CINDAS DATABASES— WHAT'S IN THEM FOR ME?

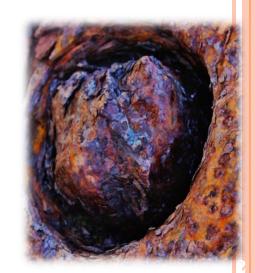
A tutorial on using the CINDAS interactive databases in your library



MATERIALS PROPERTIES



- Change with Temperature
 - Strength, ductility
 - Dimensions: expansion, contraction
- Some properties change with Time
- People who design structures (cars, airplanes, bridges, ships, turbines, oil infrastructures, etc.) need reliable materials data to pick the right material for the application.
 - Always want the best performance and lowest cost



CINDAS LLC DATABASES

- Aerospace and High Performance Alloys Database (AHAD)
- > Aerospace Structural Metals Database (ASMD)
- Thermophysical Properties of Matter Database (TPMD)
- Microelectronics Packaging Materials Database (MPMD)



WHO USES THIS THE INFORMATION?

- Current corporate and research customers include:
 - Aeronautical and Aerospace Industry
 - Government and Defense Industry
 - >Oil and Gas Industry
 - Automotive and Transportation Industry
 - Power Generation Industry
 - Nuclear Research



WHO USES THIS THE INFORMATION?

- Academic Departments and Research Groups
 - Chemical Engineering
 - > Chemistry
 - > Electrical and Electronics Engineering
 - Aerospace and Aeronautical Engineering
 - Materials Science
 - Mechanical Engineering
 - Nuclear Engineering
 - Physics and Applied Physics



SOME COMMON EXAMPLES OF CINDAS APPLICATIONS

- The following slides will take you through some examples of potential or existing uses including:
 - Chemical Processing
 - Energy and Nuclear
 - Electronics
 - Marine and Maritime
 - Medical
 - Oil and Gas
 - Aerospace
 - Defense



TPMD CONTENTS

- Contains data on over 5000 materials
- In 85 Material Groups
- Covering 107 different properties
- With over 51,000 data curves

CINDAS PRODUCTS PROVIDE IMPORTANT DATA ON PROPERTIES FOR MATERIALS

- Density
- Entropy
- Specific Heat Capacity
- Thermal Conductivity
- Coefficient of Thermal Expansion
- Viscosity
- Transmittance
- Absorption
- Reflectance
- Emittance
- Extinction Coefficient
- Absorbance
- Refractive Index

Thermophysical

Thermoradiative

Optical



FOUR WAYS TO SEARCH THE DATABASE

CINDAS I C Global Benchmark for Critically Evaluated Materials Properties Data

Home

About Us →

Products -

Support +

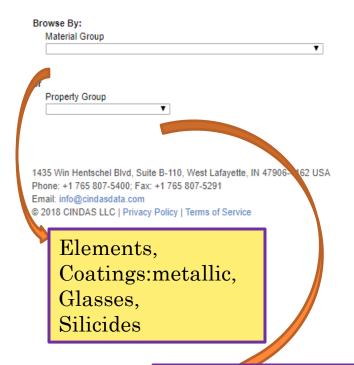
Contact

Database Menu

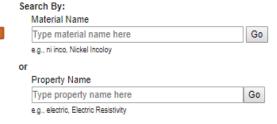
Administration

Logout

TPMD (version 10, data updated 2016.2)



Thermophysical Thermoradiative Optical Start Over | TOC | PDF | Help



Uranium Nickel Aluminides Cermet

Back to top

Thermal Conductivity
Thermal Diffusivity
Specific Heat

To compare the same property of two or more materials search by Property Group.

| Browse By: Material Group Material Name Type material name here e.g., ni inco, Nickel Incoloy Or Property Group Thermophysical Properties Type property Name Type property Name Type property name here e.g., electric, Electric Resistivity 435 Win Hentschel Blvd, Suite B-0, West Lafayette, IN 47906-4162 USA | ΓΡΜD (version 10, data updated 2016.2) | | Start Over TOC PDF Help |
|---|--|--|-------------------------------|
| Property Group Thermophysical Properties Type property name here e.g., electric, Electric Resistivity Sylvan Hentschel Blvd, Suite B-0, West Lafayette, IN 47906-4162 USA | Material Group | Material Name Type material name here | Go |
| | Property Group | or Property Name Type property name here | Go |
| nail: info@cindasdata.com | none: +1 765 807-5400; Fax: +1 5 807-5291 nail: info@cindasdata.com | | Back to top |

