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APPENDIX

Appendix A **Calibration of gas products**

The relationship between the peak area from GC analysis and the gas concentration was conducted for the possible gas products such as hydrogen, carbon monoxide, and carbon dioxide.

Hydrogen

Peak Area	Amount (%)
9646.38	10.36
29585.25	27.60
60355.00	49.79
83094.00	69.32

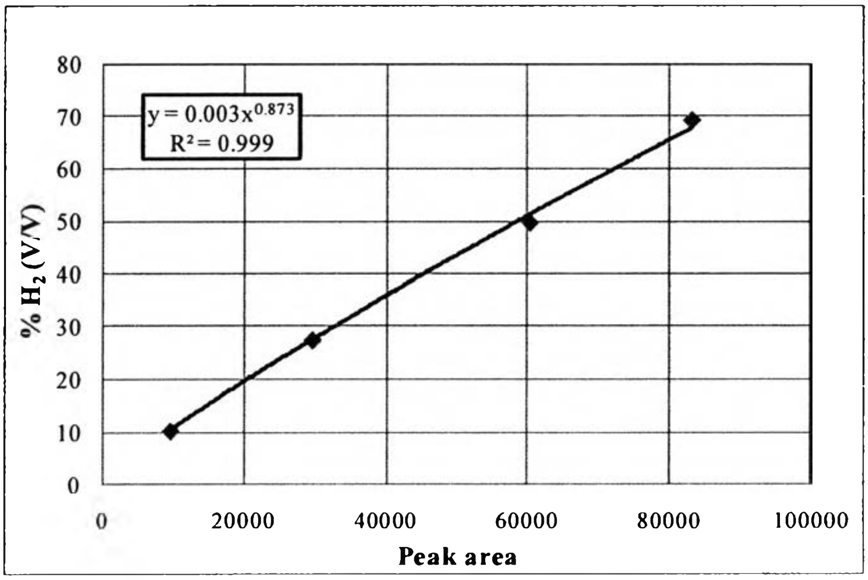


Figure A1 Calibration curve of gas hydrogen.

Where x is peak area from GC analysis

y is concentration (%)

Carbon dioxide

Peak Area	Amount (%)
0	0
335074.0	5.17
1516532.8	24.81
3219721.0	51.34
5050441.0	73.36

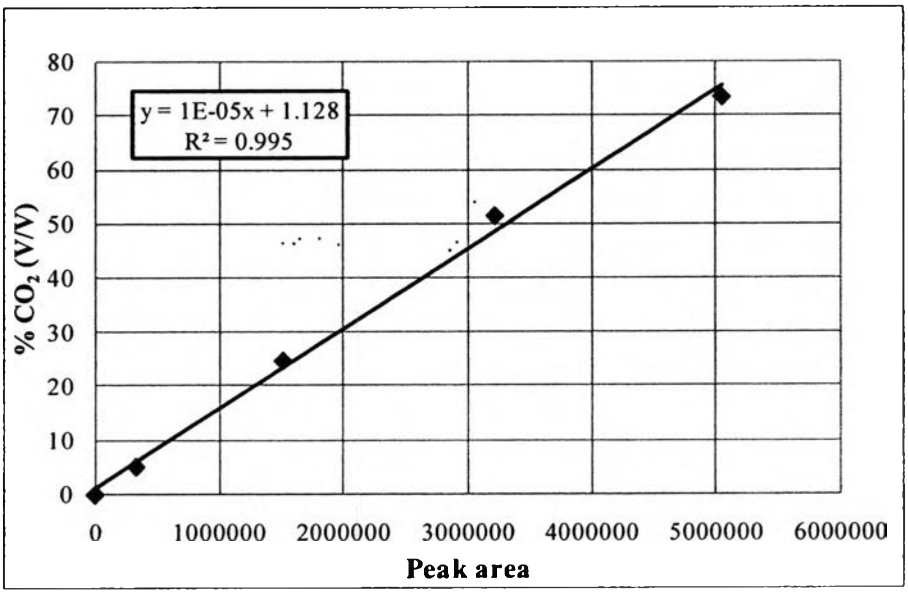


Figure A2 Calibration curve of gas carbondioxide.

