Predicting the Density and Viscosity of Supercritical CO_2 Applet

by John R. Victorine

Introduction

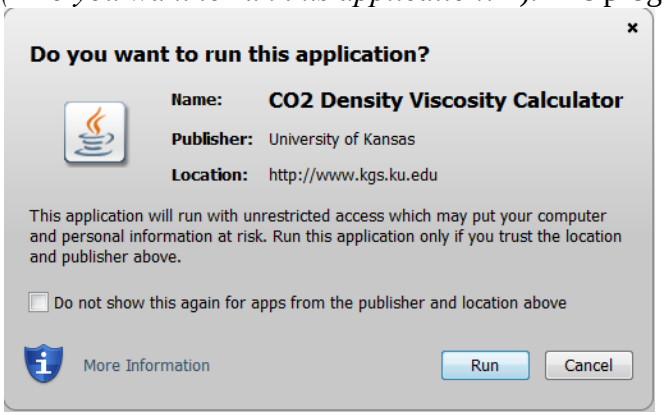
This applet allows the user to import a comma delimited file containing columns of pressure (psia) and temperature (^oC) for supercritical carbon dioxide which will then create a comma delimited file with the contents of the first file with two new columns containing the density (kg/m^3) and viscosity (cp). The user only needs to identify the header section, the start of the data and the pressure and temperature columns. The program will then parse the pressure and temperature from the file and compute the density and viscosity using Liang-Biao Ouyang[1] equations.

This program uses the equations created by Liang-Biao Ouyang[1] paper to predict the density and viscosity of supercritical carbon dioxide under conditions in carbon capture and sequestration operations. Liang-Biao Ouyang cites examples between the pressures of 1100 to 9000 psia and at temperatures between 40 to 100 deg C.

This method uses the Java BigDecimal Math package to compute the density and viscosity.

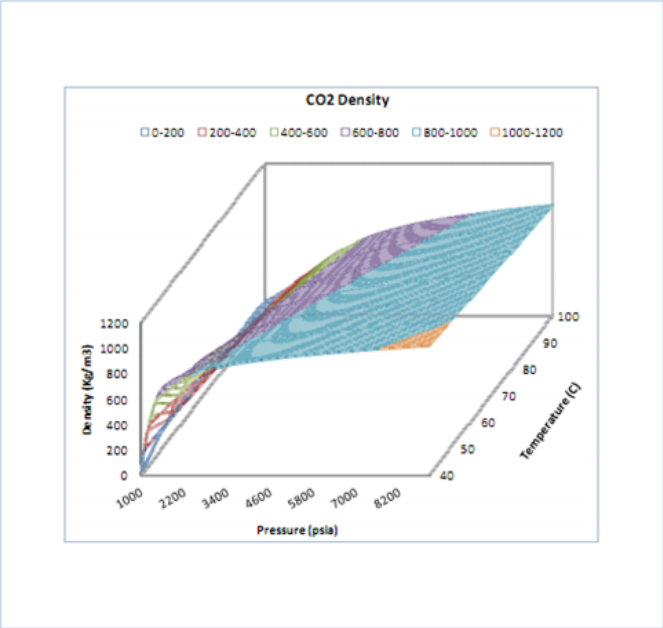
NOTE: Pressure and Temperature must be in units of psia and degree Celsius.

To access this Predicting the Density and Viscosity of Supercritical CO_2 Applet, go to the web address, http://www.kgs.ku.edu/PRS/Ozark/CO2/. A "Warning - Security" Dialog will appear *("Do you want to run this application?")*. The program has to be able to read and write to the user's PC. The program does not save your files to KGS, but allows you to access the KGS for well information. The program does not use Cookies or any hidden software. The blue shield on the warning dialog is a symbol that the Java web app is created by a trusted source, which is the University of Kansas. Select the "Run" Button, which will display the Seismic Image Icon Button in the "Enter" Panel illustrated below,