CINDAS LLC

Global Benchmark for Critically Evaluated Materials Properties Data

Home

About Us -

Products -

Support - Contact

Database Menu

Administration

Logout

TPMD (version 10, data updated 2016.2)

Start Over | TOC | PDF | Help

| Select Property Group: Thermophysical Properties ▼ | |
|--|----------|
| (4 property groups) | |
| Select Property Name: | ▼ |
| (34 properties) | |
| | |
| 1435 Win Hentschel Blvd, Suite B-110, West Lafayette, IN 47906 | -4162 US |
| Phone: +1 765 807-5400; Fax: +1 765 807-5291 | |
| Email: info@cindasdata.com | |
| © 2018 CINDAS LLC Privacy Policy Terms of Service | |

Of the 34 properties, choose Thermal Conductivity

Back to top



TPMD (version 10, data updated 2016.2)

Select Property Group: Thermophysical Properties ▼

(4 property groups)

Select Property Name: Thermal Conductivity

(34 properties)

Property Range

Thermal Conductivity (W cm[-1] K[-1])0.0 - 158.0

Select an Independent Variable, and then click the Show Graph or Show Text button.

•

| • | | |
|--|-------------|-----------|
| Independent Variable | Minimum | Maximum |
| OAging Time (days) | 0.0 | 5280.0 |
| OAir Pressure (MPa) | 1.33322e-06 | 0.93 |
| OAngle (degree) | -160.0 | 180.0 |
| OAnnealing Temperature (K) | 225.0 | 1548.2 |
| Apparent Specific Gravity (fraction) | 1.21 | 1.29 |
| OArgon Pressure (MPa) | 1.33322e-06 | 0.71 |
| OCarbon Dioxide Pressure (MPa) | 80.0 | 6.41 |
| Ocos [2] Angle (alternate/no units) | 0.0 | 1.0 |
| ODensity (g cm[-3]) | 0.00756 | 1.84 |
| Electric Conductivity (ohm[-1] cm[-1]) | 258.0 | 1497.0 |
| OFreon-12 Pressure (MPa) | 80.0 | 0.12 |
| OHelium Pressure (MPa) | 9.7725e-09 | 8.12 |
| OHydrogen Pressure (MPa) | 7.99932e-07 | 8.54 |
| Olrradiation Level (MWD Te[-1]) | 985.0 | 3157.0 |
| Magnetic Field Strength (A/m) | 13528.09 | 1018585.6 |
| Magnetic Flux Density (T) | 0.0 | 0.98 |
| OMethane Pressure (MPa) | 1.33322e-06 | 0.49 |
| Moisture Content (percent) | 1.0 | 26.8 |
| Mole Fraction of Acetylene (fraction) | 0.0 | 1.0 |
| Mole Fraction of Air (fraction) | 0.0 | 1.0 |
| Mole Fraction of Ammonia (fraction) | 0.1 | 1.0 |
| Mole Fraction of Argon (fraction) | 0.09 | 1.0 |
| Mole Fraction of Benzene (fraction) | 0.0 | 1.0 |
| Mole Fraction of Carbon Dioxide (fraction) | 0.0 | 1.0 |
| Mole Fraction of Carbon Monoxide (fraction) | 0.0 | 1.0 |
| Mole Fraction of Chloroform (fraction) | 0.0 | 1.0 |
| Mole Fraction of Cyclopropane (fraction) | 0.0 | 1.0 |
| | 0.09 | 1.0 |
| Mole Fraction of Dimethyl Ether (fraction) | 0.0 | 1.0 |
| Mole Fraction of Ethane (fraction) | 0.0 | 1.0 |
| OMole Fraction of Ethyl Ether (fraction) | 0.0 | 1.0 |
| OMole Fraction of Ethylene (fraction) | 0.0 | 1.0 |
| Mole Fraction of Helium (fraction) | 80.0 | 1.0 |
| OMole Fraction of Hexane (fraction) | 0.0 | 1.0 |
| OMole Fraction of Hydrogen (fraction) | 0.12 | 1.0 |
| OMole Fraction of Krypton (fraction) | 0.09 | 1.0 |
| III | | |

Choose Moisture Content as independent variable

Click on Show Graph



Home

About Us **▼**

Products -

Support **▼**

Contact

Database Menu

Administration

Logout

TPMD (version 10, data updated 2016.2)

Start Over | TOC | PDF | Help

Property Group: Thermophysical Properties

Thermal Conductivity (W cm[-1] K[-1]) Change Units ▼ ■ Logarithmic Property:

Independent Variable: Moisture Content (percent) Change Units 🔻 🗆 Logarithmic

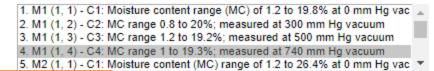
Edit Selection Show Text

Select Materials?

