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APPENDIX A

VAPOR PRESSURE OF ETHANOL

The partial vapor pressure of the ethanol to the requirement was set by adjusting the temperature of saturator following Antoine equation [24];

$$\ln P = A - \frac{B}{(t+C)}$$

When P = vapor pressure of reactant, mm Hg

t = temperature, °C

A, B and C are constants shown in Table A-1

Table A-2 reports the calculation results for the range of temperature of 50-57°C. It was found that temperature around 51°C would provide ca. 30% ethanol by stream volume.

Table A-1 The values of constants.

Constant	Value of constant
A	8.32
B	1718.10
C	237.52

Table A-2 The value % mole of ethanol.

% ethanol	Temperature(°C)
29.15	50
30.57	51
32.06	52
36.88	55
40.43	57

APPENDIX B

CALCULATION OF CATALYST PREPARATION

The example of calculation shown below is for 2wt%Pd/ y wt% La_2O_3/SiO_2 catalyst. The silica support weight used for all preparation was 2.0 g.

Based on catalyst 100 g, in order to prepare 2wt%Pd/ y wt% La_2O_3/SiO_2, the catalyst is composed of

Palladium	2	g
Lanthana	y	g
Silica support	98-y	g

The palladium compound used is Palladium (II) Chloride ($PdCl_2$), which has a molecular weight of 177.0, and the molecular weight of palladium is 106.4.

The lanthana (La_2O_3) used is Lanthanum nitrate hydrate, which has a molecular weight of 443.0, and the molecular weight of Lanthanum (La) is 138.9.

The calculation of the amount of each ingredient for required composition of the 2wt%Pd/ywt%La_2O_3/SiO_2 catalyst is shown as follows:

For 2.0 g of silica support used:

1. Lanthana amount

In 100 g of 2wt%Pd/ywt%La_2O_3/SiO_2 catalyst has lanthana = y g

In 100 g of 2wt%Pd/ywt%La_2O_3/SiO_2 catalyst has silica = 100-y g

Therefore, for 2.0 g of silica, lanthana required $= \frac{2\,y}{(100-y)}$ g

Lanthana (La_2O_3) 325.91 g has lanthanum (La) = 277.82 g

Lanthanum nitrate hydrate ($La(NO_3)$-$6H_2O$) 433.01 g has lanthanum= 38.91 g

Lanthana 2 y /(100-y) g required Lanthanum nitrate hydrate

$= (433.10/138.91)\times(277.82/325.91)\times(2\,y/(100-y))$ g

$= 5.3161 \times y/(100-y)$ g

Therefore, required Lanthanum nitrate hydrate for 2.0 g of silica

$= 0.1063 \times y/(100- y)$ g

2. Palladium amount

In 100 g of 2wt%Pd/ywt%La_2O_3/SiO_2 catalyst has Palladium = 2 g

In 100 grams of 2wt%Pd/ywt%La_2O_3/SiO_2 catalyst
has ywt%La_2O_3/SiO_2 = 98 g

If used ywt%La_2O_3/SiO_2 2 g required palladium = 0.0408 g

Palladium (II) Chloride ($PdCl_2$) 177 g has Palladium (Pd) = 106.40 g

Palladium 0.0408 g requires palladium (II) Chloride = 0.0678 g

If used ywt%La_2O_3/SiO_2 2 g requires palladium (II) Chloride = 0.0678 g

APPENDIX C

CALCULATION OF CRYSTALLITE DIAMETER

The mean metal crystallite diameter of the catalyst (D), can be calculated from the following equation:

$$D = \frac{k\lambda}{\beta\cos\theta}$$

where

$$\beta = \sqrt{B^2 - b^2}$$

where

k = shape factor, related to crystallite shape (take as 0.9)

λ = X-ray wavelength, for Cu K_α = 1.5418 Å

θ = diffraction angle

β = Pure breadth of a powder diffraction

B = Breadth at half the maximum intensity of sample

b = Breadth at half the maximum intensity of metal standard

APPENDIX D
CALCULATION OF METAL ACTIVE SITES

The calculation of metal active sites of the catalyst by purity CO adsorption at room temperature has a procedure as follows:

Let the weight of catalyst used	= W	g
Height of CO peak after adsorption	= A	unit
Height of 40 μl standard CO peak	= B	unit
Amounts of CO adsorbed on catalyst	= B-A	unit
Volume of CO adsorbed on catalyst	$=[(B-A)/B]\times(40)$	μl
Volume of CO 1 mole at 30°C	$= 24.86\times10^{6}$	μl
Mole of CO adsorbed on catalyst	$= \dfrac{[(B-A)/B]\times(40)}{24.86\text{x}10^{6}}$	mole
Molecule of CO adsorbed on catalyst	$=\dfrac{[(B-A)/B](6.02\times10^{23})}{24.86\times10^{6}}$	molecules
Metal active sites	$=\dfrac{9.68\times10^{7}\times[(B-A)/B]}{W}$	site /g cat

APPENDIX E

CALIBRATION CURVE

The thermal conductivity detector, model 14B, was used to analyze the concentration of ethanol and products of the reaction by using Porapak N column while carbon dioxide for TPO technique was analyzed by GC 8AIT equipped with Porapak Q column.

