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# APPENDICES

# APPENDIX A

## CALCULATION OF DISCHAGE TIME AND FLOW RATE ESTIMATION

It is applied mass material balance and dynamic model of tank discharge by gravity and Bernoulli's equation to simulate volume flow rate discharge from autoclave to DGZ which is gradually decreased when liquid head in autoclave decreases. The simple diagram is shown in Fig A and model is here below in formula.

Calculation sheet for vertical vessel with ellipsoidal head (2:1) is here below.

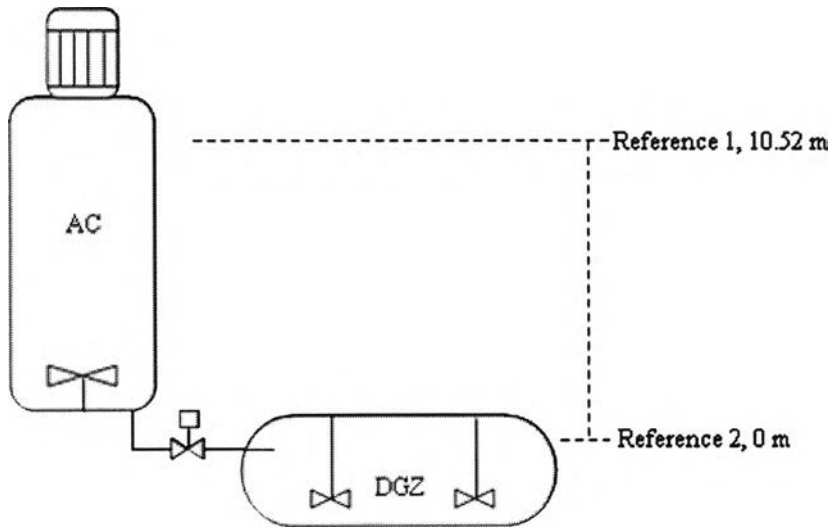


**Figure A** Diagram of slurry discharging from AC to DGZ

Autoclave data: AC

| | | |
|---|---|---|
| High tangent to tangent | : | 8.150 m |
| High tangent to bottom | : | 9.230 m |
| Internal diameter | : | 4.300 m |
| Density of slurry | : | 1,185 kg/m$^3$ (assume constant) |

Consider reference of calculation by dot line

Raw data for calculation

- Pipe side 10" SS. : neglect pressure drop.
- Gate valve 10" ($K_1$ = 0.06) : 1
- Round entrance ($C_1$ = 0.1) : 1
- Sharp income ($C_2$ = 1.0) : 1
- 90° elbow standard ($K_2$ = 0.25) : 4

Use Bernoulli equation balance between (1) & (2)

$$\left[\frac{P_1}{\rho g}+\frac{v_1^2}{2g}+H_1\right]=\left[\frac{P_2}{\rho g}+\frac{v_2^2}{2g}+H_2+loss\right] \quad (1)$$

$P_1$ = $P_2$ became balance pressure when discharge
$v_1$ = 0 assume no moment of liquid
$H_1$ = 10.524 m from reference, keep parameter
$H_2$ = 0

$$loss=\frac{kv^2}{2g} \quad (2)$$

Consider for all minor loss by input value in (1)

$$[K_1+K_2+C_1+C_2]\frac{v^2}{2g}=[0.06+(0.25\times 4)+0.1+1+1]\frac{v^2}{2g} \quad (3)$$

$0.16v^2 = loss$ Put back to

$$H_1 = 0.16v^2 \quad (4)$$

Consider mass balance

$$\frac{d\rho v}{dt}=-\rho F$$

$$\rho\frac{Adh}{dt}=-\rho F$$

$$\frac{dh}{dt}=-\frac{F}{A}=\frac{Av}{A};\frac{dh}{dt}=v \quad (5)$$

But from (3)

$$v^2=\frac{H_1}{0.16}$$

$$\therefore v=\sqrt{6.25H_1}=-2.5\sqrt{H_1}=-2.5\sqrt{h}$$

$$\frac{dh}{dt}=-2.5\sqrt{h} \quad (6)$$

Use this model (4) for Calculation of discharge time and flow rate estimation for AC1 and AC2.

# APPENDIX B

## DERIVE FORMULA OF DEGASSER

We derive formula for calculation volume of the horizontal vessel with ellipsoidal head (2:1) in order to check the volume of DGZ. As we known, the volume of DGZ is equaled to 180 $m^3$, so set volume 0 $m^3$ equals to 0% and 180$m^3$ equals to 100%. Apply linear regression programming to find the relation between volume and percentage and plots in graph.

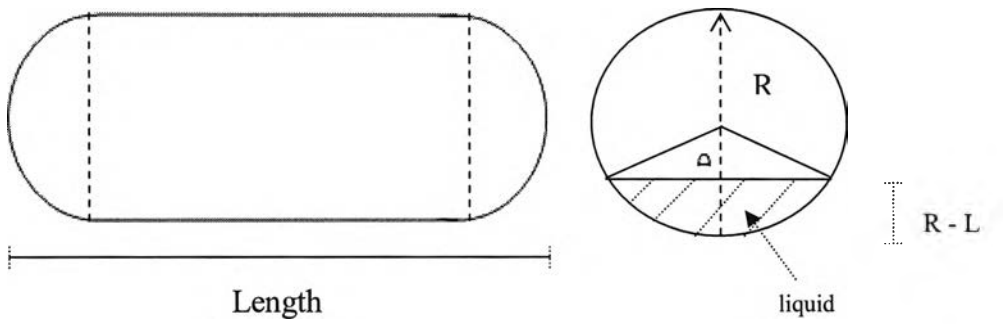


**Figure B1** Simple diagram for calculation volume in vessel

Length = 9.05 m
Diameter = 4.65 m; Radius = 2.325 m
Density of slurry = 1,185 kg/$m^3$ (assume constant)