Where x is peak area from GC analysis

y is concentration (%)

Carbon monoxide

Peak Area	Amount (%)
0	0
81433.2	0.5
152432.1	1.64
511313.4	5.69

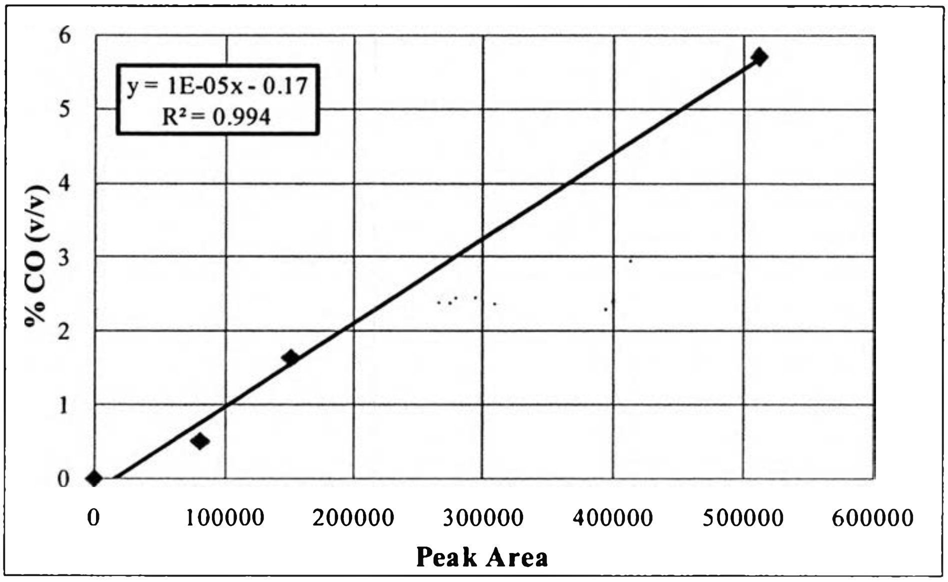


Figure A3 Calibration curve of gas carbon monoxide.

Where x is peak area from GC analysis

y is concentration (%)

Methane

Peak Area	Amount (%)
0	0
233178	5.67
813712.67	16.92
1431971	31.0

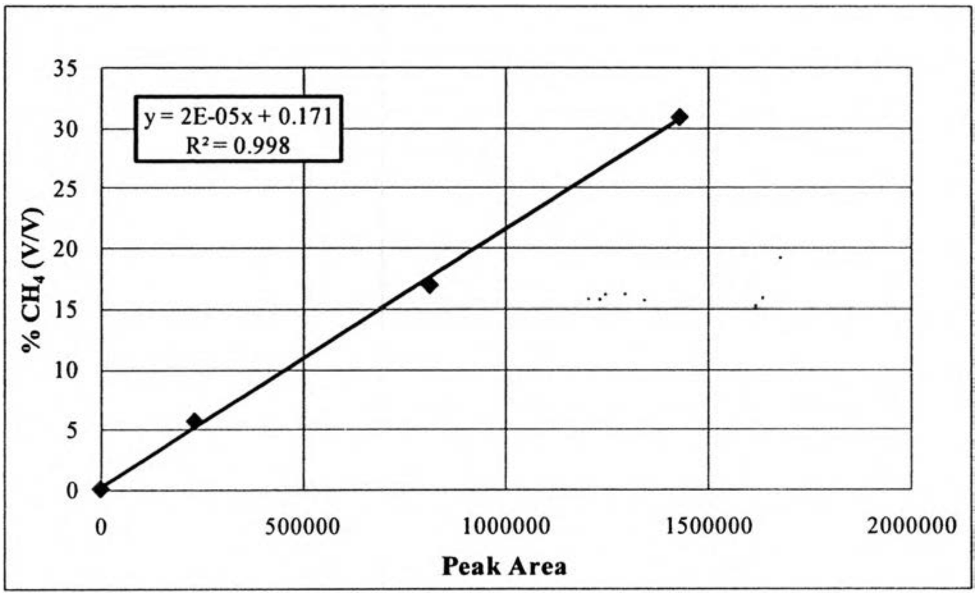
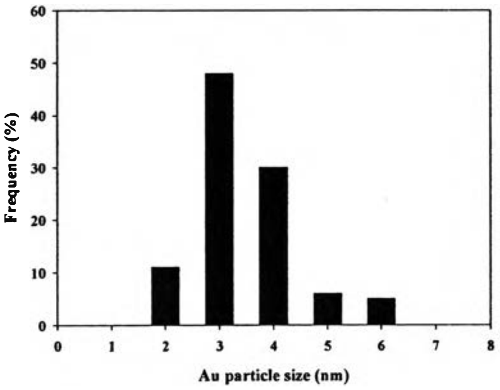


