

REFERENCES

- Ashcroft, A.T., Cheethan, A.K., Green, M.L.H., and Vernon, P.D.F. (1991) Partial oxidation of methane to synthesis gas using carbon dioxide. Nature, 352, 225-226.
- Bhat, R.N. and Sachtler, W.M.H. (1997) Potential of zeolite supported rhodium catalysts for the CO₂ reforming of CH₄. Applied Catalysis A: General, 150 (2), 279-296.
- Bradford, M.C.J. and Vannice, M.A. (1999) CO₂ reforming of CH₄. Catalysis Reviews Science and Engineering, 41 (1), 1-42.
- Chang, J.S., Park, S.E., and Lee, K.W. (1994) Catalytic reforming of methane with carbon dioxide over pentasil zeolite-supported nickel catalyst. Studies in Surface Science and Catalysis, 84, 1587.
- Chang, J.S., Park, S.E., and Chon, H. (1996) Catalytic activity and coke resistance in the carbon dioxide reforming of methane to synthesis gas over zeolite-supported catalysts. Applied Catalysis A: General, 145, 111-124.
- Cheng, Z., Wu, Q., Li, J., and Zhu, Q. (1996) Effects of promoters and preparation procedures on reforming of methane with carbon dioxide over Ni/Al₂O₃ catalyst. Catalysis Today, 30, 147-155.
- Chubb, T.A. (1980) Characteristics of CO₂-CH₄ reforming-methanation cycle relevant to the solchem thermochemical power system. Solar Energy, 24 (4), 341-345.
- Dong, W.-S., Roh, H.-S., Jun, K.-W., Park, S.-E., Oh, Y.-S. (2002) Methane reforming with CO₂ over Ni/Ce-ZrO₂ catalysts: effect of nickel content. Applied Catalysis A: General, 226, 63-72.
- Erdohelyi, A., Cserenyi, J., Papp, E., and Solymosi, F. (1994) Catalytic reaction of methane with carbon dioxide over supported palladium. Applied Catalysis A: General, 108, 205-219.
- Gadalla, A.M. and Bower, B. (1988) The role of catalyst support on the activity of nickel for reforming methane with CO₂. Chemical Engineering Science, 42, 3049-3062.

- Gesser, H.D., Hunter, N.R., Shigapov, A.N., and Januati, V. (1994) Carbon dioxide reforming with methane to CO and H₂ in a hot wire thermal diffusion column (TDC) reactor. Energy & Fuels, 8, 1123-1125.
- Lee, H.C., Woo, H.C., Chung, S.H., Kim, H.J., Lee, K.H., and Lee, J.S. (2002) Effects of Metal Cation on the Skeletal Isomerization of 1-Butene over Clinoptilolite. Journal of Catalysis, 211 (1), 216-225.
- Lee, H.C., Woo, H.C., Ryoo, R., Lee, K.H., and Lee, J.S. (2000) Skeletal isomerization of n-butenes to isobutene over acid-treated natural clinoptilolite zeolites. Applied Catalysis A: General, 196 (1), 135-142.
- Matsukata, J., Matsushita, T., and Ueyama, K. (1995) A circulating fluidized bed CH₄ reformer: Performance of supported Ni catalysts. Energy & Fuels, 9, 822-828.
- McCrary, J. H., McCrary, G. E., Chubb, T. A., Nemecek, J. J., and Simmons, D. E. (1982) An experimental study of the CO₂---CH₄ reforming-methanation cycle as a mechanism for converting and transporting solar energy. Solar Energy, 29 (2), 141-151.
- Montoya, J.A., Romero-Pascual, E., Gimón, C., Angel, P.D., and Monzon, A. (2000) Methane reforming with CO₂ over Ni/ZrO₂-CeO₂ catalysis prepared by sol-gel. Catalysis Today, 63, 71-85.
- Nakamura, J., Aikawa, K., Sato, K., and Uchijima, T. (1994) Role of support in reforming of CH₄ with CO₂ over Rh catalysts. Catalysis Letters, 25, 265-270.
- Noronha, F.B., Fendley, E.C., Soares, R.R., Alvarez, W.E., and Resasco, D.E. (2001) Correlation between catalytic activity and support reducibility in the CO₂ reforming of methane over Pt/Ce_xZr_{1-x}O₂ catalysts. Chemical Engineering Journal, 82, 21-31.
- Potdar, H.S., Roh, H.-S., Jun, K.-W., Ji, M., and Liu, Z.-W. (2002) Carbon dioxide reforming of methane over co-precipitated Ni-Ce-ZrO₂ catalysts. Catalysis Letters, 84, 95-100.
- Richardson, J.T. and Paripatyadar, S.A. (1990) Carbon dioxide reforming of methane with supported rhodium. Applied Catalysis, 61(1), 293-309.

- Roh, H.-S., Jun, K.-W., Baek, S.-C., and Park, S.-E. (2002) Carbon dioxide reforming of methane over Ni/ θ -Al₂O₃ catalysts: Effect of Ni content. Bulletin of the Korean Chemical Society, 23(8), 1166-1168.
- Ruckenstein, E. and Hu, Y.H. (1996) Interactions between Ni and La₂O₃ in Ni/La₂O₃ catalysts prepared using different Ni precursors. Journal of Catalysis, 161, 55-61.
- Shamsi, A. and Johnson, C. (2003) Effect of pressure on the carbon deposition route in CO₂ reforming of ¹³CH₄. Catalysis Today, 84, 17-25.
- Stagg, S.M. and Resasco, D.E. (1998) Effect of promoters on supported Pt catalysts for CO₂ reforming of CH₄. Studies in Surface Science and Catalysis, 119, 813-818.
- Takano, A., Tagawa, T., and Goto, S. (1994) Carbon dioxide reforming of methane on supported nickel catalysts. Journal of Chemical Engineering Japan, 27, 723-731.
- Tsipouriari, V.A., Efstahiou, A.M., and Verykios, X.E. (1994) Reforming of methane with carbon dioxide to synthesis gas over supported Rh catalysts. Catalysis Today, 21, 579-587.
- Wang, S. and Lu, G.Q. (1996) Carbon dioxide reforming of methane to produce synthesis gas over metal-supported catalysts: State of art. Energy & Fuels, 10, 896-904.
- Wang, S., and Lu, G.Q. (1998a) CO₂ reforming of methane on Ni catalysts: Effects of the support phase and preparation technique. Applied Catalysis B: Environmental, 16, 269-277.
- Wang, S. and Lu, G.Q. (1998b) Reforming of methane with carbon dioxide over Ni/Al₂O₃ catalysts: Effect of nickel precursor. Applied Catalysis A: General, 169, 271-280.
- Wang, S. and Lu, G.Q. (1998c) Role of CeO₂ in Ni/CeO₂-Al₂O₃ catalysts for carbon dioxide reforming of methane. Applied Catalysis B: Environmental, 19, 267-277.

Wang, S. and Lu, G.Q. (1999) A comprehensive study on carbon dioxide reforming of methane over Ni/ γ -Al₂O₃ catalysts. Industrial Engineering Chemistry Research, 38, 2615-2625.

APPENDICES

Appendix A Assumptions, definitions, and calculations.

To facilitate the calculations in this work, some assumptions were made as follows:

1. All the gaseous behaviors obey the ideal gas law.
2. Pressure drop across the system is very small and can be negligible.
3. The pressure in the system equals to the atmospheric pressure.

1. Catalyst Preparation

1.1 Amount of Ni loading

Prepared 1 g of 1wt%Ni/Clino

- To prepare 1 g of catalyst with 1wt%Ni (MW=58.69 g/mole) need to have

$$1 * 1/100 = 0.01 \text{ g of Ni}$$

- Amount of $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ (MW=290.81 g/mole)

$$0.01 * 290.81 / 58.69 = 0.04955 \text{ g}$$

- Amount of clinoptilolite

$$1 - 0.01 = 0.99 \text{ g}$$

1.2 Amount of Ce Loading

Prepared 1 g of 8%Ni-1%Ce/Clino

- To prepare 1 g of catalyst with 8wt%Ni (MW=58.69 g/mole) need to have

$$1 * 8/100 = 0.08 \text{ g of Ni}$$

- Amount of $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ (MW=290.81 g/mole) that was used

$$0.08 * 290.81 / 58.69 = 0.396 \text{ g}$$

- To prepare 1 g of catalyst with 1wt%Ce (MW=140.12 g/mole) need to have

$$1 * 1/100 = 0.01 \text{ g of Ce}$$

- Amount of $\text{Ce}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$ (MW=434.23 g/mole) that was used

$$0.01 * 434.23 / 140.12 = 0.031 \text{ g}$$

- Amount of clinoptilolite

$$1 - 0.08 - 0.01 = 0.91 \text{ g}$$

1.3 Amount of Zr Loading

Prepared 1 g of 8%Ni-1%Zr/Clino

- To prepare 1 g of catalyst with 8wt%Ni (MW=58.69 g/mole) need to have

$$1 * 8/100 = 0.08 \text{ g of Ni}$$

- Amount of Ni(NO₃)₂•6H₂O (MW=290.81 g/mole) that was used

$$0.08 * 290.81 / 58.69 = 0.396 \text{ g}$$

- To prepare 1 g of catalyst with 1wt%Zr (MW=91.22 g/mole) need to have

$$1 * 1/100 = 0.01 \text{ g of Zr}$$

- Amount of ZrOCl₂•8H₂O (MW=322.13 g/mole) that was used

$$0.01 * 322.13 / 91.22 = 0.035 \text{ g}$$

- Amount of clinoptilolite

$$1 - 0.08 - 0.01 = 0.91 \text{ g}$$

2. Conversion and Selectivity

2.1 Methane Conversion

$$\text{CH}_4 \text{ conversion} = \frac{CH_{4,in} - CH_{4,out}}{CH_{4,in}} \times 100$$

Where CH_{4,in} = CH₄ fed to the reactor

CH_{4,out} = CH₄ left the reactor

2.2 Carbon Dioxide Conversion

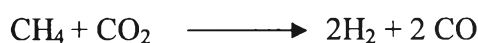
$$\text{CO}_2 \text{ conversion} = \frac{CO_{2,in} - CO_{2,out}}{CO_{2,in}} \times 100$$

Where CO_{2,in} = CO₂ fed to the reactor

CO_{2,out} = CO₂ left the reactor

2.3 Hydrogen Selectivity

Calculation H₂ selectivity vs CO selectivity:



$$\text{H}_2 \text{ selectivity} = \frac{\frac{1}{2} * F_{,out} * y_{(H_2,out)}}{F_{,in} * y_{(CH_4,in)} - F_{,out} * y_{(CH_4,out)}} * 100$$

$$\text{CO selectivity} = \frac{\frac{1}{2} * F_{,out} * y_{(CO,out)}}{F_{,in} * y_{(CH_4,in)} - F_{,out} * y_{(CH_4,out)}} * 100$$

$$\text{Therefore, selectivity of H}_2 \text{ vs CO} = \frac{H_2 \text{ selectivity}}{CO \text{ selectivity} + H_2 \text{ selectivity}} * 100$$

$$= \frac{\frac{1}{2} * y_{(H_2,out)}}{\left(\frac{1}{2} * y_{(H_2,out)}\right) + \left(\frac{1}{2} * y_{(CO,out)}\right)} * 100$$

$$= \frac{y_{(H_2,out)}}{y_{(H_2,out)} + y_{(CO,out)}} * 100$$

Where $F_{,in}$ = Total flow rate of feed stream that fed to the reactor

$F_{,out}$ = Total flow rate that left the reactor

$y_{(H_2,out)}$ = Mole fraction of H_2 in the effluent stream

$y_{(CO,out)}$ = Mole fraction of CO in the effluent stream

$y_{(CH_4,in)}$ = Mole fraction of CH_4 in the feed stream

$y_{(CH_4,out)}$ = Mole fraction of CH_4 in the effluent stream

Appendix B Experimental data.

Table B1 Effect of Ni loading: H₂ production, CO production, H₂ selectivity, CH₄ conversion, CO₂ conversion, and H₂ yield

| 1%Ni/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | CO ₂ | | | | H ₂ Yield | | |
|------------|-------|----------------|-------|--------|-------|----------------|-----------------|-------|--------|---------|-----------------|---------|-------|--------|----------------------|---------|-------------|
| Time(h) | F out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | | convert | %conversion |
| 0.03 | 98 | 1358 | 4.05 | 314394 | 3.21 | 55.84 | 1089793 | 13.72 | 13.45 | 1.62 | 10.76 | 1494482 | 11.21 | 10.98 | 3.42 | 23.76 | 6.01 |
| 0.28 | 98 | 699 | 2.41 | 71808 | 0.73 | 76.69 | 1170323 | 14.74 | 14.44 | 0.63 | 4.17 | 1842685 | 13.82 | 13.54 | 0.86 | 6.00 | 3.20 |
| 0.53 | 98 | 137 | 0.57 | 23675 | 0.24 | 70.25 | 1184930 | 14.92 | 14.62 | 0.45 | 2.97 | 1905954 | 14.29 | 14.01 | 0.40 | 2.77 | 2.09 |
| 0.78 | 98 | 31 | 0.14 | 11664 | 0.12 | 53.42 | 1192363 | 15.01 | 14.71 | 0.36 | 2.36 | 1922387 | 14.42 | 14.13 | 0.28 | 1.93 | 1.26 |
| 1.03 | 98 | 30 | 0.13 | 7910 | 0.08 | 62.09 | 1194867 | 15.05 | 14.74 | 0.33 | 2.16 | 1924340 | 14.43 | 14.14 | 0.26 | 1.83 | 1.34 |
| 1.28 | 98 | 12 | 0.05 | 5832 | 0.06 | 47.27 | 1197012 | 15.07 | 14.77 | 0.30 | 1.98 | 1918120 | 14.39 | 14.10 | 0.31 | 2.15 | 0.94 |
| 1.53 | 98 | 10 | 0.04 | 5003 | 0.05 | 46.59 | 1196066 | 15.06 | 14.76 | 0.31 | 2.06 | 1928708 | 14.46 | 14.18 | 0.23 | 1.61 | 0.96 |

| 3%Ni/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|------------|-------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | F out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 108 | 4112 | 8.89 | 1097145 | 11.19 | 44.27 | 714320 | 8.99 | 9.71 | 5.16 | 34.71 | 1000457 | 7.50 | 8.10 | 6.33 | 43.86 | 15.37 |
| 0.53 | 108 | 3973 | 8.69 | 1079431 | 11.01 | 44.11 | 723440 | 9.11 | 9.84 | 5.04 | 33.87 | 1032987 | 7.75 | 8.37 | 6.07 | 42.04 | 14.94 |
| 0.78 | 108 | 3655 | 8.21 | 1040951 | 10.61 | 43.62 | 747803 | 9.42 | 10.17 | 4.71 | 31.65 | 1075009 | 8.06 | 8.71 | 5.73 | 39.68 | 13.80 |
| 1.03 | 108 | 3425 | 7.86 | 1005308 | 10.25 | 43.39 | 765683 | 9.64 | 10.41 | 4.47 | 30.01 | 1100024 | 8.25 | 8.91 | 5.53 | 38.28 | 13.02 |
| 1.28 | 108 | 3190 | 7.48 | 969299 | 9.88 | 43.09 | 785238 | 9.89 | 10.68 | 4.20 | 28.23 | 1135322 | 8.51 | 9.20 | 5.24 | 36.30 | 12.16 |
| 1.53 | 107 | 2971 | 7.13 | 925406 | 9.44 | 43.03 | 802664 | 10.11 | 10.81 | 4.06 | 27.31 | 1165461 | 8.74 | 9.35 | 5.08 | 35.21 | 11.75 |
| 1.78 | 107 | 2762 | 6.78 | 890214 | 9.08 | 42.74 | 819930 | 10.32 | 11.05 | 3.83 | 25.75 | 1197109 | 8.98 | 9.61 | 4.83 | 33.45 | 11.01 |
| 2.03 | 105 | 2611 | 6.52 | 856557 | 8.73 | 42.73 | 834676 | 10.51 | 11.04 | 3.84 | 25.83 | 1220228 | 9.15 | 9.61 | 4.83 | 33.43 | 11.03 |
| 2.28 | 105 | 2432 | 6.20 | 823791 | 8.40 | 42.46 | 852319 | 10.73 | 11.27 | 3.61 | 24.26 | 1247662 | 9.36 | 9.82 | 4.61 | 31.94 | 10.30 |
| 2.53 | 105 | 2204 | 5.78 | 794620 | 8.10 | 41.64 | 866926 | 10.92 | 11.46 | 3.42 | 22.96 | 1279242 | 9.59 | 10.07 | 4.36 | 30.21 | 9.56 |
| 2.78 | 105 | 2149 | 5.68 | 764726 | 7.80 | 42.13 | 877390 | 11.05 | 11.60 | 3.28 | 22.03 | 1300198 | 9.75 | 10.24 | 4.20 | 29.07 | 9.28 |
| 3.03 | 105 | 2037 | 5.46 | 737803 | 7.52 | 42.07 | 890728 | 11.22 | 11.78 | 3.10 | 20.85 | 1323925 | 9.93 | 10.43 | 4.01 | 27.78 | 8.77 |
| 3.28 | 105 | 1924 | 5.24 | 710136 | 7.24 | 42.00 | 903703 | 11.38 | 11.95 | 2.93 | 19.69 | 1348678 | 10.11 | 10.62 | 3.81 | 26.43 | 8.27 |
| 3.53 | 105 | 1789 | 4.97 | 680059 | 6.93 | 41.77 | 915399 | 11.53 | 12.10 | 2.78 | 18.65 | 1376471 | 10.32 | 10.84 | 3.60 | 24.91 | 7.79 |
| 3.78 | 104 | 1652 | 4.69 | 646934 | 6.60 | 41.56 | 928719 | 11.69 | 12.16 | 2.72 | 18.26 | 1398907 | 10.49 | 10.91 | 3.52 | 24.41 | 7.59 |
| 4.03 | 104 | 1560 | 4.50 | 617987 | 6.30 | 41.64 | 940495 | 11.84 | 12.32 | 2.56 | 17.22 | 1418433 | 10.64 | 11.06 | 3.37 | 23.36 | 7.17 |
| 4.28 | 104 | 1453 | 4.27 | 594102 | 6.06 | 41.32 | 951449 | 11.98 | 12.46 | 2.42 | 16.25 | 1440810 | 10.81 | 11.24 | 3.20 | 22.15 | 6.72 |
| 4.53 | 103 | 1363 | 4.07 | 566794 | 5.78 | 41.30 | 958796 | 12.07 | 12.44 | 2.44 | 16.42 | 1451944 | 10.89 | 11.22 | 3.22 | 22.30 | 6.78 |
| 4.78 | 103 | 1312 | 3.95 | 542849 | 5.54 | 41.64 | 971179 | 12.23 | 12.60 | 2.28 | 15.34 | 1475758 | 11.07 | 11.40 | 3.04 | 21.03 | 6.39 |
| 5.03 | 103 | 1218 | 3.73 | 521989 | 5.32 | 41.22 | 983249 | 12.38 | 12.75 | 2.13 | 14.29 | 1501123 | 11.26 | 11.60 | 2.84 | 19.67 | 5.89 |
| 5.28 | 102 | 1139 | 3.55 | 496488 | 5.06 | 41.19 | 989705 | 12.46 | 12.71 | 2.17 | 14.56 | 1519484 | 11.40 | 11.62 | 2.81 | 19.48 | 6.00 |
| 5.53 | 102 | 1102 | 3.46 | 474091 | 4.83 | 41.70 | 1001608 | 12.61 | 12.86 | 2.01 | 13.54 | 1542591 | 11.57 | 11.80 | 2.63 | 18.25 | 5.64 |
| 5.78 | 102 | 954 | 3.09 | 454592 | 4.64 | 40.00 | 1010243 | 12.72 | 12.98 | 1.90 | 12.79 | 1562783 | 11.72 | 11.95 | 2.48 | 17.18 | 5.12 |

| 5%Ni/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|------------|-------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | F out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 115 | 11230 | 16.94 | 1813497 | 18.49 | 47.81 | 298603 | 3.76 | 4.32 | 10.53 | 70.90 | 515133 | 3.86 | 4.44 | 10.03 | 69.29 | 33.90 |
| 0.53 | 115 | 10575 | 16.32 | 1771584 | 18.06 | 47.47 | 336063 | 4.23 | 4.87 | 9.99 | 67.25 | 489390 | 3.67 | 4.22 | 10.25 | 70.83 | 31.92 |
| 0.78 | 115 | 9487 | 15.25 | 1680983 | 17.14 | 47.08 | 388675 | 4.89 | 5.63 | 9.23 | 62.12 | 566735 | 4.25 | 4.89 | 9.58 | 66.22 | 29.25 |
| 1.03 | 115 | 8321 | 14.04 | 1585681 | 16.17 | 46.48 | 447998 | 5.64 | 6.49 | 8.37 | 56.34 | 639318 | 4.79 | 5.51 | 8.95 | 61.89 | 26.19 |
| 1.28 | 115 | 7439 | 13.08 | 1499379 | 15.29 | 46.10 | 495607 | 6.24 | 7.18 | 7.68 | 51.70 | 708859 | 5.32 | 6.11 | 8.35 | 57.74 | 23.83 |
| 1.53 | 115 | 6652 | 12.18 | 1412212 | 14.40 | 45.82 | 542868 | 6.84 | 7.86 | 7.00 | 47.09 | 773483 | 5.80 | 6.67 | 7.80 | 53.89 | 21.57 |
| 1.78 | 115 | 5911 | 11.28 | 1330010 | 13.56 | 45.41 | 586868 | 7.39 | 8.50 | 6.36 | 42.80 | 844787 | 6.34 | 7.29 | 7.18 | 49.64 | 19.44 |
| 2.03 | 112 | 5328 | 10.55 | 1258735 | 12.83 | 45.11 | 625895 | 7.88 | 8.83 | 6.03 | 40.59 | 902634 | 6.77 | 7.58 | 6.89 | 47.60 | 18.31 |
| 2.28 | 113 | 4811 | 9.86 | 1188670 | 12.12 | 44.87 | 662239 | 8.34 | 9.34 | 5.52 | 37.14 | 958626 | 7.19 | 8.05 | 6.42 | 44.35 | 16.66 |
| 2.53 | 111 | 4412 | 9.31 | 1124907 | 11.47 | 44.81 | 696942 | 8.78 | 9.74 | 5.12 | 34.44 | 1009640 | 7.57 | 8.40 | 6.06 | 41.91 | 15.43 |
| 2.78 | 111 | 4001 | 8.73 | 1064152 | 10.85 | 44.57 | 723148 | 9.11 | 10.11 | 4.75 | 31.97 | 1063077 | 7.97 | 8.85 | 5.62 | 38.83 | 14.25 |
| 3.03 | 110 | 3672 | 8.24 | 1008284 | 10.28 | 44.48 | 749041 | 9.43 | 10.37 | 4.48 | 30.17 | 1112946 | 8.35 | 9.18 | 5.29 | 36.54 | 13.42 |
| 3.28 | 110 | 3353 | 7.74 | 952720 | 9.71 | 44.36 | 773579 | 9.74 | 10.71 | 4.14 | 27.88 | 1158739 | 8.69 | 9.56 | 4.91 | 33.93 | 12.37 |
| 3.53 | 110 | 3090 | 7.32 | 905333 | 9.23 | 44.23 | 796108 | 10.02 | 10.93 | 3.93 | 26.46 | 1198566 | 8.99 | 9.80 | 4.67 | 32.28 | 11.70 |
| 3.78 | 109 | 2829 | 6.89 | 854653 | 8.71 | 44.15 | 819061 | 10.31 | 11.24 | 3.62 | 24.34 | 1233371 | 9.25 | 10.08 | 4.39 | 30.31 | 10.74 |
| 4.03 | 109 | 2646 | 6.58 | 814863 | 8.31 | 44.18 | 835985 | 10.53 | 11.47 | 3.38 | 22.77 | 1269705 | 9.52 | 10.38 | 4.09 | 28.26 | 10.06 |
| 4.28 | 109 | 2420 | 6.18 | 770401 | 7.86 | 44.02 | 853524 | 10.75 | 11.71 | 3.14 | 21.15 | 1303954 | 9.78 | 10.56 | 3.91 | 27.00 | 9.31 |
| 4.53 | 108 | 2246 | 5.86 | 733694 | 7.48 | 43.92 | 864428 | 10.88 | 11.76 | 3.10 | 20.88 | 1320822 | 9.91 | 10.70 | 3.77 | 26.06 | 9.17 |
| 4.78 | 108 | 2098 | 5.58 | 702023 | 7.16 | 43.81 | 881393 | 11.10 | 11.99 | 2.87 | 19.32 | 1355751 | 10.17 | 10.98 | 3.49 | 24.10 | 8.47 |
| 5.03 | 108 | 1960 | 5.31 | 665183 | 6.78 | 43.93 | 899839 | 11.33 | 12.24 | 2.62 | 17.64 | 1391753 | 10.44 | 11.27 | 3.20 | 22.09 | 7.75 |
| 5.28 | 108 | 1841 | 5.08 | 630686 | 6.43 | 44.12 | 913921 | 11.51 | 12.43 | 2.43 | 16.35 | 1414907 | 10.61 | 11.46 | 3.01 | 20.79 | 7.21 |

