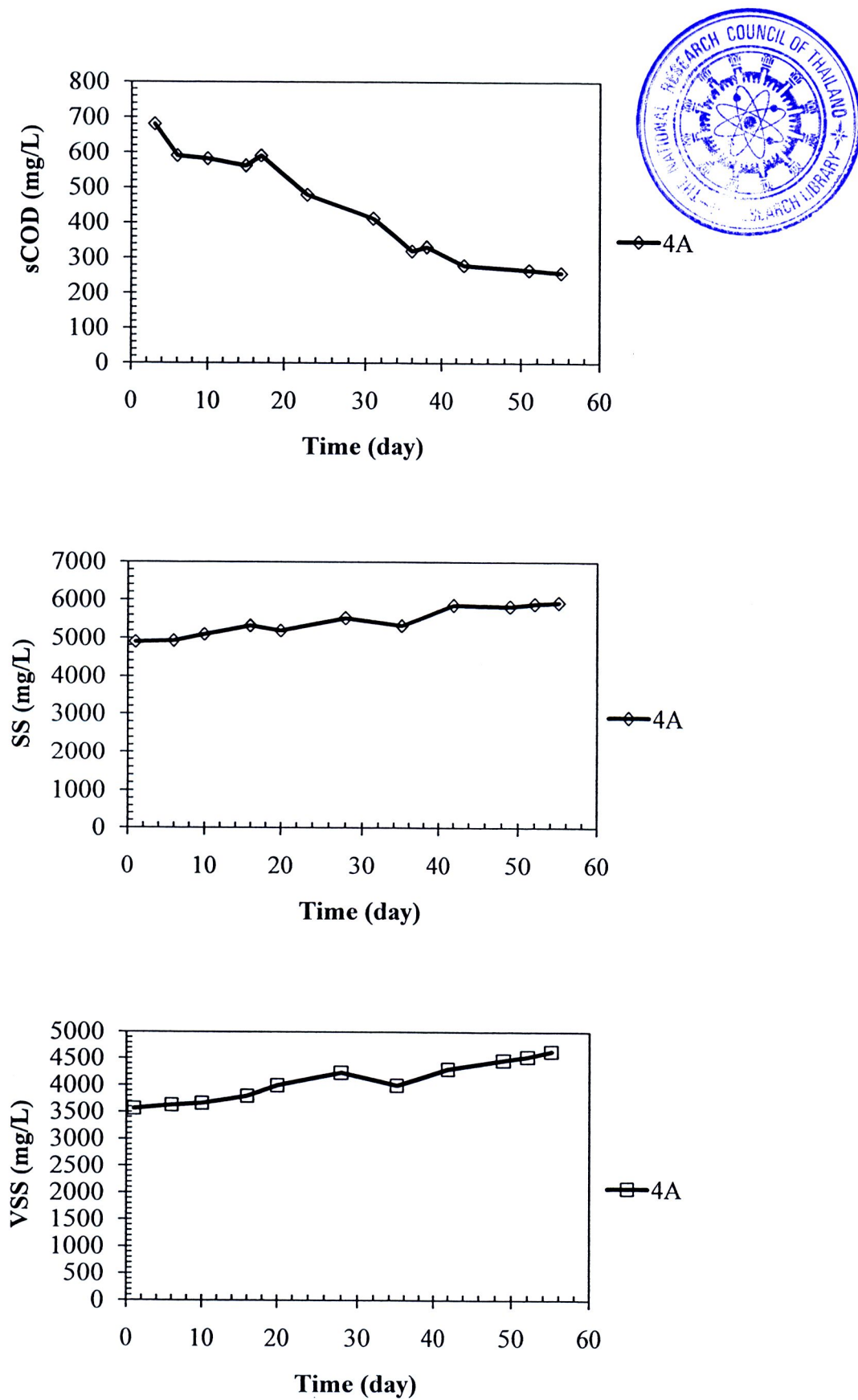


Figure A.4 Profile of sCOD, SS and VSS of reactor 4A

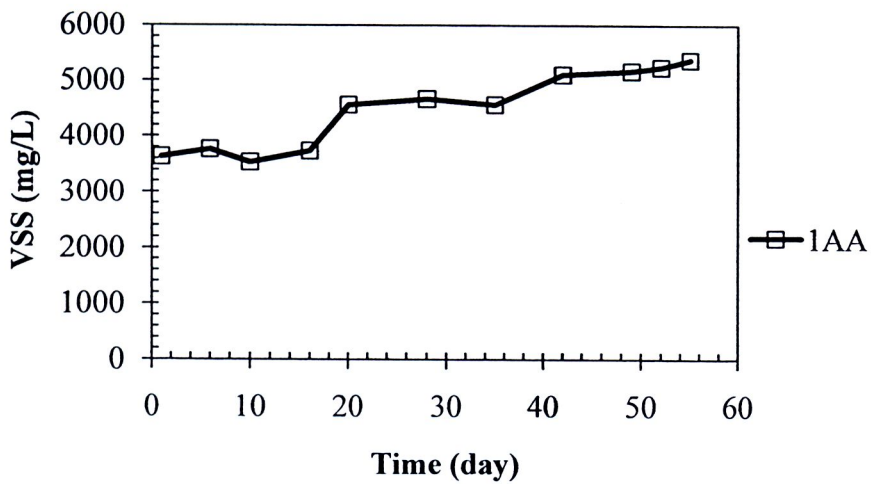
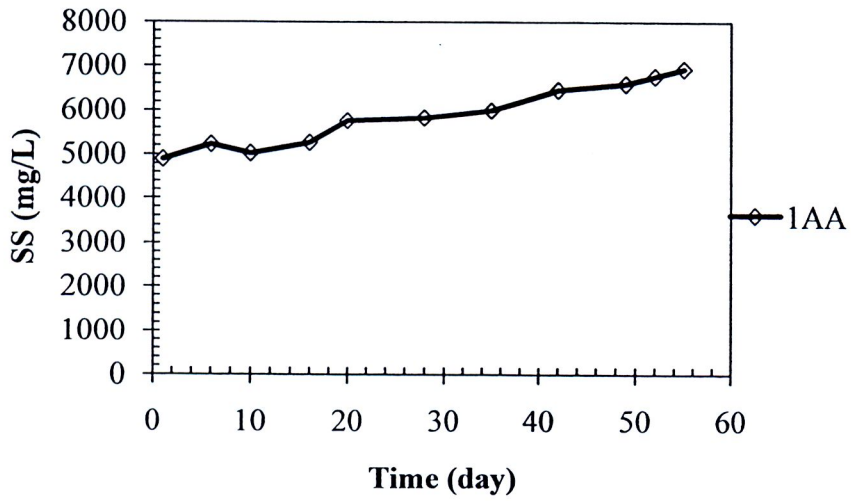
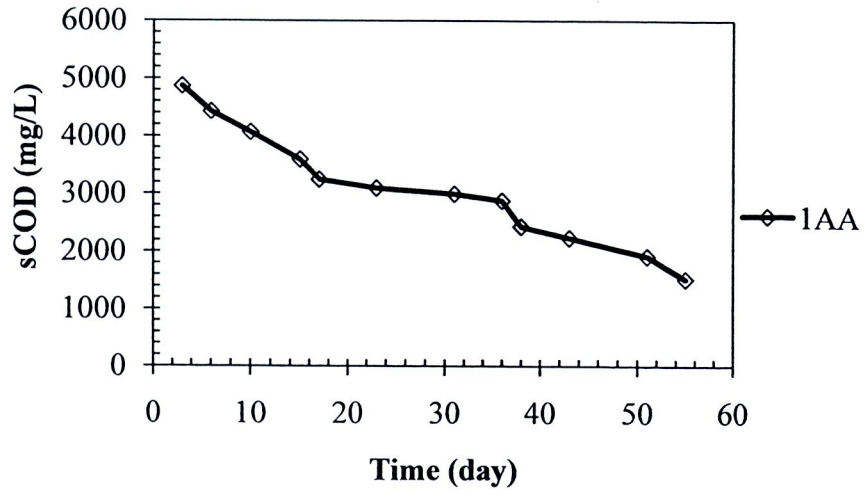
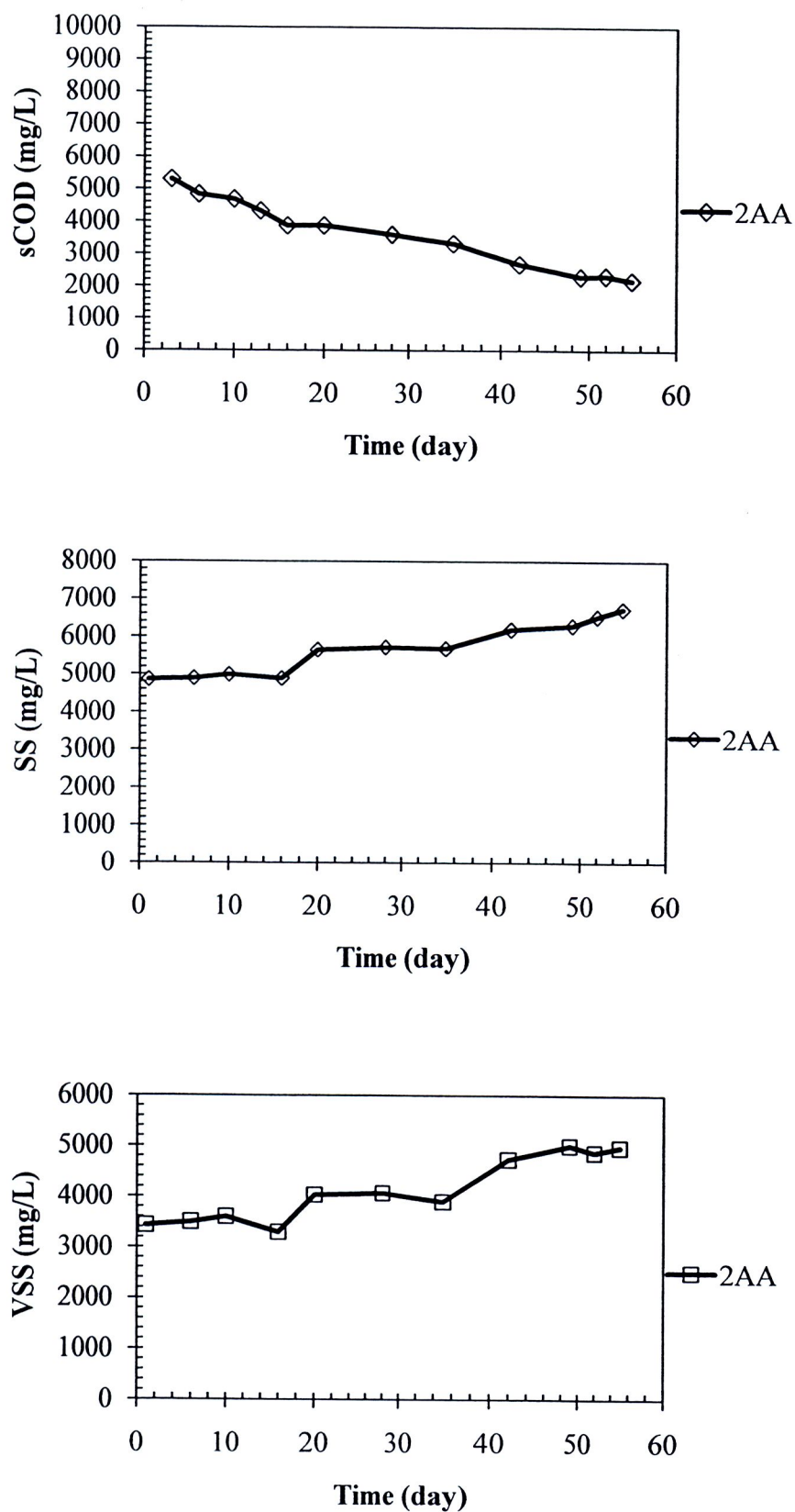
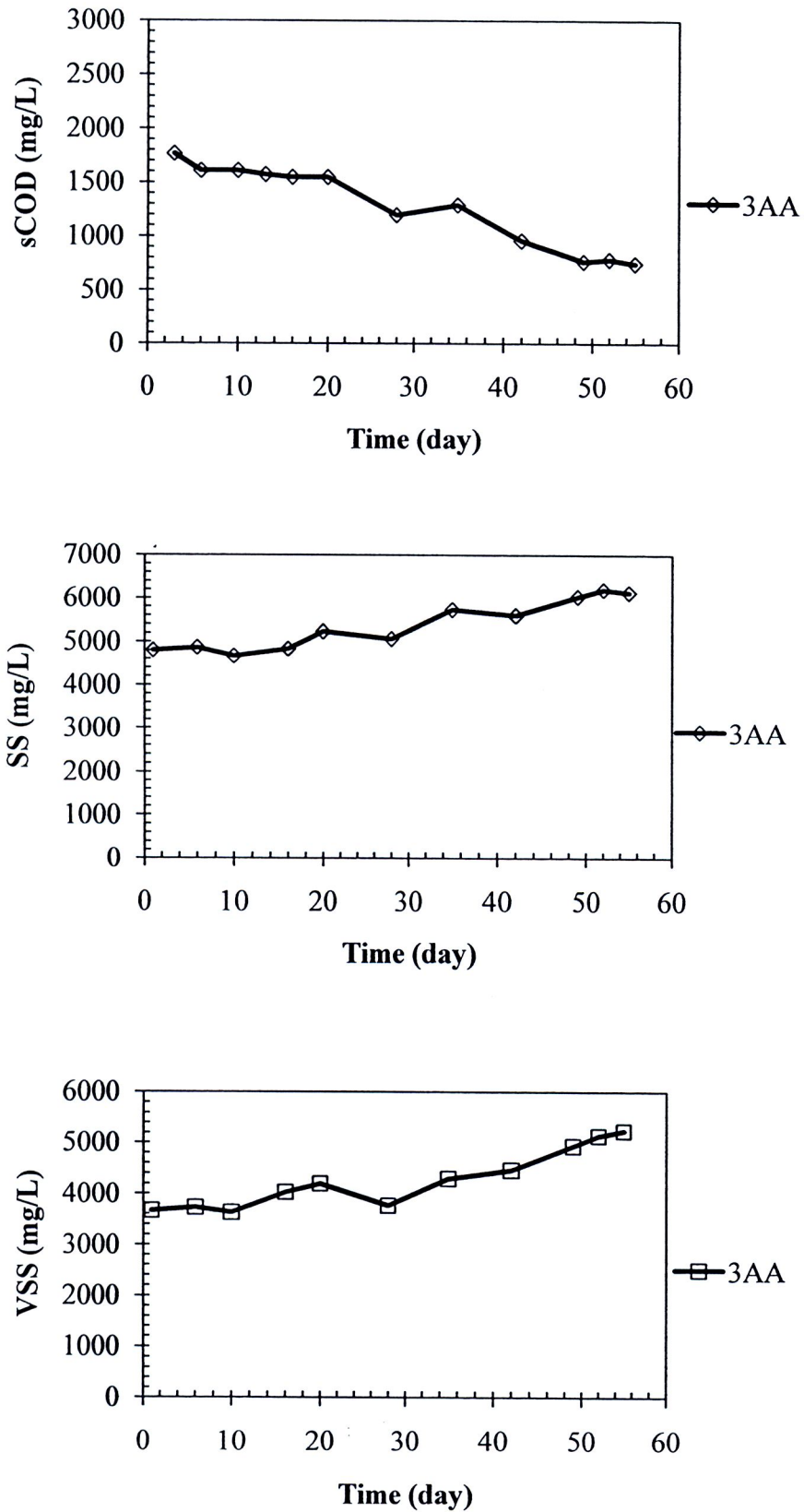