Figure A4 Calibration curve of gas methane.

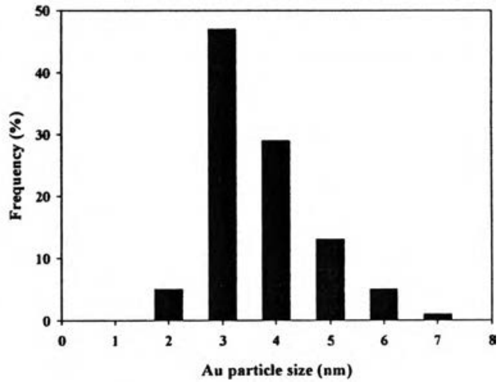
Where x is peak area from GC analysis

y is concentration (%)

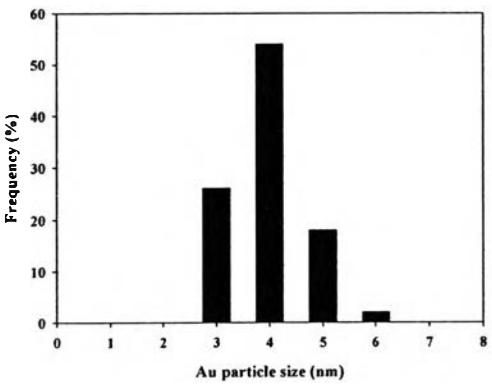
Appendix B Particle size distribution from TEM analysis