| 8%Ni/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|------------|-------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | F out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 117 | 11046 | 16.77 | 1741668 | 17.76 | 48.57 | 312538 | 3.94 | 4.60 | 9.84 | 68.11 | 502151 | 3.77 | 4.41 | 9.96 | 69.34 | 33.08 |
| 0.53 | 117 | 9774 | 15.54 | 1651709 | 16.84 | 47.99 | 371603 | 4.68 | 5.47 | 8.97 | 62.09 | 577373 | 4.33 | 5.07 | 9.30 | 64.74 | 29.79 |
| 0.78 | 117 | 9466 | 15.23 | 1633076 | 16.65 | 47.77 | 383900 | 4.83 | 5.66 | 8.78 | 60.83 | 590959 | 4.43 | 5.19 | 9.18 | 63.91 | 29.06 |
| 1.03 | 117 | 9121 | 14.88 | 1609158 | 16.41 | 47.55 | 400114 | 5.04 | 5.89 | 8.55 | 59.18 | 611473 | 4.59 | 5.37 | 9.00 | 62.66 | 28.14 |
| 1.28 | 117 | 8799 | 14.55 | 1581770 | 16.13 | 47.42 | 415254 | 5.23 | 6.12 | 8.32 | 57.63 | 630786 | 4.73 | 5.53 | 8.83 | 61.48 | 27.33 |
| 1.53 | 117 | 8610 | 14.35 | 1564098 | 15.95 | 47.36 | 427056 | 5.38 | 6.29 | 8.15 | 56.43 | 645775 | 4.84 | 5.67 | 8.70 | 60.57 | 26.72 |
| 1.78 | 117 | 8301 | 14.02 | 1536877 | 15.67 | 47.22 | 441092 | 5.55 | 6.50 | 7.94 | 55.00 | 664330 | 4.98 | 5.83 | 8.54 | 59.43 | 25.97 |
| 2.03 | 116 | 8017 | 13.72 | 1518512 | 15.48 | 46.97 | 453685 | 5.71 | 6.63 | 7.81 | 54.11 | 681103 | 5.11 | 5.93 | 8.44 | 58.76 | 25.42 |
| 2.28 | 116 | 7844 | 13.53 | 1496591 | 15.26 | 46.99 | 464352 | 5.85 | 6.78 | 7.66 | 53.03 | 694982 | 5.21 | 6.05 | 8.32 | 57.92 | 24.92 |
| 2.53 | 115 | 7637 | 13.30 | 1480114 | 15.09 | 46.84 | 476863 | 6.00 | 6.91 | 7.53 | 52.18 | 712748 | 5.35 | 6.15 | 8.22 | 57.22 | 24.44 |
| 2.78 | 115 | 7491 | 13.14 | 1462284 | 14.91 | 46.84 | 486427 | 6.12 | 7.04 | 7.40 | 51.22 | 725386 | 5.44 | 6.26 | 8.11 | 56.46 | 23.99 |
| 3.03 | 115 | 7195 | 12.80 | 1445100 | 14.74 | 46.49 | 496831 | 6.26 | 7.19 | 7.25 | 50.18 | 740324 | 5.55 | 6.38 | 7.98 | 55.56 | 23.33 |
| 3.28 | 114 | 7076 | 12.67 | 1420685 | 14.49 | 46.65 | 508323 | 6.40 | 7.30 | 7.14 | 49.47 | 756504 | 5.67 | 6.47 | 7.90 | 54.99 | 23.08 |
| 3.53 | 114 | 6827 | 12.38 | 1400169 | 14.28 | 46.44 | 520574 | 6.55 | 7.47 | 6.97 | 48.25 | 774690 | 5.81 | 6.62 | 7.75 | 53.91 | 22.41 |
| 3.78 | 114 | 6759 | 12.30 | 1388211 | 14.16 | 46.50 | 525766 | 6.62 | 7.55 | 6.89 | 47.73 | 781190 | 5.86 | 6.68 | 7.69 | 53.52 | 22.19 |
| 4.03 | 114 | 6573 | 12.08 | 1375762 | 14.03 | 46.28 | 536028 | 6.75 | 7.69 | 6.75 | 46.71 | 796378 | 5.97 | 6.81 | 7.56 | 52.62 | 21.62 |
| 4.28 | 114 | 6420 | 11.90 | 1358426 | 13.85 | 46.21 | 545444 | 6.87 | 7.83 | 6.61 | 45.78 | 810022 | 6.07 | 6.93 | 7.44 | 51.80 | 21.16 |
| 4.53 | 113 | 6051 | 11.46 | 1339038 | 13.65 | 45.62 | 552668 | 6.96 | 7.86 | 6.58 | 45.54 | 818750 | 6.14 | 6.94 | 7.43 | 51.71 | 20.78 |
| 4.78 | 112 | 6030 | 11.43 | 1325171 | 13.51 | 45.82 | 560598 | 7.06 | 7.91 | 6.53 | 45.25 | 830667 | 6.23 | 6.98 | 7.39 | 51.44 | 20.73 |
| 5.03 | 112 | 5913 | 11.29 | 1304750 | 13.30 | 45.89 | 572342 | 7.21 | 8.07 | 6.37 | 44.10 | 849388 | 6.37 | 7.13 | 7.23 | 50.35 | 20.24 |
| 5.28 | 112 | 5825 | 11.18 | 1290251 | 13.16 | 45.93 | 582525 | 7.34 | 8.22 | 6.22 | 43.11 | 864823 | 6.49 | 7.26 | 7.10 | 49.45 | 19.80 |
| 5.53 | 112 | 5661 | 10.97 | 1278452 | 13.04 | 45.70 | 589511 | 7.42 | 8.31 | 6.13 | 42.43 | 875224 | 6.56 | 7.35 | 7.02 | 48.84 | 19.39 |

| 10%Ni/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-------------|-------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | F out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 110 | 3901 | 8.58 | 1106874 | 11.29 | 43.19 | 692452 | 8.72 | 9.59 | 5.02 | 34.38 | 1054841 | 7.91 | 8.70 | 5.58 | 39.06 | 14.85 |
| 0.53 | 110 | 4142 | 8.93 | 1153729 | 11.76 | 43.15 | 677423 | 8.53 | 9.38 | 5.23 | 35.80 | 975210 | 7.31 | 8.05 | 6.23 | 43.66 | 15.45 |
| 0.78 | 110 | 4182 | 8.99 | 1142759 | 11.65 | 43.54 | 684412 | 8.62 | 9.48 | 5.14 | 35.14 | 977772 | 7.33 | 8.07 | 6.21 | 43.51 | 15.30 |
| 1.03 | 110 | 4147 | 8.94 | 1133392 | 11.56 | 43.61 | 688980 | 8.68 | 9.54 | 5.07 | 34.71 | 991758 | 7.44 | 8.18 | 6.10 | 42.70 | 15.14 |
| 1.28 | 110 | 3984 | 8.70 | 1108219 | 11.30 | 43.50 | 700991 | 8.83 | 9.71 | 4.91 | 33.57 | 1016429 | 7.62 | 8.39 | 5.89 | 41.28 | 14.60 |
| 1.53 | 110 | 3790 | 8.41 | 1087395 | 11.09 | 43.14 | 711782 | 8.96 | 9.86 | 4.76 | 32.55 | 1030400 | 7.73 | 8.50 | 5.78 | 40.47 | 14.04 |
| 1.78 | 110 | 3687 | 8.26 | 1061464 | 10.82 | 43.28 | 724729 | 9.13 | 9.95 | 4.67 | 31.94 | 1047498 | 7.86 | 8.56 | 5.72 | 40.03 | 13.83 |
| 2.03 | 109 | 3496 | 7.97 | 1030014 | 10.50 | 43.13 | 734530 | 9.25 | 10.08 | 4.53 | 31.02 | 1057890 | 7.93 | 8.65 | 5.63 | 39.44 | 13.38 |
| 2.28 | 109 | 3382 | 7.79 | 1009947 | 10.30 | 43.06 | 748810 | 9.43 | 10.28 | 4.34 | 29.68 | 1082874 | 8.12 | 8.85 | 5.43 | 38.01 | 12.78 |
| 2.53 | 109 | 3157 | 7.43 | 983237 | 10.03 | 42.57 | 763843 | 9.62 | 10.48 | 4.13 | 28.27 | 1101103 | 8.26 | 9.00 | 5.28 | 36.96 | 12.04 |
| 2.78 | 109 | 3037 | 7.24 | 961101 | 9.80 | 42.47 | 773807 | 9.74 | 10.62 | 4.00 | 27.34 | 1122227 | 8.42 | 9.17 | 5.11 | 35.75 | 11.61 |
| 3.03 | 107 | 2939 | 7.07 | 933734 | 9.52 | 42.63 | 786558 | 9.90 | 10.60 | 4.02 | 27.49 | 1139321 | 8.54 | 9.14 | 5.14 | 35.97 | 11.72 |
| 3.28 | 107 | 2799 | 6.84 | 908492 | 9.26 | 42.47 | 798881 | 10.06 | 10.76 | 3.85 | 26.36 | 1157106 | 8.68 | 9.29 | 4.99 | 34.97 | 11.19 |
| 3.53 | 107 | 2679 | 6.63 | 885579 | 9.03 | 42.35 | 812026 | 10.22 | 10.84 | 3.78 | 25.85 | 1185218 | 8.89 | 9.42 | 4.86 | 34.01 | 10.95 |
| 3.78 | 106 | 2571 | 6.45 | 859481 | 8.76 | 42.38 | 824198 | 10.38 | 11.00 | 3.62 | 24.73 | 1199029 | 8.99 | 9.53 | 4.75 | 33.25 | 10.48 |
| 4.03 | 106 | 2418 | 6.17 | 831713 | 8.48 | 42.13 | 841715 | 10.60 | 11.23 | 3.38 | 23.13 | 1228041 | 9.21 | 9.76 | 4.52 | 31.63 | 9.75 |
| 4.87 | 106 | 2218 | 5.81 | 767721 | 7.83 | 42.59 | 870851 | 10.97 | 11.62 | 2.99 | 20.47 | 1272154 | 9.54 | 10.11 | 4.17 | 29.17 | 8.72 |
| 5.12 | 106 | 2076 | 5.54 | 746039 | 7.61 | 42.13 | 883436 | 11.12 | 11.79 | 2.82 | 19.33 | 1296007 | 9.72 | 10.30 | 3.98 | 27.85 | 8.14 |
| 5.37 | 106 | 1934 | 5.26 | 713113 | 7.27 | 41.99 | 897495 | 11.30 | 11.87 | 2.75 | 18.81 | 1325952 | 9.94 | 10.44 | 3.84 | 26.88 | 7.90 |
| 5.62 | 105 | 1904 | 5.20 | 694123 | 7.08 | 42.37 | 906102 | 11.41 | 11.98 | 2.64 | 18.04 | 1339192 | 10.04 | 10.55 | 3.73 | 26.15 | 7.64 |

| 15%Ni/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-------------|-------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | F out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 113 | 4521 | 9.47 | 1147806 | 11.70 | 44.71 | 646768 | 8.14 | 9.20 | 5.19 | 36.05 | 1103381 | 8.27 | 9.35 | 4.73 | 33.58 | 16.12 |
| 0.53 | 113 | 4802 | 9.85 | 1205544 | 12.29 | 44.49 | 639053 | 8.05 | 9.09 | 5.30 | 36.81 | 959697 | 7.20 | 8.13 | 5.95 | 42.23 | 16.38 |
| 0.78 | 113 | 4659 | 9.66 | 1189159 | 12.13 | 44.33 | 642979 | 8.10 | 9.15 | 5.24 | 36.42 | 974963 | 7.31 | 8.26 | 5.82 | 41.31 | 16.15 |
| 1.03 | 113 | 4503 | 9.44 | 1167764 | 11.91 | 44.22 | 656234 | 8.26 | 9.34 | 5.05 | 35.11 | 993790 | 7.45 | 8.42 | 5.66 | 40.18 | 15.53 |
| 1.28 | 113 | 4420 | 9.33 | 1153044 | 11.76 | 44.23 | 662229 | 8.34 | 9.42 | 4.97 | 34.52 | 999877 | 7.50 | 8.47 | 5.61 | 39.81 | 15.27 |
| 1.53 | 113 | 4274 | 9.12 | 1139422 | 11.62 | 43.97 | 672318 | 8.47 | 9.57 | 4.82 | 33.52 | 1019336 | 7.64 | 8.64 | 5.44 | 38.64 | 14.74 |
| 1.78 | 113 | 4214 | 9.03 | 1125743 | 11.48 | 44.04 | 678594 | 8.54 | 9.66 | 4.73 | 32.90 | 1028686 | 7.71 | 8.72 | 5.36 | 38.08 | 14.49 |
| 2.03 | 113 | 4024 | 8.76 | 1105659 | 11.27 | 43.72 | 689335 | 8.68 | 9.81 | 4.58 | 31.84 | 1048912 | 7.87 | 8.89 | 5.19 | 36.86 | 13.92 |
| 2.28 | 113 | 4001 | 8.73 | 1098989 | 11.21 | 43.78 | 692798 | 8.72 | 9.86 | 4.53 | 31.50 | 1055192 | 7.91 | 8.94 | 5.14 | 36.48 | 13.79 |
| 2.53 | 113 | 3860 | 8.52 | 1076746 | 10.98 | 43.69 | 702126 | 8.84 | 9.99 | 4.40 | 30.57 | 1070041 | 8.02 | 9.07 | 5.01 | 35.59 | 13.36 |
| 2.78 | 113 | 3732 | 8.33 | 1056823 | 10.78 | 43.59 | 711002 | 8.95 | 10.12 | 4.27 | 29.70 | 1084903 | 8.14 | 9.19 | 4.88 | 34.70 | 12.94 |
| 3.03 | 113 | 3555 | 8.06 | 1033316 | 10.54 | 43.34 | 720825 | 9.08 | 10.26 | 4.13 | 28.73 | 1106774 | 8.30 | 9.38 | 4.70 | 33.38 | 12.45 |
| 3.28 | 113 | 3446 | 7.89 | 1015152 | 10.35 | 43.25 | 733085 | 9.23 | 10.43 | 3.96 | 27.51 | 1120669 | 8.40 | 9.50 | 4.58 | 32.54 | 11.90 |
| 3.53 | 113 | 3315 | 7.68 | 988797 | 10.08 | 43.25 | 742715 | 9.35 | 10.57 | 3.82 | 26.56 | 1146681 | 8.60 | 9.72 | 4.36 | 30.98 | 11.49 |
| 3.78 | 113 | 3196 | 7.49 | 967119 | 9.86 | 43.18 | 755310 | 9.51 | 10.75 | 3.64 | 25.32 | 1165826 | 8.74 | 9.88 | 4.20 | 29.83 | 10.93 |
| 4.03 | 111 | 3130 | 7.39 | 949855 | 9.69 | 43.27 | 762183 | 9.60 | 10.65 | 3.74 | 25.97 | 1180424 | 8.85 | 9.83 | 4.25 | 30.20 | 11.24 |
| 4.28 | 111 | 2978 | 7.14 | 925047 | 9.43 | 43.08 | 775469 | 9.76 | 10.84 | 3.55 | 24.68 | 1199087 | 8.99 | 9.98 | 4.10 | 29.10 | 10.63 |
| 4.53 | 111 | 2792 | 6.83 | 897095 | 9.15 | 42.74 | 786821 | 9.91 | 11.00 | 3.39 | 23.58 | 1221281 | 9.16 | 10.17 | 3.91 | 27.79 | 10.08 |
| 4.78 | 111 | 2695 | 6.66 | 872534 | 8.90 | 42.81 | 797378 | 10.04 | 11.14 | 3.25 | 22.55 | 1240423 | 9.30 | 10.33 | 3.75 | 26.66 | 9.66 |
| 5.03 | 111 | 2582 | 6.46 | 841285 | 8.58 | 42.98 | 810681 | 10.21 | 11.33 | 3.06 | 21.26 | 1262262 | 9.47 | 10.51 | 3.57 | 25.37 | 9.14 |
| 5.28 | 111 | 2506 | 6.33 | 823600 | 8.40 | 42.98 | 815997 | 10.27 | 11.41 | 2.98 | 20.74 | 1277087 | 9.58 | 10.63 | 3.45 | 24.49 | 8.92 |

Table B2 Effect of promoter: Ce: H₂ production, CO production, H₂ selectivity, CH₄ conversion, CO₂ conversion, and H₂ yield

| 8%Ni-1%Ce/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 120 | 8621 | 14.36 | 1549033 | 15.80 | 47.62 | 428168 | 5.39 | 6.47 | 8.01 | 55.32 | 693417 | 5.20 | 6.24 | 8.33 | 57.17 | 26.34 |
| 0.53 | 120 | 9167 | 14.93 | 1595412 | 16.27 | 47.85 | 410592 | 5.17 | 6.20 | 8.28 | 57.15 | 648338 | 4.86 | 5.83 | 8.74 | 59.95 | 27.35 |
| 0.78 | 120 | 9273 | 15.03 | 1603673 | 16.35 | 47.90 | 406271 | 5.12 | 6.14 | 8.34 | 57.60 | 636662 | 4.77 | 5.73 | 8.84 | 60.67 | 27.59 |
| 1.03 | 120 | 9188 | 14.95 | 1599789 | 16.31 | 47.82 | 410690 | 5.17 | 6.21 | 8.27 | 57.14 | 635619 | 4.77 | 5.72 | 8.85 | 60.74 | 27.32 |
| 1.28 | 120 | 9088 | 14.84 | 1593162 | 16.24 | 47.75 | 416199 | 5.24 | 6.29 | 8.19 | 56.57 | 640286 | 4.80 | 5.76 | 8.81 | 60.45 | 27.01 |
| 1.53 | 120 | 8980 | 14.73 | 1582482 | 16.14 | 47.73 | 421803 | 5.31 | 6.37 | 8.11 | 55.98 | 645358 | 4.84 | 5.81 | 8.76 | 60.14 | 26.72 |
| 1.78 | 120 | 8826 | 14.57 | 1573150 | 16.04 | 47.60 | 429610 | 5.41 | 6.49 | 7.99 | 55.17 | 655871 | 4.92 | 5.90 | 8.67 | 59.49 | 26.26 |
| 2.03 | 120 | 8705 | 14.45 | 1564465 | 15.95 | 47.52 | 433637 | 5.46 | 6.55 | 7.93 | 54.75 | 661660 | 4.96 | 5.95 | 8.62 | 59.13 | 26.02 |
| 2.28 | 120 | 8568 | 14.30 | 1555977 | 15.87 | 47.41 | 440566 | 5.55 | 6.66 | 7.82 | 54.03 | 669213 | 5.02 | 6.02 | 8.55 | 58.66 | 25.61 |
| 2.53 | 118 | 8559 | 14.29 | 1552751 | 15.83 | 47.45 | 442813 | 5.58 | 6.58 | 7.90 | 54.56 | 682134 | 5.12 | 6.04 | 8.53 | 58.57 | 25.89 |
| 2.78 | 118 | 8482 | 14.21 | 1548847 | 15.79 | 47.37 | 445320 | 5.61 | 6.62 | 7.86 | 54.30 | 682731 | 5.12 | 6.04 | 8.53 | 58.53 | 25.72 |
| 3.03 | 118 | 8419 | 14.15 | 1542026 | 15.72 | 47.36 | 451267 | 5.68 | 6.71 | 7.77 | 53.69 | 685159 | 5.14 | 6.06 | 8.51 | 58.38 | 25.43 |
| 3.28 | 118 | 8330 | 14.05 | 1534430 | 15.65 | 47.31 | 455320 | 5.73 | 6.77 | 7.71 | 53.28 | 688484 | 5.16 | 6.09 | 8.48 | 58.18 | 25.21 |
| 3.53 | 118 | 8221 | 13.94 | 1527284 | 15.57 | 47.22 | 458980 | 5.78 | 6.82 | 7.66 | 52.90 | 696044 | 5.22 | 6.16 | 8.41 | 57.72 | 24.98 |
| 3.78 | 118 | 8098 | 13.80 | 1518736 | 15.49 | 47.13 | 463964 | 5.84 | 6.89 | 7.59 | 52.39 | 699689 | 5.25 | 6.19 | 8.38 | 57.50 | 24.69 |
| 4.03 | 118 | 8117 | 13.82 | 1513910 | 15.44 | 47.24 | 467597 | 5.89 | 6.95 | 7.53 | 52.02 | 703149 | 5.27 | 6.22 | 8.35 | 57.29 | 24.57 |
| 4.28 | 115 | 7928 | 13.62 | 1494587 | 15.24 | 47.19 | 475061 | 5.98 | 6.88 | 7.60 | 52.49 | 704137 | 5.28 | 6.07 | 8.50 | 58.32 | 24.77 |
| 4.53 | 115 | 7922 | 13.61 | 1498512 | 15.28 | 47.11 | 475565 | 5.99 | 6.89 | 7.59 | 52.44 | 713423 | 5.35 | 6.15 | 8.42 | 57.77 | 24.71 |
| 4.78 | 115 | 7823 | 13.50 | 1491047 | 15.20 | 47.04 | 480472 | 6.05 | 6.96 | 7.52 | 51.95 | 722743 | 5.42 | 6.23 | 8.34 | 57.22 | 24.44 |
| 5.03 | 115 | 7768 | 13.44 | 1486196 | 15.15 | 47.01 | 483976 | 6.09 | 7.01 | 7.47 | 51.60 | 727006 | 5.45 | 6.27 | 8.30 | 56.97 | 24.26 |
| 5.28 | 115 | 7623 | 13.28 | 1475268 | 15.04 | 46.89 | 488033 | 6.15 | 7.07 | 7.41 | 51.19 | 733264 | 5.50 | 6.32 | 8.25 | 56.60 | 24.01 |