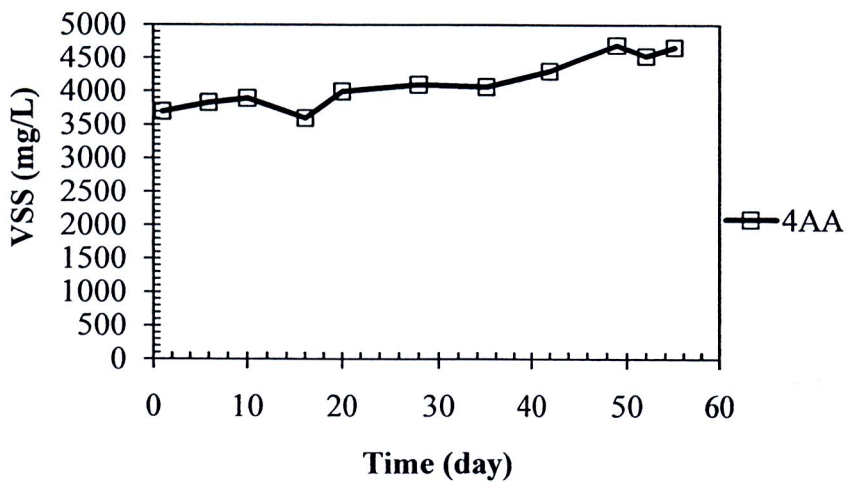
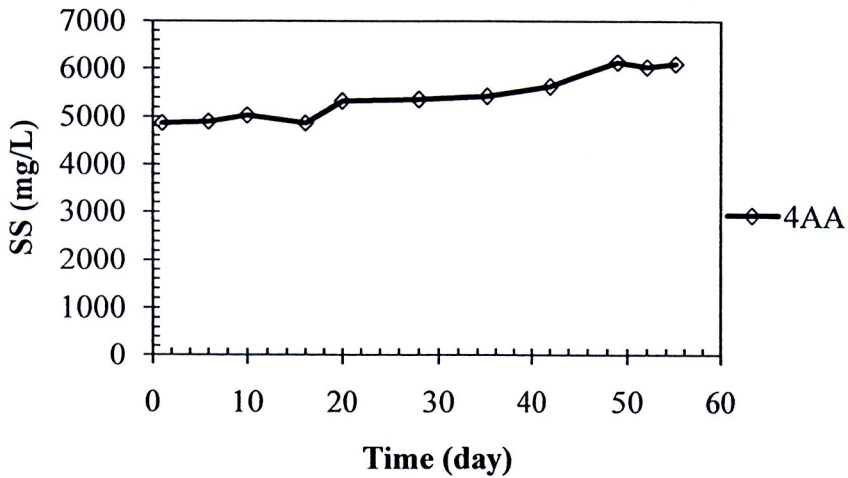
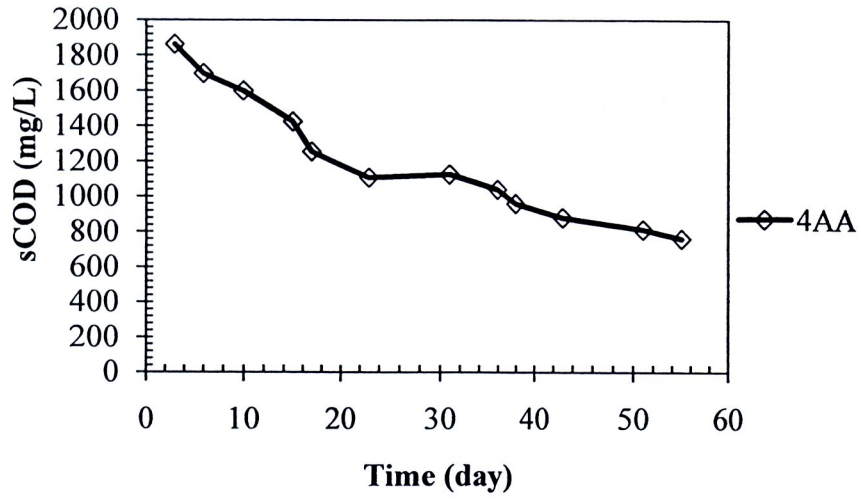
Figure A.5 Profile of sCOD, SS and VSS of reactor 1AA



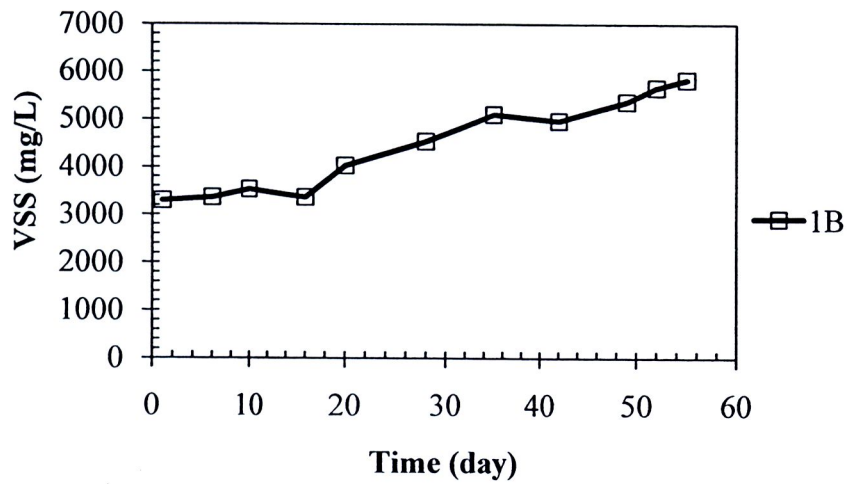
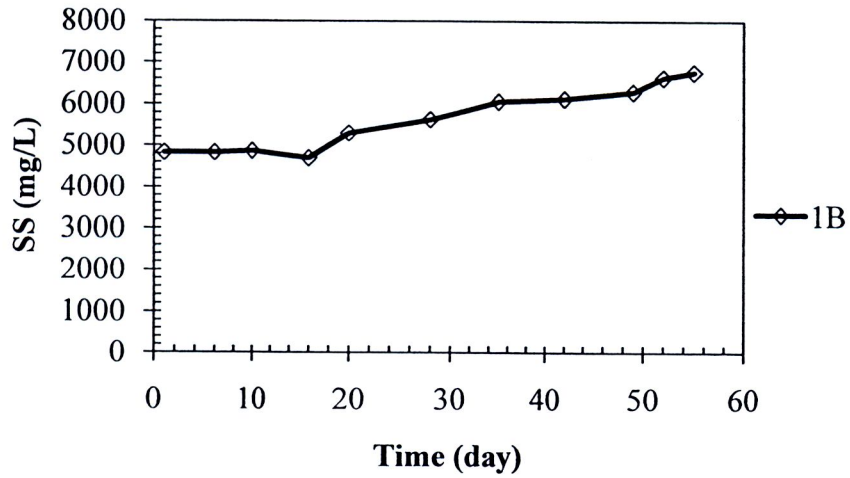
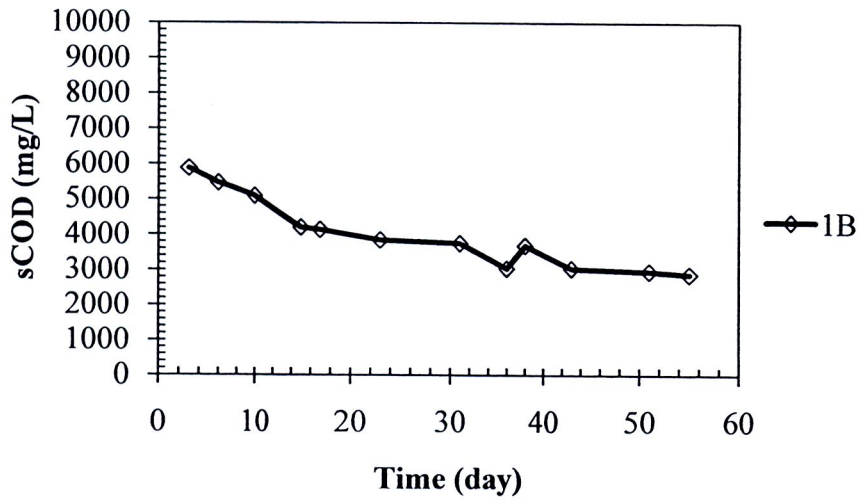
**Figure A.6** Profile of sCOD, SS and VSS of reactor 2AA



