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APPENDIX

APPENDIX A**SAMPLE OF CALCULATIONS**

| | | | |
|---|---|----------|--|
| M.W. of Si | = | 28.0855 | |
| M.W. of SiO ₂ | = | 60.0843 | |
| Weight percent of SiO ₂ in Sodium Silicate | = | 28.5 | |
| M.W. of Al | = | 26.9815 | |
| M.W. of AlCl ₃ | = | 133.3405 | |
| Weight percent purity of AlCl ₃ | = | 97 | |
| M.W. of Cu | = | 63.54 | |
| M.W. of Cu(NO ₃) ₂ ·3H ₂ O | = | 241.60 | |
| M.W. of Cu(CH ₃ COO) ₂ ·H ₂ O | = | 199.65 | |
| Weight percent purity of Cu(NO ₃) ₂ ·3H ₂ O | = | 99.5 | |
| Weight percent purity of Cu(CH ₃ COO) ₂ ·H ₂ O | = | 99 | |

A-1 Calculation of Si/Al Atomic Ratio for ZSM-5 and Cu,Al-silicate

The calculation is based on weight of Sodium Silicate (Na₂O·SiO₂·H₂O) in B1 and B2 solutions.

For example, to prepare ZSM-5 at Si/Al atomic ratio of 50.

Using Sodium Silicate 69 g with 45 g of water as B1 solution.

$$\begin{aligned}
 \text{mole of Si used} &= \frac{\text{wt. \% of SiO}_2 \cdot \text{wt. of Sod. sil.} \cdot (1 \text{ mole})}{100 \cdot (\text{M.W. of SiO}_2) \cdot (\text{M.W. of Si})} \\
 &= 69 \cdot (28.5/100) \cdot (1/60.0843) \\
 &= 0.3273
 \end{aligned}$$

Si/Al atomic ratio = 50

$$\begin{aligned}
 \text{mole of AlCl}_3 \text{ required} &= 0.3273/50 = 6.5458 \cdot 10^{-3} \text{ mole} \\
 \text{amount of AlCl}_3 &= 6.5458 \cdot 10^{-3} \cdot 133.34 (100/97) \\
 &= 0.8998 \text{ g}
 \end{aligned}$$

This is the amount of AlCl₃ used in A1 and A2 solutions

A-2 Calculation of Copper Ion-exchanged ZSM-5 and Metallosilicate

Determine the amount of Cu into catalyst = 2 wt. %

the catalyst use = x g

So that : from the equation

$$\text{Cu}/(\text{x}+\text{Cu}) = 2/100$$

$$100 \cdot \text{Cu} = 2 \cdot (\text{x}+\text{Cu})$$

$$(100-2) \cdot \text{Cu} = 2 \cdot \text{x}$$

thus $\text{Cu} = 2 \cdot \text{x} / (100-0.2) \text{ g}$

use $\text{Cu}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$ for copper source

$$\text{weight of } \text{Cu}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O} = (199.65/63.55) \cdot (100/99) \cdot (2 \cdot \text{x}) / (100-2)$$

A-3 Calculation of Reaction Flow Rate

The catalyst used = 0.50 g

packed catalyst into quartz reactor (diameter = 0.6 cm)

determine the average high of catalyst bed = x cm

So that, volume of catalyst bed = $\pi \cdot (0.3)^2 \cdot \text{x}$ ml-catalyst

used GHSV (Gas Hourly Space Velocity) = $4,000 \text{ h}^{-1}$

$$\text{GHSV} = \frac{\text{Volumetric flow rate}}{\text{Volume of Catalyst}} = 4,000 \text{ h}^{-1}$$

$$\begin{aligned}
 \text{Volumetric flow rate} &= 4,000 \cdot \text{Volume of catalyst} \\
 &= 4,000 \cdot \pi (0.3)^2 \cdot x \text{ ml/h} \\
 &= 4,000 \cdot \pi (0.3)^2 \cdot x / 60 \text{ ml/ min}
 \end{aligned}$$

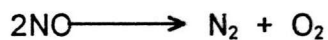
$$\text{at STP : Volumetric flow rate} = \frac{\text{Volume flow rate} \cdot (273.15+t)}{273.15}$$

where : t = room temperature, °C

A-4 Calculation of NO and C₃H₈ conversion

The effluent gas was analyzed by gas chromatography.