| 8%Ni-2%Ce/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 121 | 9895 | 15.658 | 1652416 | 16.85 | 48.17 | 375067 | 4.72 | 5.71 | 9.12 | 61.47 | 650403 | 4.88 | 5.90 | 8.38 | 58.69 | 29.61 |
| 0.53 | 121 | 11144 | 16.863 | 1739630 | 17.74 | 48.73 | 329364 | 4.15 | 5.02 | 9.81 | 66.16 | 532562 | 3.99 | 4.83 | 9.45 | 66.17 | 32.24 |
| 0.78 | 121 | 11548 | 17.212 | 1755676 | 17.9 | 49.02 | 314677 | 3.96 | 4.79 | 10.04 | 67.67 | 509918 | 3.82 | 4.63 | 9.66 | 67.61 | 33.17 |
| 1.03 | 121 | 11432 | 17.132 | 1741657 | 17.76 | 49.10 | 321404 | 4.05 | 4.90 | 9.93 | 66.98 | 514265 | 3.86 | 4.67 | 9.62 | 67.34 | 32.89 |
| 1.28 | 121 | 11209 | 16.924 | 1729395 | 17.63 | 48.97 | 332162 | 4.18 | 5.06 | 9.77 | 65.87 | 522606 | 3.92 | 4.74 | 9.54 | 66.81 | 32.26 |
| 1.53 | 121 | 10860 | 16.594 | 1713518 | 17.47 | 48.71 | 345496 | 4.35 | 5.26 | 9.57 | 64.50 | 533249 | 4.00 | 4.84 | 9.45 | 66.13 | 31.42 |
| 1.78 | 121 | 10610 | 16.355 | 1698102 | 17.32 | 48.57 | 356831 | 4.49 | 5.44 | 9.39 | 63.34 | 546045 | 4.10 | 4.96 | 9.33 | 65.32 | 30.77 |
| 2.03 | 121 | 10409 | 16.161 | 1682296 | 17.15 | 48.51 | 369221 | 4.65 | 5.63 | 9.20 | 62.07 | 559184 | 4.19 | 5.07 | 9.21 | 64.48 | 30.11 |
| 2.28 | 121 | 10181 | 15.939 | 1669239 | 17.02 | 48.36 | 378023 | 4.76 | 5.76 | 9.07 | 61.16 | 569200 | 4.27 | 5.17 | 9.12 | 63.85 | 29.58 |
| 2.53 | 121 | 10071 | 15.832 | 1658628 | 16.91 | 48.35 | 386888 | 4.87 | 5.89 | 8.94 | 60.25 | 577544 | 4.33 | 5.24 | 9.05 | 63.32 | 29.13 |
| 2.78 | 121 | 9818 | 15.582 | 1644492 | 16.77 | 48.17 | 395933 | 4.99 | 6.03 | 8.80 | 59.32 | 586872 | 4.40 | 5.33 | 8.96 | 62.72 | 28.57 |
| 3.03 | 121 | 9675 | 15.439 | 1633766 | 16.66 | 48.10 | 401081 | 5.05 | 6.11 | 8.72 | 58.79 | 594362 | 4.46 | 5.39 | 8.89 | 62.25 | 28.28 |
| 3.28 | 121 | 9513 | 15.277 | 1624550 | 16.57 | 47.98 | 406938 | 5.12 | 6.20 | 8.63 | 58.19 | 603226 | 4.52 | 5.47 | 8.81 | 61.69 | 27.92 |
| 3.53 | 121 | 9430 | 15.193 | 1611645 | 16.43 | 48.04 | 414207 | 5.22 | 6.31 | 8.52 | 57.45 | 610767 | 4.58 | 5.54 | 8.74 | 61.21 | 27.60 |
| 3.78 | 121 | 9336 | 15.098 | 1605419 | 16.37 | 47.98 | 420814 | 5.30 | 6.41 | 8.42 | 56.77 | 616616 | 4.62 | 5.60 | 8.69 | 60.83 | 27.24 |
| 4.03 | 118 | 9251 | 15.011 | 1589623 | 16.21 | 48.08 | 425481 | 5.36 | 6.32 | 8.51 | 57.37 | 614442 | 4.61 | 5.44 | 8.85 | 61.94 | 27.58 |
| 4.28 | 118 | 9221 | 14.981 | 1584019 | 16.15 | 48.12 | 432689 | 5.45 | 6.43 | 8.40 | 56.65 | 623206 | 4.67 | 5.52 | 8.77 | 61.40 | 27.26 |
| 4.53 | 118 | 9055 | 14.811 | 1578256 | 16.09 | 47.93 | 439741 | 5.54 | 6.53 | 8.30 | 55.94 | 630806 | 4.73 | 5.58 | 8.70 | 60.93 | 26.81 |
| 4.78 | 116 | 9031 | 14.786 | 1569050 | 16 | 48.03 | 444615 | 5.60 | 6.49 | 8.34 | 56.21 | 636803 | 4.78 | 5.54 | 8.75 | 61.22 | 27.00 |
| 5.03 | 116 | 8924 | 14.675 | 1563489 | 15.94 | 47.93 | 450561 | 5.67 | 6.58 | 8.25 | 55.62 | 644959 | 4.84 | 5.61 | 8.68 | 60.73 | 26.66 |
| 5.28 | 116 | 8815 | 14.562 | 1555312 | 15.86 | 47.87 | 454685 | 5.73 | 6.64 | 8.19 | 55.22 | 648966 | 4.87 | 5.65 | 8.64 | 60.48 | 26.43 |

| 8%Ni-3%Ce/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | H ₂ Yield |
| 0.28 | 122 | 12322 | 17.947 | 1802072 | 18.38 | 49.41 | 280661 | 3.53 | 4.31 | 10.43 | 70.76 | 476394 | 3.57 | 4.36 | 10.02 | 69.68 | 34.96 |
| 0.53 | 122 | 13001 | 18.552 | 1835131 | 18.71 | 49.78 | 259454 | 3.27 | 3.99 | 10.76 | 72.97 | 427248 | 3.20 | 3.91 | 10.46 | 72.80 | 36.33 |
| 0.78 | 122 | 13064 | 18.607 | 1828677 | 18.65 | 49.95 | 257461 | 3.24 | 3.96 | 10.79 | 73.18 | 434144 | 3.26 | 3.97 | 10.40 | 72.37 | 36.55 |
| 1.03 | 122 | 12846 | 18.415 | 1819375 | 18.55 | 49.82 | 266871 | 3.36 | 4.10 | 10.65 | 72.20 | 444157 | 3.33 | 4.06 | 10.31 | 71.73 | 35.97 |
| 1.28 | 122 | 12646 | 18.237 | 1808155 | 18.44 | 49.73 | 277425 | 3.49 | 4.26 | 10.48 | 71.10 | 452672 | 3.39 | 4.14 | 10.23 | 71.19 | 35.36 |
| 1.53 | 122 | 12243 | 17.876 | 1795390 | 18.31 | 49.40 | 291656 | 3.67 | 4.48 | 10.27 | 69.62 | 464576 | 3.48 | 4.25 | 10.12 | 70.43 | 34.39 |
| 1.78 | 122 | 11977 | 17.634 | 1780939 | 18.16 | 49.27 | 303645 | 3.82 | 4.66 | 10.08 | 68.37 | 475771 | 3.57 | 4.35 | 10.02 | 69.72 | 33.68 |
| 2.03 | 120 | 11695 | 17.376 | 1767981 | 18.03 | 49.08 | 316004 | 3.98 | 4.77 | 9.97 | 67.62 | 488256 | 3.66 | 4.39 | 9.98 | 69.43 | 33.19 |
| 2.28 | 120 | 11485 | 17.182 | 1750084 | 17.85 | 49.05 | 327788 | 4.13 | 4.95 | 9.79 | 66.41 | 503424 | 3.78 | 4.53 | 9.84 | 68.48 | 32.58 |
| 2.53 | 120 | 11165 | 16.883 | 1737930 | 17.72 | 48.79 | 338661 | 4.26 | 5.12 | 9.63 | 65.30 | 514349 | 3.86 | 4.63 | 9.75 | 67.80 | 31.86 |
| 2.78 | 119 | 11010 | 16.737 | 1727186 | 17.61 | 48.73 | 346034 | 4.36 | 5.19 | 9.56 | 64.84 | 523877 | 3.93 | 4.68 | 9.70 | 67.47 | 31.59 |
| 3.03 | 119 | 10709 | 16.45 | 1712488 | 17.46 | 48.51 | 355512 | 4.48 | 5.33 | 9.42 | 63.87 | 535216 | 4.01 | 4.78 | 9.60 | 66.77 | 30.98 |
| 3.28 | 119 | 10565 | 16.312 | 1702356 | 17.36 | 48.45 | 363950 | 4.58 | 5.45 | 9.29 | 63.02 | 545028 | 4.09 | 4.86 | 9.51 | 66.16 | 30.53 |
| 3.53 | 119 | 10383 | 16.136 | 1692250 | 17.26 | 48.32 | 370340 | 4.66 | 5.55 | 9.20 | 62.37 | 552330 | 4.14 | 4.93 | 9.44 | 65.71 | 30.14 |
| 3.78 | 119 | 10328 | 16.083 | 1682907 | 17.16 | 48.38 | 378386 | 4.76 | 5.67 | 9.08 | 61.55 | 563364 | 4.23 | 5.03 | 9.35 | 65.02 | 29.78 |
| 4.03 | 119 | 10186 | 15.944 | 1671764 | 17.05 | 48.33 | 380610 | 4.79 | 5.70 | 9.04 | 61.32 | 562558 | 4.22 | 5.02 | 9.35 | 65.07 | 29.64 |
| 4.28 | 119 | 10064 | 15.825 | 1663843 | 16.97 | 48.26 | 388206 | 4.89 | 5.82 | 8.93 | 60.55 | 574438 | 4.31 | 5.13 | 9.25 | 64.33 | 29.22 |
| 4.53 | 119 | 9865 | 15.628 | 1653745 | 16.86 | 48.10 | 393068 | 4.95 | 5.89 | 8.86 | 60.06 | 580296 | 4.35 | 5.18 | 9.20 | 63.97 | 28.89 |
| 4.78 | 119 | 9862 | 15.625 | 1649051 | 16.81 | 48.17 | 399596 | 5.03 | 5.99 | 8.76 | 59.39 | 589335 | 4.42 | 5.26 | 9.11 | 63.41 | 28.61 |
| 5.03 | 119 | 9773 | 15.537 | 1641068 | 16.73 | 48.15 | 404339 | 5.09 | 6.06 | 8.69 | 58.91 | 595443 | 4.47 | 5.31 | 9.06 | 63.03 | 28.36 |
| 5.28 | 119 | 9649 | 15.413 | 1633742 | 16.66 | 48.06 | 410499 | 5.17 | 6.15 | 8.60 | 58.29 | 603902 | 4.53 | 5.39 | 8.98 | 62.50 | 28.01 |

| 8%Ni-4%Ce/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | H ₂ Yield |
| 0.28 | 123 | 14775 | 20.072 | 1877271 | 19.14 | 51.19 | 176509 | 2.22 | 2.73 | 11.58 | 80.90 | 356253 | 2.67 | 3.29 | 10.70 | 76.51 | 41.41 |
| 0.53 | 123 | 14878 | 20.157 | 1848559 | 18.85 | 51.68 | 182894 | 2.30 | 2.83 | 11.48 | 80.21 | 365189 | 2.74 | 3.37 | 10.62 | 75.92 | 41.45 |
| 0.78 | 123 | 13702 | 19.162 | 1794776 | 18.3 | 51.15 | 226885 | 2.86 | 3.51 | 10.80 | 75.45 | 408174 | 3.06 | 3.77 | 10.23 | 73.09 | 38.59 |
| 1.03 | 122 | 12492 | 18.1 | 1733689 | 17.68 | 50.59 | 279663 | 3.52 | 4.30 | 10.02 | 69.99 | 464409 | 3.48 | 4.25 | 9.74 | 69.63 | 35.41 |
| 1.28 | 122 | 11494 | 17.19 | 1687769 | 17.21 | 49.97 | 318318 | 4.01 | 4.89 | 9.43 | 65.84 | 504868 | 3.79 | 4.62 | 9.37 | 66.98 | 32.90 |
| 1.53 | 122 | 10877 | 16.61 | 1650705 | 16.83 | 49.67 | 346712 | 4.37 | 5.33 | 8.99 | 62.79 | 533604 | 4.00 | 4.88 | 9.11 | 65.10 | 31.19 |
| 1.78 | 119 | 10413 | 16.165 | 1621841 | 16.54 | 49.43 | 368709 | 4.64 | 5.52 | 8.79 | 61.41 | 559429 | 4.20 | 4.99 | 9.00 | 64.32 | 30.35 |
| 2.03 | 118 | 9964 | 15.726 | 1592526 | 16.24 | 49.20 | 388535 | 4.89 | 5.77 | 8.54 | 59.67 | 584364 | 4.38 | 5.17 | 8.82 | 63.04 | 29.36 |
| 2.28 | 118 | 9600 | 15.364 | 1564757 | 15.96 | 49.06 | 406599 | 5.12 | 6.04 | 8.27 | 57.80 | 608964 | 4.57 | 5.39 | 8.60 | 61.48 | 28.35 |
| 2.53 | 118 | 9237 | 14.997 | 1535704 | 15.66 | 48.92 | 422800 | 5.32 | 6.28 | 8.03 | 56.12 | 634333 | 4.76 | 5.61 | 8.38 | 59.88 | 27.45 |
| 2.78 | 118 | 8959 | 14.712 | 1505800 | 15.35 | 48.93 | 439462 | 5.53 | 6.53 | 7.79 | 54.39 | 659621 | 4.95 | 5.84 | 8.15 | 58.28 | 26.61 |
| 3.03 | 118 | 8555 | 14.29 | 1475419 | 15.04 | 48.71 | 456953 | 5.75 | 6.79 | 7.53 | 52.57 | 682336 | 5.12 | 6.04 | 7.95 | 56.84 | 25.61 |
| 3.28 | 116 | 8315 | 14.035 | 1446266 | 14.75 | 48.76 | 470750 | 5.93 | 6.88 | 7.44 | 51.97 | 704596 | 5.28 | 6.13 | 7.86 | 56.19 | 25.34 |
| 3.53 | 116 | 8080 | 13.783 | 1421258 | 14.49 | 48.75 | 484796 | 6.10 | 7.08 | 7.23 | 50.53 | 728499 | 5.46 | 6.34 | 7.65 | 54.70 | 24.63 |
| 3.78 | 116 | 7837 | 13.519 | 1394483 | 14.22 | 48.74 | 497273 | 6.26 | 7.26 | 7.05 | 49.26 | 749695 | 5.62 | 6.52 | 7.47 | 53.38 | 24.01 |
| 4.03 | 116 | 7616 | 13.275 | 1372813 | 14 | 48.67 | 509154 | 6.41 | 7.44 | 6.88 | 48.05 | 771267 | 5.78 | 6.71 | 7.28 | 52.04 | 23.39 |
| 4.28 | 116 | 7370 | 13.001 | 1347177 | 13.74 | 48.62 | 519697 | 6.54 | 7.59 | 6.72 | 46.97 | 786236 | 5.90 | 6.84 | 7.15 | 51.11 | 22.84 |
| 4.53 | 116 | 7278 | 12.897 | 1328257 | 13.54 | 48.78 | 527258 | 6.64 | 7.70 | 6.61 | 46.20 | 799125 | 5.99 | 6.95 | 7.04 | 50.31 | 22.54 |
| 4.78 | 116 | 7177 | 12.782 | 1309272 | 13.35 | 48.91 | 540281 | 6.80 | 7.89 | 6.42 | 44.87 | 819277 | 6.14 | 7.13 | 6.86 | 49.06 | 21.95 |
| 5.03 | 116 | 6965 | 12.54 | 1289909 | 13.15 | 48.81 | 549253 | 6.92 | 8.02 | 6.29 | 43.96 | 838773 | 6.29 | 7.30 | 6.69 | 47.85 | 21.45 |
| 5.28 | 116 | 6790 | 12.337 | 1267661 | 12.93 | 48.83 | 557828 | 7.02 | 8.15 | 6.17 | 43.08 | 853156 | 6.40 | 7.42 | 6.57 | 46.95 | 21.04 |

Table B3 Effect of promoter: Zr: H₂ production, CO production, H₂ selectivity, CH₄ conversion, CO₂ conversion, and H₂ yield

| 8%Ni-1%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 118 | 10115 | 15.875 | 1626011 | 16.58 | 48.91 | 391266 | 4.93 | 5.81 | 8.90 | 60.49 | 633771 | 4.75 | 5.61 | 8.75 | 60.93 | 29.59 |
| 0.53 | 118 | 10268 | 16.024 | 1633269 | 16.65 | 49.04 | 390433 | 4.92 | 5.80 | 8.91 | 60.57 | 608589 | 4.56 | 5.39 | 8.97 | 62.49 | 29.70 |
| 0.78 | 118 | 9951 | 15.713 | 1615525 | 16.47 | 48.82 | 403473 | 5.08 | 5.99 | 8.72 | 59.25 | 621527 | 4.66 | 5.50 | 8.86 | 61.69 | 28.93 |
| 1.03 | 118 | 9719 | 15.483 | 1602100 | 16.34 | 48.66 | 413588 | 5.21 | 6.15 | 8.57 | 58.23 | 635789 | 4.77 | 5.63 | 8.73 | 60.81 | 28.34 |
| 1.28 | 118 | 9490 | 15.253 | 1587336 | 16.19 | 48.52 | 421081 | 5.30 | 6.26 | 8.46 | 57.48 | 645099 | 4.84 | 5.71 | 8.65 | 60.24 | 27.89 |
| 1.53 | 118 | 9397 | 15.16 | 1581707 | 16.13 | 48.45 | 427278 | 5.38 | 6.35 | 8.36 | 56.85 | 654981 | 4.91 | 5.80 | 8.56 | 59.63 | 27.55 |
| 1.78 | 118 | 9271 | 15.032 | 1570464 | 16.01 | 48.42 | 433514 | 5.46 | 6.44 | 8.27 | 56.22 | 663293 | 4.97 | 5.87 | 8.49 | 59.12 | 27.22 |
| 2.03 | 118 | 9127 | 14.885 | 1560779 | 15.91 | 48.33 | 437487 | 5.51 | 6.50 | 8.21 | 55.82 | 668770 | 5.02 | 5.92 | 8.44 | 58.78 | 26.98 |
| 2.28 | 118 | 9043 | 14.798 | 1554680 | 15.85 | 48.28 | 441111 | 5.55 | 6.55 | 8.16 | 55.45 | 673441 | 5.05 | 5.96 | 8.40 | 58.49 | 26.77 |
| 2.53 | 118 | 8976 | 14.729 | 1548973 | 15.79 | 48.25 | 445004 | 5.60 | 6.61 | 8.10 | 55.06 | 680216 | 5.10 | 6.02 | 8.34 | 58.07 | 26.57 |
| 2.78 | 118 | 8879 | 14.629 | 1542092 | 15.72 | 48.20 | 448066 | 5.64 | 6.66 | 8.06 | 54.75 | 681556 | 5.11 | 6.03 | 8.33 | 57.99 | 26.39 |
| 3.03 | 118 | 8818 | 14.565 | 1535719 | 15.66 | 48.19 | 452261 | 5.69 | 6.72 | 7.99 | 54.33 | 683605 | 5.13 | 6.05 | 8.31 | 57.86 | 26.18 |
| 3.28 | 118 | 8772 | 14.517 | 1530976 | 15.61 | 48.18 | 454452 | 5.72 | 6.75 | 7.96 | 54.11 | 684141 | 5.13 | 6.05 | 8.30 | 57.83 | 26.07 |
| 3.53 | 118 | 8693 | 14.435 | 1525238 | 15.55 | 48.14 | 457995 | 5.77 | 6.81 | 7.91 | 53.75 | 686112 | 5.15 | 6.07 | 8.29 | 57.71 | 25.87 |
| 3.78 | 118 | 8655 | 14.395 | 1519993 | 15.5 | 48.15 | 462357 | 5.82 | 6.87 | 7.84 | 53.31 | 688025 | 5.16 | 6.09 | 8.27 | 57.59 | 25.67 |
| 4.03 | 118 | 8635 | 14.374 | 1517821 | 15.48 | 48.15 | 465271 | 5.86 | 6.91 | 7.80 | 53.01 | 689886 | 5.17 | 6.11 | 8.25 | 57.48 | 25.53 |
| 4.28 | 118 | 8604 | 14.342 | 1511602 | 15.41 | 48.20 | 466618 | 5.88 | 6.93 | 7.78 | 52.88 | 690403 | 5.18 | 6.11 | 8.25 | 57.44 | 25.49 |
| 4.53 | 118 | 8506 | 14.238 | 1508798 | 15.38 | 48.06 | 468167 | 5.90 | 6.96 | 7.76 | 52.72 | 689168 | 5.17 | 6.10 | 8.26 | 57.52 | 25.34 |
| 4.78 | 118 | 8446 | 14.175 | 1507620 | 15.37 | 47.97 | 472692 | 5.95 | 7.02 | 7.69 | 52.26 | 700182 | 5.25 | 6.20 | 8.16 | 56.84 | 25.07 |
| 5.03 | 118 | 8486 | 14.217 | 1500590 | 15.3 | 48.16 | 475540 | 5.99 | 7.07 | 7.65 | 51.98 | 704674 | 5.28 | 6.24 | 8.12 | 56.56 | 25.03 |
| 5.28 | 118 | 8461 | 14.191 | 1498650 | 15.28 | 48.15 | 478283 | 6.02 | 7.11 | 7.61 | 51.70 | 708389 | 5.31 | 6.27 | 8.09 | 56.34 | 24.89 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 16.843 | 9259 | 15.019 | 1537993 | 15.68 | 48.92 | 428369 | 5.39 | 6.36 | 8.46 | 57.07 | 712595 | 5.34 | 6.31 | 8.06 | 56.11 | 27.92 |
| 0.53 | 31.843 | 9706 | 15.47 | 1584190 | 16.15 | 48.92 | 419198 | 5.28 | 6.23 | 8.60 | 57.99 | 652082 | 4.89 | 5.77 | 8.60 | 59.83 | 28.37 |
| 0.78 | 46.843 | 9634 | 15.398 | 1587598 | 16.19 | 48.75 | 423889 | 5.34 | 6.30 | 8.53 | 57.52 | 646362 | 4.85 | 5.72 | 8.65 | 60.19 | 28.04 |
| 1.03 | 61.843 | 9456 | 15.212 | 1584306 | 16.15 | 48.50 | 430762 | 5.42 | 6.40 | 8.42 | 56.83 | 651337 | 4.88 | 5.76 | 8.60 | 59.88 | 27.56 |
| 1.28 | 76.843 | 9427 | 15.19 | 1578542 | 16.1 | 48.55 | 434576 | 5.47 | 6.46 | 8.37 | 56.44 | 651960 | 4.89 | 5.77 | 8.60 | 59.84 | 27.41 |
| 1.53 | 91.843 | 9312 | 15.073 | 1575175 | 16.06 | 48.41 | 438438 | 5.52 | 6.35 | 8.48 | 57.17 | 655856 | 4.92 | 5.66 | 8.71 | 60.63 | 27.68 |
| 1.78 | 106.843 | 9231 | 14.991 | 1574907 | 16.06 | 48.28 | 440163 | 5.54 | 6.37 | 8.45 | 57.01 | 655378 | 4.92 | 5.65 | 8.71 | 60.66 | 27.52 |
| 2.03 | 121.843 | 9211 | 14.97 | 1571880 | 16.03 | 48.29 | 442613 | 5.57 | 6.41 | 8.42 | 56.77 | 657694 | 4.93 | 5.67 | 8.69 | 60.52 | 27.41 |
| 2.28 | 136.843 | 9149 | 14.907 | 1570484 | 16.01 | 48.21 | 444200 | 5.59 | 6.43 | 8.39 | 56.61 | 661129 | 4.96 | 5.70 | 8.67 | 60.31 | 27.29 |
| 2.53 | 151.843 | 9119 | 14.876 | 1568047 | 15.99 | 48.20 | 445904 | 5.61 | 6.46 | 8.37 | 56.45 | 663019 | 4.97 | 5.72 | 8.65 | 60.20 | 27.21 |
| 2.78 | 166.843 | 9029 | 14.784 | 1565209 | 15.96 | 48.09 | 445179 | 5.61 | 6.45 | 8.38 | 56.52 | 661718 | 4.96 | 5.71 | 8.66 | 60.28 | 27.18 |
| 3.03 | 181.843 | 8959 | 14.712 | 1562913 | 15.94 | 48.00 | 448238 | 5.64 | 6.49 | 8.33 | 56.22 | 664802 | 4.99 | 5.73 | 8.63 | 60.09 | 26.99 |
| 3.28 | 196.843 | 8930 | 14.682 | 1561609 | 15.92 | 47.97 | 449048 | 5.65 | 6.50 | 8.32 | 56.14 | 667337 | 5.00 | 5.76 | 8.61 | 59.94 | 26.93 |
| 3.53 | 211.843 | 8918 | 14.669 | 1558831 | 15.89 | 47.99 | 450867 | 5.68 | 6.53 | 8.30 | 55.96 | 668478 | 5.01 | 5.77 | 8.60 | 59.87 | 26.86 |
| 3.78 | 226.843 | 8890 | 14.64 | 1560657 | 15.91 | 47.92 | 451761 | 5.69 | 6.54 | 8.28 | 55.87 | 669300 | 5.02 | 5.77 | 8.59 | 59.82 | 26.77 |
| 4.03 | 241.843 | 8838 | 14.586 | 1556897 | 15.88 | 47.88 | 452727 | 5.70 | 6.56 | 8.27 | 55.78 | 669754 | 5.02 | 5.78 | 8.59 | 59.79 | 26.71 |
| 4.28 | 256.843 | 8807 | 14.554 | 1552624 | 15.83 | 47.90 | 456165 | 5.74 | 6.61 | 8.22 | 55.44 | 672994 | 5.05 | 5.80 | 8.56 | 59.60 | 26.56 |
| 4.53 | 271.843 | 8833 | 14.581 | 1548035 | 15.78 | 48.02 | 454457 | 5.72 | 6.58 | 8.24 | 55.61 | 670329 | 5.03 | 5.78 | 8.59 | 59.76 | 26.70 |
| 4.78 | 286.843 | 8683 | 14.424 | 1549483 | 15.8 | 47.72 | 457100 | 5.76 | 6.62 | 8.21 | 55.35 | 675032 | 5.06 | 5.82 | 8.55 | 59.48 | 26.42 |
| 5.03 | 301.843 | 8712 | 14.455 | 1546489 | 15.77 | 47.83 | 459764 | 5.79 | 6.66 | 8.17 | 55.09 | 677581 | 5.08 | 5.84 | 8.52 | 59.32 | 26.35 |
| 5.28 | 316.843 | 8615 | 14.353 | 1543063 | 15.73 | 47.70 | 461532 | 5.81 | 6.68 | 8.14 | 54.92 | 681120 | 5.11 | 5.87 | 8.49 | 59.11 | 26.20 |

