



# **Analysis**

**Operator:** Hashagen  
**Sample ID:** S36328\_C.Marshall  
**Sample Desc:** NiO-MgO  
**Outgas Time:** 6.0 hrs  
**Analysis gas:** Nitrogen  
**Analysis Time:** 694.3 min

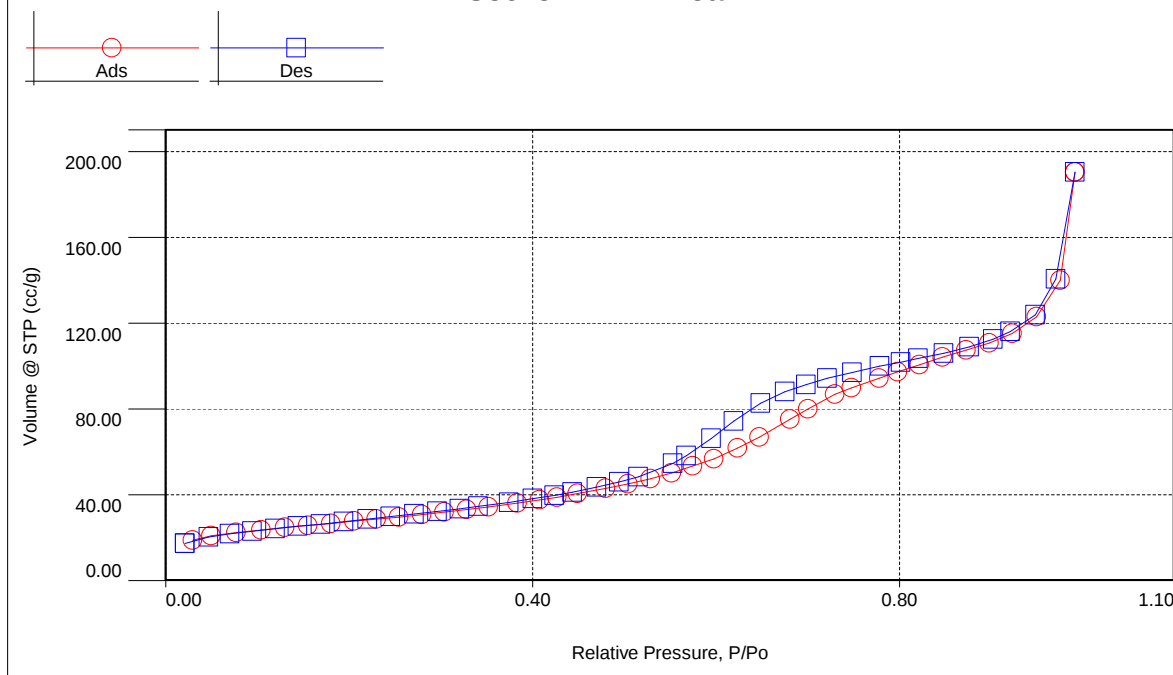
**Date:** 8/17/2022

**Filename:** ASMS\_20220817\_01\_St1.QPS  
**Comment:** 79 point isotherm  
**Outgas Temp:** 180.0 °C  
**Molec. Wt:** 28.0134 g  
**Instrument:** Autosorb Station 1

# **Report**

**Operator:** Hashagen  
**Date:** 2022/08/18  
**Sample Weight:** 0.1734 g  
**Non-ideality:** 6.58e-05 1/Torr  
**Bath temp.:** 77.35 K