The calibration curve of methane, carbon monoxide, carbon dioxide, ethylene, ethane, ethanol, acetaldehyde, hydrogen, and carbon dioxide (for TPO technique) are illustrated in the following figures.

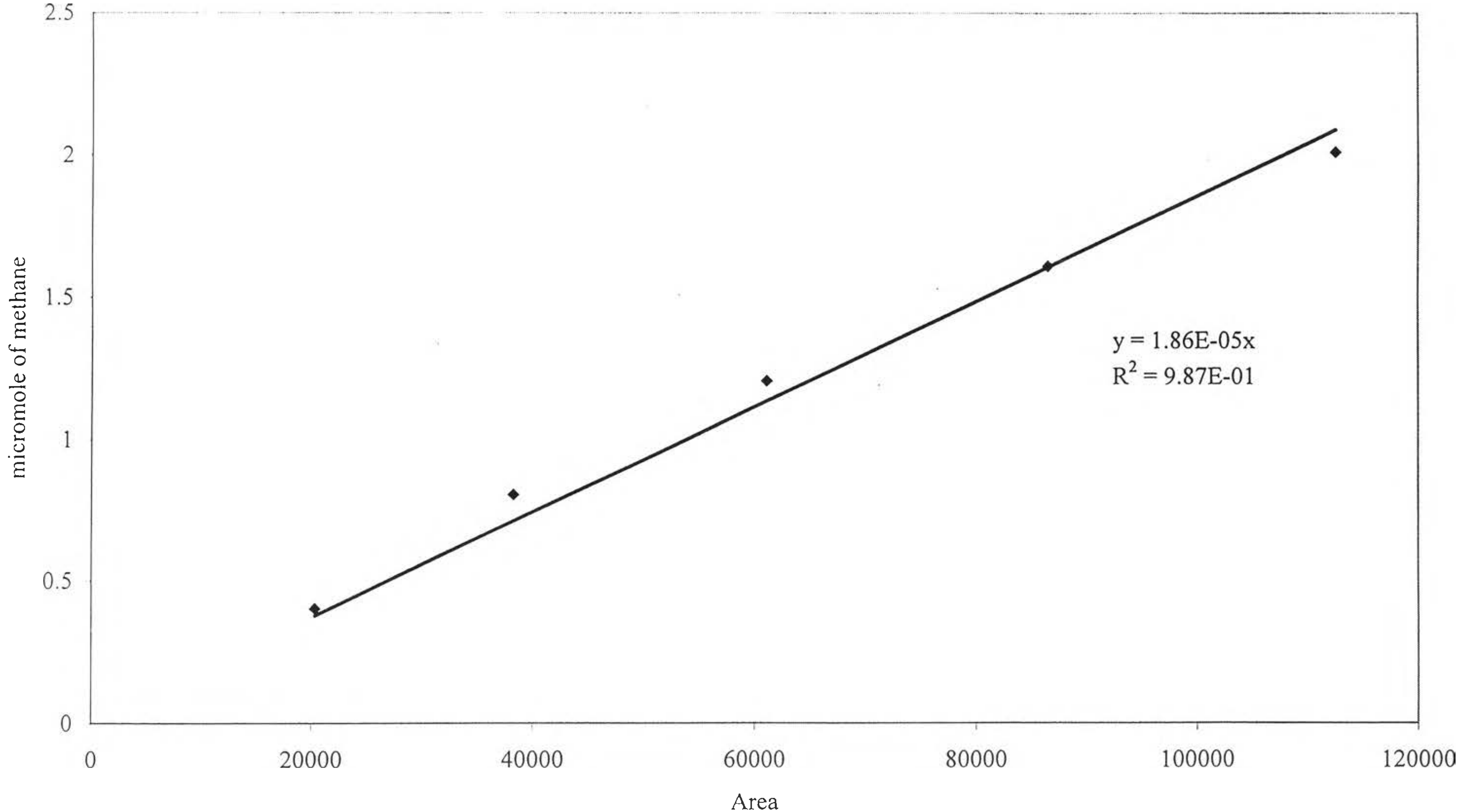

Figure E-1 The calibration curve of methane.