| 8%Ni-3%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 120 | 12295 | 17.923 | 1789595 | 18.25 | 49.55 | 272455 | 3.43 | 4.12 | 10.75 | 72.31 | 478706 | 3.59 | 4.31 | 10.15 | 70.21 | 35.83 |
| 0.53 | 120 | 12166 | 17.806 | 1774853 | 18.1 | 49.59 | 285668 | 3.60 | 4.32 | 10.55 | 70.97 | 484470 | 3.63 | 4.36 | 10.10 | 69.85 | 35.20 |
| 0.78 | 120 | 11781 | 17.455 | 1753769 | 17.88 | 49.39 | 306206 | 3.86 | 4.63 | 10.24 | 68.88 | 497057 | 3.73 | 4.47 | 9.99 | 69.07 | 34.03 |
| 1.03 | 118 | 11337 | 17.044 | 1729972 | 17.64 | 49.14 | 325109 | 4.09 | 4.83 | 10.04 | 67.51 | 514321 | 3.86 | 4.55 | 9.91 | 68.53 | 33.18 |
| 1.28 | 118 | 11040 | 16.765 | 1708198 | 17.42 | 49.04 | 342390 | 4.31 | 5.09 | 9.78 | 65.79 | 531595 | 3.99 | 4.70 | 9.76 | 67.47 | 32.27 |
| 1.53 | 118 | 10768 | 16.507 | 1686936 | 17.2 | 48.97 | 357207 | 4.50 | 5.31 | 9.56 | 64.31 | 548954 | 4.12 | 4.86 | 9.60 | 66.41 | 31.49 |
| 1.78 | 116 | 10423 | 16.175 | 1669589 | 17.02 | 48.72 | 371058 | 4.67 | 5.42 | 9.45 | 63.55 | 567179 | 4.25 | 4.93 | 9.53 | 65.88 | 30.96 |
| 2.03 | 116 | 10176 | 15.935 | 1650887 | 16.83 | 48.63 | 382062 | 4.81 | 5.58 | 9.29 | 62.47 | 580214 | 4.35 | 5.05 | 9.41 | 65.10 | 30.38 |
| 2.28 | 116 | 9919 | 15.682 | 1634762 | 16.67 | 48.47 | 394680 | 4.97 | 5.76 | 9.11 | 61.23 | 592367 | 4.44 | 5.15 | 9.31 | 64.37 | 29.68 |
| 2.53 | 116 | 9787 | 15.551 | 1624753 | 16.57 | 48.42 | 402153 | 5.06 | 5.87 | 9.00 | 60.50 | 600767 | 4.51 | 5.23 | 9.24 | 63.86 | 29.29 |
| 2.78 | 114 | 9622 | 15.386 | 1613950 | 16.46 | 48.32 | 410448 | 5.17 | 5.89 | 8.98 | 60.38 | 611330 | 4.58 | 5.23 | 9.24 | 63.86 | 29.17 |
| 3.03 | 114 | 9544 | 15.308 | 1608076 | 16.4 | 48.28 | 413930 | 5.21 | 5.94 | 8.93 | 60.04 | 615865 | 4.62 | 5.27 | 9.20 | 63.59 | 28.99 |
| 3.28 | 114 | 9473 | 15.236 | 1603680 | 16.35 | 48.23 | 417579 | 5.26 | 5.99 | 8.88 | 59.69 | 622352 | 4.67 | 5.32 | 9.14 | 63.21 | 28.79 |
| 3.53 | 112 | 9320 | 15.081 | 1598962 | 16.3 | 48.05 | 422195 | 5.32 | 5.95 | 8.92 | 59.96 | 631792 | 4.74 | 5.31 | 9.16 | 63.31 | 28.81 |
| 3.78 | 112 | 9246 | 15.006 | 1593492 | 16.25 | 48.01 | 427949 | 5.39 | 6.04 | 8.83 | 59.41 | 640511 | 4.80 | 5.38 | 9.08 | 62.80 | 28.53 |
| 4.03 | 112 | 9104 | 14.861 | 1589930 | 16.21 | 47.83 | 432604 | 5.45 | 6.10 | 8.77 | 58.97 | 648033 | 4.86 | 5.44 | 9.02 | 62.36 | 28.20 |
| 4.28 | 112 | 9035 | 14.79 | 1584059 | 16.15 | 47.80 | 436378 | 5.49 | 6.15 | 8.72 | 58.61 | 649118 | 4.87 | 5.45 | 9.01 | 62.30 | 28.02 |
| 4.53 | 111 | 9088 | 14.844 | 1580201 | 16.11 | 47.95 | 437303 | 5.51 | 6.11 | 8.76 | 58.90 | 646943 | 4.85 | 5.39 | 9.08 | 62.76 | 28.24 |
| 4.78 | 111 | 9069 | 14.825 | 1580378 | 16.11 | 47.92 | 439905 | 5.54 | 6.15 | 8.72 | 58.65 | 649755 | 4.87 | 5.41 | 9.05 | 62.60 | 28.10 |
| 5.03 | 111 | 9076 | 14.832 | 1578095 | 16.09 | 47.96 | 444424 | 5.60 | 6.21 | 8.66 | 58.23 | 655164 | 4.91 | 5.45 | 9.01 | 62.29 | 27.93 |
| 5.28 | 111 | 9035 | 14.79 | 1573416 | 16.04 | 47.97 | 446736 | 5.63 | 6.24 | 8.63 | 58.01 | 657981 | 4.93 | 5.48 | 8.98 | 62.13 | 27.83 |

| 8%Ni-4%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 123 | 13272 | 18.79 | 1823714 | 18.6 | 50.26 | 233281 | 2.94 | 3.61 | 10.75 | 74.84 | 441902 | 3.31 | 4.08 | 9.92 | 70.88 | 35.83 |
| 0.53 | 123 | 14309 | 19.68 | 1862590 | 18.99 | 50.89 | 211173 | 2.66 | 3.27 | 11.09 | 77.22 | 367981 | 2.76 | 3.39 | 10.61 | 75.75 | 35.20 |
| 0.78 | 123 | 14182 | 19.573 | 1855410 | 18.92 | 50.85 | 215423 | 2.71 | 3.34 | 11.02 | 76.77 | 376692 | 2.83 | 3.47 | 10.53 | 75.18 | 34.03 |
| 1.03 | 123 | 13843 | 19.284 | 1836725 | 18.73 | 50.73 | 229914 | 2.90 | 3.56 | 10.80 | 75.20 | 392388 | 2.94 | 3.62 | 10.38 | 74.15 | 33.18 |
| 1.28 | 123 | 13365 | 18.871 | 1816242 | 18.52 | 50.47 | 246639 | 3.11 | 3.82 | 10.54 | 73.40 | 408930 | 3.07 | 3.77 | 10.23 | 73.06 | 32.27 |
| 1.53 | 123 | 12917 | 18.478 | 1792494 | 18.28 | 50.27 | 264478 | 3.33 | 4.10 | 10.26 | 71.47 | 425604 | 3.19 | 3.93 | 10.07 | 71.96 | 31.49 |
| 1.78 | 123 | 12427 | 18.042 | 1768332 | 18.03 | 50.02 | 283715 | 3.57 | 4.39 | 9.97 | 69.40 | 446567 | 3.35 | 4.12 | 9.88 | 70.58 | 30.96 |
| 2.03 | 123 | 12036 | 17.688 | 1749615 | 17.84 | 49.79 | 297620 | 3.75 | 4.61 | 9.75 | 67.90 | 462123 | 3.47 | 4.26 | 9.74 | 69.55 | 30.38 |
| 2.28 | 123 | 11749 | 17.426 | 1730889 | 17.65 | 49.68 | 310791 | 3.91 | 4.81 | 9.55 | 66.48 | 477281 | 3.58 | 4.40 | 9.60 | 68.55 | 29.68 |
| 2.53 | 119 | 11434 | 17.134 | 1711952 | 17.46 | 49.53 | 324093 | 4.08 | 4.86 | 9.50 | 66.18 | 492011 | 3.69 | 4.39 | 9.61 | 68.64 | 29.29 |
| 2.78 | 119 | 11233 | 16.946 | 1697469 | 17.31 | 49.47 | 333856 | 4.20 | 5.00 | 9.36 | 65.16 | 503456 | 3.78 | 4.49 | 9.51 | 67.91 | 29.17 |
| 3.03 | 119 | 11053 | 16.777 | 1687460 | 17.21 | 49.37 | 342254 | 4.31 | 5.13 | 9.23 | 64.29 | 513301 | 3.85 | 4.58 | 9.42 | 67.28 | 28.99 |
| 3.28 | 119 | 10726 | 16.466 | 1672132 | 17.05 | 49.13 | 351364 | 4.42 | 5.26 | 9.10 | 63.34 | 524499 | 3.93 | 4.68 | 9.32 | 66.56 | 28.79 |
| 3.53 | 119 | 10688 | 16.43 | 1663537 | 16.96 | 49.20 | 357936 | 4.51 | 5.36 | 9.00 | 62.65 | 532482 | 3.99 | 4.75 | 9.25 | 66.06 | 28.81 |
| 3.78 | 119 | 10493 | 16.243 | 1650894 | 16.83 | 49.11 | 364651 | 4.59 | 5.46 | 8.90 | 61.95 | 540262 | 4.05 | 4.82 | 9.18 | 65.56 | 28.53 |
| 4.03 | 119 | 10427 | 16.179 | 1644142 | 16.76 | 49.11 | 370410 | 4.66 | 5.55 | 8.81 | 61.35 | 547868 | 4.11 | 4.89 | 9.11 | 65.08 | 28.20 |
| 4.28 | 116 | 10233 | 15.99 | 1635693 | 16.68 | 48.95 | 376705 | 4.74 | 5.50 | 8.86 | 61.68 | 555509 | 4.17 | 4.83 | 9.17 | 65.48 | 28.02 |
| 4.53 | 116 | 10232 | 15.989 | 1625132 | 16.57 | 49.11 | 379100 | 4.77 | 5.54 | 8.82 | 61.44 | 557972 | 4.18 | 4.85 | 9.15 | 65.33 | 28.24 |
| 4.78 | 116 | 10063 | 15.824 | 1616551 | 16.48 | 48.98 | 385727 | 4.86 | 5.63 | 8.73 | 60.77 | 566554 | 4.25 | 4.93 | 9.07 | 64.79 | 28.10 |
| 5.03 | 116 | 9978 | 15.74 | 1609721 | 16.41 | 48.95 | 391228 | 4.93 | 5.71 | 8.65 | 60.21 | 575538 | 4.32 | 5.01 | 8.99 | 64.24 | 27.93 |
| 5.28 | 116 | 9830 | 15.594 | 1606369 | 16.38 | 48.77 | 395336 | 4.98 | 5.77 | 8.59 | 59.79 | 580162 | 4.35 | 5.05 | 8.95 | 63.95 | 27.83 |

| 8%Ni-5%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 120 | 13401 | 18.902 | 1813171 | 18.49 | 50.55 | 239137 | 3.01 | 3.61 | 10.79 | 74.91 | 410399 | 3.08 | 3.69 | 10.33 | 73.66 | 37.87 |
| 0.53 | 120 | 13199 | 18.726 | 1800213 | 18.36 | 50.50 | 254964 | 3.21 | 3.85 | 10.55 | 73.25 | 414749 | 3.11 | 3.73 | 10.29 | 73.38 | 36.99 |
| 0.78 | 120 | 12846 | 18.415 | 1788915 | 18.24 | 50.24 | 270638 | 3.41 | 4.09 | 10.31 | 71.61 | 426919 | 3.20 | 3.84 | 10.18 | 72.60 | 35.97 |
| 1.03 | 120 | 12417 | 18.033 | 1771966 | 18.07 | 49.95 | 283902 | 3.57 | 4.29 | 10.11 | 70.22 | 438432 | 3.29 | 3.95 | 10.07 | 71.86 | 35.07 |
| 1.28 | 120 | 12270 | 17.9 | 1762560 | 17.97 | 49.90 | 294506 | 3.71 | 4.45 | 9.95 | 69.11 | 447067 | 3.35 | 4.02 | 10.00 | 71.30 | 34.48 |
| 1.53 | 120 | 12081 | 17.729 | 1753533 | 17.88 | 49.79 | 302196 | 3.81 | 4.57 | 9.84 | 68.30 | 454039 | 3.41 | 4.09 | 9.93 | 70.85 | 34.00 |
| 1.78 | 120 | 11856 | 17.524 | 1747157 | 17.82 | 49.59 | 307956 | 3.88 | 4.65 | 9.75 | 67.69 | 461512 | 3.46 | 4.15 | 9.87 | 70.38 | 33.57 |
| 2.03 | 120 | 11860 | 17.527 | 1743190 | 17.77 | 49.65 | 312777 | 3.94 | 4.73 | 9.68 | 67.19 | 467141 | 3.50 | 4.20 | 9.82 | 70.01 | 33.36 |
| 2.28 | 120 | 11548 | 17.24 | 1735734 | 17.7 | 49.34 | 316242 | 3.98 | 4.78 | 9.63 | 66.83 | 471975 | 3.54 | 4.25 | 9.77 | 69.70 | 32.97 |
| 2.53 | 119 | 11502 | 17.197 | 1731440 | 17.65 | 49.34 | 321222 | 4.04 | 4.81 | 9.59 | 66.58 | 477445 | 3.58 | 4.26 | 9.76 | 69.61 | 32.85 |
| 2.78 | 119 | 11449 | 17.148 | 1724059 | 17.58 | 49.38 | 326868 | 4.12 | 4.90 | 9.51 | 66.00 | 482064 | 3.62 | 4.30 | 9.72 | 69.31 | 32.59 |
| 3.03 | 119 | 11310 | 17.019 | 1712645 | 17.46 | 49.36 | 332494 | 4.19 | 4.98 | 9.42 | 65.41 | 489531 | 3.67 | 4.37 | 9.65 | 68.84 | 32.28 |
| 3.28 | 119 | 11224 | 16.938 | 1710785 | 17.44 | 49.26 | 335548 | 4.23 | 5.03 | 9.38 | 65.09 | 491061 | 3.68 | 4.38 | 9.64 | 68.74 | 32.07 |
| 3.53 | 119 | 10995 | 16.722 | 1696990 | 17.3 | 49.15 | 340490 | 4.29 | 5.10 | 9.30 | 64.58 | 496754 | 3.73 | 4.43 | 9.59 | 68.38 | 31.74 |
| 3.78 | 119 | 10914 | 16.646 | 1691901 | 17.25 | 49.11 | 345178 | 4.35 | 5.17 | 9.23 | 64.09 | 502493 | 3.77 | 4.48 | 9.54 | 68.01 | 31.47 |
| 4.03 | 119 | 10877 | 16.61 | 1688611 | 17.22 | 49.10 | 348535 | 4.39 | 5.22 | 9.18 | 63.74 | 506929 | 3.80 | 4.52 | 9.50 | 67.73 | 31.30 |
| 4.28 | 119 | 10872 | 16.606 | 1686525 | 17.2 | 49.13 | 349494 | 4.40 | 5.24 | 9.17 | 63.64 | 508137 | 3.81 | 4.53 | 9.49 | 67.65 | 31.27 |
| 4.53 | 119 | 10766 | 16.505 | 1678728 | 17.12 | 49.09 | 352682 | 4.44 | 5.28 | 9.12 | 63.31 | 508970 | 3.82 | 4.54 | 9.48 | 67.60 | 31.08 |
| 4.78 | 118 | 10709 | 16.45 | 1672109 | 17.05 | 49.10 | 358285 | 4.51 | 5.32 | 9.08 | 63.04 | 516638 | 3.87 | 4.57 | 9.45 | 67.39 | 30.96 |
| 5.03 | 118 | 10658 | 16.401 | 1673767 | 17.07 | 49.01 | 357443 | 4.50 | 5.31 | 9.09 | 63.13 | 517182 | 3.88 | 4.58 | 9.44 | 67.35 | 30.94 |
| 5.28 | 118 | 10566 | 16.313 | 1670902 | 17.04 | 48.91 | 360420 | 4.54 | 5.36 | 9.05 | 62.82 | 520401 | 3.90 | 4.61 | 9.41 | 67.15 | 30.73 |

| 8%Ni-6%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 115 | 6684 | 12.213 | 1330884 | 13.57 | 47.37 | 534245 | 6.73 | 7.74 | 6.59 | 45.98 | 809567 | 6.07 | 6.98 | 7.01 | 50.09 | 21.78 |
| 0.53 | 115 | 6558 | 12.065 | 1332126 | 13.58 | 47.04 | 554233 | 6.98 | 8.03 | 6.30 | 43.96 | 804820 | 6.04 | 6.94 | 7.05 | 50.38 | 20.68 |
| 0.78 | 114 | 6193 | 11.628 | 1304797 | 13.3 | 46.64 | 573284 | 7.22 | 8.23 | 6.09 | 42.54 | 824081 | 6.18 | 7.05 | 6.94 | 49.64 | 19.84 |
| 1.03 | 114 | 5891 | 11.258 | 1273726 | 12.99 | 46.43 | 594456 | 7.49 | 8.53 | 5.79 | 40.42 | 848919 | 6.37 | 7.26 | 6.73 | 48.12 | 18.77 |
| 1.28 | 113 | 5542 | 10.82 | 1241092 | 12.66 | 46.09 | 612989 | 7.72 | 8.72 | 5.60 | 39.10 | 873331 | 6.55 | 7.40 | 6.59 | 47.10 | 18.02 |
| 1.53 | 112 | 5138 | 10.298 | 1208587 | 12.32 | 45.52 | 632003 | 7.96 | 8.91 | 5.41 | 37.77 | 899463 | 6.75 | 7.56 | 6.43 | 46.00 | 17.19 |
| 1.78 | 111 | 4906 | 9.99 | 1171957 | 11.95 | 45.53 | 650494 | 8.19 | 9.09 | 5.23 | 36.52 | 925721 | 6.94 | 7.71 | 6.28 | 44.92 | 16.63 |
| 2.03 | 110 | 4608 | 9.586 | 1143425 | 11.66 | 45.12 | 666558 | 8.39 | 9.23 | 5.09 | 35.54 | 950896 | 7.13 | 7.84 | 6.15 | 43.93 | 16.03 |
| 2.28 | 110 | 4314 | 9.1758 | 1112716 | 11.35 | 44.71 | 681880 | 8.59 | 9.44 | 4.88 | 34.05 | 976216 | 7.32 | 8.05 | 5.94 | 42.43 | 15.23 |
| 2.53 | 109 | 4110 | 8.8841 | 1079651 | 11.01 | 44.66 | 697991 | 8.79 | 9.58 | 4.74 | 33.11 | 997605 | 7.48 | 8.16 | 5.83 | 41.71 | 14.79 |
| 2.78 | 108 | 3910 | 8.5921 | 1051546 | 10.72 | 44.49 | 712829 | 8.98 | 9.69 | 4.63 | 32.32 | 1017586 | 7.63 | 8.24 | 5.75 | 41.09 | 14.38 |
| 3.03 | 107 | 3695 | 8.2711 | 1023438 | 10.44 | 44.21 | 724746 | 9.13 | 9.76 | 4.56 | 31.82 | 1036459 | 7.77 | 8.32 | 5.67 | 40.55 | 14.07 |
| 3.28 | 106 | 3511 | 7.99 | 996647 | 10.16 | 44.02 | 739165 | 9.31 | 9.87 | 4.46 | 31.11 | 1060038 | 7.95 | 8.43 | 5.56 | 39.76 | 13.70 |
| 3.53 | 105 | 3318 | 7.6884 | 970320 | 9.894 | 43.73 | 752231 | 9.47 | 9.95 | 4.38 | 30.56 | 1079719 | 8.10 | 8.50 | 5.49 | 39.23 | 13.36 |
| 3.78 | 105 | 3161 | 7.4377 | 946042 | 9.647 | 43.54 | 766238 | 9.65 | 10.13 | 4.19 | 29.26 | 1101769 | 8.26 | 8.68 | 5.31 | 37.98 | 12.74 |
| 4.03 | 105 | 3047 | 7.2524 | 922816 | 9.41 | 43.53 | 778533 | 9.80 | 10.29 | 4.03 | 28.13 | 1120683 | 8.40 | 8.82 | 5.17 | 36.92 | 12.24 |
| 4.28 | 105 | 2856 | 6.9353 | 898606 | 9.163 | 43.08 | 790724 | 9.96 | 10.45 | 3.87 | 27.00 | 1139000 | 8.54 | 8.97 | 5.02 | 35.89 | 11.63 |
| 4.53 | 105 | 2767 | 6.7846 | 877599 | 8.949 | 43.12 | 797428 | 10.04 | 10.54 | 3.78 | 26.39 | 1148958 | 8.62 | 9.05 | 4.94 | 35.33 | 11.38 |
| 4.78 | 105 | 2650 | 6.5834 | 856313 | 8.732 | 42.99 | 808878 | 10.19 | 10.69 | 3.63 | 25.33 | 1171491 | 8.79 | 9.23 | 4.76 | 34.06 | 10.89 |
| 5.03 | 105 | 2515 | 6.3467 | 836316 | 8.528 | 42.67 | 821187 | 10.34 | 10.86 | 3.46 | 24.19 | 1191160 | 8.93 | 9.38 | 4.61 | 32.95 | 10.32 |
| 5.28 | 105 | 2396 | 6.1337 | 817077 | 8.331 | 42.40 | 833523 | 10.50 | 11.02 | 3.30 | 23.05 | 1211063 | 9.08 | 9.54 | 4.45 | 31.83 | 9.78 |