## **Isotherm : Linear**



## **Isotherm**

| Relative Pressure | Volume @ STP [cc/g] | Relative Pressure | Volume @ STP [cc/g] | Relative Pressure | Volume @ STP [cc/g] |
|-------------------|---------------------|-------------------|---------------------|-------------------|---------------------|
| 2.94716e-02       | 18.7244             | 5.97530e-01       | 56.6576             | 8.20691e-01       | 103.4020            |
| 5.01438e-02       | 20.6464             | 6.23774e-01       | 61.6721             | 8.01554e-01       | 101.7595            |
| 7.72003e-02       | 22.2313             | 6.47277e-01       | 66.6934             | 7.78568e-01       | 99.9346             |
| 1.04221e-01       | 23.4742             | 6.80972e-01       | 75.2521             | 7.48230e-01       | 97.0809             |
| 1.30012e-01       | 24.5641             | 7.00144e-01       | 80.0602             | 7.21135e-01       | 94.1813             |
| 1.55552e-01       | 25.5709             | 7.29938e-01       | 86.8335             | 6.98058e-01       | 91.2569             |
| 1.80430e-01       | 26.5650             | 7.47638e-01       | 89.8773             | 6.75426e-01       | 87.8482             |
| 2.05608e-01       | 27.5170             | 7.77836e-01       | 94.3144             | 6.48641e-01       | 82.7139             |
| 2.30015e-01       | 28.5285             | 7.98130e-01       | 97.2573             | 6.19170e-01       | 74.3782             |
| 2.54568e-01       | 29.5762             | 8.21969e-01       | 100.5920            | 5.94887e-01       | 66.2818             |
| 2.79221e-01       | 30.6725             | 8.46784e-01       | 103.9833            | 5.68066e-01       | 58.0291             |
| 3.03979e-01       | 31.7943             | 8.73023e-01       | 107.2702            | 5.52971e-01       | 54.6129             |
| 3.28344e-01       | 32.9684             | 8.98140e-01       | 110.5553            | 5.15197e-01       | 48.3174             |
| 3.52199e-01       | 34.2732             | 9.23041e-01       | 115.2987            | 4.94861e-01       | 45.9077             |
| 3.83253e-01       | 36.0316             | 9.49656e-01       | 122.9278            | 4.69795e-01       | 43.4365             |
| 4.08118e-01       | 37.5326             | 9.75600e-01       | 139.9945            | 4.43446e-01       | 41.2008             |
| 4.26798e-01       | 38.7995             | 9.91291e-01       | 190.4798            | 4.24208e-01       | 39.6967             |
| 4.49198e-01       | 40.3825             | 9.70686e-01       | 140.6176            | 4.00334e-01       | 38.0246             |
| 4.80070e-01       | 42.7721             | 9.48363e-01       | 123.9637            | 3.74645e-01       | 36.4027             |
| 5.04539e-01       | 45.0409             | 9.21249e-01       | 116.1086            | 3.41181e-01       | 34.4649             |
| 5.28419e-01       | 47.4784             | 9.01874e-01       | 112.5269            | 3.20697e-01       | 33.3255             |
| 5.51967e-01       | 50.1572             | 8.76512e-01       | 108.8848            | 2.96468e-01       | 32.0602             |
| 5.74695e-01       | 53.1963             | 8.48009e-01       | 105.9051            | 2.71155e-01       | 30.8053             |

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**ASMS\_20220817\_01\_St1.QPS**

**Date:** 2022/08/18

**Isotherm** continued

| Relative Pressure | Volume @ STP<br>[cc/g] | Relative Pressure | Volume @ STP<br>[cc/g] | Relative Pressure | Volume @ STP<br>[cc/g] |
|-------------------|------------------------|-------------------|------------------------|-------------------|------------------------|
| 2.45633e-01       | 29.5968                | 1.44324e-01       | 25.1773                | 4.69242e-02       | 20.1366                |
| 2.19998e-01       | 28.4494                | 1.19390e-01       | 24.0835                | 2.12727e-02       | 17.0636                |
| 1.94726e-01       | 27.3476                | 9.46214e-02       | 22.9252                |                   |                        |
| 1.69497e-01       | 26.2674                | 7.03153e-02       | 21.6644                |                   |                        |