**Define volume of liquid in cylindrical part.**

The volume will be varied following the level of slurry inside

Example of calculation

Define volume at 20% of vessel

$L_1 = 0.3 \times 4.65 = 1.395$ m = 139.5 cm

Define $\theta$

$$\theta = \text{Arc}\cos\frac{R - L_1}{R} \times \frac{180}{\pi} = \frac{(2.325 - 1.395)}{2.325} \times \frac{180}{\pi} \qquad (1)$$

$$= 66.42$$

Change to degree

$$\frac{360}{66.42} = 5.4199^{\circ}$$

Define volume of liquid

*Volume = Volume of curve triangle = Volume of triangle* (2)

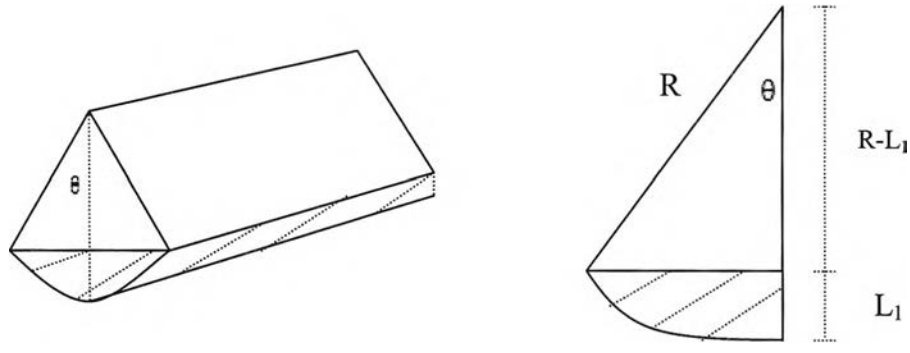


**Figure B2** Triangle volume with circular base

Volume of triangle = $\frac{1}{2}[R^2-(R-L)^2]^{\frac{1}{2}} \times (R-L) \times Length \times 2$

**Volume of curve triangle**

From

$$\theta = \frac{S}{R} \therefore s = \theta R = \frac{1}{2}\left[\frac{Arc\cos\theta}{180\times\pi} \times R \times R\right] \times Length \qquad (2)$$

Instead all value get

V = 38.78 $m^3$

$m = \rho v = 1{,}185\frac{kg}{m^3} \times 38.78m^3 = 45{,}952.29kg$

Full volume of vessel

$= \frac{\pi d^2}{4} \times$ Length $= 153.69m^3$

$$\therefore \%volume = \frac{38.78}{153.69} \times 100 = 25.23\%$$

**Volume of cap**

From
D = 4.65 m

h = 1.395 m; vary became equal to $L_1$

$$Volume = \frac{\pi h^2}{2} \times \frac{\left(\frac{D}{2}-\frac{h}{3}\right)}{2} \qquad (3)$$

$= 2.8428\ m^3$

Total volume = (38.78) + 2 x (2.8428)

$= 44.464\ m^3$

Total mass $= 1{,}185 \times 44.464$

$= 52{,}689.80\ kg$

Key in excel and vary $L_1$ from 0-100%

Plot data between $L_1$ and mass get, the formula following Fig B1.

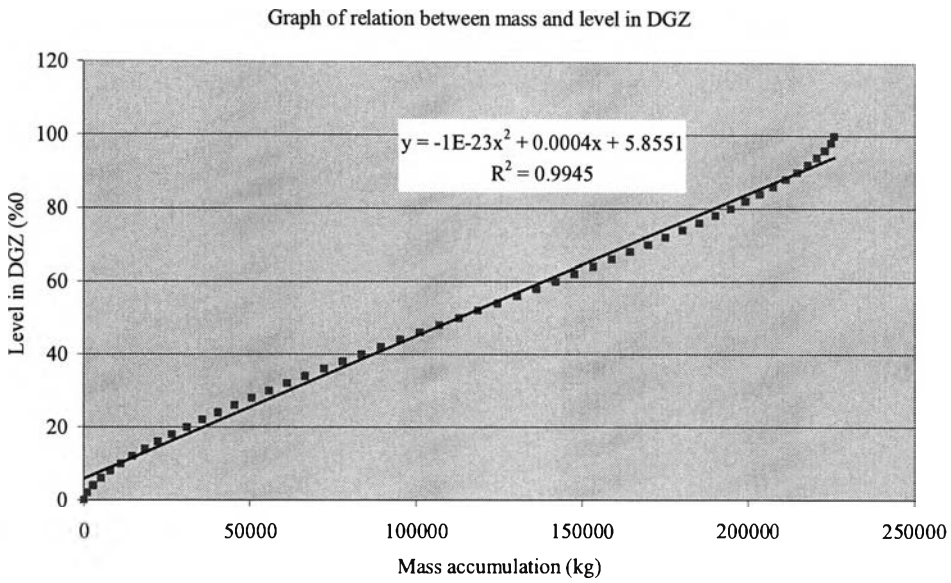


**Figure B3** Mass versus level in DGZ

Plot data between $L_1$ and volume, the formula following Fig B2.