Table B4 Stability test: H₂ production, CO production, H₂ selectivity, CH₄ conversion, CO₂ conversion, and H₂ yield

| 8%Ni-5%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 117 | 12958 | 18.514 | 1769261 | 18.04 | 50.65 | 192681 | 2.43 | 2.84 | 11.23 | 79.82 | 455791 | 3.42 | 4.00 | 9.90 | 71.23 | 40.43 |
| 0.53 | 121 | 13524 | 19.009 | 1806958 | 18.42 | 50.78 | 211745 | 2.67 | 3.23 | 10.84 | 77.07 | 386197 | 2.90 | 3.50 | 10.39 | 74.79 | 39.14 |
| 0.78 | 121 | 13287 | 18.803 | 1803203 | 18.39 | 50.56 | 221261 | 2.79 | 3.37 | 10.70 | 76.04 | 390847 | 2.93 | 3.55 | 10.35 | 74.48 | 38.45 |
| 1.03 | 121 | 12995 | 18.547 | 1792387 | 18.28 | 50.37 | 229437 | 2.89 | 3.50 | 10.57 | 75.15 | 395872 | 2.97 | 3.59 | 10.31 | 74.15 | 37.85 |
| 1.28 | 120 | 12918 | 18.479 | 1783839 | 18.19 | 50.40 | 238481 | 3.00 | 3.60 | 10.47 | 74.39 | 405108 | 3.04 | 3.65 | 10.25 | 73.77 | 37.49 |
| 1.53 | 120 | 12740 | 18.321 | 1772573 | 18.07 | 50.34 | 245733 | 3.09 | 3.71 | 10.36 | 73.61 | 412320 | 3.09 | 3.71 | 10.19 | 73.30 | 37.05 |
| 1.78 | 119 | 12411 | 18.027 | 1762616 | 17.97 | 50.08 | 254030 | 3.20 | 3.81 | 10.26 | 72.95 | 420824 | 3.16 | 3.76 | 10.14 | 72.98 | 36.53 |
| 2.03 | 119 | 12314 | 17.94 | 1752359 | 17.87 | 50.10 | 262760 | 3.31 | 3.94 | 10.13 | 72.02 | 428999 | 3.22 | 3.83 | 10.07 | 72.45 | 36.08 |
| 2.28 | 119 | 12077 | 17.725 | 1741002 | 17.75 | 49.96 | 271030 | 3.41 | 4.06 | 10.01 | 71.14 | 438285 | 3.29 | 3.91 | 9.99 | 71.86 | 35.54 |
| 2.53 | 119 | 11819 | 17.49 | 1729470 | 17.63 | 49.79 | 277230 | 3.49 | 4.15 | 9.92 | 70.48 | 445825 | 3.34 | 3.98 | 9.92 | 71.37 | 35.09 |
| 2.78 | 119 | 11655 | 17.339 | 1720248 | 17.54 | 49.71 | 285302 | 3.59 | 4.28 | 9.79 | 69.62 | 455814 | 3.42 | 4.07 | 9.83 | 70.73 | 34.61 |
| 3.03 | 119 | 11621 | 17.308 | 1708436 | 17.42 | 49.84 | 292197 | 3.68 | 4.38 | 9.69 | 68.88 | 461569 | 3.46 | 4.12 | 9.78 | 70.36 | 34.33 |
| 3.28 | 119 | 11262 | 16.974 | 1700941 | 17.34 | 49.46 | 299133 | 3.77 | 4.48 | 9.59 | 68.14 | 471391 | 3.54 | 4.21 | 9.69 | 69.73 | 33.70 |
| 3.53 | 118 | 11242 | 16.955 | 1688022 | 17.21 | 49.62 | 302650 | 3.81 | 4.50 | 9.57 | 68.04 | 473811 | 3.55 | 4.19 | 9.71 | 69.83 | 33.76 |
| 3.78 | 118 | 11140 | 16.859 | 1678864 | 17.12 | 49.62 | 312311 | 3.93 | 4.64 | 9.43 | 67.02 | 487046 | 3.65 | 4.31 | 9.59 | 68.99 | 33.25 |
| 4.03 | 118 | 10985 | 16.713 | 1666163 | 16.99 | 49.59 | 319115 | 4.02 | 4.74 | 9.33 | 66.30 | 493384 | 3.70 | 4.37 | 9.53 | 68.59 | 32.88 |
| 4.28 | 118 | 10688 | 16.43 | 1659275 | 16.92 | 49.27 | 327195 | 4.12 | 4.86 | 9.21 | 65.45 | 504201 | 3.78 | 4.46 | 9.44 | 67.90 | 32.24 |
| 4.53 | 118 | 10533 | 16.281 | 1644557 | 16.77 | 49.26 | 335610 | 4.23 | 4.99 | 9.08 | 64.56 | 515270 | 3.86 | 4.56 | 9.34 | 67.19 | 31.80 |
| 4.78 | 118 | 10407 | 16.159 | 1633187 | 16.65 | 49.25 | 342972 | 4.32 | 5.10 | 8.97 | 63.78 | 524440 | 3.93 | 4.64 | 9.26 | 66.61 | 31.41 |
| 5.03 | 117 | 10067 | 15.828 | 1616158 | 16.48 | 48.99 | 352311 | 4.44 | 5.19 | 8.88 | 63.11 | 534904 | 4.01 | 4.69 | 9.21 | 66.23 | 30.92 |
| 5.28 | 117 | 9885 | 15.648 | 1601249 | 16.33 | 48.94 | 360488 | 4.54 | 5.31 | 8.76 | 62.25 | 546595 | 4.10 | 4.80 | 9.10 | 65.49 | 30.47 |
| 5.53 | 116 | 9676 | 15.44 | 1587355 | 16.19 | 48.82 | 369855 | 4.66 | 5.40 | 8.67 | 61.60 | 558999 | 4.19 | 4.86 | 9.04 | 65.01 | 30.08 |
| 5.78 | 116 | 9483 | 15.25 | 1574690 | 16.06 | 48.71 | 377984 | 4.76 | 5.52 | 8.55 | 60.76 | 569209 | 4.27 | 4.95 | 8.95 | 64.37 | 29.59 |
| 6.03 | 116 | 9333 | 15.10 | 1558660 | 15.89 | 48.71 | 388728 | 4.89 | 5.68 | 8.39 | 59.65 | 582374 | 4.37 | 5.07 | 8.83 | 63.55 | 29.05 |
| 6.28 | 116 | 9118 | 14.88 | 1541898 | 15.72 | 48.62 | 397983 | 5.01 | 5.81 | 8.26 | 58.68 | 594478 | 4.46 | 5.17 | 8.73 | 62.79 | 28.53 |
| 6.53 | 116 | 8857 | 14.61 | 1529174 | 15.59 | 48.37 | 407389 | 5.13 | 5.95 | 8.12 | 57.71 | 606192 | 4.55 | 5.27 | 8.63 | 62.06 | 27.91 |
| 6.78 | 116 | 8618 | 14.36 | 1511292 | 15.41 | 48.23 | 416787 | 5.25 | 6.09 | 7.98 | 56.73 | 620123 | 4.65 | 5.39 | 8.50 | 61.19 | 27.36 |
| 7.03 | 115 | 8492 | 14.22 | 1496605 | 15.26 | 48.24 | 427383 | 5.38 | 6.19 | 7.88 | 56.01 | 632019 | 4.74 | 5.45 | 8.45 | 60.78 | 27.02 |
| 7.28 | 115 | 8267 | 13.98 | 1478496 | 15.08 | 48.12 | 438082 | 5.52 | 6.34 | 7.73 | 54.91 | 646328 | 4.85 | 5.57 | 8.32 | 59.89 | 26.43 |
| 7.53 | 114 | 8034 | 13.73 | 1463187 | 14.92 | 47.93 | 448617 | 5.65 | 6.44 | 7.63 | 54.23 | 658794 | 4.94 | 5.63 | 8.27 | 59.48 | 25.99 |
| 7.78 | 114 | 7880 | 13.57 | 1445396 | 14.74 | 47.93 | 454516 | 5.72 | 6.52 | 7.55 | 53.63 | 664589 | 4.98 | 5.68 | 8.22 | 59.12 | 25.70 |
| 8.03 | 113 | 7648 | 13.31 | 1430038 | 14.58 | 47.72 | 466270 | 5.87 | 6.63 | 7.44 | 52.85 | 682468 | 5.12 | 5.78 | 8.12 | 58.39 | 25.22 |
| 8.28 | 113 | 7454 | 13.10 | 1412590 | 14.40 | 47.62 | 477874 | 6.02 | 6.80 | 7.27 | 51.67 | 696336 | 5.22 | 5.90 | 8.00 | 57.54 | 24.61 |

| 8%Ni-5%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 9.03 | 112 | 6854 | 12.41 | 1361085 | 13.88 | 47.21 | 508473 | 6.40 | 7.17 | 6.90 | 49.03 | 741015 | 5.56 | 6.22 | 7.67 | 55.22 | 23.15 |
| 9.28 | 112 | 6694 | 12.23 | 1350911 | 13.77 | 47.02 | 515650 | 6.49 | 7.27 | 6.80 | 48.31 | 751166 | 5.63 | 6.31 | 7.59 | 54.60 | 22.72 |
| 9.53 | 111 | 6500 | 12.00 | 1328401 | 13.55 | 46.97 | 527580 | 6.64 | 7.37 | 6.70 | 47.59 | 767436 | 5.76 | 6.39 | 7.51 | 54.04 | 22.35 |
| 9.78 | 111 | 6347 | 11.81 | 1316370 | 13.42 | 46.81 | 535858 | 6.75 | 7.49 | 6.58 | 46.77 | 778901 | 5.84 | 6.48 | 7.41 | 53.35 | 21.89 |
| 10.03 | 111 | 6197 | 11.63 | 1297097 | 13.23 | 46.80 | 544774 | 6.86 | 7.61 | 6.46 | 45.88 | 790888 | 5.93 | 6.58 | 7.32 | 52.63 | 21.47 |
| 10.28 | 111 | 5962 | 11.35 | 1283260 | 13.09 | 46.44 | 554481 | 6.98 | 7.75 | 6.32 | 44.92 | 805125 | 6.04 | 6.70 | 7.20 | 51.78 | 20.86 |
| 10.53 | 110 | 5861 | 11.22 | 1266856 | 12.92 | 46.49 | 563115 | 7.09 | 7.80 | 6.27 | 44.57 | 816911 | 6.13 | 6.74 | 7.16 | 51.51 | 20.72 |
| 10.78 | 110 | 5664 | 10.97 | 1248610 | 12.73 | 46.29 | 573775 | 7.22 | 7.95 | 6.12 | 43.52 | 832652 | 6.24 | 6.87 | 7.03 | 50.58 | 20.14 |
| 11.03 | 109 | 5556 | 10.84 | 1230110 | 12.54 | 46.35 | 581434 | 7.32 | 7.98 | 6.09 | 43.28 | 843283 | 6.32 | 6.89 | 7.01 | 50.40 | 20.06 |
| 11.28 | 108 | 5352 | 10.58 | 1217213 | 12.41 | 46.01 | 592297 | 7.46 | 8.05 | 6.02 | 42.75 | 856882 | 6.43 | 6.94 | 6.96 | 50.07 | 19.67 |
| 11.53 | 108 | 5271 | 10.47 | 1201333 | 12.25 | 46.09 | 599564 | 7.55 | 8.15 | 5.92 | 42.05 | 867275 | 6.50 | 7.02 | 6.87 | 49.46 | 19.38 |
| 11.78 | 107 | 5054 | 10.19 | 1186567 | 12.10 | 45.71 | 609699 | 7.68 | 8.21 | 5.86 | 41.62 | 882204 | 6.62 | 7.08 | 6.82 | 49.07 | 19.02 |
| 12.03 | 107 | 4955 | 10.06 | 1171470 | 11.95 | 45.71 | 617402 | 7.77 | 8.32 | 5.75 | 40.88 | 891212 | 6.68 | 7.15 | 6.75 | 48.55 | 18.68 |
| 12.28 | 106 | 4858 | 9.92 | 1151687 | 11.74 | 45.79 | 622239 | 7.84 | 8.31 | 5.76 | 40.97 | 897389 | 6.73 | 7.13 | 6.77 | 48.67 | 18.76 |
| 12.53 | 106 | 4699 | 9.71 | 1143551 | 11.66 | 45.44 | 629431 | 7.93 | 8.40 | 5.67 | 40.29 | 911452 | 6.84 | 7.25 | 6.65 | 47.87 | 18.31 |
| 12.78 | 106 | 4664 | 9.66 | 1127883 | 11.50 | 45.66 | 636297 | 8.01 | 8.49 | 5.58 | 39.64 | 920830 | 6.91 | 7.32 | 6.58 | 47.33 | 18.10 |
| 13.03 | 106 | 4550 | 9.51 | 1115053 | 11.37 | 45.54 | 646813 | 8.14 | 8.63 | 5.44 | 38.64 | 937823 | 7.03 | 7.46 | 6.44 | 46.36 | 17.60 |
| 13.28 | 106 | 4395 | 9.29 | 1103359 | 11.25 | 45.23 | 653396 | 8.23 | 8.72 | 5.35 | 38.02 | 948137 | 7.11 | 7.54 | 6.36 | 45.77 | 17.19 |
| 13.53 | 106 | 4293 | 9.15 | 1089124 | 11.11 | 45.16 | 659453 | 8.30 | 8.80 | 5.27 | 37.44 | 958039 | 7.18 | 7.62 | 6.28 | 45.20 | 16.91 |
| 13.78 | 106 | 4138 | 8.92 | 1072801 | 10.94 | 44.93 | 670888 | 8.45 | 8.95 | 5.12 | 36.36 | 971994 | 7.29 | 7.73 | 6.17 | 44.41 | 16.34 |
| 14.03 | 106 | 4114 | 8.89 | 1063043 | 10.84 | 45.06 | 675167 | 8.50 | 9.01 | 5.06 | 35.95 | 981695 | 7.36 | 7.80 | 6.09 | 43.85 | 16.20 |
| 14.28 | 106 | 3980 | 8.70 | 1052576 | 10.73 | 44.76 | 682433 | 8.59 | 9.11 | 4.96 | 35.26 | 993377 | 7.45 | 7.90 | 6.00 | 43.18 | 15.78 |
| 14.53 | 106 | 3864 | 8.52 | 1039446 | 10.60 | 44.58 | 690110 | 8.69 | 9.21 | 4.86 | 34.53 | 1004997 | 7.54 | 7.99 | 5.91 | 42.52 | 15.39 |
| 14.78 | 106 | 3835 | 8.48 | 1025269 | 10.45 | 44.79 | 696433 | 8.77 | 9.30 | 4.77 | 33.93 | 1015736 | 7.62 | 8.07 | 5.82 | 41.90 | 15.20 |
| 15.03 | 106 | 3726 | 8.32 | 1013244 | 10.33 | 44.60 | 702731 | 8.85 | 9.38 | 4.69 | 33.34 | 1025139 | 7.69 | 8.15 | 5.75 | 41.37 | 14.87 |
| 15.28 | 106 | 3676 | 8.24 | 998878 | 10.19 | 44.73 | 708932 | 8.93 | 9.46 | 4.61 | 32.75 | 1035567 | 7.77 | 8.23 | 5.67 | 40.77 | 14.65 |
| 15.53 | 106 | 3510 | 7.99 | 986705 | 10.06 | 44.26 | 715100 | 9.00 | 9.54 | 4.53 | 32.16 | 1046307 | 7.85 | 8.32 | 5.58 | 40.16 | 14.23 |
| 15.78 | 106 | 3468 | 7.92 | 975301 | 9.94 | 44.34 | 721428 | 9.08 | 9.63 | 4.44 | 31.56 | 1056970 | 7.93 | 8.40 | 5.50 | 39.55 | 14.00 |
| 16.03 | 106 | 3380 | 7.79 | 960376 | 9.79 | 44.29 | 727766 | 9.16 | 9.71 | 4.36 | 30.96 | 1065898 | 7.99 | 8.47 | 5.43 | 39.03 | 13.71 |
| 16.28 | 106 | 3296 | 7.65 | 951383 | 9.70 | 44.10 | 733016 | 9.23 | 9.78 | 4.29 | 30.46 | 1075329 | 8.06 | 8.55 | 5.35 | 38.50 | 13.43 |
| 16.53 | 105 | 3234 | 7.55 | 935770 | 9.54 | 44.19 | 739739 | 9.31 | 9.78 | 4.29 | 30.49 | 1085995 | 8.14 | 8.55 | 5.35 | 38.47 | 13.47 |
| 16.78 | 105 | 3174 | 7.46 | 924911 | 9.43 | 44.16 | 741604 | 9.34 | 9.81 | 4.26 | 30.31 | 1088086 | 8.16 | 8.57 | 5.33 | 38.35 | 13.39 |
| 17.03 | 105 | 3066 | 7.28 | 913376 | 9.31 | 43.88 | 750292 | 9.45 | 9.92 | 4.15 | 29.50 | 1102289 | 8.27 | 8.68 | 5.22 | 37.55 | 12.94 |
| 17.28 | 105 | 3028 | 7.22 | 902297 | 9.20 | 43.97 | 755381 | 9.51 | 9.99 | 4.08 | 29.02 | 1111253 | 8.33 | 8.75 | 5.15 | 37.04 | 12.76 |
| 17.53 | 104 | 2947 | 7.09 | 891279 | 9.09 | 43.82 | 762758 | 9.60 | 9.99 | 4.08 | 29.01 | 1123567 | 8.43 | 8.76 | 5.14 | 36.95 | 12.71 |
| 17.78 | 104 | 2905 | 7.02 | 879816 | 8.97 | 43.89 | 766980 | 9.66 | 10.04 | 4.03 | 28.61 | 1131857 | 8.49 | 8.83 | 5.07 | 36.48 | 12.56 |