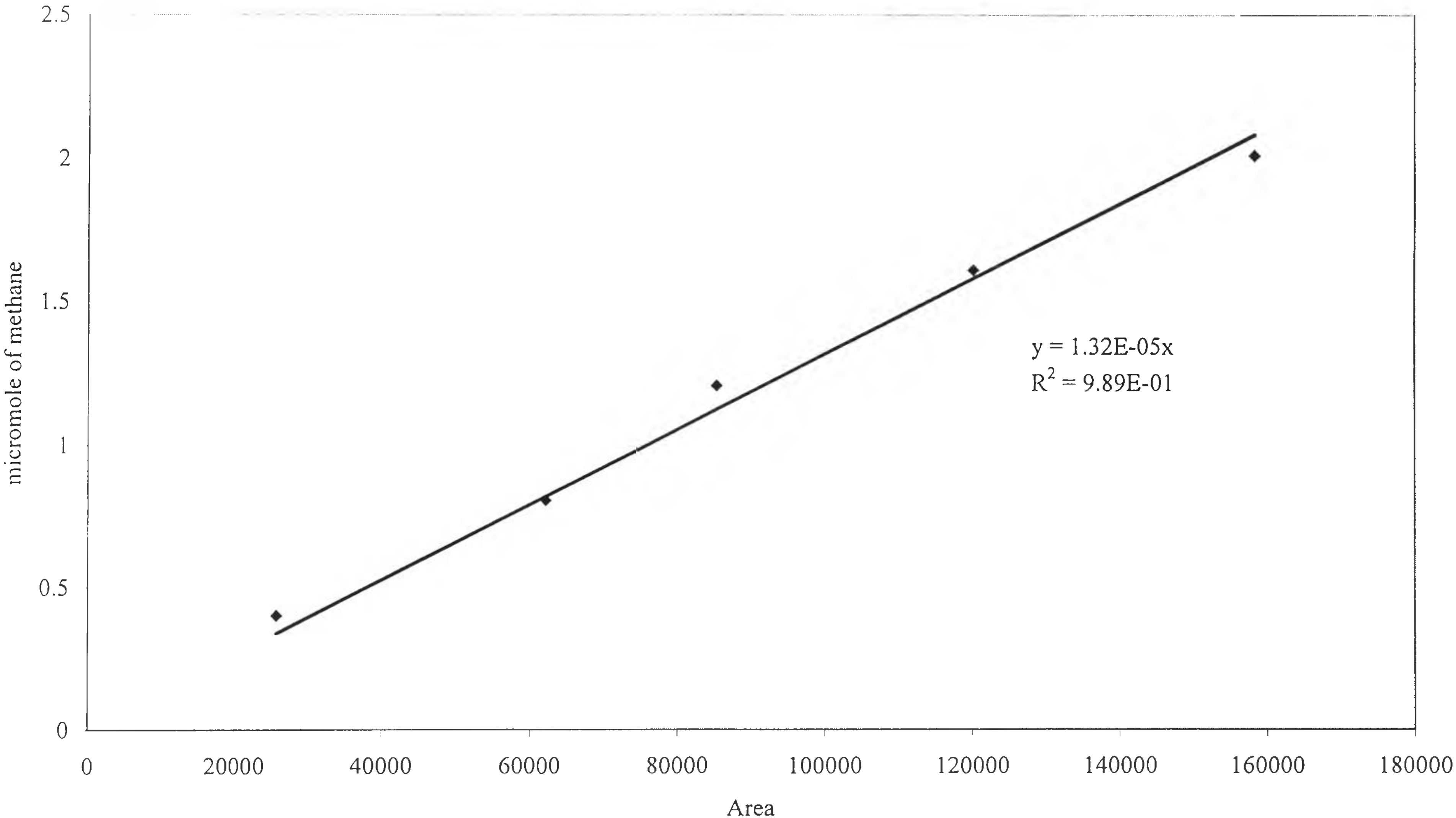

Figure E-2 The calibration curve of carbon monoxide.

