

## REFERENCES

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## APPENDIX A

### OPERATING CONDITION AND RESULT OF Hg INTRUSION

The average pore diameter of the monolith was measured by a Pore Sizer , micromeritic(model 9320) at Analytical Center of Chemical Engineering Department, Chulalongkorn University. Small pores and pores that can not be seen by SEM can be measured by the Hg intrusion method. The data were provided for future use which may occur. The data obtained were recorded on a micro computer.

The method was a mercury intrusion in the pores of monolith.

Operating Conditions of Pore Sizer were:

1. Equilibration time : 10 seconds
2. Maximum intrusion volume : 50.0 ml/g

Procedure:

1. Monolith sample was weighted and placed in a penetrometer.
2. The penetrometer was placed in Pore Size 9320 under vacuum to remove the air in the pores of the monolith before analysis.
3. The mercury was gradually filled in the pores by increasing pressure and the pore diameter automatically analyzed.

The samples intrusion data summary are shown below:

#### 1. Blank monolith

Total intrusion volume	= 0.2177 ml/g
Total pore area	= 18.714 sq-m/g
Median pore diameter (volume)	= 843 Å
Median pore diameter (area)	= 207 Å
Average pore diameter (4V/A)	= 465 Å

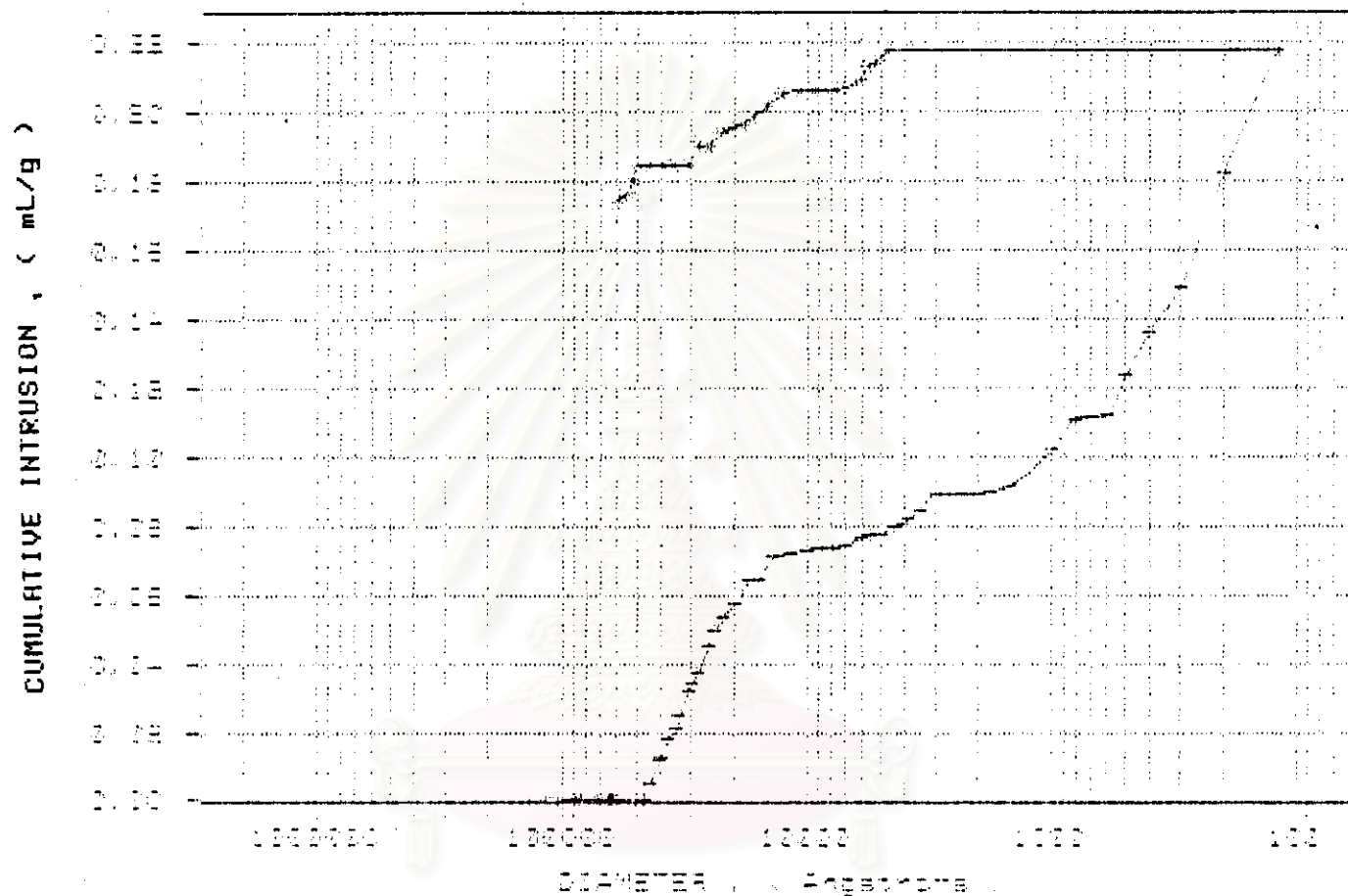


Figure A-1 Cumulative intrusion vs diameter of blank monolith

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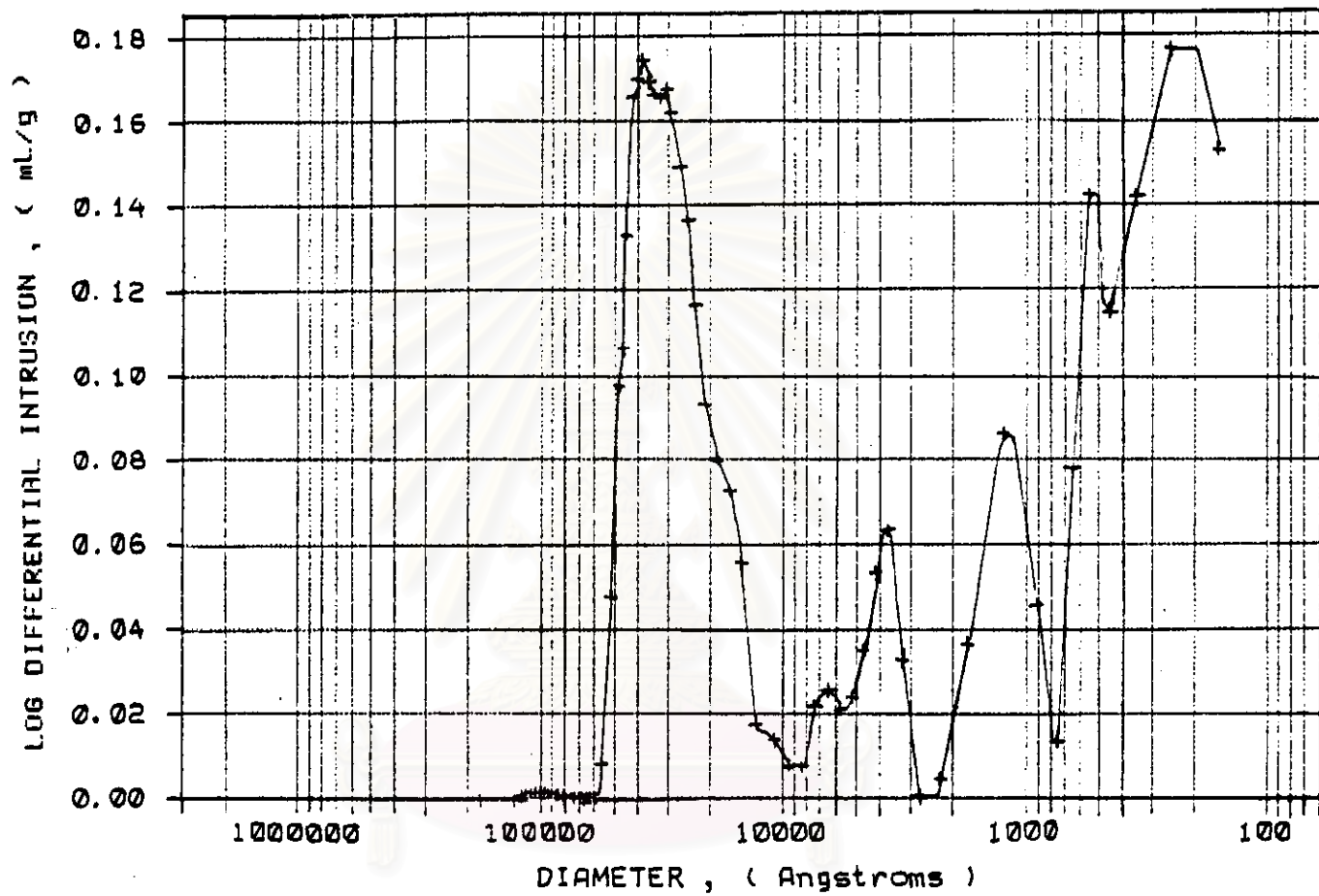


Figure A-2 Log differential intrusion vs diameter of blank monolith

2. Monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 2 min.

Total intrusion volume	= 0.2126 ml/g
Total pore area	= 20.200 sq-m/g
Median pore diameter (volume)	= 577 Å
Median pore diameter (area)	= 184 Å
Average pore diameter ( $4V/A$ )	= 421 Å

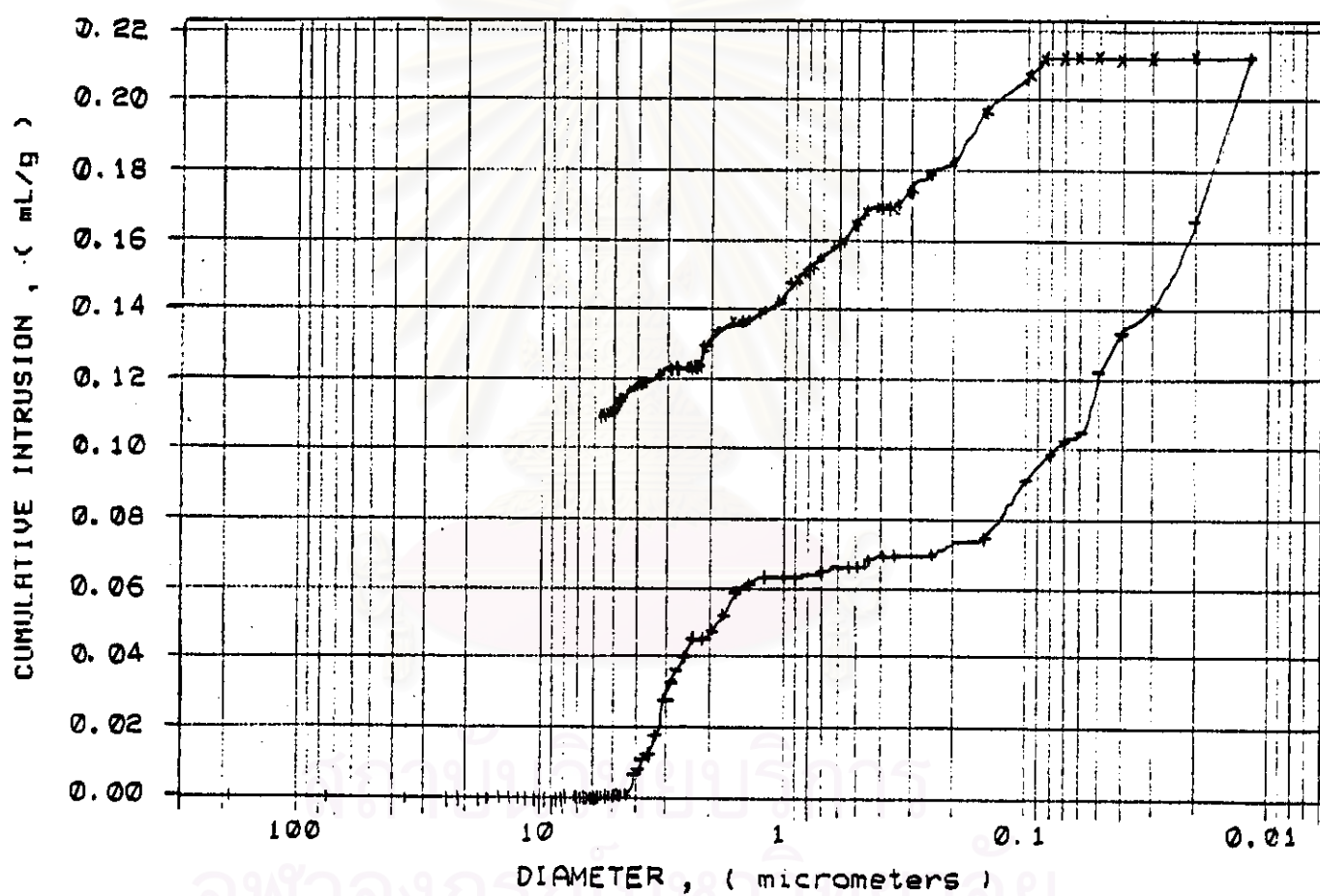


Figure A-3 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 2 min.

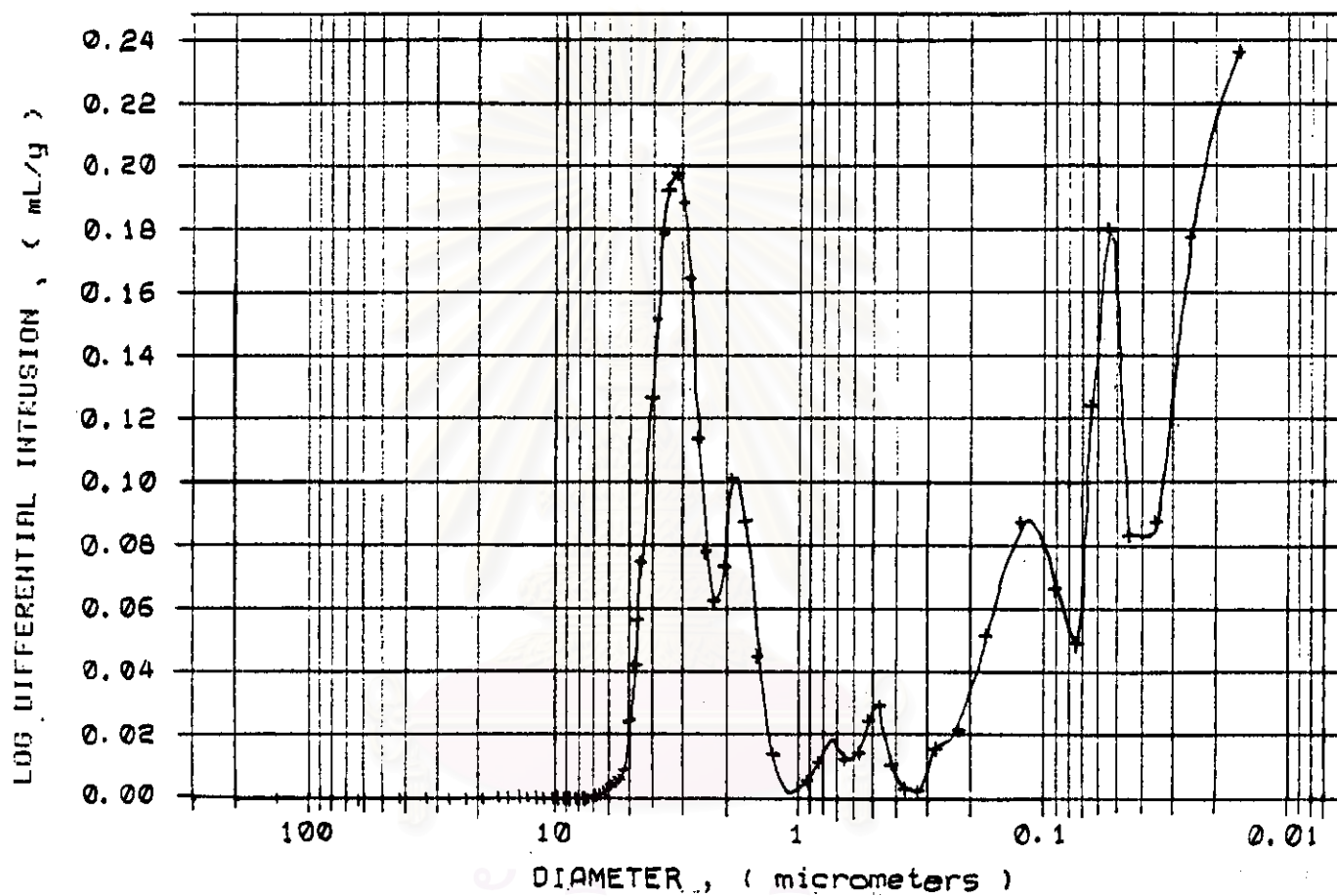


Figure A-4 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 2 min.

3. Monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 5 min.

Total intrusion volume	= 0.3405 ml/g
Total pore area	= 47.904 sq-m/g
Median pore diameter (volume)	= 287 Å
Median pore diameter (area)	= 175 Å
Average pore diameter ( $4V/A$ )	= 284 Å

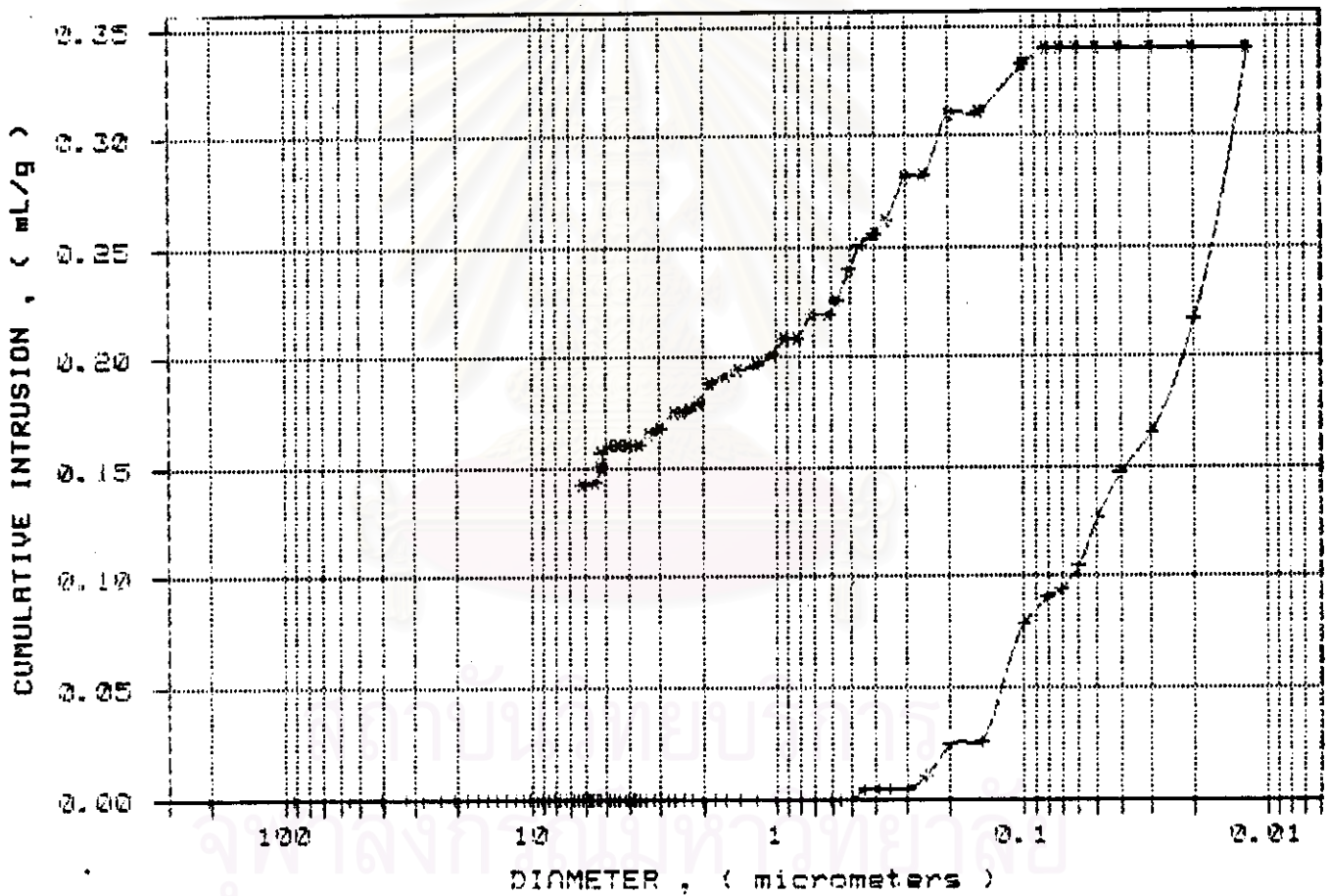


Figure A-5 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 5 min.

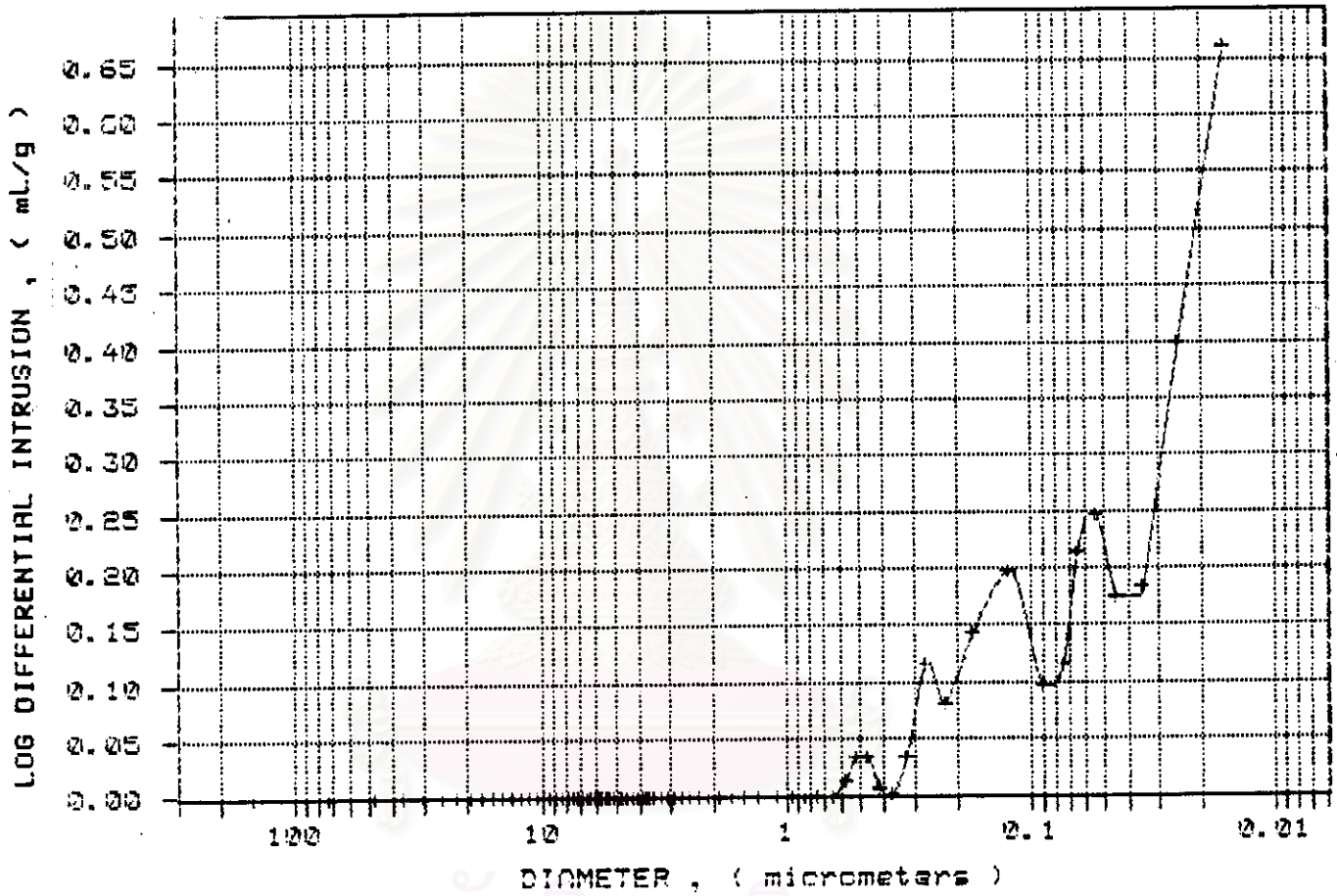


Figure A-6 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 5 min.



4. Monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 10 min

Total intrusion volume	= 0.3812 ml/g
Total pore area	= 42.145 sq-m/g
Median pore diameter (volume)	= 580 Å
Median pore diameter (area)	= 185 Å
Average pore diameter ( $4V/A$ )	= 362 Å

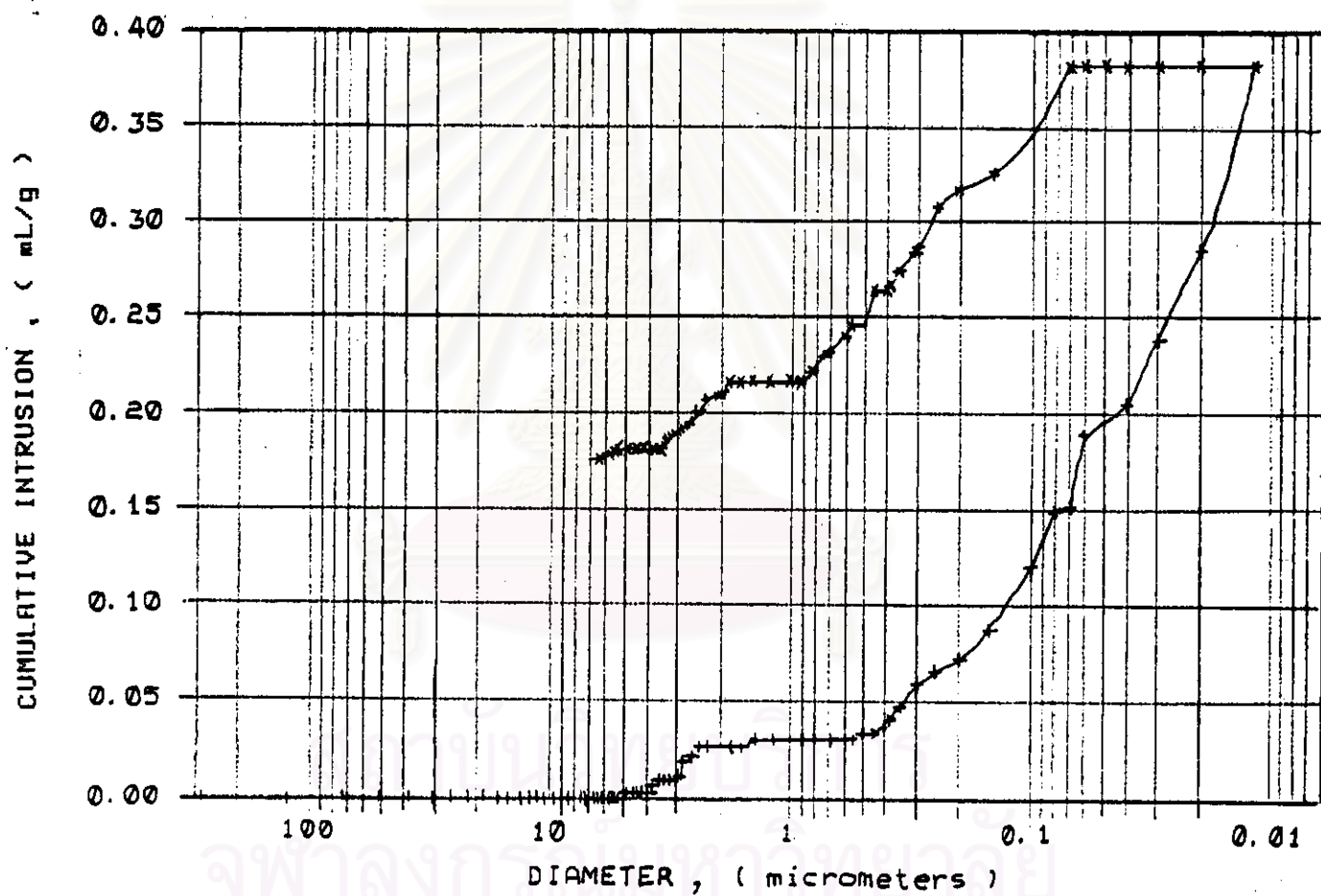


Figure A-7 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 10 min.