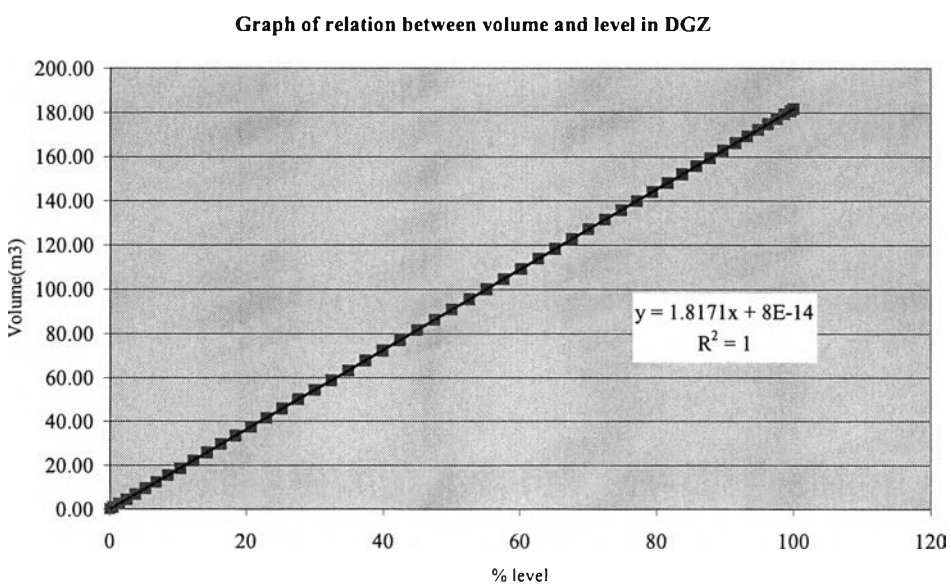


**Figure B4** level versus volume in DGZ

# APPENDIX C

## RESULT FROM OPTIMIZATION PROGRAM

**Table C1** Optimization by using seed = 10

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 10 | 1 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 2 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 3 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 4 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 5 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 6 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 7 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 8 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 9 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 10 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 11 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 12 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 13 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 14 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 15 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 16 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 17 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 18 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 19 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 20 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 21 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 22 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 23 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 24 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 25 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 26 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 27 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 28 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 29 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 30 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 31 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 32 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 33 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 34 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 35 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 36 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 37 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 38 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 39 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 40 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 41 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |

| 10 | 42 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
|---|---|---|---|---|---|---|---|---|
| 10 | 43 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 44 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 45 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 46 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 47 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 48 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 49 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 50 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 51 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 52 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 53 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 54 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 55 | 1 | 371 | 754 | 114 | 475 | 935 | 388 |
| 10 | 56 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 57 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 58 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 59 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 60 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 61 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 62 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 63 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 64 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 65 | 1 | 342 | 705 | 105 | 420 | 830 | 422 |
| 10 | 66 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 67 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 68 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 69 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 70 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 71 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 72 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 73 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 74 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 75 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 76 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 77 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 78 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 79 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 80 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 81 | 1 | 385 | 784 | 130 | 461 | 927 | 430 |
| 10 | 82 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 83 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 84 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 85 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 86 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 87 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 88 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 89 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 90 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 91 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 92 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 93 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10 | 94 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 95 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 96 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 97 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 98 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 99 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |
| 10 | 100 | 1 | 373 | 765 | 125 | 445 | 899 | 442 |

**Table C2** Optimization by using seed = 30

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 30 | 1 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 2 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 3 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 4 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 5 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 6 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 7 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 8 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 9 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 10 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 11 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 12 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 13 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 14 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 15 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 16 | 1 | 360 | 732 | 135 | 449 | 940 | 392 |
| 30 | 17 | 1 | 391 | 739 | 103 | 483 | 876 | 403 |
| 30 | 18 | 1 | 376 | 729 | 155 | 453 | 936 | 406 |
| 30 | 19 | 1 | 376 | 729 | 155 | 453 | 936 | 406 |
| 30 | 20 | 1 | 376 | 729 | 155 | 453 | 936 | 406 |
| 30 | 21 | 1 | 376 | 729 | 155 | 453 | 936 | 406 |
| 30 | 22 | 1 | 376 | 729 | 155 | 453 | 936 | 406 |
| 30 | 23 | 1 | 376 | 729 | 155 | 453 | 936 | 406 |
| 30 | 24 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 25 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 26 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 27 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 28 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 29 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 30 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 31 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 32 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 33 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 34 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 35 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 36 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 37 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 38 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 39 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 40 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |

| 30 | 41 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
|---|---|---|---|---|---|---|---|---|
| 30 | 42 | 1 | 359 | 740 | 114 | 443 | 916 | 406 |
| 30 | 43 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 44 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 45 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 46 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 47 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 48 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 49 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 50 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 51 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 52 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 53 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 54 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 55 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 56 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 57 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 58 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 59 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 60 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 61 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 62 | 1 | 385 | 767 | 134 | 455 | 959 | 451 |
| 30 | 63 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 64 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 65 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 66 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 67 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 68 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 69 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 70 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 71 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 72 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 73 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 74 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 75 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 76 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 77 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 78 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 79 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 80 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 81 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 82 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 83 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 84 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 85 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 86 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 87 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 88 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 89 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 90 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 91 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 92 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 93 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 94 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 95 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 30 | 96 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 97 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 98 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 99 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |
| 30 | 100 | 1 | 360 | 799 | 102 | 431 | 928 | 465 |