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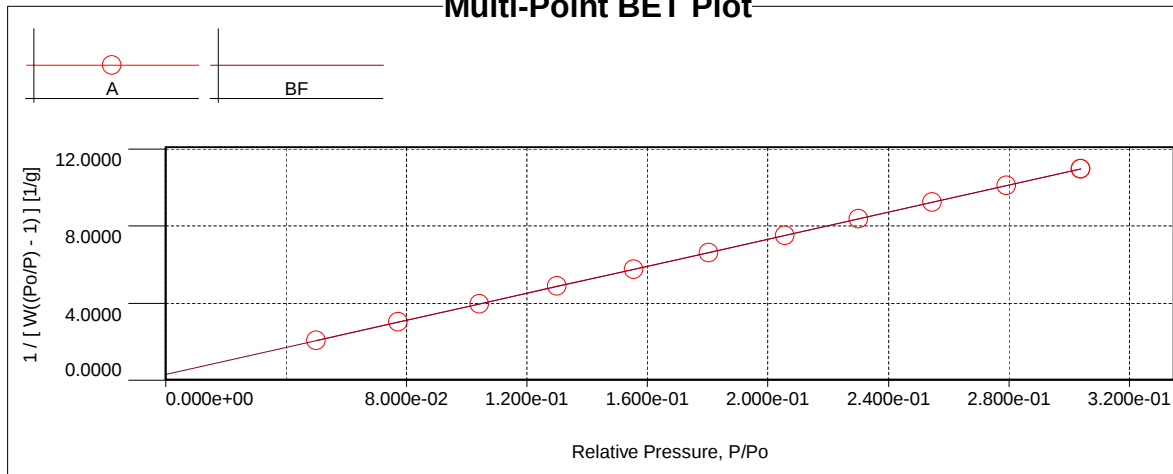
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Date: 2022/08/18

### Multi-Point BET Plot



### Multi-Point BET

| Relative Pressure<br>[P/Po] | Volume @ STP<br>[cc/g] | 1 / [ W((Po/P) - 1) ]<br>[1/g] | Relative Pressure<br>[P/Po] | Volume @ STP<br>[cc/g] | 1 / [ W((Po/P) - 1) ]<br>[1/g] |
|-----------------------------|------------------------|--------------------------------|-----------------------------|------------------------|--------------------------------|
| 5.01438e-02                 | 20.6464                | 2.0458e+00                     | 2.05608e-01                 | 27.5170                | 7.5259e+00                     |
| 7.72003e-02                 | 22.2313                | 3.0109e+00                     | 2.30015e-01                 | 28.5285                | 8.3781e+00                     |
| 1.04221e-01                 | 23.4742                | 3.9656e+00                     | 2.54568e-01                 | 29.5762                | 9.2385e+00                     |
| 1.30012e-01                 | 24.5641                | 4.8676e+00                     | 2.79221e-01                 | 30.6725                | 1.0105e+01                     |
| 1.55552e-01                 | 25.5709                | 5.7638e+00                     | 3.03979e-01                 | 31.7943                | 1.0991e+01                     |
| 1.80430e-01                 | 26.5650                | 6.6308e+00                     |                             |                        |                                |

### MBET summary

Slope = 35.166 1/g  
Intercept = 2.920e-01 1/g  
Correlation coefficient, r = 0.999998  
C constant = 121.421  
Surface Area = 98.215 m<sup>2</sup>/g

### Total Pore Volume data

#### Total Pore Volume

Total pore volume = 2.946e-01 cc/g for  
pores smaller than 222.0 nm (Diameter)  
at P/Po = 0.99129