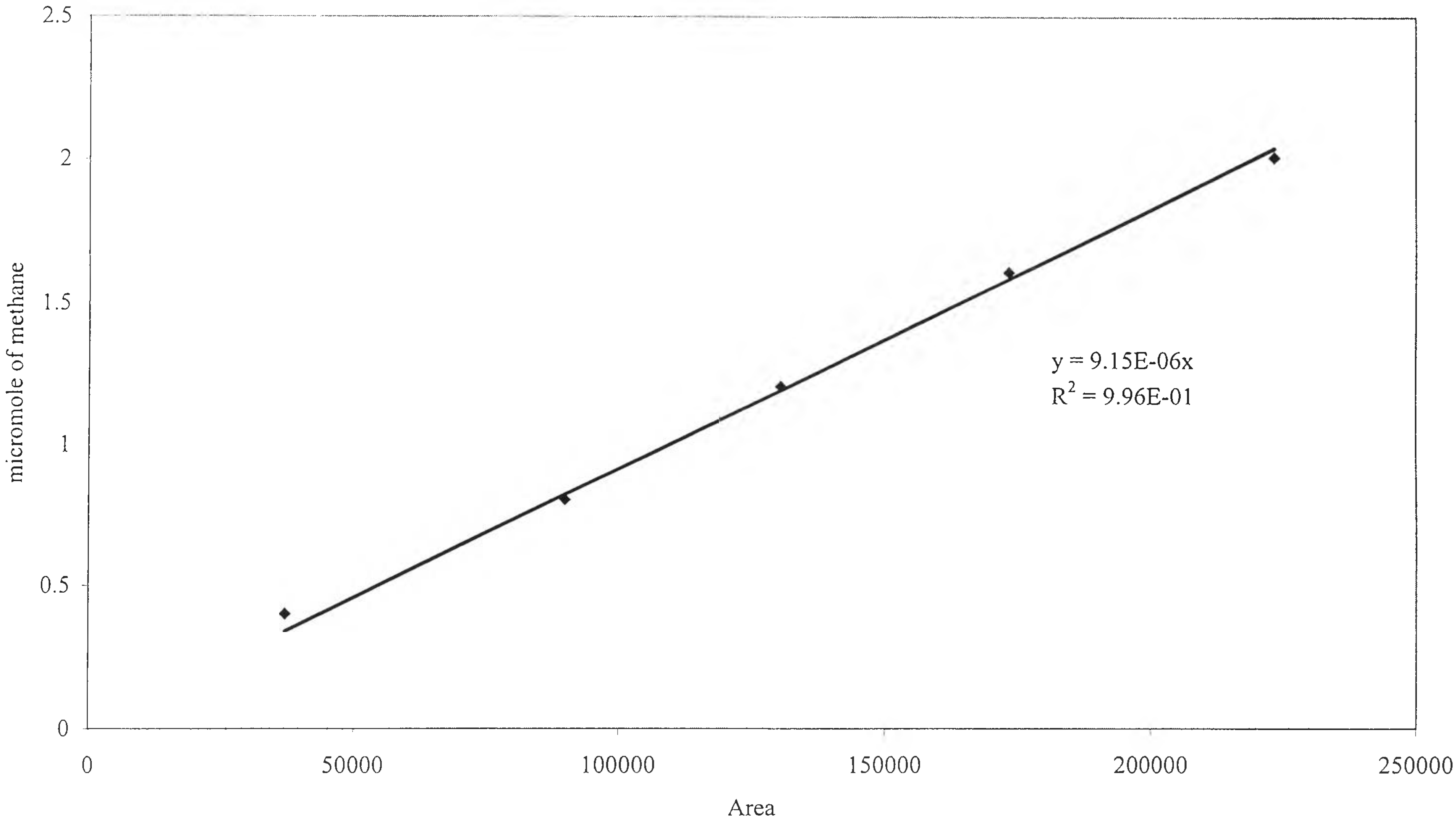

Figure E-3 The calibration curve of carbon dioxide.

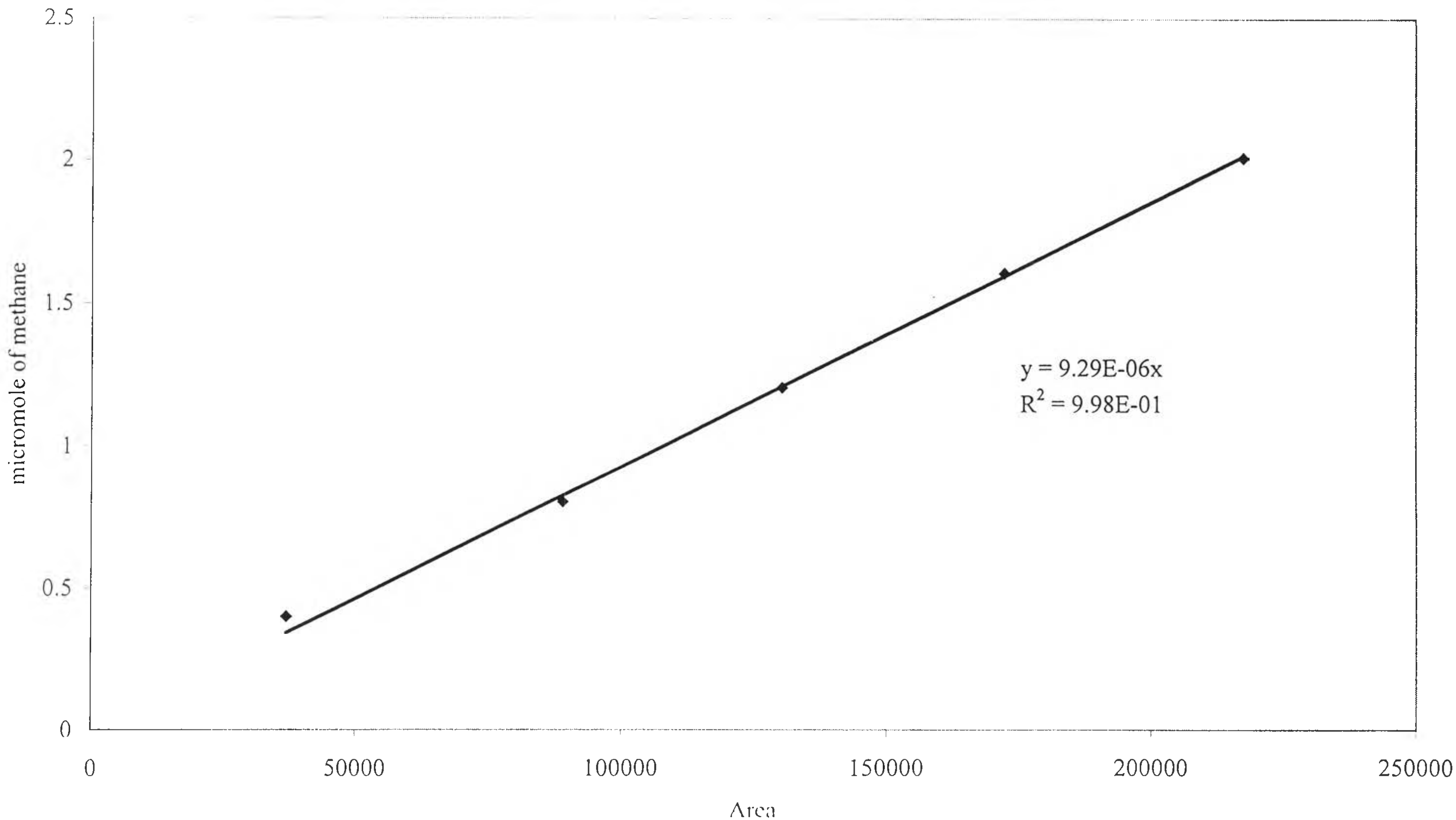

Figure E-4 The calibration curve of ethylene.