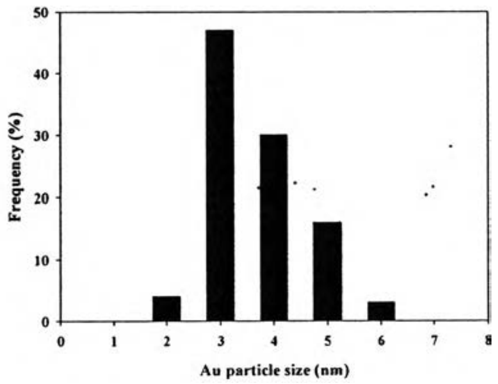
(a) 1% Au/ZnO, calcined at 400°C



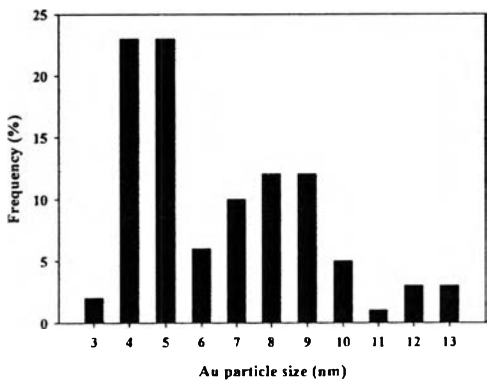
(b) 3% Au/ZnO, calcined at 400°C



(C) 5% Au/ZnO, calcined at 400°C

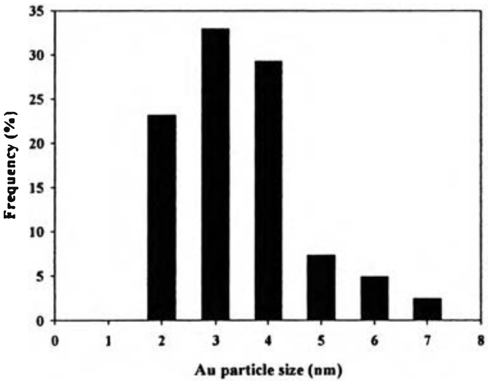


(d) 5% Au/ZnO, calcined at 300°C

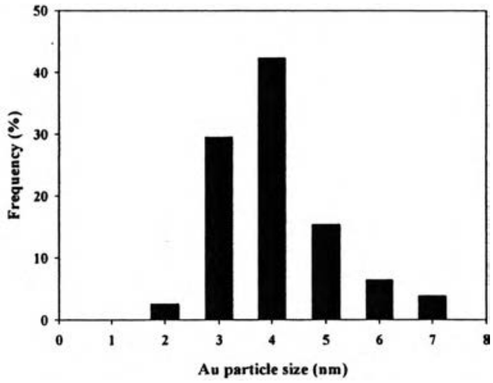


(e) 5% Au/ZnO, calcined at 500°C

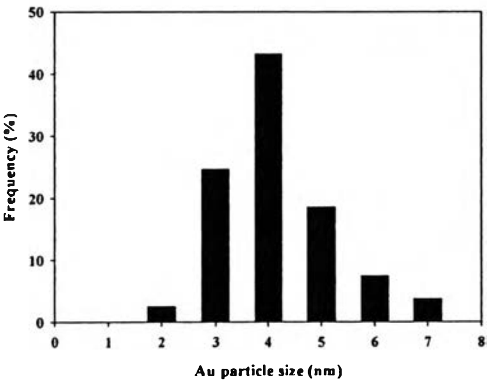
Figure B1 Particle size distribution of Au/ZnO catalysts at various Au contents and calcination temperatures.