### Average PoreSize data

Average pore Diameter = 1.19997e+01 nm



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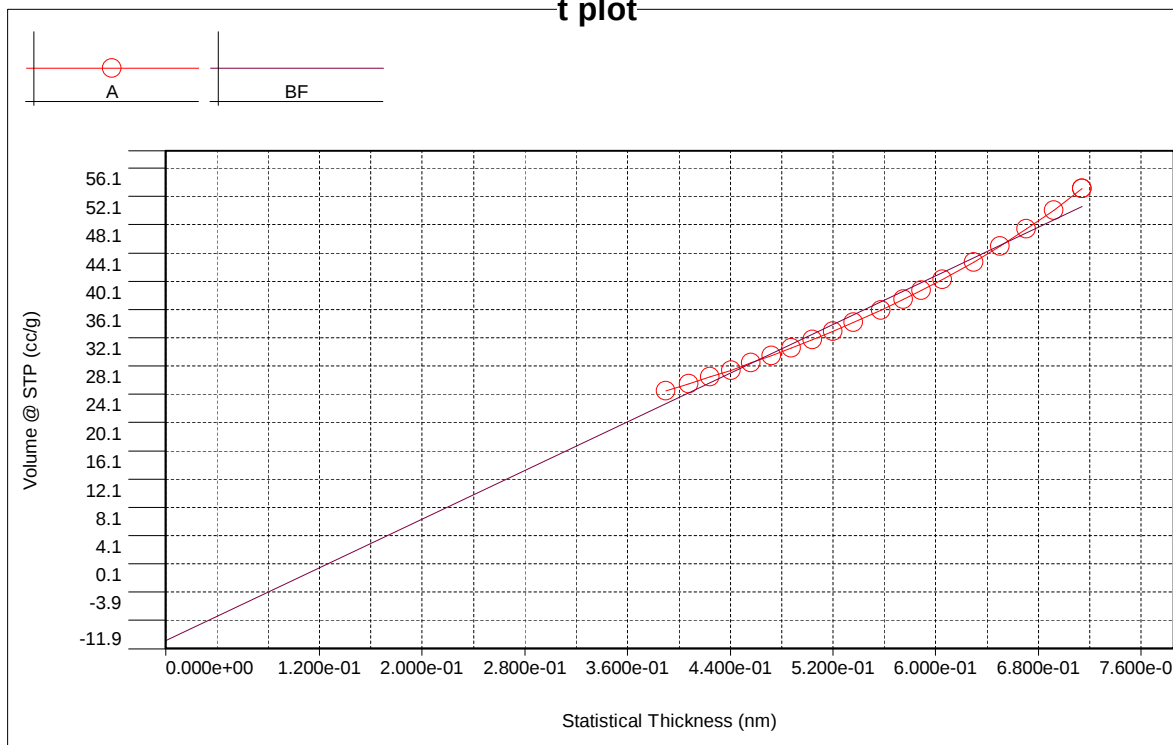
Date: 8/17/2022  
Filename:

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ASMS\_20220817\_01\_St1.QPS

Date: 2022/08/18

## t plot



## t-Plot Method Micropore Analysis

| Relative Pressure | Thickness<br>[(nm)] | Volume @ STP<br>[(cc/g)] | Relative Pressure | Thickness<br>[(nm)] | Volume @ STP<br>[(cc/g)] |
|-------------------|---------------------|--------------------------|-------------------|---------------------|--------------------------|
| 1.300115e-01      | 3.8995e-01          | 24.564                   | 3.832527e-01      | 5.5726e-01          | 36.032                   |
| 1.555519e-01      | 4.0759e-01          | 25.571                   | 4.081185e-01      | 5.7495e-01          | 37.533                   |
| 1.804304e-01      | 4.2414e-01          | 26.565                   | 4.267977e-01      | 5.8862e-01          | 38.800                   |
| 2.056084e-01      | 4.4051e-01          | 27.517                   | 4.491983e-01      | 6.0552e-01          | 40.383                   |
| 2.300145e-01      | 4.5619e-01          | 28.529                   | 4.800698e-01      | 6.2981e-01          | 42.772                   |
| 2.545678e-01      | 4.7191e-01          | 29.576                   | 5.045391e-01      | 6.5002e-01          | 45.041                   |
| 2.792206e-01      | 4.8775e-01          | 30.672                   | 5.284186e-01      | 6.7068e-01          | 47.478                   |
| 3.039787e-01      | 5.0382e-01          | 31.794                   | 5.519671e-01      | 6.9207e-01          | 50.157                   |
| 3.283437e-01      | 5.1985e-01          | 32.968                   | 5.746946e-01      | 7.1382e-01          | 53.196                   |
| 3.521988e-01      | 5.3586e-01          | 34.273                   |                   |                     |                          |

## V-t method summary

Thickness method: DeBoer  
Slope = 8.604  
Intercept = -10.765  
Correlation coefficient, r = 0.991545  
  
Micropore volume = 0.000 cc/g  
Micropore area = 0.000 m<sup>2</sup>/g  
External surface area = 98.215 m<sup>2</sup>/g