**Table C3** Optimization by using seed = 70

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 70 | 1 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 2 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 3 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 4 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 5 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 6 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 7 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 8 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 9 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 10 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 11 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 12 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 13 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 14 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 15 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 16 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 17 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 18 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 19 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 20 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 21 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 22 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 23 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 24 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 25 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 26 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 27 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 28 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 29 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 30 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 31 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 32 | 1 | 380 | 722 | 130 | 483 | 899 | 379 |
| 70 | 33 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 34 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 35 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 36 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 37 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 38 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 39 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |

| 70 | 40 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
|---|---|---|---|---|---|---|---|---|
| 70 | 41 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 42 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 43 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 44 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 45 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 46 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 47 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 48 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 49 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 50 | 1 | 362 | 786 | 133 | 455 | 939 | 392 |
| 70 | 51 | 1 | 340 | 727 | 118 | 416 | 850 | 425 |
| 70 | 52 | 1 | 340 | 727 | 118 | 416 | 850 | 425 |
| 70 | 53 | 1 | 340 | 727 | 118 | 416 | 850 | 425 |
| 70 | 54 | 1 | 340 | 727 | 118 | 416 | 850 | 425 |
| 70 | 55 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 56 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 57 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 58 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 59 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 60 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 61 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 62 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 63 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 64 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 65 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 66 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 67 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 68 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 69 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 70 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 71 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 72 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 73 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 74 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 75 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 76 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 77 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 78 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 79 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 80 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 81 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 82 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 83 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 84 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 85 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 86 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 87 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 88 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 89 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 90 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 91 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 70 | 92 | 1 | 382 | 759 | 114 | 458 | 924 | 426 |
| 70 | 93 | 1 | 348 | 742 | 101 | 423 | 911 | 441 |
| 70 | 94 | 1 | 348 | 742 | 101 | 423 | 911 | 441 |
| 70 | 95 | 1 | 374 | 784 | 104 | 445 | 983 | 465 |
| 70 | 96 | 1 | 374 | 784 | 104 | 445 | 983 | 465 |
| 70 | 97 | 1 | 374 | 784 | 104 | 445 | 983 | 465 |
| 70 | 98 | 1 | 374 | 784 | 104 | 445 | 983 | 465 |
| 70 | 99 | 1 | 374 | 784 | 104 | 445 | 983 | 465 |
| 70 | 100 | 1 | 374 | 784 | 104 | 445 | 983 | 465 |

**Table C4** Optimization by using seed = 150

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 150 | 1 | 1 | 345 | 748 | 155 | 487 | 918 | 362 |
| 150 | 2 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 3 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 4 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 5 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 6 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 7 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 8 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 9 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 10 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 11 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 12 | 1 | 359 | 756 | 180 | 487 | 943 | 362 |
| 150 | 13 | 1 | 367 | 753 | 141 | 516 | 933 | 364 |
| 150 | 14 | 1 | 367 | 753 | 141 | 516 | 933 | 364 |
| 150 | 15 | 1 | 367 | 753 | 141 | 516 | 933 | 364 |
| 150 | 16 | 1 | 367 | 753 | 141 | 516 | 933 | 364 |
| 150 | 17 | 1 | 367 | 753 | 141 | 516 | 933 | 364 |
| 150 | 18 | 1 | 367 | 753 | 141 | 516 | 933 | 364 |
| 150 | 19 | 1 | 367 | 753 | 141 | 516 | 933 | 364 |
| 150 | 20 | 1 | 382 | 793 | 106 | 561 | 973 | 377 |
| 150 | 21 | 1 | 382 | 793 | 106 | 561 | 973 | 377 |
| 150 | 22 | 1 | 382 | 793 | 106 | 561 | 973 | 377 |
| 150 | 23 | 1 | 386 | 779 | 168 | 470 | 944 | 397 |
| 150 | 24 | 1 | 386 | 779 | 168 | 470 | 944 | 397 |
| 150 | 25 | 1 | 386 | 779 | 168 | 470 | 944 | 397 |
| 150 | 26 | 1 | 386 | 779 | 168 | 470 | 944 | 397 |
| 150 | 27 | 1 | 386 | 779 | 168 | 470 | 944 | 397 |
| 150 | 28 | 1 | 386 | 779 | 168 | 470 | 944 | 397 |
| 150 | 29 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 30 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 31 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 32 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 33 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 34 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 35 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 36 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 37 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 38 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 39 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |

| 150 | 40 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
|---|---|---|---|---|---|---|---|---|
| 150 | 41 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 42 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 43 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 44 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 45 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 46 | 1 | 373 | 714 | 142 | 450 | 951 | 410 |
| 150 | 47 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 48 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 49 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 50 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 51 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 52 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 53 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 54 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 55 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 56 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 57 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 58 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 59 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 60 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 61 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 62 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 63 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 64 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 65 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 66 | 1 | 362 | 725 | 127 | 435 | 848 | 434 |
| 150 | 67 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 68 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 69 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 70 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 71 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 72 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 73 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 74 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 75 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 76 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 77 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 78 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 79 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 80 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 81 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 82 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 83 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 84 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 85 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 86 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 87 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 88 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 89 | 1 | 382 | 753 | 123 | 454 | 939 | 440 |
| 150 | 90 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
| 150 | 91 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
| 150 | 92 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
| 150 | 93 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
| 150 | 94 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |

| 150 | 95 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
|---|---|---|---|---|---|---|---|---|
| 150 | 96 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
| 150 | 97 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
| 150 | 98 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
| 150 | 99 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |
| 150 | 100 | 1 | 356 | 761 | 126 | 426 | 902 | 456 |