| 8%Ni-5%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|--------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | H ₂ Yield |
| 18.03 | 104 | 2830 | 6.89 | 869272 | 8.86 | 43.74 | 773050 | 9.73 | 10.12 | 3.95 | 28.05 | 1142280 | 8.57 | 8.91 | 4.99 | 35.90 | 12.27 |
| 18.28 | 104 | 2770 | 6.79 | 855850 | 8.73 | 43.76 | 777920 | 9.80 | 10.19 | 3.88 | 27.60 | 1150343 | 8.63 | 8.97 | 4.93 | 35.45 | 12.08 |
| 18.53 | 104 | 2687 | 6.65 | 845944 | 8.63 | 43.52 | 783770 | 9.87 | 10.26 | 3.81 | 27.05 | 1161368 | 8.71 | 9.06 | 4.84 | 34.83 | 11.77 |
| 18.78 | 104 | 2617 | 6.53 | 833833 | 8.50 | 43.42 | 789907 | 9.95 | 10.34 | 3.73 | 26.48 | 1170965 | 8.78 | 9.13 | 4.77 | 34.29 | 11.50 |
| 19.03 | 104 | 2545 | 6.40 | 822326 | 8.39 | 43.29 | 794126 | 10.00 | 10.40 | 3.67 | 26.09 | 1178832 | 8.84 | 9.19 | 4.70 | 33.85 | 11.29 |
| 19.28 | 104 | 2481 | 6.29 | 813652 | 8.30 | 43.11 | 799456 | 10.07 | 10.47 | 3.60 | 25.59 | 1187723 | 8.91 | 9.26 | 4.64 | 33.35 | 11.03 |
| 19.53 | 103 | 2426 | 6.19 | 800824 | 8.17 | 43.11 | 804716 | 10.13 | 10.44 | 3.63 | 25.82 | 1194130 | 8.96 | 9.22 | 4.67 | 33.63 | 11.13 |
| 19.78 | 103 | 2397 | 6.14 | 793209 | 8.09 | 43.14 | 809997 | 10.20 | 10.51 | 3.56 | 25.34 | 1204055 | 9.03 | 9.30 | 4.60 | 33.08 | 10.93 |
| 20.03 | 103 | 2339 | 6.03 | 780904 | 7.96 | 43.09 | 816727 | 10.28 | 10.59 | 3.48 | 24.72 | 1214770 | 9.11 | 9.38 | 4.52 | 32.49 | 10.65 |
| 20.28 | 103 | 2285 | 5.93 | 770768 | 7.86 | 43.01 | 820938 | 10.34 | 10.65 | 3.42 | 24.33 | 1222291 | 9.17 | 9.44 | 4.46 | 32.07 | 10.46 |
| 20.53 | 103 | 2227 | 5.82 | 760486 | 7.75 | 42.89 | 825409 | 10.39 | 10.71 | 3.36 | 23.92 | 1229598 | 9.22 | 9.50 | 4.40 | 31.66 | 10.26 |
| 20.78 | 103 | 2194 | 5.76 | 752161 | 7.67 | 42.90 | 830642 | 10.46 | 10.77 | 3.30 | 23.43 | 1238503 | 9.29 | 9.57 | 4.33 | 31.17 | 10.05 |
| 21.03 | 103 | 2119 | 5.62 | 741170 | 7.56 | 42.65 | 836796 | 10.54 | 10.85 | 3.22 | 22.87 | 1245442 | 9.34 | 9.62 | 4.28 | 30.78 | 9.75 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | H ₂ Yield |
| 0.28 | 110 | 3736 | 8.33 | 981723 | 10.01 | 45.43 | 709958 | 8.94 | 9.83 | 4.89 | 33.19 | 1057408 | 7.93 | 8.72 | 5.36 | 38.05 | 15.08 |
| 0.53 | 110 | 4984 | 10.09 | 1170378 | 11.93 | 45.82 | 625941 | 7.88 | 8.67 | 6.05 | 41.10 | 914439 | 6.86 | 7.54 | 6.54 | 46.42 | 18.83 |
| 0.78 | 112 | 5967 | 11.35 | 1255078 | 12.80 | 47.01 | 578237 | 7.28 | 8.15 | 6.56 | 44.60 | 835335 | 6.26 | 7.02 | 7.06 | 50.17 | 20.96 |
| 1.03 | 113 | 6644 | 12.17 | 1319147 | 13.45 | 47.49 | 546490 | 6.88 | 7.78 | 6.94 | 47.17 | 785600 | 5.89 | 6.66 | 7.42 | 52.72 | 22.40 |
| 1.28 | 112 | 7185 | 12.79 | 1369252 | 13.96 | 47.81 | 509331 | 6.41 | 7.18 | 7.54 | 51.20 | 748539 | 5.61 | 6.29 | 7.79 | 55.35 | 24.48 |
| 1.53 | 114 | 7988 | 13.68 | 1441834 | 14.70 | 48.21 | 468664 | 5.90 | 6.73 | 7.99 | 54.29 | 687111 | 5.15 | 5.87 | 8.21 | 58.28 | 26.17 |
| 1.78 | 114 | 8275 | 13.99 | 1459724 | 14.88 | 48.46 | 454553 | 5.72 | 6.52 | 8.19 | 55.67 | 668610 | 5.01 | 5.72 | 8.36 | 59.40 | 26.98 |
| 2.03 | 115 | 8429 | 14.16 | 1479363 | 15.08 | 48.41 | 444225 | 5.59 | 6.43 | 8.29 | 56.30 | 652980 | 4.90 | 5.63 | 8.45 | 60.00 | 27.26 |
| 2.28 | 116 | 8697 | 14.44 | 1496602 | 15.26 | 48.62 | 434780 | 5.47 | 6.35 | 8.37 | 56.85 | 641719 | 4.81 | 5.58 | 8.50 | 60.35 | 27.64 |
| 2.53 | 116 | 8738 | 14.48 | 1507347 | 15.37 | 48.51 | 426409 | 5.37 | 6.23 | 8.49 | 57.69 | 630318 | 4.73 | 5.48 | 8.60 | 61.05 | 27.98 |
| 2.78 | 117 | 8886 | 14.64 | 1516935 | 15.47 | 48.62 | 420042 | 5.29 | 6.19 | 8.53 | 57.96 | 621581 | 4.66 | 5.45 | 8.63 | 61.26 | 28.18 |
| 3.03 | 117 | 8970 | 14.72 | 1526050 | 15.56 | 48.62 | 416379 | 5.24 | 6.13 | 8.58 | 58.32 | 616308 | 4.62 | 5.41 | 8.67 | 61.59 | 28.36 |
| 3.28 | 117 | 9013 | 14.77 | 1532880 | 15.63 | 48.58 | 411614 | 5.18 | 6.06 | 8.65 | 58.80 | 608816 | 4.57 | 5.34 | 8.74 | 62.06 | 28.57 |
| 3.53 | 117 | 9180 | 14.94 | 1540355 | 15.71 | 48.75 | 408358 | 5.14 | 6.02 | 8.70 | 59.13 | 605046 | 4.54 | 5.31 | 8.77 | 62.29 | 28.82 |
| 3.78 | 117 | 9229 | 14.99 | 1545970 | 15.76 | 48.74 | 404765 | 5.10 | 5.96 | 8.76 | 59.49 | 599522 | 4.50 | 5.26 | 8.82 | 62.64 | 28.99 |
| 4.03 | 117 | 9256 | 15.02 | 1545339 | 15.76 | 48.80 | 403950 | 5.09 | 5.95 | 8.77 | 59.57 | 598433 | 4.49 | 5.25 | 8.83 | 62.71 | 29.07 |
| 4.28 | 117 | 9231 | 14.99 | 1548257 | 15.79 | 48.71 | 401411 | 5.05 | 5.91 | 8.81 | 59.82 | 594519 | 4.46 | 5.22 | 8.86 | 62.95 | 29.14 |
| 4.53 | 117 | 9402 | 15.17 | 1553320 | 15.84 | 48.91 | 400142 | 5.04 | 5.90 | 8.82 | 59.95 | 592517 | 4.44 | 5.20 | 8.88 | 63.07 | 29.32 |
| 4.78 | 117 | 9386 | 15.15 | 1552314 | 15.83 | 48.90 | 400539 | 5.04 | 5.90 | 8.82 | 59.91 | 593401 | 4.45 | 5.21 | 8.87 | 63.02 | 29.30 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 5.03 | 117 | 9481 | 15.24 | 1556492 | 15.87 | 48.99 | 398446 | 5.02 | 5.87 | 8.85 | 60.12 | 587638 | 4.41 | 5.16 | 8.92 | 63.38 | 29.45 |
| 5.28 | 117 | 9543 | 15.31 | 1554592 | 15.85 | 49.13 | 394056 | 4.96 | 5.81 | 8.91 | 60.56 | 584895 | 4.39 | 5.13 | 8.95 | 63.55 | 29.75 |
| 5.53 | 117 | 9449 | 15.21 | 1556657 | 15.87 | 48.94 | 396783 | 5.00 | 5.85 | 8.87 | 60.29 | 587280 | 4.40 | 5.15 | 8.93 | 63.40 | 29.50 |
| 5.78 | 117 | 9423 | 15.19 | 1554568 | 15.85 | 48.93 | 396122 | 4.99 | 5.84 | 8.88 | 60.35 | 587270 | 4.40 | 5.15 | 8.93 | 63.40 | 29.53 |
| 6.03 | 117 | 9350 | 15.11 | 1554937 | 15.86 | 48.80 | 397774 | 5.01 | 5.86 | 8.86 | 60.19 | 590290 | 4.43 | 5.18 | 8.90 | 63.21 | 29.37 |
| 6.28 | 117 | 9372 | 15.13 | 1553093 | 15.84 | 48.87 | 397608 | 5.01 | 5.86 | 8.86 | 60.20 | 589995 | 4.42 | 5.18 | 8.90 | 63.23 | 29.42 |
| 6.53 | 117 | 9413 | 15.18 | 1553492 | 15.84 | 48.93 | 398348 | 5.02 | 5.87 | 8.85 | 60.13 | 590789 | 4.43 | 5.18 | 8.90 | 63.18 | 29.42 |
| 6.78 | 117 | 9321 | 15.08 | 1550956 | 15.81 | 48.81 | 398818 | 5.02 | 5.88 | 8.84 | 60.08 | 591302 | 4.43 | 5.19 | 8.89 | 63.15 | 29.33 |
| 7.03 | 117 | 9263 | 15.02 | 1552829 | 15.83 | 48.69 | 399268 | 5.03 | 5.88 | 8.84 | 60.04 | 592814 | 4.45 | 5.20 | 8.88 | 63.06 | 29.23 |
| 7.28 | 117 | 9192 | 14.95 | 1546860 | 15.77 | 48.66 | 399681 | 5.03 | 5.89 | 8.83 | 60.00 | 593024 | 4.45 | 5.20 | 8.88 | 63.04 | 29.20 |
| 7.53 | 117 | 9244 | 15.00 | 1548255 | 15.79 | 48.73 | 401298 | 5.05 | 5.91 | 8.81 | 59.83 | 595764 | 4.47 | 5.23 | 8.85 | 62.87 | 29.16 |
| 7.78 | 117 | 9290 | 15.05 | 1547046 | 15.77 | 48.83 | 402092 | 5.06 | 5.92 | 8.80 | 59.75 | 596647 | 4.47 | 5.24 | 8.84 | 62.82 | 29.18 |
| 8.03 | 117 | 9180 | 14.94 | 1545921 | 15.76 | 48.66 | 402669 | 5.07 | 5.93 | 8.79 | 59.70 | 598179 | 4.49 | 5.25 | 8.83 | 62.72 | 29.05 |
| 8.28 | 117 | 9330 | 15.09 | 1545280 | 15.76 | 48.92 | 404205 | 5.09 | 5.95 | 8.76 | 59.54 | 599359 | 4.49 | 5.26 | 8.82 | 62.65 | 29.13 |
| 8.53 | 117 | 9248 | 15.01 | 1540074 | 15.70 | 48.87 | 405788 | 5.11 | 5.98 | 8.74 | 59.38 | 601001 | 4.51 | 5.27 | 8.81 | 62.55 | 29.02 |
| 8.78 | 117 | 9183 | 14.94 | 1540010 | 15.70 | 48.76 | 406572 | 5.12 | 5.99 | 8.73 | 59.31 | 602589 | 4.52 | 5.29 | 8.79 | 62.45 | 28.92 |
| 9.03 | 117 | 9195 | 14.95 | 1541490 | 15.72 | 48.75 | 406267 | 5.12 | 5.99 | 8.73 | 59.34 | 601784 | 4.51 | 5.28 | 8.80 | 62.50 | 28.93 |
| 9.28 | 117 | 9115 | 14.87 | 1540386 | 15.71 | 48.63 | 407833 | 5.14 | 6.01 | 8.71 | 59.18 | 603877 | 4.53 | 5.30 | 8.78 | 62.37 | 28.78 |
| 9.53 | 117 | 9082 | 14.84 | 1537162 | 15.67 | 48.63 | 407269 | 5.13 | 6.00 | 8.72 | 59.24 | 603845 | 4.53 | 5.30 | 8.78 | 62.37 | 28.81 |
| 9.78 | 117 | 9116 | 14.87 | 1528367 | 15.58 | 48.83 | 409070 | 5.15 | 6.03 | 8.69 | 59.06 | 601545 | 4.51 | 5.28 | 8.80 | 62.51 | 28.84 |
| 10.03 | 116 | 9096 | 14.85 | 1528894 | 15.59 | 48.79 | 410802 | 5.17 | 6.00 | 8.72 | 59.23 | 604302 | 4.53 | 5.26 | 8.82 | 62.66 | 28.90 |
| 10.28 | 116 | 9091 | 14.85 | 1529731 | 15.60 | 48.77 | 412675 | 5.20 | 6.03 | 8.69 | 59.05 | 605747 | 4.54 | 5.27 | 8.81 | 62.57 | 28.80 |
| 10.53 | 116 | 9094 | 14.85 | 1526242 | 15.56 | 48.83 | 414064 | 5.21 | 6.05 | 8.67 | 58.91 | 606995 | 4.55 | 5.28 | 8.80 | 62.50 | 28.77 |
| 10.78 | 115 | 9084 | 14.84 | 1525882 | 15.56 | 48.82 | 415912 | 5.24 | 6.02 | 8.70 | 59.08 | 609234 | 4.57 | 5.25 | 8.83 | 62.68 | 28.84 |
| 11.03 | 115 | 9020 | 14.78 | 1526452 | 15.56 | 48.70 | 417522 | 5.26 | 6.05 | 8.67 | 58.92 | 609540 | 4.57 | 5.26 | 8.82 | 62.66 | 28.70 |
| 11.28 | 115 | 9040 | 14.80 | 1526088 | 15.56 | 48.74 | 418272 | 5.27 | 6.06 | 8.66 | 58.85 | 610554 | 4.58 | 5.27 | 8.81 | 62.60 | 28.68 |
| 11.53 | 115 | 9020 | 14.78 | 1523719 | 15.54 | 48.74 | 422560 | 5.32 | 6.12 | 8.60 | 58.43 | 615440 | 4.62 | 5.31 | 8.77 | 62.30 | 28.48 |
| 11.78 | 115 | 8994 | 14.75 | 1522621 | 15.53 | 48.72 | 422153 | 5.32 | 6.11 | 8.61 | 58.47 | 616658 | 4.62 | 5.32 | 8.76 | 62.23 | 28.48 |
| 12.03 | 115 | 8963 | 14.72 | 1523388 | 15.53 | 48.65 | 422861 | 5.32 | 6.12 | 8.60 | 58.40 | 618432 | 4.64 | 5.33 | 8.75 | 62.12 | 28.41 |
| 12.28 | 115 | 8941 | 14.69 | 1520089 | 15.50 | 48.66 | 426174 | 5.37 | 6.17 | 8.55 | 58.07 | 621997 | 4.66 | 5.36 | 8.72 | 61.90 | 28.26 |
| 12.53 | 115 | 8879 | 14.63 | 1518119 | 15.48 | 48.59 | 425736 | 5.36 | 6.16 | 8.55 | 58.12 | 622077 | 4.67 | 5.37 | 8.71 | 61.90 | 28.24 |
| 12.78 | 115 | 8820 | 14.57 | 1517739 | 15.48 | 48.49 | 426910 | 5.38 | 6.18 | 8.54 | 58.00 | 623633 | 4.68 | 5.38 | 8.70 | 61.80 | 28.12 |
| 13.03 | 115 | 8756 | 14.50 | 1511542 | 15.41 | 48.48 | 428112 | 5.39 | 6.20 | 8.52 | 57.88 | 624001 | 4.68 | 5.38 | 8.70 | 61.78 | 28.06 |
| 13.28 | 115 | 8808 | 14.56 | 1512162 | 15.42 | 48.56 | 429315 | 5.41 | 6.22 | 8.50 | 57.76 | 626431 | 4.70 | 5.40 | 8.68 | 61.63 | 28.05 |
| 13.53 | 115 | 8786 | 14.53 | 1512654 | 15.42 | 48.51 | 430148 | 5.42 | 6.23 | 8.49 | 57.68 | 627676 | 4.71 | 5.41 | 8.67 | 61.55 | 27.98 |
| 13.78 | 115 | 8795 | 14.54 | 1508334 | 15.38 | 48.60 | 431400 | 5.43 | 6.25 | 8.47 | 57.56 | 628157 | 4.71 | 5.42 | 8.66 | 61.52 | 27.97 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 14.03 | 115 | 8730 | 14.47 | 1508719 | 15.38 | 48.48 | 432216 | 5.44 | 6.26 | 8.46 | 57.48 | 627838 | 4.71 | 5.41 | 8.67 | 61.54 | 27.86 |
| 14.28 | 114 | 8728 | 14.47 | 1502855 | 15.32 | 48.57 | 433472 | 5.46 | 6.22 | 8.50 | 57.73 | 627964 | 4.71 | 5.37 | 8.71 | 61.87 | 28.04 |
| 14.53 | 114 | 8738 | 14.48 | 1503212 | 15.33 | 48.58 | 433705 | 5.46 | 6.23 | 8.49 | 57.70 | 629339 | 4.72 | 5.38 | 8.70 | 61.79 | 28.03 |
| 14.78 | 114 | 8661 | 14.40 | 1500508 | 15.30 | 48.49 | 435428 | 5.48 | 6.25 | 8.47 | 57.54 | 631196 | 4.73 | 5.40 | 8.68 | 61.67 | 27.90 |
| 15.03 | 114 | 8657 | 14.40 | 1498318 | 15.28 | 48.52 | 437382 | 5.51 | 6.28 | 8.44 | 57.34 | 634040 | 4.76 | 5.42 | 8.66 | 61.50 | 27.82 |
| 15.28 | 114 | 8653 | 14.39 | 1498786 | 15.28 | 48.50 | 438244 | 5.52 | 6.29 | 8.43 | 57.26 | 634499 | 4.76 | 5.42 | 8.66 | 61.47 | 27.77 |
| 15.53 | 114 | 8614 | 14.35 | 1492555 | 15.22 | 48.53 | 437654 | 5.51 | 6.28 | 8.44 | 57.32 | 633340 | 4.75 | 5.41 | 8.67 | 61.54 | 27.82 |
| 15.78 | 114 | 8618 | 14.36 | 1492955 | 15.22 | 48.53 | 439751 | 5.54 | 6.31 | 8.41 | 57.11 | 636464 | 4.77 | 5.44 | 8.64 | 61.35 | 27.72 |
| 16.03 | 114 | 8615 | 14.35 | 1492351 | 15.22 | 48.54 | 441552 | 5.56 | 6.34 | 8.38 | 56.94 | 638608 | 4.79 | 5.46 | 8.62 | 61.22 | 27.64 |
| 16.28 | 114 | 8619 | 14.36 | 1490041 | 15.19 | 48.58 | 441852 | 5.56 | 6.34 | 8.38 | 56.91 | 638489 | 4.79 | 5.46 | 8.62 | 61.23 | 27.65 |
| 16.53 | 114 | 8573 | 14.31 | 1491025 | 15.20 | 48.48 | 442864 | 5.58 | 6.36 | 8.36 | 56.81 | 639799 | 4.80 | 5.47 | 8.61 | 61.15 | 27.54 |
| 16.78 | 114 | 8535 | 14.27 | 1485003 | 15.14 | 48.52 | 443212 | 5.58 | 6.36 | 8.36 | 56.78 | 640813 | 4.81 | 5.48 | 8.60 | 61.09 | 27.55 |
| 17.03 | 114 | 8529 | 14.26 | 1485321 | 15.15 | 48.50 | 445715 | 5.61 | 6.40 | 8.32 | 56.53 | 643547 | 4.83 | 5.50 | 8.58 | 60.92 | 27.42 |
| 17.28 | 114 | 8478 | 14.21 | 1485874 | 15.15 | 48.40 | 447819 | 5.64 | 6.43 | 8.29 | 56.33 | 647996 | 4.86 | 5.54 | 8.54 | 60.65 | 27.26 |
| 17.53 | 114 | 8450 | 14.18 | 1483013 | 15.12 | 48.39 | 448075 | 5.64 | 6.43 | 8.29 | 56.30 | 647072 | 4.85 | 5.53 | 8.55 | 60.71 | 27.25 |
| 17.78 | 114 | 8438 | 14.17 | 1480347 | 15.09 | 48.41 | 446360 | 5.62 | 6.41 | 8.31 | 56.47 | 643470 | 4.83 | 5.50 | 8.58 | 60.93 | 27.34 |
| 18.03 | 114 | 8455 | 14.18 | 1475234 | 15.04 | 48.53 | 446456 | 5.62 | 6.41 | 8.31 | 56.46 | 644336 | 4.83 | 5.51 | 8.57 | 60.88 | 27.40 |
| 18.28 | 114 | 8424 | 14.15 | 1473396 | 15.02 | 48.50 | 449151 | 5.66 | 6.45 | 8.27 | 56.20 | 646726 | 4.85 | 5.53 | 8.55 | 60.73 | 27.26 |
| 18.53 | 114 | 8374 | 14.10 | 1473467 | 15.02 | 48.41 | 452871 | 5.70 | 6.50 | 8.22 | 55.83 | 652194 | 4.89 | 5.58 | 8.50 | 60.40 | 27.03 |
| 18.78 | 114 | 8342 | 14.06 | 1471293 | 15.00 | 48.39 | 452911 | 5.70 | 6.50 | 8.22 | 55.83 | 652678 | 4.89 | 5.58 | 8.50 | 60.37 | 27.01 |
| 19.03 | 114 | 8322 | 14.04 | 1474270 | 15.03 | 48.30 | 455587 | 5.74 | 6.54 | 8.18 | 55.57 | 656341 | 4.92 | 5.61 | 8.47 | 60.15 | 26.84 |
| 19.28 | 114 | 8304 | 14.02 | 1471898 | 15.01 | 48.30 | 457874 | 5.77 | 6.57 | 8.15 | 55.35 | 659903 | 4.95 | 5.64 | 8.44 | 59.93 | 26.73 |
| 19.53 | 114 | 8280 | 14.00 | 1471357 | 15.00 | 48.27 | 456974 | 5.75 | 6.56 | 8.16 | 55.43 | 659256 | 4.94 | 5.64 | 8.44 | 59.97 | 26.76 |
| 19.78 | 114 | 8271 | 13.99 | 1470953 | 15.00 | 48.26 | 458770 | 5.78 | 6.59 | 8.13 | 55.26 | 661190 | 4.96 | 5.65 | 8.43 | 59.85 | 26.67 |
| 20.03 | 114 | 8228 | 13.94 | 1466154 | 14.95 | 48.26 | 460171 | 5.79 | 6.61 | 8.11 | 55.12 | 664371 | 4.98 | 5.68 | 8.40 | 59.66 | 26.60 |
| 20.28 | 114 | 8158 | 13.87 | 1463599 | 14.92 | 48.16 | 463019 | 5.83 | 6.65 | 8.07 | 54.84 | 666918 | 5.00 | 5.70 | 8.38 | 59.50 | 26.42 |
| 20.53 | 114 | 8180 | 13.89 | 1464137 | 14.93 | 48.20 | 462037 | 5.82 | 6.63 | 8.09 | 54.94 | 666626 | 5.00 | 5.70 | 8.38 | 59.52 | 26.48 |
| 20.78 | 114 | 8069 | 13.77 | 1461037 | 14.90 | 48.03 | 462237 | 5.82 | 6.64 | 8.08 | 54.92 | 667259 | 5.00 | 5.70 | 8.38 | 59.48 | 26.38 |
| 21.03 | 113 | 8134 | 13.84 | 1456849 | 14.86 | 48.23 | 464962 | 5.85 | 6.62 | 8.10 | 55.05 | 670409 | 5.03 | 5.68 | 8.40 | 59.65 | 26.55 |
| 21.28 | 113 | 8090 | 13.79 | 1459850 | 14.89 | 48.10 | 466310 | 5.87 | 6.63 | 8.08 | 54.92 | 670573 | 5.03 | 5.68 | 8.40 | 59.64 | 26.42 |
| 21.53 | 113 | 8059 | 13.76 | 1458348 | 14.87 | 48.06 | 467520 | 5.89 | 6.65 | 8.07 | 54.81 | 673815 | 5.05 | 5.71 | 8.37 | 59.44 | 26.34 |
| 21.78 | 113 | 8091 | 13.80 | 1455773 | 14.84 | 48.17 | 467709 | 5.89 | 6.65 | 8.06 | 54.79 | 673834 | 5.05 | 5.71 | 8.37 | 59.44 | 26.39 |
| 22.03 | 113 | 8027 | 13.73 | 1453882 | 14.82 | 48.08 | 470387 | 5.92 | 6.69 | 8.03 | 54.53 | 676894 | 5.08 | 5.74 | 8.34 | 59.26 | 26.21 |
| 22.28 | 113 | 8084 | 13.79 | 1450268 | 14.79 | 48.25 | 465750 | 5.86 | 6.63 | 8.09 | 54.98 | 673535 | 5.05 | 5.71 | 8.37 | 59.46 | 26.53 |
| 22.53 | 113 | 8000 | 13.70 | 1451932 | 14.80 | 48.05 | 469395 | 5.91 | 6.68 | 8.04 | 54.62 | 676137 | 5.07 | 5.73 | 8.35 | 59.30 | 26.25 |
| 22.78 | 113 | 8016 | 13.71 | 1448719 | 14.77 | 48.14 | 470770 | 5.93 | 6.70 | 8.02 | 54.49 | 680993 | 5.11 | 5.77 | 8.31 | 59.01 | 26.23 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 23.03 | 113 | 8002 | 13.70 | 1447470 | 14.76 | 48.14 | 471274 | 5.93 | 6.71 | 8.01 | 54.44 | 681254 | 5.11 | 5.77 | 8.31 | 59.00 | 26.21 |
| 23.28 | 113 | 7926 | 13.62 | 1443392 | 14.72 | 48.06 | 472353 | 5.95 | 6.72 | 8.00 | 54.34 | 682708 | 5.12 | 5.79 | 8.29 | 58.91 | 26.11 |
| 23.53 | 113 | 7916 | 13.61 | 1442964 | 14.71 | 48.04 | 474273 | 5.97 | 6.75 | 7.97 | 54.15 | 684847 | 5.14 | 5.80 | 8.28 | 58.78 | 26.02 |
| 23.78 | 113 | 7939 | 13.63 | 1438832 | 14.67 | 48.16 | 473456 | 5.96 | 6.74 | 7.98 | 54.23 | 685372 | 5.14 | 5.81 | 8.27 | 58.75 | 26.12 |
| 24.03 | 113 | 7911 | 13.60 | 1438032 | 14.66 | 48.12 | 475329 | 5.99 | 6.76 | 7.96 | 54.05 | 687908 | 5.16 | 5.83 | 8.25 | 58.60 | 26.01 |
| 24.28 | 113 | 7960 | 13.65 | 1436716 | 14.65 | 48.24 | 476774 | 6.00 | 6.78 | 7.94 | 53.91 | 691517 | 5.19 | 5.86 | 8.22 | 58.38 | 26.01 |
| 24.53 | 113 | 7861 | 13.55 | 1433582 | 14.62 | 48.10 | 478527 | 6.03 | 6.81 | 7.91 | 53.74 | 692793 | 5.20 | 5.87 | 8.21 | 58.30 | 25.85 |
| 24.78 | 113 | 7799 | 13.48 | 1431173 | 14.59 | 48.01 | 478596 | 6.03 | 6.81 | 7.91 | 53.73 | 693329 | 5.20 | 5.88 | 8.20 | 58.27 | 25.80 |
| 25.03 | 113 | 7830 | 13.51 | 1428481 | 14.57 | 48.12 | 480153 | 6.05 | 6.83 | 7.89 | 53.58 | 695500 | 5.22 | 5.89 | 8.19 | 58.14 | 25.79 |
| 25.28 | 113 | 7708 | 13.38 | 1413374 | 14.41 | 48.14 | 477041 | 6.01 | 6.79 | 7.93 | 53.88 | 692113 | 5.19 | 5.87 | 8.21 | 58.34 | 25.94 |
| 25.53 | 113 | 7732 | 13.40 | 1417596 | 14.45 | 48.11 | 479800 | 6.04 | 6.83 | 7.89 | 53.62 | 696699 | 5.22 | 5.90 | 8.18 | 58.07 | 25.80 |
| 25.78 | 113 | 7695 | 13.36 | 1417792 | 14.46 | 48.03 | 481441 | 6.06 | 6.85 | 7.87 | 53.46 | 700095 | 5.25 | 5.93 | 8.15 | 57.86 | 25.68 |
| 26.03 | 113 | 7590 | 13.25 | 1403195 | 14.31 | 48.07 | 478055 | 6.02 | 6.80 | 7.92 | 53.79 | 695782 | 5.22 | 5.90 | 8.18 | 58.12 | 25.86 |
| 26.28 | 113 | 7683 | 13.35 | 1409237 | 14.37 | 48.16 | 479801 | 6.04 | 6.83 | 7.89 | 53.62 | 699649 | 5.25 | 5.93 | 8.15 | 57.89 | 25.82 |
| 26.53 | 113 | 7616 | 13.28 | 1410304 | 14.38 | 48.00 | 482204 | 6.07 | 6.86 | 7.86 | 53.39 | 699640 | 5.25 | 5.93 | 8.15 | 57.89 | 25.63 |
| 26.78 | 113 | 7691 | 13.36 | 1406536 | 14.34 | 48.22 | 480556 | 6.05 | 6.84 | 7.88 | 53.55 | 701658 | 5.26 | 5.95 | 8.13 | 57.77 | 25.82 |
| 27.03 | 113 | 7683 | 13.35 | 1406894 | 14.35 | 48.20 | 484155 | 6.10 | 6.89 | 7.83 | 53.20 | 708256 | 5.31 | 6.00 | 8.08 | 57.37 | 25.64 |
| 27.28 | 113 | 7637 | 13.30 | 1403579 | 14.31 | 48.17 | 486261 | 6.12 | 6.92 | 7.80 | 52.99 | 711545 | 5.34 | 6.03 | 8.05 | 57.17 | 25.52 |
| 27.53 | 113 | 7590 | 13.25 | 1403125 | 14.31 | 48.07 | 486691 | 6.13 | 6.92 | 7.79 | 52.95 | 713395 | 5.35 | 6.05 | 8.03 | 57.06 | 25.46 |
| 27.78 | 113 | 7595 | 13.25 | 1402483 | 14.30 | 48.10 | 487335 | 6.14 | 6.93 | 7.78 | 52.89 | 710698 | 5.33 | 6.02 | 8.06 | 57.22 | 25.44 |
| 28.03 | 113 | 7591 | 13.25 | 1402395 | 14.30 | 48.09 | 490473 | 6.18 | 6.98 | 7.74 | 52.59 | 714982 | 5.36 | 6.06 | 8.02 | 56.97 | 25.29 |
| 28.28 | 113 | 7560 | 13.21 | 1399996 | 14.28 | 48.07 | 491892 | 6.19 | 7.00 | 7.72 | 52.45 | 716719 | 5.38 | 6.07 | 8.01 | 56.86 | 25.21 |
| 28.53 | 113 | 7530 | 13.18 | 1398673 | 14.26 | 48.03 | 493166 | 6.21 | 7.02 | 7.70 | 52.33 | 717679 | 5.38 | 6.08 | 8.00 | 56.80 | 25.13 |
| 28.78 | 113 | 7544 | 13.20 | 1395028 | 14.22 | 48.12 | 494241 | 6.22 | 7.03 | 7.69 | 52.22 | 716397 | 5.37 | 6.07 | 8.01 | 56.88 | 25.13 |
| 29.03 | 113 | 7477 | 13.12 | 1394075 | 14.21 | 48.00 | 495568 | 6.24 | 7.05 | 7.67 | 52.09 | 717637 | 5.38 | 6.08 | 8.00 | 56.81 | 25.00 |
| 29.28 | 113 | 7529 | 13.18 | 1392476 | 14.20 | 48.14 | 497072 | 6.26 | 7.07 | 7.65 | 51.95 | 718208 | 5.39 | 6.09 | 7.99 | 56.77 | 25.01 |
| 29.53 | 113 | 7511 | 13.16 | 1392594 | 14.20 | 48.10 | 497104 | 6.26 | 7.07 | 7.65 | 51.95 | 716896 | 5.38 | 6.08 | 8.00 | 56.85 | 24.98 |
| 29.78 | 113 | 7404 | 13.04 | 1391439 | 14.19 | 47.89 | 499227 | 6.29 | 7.10 | 7.62 | 51.74 | 717688 | 5.38 | 6.08 | 8.00 | 56.80 | 24.78 |
| 30.03 | 113 | 7494 | 13.14 | 1389747 | 14.17 | 48.11 | 500094 | 6.30 | 7.12 | 7.60 | 51.66 | 716494 | 5.37 | 6.07 | 8.01 | 56.88 | 24.85 |
| 30.28 | 113 | 7453 | 13.09 | 1387694 | 14.15 | 48.06 | 499685 | 6.29 | 7.11 | 7.61 | 51.70 | 715419 | 5.37 | 6.06 | 8.02 | 56.94 | 24.85 |
| 30.53 | 113 | 7461 | 13.10 | 1388239 | 14.16 | 48.07 | 503556 | 6.34 | 7.16 | 7.55 | 51.32 | 722674 | 5.42 | 6.12 | 7.96 | 56.50 | 24.67 |
| 30.78 | 113 | 7445 | 13.09 | 1385947 | 14.13 | 48.08 | 502700 | 6.33 | 7.15 | 7.57 | 51.40 | 724427 | 5.43 | 6.14 | 7.94 | 56.40 | 24.71 |
| 31.03 | 113 | 7407 | 13.05 | 1387635 | 14.15 | 47.97 | 504587 | 6.35 | 7.18 | 7.54 | 51.22 | 730260 | 5.48 | 6.19 | 7.89 | 56.05 | 24.57 |
| 31.28 | 113 | 7365 | 13.00 | 1383222 | 14.10 | 47.95 | 505597 | 6.37 | 7.19 | 7.53 | 51.12 | 730979 | 5.48 | 6.19 | 7.89 | 56.00 | 24.52 |
| 31.53 | 113 | 7305 | 12.93 | 1382156 | 14.09 | 47.84 | 508068 | 6.40 | 7.23 | 7.49 | 50.89 | 732914 | 5.50 | 6.21 | 7.87 | 55.89 | 24.34 |
| 31.78 | 113 | 7307 | 12.93 | 1378928 | 14.06 | 47.91 | 513099 | 6.46 | 7.30 | 7.42 | 50.40 | 736724 | 5.53 | 6.24 | 7.84 | 55.66 | 24.14 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 32.03 | 113 | 7271 | 12.89 | 1376215 | 14.03 | 47.88 | 509423 | 6.41 | 7.25 | 7.47 | 50.75 | 738150 | 5.54 | 6.26 | 7.82 | 55.57 | 24.30 |
| 32.28 | 113 | 7195 | 12.80 | 1373584 | 14.01 | 47.76 | 510735 | 6.43 | 7.27 | 7.45 | 50.63 | 743052 | 5.57 | 6.30 | 7.78 | 55.28 | 24.18 |
| 32.53 | 113 | 7293 | 12.91 | 1372586 | 14.00 | 47.99 | 509960 | 6.42 | 7.26 | 7.46 | 50.70 | 742037 | 5.56 | 6.29 | 7.79 | 55.34 | 24.33 |
| 32.78 | 113 | 7236 | 12.85 | 1370922 | 13.98 | 47.89 | 512574 | 6.45 | 7.29 | 7.43 | 50.45 | 745816 | 5.59 | 6.32 | 7.76 | 55.11 | 24.16 |
| 33.03 | 113 | 7155 | 12.76 | 1366454 | 13.93 | 47.80 | 513294 | 6.46 | 7.30 | 7.42 | 50.38 | 746612 | 5.60 | 6.33 | 7.75 | 55.06 | 24.08 |
| 33.28 | 113 | 7186 | 12.79 | 1368263 | 13.95 | 47.83 | 515284 | 6.49 | 7.33 | 7.39 | 50.19 | 748499 | 5.61 | 6.34 | 7.74 | 54.95 | 24.01 |
| 33.53 | 113 | 7104 | 12.70 | 1362060 | 13.89 | 47.76 | 515361 | 6.49 | 7.33 | 7.39 | 50.18 | 749971 | 5.62 | 6.36 | 7.72 | 54.86 | 23.97 |
| 33.78 | 113 | 7074 | 12.67 | 1362780 | 13.90 | 47.68 | 517570 | 6.52 | 7.36 | 7.35 | 49.97 | 753172 | 5.65 | 6.38 | 7.70 | 54.67 | 23.83 |
| 34.03 | 113 | 7024 | 12.61 | 1356468 | 13.83 | 47.69 | 520737 | 6.56 | 7.41 | 7.31 | 49.66 | 758893 | 5.69 | 6.43 | 7.65 | 54.32 | 23.68 |
| 34.28 | 113 | 6966 | 12.54 | 1355131 | 13.82 | 47.58 | 517764 | 6.52 | 7.37 | 7.35 | 49.95 | 758333 | 5.69 | 6.43 | 7.65 | 54.36 | 23.76 |
| 34.53 | 113 | 7028 | 12.61 | 1356265 | 13.83 | 47.70 | 517403 | 6.52 | 7.36 | 7.36 | 49.98 | 759291 | 5.69 | 6.43 | 7.65 | 54.30 | 23.84 |
| 34.78 | 113 | 6971 | 12.55 | 1346269 | 13.73 | 47.75 | 517554 | 6.52 | 7.36 | 7.35 | 49.97 | 757833 | 5.68 | 6.42 | 7.66 | 54.39 | 23.86 |
| 35.03 | 113 | 6877 | 12.44 | 1348844 | 13.75 | 47.49 | 519659 | 6.54 | 7.39 | 7.32 | 49.77 | 762674 | 5.72 | 6.46 | 7.62 | 54.10 | 23.63 |
| 35.28 | 113 | 7005 | 12.59 | 1348087 | 13.75 | 47.80 | 519819 | 6.55 | 7.40 | 7.32 | 49.75 | 762798 | 5.72 | 6.46 | 7.62 | 54.09 | 23.78 |
| 35.53 | 113 | 6779 | 12.32 | 1346670 | 13.73 | 47.30 | 523097 | 6.59 | 7.44 | 7.28 | 49.43 | 768778 | 5.77 | 6.52 | 7.56 | 53.73 | 23.38 |
| 35.78 | 113 | 6846 | 12.40 | 1344439 | 13.71 | 47.50 | 523381 | 6.59 | 7.45 | 7.27 | 49.41 | 770095 | 5.78 | 6.53 | 7.55 | 53.65 | 23.47 |
| 36.03 | 113 | 6861 | 12.42 | 1345047 | 13.72 | 47.52 | 524352 | 6.60 | 7.46 | 7.26 | 49.31 | 769242 | 5.77 | 6.52 | 7.56 | 53.70 | 23.43 |
| 36.28 | 112 | 6920 | 12.49 | 1336198 | 13.62 | 47.82 | 523091 | 6.59 | 7.38 | 7.34 | 49.88 | 768820 | 5.77 | 6.46 | 7.62 | 54.14 | 23.85 |
| 36.53 | 112 | 6821 | 12.37 | 1337280 | 13.64 | 47.57 | 527171 | 6.64 | 7.43 | 7.28 | 49.49 | 774825 | 5.81 | 6.51 | 7.57 | 53.78 | 23.54 |
| 36.78 | 112 | 6842 | 12.40 | 1329894 | 13.56 | 47.76 | 525983 | 6.62 | 7.42 | 7.30 | 49.60 | 772232 | 5.79 | 6.49 | 7.59 | 53.93 | 23.69 |
| 37.03 | 112 | 6808 | 12.36 | 1333314 | 13.60 | 47.62 | 528404 | 6.65 | 7.45 | 7.27 | 49.37 | 778023 | 5.83 | 6.54 | 7.54 | 53.59 | 23.51 |
| 37.28 | 112 | 6761 | 12.30 | 1332168 | 13.58 | 47.53 | 530728 | 6.68 | 7.48 | 7.23 | 49.15 | 780489 | 5.85 | 6.56 | 7.52 | 53.44 | 23.36 |
| 37.53 | 112 | 6820 | 12.37 | 1328284 | 13.54 | 47.74 | 532266 | 6.70 | 7.51 | 7.21 | 49.00 | 783431 | 5.88 | 6.58 | 7.50 | 53.26 | 23.39 |
| 37.78 | 112 | 6681 | 12.21 | 1327667 | 13.54 | 47.42 | 534116 | 6.73 | 7.53 | 7.19 | 48.82 | 785470 | 5.89 | 6.60 | 7.48 | 53.14 | 23.15 |
| 38.03 | 112 | 6770 | 12.31 | 1324620 | 13.51 | 47.69 | 534561 | 6.73 | 7.54 | 7.18 | 48.78 | 786212 | 5.90 | 6.60 | 7.48 | 53.10 | 23.26 |
| 38.28 | 112 | 6740 | 12.28 | 1323187 | 13.49 | 47.65 | 534902 | 6.74 | 7.54 | 7.18 | 48.75 | 786663 | 5.90 | 6.61 | 7.47 | 53.07 | 23.23 |
| 38.53 | 112 | 6673 | 12.20 | 1319462 | 13.45 | 47.56 | 537001 | 6.76 | 7.57 | 7.15 | 48.55 | 788888 | 5.92 | 6.63 | 7.45 | 52.94 | 23.09 |
| 38.78 | 112 | 6638 | 12.16 | 1317617 | 13.44 | 47.51 | 538169 | 6.78 | 7.59 | 7.13 | 48.44 | 790930 | 5.93 | 6.64 | 7.44 | 52.82 | 23.01 |
| 39.03 | 112 | 6693 | 12.22 | 1316578 | 13.42 | 47.66 | 539948 | 6.80 | 7.61 | 7.10 | 48.27 | 793514 | 5.95 | 6.67 | 7.41 | 52.66 | 23.00 |
| 39.28 | 112 | 6676 | 11.97 | 1310962 | 13.37 | 47.24 | 540702 | 6.81 | 7.63 | 7.09 | 48.19 | 793561 | 5.95 | 6.67 | 7.41 | 52.66 | 22.77 |
| 39.53 | 112 | 6667 | 12.19 | 1312764 | 13.39 | 47.67 | 541496 | 6.82 | 7.64 | 7.08 | 48.12 | 794521 | 5.96 | 6.67 | 7.41 | 52.60 | 22.94 |
| 39.78 | 112 | 6628 | 12.15 | 1309167 | 13.35 | 47.64 | 544763 | 6.86 | 7.68 | 7.04 | 47.80 | 799512 | 6.00 | 6.72 | 7.36 | 52.30 | 22.78 |
| 40.03 | 112 | 6509 | 12.01 | 1304425 | 13.30 | 47.44 | 544904 | 6.86 | 7.68 | 7.03 | 47.79 | 800410 | 6.00 | 6.72 | 7.36 | 52.25 | 22.67 |
| 40.28 | 112 | 6567 | 12.08 | 1304545 | 13.30 | 47.58 | 546645 | 6.88 | 7.71 | 7.01 | 47.62 | 802097 | 6.02 | 6.74 | 7.34 | 52.15 | 22.66 |
| 40.53 | 112 | 6430 | 11.91 | 1299287 | 13.25 | 47.35 | 545580 | 6.87 | 7.69 | 7.02 | 47.73 | 800582 | 6.00 | 6.72 | 7.36 | 52.24 | 22.60 |
| 40.78 | 112 | 6566 | 12.07 | 1298565 | 13.24 | 47.69 | 546693 | 6.88 | 7.71 | 7.01 | 47.62 | 798803 | 5.99 | 6.71 | 7.37 | 52.35 | 22.71 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 41.03 | 112 | 6504 | 12.00 | 1298427 | 13.24 | 47.55 | 550139 | 6.93 | 7.76 | 6.96 | 47.29 | 805088 | 6.04 | 6.76 | 7.32 | 51.97 | 22.48 |
| 41.28 | 112 | 6491 | 11.99 | 1293868 | 13.19 | 47.60 | 552828 | 6.96 | 7.80 | 6.92 | 47.03 | 810017 | 6.07 | 6.80 | 7.28 | 51.68 | 22.39 |
| 41.53 | 112 | 6508 | 12.01 | 1296176 | 13.22 | 47.60 | 552918 | 6.96 | 7.80 | 6.92 | 47.02 | 810253 | 6.08 | 6.81 | 7.27 | 51.66 | 22.38 |
| 41.78 | 112 | 6469 | 11.96 | 1291556 | 13.17 | 47.59 | 554662 | 6.98 | 7.82 | 6.90 | 46.86 | 812350 | 6.09 | 6.82 | 7.26 | 51.54 | 22.30 |
| 42.03 | 112 | 6458 | 11.95 | 1289157 | 13.15 | 47.61 | 556355 | 7.01 | 7.85 | 6.87 | 46.69 | 815249 | 6.11 | 6.85 | 7.23 | 51.37 | 22.23 |
| 42.28 | 112 | 6465 | 11.96 | 1286442 | 13.12 | 47.68 | 557503 | 7.02 | 7.86 | 6.86 | 46.58 | 817325 | 6.13 | 6.87 | 7.21 | 51.24 | 22.21 |
| 42.53 | 112 | 6353 | 11.82 | 1284676 | 13.10 | 47.43 | 558832 | 7.04 | 7.88 | 6.84 | 46.46 | 818867 | 6.14 | 6.88 | 7.20 | 51.15 | 22.04 |
| 42.78 | 112 | 6285 | 11.74 | 1283906 | 13.09 | 47.28 | 560218 | 7.05 | 7.90 | 6.82 | 46.32 | 821525 | 6.16 | 6.90 | 7.18 | 50.99 | 21.90 |
| 43.03 | 112 | 6291 | 11.75 | 1283868 | 13.09 | 47.29 | 560821 | 7.06 | 7.91 | 6.81 | 46.27 | 822667 | 6.17 | 6.91 | 7.17 | 50.92 | 21.88 |
| 43.28 | 112 | 6310 | 11.77 | 1278369 | 13.04 | 47.45 | 563564 | 7.10 | 7.95 | 6.77 | 46.00 | 826631 | 6.20 | 6.94 | 7.14 | 50.69 | 21.83 |
| 43.53 | 112 | 6238 | 11.68 | 1277224 | 13.02 | 47.29 | 564445 | 7.11 | 7.96 | 6.76 | 45.92 | 828709 | 6.22 | 6.96 | 7.12 | 50.56 | 21.71 |
| 43.78 | 112 | 6267 | 11.72 | 1276704 | 13.02 | 47.37 | 565681 | 7.12 | 7.98 | 6.74 | 45.80 | 829657 | 6.22 | 6.97 | 7.11 | 50.51 | 21.70 |
| 44.03 | 111 | 6233 | 11.68 | 1269566 | 12.95 | 47.42 | 566085 | 7.13 | 7.91 | 6.81 | 46.25 | 830397 | 6.23 | 6.91 | 7.17 | 50.90 | 21.93 |
| 44.28 | 111 | 6200 | 11.64 | 1269027 | 12.94 | 47.35 | 568228 | 7.15 | 7.94 | 6.78 | 46.04 | 834032 | 6.25 | 6.94 | 7.14 | 50.69 | 21.80 |
| 44.53 | 111 | 6160 | 11.59 | 1267965 | 12.93 | 47.27 | 568960 | 7.16 | 7.95 | 6.77 | 45.97 | 836360 | 6.27 | 6.96 | 7.12 | 50.55 | 21.73 |
| 44.78 | 111 | 6216 | 11.66 | 1264345 | 12.89 | 47.48 | 570146 | 7.18 | 7.97 | 6.75 | 45.86 | 835443 | 6.27 | 6.95 | 7.13 | 50.61 | 21.78 |
| 45.03 | 111 | 6146 | 11.57 | 1258289 | 12.83 | 47.42 | 570512 | 7.18 | 7.97 | 6.75 | 45.83 | 834707 | 6.26 | 6.95 | 7.13 | 50.65 | 21.73 |
| 45.28 | 111 | 6100 | 11.52 | 1262483 | 12.87 | 47.22 | 571611 | 7.20 | 7.99 | 6.73 | 45.72 | 838743 | 6.29 | 6.98 | 7.10 | 50.41 | 21.59 |
| 45.53 | 111 | 5997 | 11.50 | 1260593 | 12.85 | 47.22 | 573334 | 7.22 | 8.01 | 6.71 | 45.56 | 841554 | 6.31 | 7.01 | 7.07 | 50.24 | 21.51 |
| 45.78 | 111 | 6168 | 11.60 | 1258134 | 12.83 | 47.48 | 575931 | 7.25 | 8.05 | 6.67 | 45.31 | 845908 | 6.34 | 7.04 | 7.04 | 49.99 | 21.51 |
| 46.03 | 111 | 6025 | 11.42 | 1250073 | 12.75 | 47.26 | 575409 | 7.25 | 8.04 | 6.68 | 45.36 | 845851 | 6.34 | 7.04 | 7.04 | 49.99 | 21.44 |
| 46.28 | 111 | 6015 | 11.41 | 1248266 | 12.73 | 47.27 | 577723 | 7.27 | 8.07 | 6.64 | 45.14 | 847839 | 6.36 | 7.06 | 7.02 | 49.87 | 21.34 |
| 46.53 | 111 | 6031 | 11.43 | 1247962 | 12.73 | 47.32 | 578448 | 7.28 | 8.08 | 6.63 | 45.07 | 847772 | 6.36 | 7.06 | 7.02 | 49.88 | 21.33 |
| 46.78 | 111 | 6063 | 11.47 | 1243646 | 12.68 | 47.49 | 580271 | 7.31 | 8.11 | 6.61 | 44.90 | 851157 | 6.38 | 7.09 | 6.99 | 49.68 | 21.32 |
| 47.03 | 111 | 6008 | 11.40 | 1242923 | 12.67 | 47.36 | 581583 | 7.32 | 8.13 | 6.59 | 44.77 | 853289 | 6.40 | 7.10 | 6.98 | 49.55 | 21.20 |
| 47.28 | 111 | 5948 | 11.33 | 1240810 | 12.65 | 47.24 | 583934 | 7.35 | 8.16 | 6.56 | 44.55 | 856664 | 6.42 | 7.13 | 6.95 | 49.35 | 21.05 |
| 47.53 | 111 | 5921 | 11.30 | 1235184 | 12.59 | 47.28 | 585530 | 7.37 | 8.18 | 6.54 | 44.40 | 858854 | 6.44 | 7.15 | 6.93 | 49.22 | 20.99 |
| 47.78 | 111 | 5975 | 11.36 | 1234175 | 12.58 | 47.45 | 585460 | 7.37 | 8.18 | 6.54 | 44.41 | 860432 | 6.45 | 7.16 | 6.92 | 49.13 | 21.07 |
| 48.03 | 111 | 5927 | 11.30 | 1230455 | 12.55 | 47.39 | 587997 | 7.40 | 8.22 | 6.50 | 44.17 | 862066 | 6.47 | 7.18 | 6.90 | 49.03 | 20.93 |
| 48.28 | 111 | 5901 | 11.27 | 1220021 | 12.44 | 47.53 | 590124 | 7.43 | 8.25 | 6.47 | 43.96 | 859833 | 6.45 | 7.16 | 6.92 | 49.16 | 20.90 |
| 48.53 | 111 | 5926 | 11.30 | 1224890 | 12.49 | 47.50 | 587700 | 7.40 | 8.21 | 6.50 | 44.19 | 862479 | 6.47 | 7.18 | 6.90 | 49.01 | 20.99 |
| 48.78 | 111 | 5782 | 11.12 | 1221253 | 12.45 | 47.18 | 589634 | 7.42 | 8.24 | 6.48 | 44.01 | 866283 | 6.50 | 7.21 | 6.87 | 48.78 | 20.76 |
| 49.03 | 111 | 5850 | 11.21 | 1218092 | 12.42 | 47.43 | 590625 | 7.44 | 8.26 | 6.46 | 43.92 | 867921 | 6.51 | 7.23 | 6.85 | 48.69 | 20.83 |
| 49.28 | 111 | 5903 | 11.27 | 1216104 | 12.40 | 47.62 | 592128 | 7.46 | 8.28 | 6.44 | 43.77 | 872460 | 6.54 | 7.26 | 6.82 | 48.42 | 20.84 |
| 49.53 | 111 | 5827 | 11.18 | 1211148 | 12.35 | 47.51 | 590579 | 7.44 | 8.25 | 6.46 | 43.92 | 869827 | 6.52 | 7.24 | 6.84 | 48.57 | 20.87 |
| 49.78 | 111 | 5831 | 11.18 | 1207086 | 12.31 | 47.60 | 593961 | 7.48 | 8.30 | 6.42 | 43.60 | 874730 | 6.56 | 7.28 | 6.80 | 48.28 | 20.76 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 50.03 | 111 | 5839 | 11.19 | 1205256 | 12.29 | 47.67 | 595790 | 7.50 | 8.33 | 6.39 | 43.43 | 879127 | 6.59 | 7.32 | 6.76 | 48.02 | 20.70 |
| 50.28 | 111 | 5739 | 11.07 | 1205140 | 12.29 | 47.39 | 597239 | 7.52 | 8.35 | 6.37 | 43.29 | 879692 | 6.60 | 7.32 | 6.76 | 47.99 | 20.51 |
| 50.53 | 111 | 5718 | 11.04 | 1200792 | 12.24 | 47.42 | 599135 | 7.54 | 8.37 | 6.34 | 43.11 | 884595 | 6.63 | 7.36 | 6.72 | 47.70 | 20.44 |
| 50.78 | 111 | 5673 | 10.99 | 1198155 | 12.22 | 47.35 | 600397 | 7.56 | 8.39 | 6.33 | 42.99 | 887504 | 6.66 | 7.39 | 6.69 | 47.53 | 20.35 |
| 51.03 | 111 | 5589 | 10.88 | 1194303 | 12.18 | 47.19 | 600282 | 7.56 | 8.39 | 6.33 | 43.00 | 888130 | 6.66 | 7.39 | 6.69 | 47.49 | 20.29 |
| 51.28 | 111 | 5650 | 10.95 | 1189504 | 12.13 | 47.45 | 603146 | 7.59 | 8.43 | 6.29 | 42.73 | 893215 | 6.70 | 7.44 | 6.64 | 47.19 | 20.27 |
| 51.53 | 111 | 5685 | 11.00 | 1188193 | 12.12 | 47.59 | 603222 | 7.60 | 8.43 | 6.29 | 42.72 | 893536 | 6.70 | 7.44 | 6.64 | 47.17 | 20.33 |
| 51.78 | 111 | 5666 | 10.98 | 1188536 | 12.12 | 47.53 | 603979 | 7.61 | 8.44 | 6.28 | 42.65 | 894155 | 6.71 | 7.44 | 6.64 | 47.13 | 20.27 |
| 52.03 | 111 | 5519 | 10.79 | 1181514 | 12.05 | 47.25 | 604550 | 7.61 | 8.45 | 6.27 | 42.59 | 896091 | 6.72 | 7.46 | 6.62 | 47.02 | 20.12 |
| 52.28 | 110 | 5577 | 10.86 | 1182023 | 12.05 | 47.41 | 605517 | 7.62 | 8.39 | 6.33 | 43.02 | 897955 | 6.73 | 7.41 | 6.67 | 47.39 | 20.39 |
| 52.53 | 110 | 5564 | 10.85 | 1179756 | 12.03 | 47.42 | 607837 | 7.65 | 8.42 | 6.30 | 42.80 | 901873 | 6.76 | 7.44 | 6.64 | 47.16 | 20.30 |
| 52.78 | 110 | 5652 | 10.96 | 1173927 | 11.97 | 47.80 | 607700 | 7.65 | 8.42 | 6.30 | 42.81 | 898967 | 6.74 | 7.42 | 6.66 | 47.33 | 20.46 |
| 53.03 | 110 | 5601 | 10.90 | 1171051 | 11.94 | 47.71 | 610327 | 7.69 | 8.45 | 6.27 | 42.57 | 904794 | 6.79 | 7.46 | 6.62 | 46.99 | 20.31 |
| 53.28 | 110 | 5542 | 10.82 | 1169897 | 11.93 | 47.56 | 612762 | 7.72 | 8.49 | 6.23 | 42.34 | 909494 | 6.82 | 7.50 | 6.58 | 46.71 | 20.14 |
| 53.53 | 110 | 5524 | 10.80 | 1166827 | 11.90 | 47.57 | 614830 | 7.74 | 8.52 | 6.20 | 42.14 | 913649 | 6.85 | 7.54 | 6.54 | 46.47 | 20.05 |
| 53.78 | 110 | 5437 | 10.69 | 1163749 | 11.87 | 47.38 | 615780 | 7.75 | 8.53 | 6.19 | 42.05 | 914553 | 6.86 | 7.54 | 6.54 | 46.42 | 19.93 |
| 54.03 | 110 | 5312 | 10.53 | 1160263 | 11.83 | 47.08 | 617078 | 7.77 | 8.55 | 6.17 | 41.93 | 918213 | 6.89 | 7.57 | 6.51 | 46.20 | 19.74 |
| 54.28 | 110 | 5465 | 10.72 | 1155186 | 11.78 | 47.65 | 620574 | 7.81 | 8.60 | 6.12 | 41.60 | 922378 | 6.92 | 7.61 | 6.47 | 45.96 | 19.82 |
| 54.53 | 110 | 5409 | 10.65 | 1155691 | 11.78 | 47.47 | 620754 | 7.82 | 8.60 | 6.12 | 41.59 | 921802 | 6.91 | 7.60 | 6.48 | 45.99 | 19.74 |
| 54.78 | 110 | 5347 | 10.57 | 1150359 | 11.73 | 47.40 | 623880 | 7.86 | 8.64 | 6.08 | 41.29 | 927091 | 6.95 | 7.65 | 6.43 | 45.68 | 19.57 |
| 55.03 | 110 | 5347 | 10.57 | 1147083 | 11.70 | 47.47 | 622891 | 7.84 | 8.63 | 6.09 | 41.38 | 926355 | 6.95 | 7.64 | 6.44 | 45.72 | 19.65 |
| 55.28 | 110 | 5376 | 10.61 | 1145906 | 11.68 | 47.59 | 625755 | 7.88 | 8.67 | 6.05 | 41.11 | 929804 | 6.97 | 7.67 | 6.41 | 45.52 | 19.56 |
| 55.53 | 110 | 5359 | 10.59 | 1144770 | 11.67 | 47.56 | 626773 | 7.89 | 8.68 | 6.04 | 41.02 | 931996 | 6.99 | 7.69 | 6.39 | 45.39 | 19.51 |
| 55.78 | 110 | 5333 | 10.55 | 1140766 | 11.63 | 47.57 | 628708 | 7.92 | 8.71 | 6.01 | 40.84 | 935049 | 7.01 | 7.71 | 6.37 | 45.21 | 19.42 |
| 56.03 | 110 | 5269 | 10.47 | 1139032 | 11.61 | 47.41 | 630170 | 7.93 | 8.73 | 5.99 | 40.70 | 938134 | 7.04 | 7.74 | 6.34 | 45.03 | 19.29 |
| 56.28 | 110 | 5180 | 10.35 | 1136357 | 11.59 | 47.19 | 631267 | 7.95 | 8.74 | 5.98 | 40.60 | 938580 | 7.04 | 7.74 | 6.34 | 45.01 | 19.16 |
| 56.53 | 110 | 5154 | 10.32 | 1132011 | 11.54 | 47.20 | 634047 | 7.98 | 8.78 | 5.94 | 40.33 | 943197 | 7.07 | 7.78 | 6.30 | 44.74 | 19.04 |
| 56.78 | 110 | 5150 | 10.31 | 1126852 | 11.49 | 47.30 | 635130 | 8.00 | 8.80 | 5.92 | 40.23 | 945174 | 7.09 | 7.80 | 6.28 | 44.62 | 19.03 |
| 57.03 | 110 | 5166 | 10.32 | 1125421 | 11.48 | 47.34 | 637348 | 8.03 | 8.83 | 5.89 | 40.02 | 948711 | 7.11 | 7.83 | 6.25 | 44.41 | 18.95 |
| 57.28 | 110 | 5156 | 10.32 | 1122593 | 11.45 | 47.42 | 635783 | 8.01 | 8.81 | 5.91 | 40.17 | 945166 | 7.09 | 7.80 | 6.28 | 44.62 | 19.05 |
| 57.53 | 109 | 5154 | 10.32 | 1121040 | 11.43 | 47.44 | 637314 | 8.02 | 8.75 | 5.97 | 40.57 | 948365 | 7.11 | 7.75 | 6.33 | 44.94 | 19.25 |
| 57.78 | 109 | 5107 | 10.26 | 1116975 | 11.39 | 47.38 | 639205 | 8.05 | 8.77 | 5.95 | 40.40 | 952015 | 7.14 | 7.78 | 6.30 | 44.73 | 19.14 |
| 58.03 | 109 | 5113 | 10.27 | 1112594 | 11.34 | 47.50 | 643052 | 8.10 | 8.83 | 5.89 | 40.04 | 957732 | 7.18 | 7.83 | 6.25 | 44.40 | 19.02 |
| 58.28 | 109 | 4989 | 10.10 | 1111483 | 11.33 | 47.13 | 642304 | 8.09 | 8.82 | 5.90 | 40.11 | 957837 | 7.18 | 7.83 | 6.25 | 44.39 | 18.90 |
| 58.53 | 109 | 5069 | 10.21 | 1108374 | 11.30 | 47.46 | 645289 | 8.13 | 8.86 | 5.86 | 39.83 | 961837 | 7.21 | 7.86 | 6.22 | 44.16 | 18.90 |
| 58.78 | 109 | 5059 | 10.19 | 1104097 | 11.26 | 47.52 | 646762 | 8.14 | 8.88 | 5.84 | 39.69 | 964946 | 7.24 | 7.89 | 6.19 | 43.98 | 18.86 |