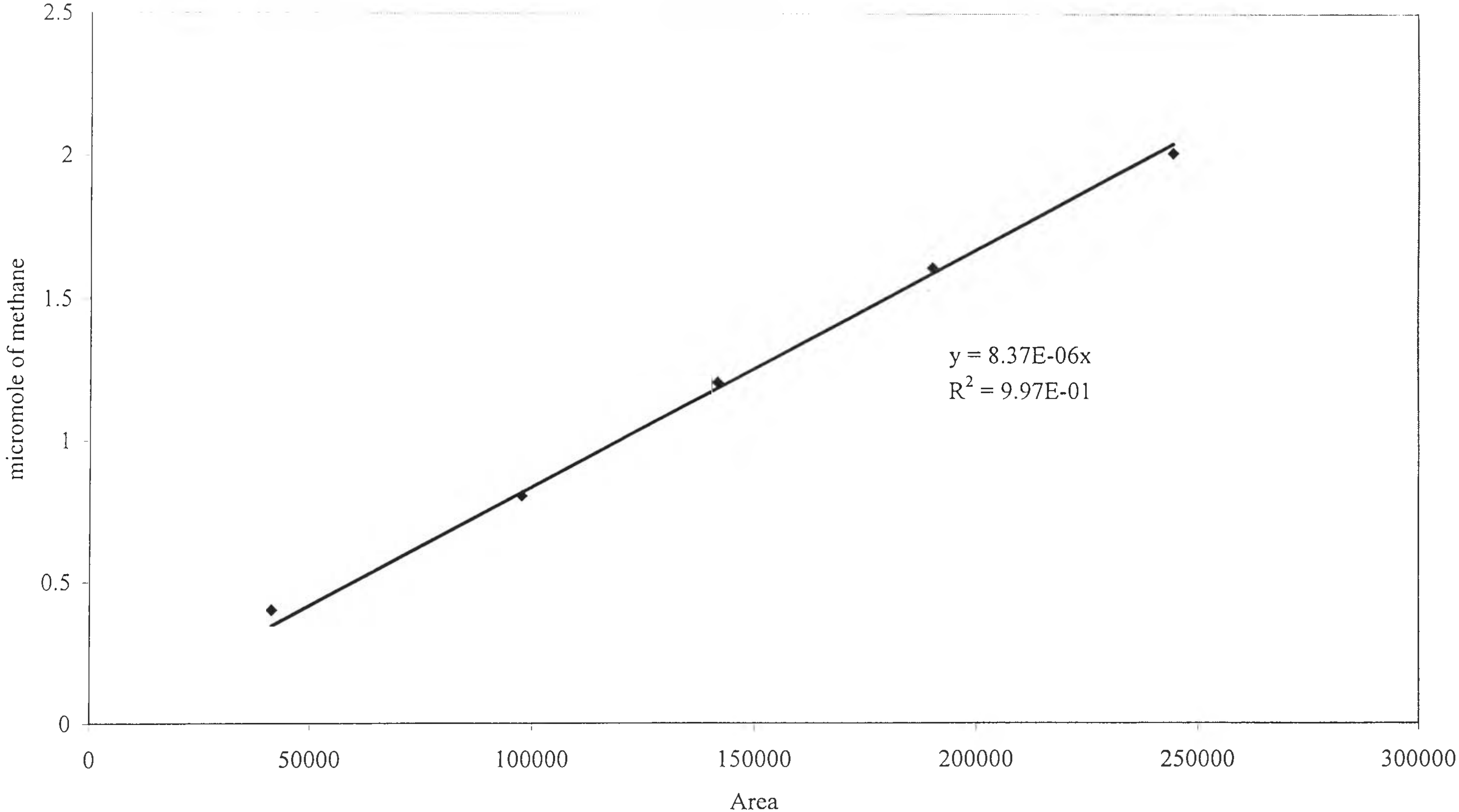

Figure E-5 The calibration curve of ethane.