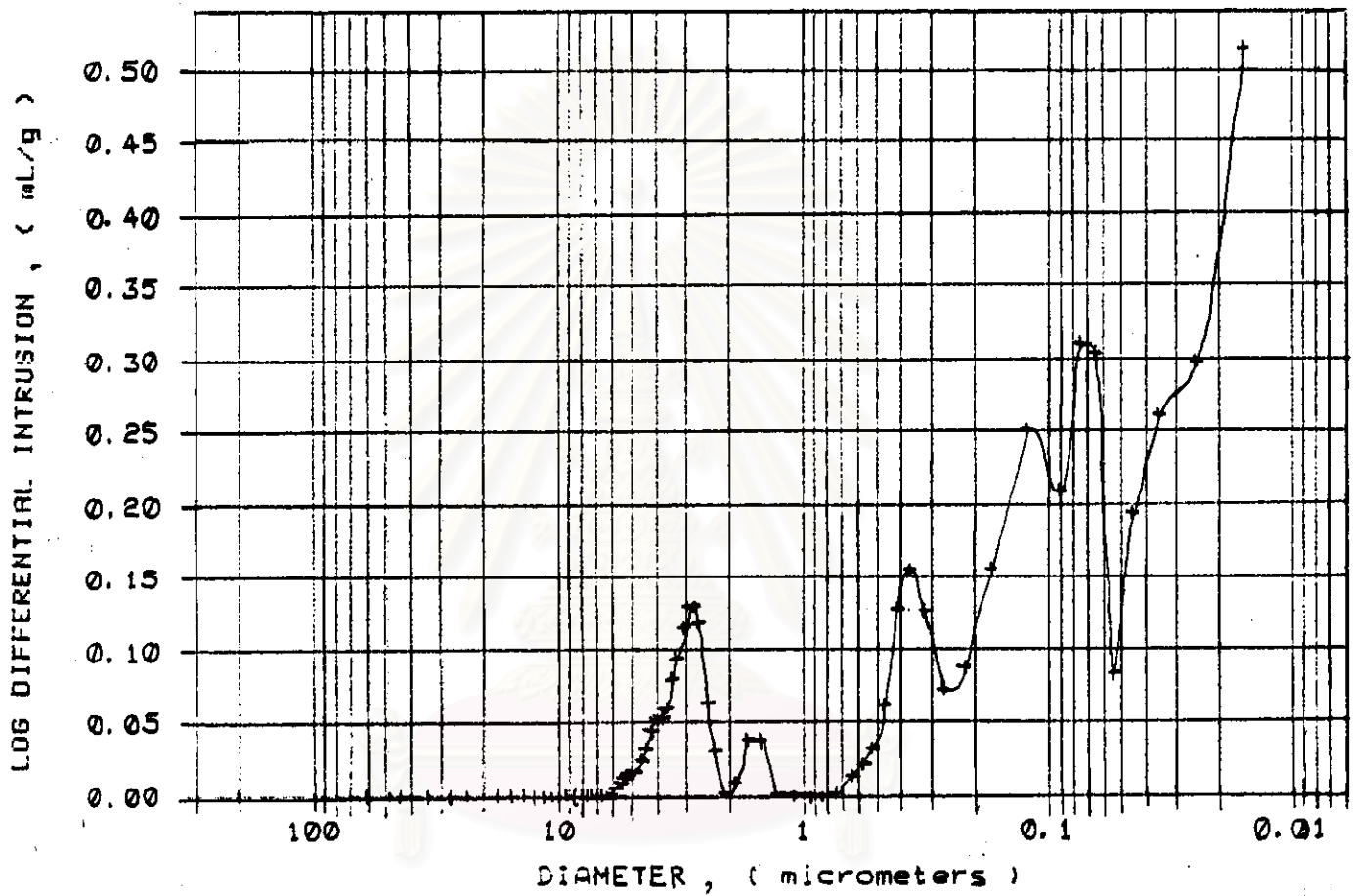


Figure A-8 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of HNO<sub>3</sub> for 10 min.

5. Monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 30 min

Total intrusion volume	= 0.4329 ml/g
Total pore area	= 58.474 sq-m/g
Median pore diameter (volume)	= 348 Å
Median pore diameter (area)	= 173 Å
Average pore diameter (4V/A)	= 296 Å

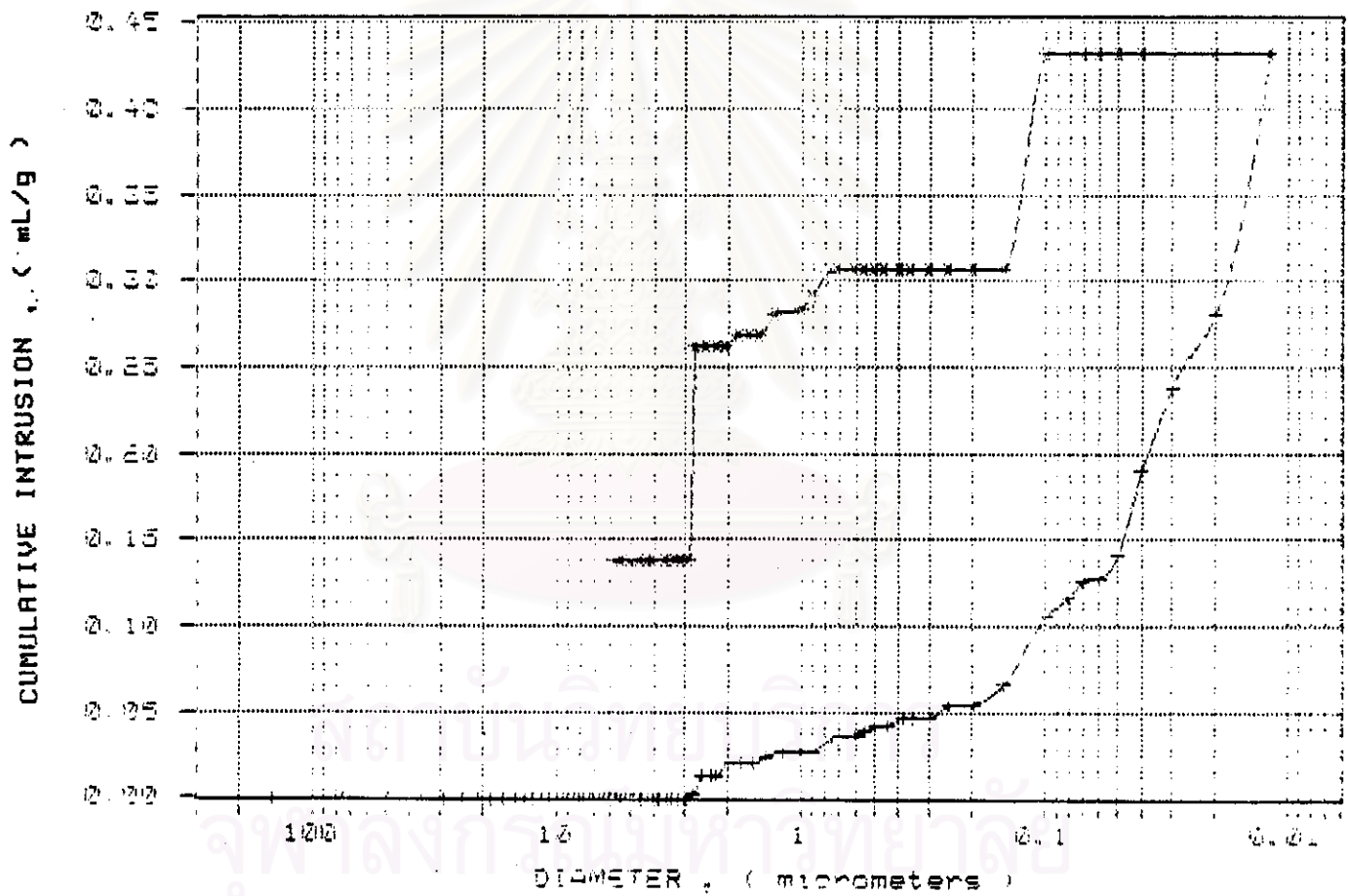


Figure A-9 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 30 min.

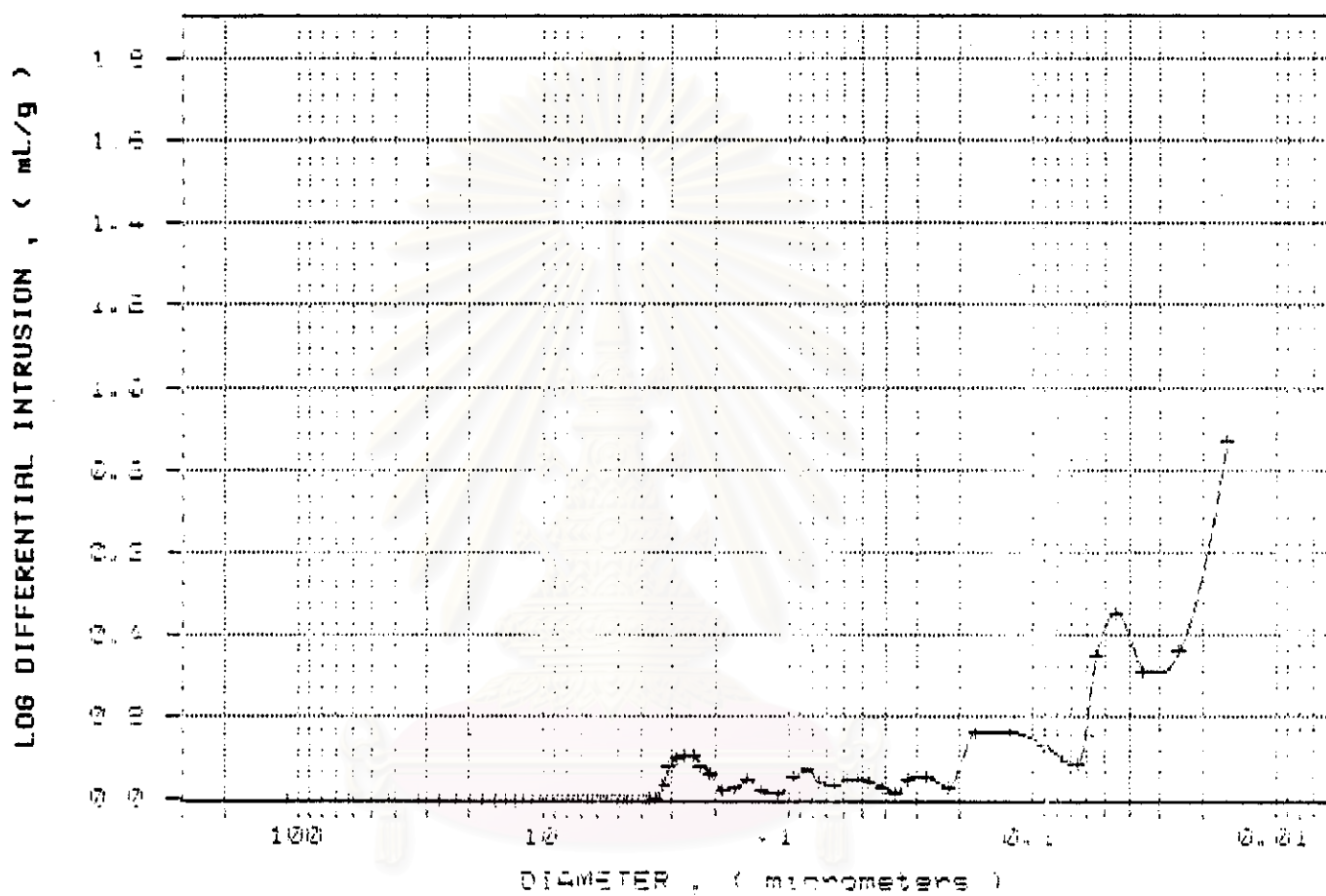


Figure A-10 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 30 min.

6. Monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 1 hr.

Total intrusion volume	= 1.6634 ml/g
Total pore area	= 59.462 sq-m/g
Median pore diameter (volume)	= 26.9008 Å
Median pore diameter (area)	= 187 Å
Average pore diameter (4V/A)	= 1119 Å

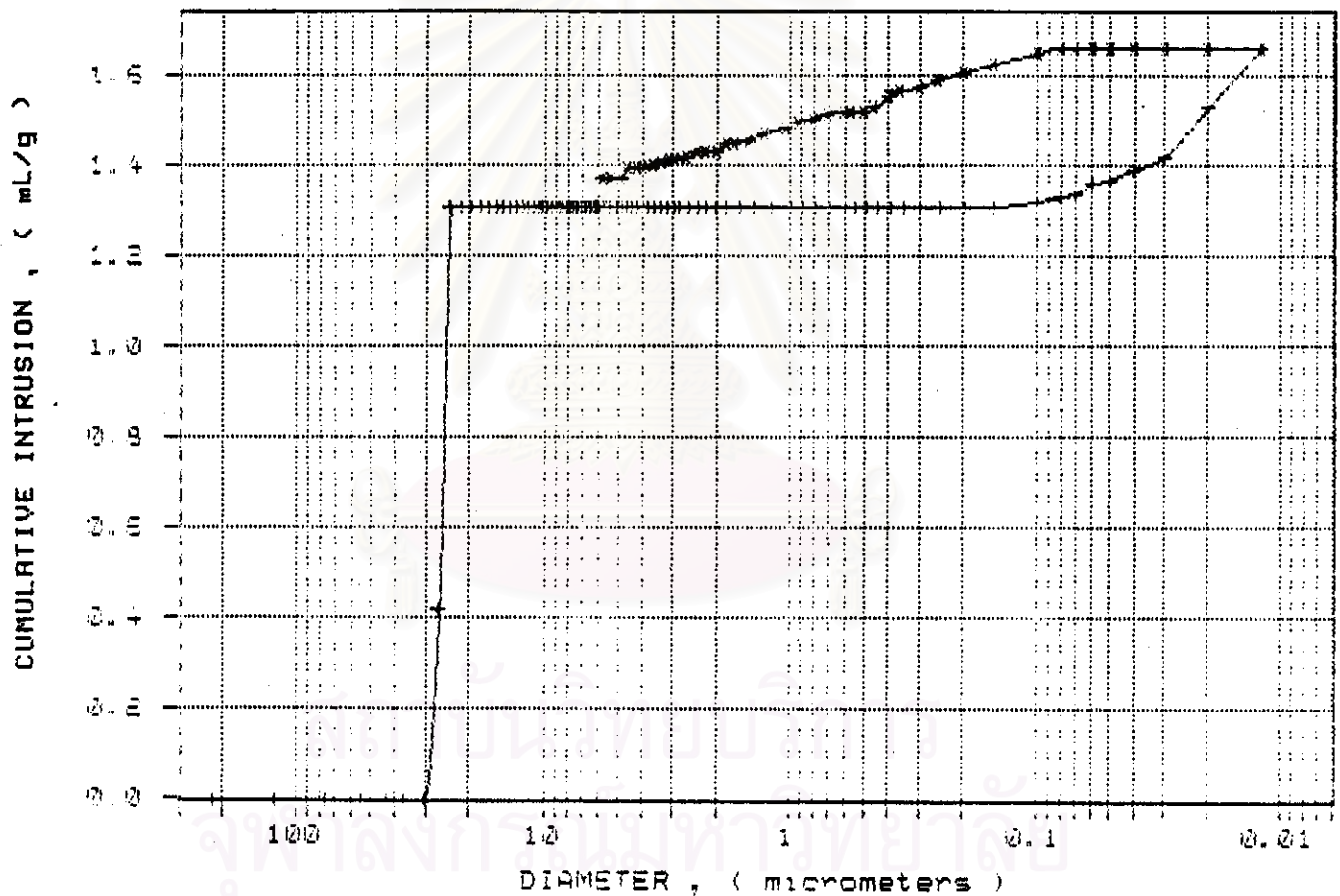


Figure A-11 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 1 hr.