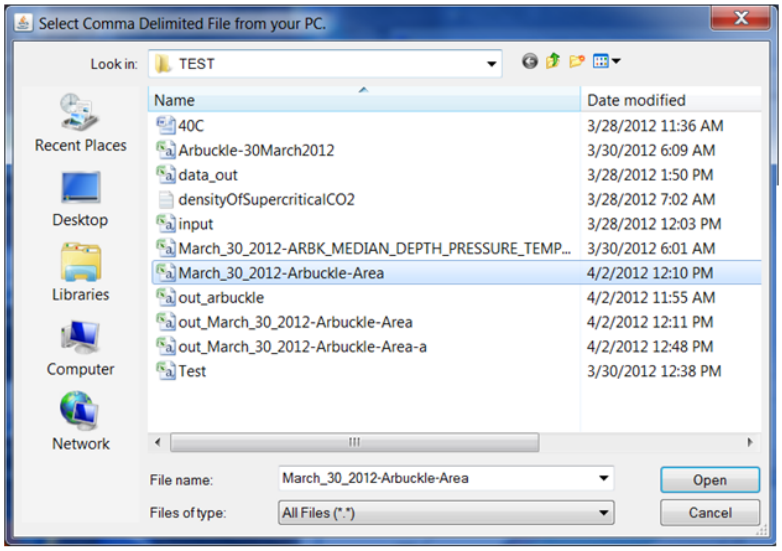
References:

(1) New Correlations for Predicting the Density and Viscosity of Supercritical Carbon Dioxide Under Conditions Expected in Carbon Capture and Sequestration Operations by Liang-Biao Ouyang The Open Petroleum Engineering Journal, 2011, 4, 13-21



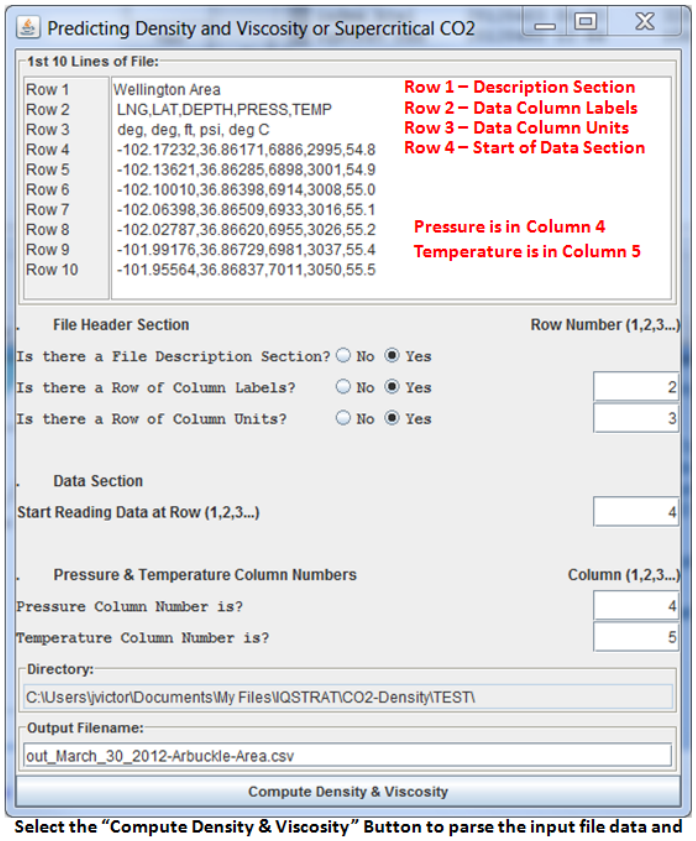
Enter

Select the CO2 Density Icon Button to launch the Search for Comma Delimited File Dialog.



Select the Comma Delimited File on your PC.

```
Wellington Area
LNG,LAT,DEPTH,PRESS,TEMP
deg, deg, ft, psi, deg C
-102.17232,36.86171,6886,2995,54.8
-102.13621,36.86285,6898,3001,54.9
-102.10010,36.86398,6914,3008,55.0
-102.06398,36.86509,6933,3016,55.1
-102.02787,36.86620,6955,3026,55.2
-101.99176,36.86729,6981,3037,55.4
-101.95564,36.86837,7011,3050,55.5
-101.91953,36.86944,7045,3065,55.8
-101.88341,36.87050,7084,3082,56.0
-101.84729,36.87155,7128,3101,56.3
-101.81117,36.87258,7178,3122,56.6
-101.77505,36.87361,7232,3146,56.9
-101.73893,36.87462,7292,3172,57.3
-101.70281,36.87563,7357,3200,57.7
-101.66669,36.87662,7426,3230,58.1
-101.63057,36.87760,7499,3262,58.5
-101.59444,36.87857,7573,3294,59.0
-101.55832,36.87953,7648,3327,59.4
-101.52219,36.88047,7723,3360,59.9
-101.48606,36.88141,7796,3391,60.3
-101.44993,36.88233,7865,3421,60.8
-101.41380,36.88325,7930,3449,61.2
-101.37767,36.88415,7988,3475,61.5
-101.34154,36.88504,8040,3497,61.8
-101.30541,36.88592,8084,3516,62.1
-101.26928,36.88679,8119,3532,62.3
-101.23315,36.88764,8144,3543,62.5
-101.19701,36.88849,8160,3550,62.6
-101.16088,36.88932,8169,3553,62.6
```