**Figure A.7** Profile of sCOD, SS and VSS of reactor 3AA



**Figure A.8** Profile of sCOD, SS and VSS of reactor 4AA



**Figure A.9** Profile of sCOD, SS and VSS of reactor 1B

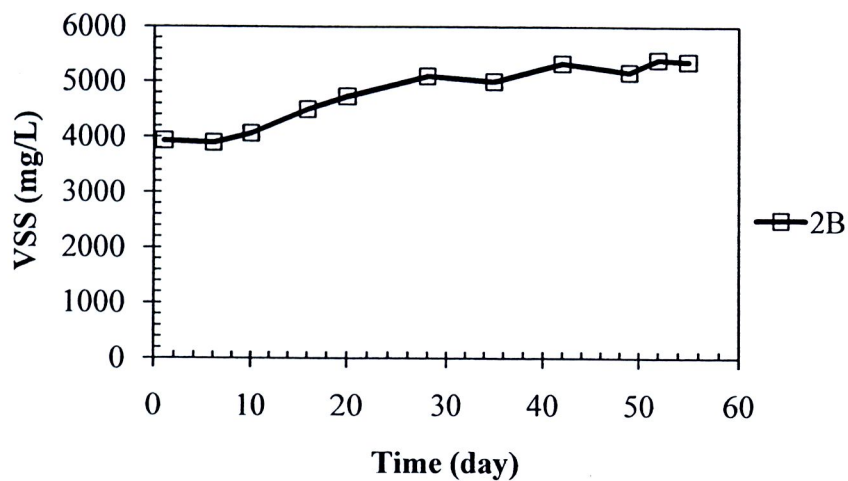
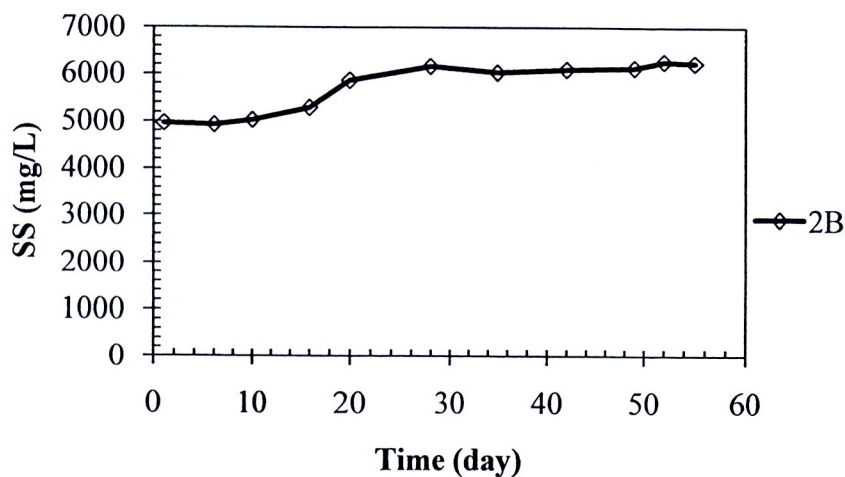
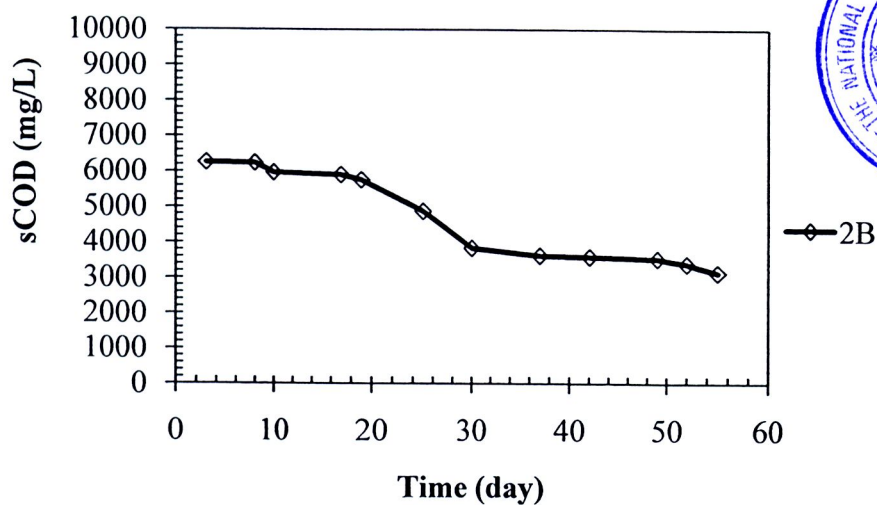


Figure A.10 Profile of sCOD, SS and VSS of reactor 2B

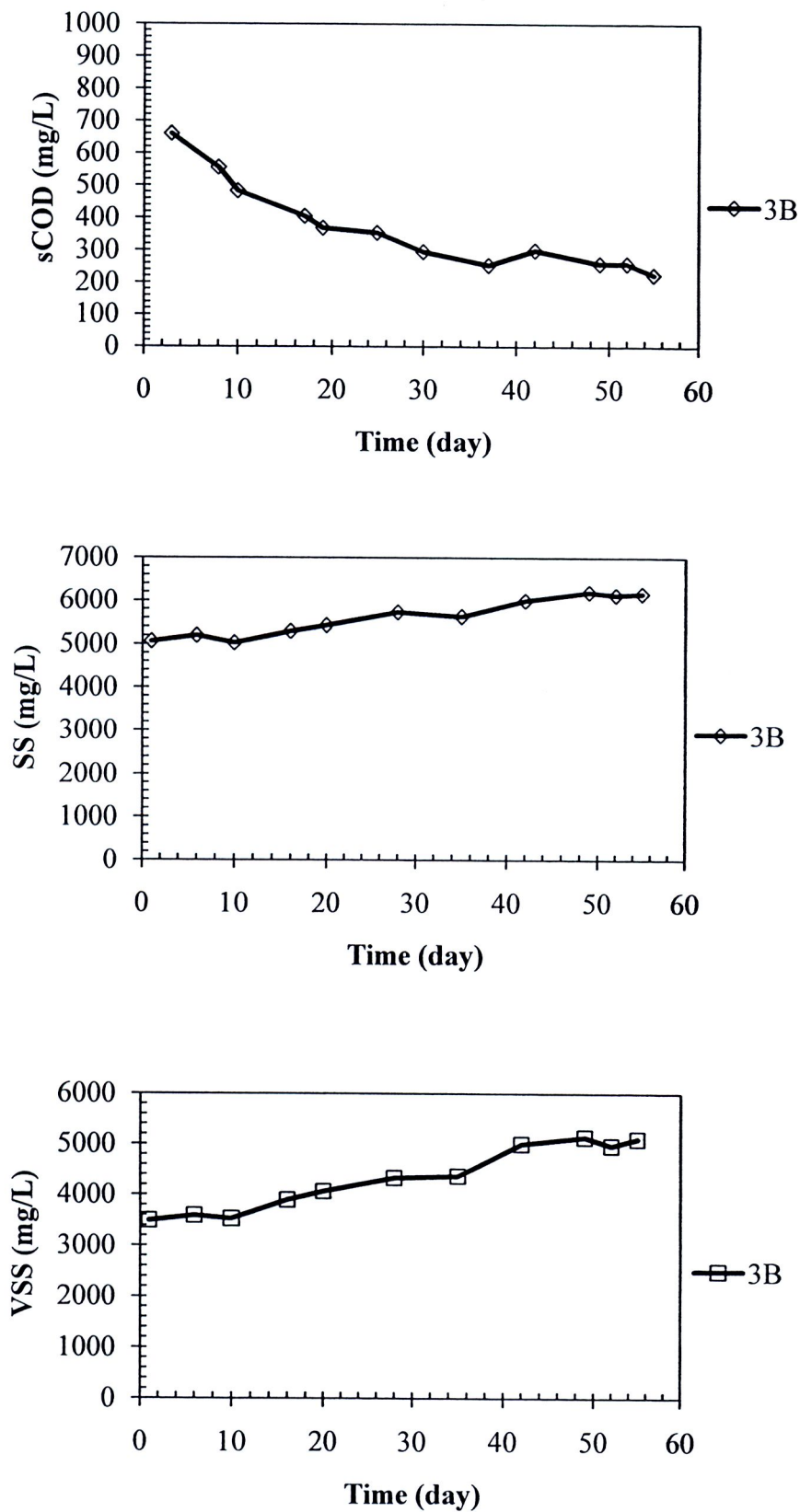


Figure A.11 Profile of sCOD, SS and VSS of reactor 3B

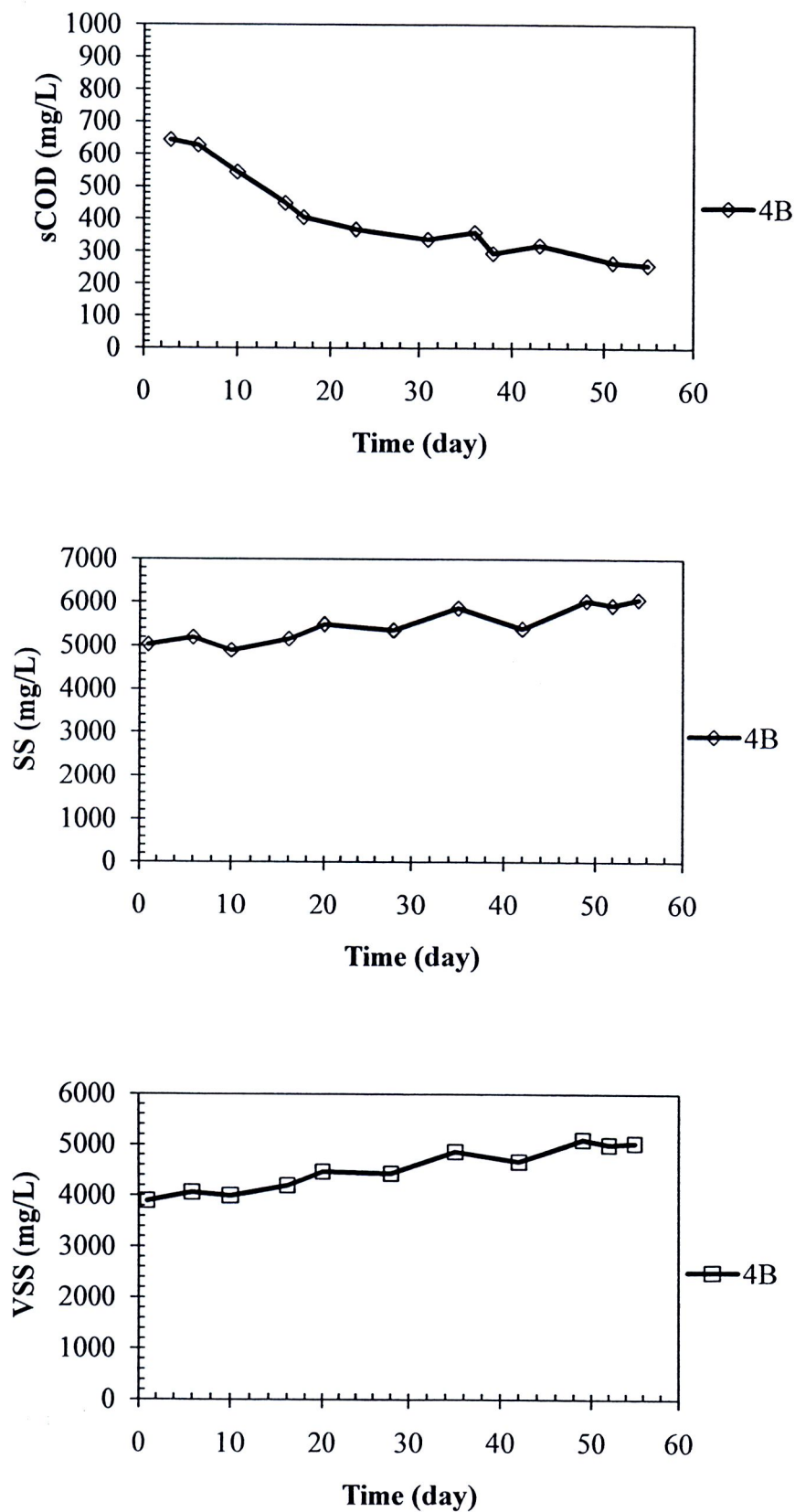
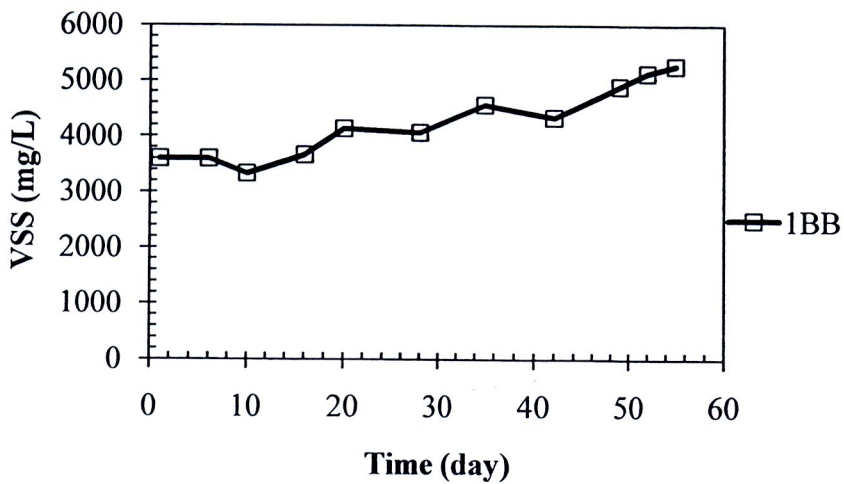
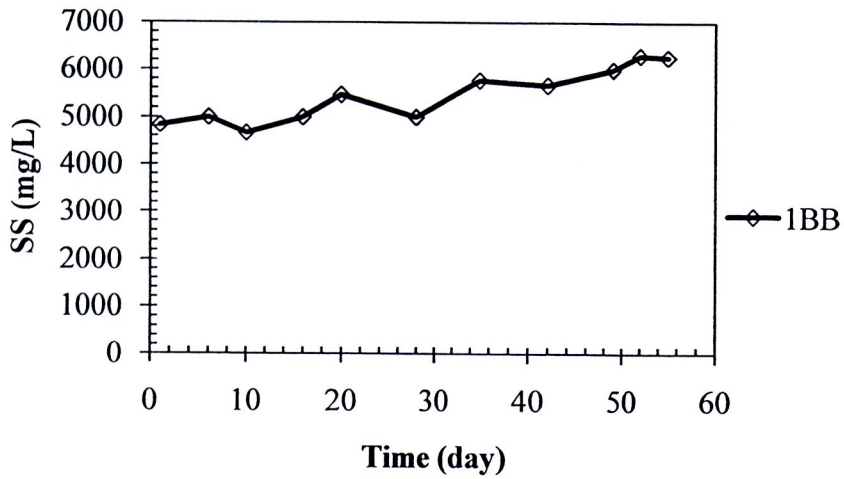
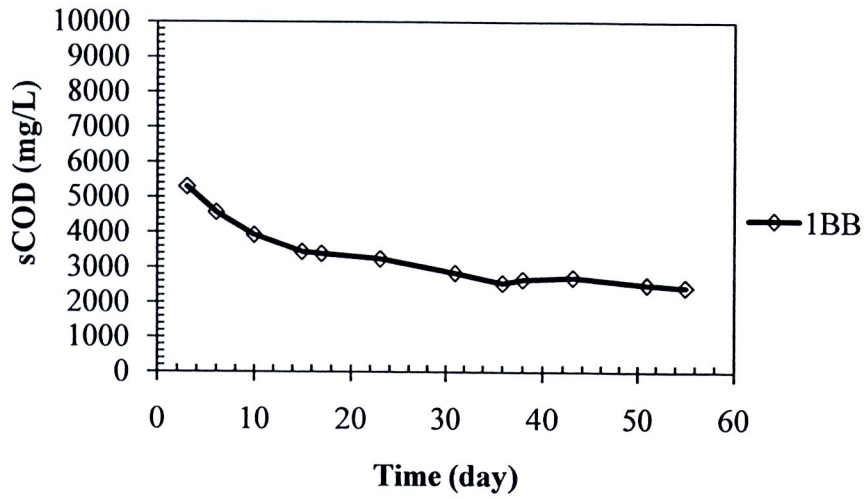