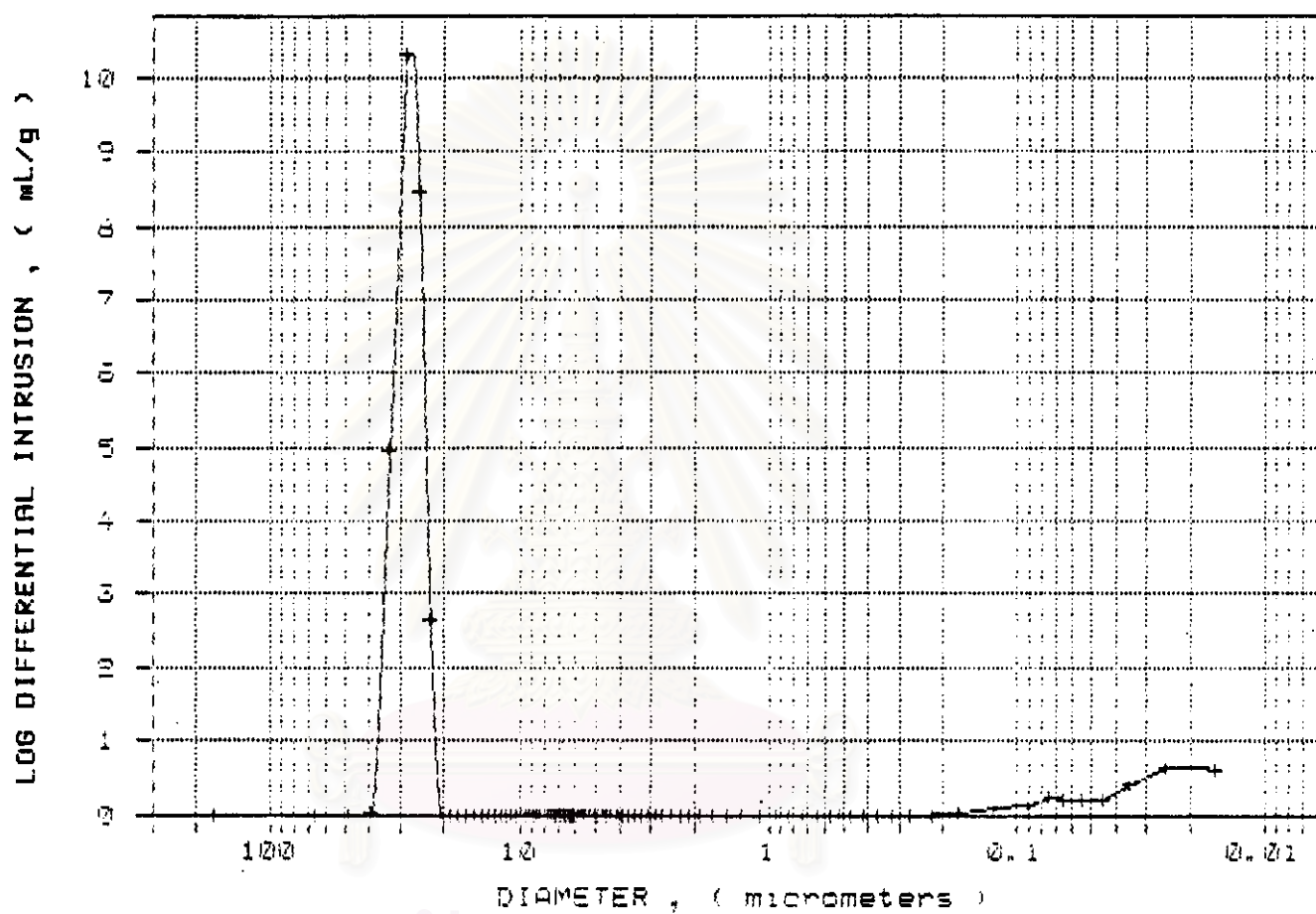


Figure A-12 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 1 hr.

7. Monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 2 hr.

Total intrusion volume	= 0.2823 ml/g
Total pore area	= 39.603 sq-m/g
Median pore diameter (volume)	= 333 Å
Median pore diameter (area)	= 174 Å
Average pore diameter ( $4V/A$ )	= 285 Å

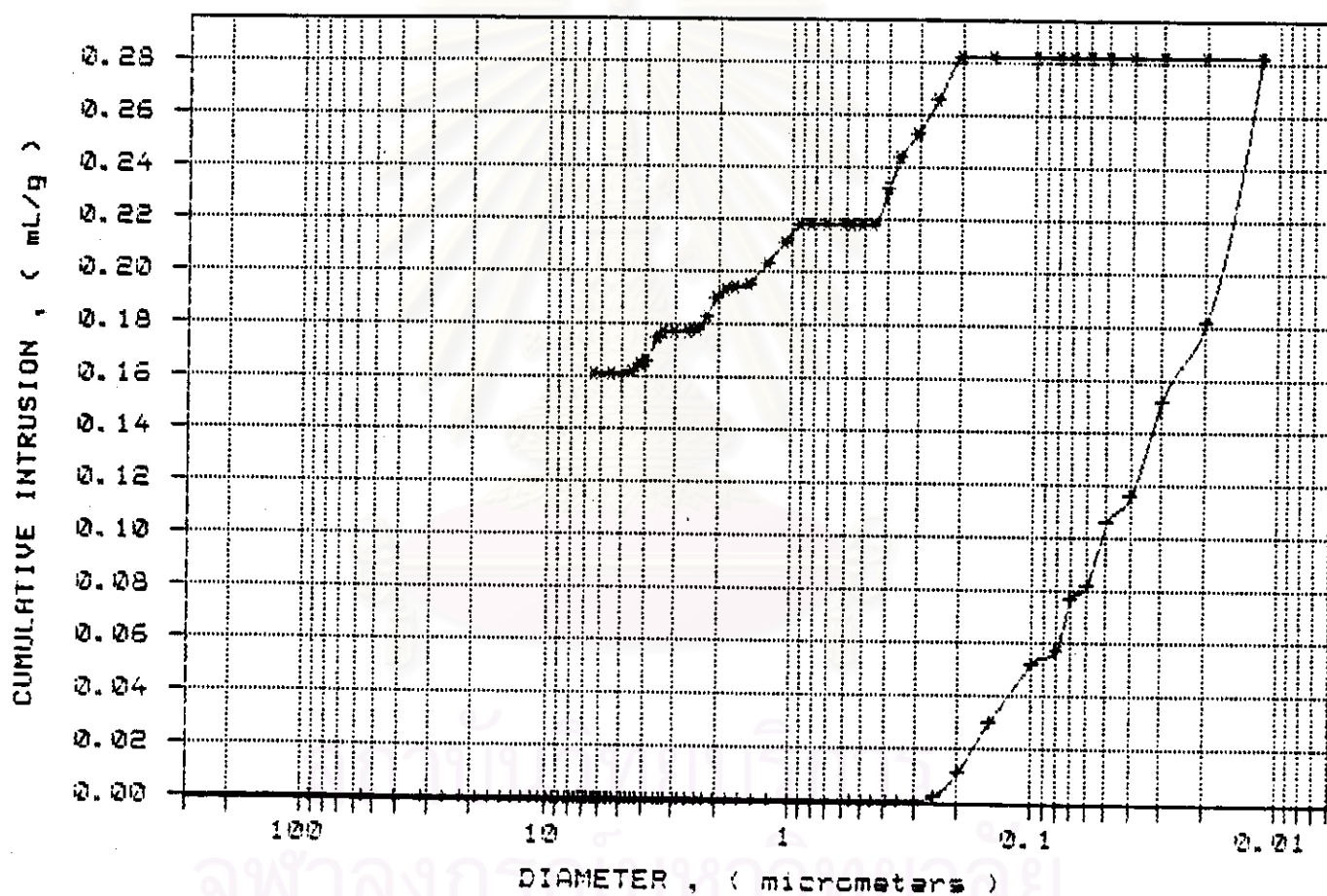


Figure A-13 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 2 hr.

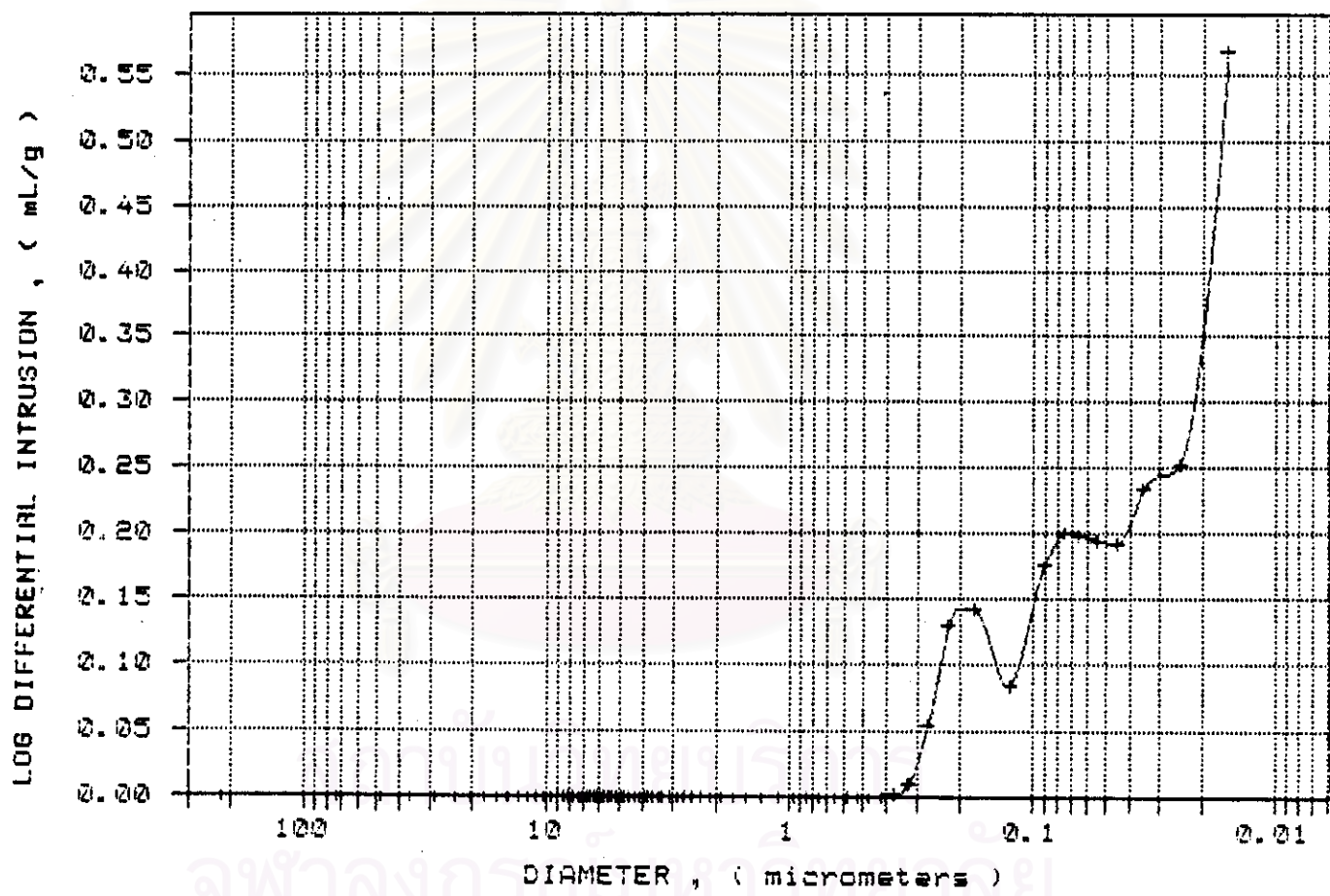


Figure A-14 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 2 hr.



8. Monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 9 hr.

Total intrusion volume = 0.2949 ml/g

Total pore area = 39.528 sq-m/g

Median pore diameter (volume) = 359 Å

Median pore diameter (area) = 185 Å

Average pore diameter ( $4V/A$ ) = 298 Å

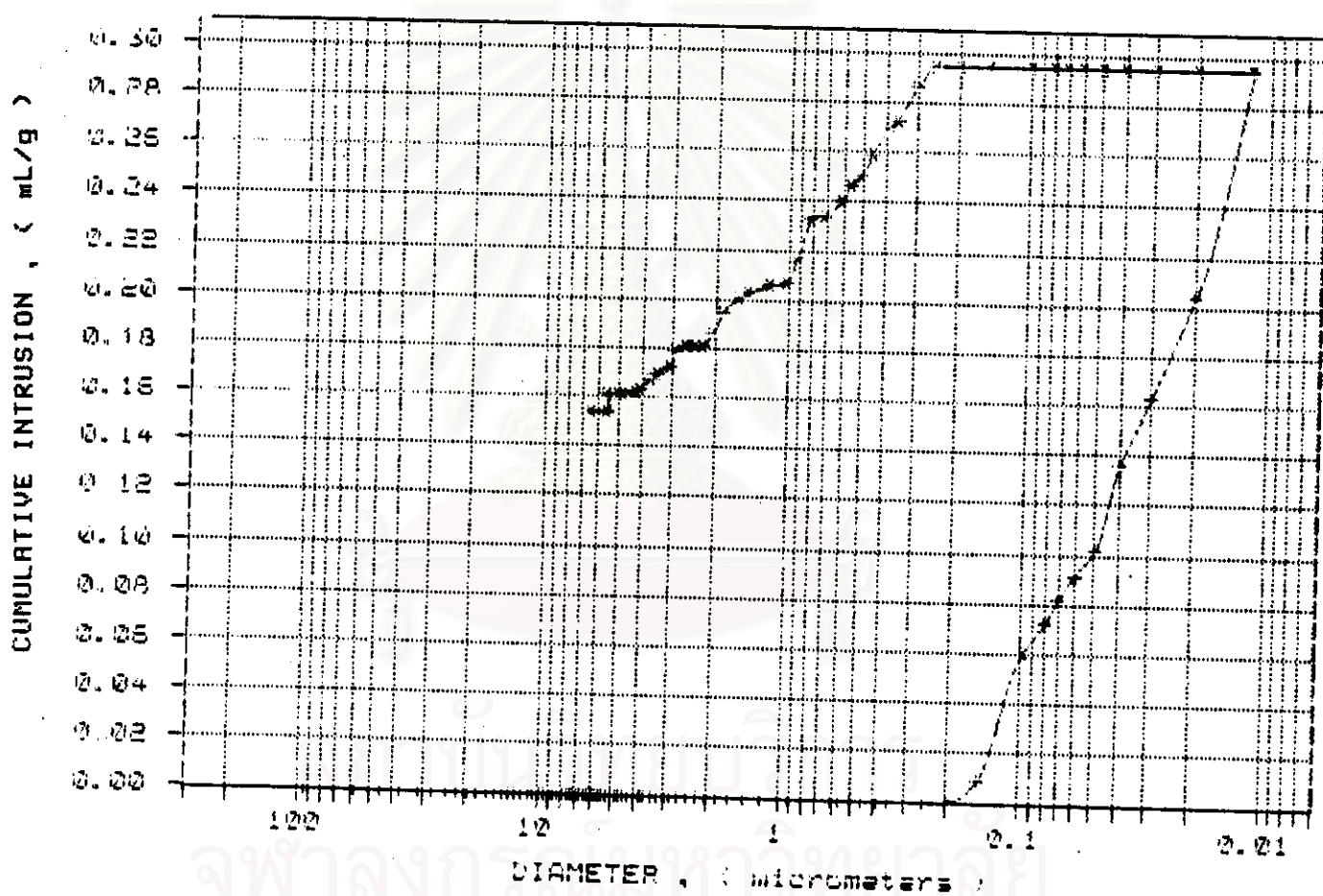


Figure A-15 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 9 hr.