**Table C5** Optimization by using seed = 300

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 300 | 1 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 2 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 3 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 4 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 5 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 6 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 7 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 8 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 9 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 10 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 11 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 12 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 13 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 14 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 15 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 16 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 17 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 18 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 19 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 20 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 21 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 22 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 23 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 24 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 25 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 26 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 27 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 28 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 29 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 30 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 31 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 32 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 33 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 34 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 35 | 1 | 381 | 723 | 125 | 487 | 966 | 380 |
| 300 | 36 | 1 | 381 | 785 | 158 | 464 | 911 | 401 |
| 300 | 37 | 1 | 381 | 785 | 158 | 464 | 911 | 401 |
| 300 | 38 | 1 | 381 | 785 | 158 | 464 | 911 | 401 |
| 300 | 39 | 1 | 381 | 785 | 158 | 464 | 911 | 401 |
| 300 | 40 | 1 | 381 | 785 | 158 | 464 | 911 | 401 |

| 300 | 41 | 1 | 381 | 785 | 158 | 464 | 911 | 401 |
|---|---|---|---|---|---|---|---|---|
| 300 | 42 | 1 | 381 | 785 | 158 | 464 | 911 | 401 |
| 300 | 43 | 1 | 381 | 785 | 158 | 464 | 911 | 401 |
| 300 | 44 | 1 | 374 | 791 | 144 | 450 | 930 | 429 |
| 300 | 45 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 46 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 47 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 48 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 49 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 50 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 51 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 52 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 53 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 54 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 55 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 56 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 57 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 58 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 59 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 60 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 61 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 62 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 63 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 64 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 65 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 66 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 67 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 68 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 69 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 70 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 71 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 72 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 73 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 74 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 75 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 76 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 77 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 78 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 79 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 80 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 81 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 82 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 83 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 84 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 85 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 86 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 87 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 88 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 89 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 90 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 91 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 92 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 300 | 93 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 94 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 95 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 96 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 97 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 98 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 99 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |
| 300 | 100 | 1 | 375 | 755 | 113 | 449 | 894 | 436 |

**Table C6** Optimization by using seed = 500

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 500 | 1 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 2 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 3 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 4 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 5 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 6 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 7 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 8 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 9 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 10 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 11 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 12 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 13 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 14 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 15 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 16 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 17 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 18 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 19 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 20 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 21 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 22 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 23 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 24 | 1 | 389 | 728 | 125 | 488 | 945 | 384 |
| 500 | 25 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 26 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 27 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 28 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 29 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 30 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 31 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 32 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 33 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 34 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 35 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 36 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 37 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 38 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 39 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |
| 500 | 40 | 1 | 365 | 761 | 151 | 452 | 922 | 392 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 500 | 41 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 42 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 43 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 44 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 45 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 46 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 47 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 48 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 49 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 50 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 51 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 52 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 53 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 54 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 55 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 56 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 57 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 58 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 59 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 60 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 61 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 62 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 63 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 64 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 65 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 66 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 67 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 68 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 69 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 70 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 71 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 72 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 73 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 74 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 75 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 76 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 77 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 78 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 79 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 80 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 81 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 82 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 83 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 84 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 85 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 86 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 87 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 88 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 89 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 90 | 1 | 364 | 725 | 105 | 445 | 950 | 420 |
| 500 | 91 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |
| 500 | 92 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |
| 500 | 93 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |
| 500 | 94 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |
| 500 | 95 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |

| 500 | 96 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |
|---|---|---|---|---|---|---|---|---|
| 500 | 97 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |
| 500 | 98 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |
| 500 | 99 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |
| 500 | 100 | 1 | 346 | 771 | 103 | 430 | 925 | 422 |

**Table C7** Optimization by using seed = 500

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 700 | 1 | 1 | 367 | 704 | 182 | 512 | 919 | 357 |
| 700 | 2 | 1 | 367 | 704 | 182 | 512 | 919 | 357 |
| 700 | 3 | 1 | 367 | 704 | 182 | 512 | 919 | 357 |
| 700 | 4 | 1 | 370 | 743 | 152 | 540 | 901 | 358 |
| 700 | 5 | 1 | 370 | 743 | 152 | 540 | 901 | 358 |
| 700 | 6 | 1 | 370 | 743 | 152 | 540 | 901 | 358 |
| 700 | 7 | 1 | 370 | 743 | 152 | 540 | 901 | 358 |
| 700 | 8 | 1 | 370 | 743 | 152 | 540 | 901 | 358 |
| 700 | 9 | 1 | 370 | 743 | 152 | 540 | 901 | 358 |
| 700 | 10 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 11 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 12 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 13 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 14 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 15 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 16 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 17 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 18 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 19 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 20 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 21 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 22 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 23 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 24 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 25 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 26 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 27 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 28 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 29 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 30 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 31 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 32 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 33 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 34 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 35 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 36 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 37 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 38 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 39 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 40 | 1 | 358 | 715 | 101 | 523 | 971 | 378 |
| 700 | 41 | 1 | 369 | 720 | 116 | 454 | 841 | 400 |
| 700 | 42 | 1 | 369 | 720 | 116 | 454 | 841 | 400 |
| 700 | 43 | 1 | 369 | 720 | 116 | 454 | 841 | 400 |