| 8%Ni-2%Zr/clino | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|-----------------|----------|----------------|-------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 59.03 | 109 | 4993 | 10.11 | 1101792 | 11.23 | 47.36 | 649104 | 8.17 | 8.91 | 5.81 | 39.47 | 968221 | 7.26 | 7.91 | 6.17 | 43.79 | 18.69 |
| 59.28 | 108 | 4998 | 10.11 | 1096824 | 11.18 | 47.49 | 649781 | 8.18 | 8.84 | 5.88 | 39.97 | 968980 | 7.27 | 7.85 | 6.23 | 44.26 | 18.98 |
| 59.53 | 108 | 4973 | 10.08 | 1095295 | 11.17 | 47.44 | 651616 | 8.20 | 8.86 | 5.86 | 39.80 | 971860 | 7.29 | 7.87 | 6.21 | 44.09 | 18.88 |
| 59.78 | 108 | 4914 | 10.00 | 1090575 | 11.12 | 47.35 | 655100 | 8.25 | 8.91 | 5.81 | 39.47 | 977348 | 7.33 | 7.92 | 6.16 | 43.78 | 18.69 |
| 60.03 | 108 | 4910 | 10.00 | 1089227 | 11.11 | 47.37 | 653547 | 8.23 | 8.89 | 5.83 | 39.62 | 975364 | 7.31 | 7.90 | 6.18 | 43.89 | 18.77 |
| 60.28 | 108 | 4900 | 9.98 | 1084947 | 11.06 | 47.43 | 656927 | 8.27 | 8.93 | 5.79 | 39.31 | 981163 | 7.36 | 7.95 | 6.13 | 43.56 | 18.64 |
| 60.53 | 107 | 4905 | 9.99 | 1080788 | 11.02 | 47.55 | 656958 | 8.27 | 8.85 | 5.87 | 39.86 | 980357 | 7.35 | 7.87 | 6.21 | 44.13 | 18.95 |
| 60.78 | 107 | 4924 | 10.01 | 1077455 | 10.99 | 47.68 | 655707 | 8.26 | 8.83 | 5.88 | 39.98 | 978431 | 7.34 | 7.85 | 6.23 | 44.24 | 19.06 |
| 61.03 | 107 | 4723 | 9.74 | 1076755 | 10.98 | 47.02 | 659568 | 8.31 | 8.89 | 5.83 | 39.63 | 985848 | 7.39 | 7.91 | 6.17 | 43.81 | 18.63 |
| 61.28 | 107 | 4808 | 9.86 | 1072240 | 10.93 | 47.42 | 660439 | 8.32 | 8.90 | 5.82 | 39.55 | 987315 | 7.40 | 7.92 | 6.16 | 43.73 | 18.75 |
| 61.53 | 107 | 4915 | 10.00 | 1069981 | 10.91 | 47.83 | 663478 | 8.35 | 8.94 | 5.78 | 39.27 | 991683 | 7.44 | 7.96 | 6.12 | 43.48 | 18.78 |
| 61.78 | 107 | 5139 | 10.02 | 1097005 | 11.19 | 47.26 | 638156 | 8.04 | 8.60 | 6.12 | 41.59 | 972702 | 7.29 | 7.81 | 6.27 | 44.56 | 19.65 |
| 62.03 | 107 | 4925 | 10.02 | 1092532 | 11.14 | 47.34 | 645524 | 8.13 | 8.70 | 6.02 | 40.91 | 973203 | 7.30 | 7.81 | 6.27 | 44.53 | 19.37 |
| 62.28 | 107 | 5011 | 10.13 | 1082360 | 11.04 | 47.86 | 650155 | 8.19 | 8.76 | 5.96 | 40.49 | 978044 | 7.33 | 7.85 | 6.23 | 44.26 | 19.38 |
| 62.53 | 107 | 4912 | 10.00 | 1080593 | 11.02 | 47.57 | 653665 | 8.23 | 8.81 | 5.91 | 40.17 | 981271 | 7.36 | 7.87 | 6.21 | 44.07 | 19.11 |
| 62.78 | 107 | 4999 | 10.11 | 1075171 | 10.96 | 47.99 | 655987 | 8.26 | 8.84 | 5.88 | 39.95 | 985497 | 7.39 | 7.91 | 6.17 | 43.83 | 19.17 |
| 63.03 | 107 | 4938 | 10.03 | 1069673 | 10.91 | 47.91 | 657758 | 8.28 | 8.86 | 5.86 | 39.79 | 988153 | 7.41 | 7.93 | 6.15 | 43.68 | 19.07 |
| 63.28 | 107 | 4822 | 9.88 | 1066155 | 10.87 | 47.61 | 659668 | 8.31 | 8.89 | 5.83 | 39.62 | 991770 | 7.44 | 7.96 | 6.12 | 43.48 | 18.86 |
| 63.53 | 107 | 4760 | 9.79 | 1049178 | 10.70 | 47.79 | 654658 | 8.24 | 8.82 | 5.90 | 40.08 | 983864 | 7.38 | 7.90 | 6.18 | 43.93 | 19.15 |
| 63.78 | 107 | 4655 | 9.65 | 1039575 | 10.60 | 47.66 | 652302 | 8.21 | 8.79 | 5.93 | 40.29 | 980207 | 7.35 | 7.87 | 6.21 | 44.14 | 19.20 |
| 64.03 | 107 | 4631 | 9.62 | 1042389 | 10.63 | 47.50 | 661049 | 8.32 | 8.91 | 5.81 | 39.49 | 993186 | 7.45 | 7.97 | 6.11 | 43.40 | 18.76 |
| 64.28 | 107 | 4772 | 9.81 | 1042372 | 10.63 | 48.00 | 666201 | 8.39 | 8.98 | 5.74 | 39.02 | 1003037 | 7.52 | 8.05 | 6.03 | 42.83 | 18.73 |
| 64.53 | 107 | 4688 | 9.70 | 1040878 | 10.61 | 47.74 | 670544 | 8.44 | 9.03 | 5.68 | 38.62 | 1009370 | 7.57 | 8.10 | 5.98 | 42.47 | 18.44 |
| 64.78 | 107 | 4597 | 9.57 | 1035057 | 10.55 | 47.56 | 672906 | 8.47 | 9.07 | 5.65 | 38.40 | 1014506 | 7.61 | 8.14 | 5.94 | 42.18 | 18.26 |
| 65.03 | 107 | 4679 | 9.68 | 1031386 | 10.52 | 47.94 | 672827 | 8.47 | 9.07 | 5.65 | 38.41 | 1011963 | 7.59 | 8.12 | 5.96 | 42.33 | 18.41 |
| 65.28 | 107 | 4637 | 9.63 | 1027730 | 10.48 | 47.88 | 677060 | 8.53 | 9.12 | 5.60 | 38.02 | 1020619 | 7.65 | 8.19 | 5.89 | 41.83 | 18.21 |
| 65.53 | 107 | 4509 | 9.45 | 1023363 | 10.43 | 47.52 | 678763 | 8.55 | 9.15 | 5.57 | 37.87 | 1022392 | 7.67 | 8.20 | 5.88 | 41.73 | 18.00 |
| 65.78 | 107 | 4503 | 9.44 | 1019655 | 10.40 | 47.59 | 682699 | 8.60 | 9.20 | 5.52 | 37.51 | 1031167 | 7.73 | 8.27 | 5.81 | 41.23 | 17.85 |
| 66.03 | 107 | 4606 | 9.58 | 1013605 | 10.34 | 48.11 | 686625 | 8.65 | 9.25 | 5.47 | 37.15 | 1037643 | 7.78 | 8.33 | 5.75 | 40.86 | 17.87 |
| 66.28 | 107 | 4482 | 9.41 | 1007826 | 10.28 | 47.80 | 687262 | 8.65 | 9.26 | 5.46 | 37.09 | 1040247 | 7.80 | 8.35 | 5.73 | 40.71 | 17.73 |
| 66.53 | 107 | 4565 | 9.53 | 1004262 | 10.24 | 48.20 | 689046 | 8.68 | 9.28 | 5.44 | 36.93 | 1032119 | 7.74 | 8.28 | 5.80 | 41.18 | 17.80 |