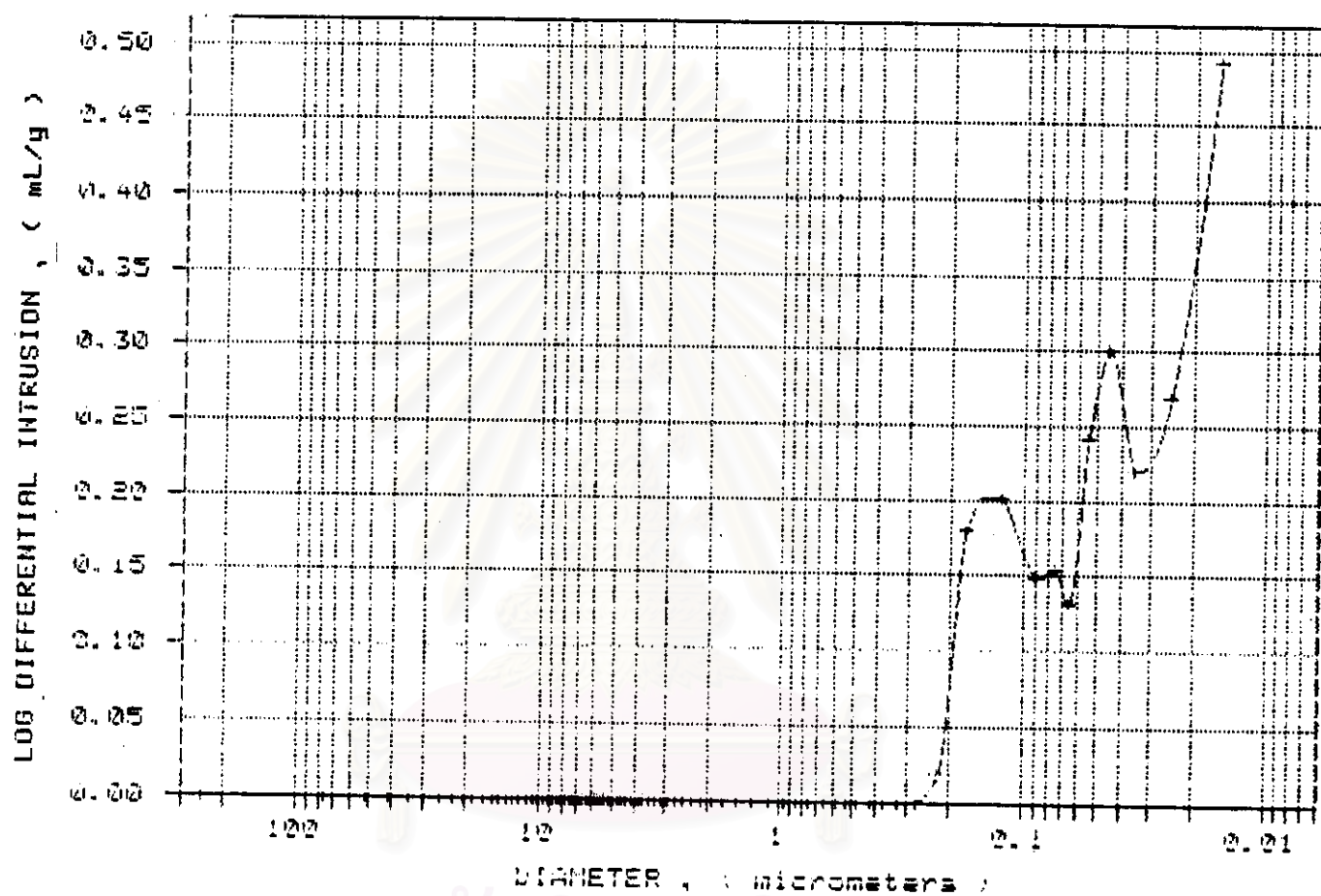


Figure A-16 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{HNO}_3$  for 9 hr.

9. Monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 2 min.

Total intrusion volume	= 0.3857 ml/g
Total pore area	= 49.658 sq-m/g
Median pore diameter (volume)	= 363 Å
Median pore diameter (area)	= 175 Å
Average pore diameter ( $4V/A$ )	= 311 Å

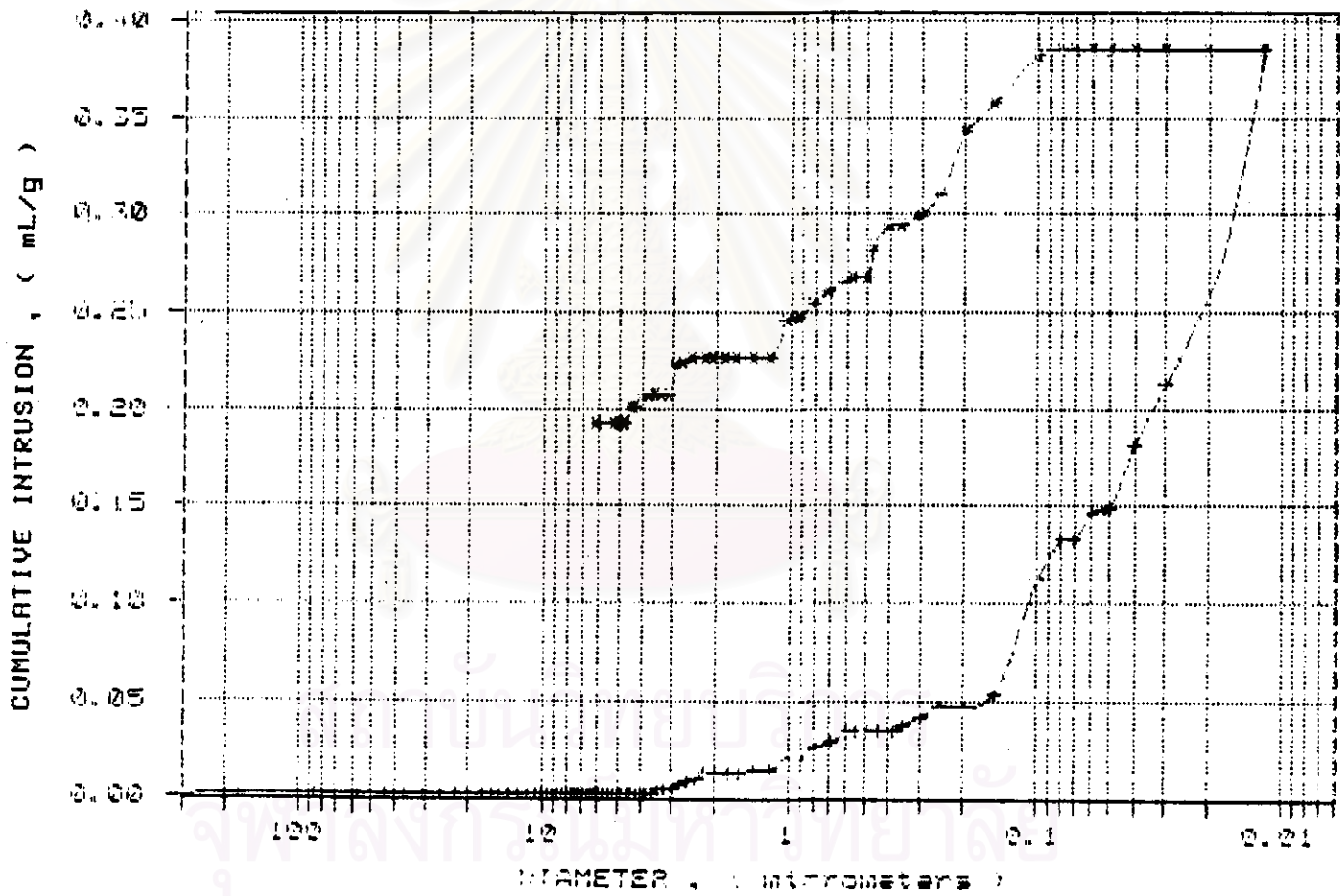


Figure A-17 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 2 min.

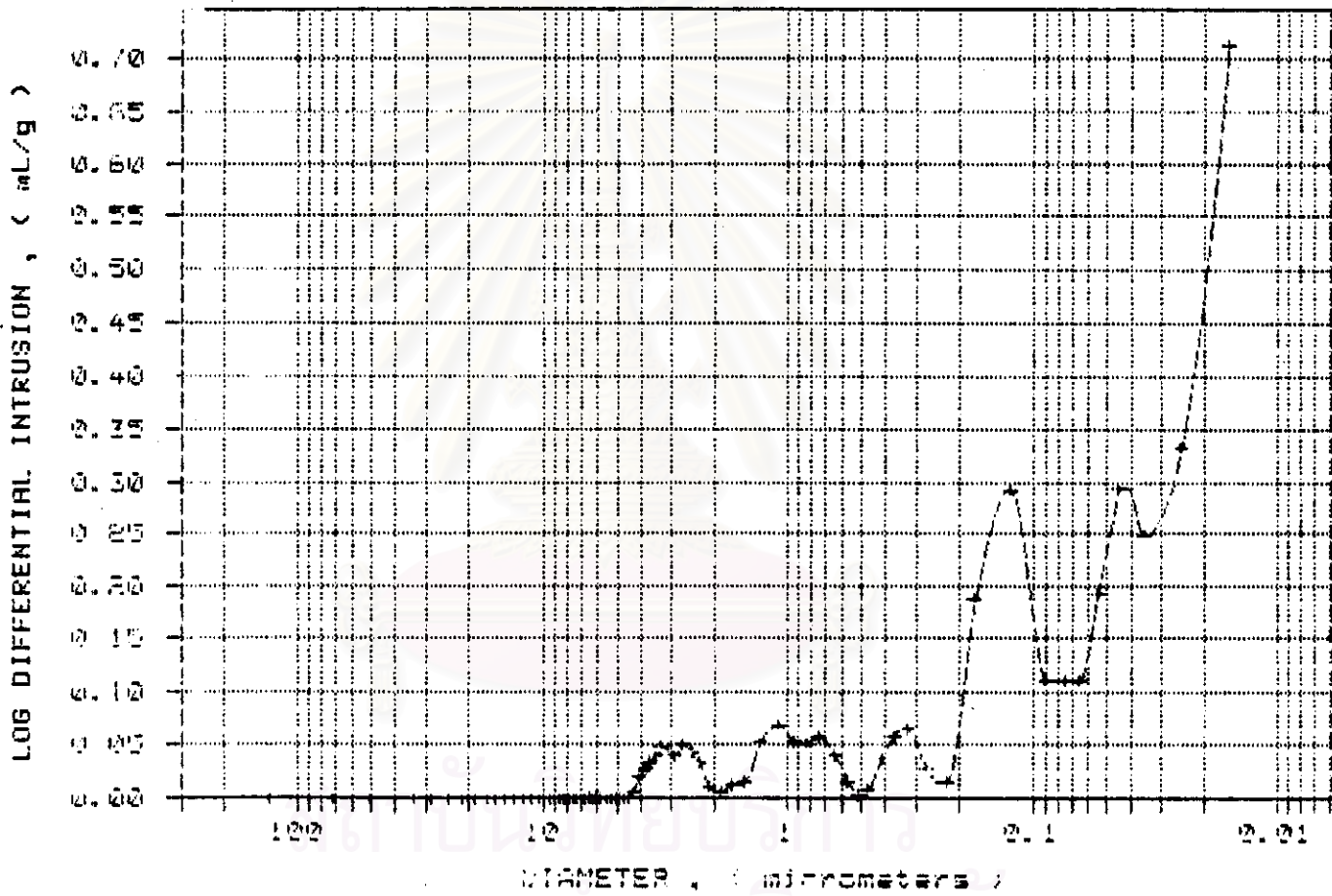


Figure A-18 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 2 min.

10. Monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 5 min.

Total intrusion volume	= 0.5174 ml/g
Total pore area	= 66.028 sq-m/g
Median pore diameter (volume)	= 392 Å
Median pore diameter (area)	= 166 Å
Average pore diameter ( $4V/A$ )	= 313 Å

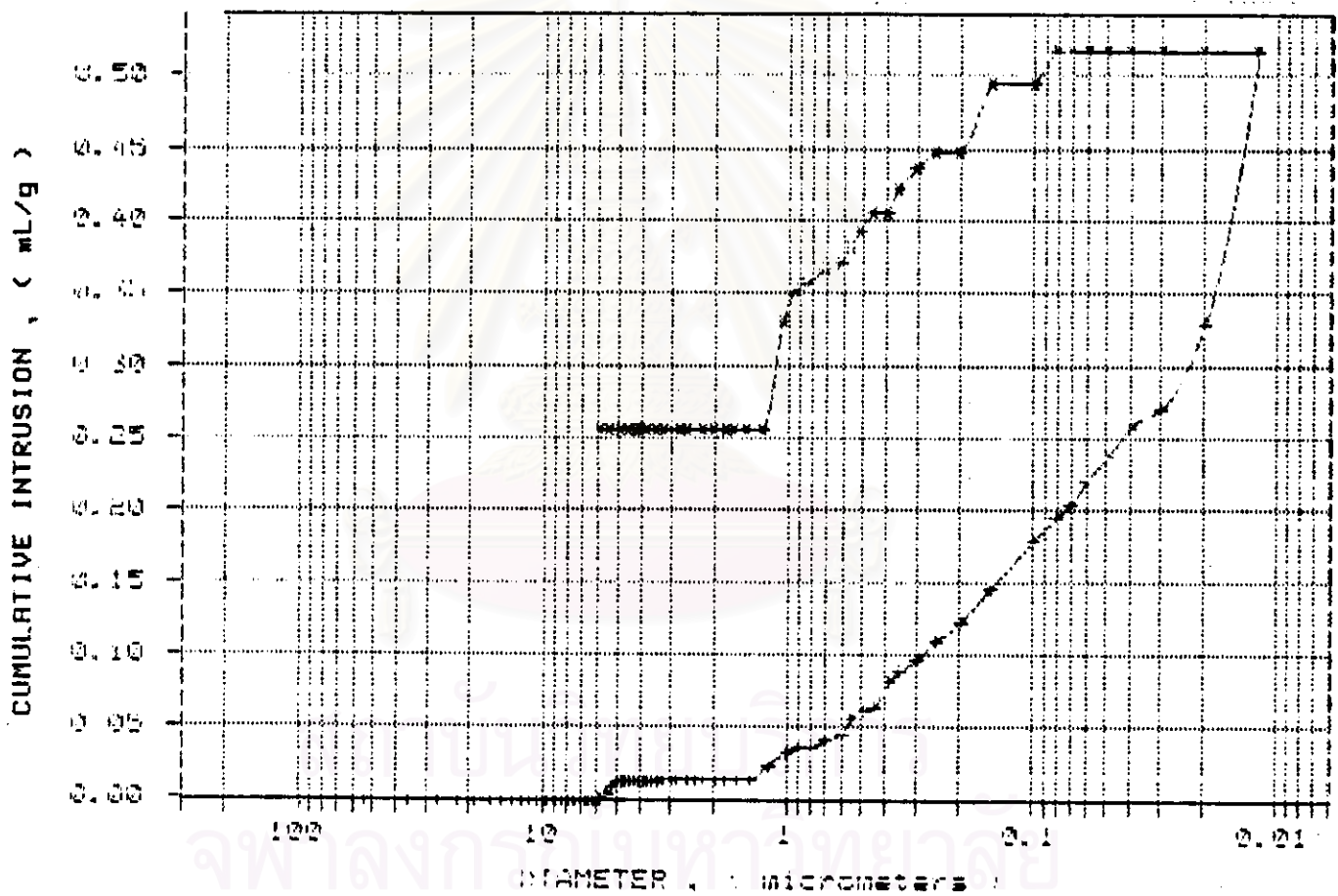


Figure A-19 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 5 min.