Figure A.12 Profile of sCOD, SS and VSS of reactor 4B



**Figure A.13** Profile of sCOD, SS and VSS of reactor 1BB

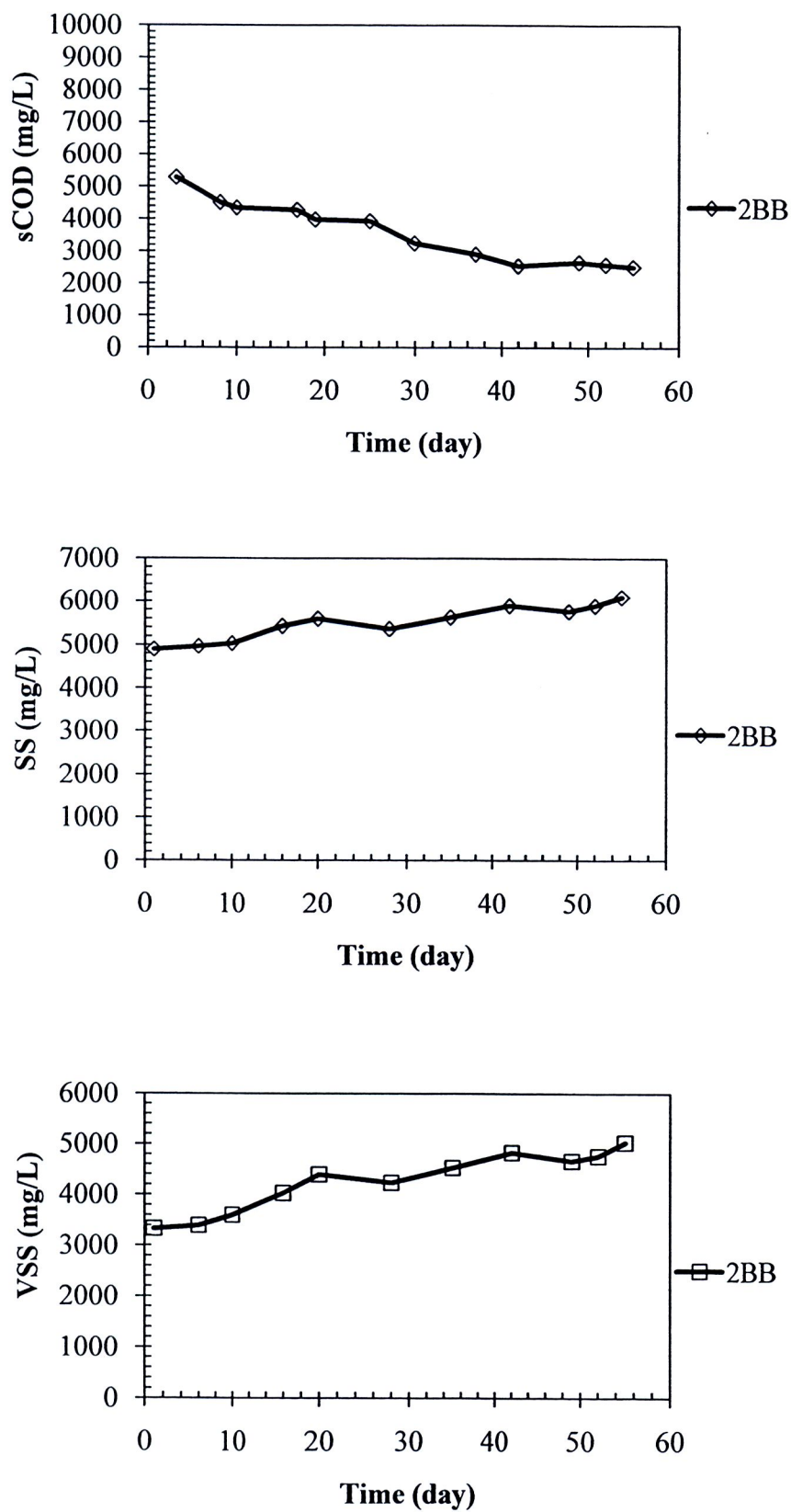


Figure A.14 Profile of sCOD, SS and VSS of reactor 2BB

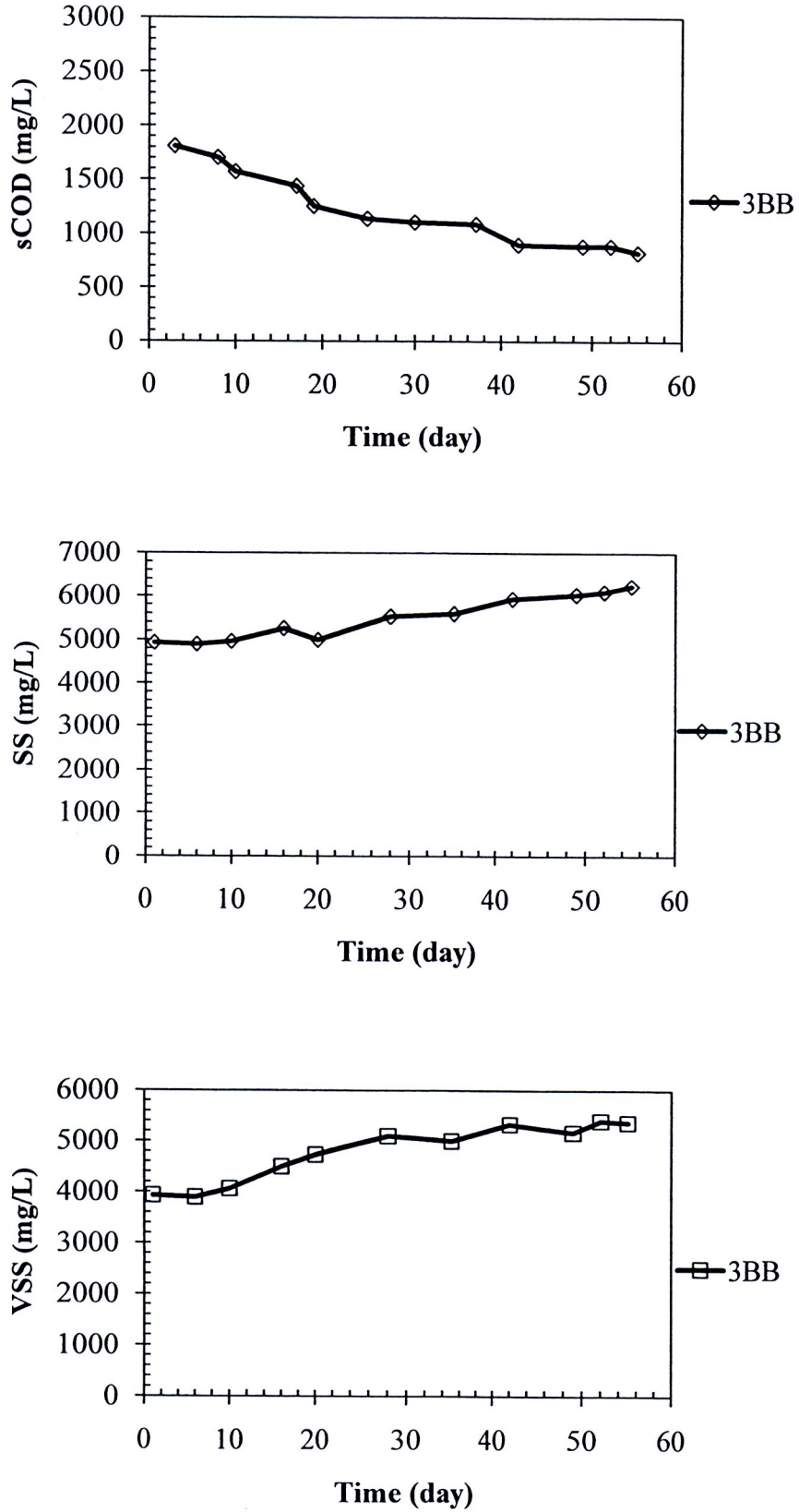


Figure A.15 Profile of sCOD, SS and VSS of reactor 3BB

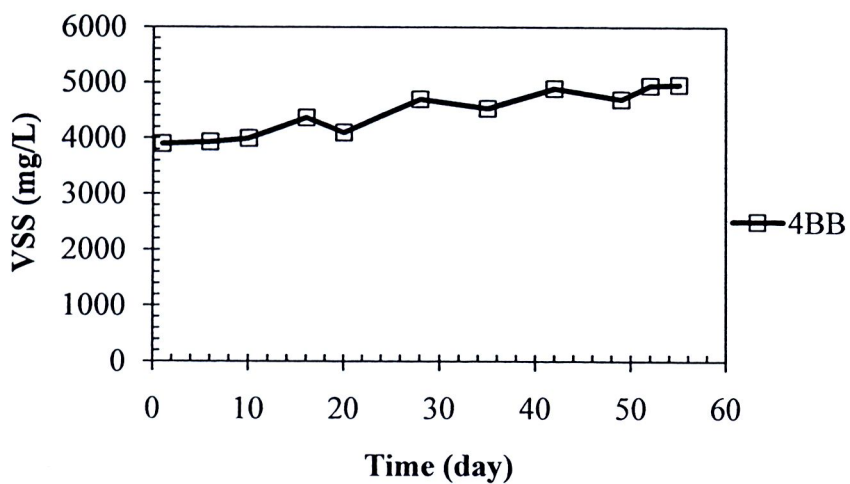
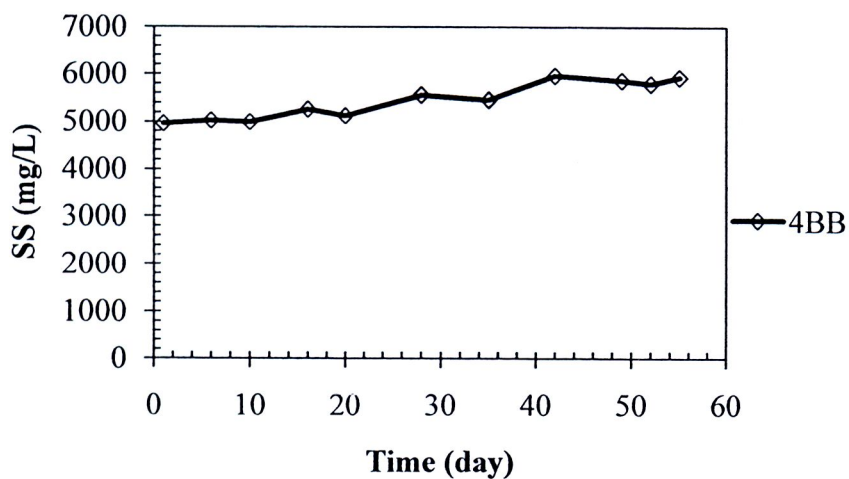
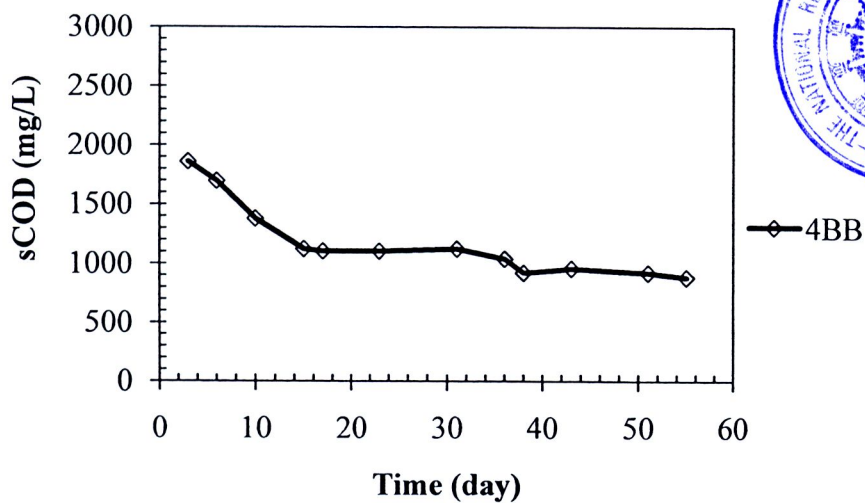