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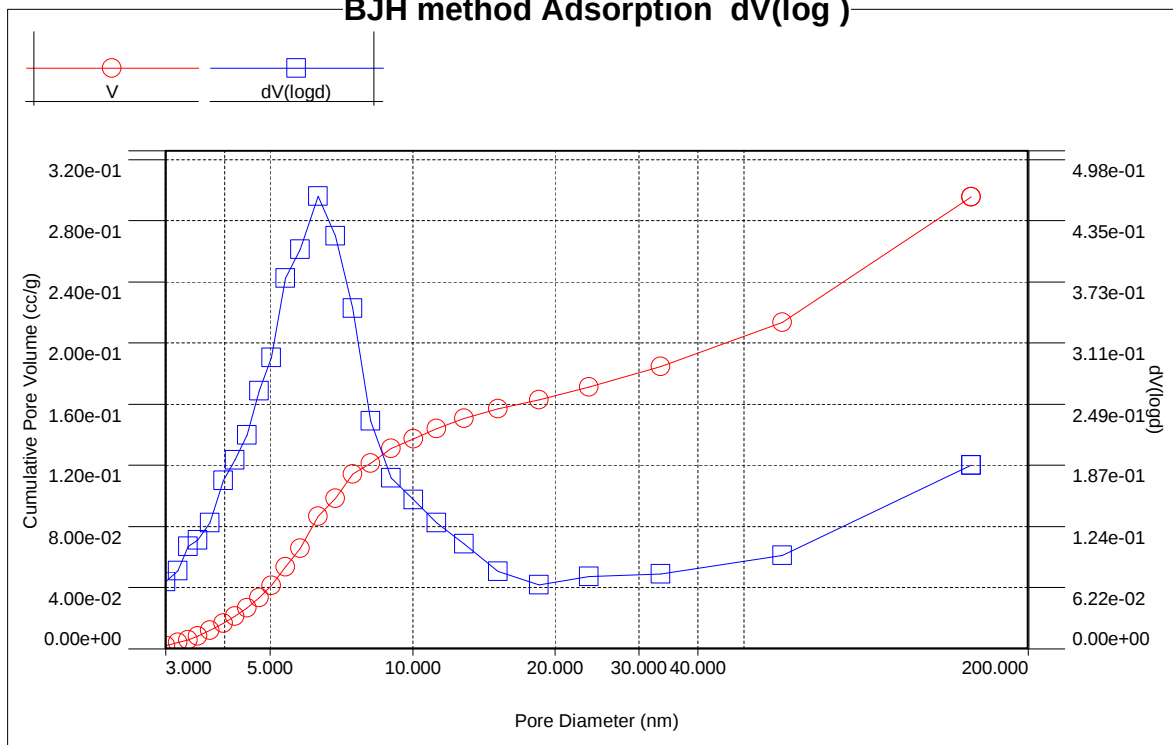
Filename:

# Report

Operator: Hashagen  
ASMS\_20220817\_01\_St1.QPS

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## BJH method Adsorption dV(log)