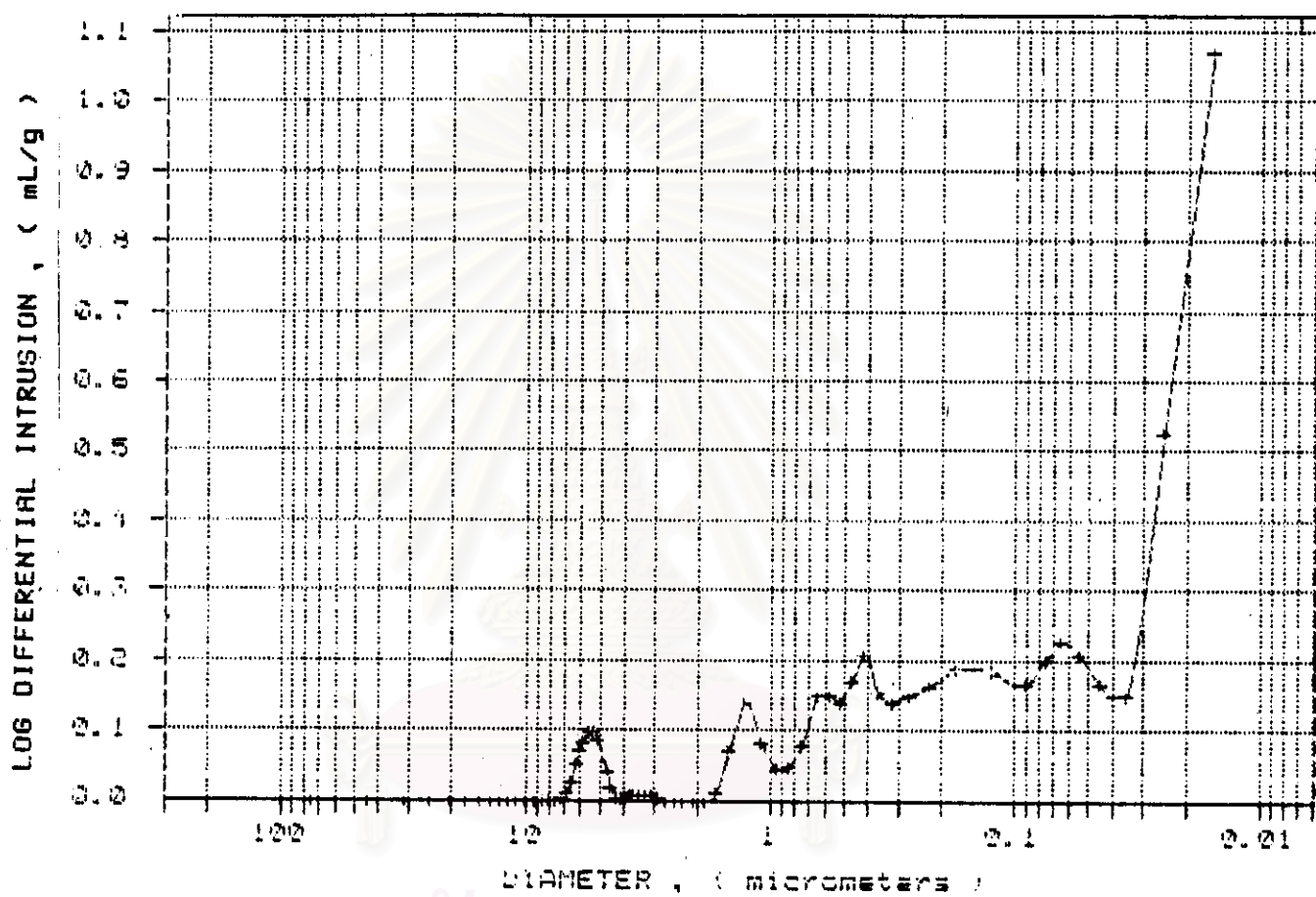


Figure A-20 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 5 min.

11. Monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 10 min.

Total intrusion volume = 0.3822 ml/g

Total pore area = 41.852 sq-m/g

Median pore diameter (volume) = 461 Å

Median pore diameter (area) = 204 Å

Average pore diameter ( $4V/A$ ) = 365 Å

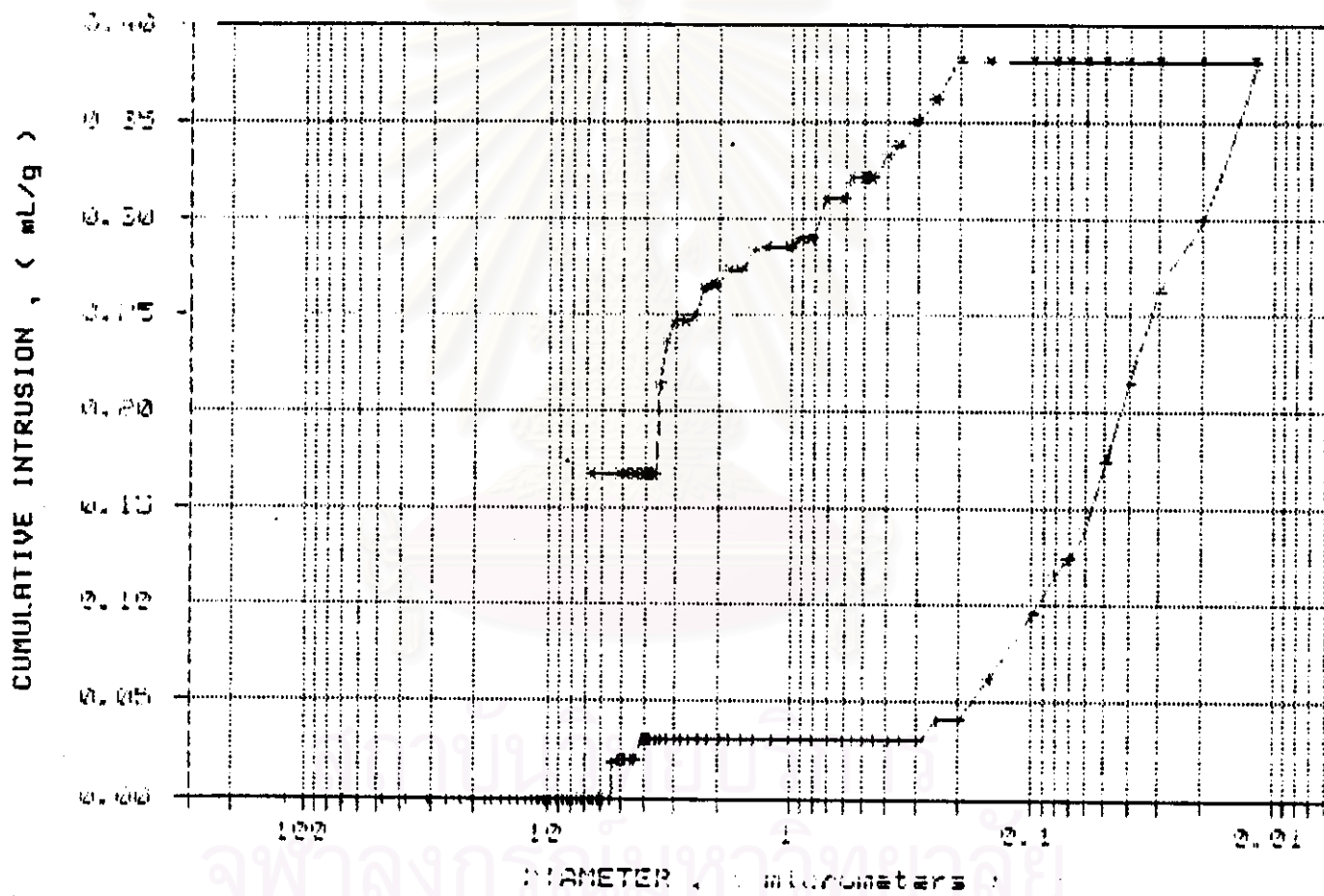


Figure A-21 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 10 min.

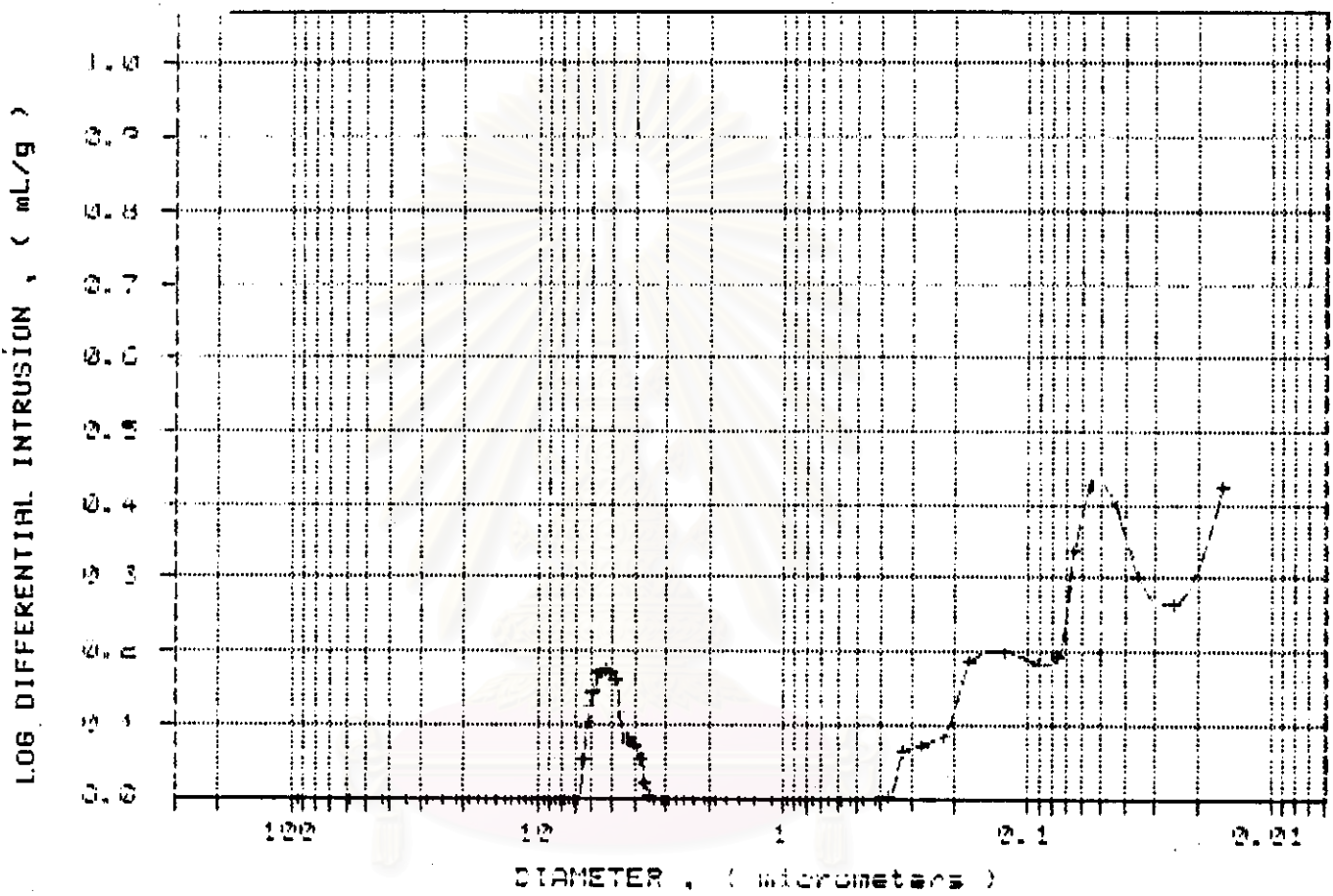


Figure A-22 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 10 min.



12. Monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 30 min.

Total intrusion volume	= 0.4928 ml/g
Total pore area	= 57.868 sq-m/g
Median pore diameter (volume)	= 361 Å
Median pore diameter (area)	= 196 Å
Average pore diameter ( $4V/A$ )	= 341 Å

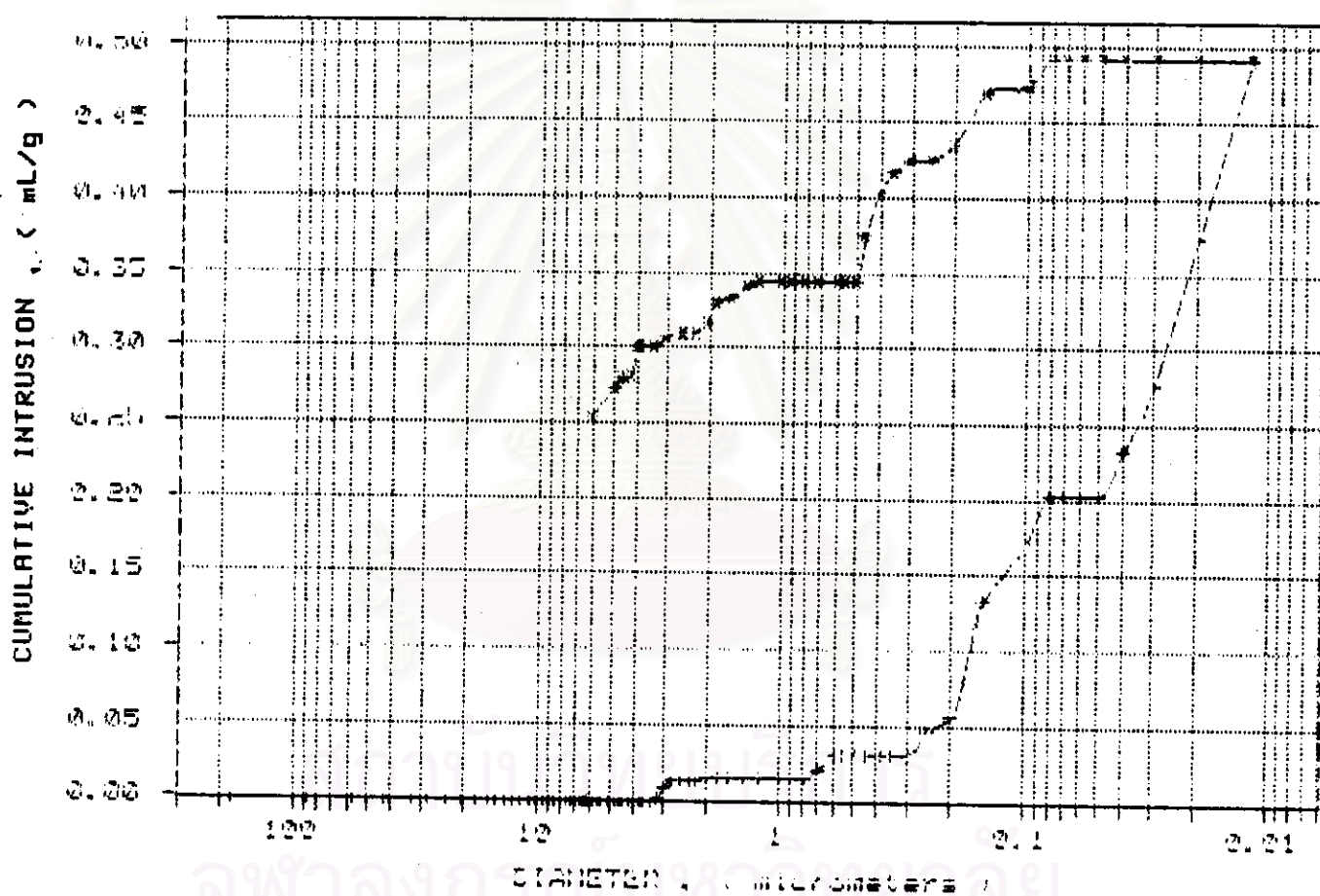


Figure A-23 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 30 min.