| 700 | 44 | 1 | 369 | 720 | 116 | 454 | 841 | 400 |
|---|---|---|---|---|---|---|---|---|
| 700 | 45 | 1 | 369 | 720 | 116 | 454 | 841 | 400 |
| 700 | 46 | 1 | 369 | 720 | 116 | 454 | 841 | 400 |
| 700 | 47 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 48 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 49 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 50 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 51 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 52 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 53 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 54 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 55 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 56 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 57 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 58 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 59 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 60 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 61 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 62 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 63 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 64 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 65 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 66 | 1 | 371 | 758 | 160 | 451 | 941 | 405 |
| 700 | 67 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 68 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 69 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 70 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 71 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 72 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 73 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 74 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 75 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 76 | 1 | 389 | 764 | 103 | 469 | 970 | 426 |
| 700 | 77 | 1 | 398 | 778 | 122 | 471 | 905 | 438 |
| 700 | 78 | 1 | 398 | 778 | 122 | 471 | 905 | 438 |
| 700 | 79 | 1 | 398 | 778 | 122 | 471 | 905 | 438 |
| 700 | 80 | 1 | 398 | 778 | 122 | 471 | 905 | 438 |
| 700 | 81 | 1 | 399 | 778 | 122 | 471 | 905 | 438 |
| 700 | 82 | 1 | 399 | 778 | 122 | 471 | 905 | 438 |
| 700 | 83 | 1 | 399 | 778 | 122 | 471 | 905 | 438 |
| 700 | 84 | 1 | 400 | 778 | 122 | 471 | 905 | 438 |
| 700 | 85 | 1 | 400 | 778 | 122 | 471 | 905 | 438 |
| 700 | 86 | 1 | 400 | 778 | 122 | 471 | 905 | 438 |
| 700 | 87 | 1 | 400 | 778 | 122 | 471 | 905 | 438 |
| 700 | 88 | 1 | 401 | 778 | 122 | 471 | 905 | 438 |
| 700 | 89 | 1 | 401 | 778 | 122 | 471 | 905 | 438 |
| 700 | 90 | 1 | 401 | 778 | 122 | 471 | 905 | 438 |
| 700 | 91 | 1 | 401 | 778 | 122 | 471 | 905 | 438 |
| 700 | 92 | 1 | 402 | 778 | 122 | 471 | 905 | 438 |
| 700 | 93 | 1 | 402 | 778 | 122 | 471 | 905 | 438 |
| 700 | 94 | 1 | 402 | 778 | 122 | 471 | 905 | 438 |
| 700 | 95 | 1 | 402 | 778 | 122 | 471 | 905 | 438 |
| 700 | 96 | 1 | 403 | 778 | 122 | 471 | 905 | 438 |
| 700 | 97 | 1 | 403 | 778 | 122 | 471 | 905 | 438 |
| 700 | 98 | 1 | 403 | 778 | 122 | 471 | 905 | 438 |
| 700 | 99 | 1 | 403 | 778 | 122 | 471 | 905 | 438 |

| 700 | 100 | 1 | 404 | 778 | 122 | 471 | 905 | 438 |
|---|---|---|---|---|---|---|---|---|

**Table C8** Optimization by using seed = 1000

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 1000 | 1 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 2 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 3 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 4 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 5 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 6 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 7 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 8 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 9 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 10 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 11 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 12 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 13 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 14 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 15 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 16 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 17 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 18 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 19 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 20 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 21 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 22 | 1 | 340 | 740 | 113 | 592 | 901 | 365 |
| 1000 | 23 | 1 | 360 | 739 | 138 | 474 | 901 | 372 |
| 1000 | 24 | 1 | 360 | 739 | 138 | 474 | 901 | 372 |
| 1000 | 25 | 1 | 360 | 739 | 138 | 474 | 901 | 372 |
| 1000 | 26 | 1 | 360 | 739 | 138 | 474 | 901 | 372 |
| 1000 | 27 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 28 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 29 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 30 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 31 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 32 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 33 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 34 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 35 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 36 | 1 | 350 | 768 | 121 | 442 | 952 | 397 |
| 1000 | 37 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 38 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 39 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 40 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 41 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 42 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 43 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 44 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 45 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 46 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 47 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 48 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |

| 1000 | 49 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
|---|---|---|---|---|---|---|---|---|
| 1000 | 50 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 51 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 52 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 53 | 1 | 392 | 746 | 120 | 474 | 904 | 407 |
| 1000 | 54 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 55 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 56 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 57 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 58 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 59 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 60 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 61 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 62 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 63 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 64 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 65 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 66 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 67 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 68 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 69 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 70 | 1 | 380 | 752 | 118 | 455 | 875 | 425 |
| 1000 | 71 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 72 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 73 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 74 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 75 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 76 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 77 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 78 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 79 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 80 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 81 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 82 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 83 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 84 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 85 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 86 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 87 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 88 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 89 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 90 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 91 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 92 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 93 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 94 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 95 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 96 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 97 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 98 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 99 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |
| 1000 | 100 | 1 | 357 | 727 | 110 | 428 | 938 | 450 |

**Table C9** Optimization by using seed = 2000

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 2000 | 1 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 2 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 3 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 4 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 5 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 6 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 7 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 8 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 9 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 10 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 11 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 12 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 13 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 14 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 15 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 16 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 17 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 18 | 1 | 387 | 726 | 150 | 486 | 906 | 377 |
| 2000 | 19 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 20 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 21 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 22 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 23 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 24 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 25 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 26 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 27 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 28 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 29 | 1 | 392 | 796 | 100 | 521 | 979 | 390 |
| 2000 | 30 | 1 | 355 | 789 | 103 | 471 | 993 | 390 |
| 2000 | 31 | 1 | 355 | 789 | 103 | 471 | 993 | 390 |
| 2000 | 32 | 1 | 355 | 789 | 103 | 471 | 993 | 390 |
| 2000 | 33 | 1 | 355 | 789 | 103 | 471 | 993 | 390 |
| 2000 | 34 | 1 | 355 | 789 | 103 | 471 | 993 | 390 |
| 2000 | 35 | 1 | 355 | 789 | 103 | 471 | 993 | 390 |
| 2000 | 36 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 37 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 38 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 39 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 40 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 41 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 42 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 43 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 44 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 45 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 46 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 47 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 48 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |