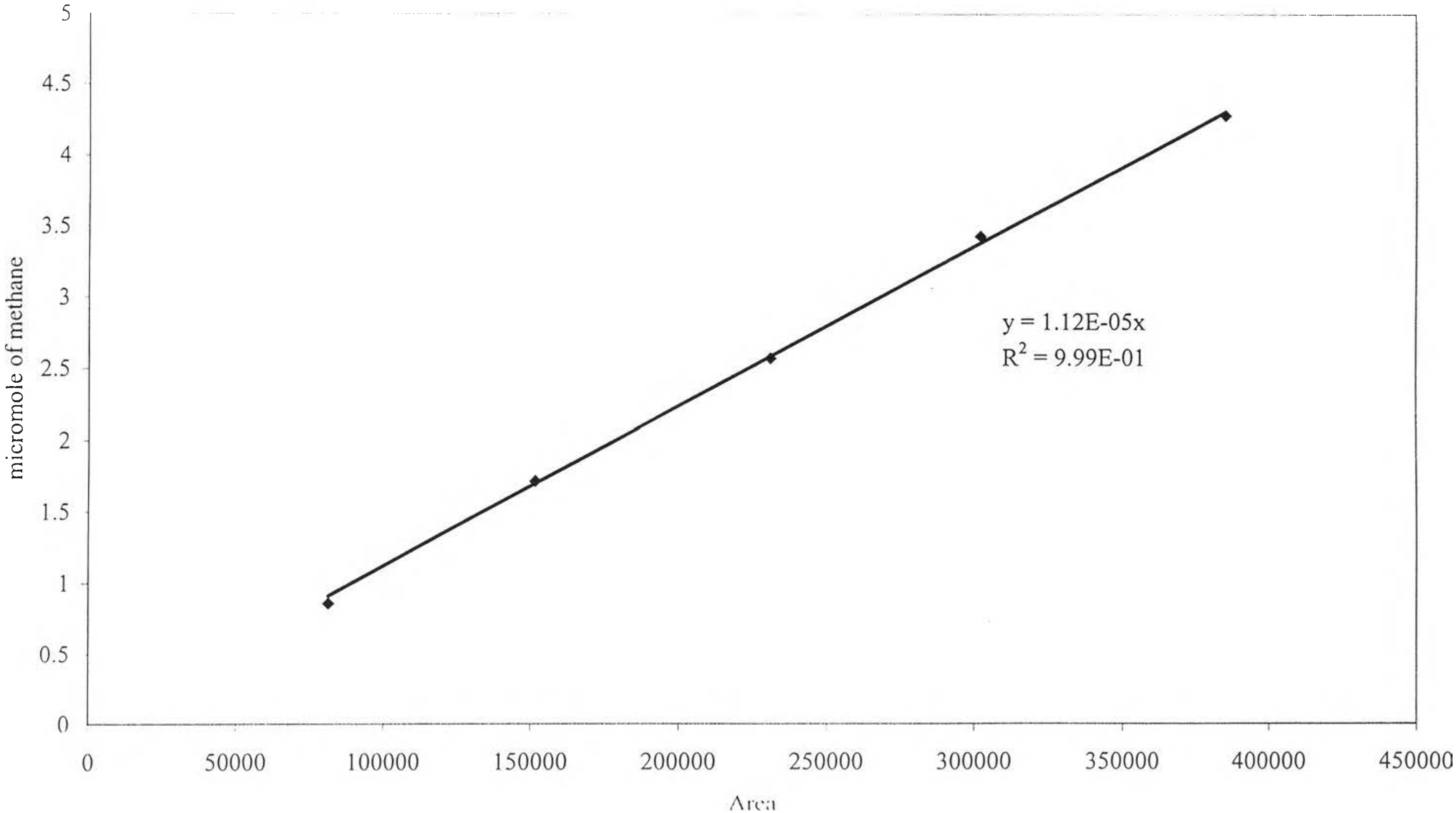

Figure E-6 The calibration curve of ethanol.