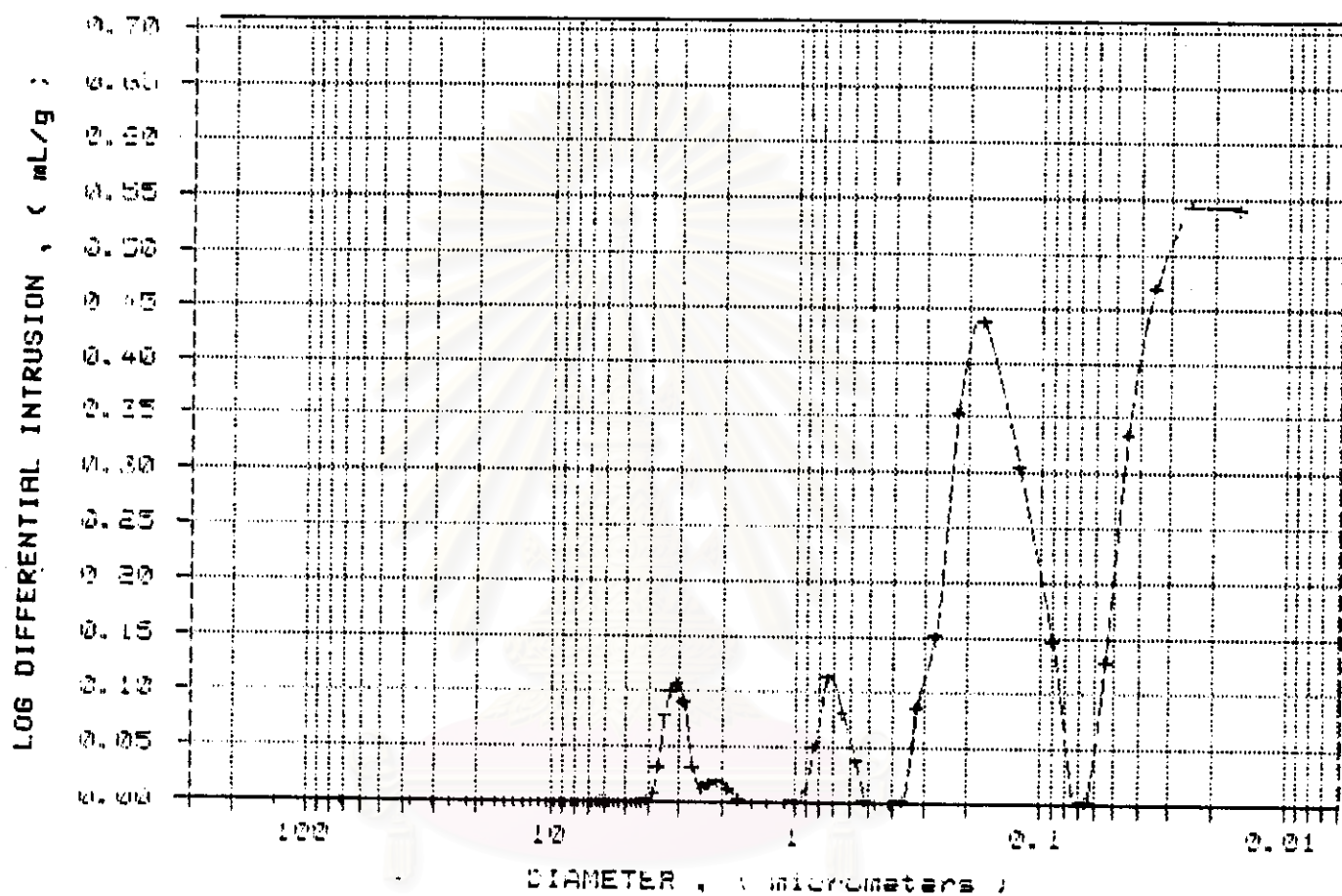


Figure A-24 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 30 min.

13. Monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 1 hr.

Total intrusion volume	= 0.5194 ml/g
Total pore area	= 70.032 sq-m/g
Median pore diameter (volume)	= 342 Å
Median pore diameter (area)	= 187 Å
Average pore diameter ( $4V/A$ )	= 297 Å

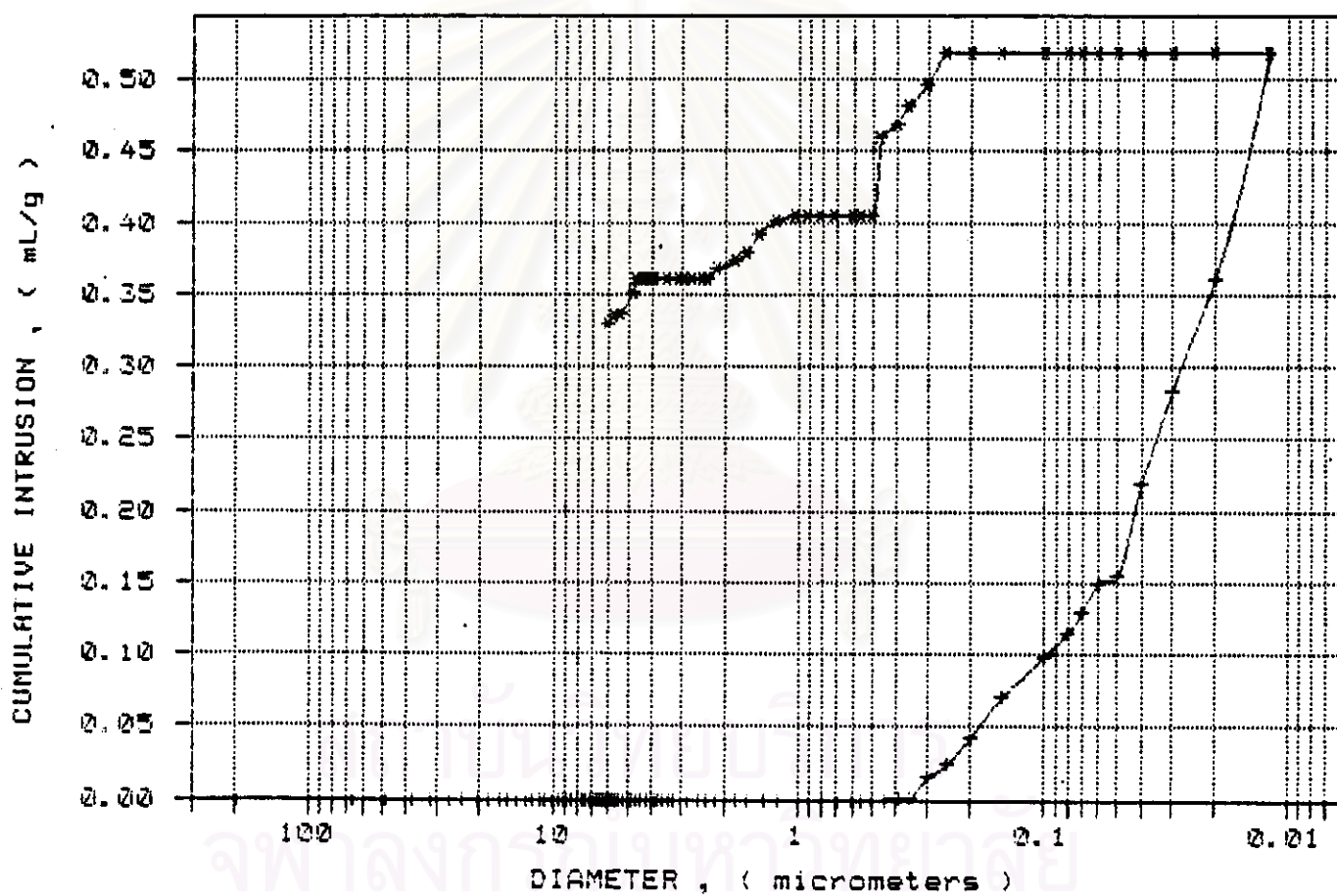


Figure A-25 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 1 hr.

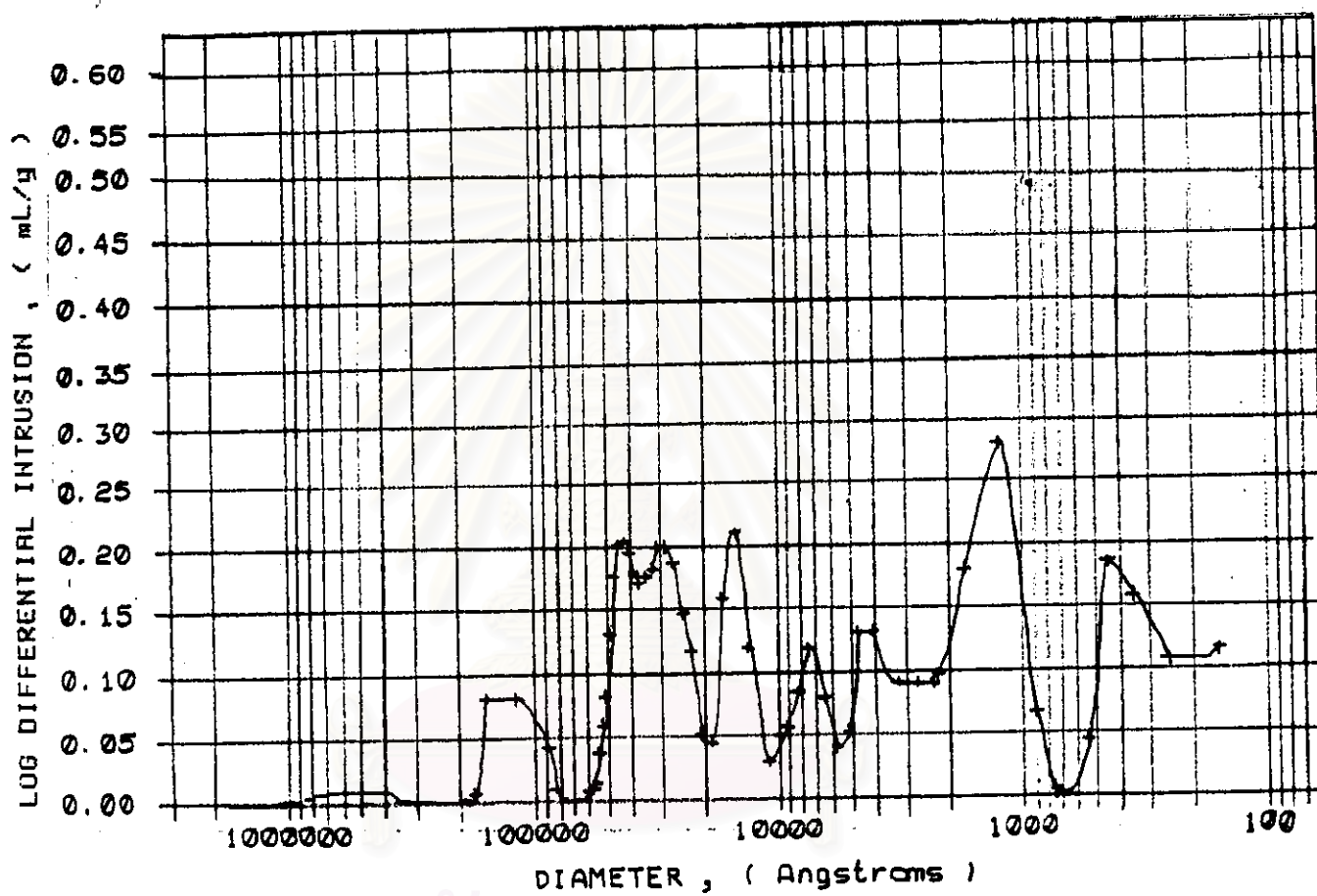


Figure A-26 Log differential intrusion vs diameter of monolith treated in 2.5%  
by weight of  $\text{CH}_3\text{COOH}$  for 1 hr.

14. Monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 2 hr.

Total intrusion volume	= 0.4803 ml/g
Total pore area	= 50.627 sq-m/g
Median pore diameter (volume)	= 465 Å
Median pore diameter (area)	= 197 Å
Average pore diameter ( $4V/A$ )	= 379 Å

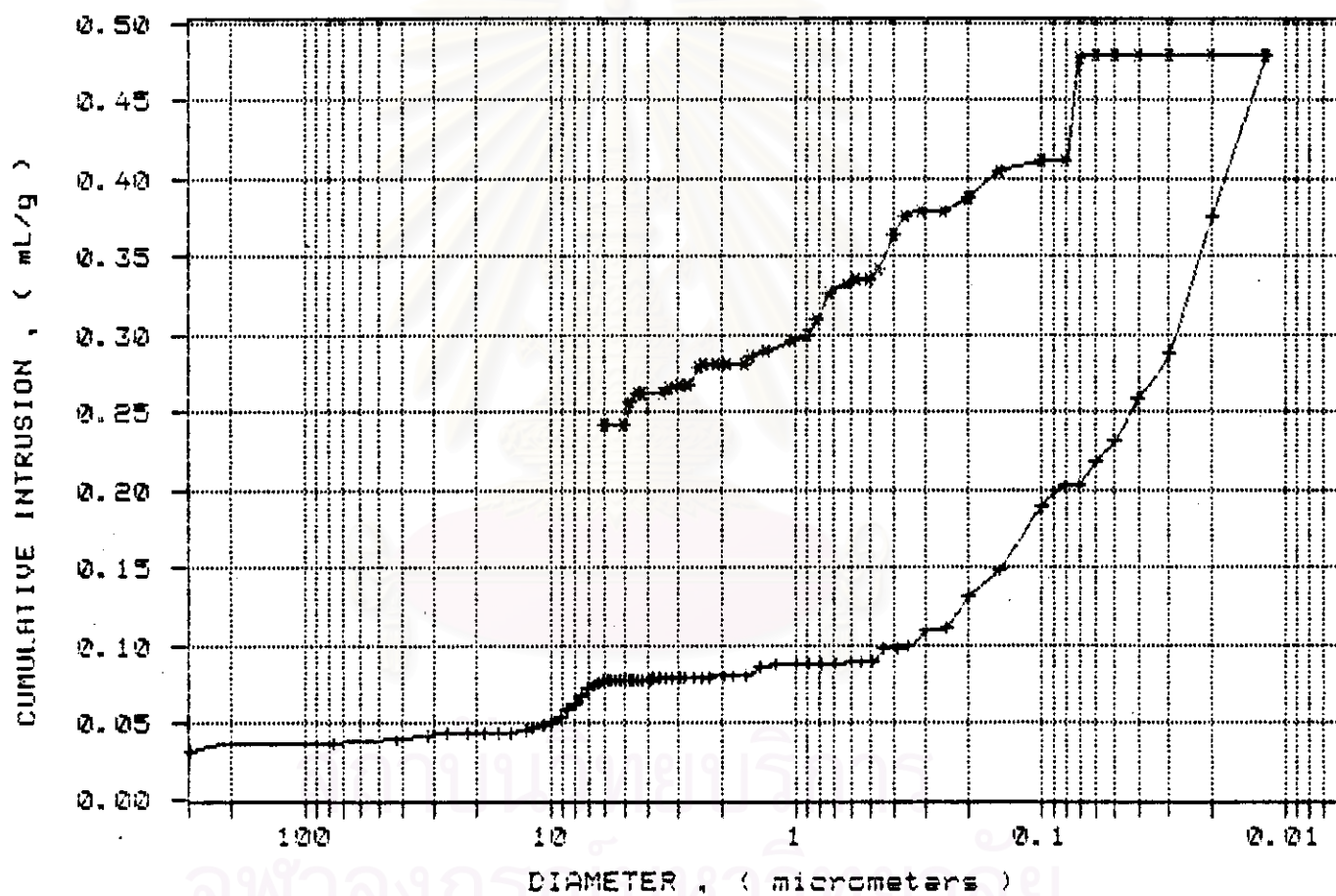


Figure A-27 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 2 hr.

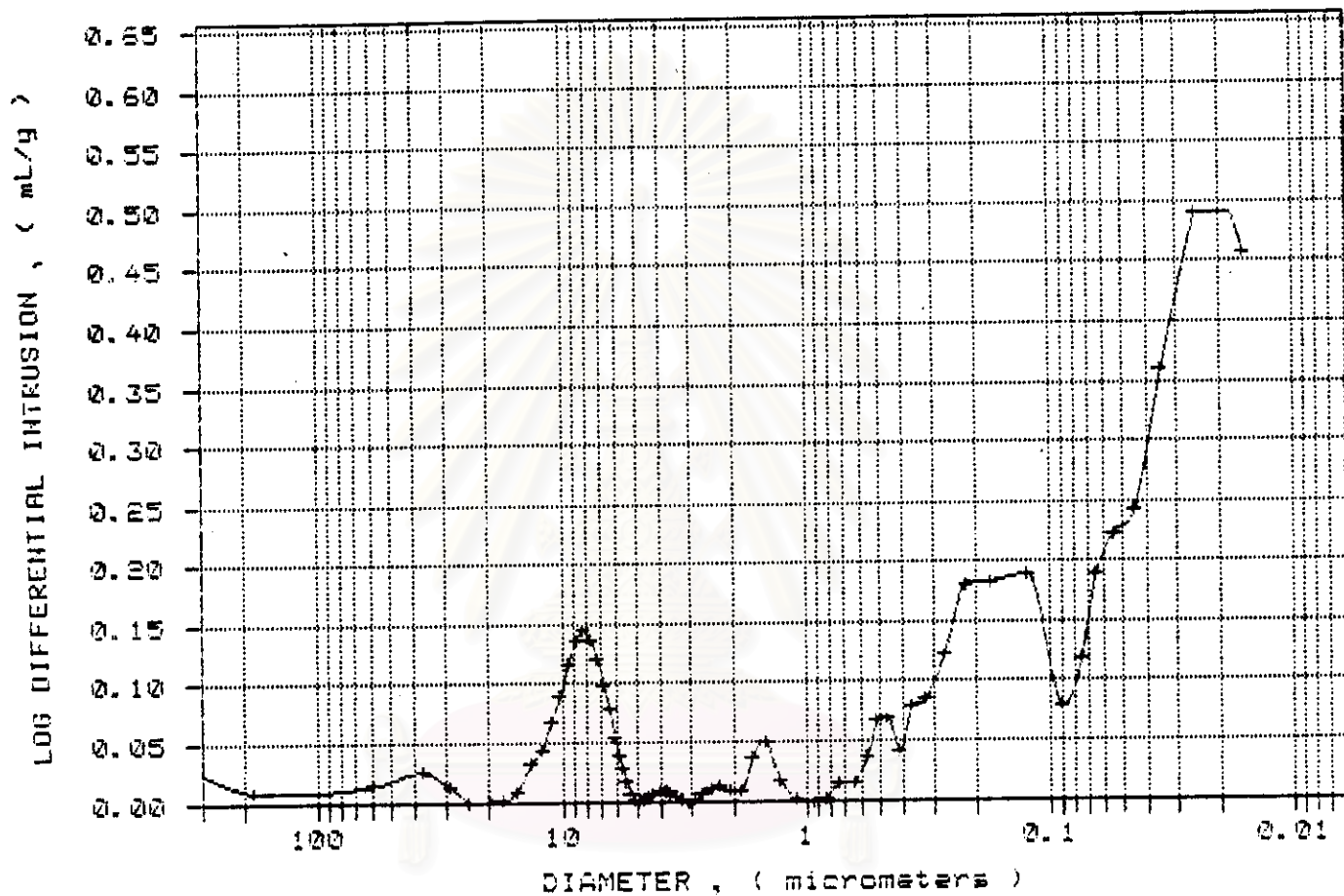


Figure A-28 Log differential intrusion vs diameter of monolith treated in 2.5%  
by weight of  $\text{CH}_3\text{COOH}$  for 2 hr.

15. Monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 9 hr.

Total intrusion volume	= 0.2562 ml/g
Total pore area	= 37.717 sq-m/g
Median pore diameter (volume)	= 296 Å
Median pore diameter (area)	= 167 Å
Average pore diameter ( $4V/A$ )	= 272 Å

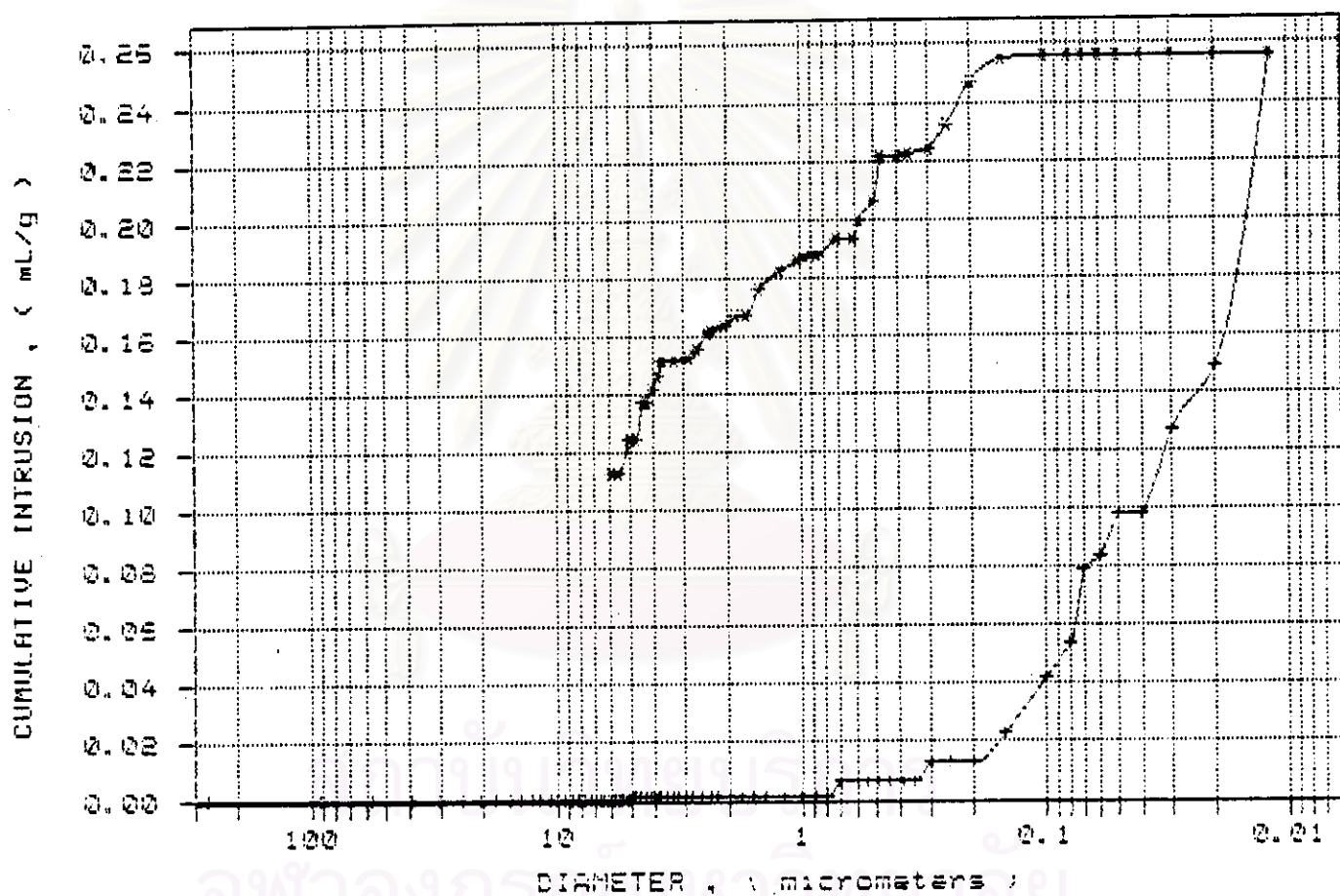


Figure A-29 Cumulative intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 9 hr.

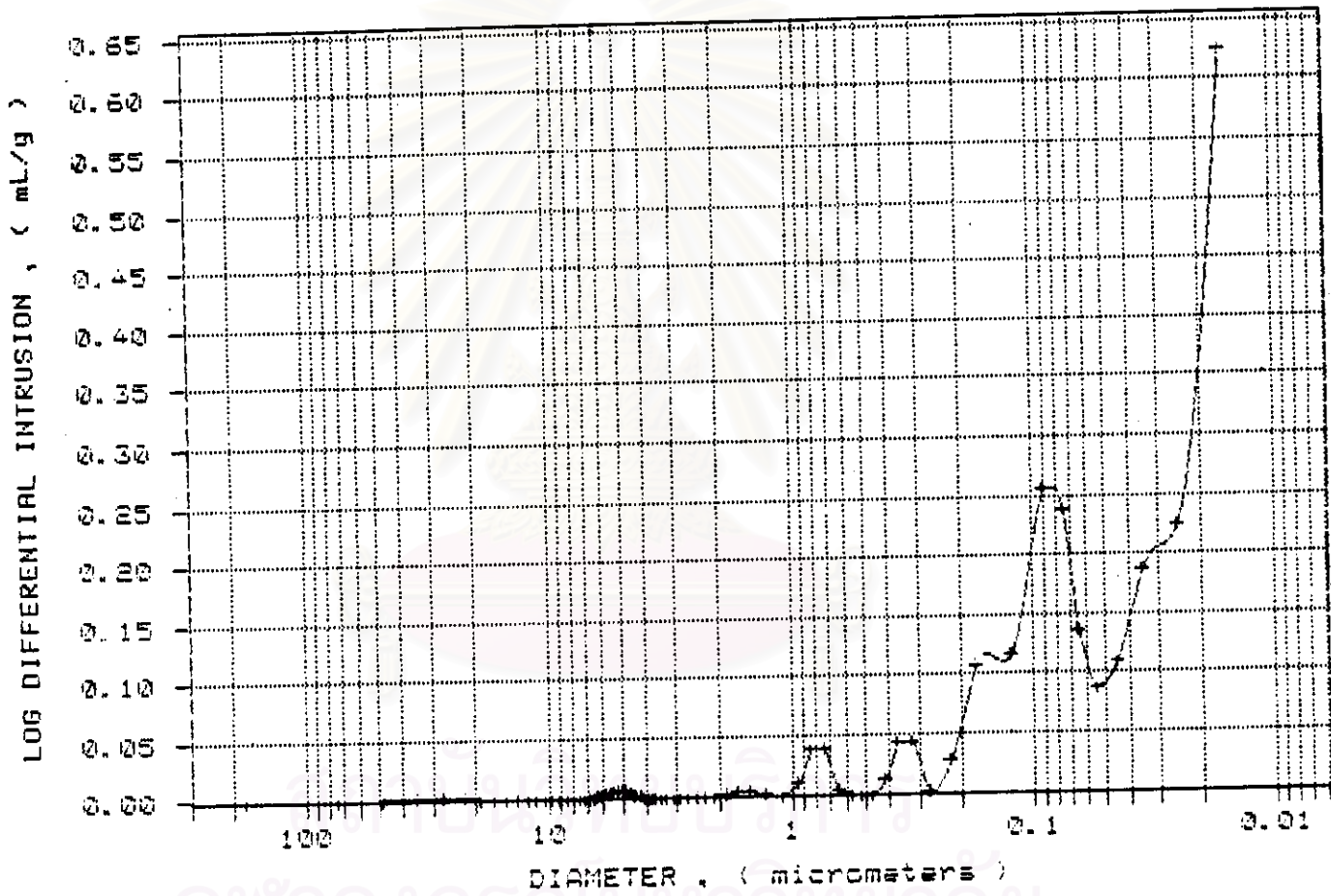


Figure A-30 Log differential intrusion vs diameter of monolith treated in 2.5% by weight of  $\text{CH}_3\text{COOH}$  for 9 hr.



## APPENDIX B

### CHEMICAL AND PHYSICAL PROPERTIES OF ALUMINA

Table B-1 Specification of Alumina Support ( $\text{Al}_2\text{O}_3$ )

Chemical Composition (weight percent)	
- $\text{Al}_2\text{O}_3$	97 %
- La	3 %
- $\text{Na}_2\text{O}$	< 100 ppm

Physical Properties	
- BET specific surface area	131 $\text{m}^2/\text{g}$
- Mean particle size	6.0 $\mu\text{m}$

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## VITA

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