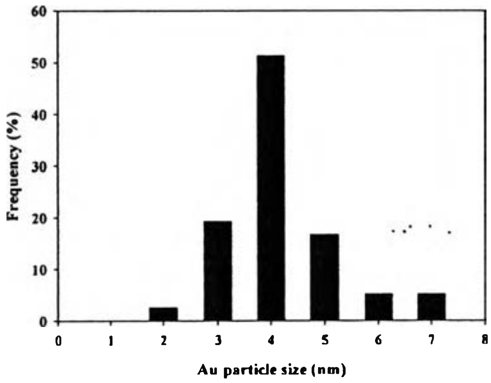
(a) $ZnO:Fe_2O_3 = 9:1$



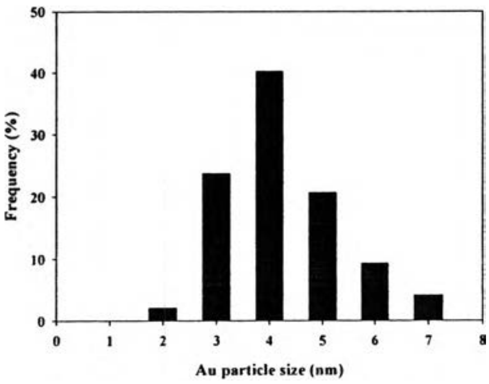
(b) $ZnO:Fe_2O_3 = 3:1$



(c) $ZnO:Fe_2O_3 = 1:1$

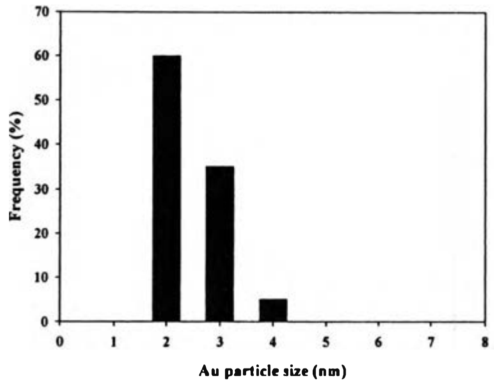


(d) $ZnO:Fe_2O_3 = 1:3$

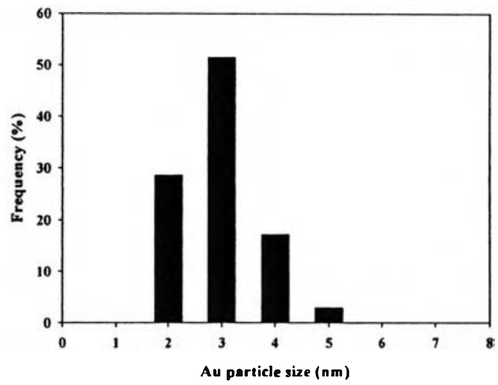


(e) $ZnO:Fe_2O_3 = 1:9$

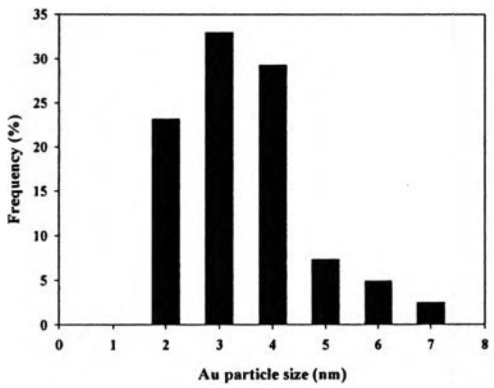
Figure B2 Particle size distribution of $Au/ZnO\text{-}Fe_2O_3$ catalysts at various molar ratios of ZnO to Fe_2O_3.



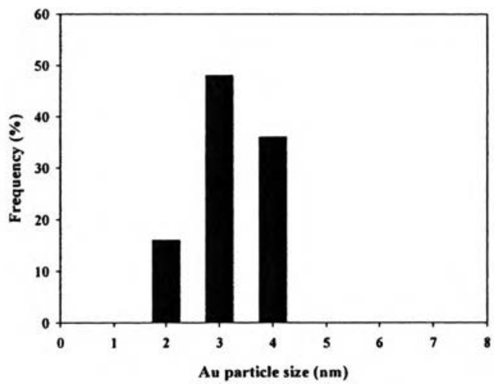
(a) 1% Au/ZnO-Fe_2O_3, calcined at 400°C



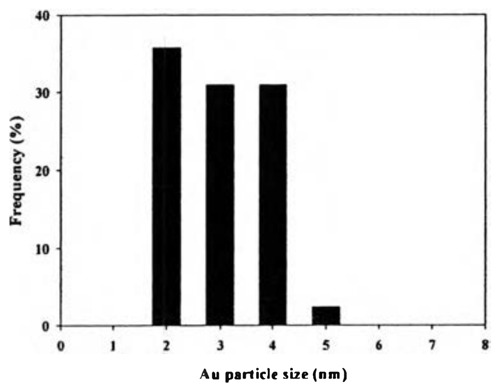
(b) 3% Au/ZnO-Fe_2O_3, calcined at 400°C



(c) 5% Au/ZnO-Fe_2O_3, calcined at 400°C



(d) 5% Au/ZnO-Fe_2O_3, calcined at 300°C



(e) 5% Au/ZnO-Fe_2O_3, calcined at 200°C

Figure B3 Particle size distribution of Au/ZnO-Fe_2O_3 catalysts at various gold contents and calcination temperatures.

Appendix C EDS pattern of Au/ZnO-Fe_2O_3 catalyst.

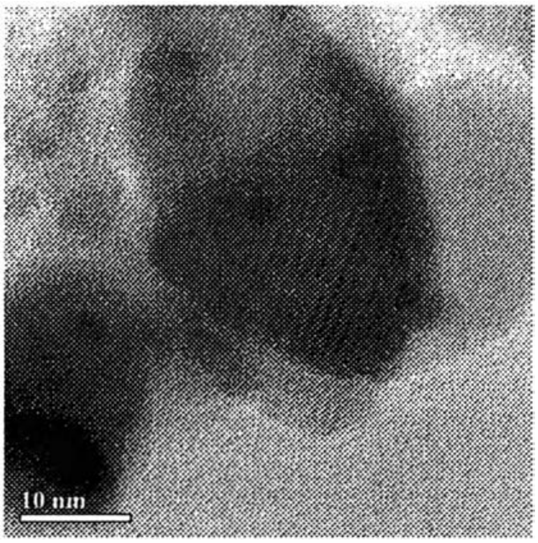


Figure C1 TEM micrograph of Au/ZnO-Fe_2O_3 catalyst.