Select the "Compute Density & Viscosity" Button to parse the input file data and compute the density and viscosity and send the information to the output file in the "Output Filename:" text field.

This dialog was created to help retain the contents of the original file. The program holds the data as Strings and only parses the Pressure and Temperature columns to compute the density and viscosity. The program then adds the density and viscosity columns to the comma delimited file as two new columns.

This section asks a series of questions to reproduce the header section of the original comma delimited file in the output file.

This section is looking for what row the data starts.

This section is looking for the column numbers for the Pressure and Temperature. The Columns start at 1, 2, 3, etc.

This section holds the information about the output directory and filename. The filename will be the same as the input file except a "out_" is pre-pended to the name. The directory is the same as where the input file was opened.

```
Wellington Area
LNG,LAT,DEPTH,PRESS,TEMP,density,viscosity
deg,deg,ft,psi,deg C,kgs/m^3,cp
-102.17232,36.86171,6886,2995,54.8,773.5382344791029,0.06621175144572349
-102.13621,36.86285,6898,3001,54.9,766.1977971217736,0.06586820771801956
-102.10010,36.86398,6914,3008,55.0,766.1848764472594,0.0658727677136217
-102.06398,36.86509,6933,3016,55.1,766.2526952955003,0.06589014601667677
-102.02787,36.86620,6955,3026,55.2,766.4810307831444,0.06593302609688251
-101.99176,36.86729,6981,3037,55.4,766.2193441498027,0.06590431030750618
-101.95564,36.86837,7011,3050,55.5,766.6885745818845,0.06598529651941046
-101.91953,36.86944,7045,3065,55.8,766.1833194010618,0.06592399134632565
-101.88341,36.87050,7084,3082,56.0,766.4079543197196,0.06597203830223555
-101.84729,36.87155,7128,3101,56.3,766.23115173402,0.065962408248918
-101.81117,36.87258,7178,3122,56.6,766.2188635860757,0.0659784945742397
-101.77505,36.87361,7232,3146,56.9,766.4494034388617,0.06603250986128638
-101.73893,36.87462,7292,3172,57.3,766.2887675419815,0.06603020833757935
-101.70281,36.87563,7357,3200,57.7,766.2951655651503,0.06605363322317193
-101.66669,36.87662,7426,3230,58.1,766.4671226835984,0.06610239361202545
-101.63057,36.87760,7499,3262,58.5,766.8026727827762,0.06617605627316235
-101.59444,36.87857,7573,3294,59.0,766.6062231433559,0.06617101837678895
-101.55832,36.87953,7648,3327,59.4,767.0340420558442,0.06625754627567024
-101.52219,36.88047,7723,3360,59.9,766.9366170470328,0.06626643392173516
-101.48606,36.88141,7796,3391,60.3,767.2219406873701,0.06632935263471948
-101.44993,36.88233,7865,3421,60.8,766.9134695785144,0.06630419546848013
-101.41380,36.88325,7930,3449,61.2,766.9821828843378,0.06633240692605769
-101.37767,36.88415,7988,3475,61.5,767.4191835689976,0.0664126960079778
-101.34154,36.88504,8040,3497,61.8,767.5526741520057,0.06644581914905502
-101.30541,36.88592,8084,3516,62.1,767.4613390442825,0.06644403897299958
-101.26928,36.88679,8119,3532,62.3,767.6547639012911,0.06648185837010456
-101.23315,36.88764,8144,3543,62.5,767.4712418651338,0.06646159071094608
-101.19701,36.88849,8160,3550,62.6,767.4934562704209,0.06646894582122999
-101.16088,36.88932,8169,3553,62.6,767.7198098660876,0.06650372393784879
```