## Adsorption

| Diameter | Pore Volume | Pore Surf      | dV(d)      | dS(d)      | dV(logd)   | dS(logd)   |
|----------|-------------|----------------|------------|------------|------------|------------|
| [nm]     | [cc/g]      | Area<br>[m²/g] | [cc/nm/g]  | [m²/nm/g]  | [cc/g]     | [cc/g]     |
| 3.0024   | 2.0104e-03  | 2.6783e+00     | 9.8588e-03 | 1.3134e+01 | 6.8130e-02 | 9.0768e+01 |
| 3.1918   | 3.8985e-03  | 5.0445e+00     | 1.0792e-02 | 1.3524e+01 | 7.9294e-02 | 9.9370e+01 |
| 3.3490   | 5.7791e-03  | 7.2907e+00     | 1.3503e-02 | 1.6128e+01 | 1.0411e-01 | 1.2435e+02 |
| 3.5071   | 8.2012e-03  | 1.0053e+01     | 1.3680e-02 | 1.5603e+01 | 1.1045e-01 | 1.2597e+02 |
| 3.7279   | 1.2144e-02  | 1.4283e+01     | 1.4901e-02 | 1.5989e+01 | 1.2786e-01 | 1.3719e+02 |
| 3.9749   | 1.6434e-02  | 1.8601e+01     | 1.8703e-02 | 1.8821e+01 | 1.7113e-01 | 1.7221e+02 |
| 4.2114   | 2.1260e-02  | 2.3185e+01     | 1.9815e-02 | 1.8820e+01 | 1.9210e-01 | 1.8245e+02 |
| 4.4643   | 2.6803e-02  | 2.8151e+01     | 2.1132e-02 | 1.8934e+01 | 2.1716e-01 | 1.9458e+02 |
| 4.7342   | 3.3481e-02  | 3.3793e+01     | 2.4072e-02 | 2.0339e+01 | 2.6233e-01 | 2.2165e+02 |
| 5.0263   | 4.1338e-02  | 4.0046e+01     | 2.5606e-02 | 2.0377e+01 | 2.9626e-01 | 2.3576e+02 |
| 5.3767   | 5.3347e-02  | 4.8980e+01     | 3.0481e-02 | 2.2676e+01 | 3.7720e-01 | 2.8062e+02 |
| 5.7727   | 6.5521e-02  | 5.7416e+01     | 3.0588e-02 | 2.1195e+01 | 4.0642e-01 | 2.8161e+02 |
| 6.3038   | 8.6600e-02  | 7.0791e+01     | 3.1740e-02 | 2.0140e+01 | 4.6028e-01 | 2.9206e+02 |
| 6.8555   | 9.8300e-02  | 7.7618e+01     | 2.6632e-02 | 1.5539e+01 | 4.2025e-01 | 2.4521e+02 |
| 7.4740   | 1.1437e-01  | 8.6221e+01     | 2.0152e-02 | 1.0785e+01 | 3.4648e-01 | 1.8544e+02 |
| 8.1515   | 1.2126e-01  | 8.9600e+01     | 1.2358e-02 | 6.0643e+00 | 2.3187e-01 | 1.1378e+02 |
| 9.0017   | 1.3087e-01  | 9.3869e+01     | 8.4036e-03 | 3.7342e+00 | 1.7395e-01 | 7.7295e+01 |
| 10.0482  | 1.3709e-01  | 9.6345e+01     | 6.5472e-03 | 2.6063e+00 | 1.5137e-01 | 6.0257e+01 |
| 11.2122  | 1.4393e-01  | 9.8786e+01     | 4.9653e-03 | 1.7714e+00 | 1.2803e-01 | 4.5675e+01 |
| 12.8357  | 1.5066e-01  | 1.0088e+02     | 3.6012e-03 | 1.1223e+00 | 1.0625e-01 | 3.3110e+01 |
| 15.1385  | 1.5686e-01  | 1.0252e+02     | 2.2643e-03 | 5.9829e-01 | 7.8713e-02 | 2.0798e+01 |
| 18.4525  | 1.6281e-01  | 1.0381e+02     | 1.5290e-03 | 3.3144e-01 | 6.4722e-02 | 1.4030e+01 |
| 23.5405  | 1.7136e-01  | 1.0526e+02     | 1.3606e-03 | 2.3120e-01 | 7.3311e-02 | 1.2457e+01 |
| 33.3882  | 1.8477e-01  | 1.0687e+02     | 9.997e-04  | 1.1980e-01 | 7.5832e-02 | 9.0848e+00 |
| 60.4430  | 2.1369e-01  | 1.0878e+02     | 7.1067e-04 | 4.7031e-02 | 9.5051e-02 | 6.2903e+00 |

Continued on next page



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**Adsorption** continued

| Diameter | Pore Volume | Pore Surf<br>Area   | dV(d)      | dS(d)                  | dV(logd)   | dS(logd)   |
|----------|-------------|---------------------|------------|------------------------|------------|------------|
| [nm]     | [cc/g]      | [m <sup>2</sup> /g] | [cc/nm/g]  | [m <sup>2</sup> /nm/g] | [cc/g]     | [cc/g]     |
| 151.4009 | 2.9556e-01  | 1.1095e+02          | 5.7976e-04 | 1.5317e-02             | 1.8650e-01 | 4.9272e+00 |