| 2000 | 49 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
|---|---|---|---|---|---|---|---|---|
| 2000 | 50 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 51 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 52 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 53 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 54 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 55 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 56 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 57 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 58 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 59 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 60 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 61 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 62 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 63 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 64 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 65 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 66 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 67 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 68 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 69 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 70 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 71 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 72 | 1 | 389 | 749 | 137 | 465 | 918 | 420 |
| 2000 | 73 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 74 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 75 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 76 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 77 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 78 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 79 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 80 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 81 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 82 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 83 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 84 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 85 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 86 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 87 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 88 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 89 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 90 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 91 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 92 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 93 | 1 | 389 | 752 | 109 | 464 | 954 | 431 |
| 2000 | 94 | 1 | 354 | 736 | 121 | 423 | 966 | 453 |
| 2000 | 95 | 1 | 354 | 736 | 121 | 423 | 966 | 453 |
| 2000 | 96 | 1 | 354 | 736 | 121 | 423 | 966 | 453 |
| 2000 | 97 | 1 | 354 | 736 | 121 | 423 | 966 | 453 |
| 2000 | 98 | 1 | 354 | 736 | 121 | 423 | 966 | 453 |
| 2000 | 99 | 1 | 354 | 736 | 121 | 423 | 966 | 453 |
| 2000 | 100 | 1 | 354 | 736 | 121 | 423 | 966 | 453 |

**Table C10** Optimization by using seed = 9000

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 9000 | 1 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 2 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 3 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 4 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 5 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 6 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 7 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 8 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 9 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 10 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 11 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 12 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 13 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 14 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 15 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 16 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 17 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 18 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 19 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 20 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 21 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 22 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 23 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 24 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 25 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 26 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 27 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 28 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 29 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 30 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 31 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 32 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 33 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 34 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 35 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 36 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 37 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 38 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 39 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 40 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 41 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 42 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 43 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 44 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 45 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 46 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |

| 9000 | 47 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
|---|---|---|---|---|---|---|---|---|
| 9000 | 48 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 49 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 50 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 51 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 52 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 53 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 54 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 55 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 56 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 57 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 58 | 1 | 380 | 787 | 108 | 460 | 949 | 425 |
| 9000 | 59 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 60 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 61 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 62 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 63 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 64 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 65 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 66 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 67 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 68 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 69 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 70 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 71 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 72 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 73 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 74 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 75 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 76 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 77 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 78 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 79 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 80 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 81 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 82 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 83 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 84 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 85 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 86 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 87 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 88 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 89 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 90 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 91 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 92 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 93 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 94 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 95 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 96 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 97 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 98 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
| 9000 | 99 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |

| 9000 | 100 | 1 | 374 | 792 | 125 | 446 | 922 | 443 |
|---|---|---|---|---|---|---|---|---|

**Table C11** Optimization by using seed = 20000

| Seed | Generation | T11 | T12 | T13 | T21 | T22 | T23 | Production from simulation (ton/day) |
|---|---|---|---|---|---|---|---|---|
| 20000 | 1 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 2 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 3 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 4 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 5 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 6 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 7 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 8 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 9 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 10 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 11 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 12 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 13 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 14 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 15 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 16 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 17 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 18 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 19 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 20 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 21 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 22 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 23 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 24 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 25 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 26 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 27 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 28 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 29 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 30 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 31 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 32 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 33 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 34 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 35 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 36 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 37 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 38 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 39 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 40 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 41 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 42 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 43 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 44 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 45 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 20000 | 46 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 47 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 48 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 49 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 50 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 51 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 52 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 53 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 54 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 55 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 56 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 57 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 58 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 59 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 60 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 61 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 62 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 63 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 64 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 65 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 66 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 67 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 68 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 69 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 70 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 71 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 72 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 73 | 1 | 398 | 767 | 113 | 470 | 954 | 445 |
| 20000 | 74 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 75 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 76 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 77 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 78 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 79 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 80 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 81 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 82 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 83 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 84 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 85 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 86 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 87 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 88 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 89 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 90 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 91 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 92 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 93 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 94 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 95 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 96 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 97 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 98 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 20000 | 99 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |
| 20000 | 100 | 1 | 381 | 757 | 124 | 452 | 959 | 446 |