Figure A.16 Profile of sCOD, SS and VSS of reactor 4BB

## **APPENDIX B**

Performance of Anaerobic Sequencing Batch Reactor experiment

**Table B.1** sCOD removal in each type of inoculums in reactor with time

| Time<br>(day) | DD1    |       | DD2   |       | DD3    |       | DD4   |       |
|---------------|--------|-------|-------|-------|--------|-------|-------|-------|
|               | mg/L   | %     | mg/L  | %     | mg/L   | %     | mg/L  | %     |
| 1             | 525.0  | 47.50 | 600.0 | 40.00 | 487.5  | 51.25 | 600.0 | 40.00 |
| 2             | 487.5  | 51.25 | 300.0 | 42.86 | 450.0  | 55.00 | 337.5 | 30.77 |
| 3             | 487.5  | 51.25 | 262.5 | 46.15 | 431.3  | 56.88 | 375.0 | 16.67 |
| 4             | 460.8  | 53.92 | 268.8 | 44.86 | 422.4  | 57.76 | 307.2 | 28.77 |
| 5             | 487.5  | 51.25 | 262.5 | 43.03 | 375.0  | 62.50 | 262.5 | 37.86 |
| 6             | 412.5  | 58.75 | 262.5 | 46.15 | 450.0  | 55.00 | 262.5 | 30.00 |
| 9             | 468.8  | 53.13 | 300.0 | 27.27 | 412.5  | 58.75 | 300.0 | 33.33 |
| 11            | 450.0  | 55.00 | 262.5 | 44.00 | 450.0  | 55.00 | 300.0 | 27.27 |
| 12            | 450.0  | 55.00 | 262.5 | 41.67 | 375.0  | 62.50 | 337.5 | 25.00 |
| 13            | 375.0  | 62.50 | 262.5 | 41.67 | 375.0  | 62.50 | 262.5 | 30.00 |
| 25            | 1142.9 | 4.76  | 838.1 | 21.43 | 1142.9 | 4.76  | 761.9 | 16.67 |
| 26            | 1066.7 | 11.11 | 914.3 | 20.00 | 990.5  | 17.46 | 838.1 | 26.67 |
| 27            | 1142.9 | 4.84  | 990.5 | 7.14  | 1066.7 | 11.19 | 914.3 | 7.69  |
| 30            | 1142.9 | 4.76  | 838.1 | 26.67 | 1142.9 | 4.76  | 838.1 | 21.43 |
| 31            | 1090.9 | 8.94  | 945.5 | 17.27 | 1090.9 | 8.94  | 872.7 | 23.64 |
| 32            | 1074.6 | 10.37 | 859.7 | 21.19 | 1003.0 | 16.35 | 788.1 | 27.76 |
| 33            | 1074.6 | 10.45 | 859.7 | 20.00 | 1074.6 | 10.45 | 859.7 | 14.29 |
| 34            | 996.9  | 16.92 | 849.2 | 20.97 | 996.9  | 16.92 | 812.3 | 24.41 |
| 36            | 967.2  | 19.40 | 752.2 | 24.54 | 967.2  | 19.40 | 788.1 | 20.95 |
| 37            | 981.8  | 18.18 | 654.5 | 32.32 | 945.5  | 21.21 | 690.9 | 28.56 |
| 38            | 960.0  | 20.00 | 812.3 | 17.26 | 960.0  | 20.00 | 775.4 | 17.99 |
| 39            | 886.2  | 26.15 | 627.7 | 34.62 | 886.2  | 26.15 | 553.8 | 42.31 |
| 40            | 882.4  | 26.47 | 705.9 | 20.34 | 917.6  | 23.53 | 776.5 | 12.38 |
| 41            | 847.1  | 29.41 | 635.3 | 28.00 | 882.4  | 26.47 | 705.9 | 23.08 |
| 42            | 886.2  | 26.15 | 590.8 | 30.26 | 886.2  | 26.15 | 701.5 | 20.49 |
| 43            | 849.2  | 29.23 | 627.7 | 29.17 | 849.2  | 29.23 | 664.6 | 25.00 |
| 44            | 823.9  | 31.34 | 573.1 | 32.51 | 823.9  | 31.34 | 537.3 | 36.73 |
| 45            | 847.1  | 29.41 | 494.1 | 40.03 | 811.8  | 32.35 | 529.4 | 35.74 |
| 46            | 811.8  | 32.35 | 494.1 | 41.67 | 776.5  | 35.29 | 423.5 | 47.83 |

**Table B.1** sCOD removal in each type of inoculums in reactor with time ( cont.)

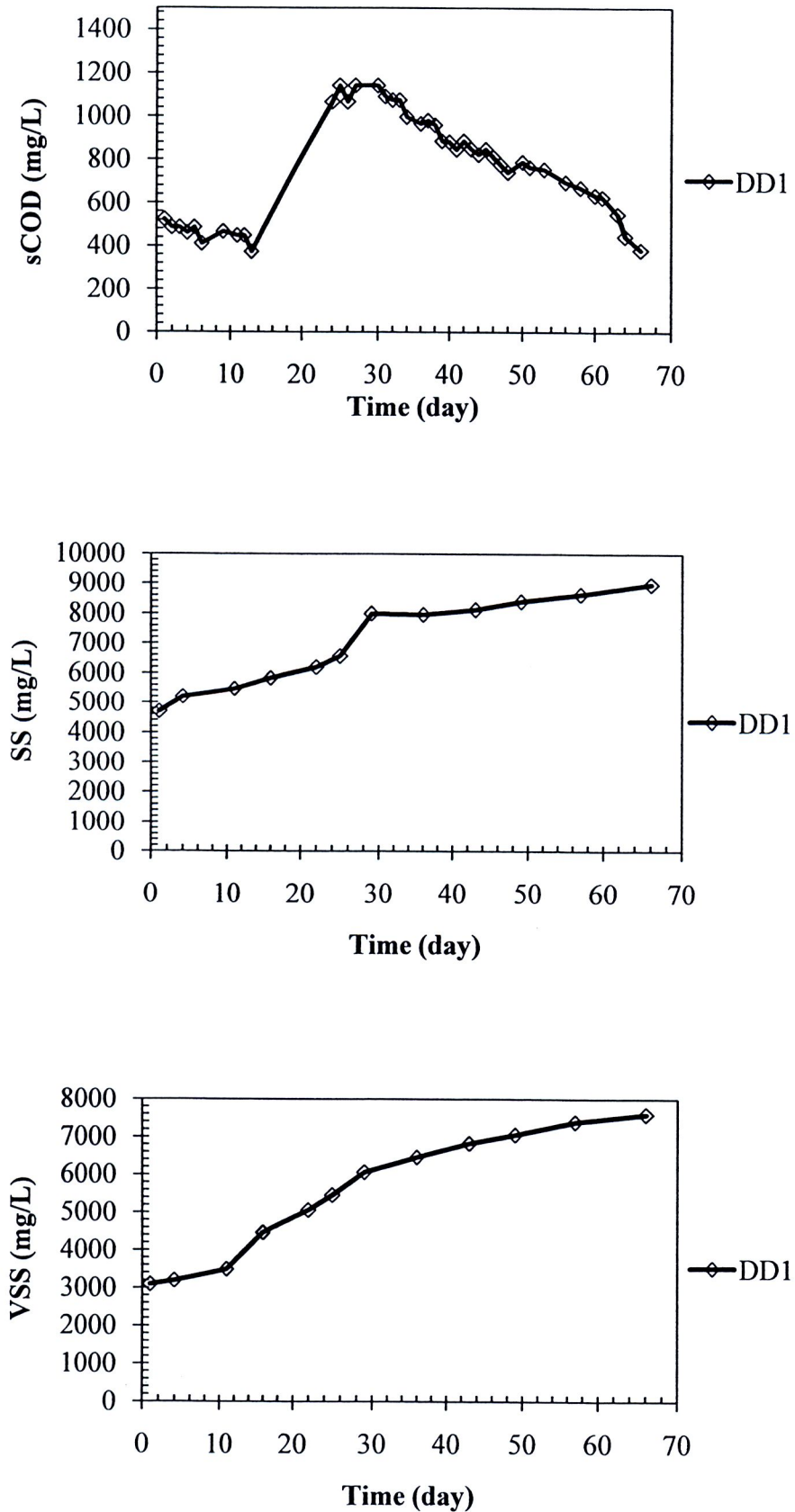
| Time<br>(day) | DD1   |       | DD2   |       | DD3   |       | DD4   |       |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|
|               | mg/L  | %     | mg/L  | %     | mg/L  | %     | mg/L  | %     |
| 47            | 776.5 | 35.29 | 494.1 | 39.13 | 811.8 | 32.35 | 388.2 | 50.00 |
| 48            | 741.2 | 38.24 | 494.1 | 36.36 | 776.5 | 35.29 | 423.5 | 47.83 |
| 50            | 788.1 | 34.33 | 501.5 | 32.34 | 788.1 | 34.33 | 394.0 | 49.25 |
| 51            | 763.6 | 36.36 | 509.1 | 35.40 | 763.6 | 36.36 | 400.0 | 49.24 |
| 53            | 754.3 | 37.14 | 480.0 | 37.14 | 754.3 | 37.14 | 377.1 | 50.61 |
| 56            | 695.7 | 42.03 | 452.2 | 40.05 | 730.4 | 39.13 | 382.6 | 49.28 |
| 58            | 670.6 | 44.12 | 388.2 | 44.19 | 705.9 | 41.18 | 388.2 | 46.85 |
| 60            | 635.3 | 47.06 | 352.9 | 47.37 | 670.6 | 44.12 | 388.2 | 45.00 |
| 61            | 626.1 | 47.83 | 313.0 | 50.72 | 660.9 | 44.93 | 347.8 | 48.13 |
| 63            | 548.6 | 54.29 | 308.6 | 50.71 | 582.9 | 51.43 | 308.6 | 53.31 |
| 64            | 445.7 | 62.86 | 240.0 | 56.25 | 480.0 | 60.00 | 274.3 | 52.94 |
| 66            | 382.6 | 68.12 | 173.9 | 60.98 | 417.4 | 65.22 | 208.7 | 56.52 |