Select Data Curves/Test Conditions?

Select one or more materials from the list below. Hold the control key to select multiple materials. Available data curves will be displayed on the right. Then proceed to Step Key: Selected Material: (Set. Curve) - Remarks 2.

Select between one and twenty data curve descriptions from the list below to view graphs. Hold the Control key to select multiple data curves.



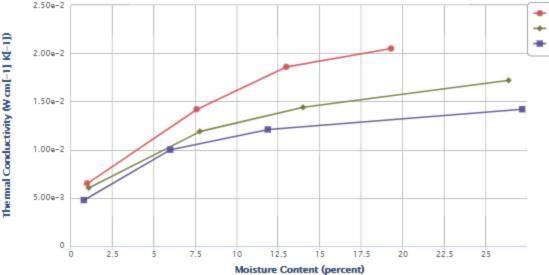
(Listing 4 materials)

M3: Clay, Kuchin M4: Spruce

M1: Clay, Ashkhabad

M2: Clav. Beshkudnikov

Thermal Conductivity vs Moisture Content 3 Materials 4. Material 1 (1, 4) 8. Material 2 (1, 4) 11. Material 3 (1, 3) Choose materials M1, M2 and M3, types of clay



Choose Curves 4, 8 and 11.

CINDAS LLC www.cindasdata.com

Home

About Us **▼**

Products -

Support **▼**

Contact

Database Menu

Administration

Logout

TPMD (version 10, data updated 2016.2)

Property Group: Thermophysical Properties

Thermal Conductivity (W cm[-1] K[-1]) Change Units ▼ □ Logarithmic Property:

Independent Variable: Moisture Content (percent) Change Units 🔻 🗆 Logarithmic

7.5

Moisture Content (percent)

Can change units for both property and independent variable.

Edit Selection Show Text

Start Over | TOC | PDF | Help

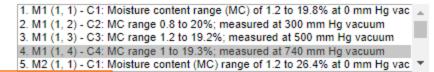
Select Materials?

Select one or more materials from the list below. Hold the control key to select multiple materials. Available data

curves will be displayed on the right. Then proceed to Step Key: Selected Material: (Set. Curve) - Remarks 2.

Select Data Curves/Test Conditions?

Select between one and twenty data curve descriptions from the list below to view graphs. Hold the Control key to select multiple data curves.



(Listing 4 materials)

2.50e-2

2.00e-2

1.50e-2

1.00e-2

5.00e-3

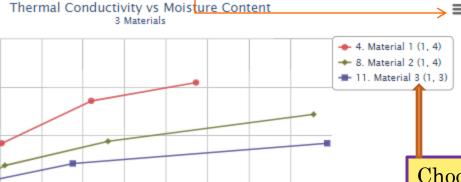
0

2.5

The mal Conductivity (W cm[-1] K[-1])

M3: Clay, Kuchin M4: Spruce

M1: Clay, Ashkhabad M2: Clav. Beshkudnikov



22.5

25

Choose materials M1, M2 and M3, types of clay

Choose Curves 4, 8 and 11.



Contact

Database Menu

TPMD (version 10, data updated 2016.2)

Products -

Start Over | TOC | PDF | Help

Administration

Edit Selection Show Text

Logout

Property Group: Thermophysical Properties

About Us **→**

▼ □ Logarithmic Thermal Conductivity (W cm[-1] K[-1]) Change Units Property:

Moisture Content (percent)

Support -

Independent Variable: Moisture Content (percent) Change Units ▼ □ Logarithmic

Select Materials?

Home

Select Data Curves/Test Conditions?

Select one or more materials from the list below. Hold the control key to select multiple materials. Available data curves will be displayed on the right. Then proceed to Step Key: Selected Material: (Set, Curve) - Remarks 2.

Select between one and twenty data curve descriptions from the list below to view graphs. Hold the Control key to select multiple data curves.