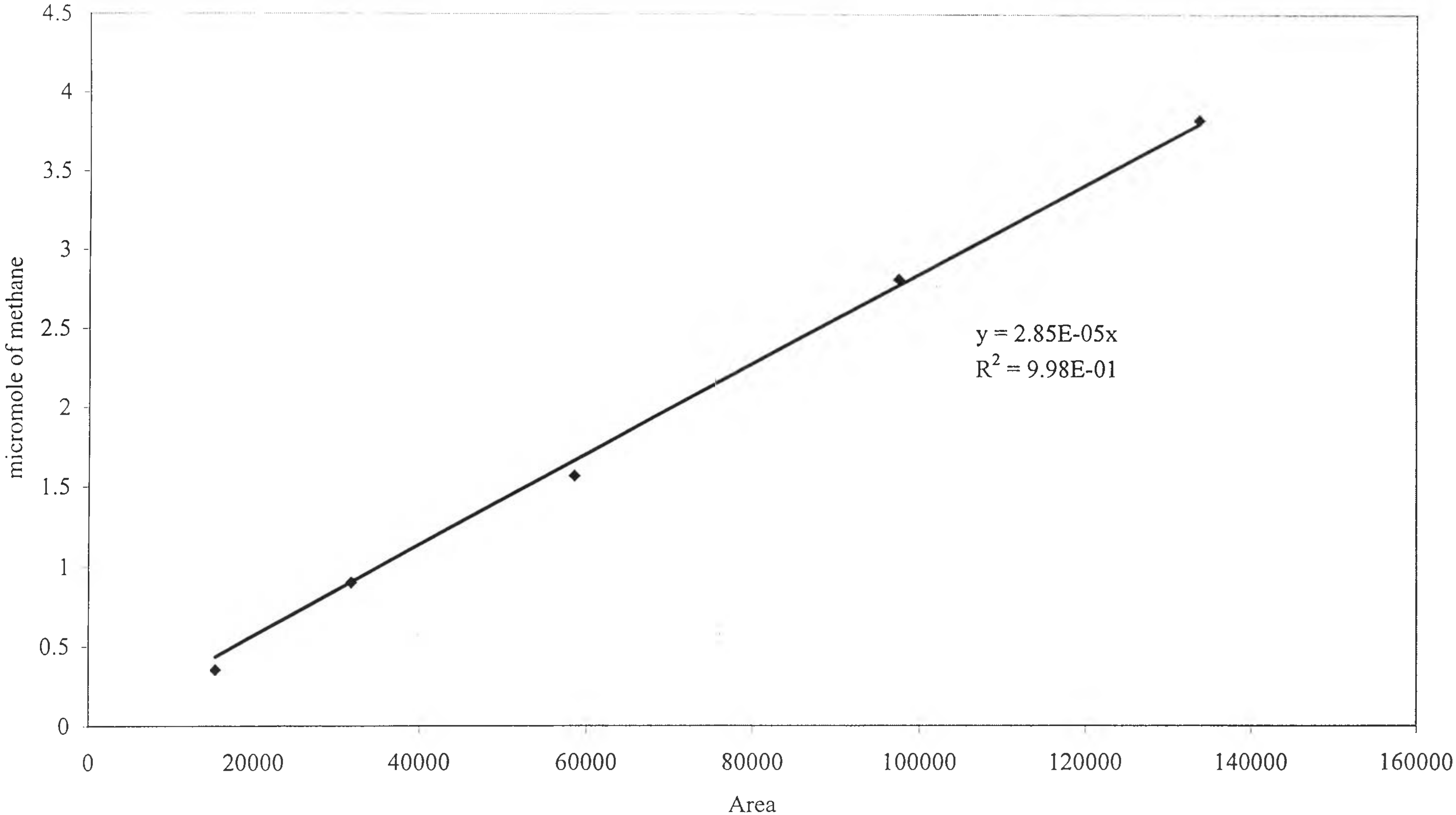

Figure E-7 The calibration curve of acetaldehyde.