**Table B.2** SS of microorganism in each type of inoculums with time

| Time<br>(day) | SS (g/L) |       |       |       |
|---------------|----------|-------|-------|-------|
|               | DD1      | DD2   | DD3   | DD4   |
| 1             | 4.700    | 5.133 | 4.897 | 4.800 |
| 4             | 5.200    | 5.367 | 4.967 | 4.733 |
| 11            | 5.467    | 4.533 | 4.267 | 4.833 |
| 16            | 5.833    | 4.800 | 4.800 | 4.433 |
| 22            | 6.200    | 5.433 | 4.867 | 4.633 |
| 25            | 6.567    | 5.067 | 6.333 | 4.667 |
| 29            | 8.000    | 5.200 | 6.033 | 4.833 |
| 36            | 7.967    | 5.967 | 6.233 | 5.400 |
| 43            | 8.133    | 6.233 | 7.367 | 5.467 |
| 49            | 8.400    | 6.367 | 7.967 | 5.667 |
| 57            | 8.633    | 6.400 | 8.267 | 6.067 |
| 66            | 8.967    | 6.633 | 8.567 | 6.200 |

**Table B.3** VSS of microorganism in each type of inoculums with time

| Time<br>(day) | VSS (g/L) |       |       |       |
|---------------|-----------|-------|-------|-------|
|               | DD1       | DD2   | DD3   | DD4   |
| 1             | 3.100     | 3.067 | 3.033 | 3.000 |
| 4             | 3.200     | 3.533 | 3.067 | 3.033 |
| 11            | 3.500     | 3.300 | 3.133 | 3.600 |
| 16            | 4.467     | 3.667 | 3.867 | 3.133 |
| 22            | 5.067     | 3.633 | 4.167 | 3.600 |
| 25            | 5.467     | 3.300 | 5.133 | 3.667 |
| 29            | 6.067     | 3.867 | 5.033 | 4.067 |
| 36            | 6.467     | 4.033 | 5.067 | 4.033 |
| 43            | 6.833     | 4.233 | 6.133 | 4.233 |
| 49            | 7.067     | 5.000 | 6.900 | 4.233 |
| 57            | 7.400     | 5.200 | 7.000 | 5.067 |
| 66            | 7.600     | 5.667 | 7.233 | 5.433 |



**Figure B.1** Profile of sCOD, SS and VSS of reactor DD1

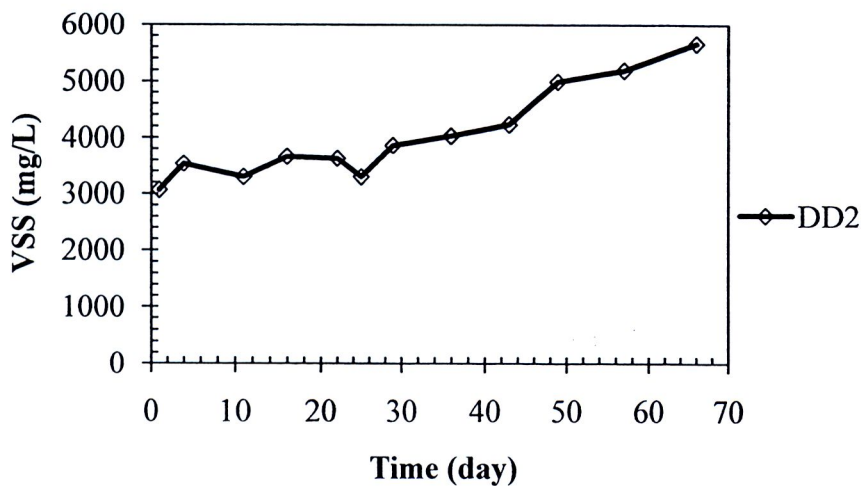
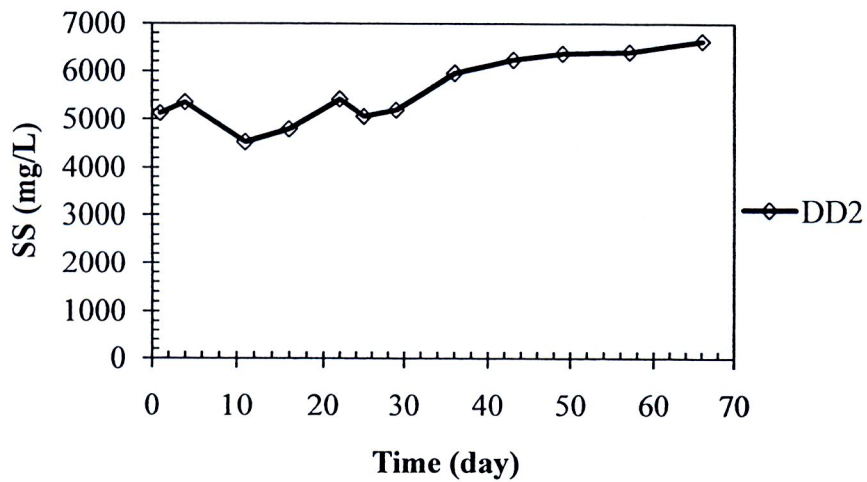
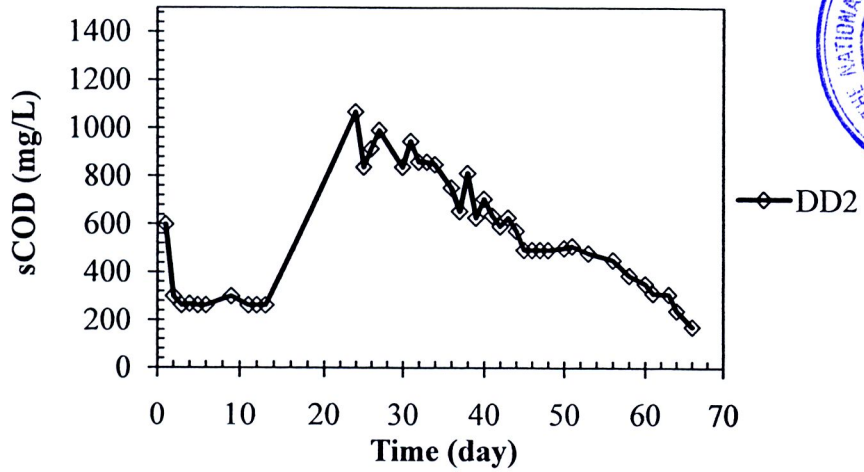
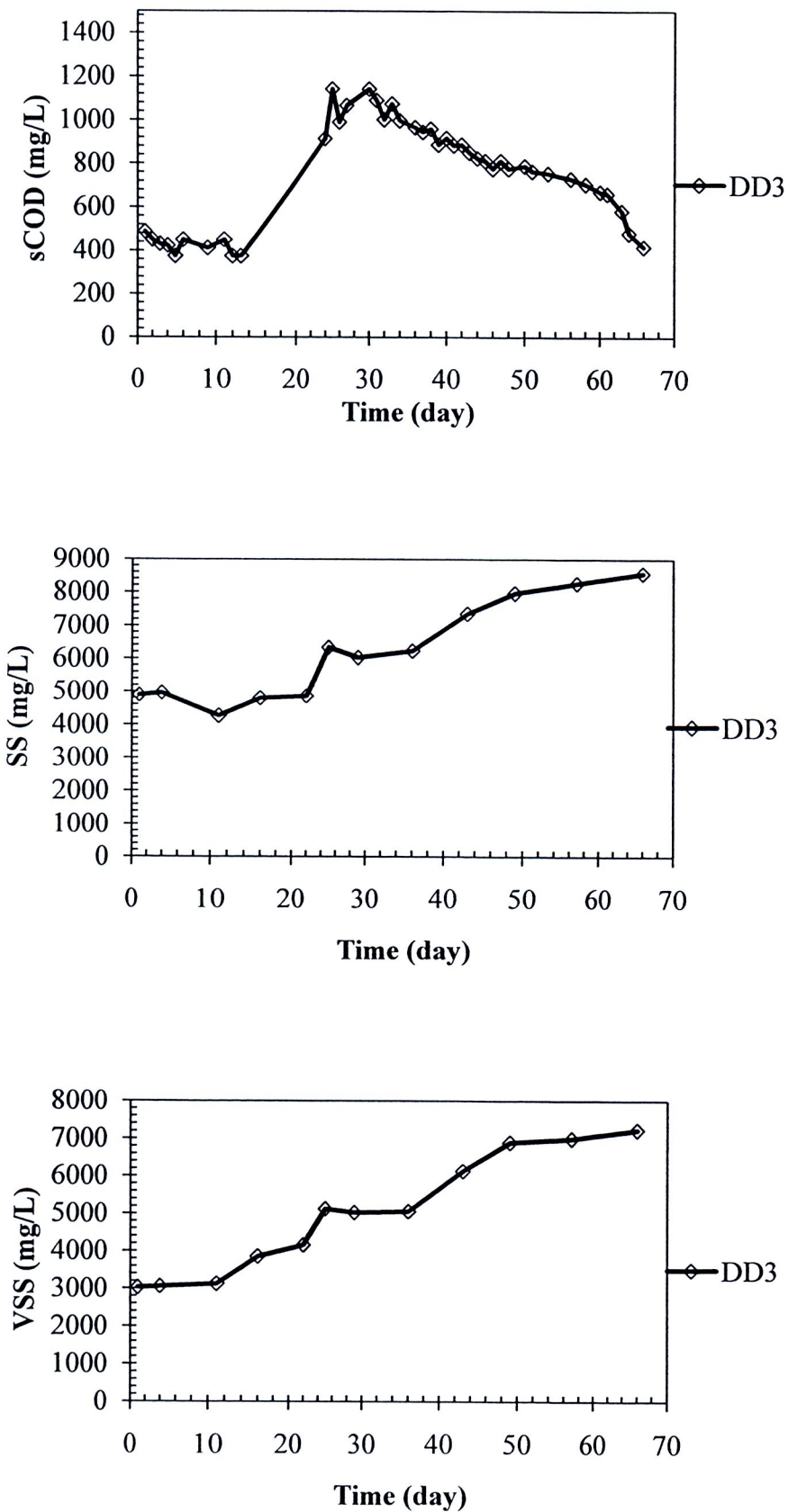
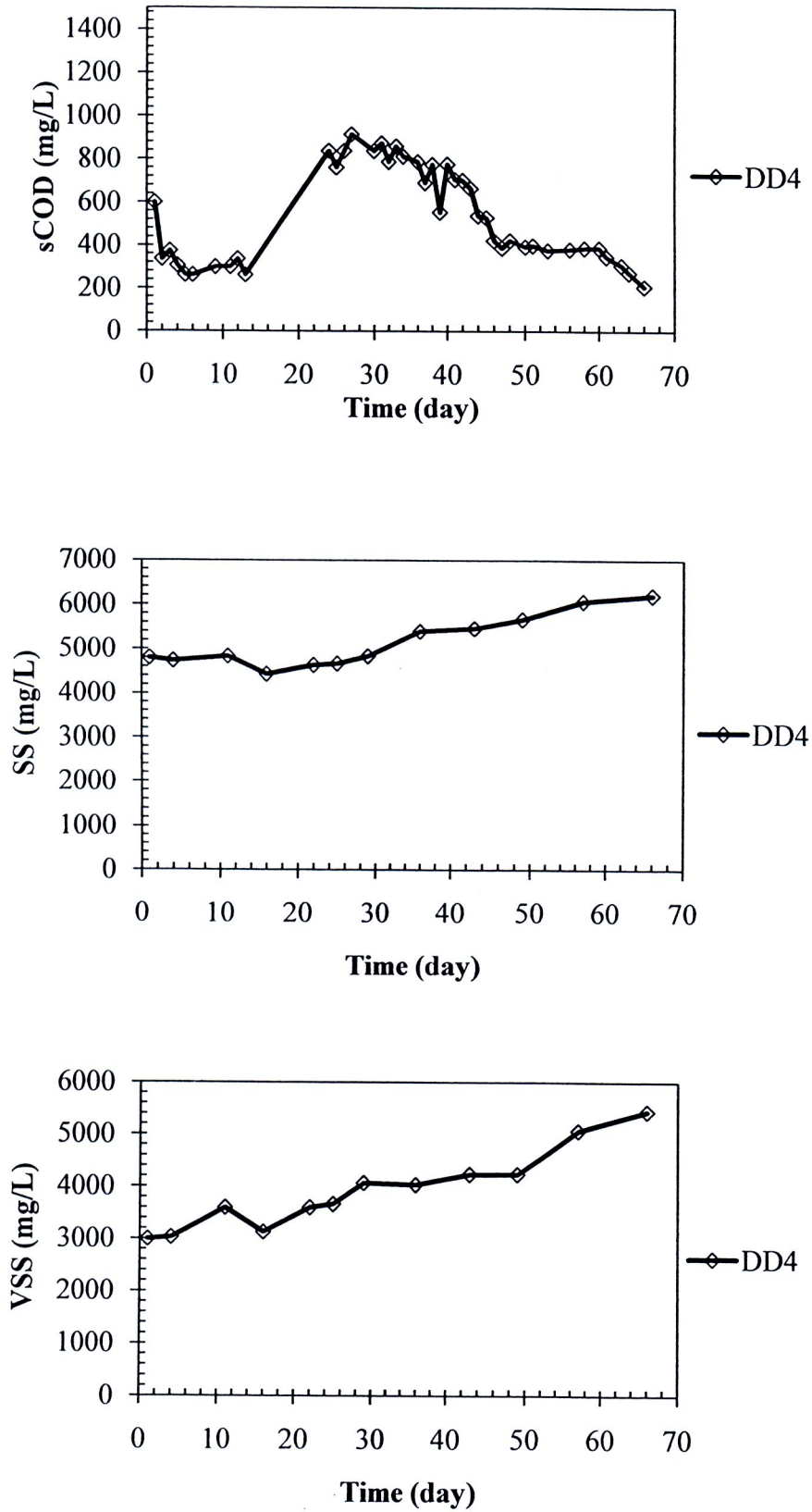