M1: Clay, Ashkhabad M2: Clav. Beshkudnikov M3: Clay, Kuchin

M4: Spruce

(Listing 4 materials)

2.50e-2

2.00e-2

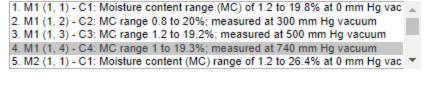
1.50e-2

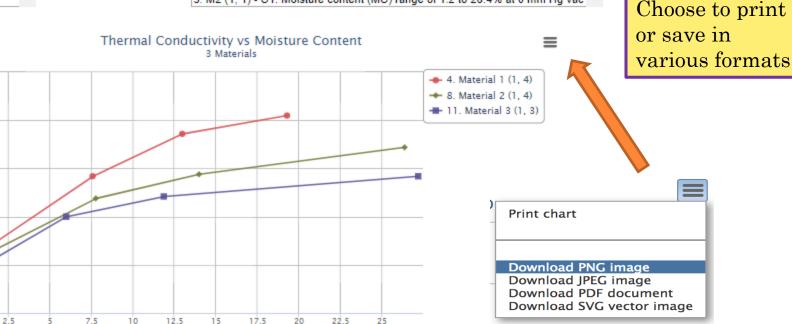
1.00e-2

5.00a-3

0

The mal Conductivity (W cm[-1] K[-1])





TPMD (version 10, data updated 2016.2)

Start Over | TOC | PDF | Help

Edit Selection

Show Text

Property Group: Thermophysical Properties

Thermal Conductivity (W cm[-1] K[-1]) Change Units ▼ □ Logarithmic Property:

Independent Variable: Moisture Content (percent) Change Units 🔻 🗆 Logarithmic

Select Materials?

Select Data Curves/Test Conditions?

control key to select multiple materials. Available data curves will be displayed on the right. Then proceed to Step Key: Selected Material: (Set, Curve) - Remarks

Select one or more materials from the list below. Hold the Select between one and twenty data curve descriptions from the list below to view graphs. Hold the Control key to select multiple data curves.

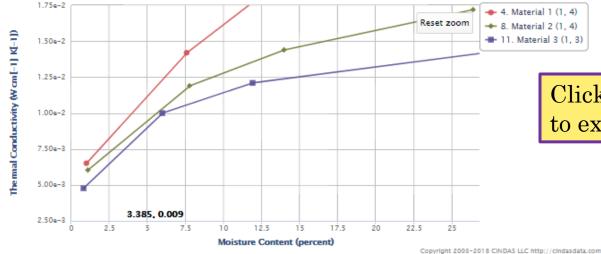
M1: Clay, Ashkhabad M2: Clay, Beshkudnikov M3: Clay, Kuchin M4: Spruce

1. M1 (1, 1) - C1: Moisture content range (MC) of 1.2 to 19.8% at 0 mm Hg vac 2. M1 (1, 2) - C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum 3. M1 (1, 3) - C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum 4. M1 (1, 4) - C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum 5. M2 (1, 1) - C1: Moisture content (MC) range of 1.2 to 26.4% at 0 mm Hg vac .

(Listing 4 materials)

Thermal Conductivity vs Moisture Content 3 Materials





Click and drag cursor to expand graph.

Learn how to use advanced features in the Help section.



TPMD (version 10, data updated 2016.2)

Start Over | TOC | PDF | Help

Edit Selection

Show Text

Property Group: Thermophysical Properties

▼ ■ Logarithmic Thermal Conductivity (W cm[-1] K[-1]) Change Units Property:

Independent Variable: Moisture Content (percent) Change Units 🔻 🗆 Logarithmic

Select Materials?

Select Data Curves/Test Conditions?

control key to select multiple materials. Available data curves will be displayed on the right. Then proceed to Step Key: Selected Material: (Set, Curve) - Remarks

3.385, 0.009

Select one or more materials from the list below. Hold the Select between one and twenty data curve descriptions from the list below to view graphs. Hold the Control key to select multiple data curves.

2. M1: Clay, Ashkhabad M2: Clay, Beshkudnikov M3: Clay, Kuchin M4: Spruce

1. M1 (1, 1) - C1: Moisture content range (MC) of 1.2 to 19.8% at 0 mm Hg vac 2. M1 (1, 2) - C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum 3. M1 (1, 3) - C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum

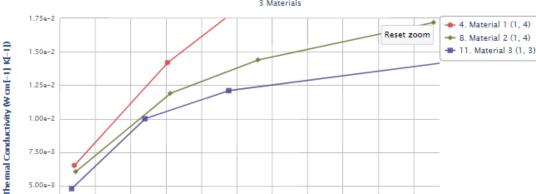
4. M1 (1, 4) - C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum 5. M2 (1, 1) - C1: Moisture content (MC) range of 1.2 to 26.4% at 0 mm Hg vac *

(Listing 4 materials)

5.00e-8

2.50a-3





15

17.5

22.5

25

Copyright 2008-2018 CINDAS LLC http://cindasdata.com

Click on Show Text to get actual data points.