**BJH adsorption summary**

Surface Area = 110.947 m<sup>2</sup>/g  
Pore Volume = 0.296 cc/g  
Pore Diameter Dv(d) = 6.304 nm



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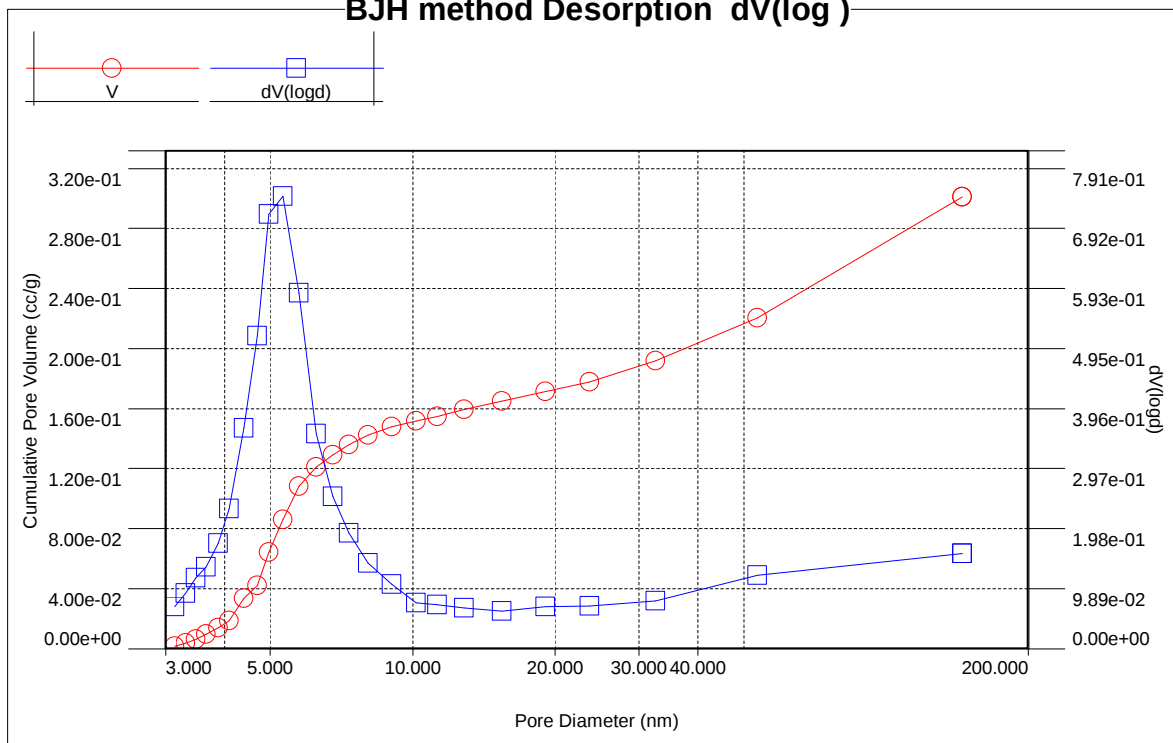
Filename:

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Date: 2022/08/18

**BJH method Desorption dV(log)**



**Desorption**

| Diameter | Pore Volume | Pore Surf      | dV(d)      | dS(d)      | dV(logd)   | dS(logd)   |
|----------|-------------|----------------|------------|------------|------------|------------|
| [nm]     | [cc/g]      | Area<br>[m²/g] | [cc/nm/g]  | [m²/nm/g]  | [cc/g]     | [cc/g]     |
| 3.1348   | 1.6864e-03  | 2.1518e+00     | 9.5269e-03 | 1.2156e+01 | 6.8749e-02 | 8.7723e+01 |
| 3.3111   | 3.7838e-03  | 4.6857e+00     | 1.1950e-02 | 1.4436e+01 | 9.1083e-02 | 1.1003e+02 |
| 3.4740   | 5.9775e-03  | 7.2115e+00     | 1.4603e-02 | 1.6815e+01 | 1.1679e-01 | 1.3448e+02 |
| 3.6592   | 9.5031e-03  | 1.1066e+01     | 1.6009e-02 | 1.7500e+01 | 1.3485e-01 | 1.4741e+02 |
| 3.8830   | 1.3927e-02  | 1.5622e+01     | 1.9459e-02 | 2.0046e+01 | 1.7393e-01 | 1.7918e+02 |
| 4.0962   | 1.8787e-02  | 2.0369e+01     | 2.4408e-02 | 2.3835e+01 | 2.3016e-01 | 2.2476e+02 |
| 4.4015   | 3.3571e-02  | 3.3804e+01     | 3.5931e-02 | 3.2654e+01 | 3.6389e-01 | 3.3070e+02 |
| 4.6982   | 4.2258e-02  | 4.1200e+01     | 4.7708e-02 | 4.0618e+01 | 5.1605e-01 | 4.3935e+02 |
| 4.9660   | 6.4382e-02  | 5.9021e+01     | 6.2614e-02 | 5.0435e+01 | 7.1566e-01 | 5.7646e+02 |
| 5.3218   | 8.6201e-02  | 7.5420e+01     | 6.0875e-02 | 4.5755e+01 | 7.4568e-01 | 5.6047e+02 |
| 5.7487   | 1.0813e-01  | 9.0681e+01     | 4.4284e-02 | 3.0813e+01 | 5.8581e-01 | 4.0762e+02 |
| 6.2570   | 1.2095e-01  | 9.8876e+01     | 2.4586e-02 | 1.5717e+01 | 3.5401e-01 | 2.2631e+02 |
| 6.7713   | 1.2910e-01  | 1.0369e+02     | 1.6073e-02 | 9.4950e+00 | 2.5049e-01 | 1.4797e+02 |
| 7.3227   | 1.3582e-01  | 1.0736e+02     | 1.1276e-02 | 6.1597e+00 | 1.9003e-01 | 1.0380e+02 |
| 8.0353   | 1.4217e-01  | 1.1052e+02     | 7.6490e-03 | 3.8077e+00 | 1.4139e-01 | 7.0387e+01 |
| 9.0273   | 1.4808e-01  | 1.1314e+02     | 5.1262e-03 | 2.2714e+00 | 1.0641e-01 | 4.7150e+01 |
| 10.1531  | 1.5161e-01  | 1.1453e+02     | 3.2153e-03 | 1.2667e+00 | 7.5096e-02 | 2.9585e+01 |
| 11.2600  | 1.5474e-01  | 1.1564e+02     | 2.8045e-03 | 9.9628e-01 | 7.2653e-02 | 2.5809e+01 |
| 12.8480  | 1.5940e-01  | 1.1709e+02     | 2.2606e-03 | 7.0379e-01 | 6.6733e-02 | 2.0776e+01 |
| 15.4164  | 1.6480e-01  | 1.1849e+02     | 1.7555e-03 | 4.5548e-01 | 6.2107e-02 | 1.6115e+01 |
| 19.0484  | 1.7141e-01  | 1.1988e+02     | 1.5777e-03 | 3.3131e-01 | 6.8922e-02 | 1.4473e+01 |
| 23.6213  | 1.7782e-01  | 1.2097e+02     | 1.2924e-03 | 2.1885e-01 | 7.0033e-02 | 1.1859e+01 |
| 32.6144  | 1.9164e-01  | 1.2266e+02     | 1.0610e-03 | 1.3012e-01 | 7.8606e-02 | 9.6406e+00 |
| 53.3621  | 2.2031e-01  | 1.2481e+02     | 1.0074e-03 | 7.5512e-02 | 1.2078e-01 | 9.0538e+00 |
| 144.8028 | 3.0126e-01  | 1.2705e+02     | 5.2419e-04 | 1.4480e-02 | 1.5673e-01 | 4.3295e+00 |



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**BJH desorption summary**

|                       |                           |
|-----------------------|---------------------------|
| Surface Area =        | 127.048 m <sup>2</sup> /g |
| Pore Volume =         | 0.301 cc/g                |
| Pore Diameter Dv(d) = | 4.966 nm                  |