Figure B.2 Profile of sCOD, SS and VSS of reactor DD2



**Figure B.3** Profile of sCOD, SS and VSS of reactor DD3



**Figure B.4** Profile of sCOD, SS and VSS of reactor DD4

**Table B.4** Cumulative hydrogen gas of reactor DD1 with time

| Time (day) | DD1            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 1          | 0              | 0.00                    | 0.00                         |
| 2          | 0              | 0.00                    | 0.00                         |
| 3          | 0              | 0.00                    | 0.00                         |
| 4          | 100            | 1.02                    | 1.02                         |
| 5          | 100            | 1.02                    | 2.04                         |
| 6          | 100            | 1.02                    | 3.07                         |
| 7          | 100            | 1.02                    | 4.09                         |
| 8          | 200            | 2.04                    | 6.13                         |
| 9          | 200            | 2.04                    | 8.18                         |
| 10         | 200            | 2.04                    | 10.22                        |
| 11         | 300            | 3.07                    | 13.29                        |
| 12         | 300            | 3.07                    | 16.35                        |
| 13         | 350            | 3.58                    | 19.93                        |
| 14         | 300            | 3.07                    | 23.00                        |
| 15         | 350            | 3.58                    | 26.57                        |
| 16         | 350            | 14.73                   | 41.31                        |
| 17         | 400            | 16.84                   | 58.15                        |
| 18         | 350            | 14.73                   | 72.88                        |
| 19         | 400            | 16.84                   | 89.72                        |
| 20         | 400            | 16.84                   | 106.56                       |
| 21         | 400            | 16.84                   | 123.40                       |
| 22         | 450            | 18.94                   | 142.34                       |
| 23         | 400            | 16.84                   | 159.18                       |
| 24         | 500            | 34.29                   | 193.48                       |
| 25         | 500            | 34.29                   | 227.77                       |
| 26         | 500            | 34.29                   | 262.06                       |
| 27         | 600            | 41.15                   | 303.21                       |
| 28         | 500            | 34.29                   | 337.50                       |
| 29         | 500            | 34.29                   | 371.80                       |

**Table B.4** Cumulative hydrogen gas of reactor DD1 with time (cont.)

| Time (day) | DD1            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 30         | 600            | 140.10                  | 511.90                       |
| 31         | 600            | 140.10                  | 652.00                       |
| 32         | 550            | 128.43                  | 780.42                       |
| 33         | 600            | 140.10                  | 920.52                       |
| 34         | 650            | 151.78                  | 1072.30                      |
| 35         | 700            | 163.45                  | 1235.75                      |
| 36         | 600            | 140.10                  | 1375.85                      |
| 37         | 600            | 140.10                  | 1515.95                      |
| 38         | 500            | 91.77                   | 1607.72                      |
| 39         | 600            | 110.12                  | 1717.84                      |
| 40         | 700            | 128.48                  | 1846.32                      |
| 41         | 600            | 110.12                  | 1956.44                      |
| 42         | 550            | 100.95                  | 2057.39                      |
| 43         | 550            | 100.95                  | 2158.34                      |
| 44         | 600            | 110.12                  | 2268.46                      |
| 45         | 700            | 128.48                  | 2396.94                      |
| 46         | 600            | 110.12                  | 2507.06                      |
| 47         | 700            | 128.48                  | 2635.54                      |
| 48         | 700            | 128.48                  | 2764.02                      |
| 49         | 800            | 146.83                  | 2910.85                      |
| 50         | 700            | 128.48                  | 3039.33                      |
| 51         | 800            | 146.83                  | 3186.16                      |
| 52         | 900            | 165.19                  | 3351.35                      |
| 53         | 800            | 120.81                  | 3472.16                      |
| 54         | 800            | 120.81                  | 3592.97                      |
| 55         | 900            | 135.92                  | 3728.89                      |
| 56         | 800            | 120.81                  | 3849.70                      |
| 57         | 800            | 120.81                  | 3970.52                      |
| 58         | 700            | 120.41                  | 4090.92                      |

**Table B.4** Cumulative hydrogen gas of reactor DD1 with time (cont.)

| Time (day) | DD1            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 59         | 600            | 103.21                  | 4194.13                      |
| 60         | 500            | 86.01                   | 4280.14                      |
| 61         | 500            | 86.01                   | 4366.14                      |
| 62         | 400            | 68.80                   | 4434.95                      |
| 63         | 500            | 86.01                   | 4520.95                      |
| 64         | 400            | 68.80                   | 4589.76                      |
| 65         | 400            | 68.80                   | 4658.56                      |
| 66         | 400            | 68.80                   | 4727.37                      |

**Table B.5** Cumulative hydrogen gas of reactor DD2 with time

| Time (day) | DD2            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 1          | 0              | 0.00                    | 0.00                         |
| 2          | 0              | 0.00                    | 0.00                         |
| 3          | 0              | 0.00                    | 0.00                         |
| 4          | 0              | 0.00                    | 0.00                         |
| 5          | 0              | 0.00                    | 0.00                         |
| 6          | 0              | 0.00                    | 0.00                         |
| 7          | 100            | 0.20                    | 0.20                         |
| 8          | 100            | 0.20                    | 0.40                         |
| 9          | 200            | 0.40                    | 0.80                         |
| 10         | 200            | 0.40                    | 1.21                         |
| 11         | 200            | 0.40                    | 1.61                         |
| 12         | 100            | 0.20                    | 1.81                         |
| 13         | 200            | 0.40                    | 2.21                         |
| 14         | 200            | 0.40                    | 2.61                         |
| 15         | 300            | 0.60                    | 3.22                         |
| 16         | 200            | 0.40                    | 3.62                         |

**Table B.5** Cumulative hydrogen gas of reactor DD2 with time (cont.)

| Time (day) | DD2            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 17         | 300            | 0.60                    | 4.22                         |
| 18         | 300            | 0.60                    | 4.82                         |
| 19         | 300            | 0.60                    | 5.43                         |
| 20         | 300            | 0.60                    | 6.03                         |
| 21         | 200            | 0.40                    | 6.43                         |
| 22         | 300            | 0.60                    | 7.04                         |
| 23         | 300            | 0.60                    | 7.64                         |
| 24         | 300            | 1.08                    | 8.72                         |
| 25         | 300            | 1.08                    | 9.79                         |
| 26         | 400            | 1.44                    | 11.23                        |
| 27         | 400            | 1.44                    | 12.67                        |
| 28         | 400            | 1.44                    | 14.11                        |
| 29         | 400            | 1.44                    | 15.54                        |
| 30         | 300            | 2.81                    | 18.35                        |
| 31         | 400            | 3.74                    | 22.09                        |
| 32         | 400            | 3.74                    | 25.83                        |
| 33         | 300            | 2.81                    | 28.64                        |
| 34         | 300            | 2.81                    | 31.45                        |
| 35         | 400            | 3.74                    | 35.19                        |
| 36         | 400            | 3.74                    | 38.93                        |
| 37         | 500            | 4.68                    | 43.61                        |
| 38         | 600            | 12.47                   | 56.07                        |
| 39         | 700            | 14.54                   | 70.62                        |
| 40         | 600            | 12.47                   | 83.08                        |
| 41         | 700            | 14.54                   | 97.62                        |
| 42         | 600            | 12.47                   | 110.09                       |
| 43         | 600            | 12.47                   | 122.55                       |
| 44         | 600            | 12.47                   | 135.02                       |
| 45         | 600            | 12.47                   | 147.48                       |

**Table B.5** Cumulative hydrogen gas of reactor DD2 with time (cont.)

| Time (day) | DD2            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 46         | 700            | 14.54                   | 162.03                       |
| 47         | 700            | 14.54                   | 176.57                       |
| 48         | 800            | 16.62                   | 193.19                       |
| 49         | 800            | 16.62                   | 209.81                       |
| 50         | 700            | 14.54                   | 224.35                       |
| 51         | 700            | 14.54                   | 238.89                       |
| 52         | 700            | 14.54                   | 253.44                       |
| 53         | 600            | 48.36                   | 301.79                       |
| 54         | 600            | 48.36                   | 350.15                       |
| 55         | 500            | 40.30                   | 390.44                       |
| 56         | 600            | 48.36                   | 438.80                       |
| 57         | 500            | 40.30                   | 479.10                       |
| 58         | 400            | 36.26                   | 515.36                       |
| 59         | 300            | 27.19                   | 542.55                       |
| 60         | 400            | 36.26                   | 578.80                       |
| 61         | 300            | 27.19                   | 606.00                       |
| 62         | 200            | 18.13                   | 624.13                       |
| 63         | 200            | 18.13                   | 642.25                       |
| 64         | 200            | 18.13                   | 660.38                       |
| 65         | 200            | 18.13                   | 678.51                       |
| 66         | 200            | 18.13                   | 696.64                       |

**Table B.6** Cumulative hydrogen gas of reactor DD3 with time

| Time (day) | DD3            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 1          | 0              | 0.00                    | 0.00                         |
| 2          | 0              | 0.00                    | 0.00                         |
| 3          | 0              | 0.00                    | 0.00                         |

**Table B.6** Cumulative hydrogen gas of reactor DD3 with time (cont.)

| Time (day) | DD3            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 4          | 100            | 1.32                    | 1.32                         |
| 5          | 100            | 1.32                    | 2.64                         |
| 6          | 100            | 1.32                    | 3.96                         |
| 7          | 200            | 2.64                    | 6.61                         |
| 8          | 100            | 1.32                    | 7.93                         |
| 9          | 200            | 2.64                    | 10.57                        |
| 10         | 300            | 3.96                    | 14.54                        |
| 11         | 200            | 2.64                    | 17.18                        |
| 12         | 300            | 3.96                    | 21.14                        |
| 13         | 300            | 3.96                    | 25.11                        |
| 14         | 300            | 3.96                    | 29.07                        |
| 15         | 300            | 3.96                    | 33.04                        |
| 16         | 300            | 18.59                   | 51.62                        |
| 17         | 350            | 21.69                   | 73.31                        |
| 18         | 400            | 24.78                   | 98.09                        |
| 19         | 400            | 24.78                   | 122.88                       |
| 20         | 400            | 24.78                   | 147.66                       |
| 21         | 300            | 18.59                   | 166.25                       |
| 22         | 400            | 24.78                   | 191.04                       |
| 23         | 400            | 24.78                   | 215.82                       |
| 24         | 500            | 46.31                   | 262.13                       |
| 25         | 500            | 46.31                   | 308.44                       |
| 26         | 550            | 50.94                   | 359.38                       |
| 27         | 500            | 46.31                   | 405.69                       |
| 28         | 550            | 50.94                   | 456.63                       |
| 29         | 600            | 55.57                   | 512.20                       |
| 30         | 550            | 99.66                   | 611.86                       |
| 31         | 600            | 108.72                  | 720.58                       |
| 32         | 600            | 108.72                  | 829.30                       |

**Table B.6** Cumulative hydrogen gas of reactor DD3 with time (cont.)

| Time (day) | DD3            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 33         | 500            | 90.60                   | 919.90                       |
| 34         | 600            | 108.72                  | 1028.62                      |
| 35         | 700            | 126.84                  | 1155.46                      |
| 36         | 700            | 126.84                  | 1282.30                      |
| 37         | 800            | 144.96                  | 1427.25                      |
| 38         | 700            | 89.44                   | 1516.69                      |
| 39         | 700            | 89.44                   | 1606.12                      |
| 40         | 800            | 102.21                  | 1708.34                      |
| 41         | 700            | 89.44                   | 1797.77                      |
| 42         | 600            | 76.66                   | 1874.43                      |
| 43         | 800            | 102.21                  | 1976.64                      |
| 44         | 700            | 89.44                   | 2066.08                      |
| 45         | 700            | 89.44                   | 2155.51                      |
| 46         | 800            | 102.21                  | 2257.73                      |
| 47         | 700            | 89.44                   | 2347.16                      |
| 48         | 700            | 89.44                   | 2436.60                      |
| 49         | 600            | 76.66                   | 2513.26                      |
| 50         | 700            | 89.44                   | 2602.69                      |
| 51         | 800            | 102.21                  | 2704.90                      |
| 52         | 800            | 102.21                  | 2807.12                      |
| 53         | 900            | 107.48                  | 2914.59                      |
| 54         | 800            | 95.54                   | 3010.13                      |
| 55         | 900            | 107.48                  | 3117.61                      |
| 56         | 800            | 95.54                   | 3213.15                      |
| 57         | 800            | 95.54                   | 3308.68                      |
| 58         | 800            | 116.22                  | 3424.91                      |
| 59         | 600            | 87.17                   | 3512.08                      |
| 60         | 600            | 87.17                   | 3599.25                      |
| 61         | 600            | 87.17                   | 3686.41                      |