Learn how to use advanced features in the Help section.

Moisture Content (percent)

12.5

10



Property: Thermal Conductivity (W cm[-1] K[-1]) Change Units ▼ □ Logarithmic Independent Variable:Moisture Content (percent) Change Units ▼ □ Logarithmic

Show Graph

Select Materials?

Select one or more materials from the list below. Hold the control key to select multiple materials. Available data curves will be displayed on the right. Then proceed to Step 2.

Budnikov, P.P. etal; J. Appl. Chem (USSR), 25, 665-73, 1952

Budnikov, P.P. etal; Zhur. Priklad, Khim; 25, 582-91, 1952

```
M1: Clay, Ashkhabad
M2: Clay, Beshkudnikov
M3: Clay, Kuchin
M4: Spruce
```

Select Data Curves/Test Conditions

Select a dataset from the box to show text.

```
1. M1 (1, 1) - C1: Moisture content range (MC) of 1.2 to 19.8% at 0 mm Hg vac 2. M1 (1, 2) - C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum 3. M1 (1, 3) - C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum 4. M1 (1, 4) - C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum 5. M2 (1, 1) - C1: Moisture content (MC) range of 1.2 to 26.4% at 0 mm Hg vac
```

```
(Listing 4 materials)
 Material:
                      Clay, Ashkhabad
 Property:
                      Thermal Conductivity (W cm[-1] K[-1])
 Independent Variable: Moisture Content (percent)
 Ashkhabad specimens; specimen 70 mm in dia and 100 mm long;
 volumetric weight 1200 Kg cm[-3]. Tested at 313.2 K.
 Periodic or transient heat flow method used.
                                                                                                   Conditions
 C1: Moisture content (MC) range of 1.2 to 19.8% at 0 mm Hg vacuum.
 C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum.
 C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum.
 C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum.
 Method Used: Periodic or transient heat flow method
 Data Points
    X
 Curve: 1
 1.200e+00
             4.650e-03 C1: MC range of 1.2 to 19.8% at 0 mm Hg vacuum.
 8.000e+00
             1.160e-02
             1.390e-02
 1.400e+01
 1.980e+01
             1.390e-02
 Curve: 2
 8.000e-01
             5.110e-03 C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum.
                                                                                                        Data
 7.400e+00
             1.210e-02
             1.580e-02
 1.360e+01
 2.000e+01
            1.670e-02
 Curve: 3
 1.200e+00
             6.040e-03 C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum.
 8.000e+00
             1.390e-02
 1.280e+01
             1.740e-02
 1.920e+01
             1.880e-02
 Curve: 4
 1.000e+00
             6.510e-03 C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum.
 7.600e+00
             1.428e-82
 1.300e+01
             1.860e-02
 1.930e+01
             2.050e-02
 References
```



Property: Thermal Conductivity (W cm[-1] K[-1]) Change Units

Logarithmic Independent Variable:Moisture Content (percent) Change Units

Logarithmic

Edit Selection Show Graph

Select Materials?

Select one or more materials from the list below. Hold the control key to select multiple materials. Available data curves will be displayed on the right. Then proceed to Step 2.

```
M1: Clay, Ashkhabad
M2: Clay, Beshkudnikov
M3: Clay, Kuchin
M4: Spruce
```