-The NO reduction was evaluated in terms of the conversion of NO into N₂.



$$\text{NO Conversion (\%)} = (2[\text{N}_2]_{\text{out}} / [\text{NO}]_{\text{in}}) \times 100$$

$$[\text{NO}]_{\text{in}} = 1000 \text{ ppm}$$

[N₂]_{out} : analyzed by gas chromatography

From calibration curve (Figure A1)

$$\text{Area} = \text{area of N}_2 \text{ peak on GC 8APT}$$

$$\text{Area} \times 10^6 = 0.0276 \times \text{conc. of N}_2 \text{ (\%)}$$

$$\text{Area} = 2.76 \times 10^4 \times \text{conc. of N}_2 \text{ (\%)}$$

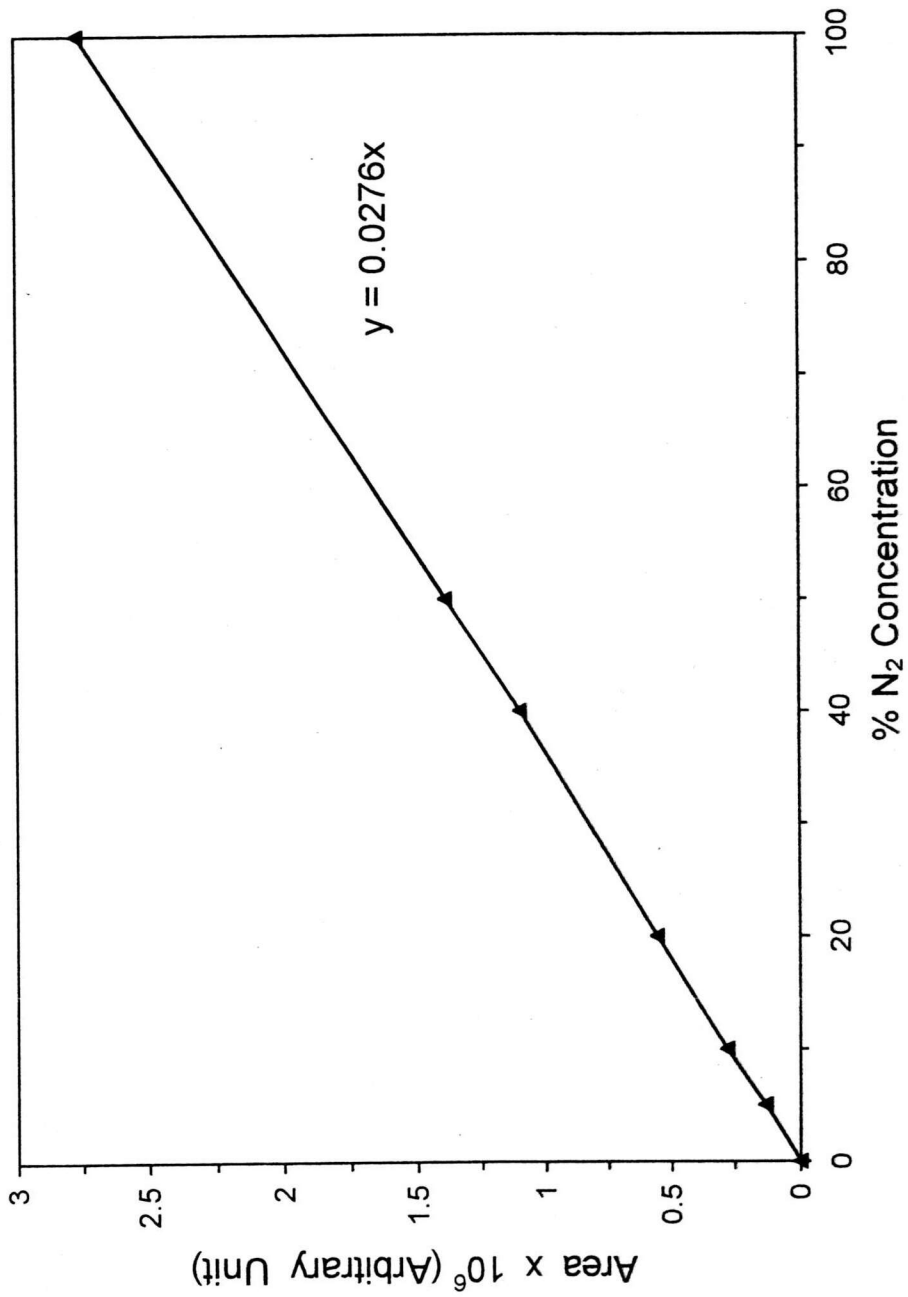


Figure A1 Calibration Curve of N₂ on GC-8APT

$$\text{Area} = 2.76 \times \text{conc of N}_2 \text{ (ppm)} ; (1 \% = 10000 \text{ ppm})$$

$$\text{Thus, } [\text{N}_2] = \text{Area} / 2.76$$

- C₃H₈ oxidation was evaluated in terms of the conversion of C₃H₈ into CO and CO₂

$$\text{C}_3\text{H}_8 \text{ Conversion (\%)} = \frac{([\text{C}_3\text{H}_8]_{\text{in}} - [\text{C}_3\text{H}_8]_{\text{out}}) \times 100}{[\text{C}_3\text{H}_8]_{\text{in}}}$$