Table B5 Effect of reaction temperature: H₂ production, CO production, H₂ selectivity, CH₄ conversion, CO₂ conversion, and H₂ Yield

| 600°C | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|---------|----------|----------------|--------|--------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 105 | 4862 | 9.9316 | 948557 | 9.672 | 50.66 | 496268 | 6.25 | 6.56 | 6.54 | 49.91 | 951128 | 7.13 | 7.49 | 5.02 | 40.13 | 25.29 |
| 0.53 | 105 | 4440 | 9.3531 | 903760 | 9.215 | 50.37 | 606070 | 7.63 | 8.01 | 5.09 | 38.83 | 991439 | 7.44 | 7.81 | 4.70 | 37.59 | 19.56 |
| 0.78 | 105 | 4053 | 8.8015 | 869784 | 8.869 | 49.81 | 638325 | 8.04 | 8.44 | 4.66 | 35.58 | 1024714 | 7.68 | 8.07 | 4.44 | 35.50 | 17.72 |
| 1.03 | 105 | 3778 | 8.3959 | 850788 | 8.675 | 49.18 | 661681 | 8.33 | 8.75 | 4.35 | 33.22 | 1043216 | 7.82 | 8.21 | 4.30 | 34.33 | 16.34 |
| 1.28 | 105 | 3653 | 8.2074 | 836856 | 8.533 | 49.03 | 677647 | 8.53 | 8.96 | 4.14 | 31.61 | 1053694 | 7.90 | 8.30 | 4.21 | 33.67 | 15.50 |
| 1.53 | 105 | 3565 | 8.0731 | 826916 | 8.432 | 48.91 | 685868 | 8.64 | 9.07 | 4.03 | 30.78 | 1064447 | 7.98 | 8.38 | 4.13 | 33.00 | 15.05 |
| 1.78 | 105 | 3423 | 7.8534 | 819897 | 8.36 | 48.44 | 699457 | 8.81 | 9.25 | 3.85 | 29.41 | 1070652 | 8.03 | 8.43 | 4.08 | 32.61 | 14.24 |
| 2.03 | 105 | 3396 | 7.8112 | 813287 | 8.293 | 48.50 | 703941 | 8.86 | 9.31 | 3.79 | 28.95 | 1078003 | 8.08 | 8.49 | 4.02 | 32.14 | 14.04 |
| 2.28 | 105 | 3322 | 7.6948 | 808816 | 8.247 | 48.27 | 708193 | 8.92 | 9.36 | 3.74 | 28.52 | 1083676 | 8.13 | 8.53 | 3.98 | 31.79 | 13.77 |
| 2.53 | 105 | 3271 | 7.6139 | 803130 | 8.189 | 48.18 | 710706 | 8.95 | 9.40 | 3.70 | 28.27 | 1083861 | 8.13 | 8.53 | 3.98 | 31.77 | 13.62 |
| 2.78 | 105 | 3206 | 7.5101 | 799154 | 8.149 | 47.96 | 713414 | 8.98 | 9.43 | 3.67 | 28.00 | 1089722 | 8.17 | 8.58 | 3.93 | 31.41 | 13.43 |
| 3.03 | 105 | 3188 | 7.4812 | 793497 | 8.091 | 48.04 | 714001 | 8.99 | 9.44 | 3.66 | 27.94 | 1090544 | 8.18 | 8.59 | 3.92 | 31.35 | 13.42 |
| 3.28 | 105 | 3127 | 7.3827 | 789224 | 8.047 | 47.85 | 718131 | 9.04 | 9.49 | 3.61 | 27.52 | 1093701 | 8.20 | 8.61 | 3.90 | 31.16 | 13.17 |
| 3.53 | 105 | 3108 | 7.3519 | 786888 | 8.024 | 47.82 | 718317 | 9.04 | 9.50 | 3.60 | 27.50 | 1095133 | 8.21 | 8.62 | 3.89 | 31.07 | 13.15 |
| 3.78 | 105 | 3078 | 7.3031 | 784923 | 8.004 | 47.71 | 721617 | 9.09 | 9.54 | 3.56 | 27.17 | 1095802 | 8.22 | 8.63 | 3.88 | 31.02 | 12.96 |

| 700°C | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|---------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 105 | 9259 | 15.019 | 1537993 | 15.68 | 48.92 | 428369 | 5.39 | 6.36 | 8.46 | 57.07 | 712595 | 5.34 | 6.31 | 8.06 | 56.11 | 25.29 |
| 0.53 | 105 | 9706 | 15.47 | 1584190 | 16.15 | 48.92 | 419198 | 5.28 | 6.23 | 8.60 | 57.99 | 652082 | 4.89 | 5.77 | 8.60 | 59.83 | 19.56 |
| 0.78 | 105 | 9634 | 15.398 | 1587598 | 16.19 | 48.75 | 423889 | 5.34 | 6.30 | 8.53 | 57.52 | 646362 | 4.85 | 5.72 | 8.65 | 60.19 | 17.72 |
| 1.03 | 105 | 9456 | 15.212 | 1584306 | 16.15 | 48.50 | 430762 | 5.42 | 6.40 | 8.42 | 56.83 | 651337 | 4.88 | 5.76 | 8.60 | 59.88 | 16.34 |
| 1.28 | 105 | 9427 | 15.19 | 1578542 | 16.1 | 48.55 | 434576 | 5.47 | 6.46 | 8.37 | 56.44 | 651960 | 4.89 | 5.77 | 8.60 | 59.84 | 15.50 |
| 1.53 | 105 | 9312 | 15.073 | 1575175 | 16.06 | 48.41 | 438438 | 5.52 | 6.35 | 8.48 | 57.17 | 655856 | 4.92 | 5.66 | 8.71 | 60.63 | 15.05 |
| 1.78 | 105 | 9231 | 14.991 | 1574907 | 16.06 | 48.28 | 440163 | 5.54 | 6.37 | 8.45 | 57.01 | 655378 | 4.92 | 5.65 | 8.71 | 60.66 | 14.24 |
| 2.03 | 105 | 9211 | 14.97 | 1571880 | 16.03 | 48.29 | 442613 | 5.57 | 6.41 | 8.42 | 56.77 | 657694 | 4.93 | 5.67 | 8.69 | 60.52 | 14.04 |
| 2.28 | 105 | 9149 | 14.907 | 1570484 | 16.01 | 48.21 | 444200 | 5.59 | 6.43 | 8.39 | 56.61 | 661129 | 4.96 | 5.70 | 8.67 | 60.31 | 13.77 |
| 2.53 | 105 | 9119 | 14.876 | 1568047 | 15.99 | 48.20 | 445904 | 5.61 | 6.46 | 8.37 | 56.45 | 663019 | 4.97 | 5.72 | 8.65 | 60.20 | 13.62 |
| 2.78 | 105 | 9029 | 14.784 | 1565209 | 15.96 | 48.09 | 445179 | 5.61 | 6.45 | 8.38 | 56.52 | 661718 | 4.96 | 5.71 | 8.66 | 60.28 | 13.43 |
| 3.03 | 105 | 8959 | 14.712 | 1562913 | 15.94 | 48.00 | 448238 | 5.64 | 6.49 | 8.33 | 56.22 | 664802 | 4.99 | 5.73 | 8.63 | 60.09 | 13.42 |
| 3.28 | 105 | 8930 | 14.682 | 1561609 | 15.92 | 47.97 | 449048 | 5.65 | 6.50 | 8.32 | 56.14 | 667337 | 5.00 | 5.76 | 8.61 | 59.94 | 13.17 |
| 3.53 | 105 | 8918 | 14.669 | 1558831 | 15.89 | 47.99 | 450867 | 5.68 | 6.53 | 8.30 | 55.96 | 668478 | 5.01 | 5.77 | 8.60 | 59.87 | 13.15 |
| 3.78 | 105 | 8890 | 14.64 | 1560657 | 15.91 | 47.92 | 451761 | 5.69 | 6.54 | 8.28 | 55.87 | 669300 | 5.02 | 5.77 | 8.59 | 59.82 | 12.96 |

| 800°C | | H ₂ | | CO | | H ₂ | CH ₄ | | | | | CO ₂ | | | | | H ₂ Yield |
|---------|----------|----------------|--------|---------|-------|----------------|-----------------|-------|--------|---------|--------------|-----------------|-------|--------|---------|-------------|----------------------|
| Time(h) | Flow out | area | Y out | area | Y out | Selectivity | area | Y out | amount | convert | % conversion | area | Y out | amount | convert | %conversion | |
| 0.28 | 105 | 17037 | 21.902 | 1875138 | 19.12 | 53.39 | 66126 | 0.83 | 0.87 | 12.23 | 93.33 | 215696 | 1.62 | 1.70 | 10.81 | 86.42 | 49.83 |
| 0.53 | 105 | 16715 | 21.648 | 1867772 | 19.05 | 53.20 | 90839 | 1.14 | 1.20 | 11.90 | 90.83 | 200461 | 1.50 | 1.58 | 10.93 | 87.38 | 48.32 |
| 0.78 | 105 | 15521 | 20.687 | 1822978 | 18.59 | 52.67 | 129417 | 1.63 | 1.71 | 11.39 | 86.94 | 242289 | 1.82 | 1.91 | 10.60 | 84.75 | 45.79 |
| 1.03 | 105 | 14522 | 19.86 | 1775220 | 18.1 | 52.32 | 167103 | 2.10 | 2.21 | 10.89 | 83.13 | 284226 | 2.13 | 2.24 | 10.27 | 82.11 | 43.49 |
| 1.28 | 105 | 13532 | 19.016 | 1726026 | 17.6 | 51.93 | 201752 | 2.54 | 2.67 | 10.43 | 79.64 | 324926 | 2.44 | 2.56 | 9.95 | 79.55 | 41.36 |
| 1.53 | 105 | 12674 | 18.262 | 1681523 | 17.15 | 51.58 | 232247 | 2.92 | 3.07 | 10.03 | 76.56 | 362490 | 2.72 | 2.85 | 9.66 | 77.18 | 39.49 |
| 1.78 | 105 | 11939 | 17.6 | 1636403 | 16.69 | 51.33 | 261039 | 3.29 | 3.45 | 9.65 | 73.65 | 399097 | 2.99 | 3.14 | 9.37 | 74.88 | 37.81 |
| 2.03 | 105 | 11378 | 17.082 | 1595873 | 16.27 | 51.21 | 288431 | 3.63 | 3.81 | 9.29 | 70.89 | 434160 | 3.26 | 3.42 | 9.09 | 72.67 | 36.30 |
| 2.28 | 105 | 10775 | 16.513 | 1557715 | 15.88 | 50.97 | 310800 | 3.91 | 4.11 | 8.99 | 68.63 | 465191 | 3.49 | 3.66 | 8.85 | 70.72 | 34.98 |
| 2.53 | 105 | 10264 | 16.02 | 1525913 | 15.56 | 50.73 | 331458 | 4.17 | 4.38 | 8.72 | 66.55 | 494116 | 3.71 | 3.89 | 8.62 | 68.90 | 33.76 |
| 2.78 | 105 | 9793 | 15.557 | 1492092 | 15.21 | 50.56 | 349501 | 4.40 | 4.62 | 8.48 | 64.73 | 518515 | 3.89 | 4.08 | 8.43 | 67.36 | 32.72 |
| 3.03 | 105 | 9487 | 15.25 | 1466019 | 14.95 | 50.50 | 366319 | 4.61 | 4.84 | 8.26 | 63.03 | 542742 | 4.07 | 4.27 | 8.24 | 65.84 | 31.83 |
| 3.28 | 105 | 9161 | 14.919 | 1436244 | 14.64 | 50.46 | 383694 | 4.83 | 5.07 | 8.03 | 61.28 | 564102 | 4.23 | 4.44 | 8.07 | 64.49 | 30.92 |
| 3.53 | 105 | 8779 | 14.525 | 1416335 | 14.44 | 50.14 | 396007 | 4.99 | 5.24 | 7.86 | 60.03 | 583500 | 4.38 | 4.59 | 7.92 | 63.27 | 30.10 |
| 3.78 | 105 | 8554 | 14.289 | 1393571 | 14.21 | 50.14 | 407703 | 5.13 | 5.39 | 7.71 | 58.85 | 600520 | 4.50 | 4.73 | 7.78 | 62.20 | 29.51 |

Appendix C Surface area analysis results.

| Catalysts | Surface area (m ² /g) |
|-----------------------|----------------------------------|
| 8%Ni-2%Ce/clino fresh | 10.66 |
| 8%Ni-2%Zr/clino fresh | 12.76 |
| 8%Ni-2%Zr/clino used | 8.33 |



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