**Table B.6** Cumulative hydrogen gas of reactor DD3 with time (cont.)

| Time (day) | DD3            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 62         | 700            | 101.70                  | 3788.11                      |
| 63         | 500            | 72.64                   | 3860.75                      |
| 64         | 500            | 72.64                   | 3933.39                      |
| 65         | 500            | 72.64                   | 4006.03                      |
| 66         | 400            | 58.11                   | 4064.15                      |

**Table B.7** Cumulative hydrogen gas of reactor DD4 with time

| Time (day) | DD4            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 1          | 0              | 0.00                    | 0.00                         |
| 2          | 0              | 0.00                    | 0.00                         |
| 3          | 0              | 0.00                    | 0.00                         |
| 4          | 0              | 0.00                    | 0.00                         |
| 5          | 0              | 0.00                    | 0.00                         |
| 6          | 0              | 0.00                    | 0.00                         |
| 7          | 100            | 0.34                    | 0.34                         |
| 8          | 100            | 0.34                    | 0.69                         |
| 9          | 100            | 0.34                    | 1.03                         |
| 10         | 100            | 0.34                    | 1.37                         |
| 11         | 100            | 0.34                    | 1.72                         |
| 12         | 100            | 0.34                    | 2.06                         |
| 13         | 100            | 0.34                    | 2.40                         |
| 14         | 100            | 0.34                    | 2.74                         |
| 15         | 100            | 0.34                    | 3.09                         |
| 16         | 100            | 0.34                    | 3.43                         |
| 17         | 200            | 0.69                    | 4.12                         |
| 18         | 200            | 0.69                    | 4.80                         |
| 19         | 300            | 1.03                    | 5.83                         |

**Table B.7** Cumulative hydrogen gas of reactor DD4 with time (cont.)

| Time (day) | DD4            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 20         | 200            | 0.69                    | 6.52                         |
| 21         | 300            | 1.03                    | 7.55                         |
| 22         | 200            | 0.69                    | 8.23                         |
| 23         | 300            | 1.03                    | 9.26                         |
| 24         | 300            | 1.14                    | 10.40                        |
| 25         | 400            | 1.52                    | 11.93                        |
| 26         | 300            | 1.14                    | 13.07                        |
| 27         | 400            | 1.52                    | 14.59                        |
| 28         | 400            | 1.52                    | 16.11                        |
| 29         | 300            | 1.14                    | 17.26                        |
| 30         | 400            | 3.78                    | 21.04                        |
| 31         | 300            | 2.84                    | 23.88                        |
| 32         | 400            | 3.78                    | 27.66                        |
| 33         | 400            | 3.78                    | 31.45                        |
| 34         | 400            | 3.78                    | 35.23                        |
| 35         | 400            | 3.78                    | 39.02                        |
| 36         | 300            | 2.84                    | 41.86                        |
| 37         | 400            | 3.78                    | 45.64                        |
| 38         | 400            | 11.05                   | 56.69                        |
| 39         | 300            | 8.29                    | 64.98                        |
| 40         | 400            | 11.05                   | 76.02                        |
| 41         | 400            | 11.05                   | 87.07                        |
| 42         | 400            | 11.05                   | 98.12                        |
| 43         | 500            | 13.81                   | 111.93                       |
| 44         | 500            | 13.81                   | 125.74                       |
| 45         | 400            | 11.05                   | 136.79                       |
| 46         | 400            | 11.05                   | 147.84                       |
| 47         | 500            | 13.81                   | 161.65                       |
| 48         | 400            | 11.05                   | 172.70                       |

**Table B.7** Cumulative hydrogen gas of reactor DD4 with time (cont.)

| Time (day) | DD4            |                         |                              |
|------------|----------------|-------------------------|------------------------------|
|            | Gas daily (mL) | H <sub>2</sub> gas (mL) | H <sub>2</sub> gas acc. (mL) |
| 49         | 400            | 11.05                   | 183.75                       |
| 50         | 500            | 13.81                   | 197.56                       |
| 51         | 400            | 11.05                   | 208.61                       |
| 52         | 400            | 11.05                   | 219.65                       |
| 53         | 500            | 26.00                   | 245.65                       |
| 54         | 500            | 26.00                   | 271.65                       |
| 55         | 600            | 31.20                   | 302.85                       |
| 56         | 500            | 26.00                   | 328.84                       |
| 57         | 500            | 26.00                   | 354.84                       |
| 58         | 400            | 24.06                   | 378.90                       |
| 59         | 500            | 30.08                   | 408.98                       |
| 60         | 400            | 24.06                   | 433.04                       |
| 61         | 400            | 24.06                   | 457.10                       |
| 62         | 500            | 30.08                   | 487.18                       |
| 63         | 400            | 24.06                   | 511.24                       |
| 64         | 500            | 30.08                   | 541.31                       |
| 65         | 500            | 30.08                   | 571.39                       |
| 66         | 400            | 24.06                   | 595.45                       |

## CURRICULUM VITAE

**NAME** Miss Sutatvadee Tammarak

**DATE OF BIRTH** 17 April 1988

### EDUCATIONAL RECORD

**HIGH SCHOOL** High School Graduation

Benchamatheputit School, Petchaburi, 2005

**BACHELOR'S DEGREE** Bachelor of Engineering (Environmental Engineering)

King Mongkut's University of Technology Thonburi,  
Bangkok, 2009

**MASTER'S DEGREE** Master of Engineering (Environmental Engineering)

King Mongkut's University of Technology Thonburi,  
Bangkok, 2011

### PUBLICATION

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"Inocula Selection for Biohydrogen Production from  
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**International Conference on Sustainable  
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2012, Bangkok, pp.136-138.

มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

ข้อตกลงว่าด้วยการโอนสิทธิในทรัพย์สินทางปัญญาของนักศึกษาระดับบัณฑิตศึกษา

วันที่ 25 เดือน มิถุนายน พ.ศ. 2555

ข้าพเจ้า (นาย/นาง/นางสาว) สุชัชวดี ธรรมรักษ์ รหัสประจำตัว 53400426 เป็นนักศึกษาของมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี ระดับ  ประกาศนียบัตรบัณฑิต  ปริญญาโท  ปริญญาเอก หลักสูตรวิศวกรรมศาสตรมหาบัณฑิต สาขาวิชา วิศวกรรมสิ่งแวดล้อม คณะ วิศวกรรมศาสตร์ อยู่บ้านเลขที่ 101 หมู่ 3 ตระกอก/ชอย - ถนน - ตำบล/แขวง บางขุนไทร อำเภอ/เขต บ้านแหลม จังหวัด เพชรบุรี รหัสไปรษณีย์ 76110 เป็น “ผู้โอน” ขอโอนสิทธิในทรัพย์สินทางปัญญาให้กับมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี โดยมี รศ. ดร. สักกมน เทพหัสดิน ณ อยุธยา ตำแหน่ง รองคณบดีฝ่ายวิจัยและวิชาการ คณะวิศวกรรมศาสตร์ เป็นตัวแทน “ผู้รับโอน” สิทธิในทรัพย์สินทางปัญญาและมีข้อตกลงดังนี้

1. ข้าพเจ้าได้จัดทำวิทยานิพนธ์เรื่อง การคัดเลือกเชื้อสำหรับกระบวนการผลิตไบโอดีเซลจากแป้ง ภายใต้สภาวะความเป็นกรด ซึ่งอยู่ในความควบคุมของ ดร. ธิติรัตน์ บุญศรี อาจารย์ที่ปรึกษา และ/หรือ ผศ. จารุรัตน์ วรรณสรานกุล อาจารย์ที่ปรึกษาร่วม ตามพระราชบัญญัติลิขสิทธิ์ พ.ศ. 2537 และถือว่าเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรของมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี
2. ข้าพเจ้าตกลงโอนลิขสิทธิ์จากผลงานทั้งหมดที่เกิดขึ้นจากการสร้างสรรค์ของข้าพเจ้าในวิทยานิพนธ์ให้กับมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี ตลอดอายุแห่งการคุ้มครองลิขสิทธิ์ตามพระราชบัญญัติลิขสิทธิ์ พ.ศ. 2537 ตั้งแต่วันที่ได้รับอนุมัติโครงร่างวิทยานิพนธ์จากมหาวิทยาลัย
3. ในกรณีที่ข้าพเจ้าประสงค์จะนำวิทยานิพนธ์ไปใช้ในการเผยแพร่ในสื่อใดๆ ก็ตาม ข้าพเจ้าจะต้องระบุว่าวิทยานิพนธ์เป็นผลงานของมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีทุกครั้งที่มีการเผยแพร่
4. ในกรณีที่ข้าพเจ้าประสงค์จะนำวิทยานิพนธ์ไปเผยแพร่ หรือให้ผู้อื่นทำซ้ำหรือดัดแปลงหรือเผยแพร่ต่อสาธารณชนหรือกระทำการอื่นใด ตามพระราชบัญญัติลิขสิทธิ์ พ.ศ. 2537 โดยมีค่าตอบแทนในเชิงธุรกิจ ข้าพเจ้าจะกระทำได้เมื่อได้รับความยินยอมเป็นลายลักษณ์อักษรจากมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี ก่อน
5. ในกรณีที่ข้าพเจ้าประสงค์จะนำข้อมูลจากวิทยานิพนธ์ไปประดิษฐ์หรือพัฒนาต่อยอดเป็นสิ่งประดิษฐ์หรืองานทรัพย์สินทางปัญญาประเภทอื่น ภายในระยะเวลาสิบ (10) ปีนับจากวันลงนามในข้อตกลงฉบับนี้ ข้าพเจ้าจะกระทำได้เมื่อได้รับความยินยอมเป็นลายลักษณ์อักษรจากมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี และมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีมีสิทธิในทรัพย์สินทางปัญญานั้น พร้อมกับได้รับชำระค่าตอบแทนการอนุญาตให้ใช้สิทธิดังกล่าว รวมถึงการจัดสรรผลประโยชน์อันพึงเกิดขึ้นจากส่วนใดส่วนหนึ่งหรือทั้งหมดของวิทยานิพนธ์ในอนาคต โดยให้เป็นไปตามระเบียบสถาบันเทคโนโลยีพระจอมเกล้าธนบุรี ว่าด้วยการบริหารผลประโยชน์อันเกิดจากทรัพย์สินทางปัญญา พ.ศ. 2538
6. ในกรณีที่มิใช่ผลประโยชน์เกิดขึ้นจากวิทยานิพนธ์หรืองานทรัพย์สินทางปัญญาอื่นที่ข้าพเจ้าทำขึ้น โดยมีมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีเป็นเจ้าของ ข้าพเจ้าจะมีสิทธิได้รับการจัดสรรผลประโยชน์อันเกิด

จากทรัพย์สินทางปัญญาดังกล่าวตามอัตราที่กำหนดไว้ในระเบียบสถาบันเทคโนโลยีพระจอมเกล้าธนบุรี ว่าด้วย  
การบริหารผลประโยชน์อันเกิดจากทรัพย์สินทางปัญญา พ.ศ. 2538

ลงชื่อ.....สุชีว์วดี ธรรมรักษ์.....ผู้โอนลิขสิทธิ์  
(นางสาวสุชีว์วดี ธรรมรักษ์)  
นักศึกษา

ลงชื่อ.....Dr. K.....ผู้รับโอนลิขสิทธิ์  
(รศ. ดร. สักกมน เทพหัสดิน ณ อยุธยา)  
รองคณบดีฝ่ายวิจัยและวิชาการ  
ปฏิบัติการแทนคณบดี

ลงชื่อ.....ดร. ธิดารัตน์ บุญศรี.....พยาน  
(ดร. ธิดารัตน์ บุญศรี)

ลงชื่อ.....Dr. J.....พยาน  
(ผศ. จารุรัตน์ วรรณิสรากุล)