[C₃H₈]_{in} = conc. of C₃H₈ in reactant gas
(evaluated by areas of C₃H₈ on GC 8AIT)

[C₃H₈]_{out} = conc. of C₃H₈ in product gas
(evaluated by areas of C₃H₈ on GC 8AIT)

APPENDIX B

PHYSICAL AND CHEMICAL PROPERTIES OF NITRIC OXIDE

| Property | Value |
|----------------------------------|--------------------------------------|
| mol. wt. | 30.1 |
| m.p., °C | -161 |
| b.p., °C | 151.18 |
| heat of fusion, kcal/mole | 0.550 |
| heat of vaporization, kcal/mole | 3.293 |
| heat of formation, kcal/mole | 21.50 |
| density [0 °C, 1 atm], g/L | 1.2536 |
| sp. gr. [0 °C, 1 atm], (air = 1) | 1.269 |
| critical temperature, °C | 1.018 |
| critical pressure, atm | 64 |
| color | colorless gas, blue liquid and solid |

APPENDIX C

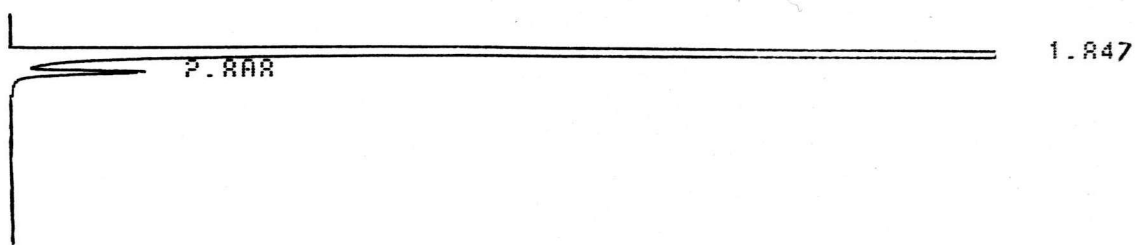
AMBIENT AIR QUALITY STANDARD OF THAILAND (1981)

| Pollutants | average value (mg/m ³) | | | | methods of measurement |
|---|------------------------------------|-----|------|--------|-----------------------------------|
| | 1 h | 8 h | 24 h | 1 year | |
| Carbon Monoxide (CO) | 50 | 20 | - | - | Non Dispersive Infrared Detection |
| Nitrogen Dioxide (NO ₂) | 0.32 | - | - | - | Gas Phase Chemiluminescence |
| Sulfur Dioxide (SO ₂) | - | - | 0.3 | 1* | Pararosanniline |
| Suspended Particulate Matter (SPM) | - | - | 0.33 | 0.1* | Gravimetric |
| Photochemical Oxidant (O ₃) | 0.20 | - | - | - | Chemiluminescence |
| Lead (Pb) | | - | - | 0.01 | Wet Ashing |

Note : * = Geometric mean

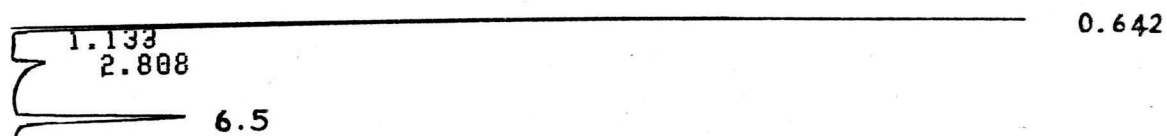
APPENDIX D

SAMPLE OF CHROMATOGRAMS



COLUMN MS-5A

| PKNO | TIME | AREA | CONC | NAME |
|------|-------|--------|---------|----------------|
| 1 | 1.847 | 233466 | 99.4342 | O ₂ |
| 2 | 2.808 | 1329 | 0.5658 | N ₂ |



COLUMN PORAPAK-Q

| PKNO | TIME | AREA | CONC | NAME |
|------|-------|-------|---------|-------------------------------|
| 1 | 0.642 | 69558 | 93.2220 | AIR |
| 2 | 2.808 | 977 | 1.3095 | H ₂ O |
| 3 | 6.500 | 4080 | 5.4684 | C ₃ H ₈ |

VITA

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