# APPENDIX D

## MATH LAB SIMULATION PART PRINT OUT

Matlab simulation program print out (only code of main program) is here below.

```
**********************************************************************

function
[V,Production]=productcal(period,t1,t2,tp1,tp2,Vsp,Vinit,Vmax,Vmin)
Period=period;%sec
Time1=t1;
Time2=t2;
btime1=tp1;
btime2=tp2;
%Vsp=30; %m3
%Vmax=150;%m3
%Vmin=10;%m3
%Vinit=100;%m3

%load data
load utillitydata;
%Time Overlapse Filtering Level 1
WDa=zeros(1,Period);
WDb=zeros(1,Period);
RMBa=zeros(1,Period);
RMBb=zeros(1,Period);
RMXa=zeros(1,Period);
RMXb=zeros(1,Period);
VCMa=zeros(1,Period);
VCMb=zeros(1,Period);
INIa=zeros(1,Period);
INIb=zeros(1,Period);
WHa=zeros(1,Period);
WHb=zeros(1,Period);
INHa=zeros(1,Period);
INHb=zeros(1,Period);
HPa=zeros(1,Period);
HPb=zeros(1,Period);
NOXa=zeros(1,Period);
NOXb=zeros(1,Period);

for j=1:length(Time1)
   WDa(Time1(j):Time1(j)+actime1-1)=WD1;
   RMBa(Time1(j):Time1(j)+actime1-1)=RMB1;
   RMXa(Time1(j):Time1(j)+actime1-1)=RMX1;
   VCMa(Time1(j):Time1(j)+actime1-1)=VCM1;
   INIa(Time1(j):Time1(j)+actime1-1)=INI1;
   WHa(Time1(j):Time1(j)+actime1-1)=WH1;
   INHa(Time1(j):Time1(j)+actime1-1)=INH1;
   HPa(Time1(j):Time1(j)+actime1-1)=HP1;
   NOXa(Time1(j):Time1(j)+actime1-1)=NOX1;
end
for k=1:length(Time2)
   WDb(Time2(k):Time2(k)+actime2-1)=WD2;
```

```
    RMBb(Time2(k):Time2(k)+actime2-1)=RMB2;
    RMXb(Time2(k):Time2(k)+actime2-1)=RMX2;
    VCMb(Time2(k):Time2(k)+actime2-1)=VCM2;
    INIb(Time2(k):Time2(k)+actime2-1)=INI2;
    WHb(Time2(k):Time2(k)+actime2-1)=WH2;
    INHb(Time2(k):Time2(k)+actime2-1)=INH2;
    HPb(Time2(k):Time2(k)+actime2-1)= HP2;
    NOXb(Time2(k):Time2(k)+actime2-1)=NOX2;
end
WD=WDa+WDb;
RMB=RMBa+RMBb;
RMX=RMXa+RMXb;
VCM=VCMa+VCMb;
INI=INIa+INIb;
WH=WHa+WHb;
INH=INHa+INHb;
HP= HPa+ HPb;
NOX=NOXa+NOXb;

nwd=length(find(WD>3543.750));
nrmb=length(find(RMB>0.966));
nrmx=length(find(RMX>132.870));
nvcm=length(find(VCM>3780.000));
nini=length(find(INI>2.614));
nwh=length(find(WH>1925.000));
ninh=length(find(INH>5.670));
nhp=length(find(HP>352.800));
nnox=length(find(NOX>5.880));

nov=nwd+nrmb+nrmx+nvcm+nini+nwh+ninh+nhp+nnox;

if nov>0 %if time of utilily overlaps, nov>0
    Production=0;
    V=zeros(1,Period);
else %if time of utilily overlaps, nov=0
    %delta_v calculation
    n=length(Time1)+length(Time2);
    delta_v=zeros(1,n);
    V1=zeros(1,Period);
    V2=zeros(1,Period);
    for i=1:n
           if mod(i,2)==1
               delta_v(i)=delta_v1;
           else
               delta_v(i)=delta_v2;
           end
    end

    %VDGZ combination
    VDGZa=zeros(1,Period);
    VDGZb=zeros(1,Period);
    for j=1:length(Time1)
       VDGZa(Time1(j):Time1(j)+actime1-1)=VDGZ1;
    end
    for k=1:length(Time2)
       VDGZb(Time2(k):Time2(k)+actime2-1)=VDGZ2;
    end
    VDGZ=VDGZa+VDGZb;

    %town finding
```

```
  Town=zeros(1,n);
  Time=zeros(1,n);
  Town1=Time1+btime1;
  Town2=Time2+btime2;
  k=1;
  l=1;
  for i=1:n
         if mod(i,2)==1
             Town(i)=Town1(k);
             Time(i)=Time1(k);
             k=k+1;
         else
             Town(i)=Town2(l);
             Time(i)=Time2(l);
             l=l+1;
         end
  end

  V=zeros(1,Period);
  Fmax=zeros(1,length(Town));
  V(1)=Vinit;
  k=1;
  Fm=(Vinit-Vsp)/Town(1);
  Fmax(1)=Fm;
  j=1;
  k=2;
  flag=1;
  tstop=Period;
  for i=2:Period,
         if j<length(Town),
          if i==Town(j)
              if mod(j,2)==0,
                  Fm=(V(i-1)+115)/(Town(j+1)-Town(j));
              else
                  Fm=(V(i-1)+97)/(Town(j+1)-Town(j));
              end
              Fmax(k)=Fm;
              j=j+1;
              k=k+1;

          end
         end
     V(i)=(V(i-1)-Fm)+VDGZ(i);
     if flag==1
      if V(i)<9
          tstop=i;
          flag=0;
      end
     end
  end
%Time Overlapse Filtering Level 2
if mod(n,2)==0
  batchtime=actime2;
else
  batchtime=actime1;
end

maxperiod=Time(n)+batchtime;
V=V(1:maxperiod);
found_index=find(V<9|V>151);
```

```
  nov2=length(find(found_index<maxperiod)); %nov2 = number of case
which V<10 or >151 within an used period
  if nov2>0, %if time of utilily overlaps, nov2>0
     Production=0;
  else %if time of utilily overlaps, nov2=0
    deta_t=zeros(0,length(Town));
    for i=1:length(Town),
        if i<length(Town)
            delta_t(i)=Town(i+1)-Town(i);
        else
            delta_t(i)=tstop-Town(i);
        end
    end
    Production=Fmax*delta_t';
  end
end
end

*********************************************************************
```

# VITA

Mr. Sathit Usaha was born on August 29, 1978 in Angthong, Thailand. He graduated high school from Angthong Pathamaroj Withayakhom School, received his Bachelor Degree of Mechanical Engineering from Faculty of Engineering, King Mongkut's University of Technology Thonburi in 2001 and received Master Degree of Economics Program in Business Economics from school of Development Economics, National Institute of Development Administration in 2005 He received Professional Mechanical Engineer license in 2006. He has been working in the field of process and project engineering in petrochemical industry before continued his Master's Degree at Chulalongkorn University in Oct 2007.