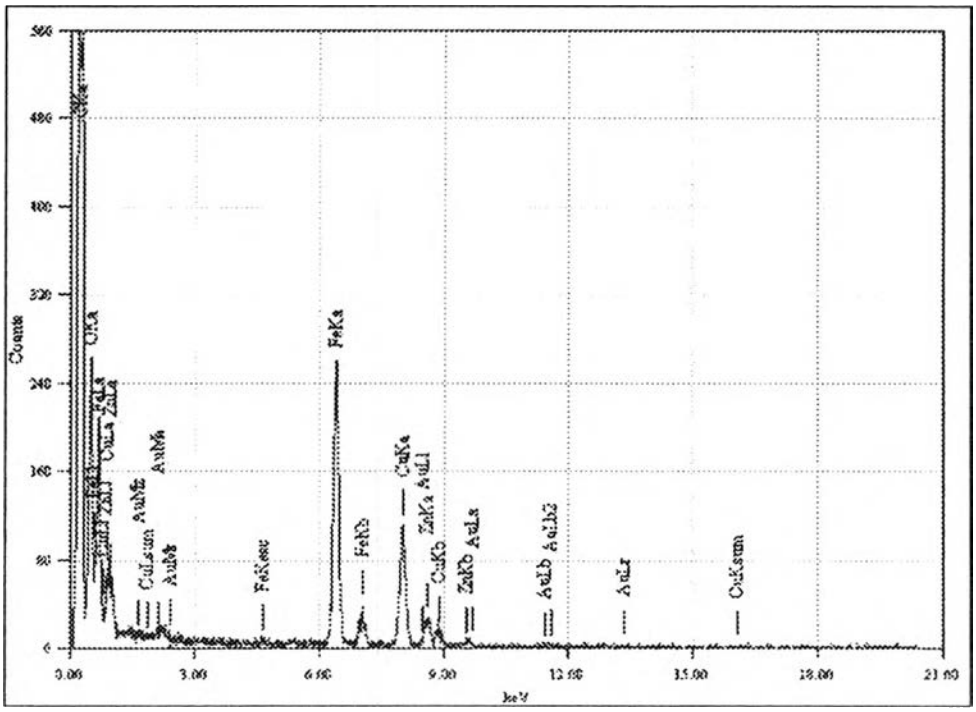
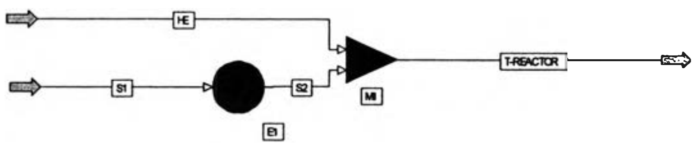


Figure C2 EDS pattern of Au/ZnO-Fe_2O_3 catalyst.

Appendix D Feed flow rate calculation from PRO/II



Stream Name		S1	S2	HE	T-REACTOR
Stream Description					
Phase		Liquid	Vapor	Vapor	Vapor
Fluid Rates	G-MOL/HR				
WATER		0.0306	0.0306	0.0000	0.0306
METHANOL		0.0235	0.0235	0.0000	0.0235
HELIUM		0.0000	0.0000	0.0433	0.0433
Rate	G-MOL/HR	0.054	0.054	0.043	0.097
Temperature	C	25.0000	150.0000	150.0000	150.0000
Pressure	ATM	1.0000	1.0000	1.0000	1.0000
Enthalpy	MM BTU/HR	0.0000	0.0000	0.0000	0.0000
Molecular Weight					
Vapor Rate	CM3/HR	1.512	n/a	n/a	n/a
Liquid Rate	G/CM3	n/a	0.001	0.000	0.001
Vapor Std. Density	G/CM3	0.870	n/a	n/a	n/a
Liquid Std. Density					

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Proceedings:

1. Thareejid S., Luengnarumitchai A., Gulari E., (2007, 29-30 October) Hydrogen Production from Steam Reforming of Methanol over Supported Au Catalyst. Proceedings of the 17^{th} Thai Chemical Engineering and Applied Chemistry Conference (TICHE 17), Chiang Mai, Thailand.