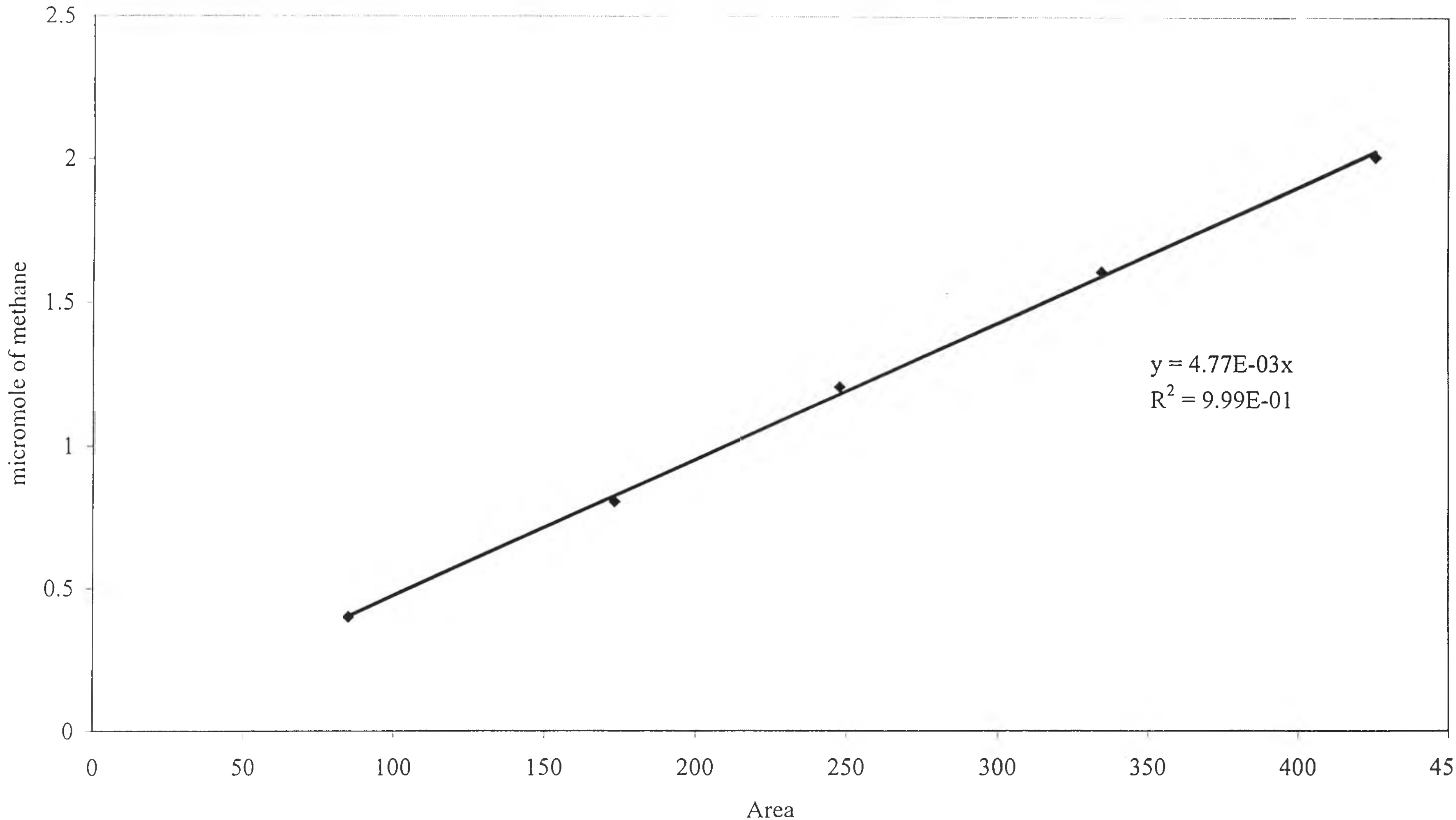

Figure E-8 The calibration curve of hydrogen.

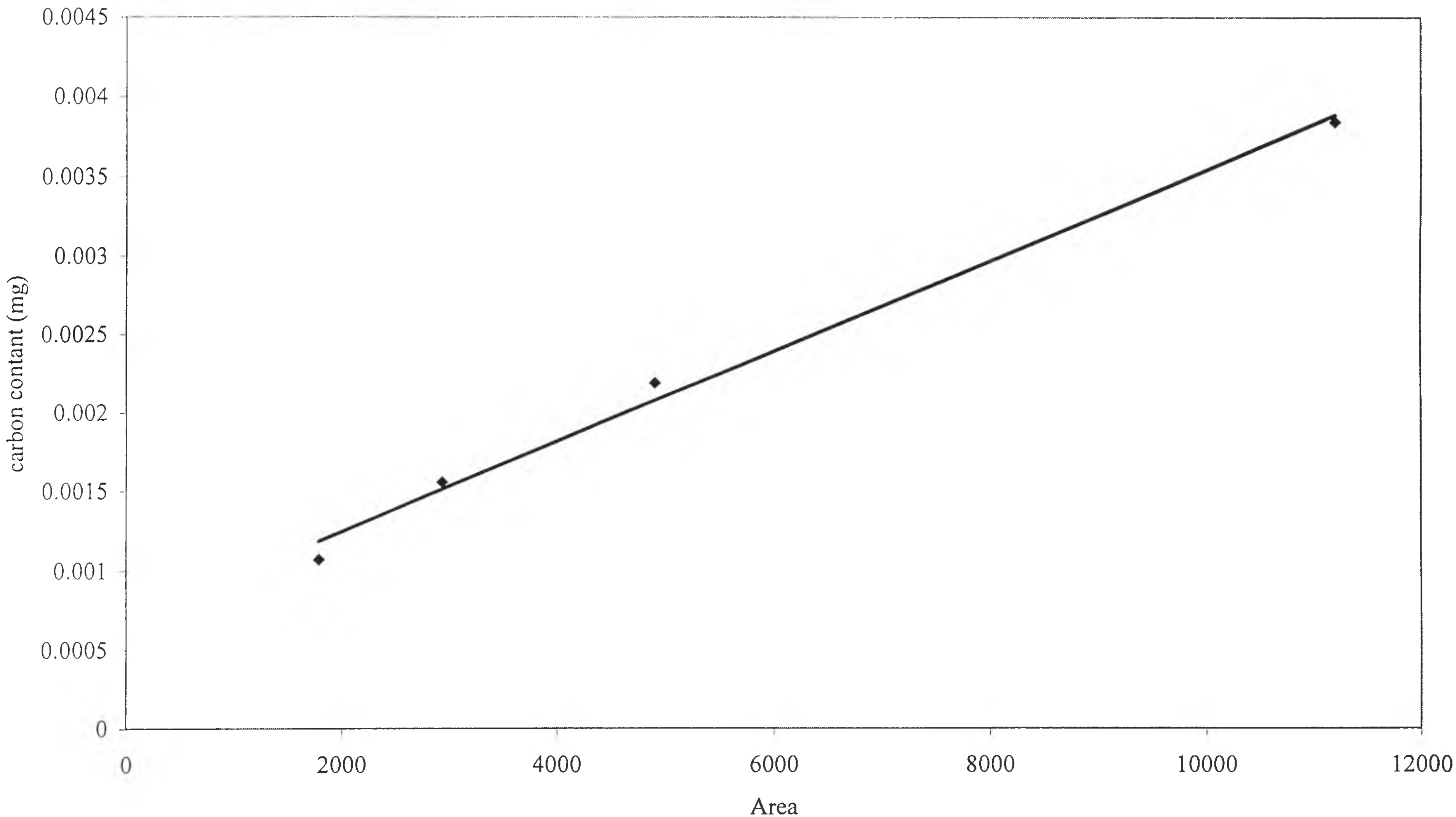

Figure E-9 The calibration curve of carbon dioxide on GC 8 AIT.

VITA

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