Select Data Curves/Test Conditions

Select a dataset from the box to show text.

```
1. M1 (1, 1) - C1: Moisture content range (MC) of 1.2 to 19.8% at 0 mm Hg vac 2. M1 (1, 2) - C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum 3. M1 (1, 3) - C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum 4. M1 (1, 4) - C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum 5. M2 (1, 1) - C1: Moisture content (MC) range of 1.2 to 26.4% at 0 mm Hg vac
```

```
(Listing 4 materials)
 Material:
                      Clay, Ashkhabad
 Property:
                      Thermal Conductivity (W cm[-1] K[-1])
 Independent Variable: Moisture Content (percent)
 Ashkhabad specimens; specimen 70 mm in dia and 100 mm long;
 volumetric weight 1200 Kg cm[-3]. Tested at 313.2 K.
 Periodic or transient heat flow method used.
 C1: Moisture content (MC) range of 1.2 to 19.8% at 0 mm Hg vacuum.
 C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum.
 C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum.
 C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum.
 Method Used: Periodic or transient heat flow method
 Data Points
    X
 Curve: 1
             4.650e-03 C1: MC range of 1.2 to 19.8% at 0 mm Hg vacuum.
 1.200e+00
 8.000e+00
             1.160e-02
             1.390e-02
 1.400e+01
 1.980e+01
             1.390e-02
 Curve: 2
 8.000e-01
             5.110e-03 C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum.
 7.400e+00
             1.210e-02
             1.580e-02
 1.360e+01
 2.000e+01
            1.670e-02
 Curve: 3
             6.040e-03 C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum.
 1.200e+00
 8.000e+00
             1.390e-02
 1.280e+01
             1.740e-02
 1.920e+01
             1.880e-02
 Curve: 4
 1.000e+00
             6.510e-03 C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum.
 7.600e+00
             1.420e-02
 1.300e+01
             1.860e-02
 1.930e+01
             2.050e-02
 References
 Budnikov, P.P. etal; J. Appl. Chem (USSR), 25, 665-73, 1952
```

Budnikov, P.P. etal; Zhur. Priklad, Khim; 25, 582-91, 1952

Curves from same reference are shown together.



Property: Thermal Conductivity (W cm[-1] K[-1]) Change Units ▼ □ Logarithmic

Independent Variable: Moisture Content (percent) Change Units ▼ □ Logarithmic

Select Materials?

Select one or more materials from the list below. Hold the control key to select multiple materials. Available data curves will be displayed on the right. Then proceed to Step 2.

Clay, Ashkhabad

M1: Clay, Ashkhabad M2: Clay, Beshkudnikov M3: Clay, Kuchin M4: Spruce

Select Data Curves/Test Conditions

Select a dataset from the box to show text.

1. M1 (1, 1) - C1: Moisture content range (MC) of 1.2 to 19.8% at 0 mm Hg vac
2. M1 (1, 2) - C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum
3. M1 (1, 3) - C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum
4. M1 (1, 4) - C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum
5. M2 (1, 1) - C1: Moisture content (MC) range of 1.2 to 26.4% at 0 mm Hg vac

```
(Listing 4 materials)
```

Material:

```
Property:
                    Thermal Conductivity (W cm[-1] K[-1])
Independent Variable: Moisture Content (percent)
Ashkhabad specimens; specimen 70 mm in dia and 100 mm long;
volumetric weight 1200 Kg cm[-3]. Tested at 313.2 K.
Periodic or transient heat flow method used.
C1: Moisture content (MC) range of 1.2 to 19.8% at 0 mm Hg vacuum.
C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum.
C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum.
C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum.
Method Used: Periodic or transient heat flow method
Data Points
   X
Curve: 1
1.200e+00
           4.650e-03 C1: MC range of 1.2 to 19.8% at 0 mm Hg vacuum.
8.000e+00
           1.160e-02
1.400e+01 1.390e-02
1.980e+01 1.390e-02
Curve: 2
8.000e-01 5.110e-03 C2: MC range 0.8 to 20%; measured at 300 mm Hg vacuum.
7.400e+00 1.210e-02
1.360e+01 1.580e-02
2.000e+01 1.670e-02
Curve: 3
1.200e+00
            6.040e-03 C3: MC range 1.2 to 19.2%; measured at 500 mm Hg vacuum.
8.000e+00
           1.390e-02
1.280e+01
           1.740e-02
1.920e+01 1.880e-02
Curve: 4
1.000e+00
            6.510e-03 C4: MC range 1 to 19.3%; measured at 740 mm Hg vacuum.
7.600e+00
           1.420e-02
1.300e+01 1.860e-02
1.930e+01 2.050e-02
```

All data is referenced.

References

Budnikov, P.P. etal; J. Appl. Chem (USSR), 25, 665-73, 1952 Budnikov, P.P. etal; Zhur. Priklad, Khim; 25, 582-91, 1952



QUESTIONS?



- Use the chat function on the screen to send us questions now.
- Questions later can always be sent to us
 - <u>info@cindasdata.com</u> or
 - <u>rob@cindasdata.com</u> or
 - patti@cindasdata.com





