

# **LIQPROP**

*Liquid Properties Program*

User Manual



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Fax: (928) 453-9587

Email: [support@systek.us](mailto:support@systek.us)

Web site: [www.systek.us](http://www.systek.us)

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# **1. Introduction**

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**LIQPROP®** calculates the specific gravity, viscosity, bulk modulus and compressibility factor of petroleum products at various temperatures and pressures.

The program also converts specific gravity to API gravity and vice versa, viscosity from centipoises, SSU and SSF to centistokes and calculates the specific gravity and viscosity of blended petroleum products.

LIQPROP uses the built-in database of liquid properties consisting of API gravity, specific gravity and viscosity at various temperatures. From the database, using the properties of the components, the program calculates the compressibility factor, using generally accepted industry standard methods.

Data is entered using the familiar pull down menus and dialog boxes under the Microsoft Windows operating environment. Default data is provided in most cases. Liquid blending data is entered using a spreadsheet. The database is stored in a proprietary format with a file name extension .SS6, but the spreadsheet information can be exchanged with Excel and compatible spreadsheets.

The calculated results are displayed on the screen, and a printed copy can be obtained as well.

Last minute changes to the program are documented in a file named README.TXT, if present on the program disk.

This software can be run on Pentium and Athlon based computers and compatibles with a minimum of 1 GB RAM running Microsoft Windows 2000/XP/Vista or Windows 7 operating systems. A minimum hard disk space of 20 MB is required for installing the program.

*The software is licensed for use on one computer, at a time. Network and multi-user licenses are available.*

## 2. Getting Started

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The software program is supplied on a CD-ROM that must be installed on your computer's hard disk as described below. *If you purchased a USB dongle version (hardware key) follow the installation steps under section 2.1 below. However, if you have an internet authenticated version of the program that does not use a dongle follow the steps under section 2.2.*

*This single user license entitles you to use the software only on one computer at a time. If you purchased a multi-user or network license, you are entitled to use the software on more than one computer as described in other documentation that accompanied the software.*

### 2.1 Installation – USB dongle version

The software is protected by a USB dongle that plugs into your computer's USB port. This dongle is plugged into the USB port *after* the installation of the software. This dongle, shown in the figure below, *must* be in place for the software to operate properly. **Do not attach the dongle until after the dongle installation step is completed.**



Since the *dongle* is critical to the operation of the software, it must be stored safely when not in use. It is recommended that Laptop computer users remove the *dongle* from the USB port before packing the laptop in its carrying case.

The software will work **only** with the specific USB dongle included with the program CD. If this is an upgrade to the program, you will continue to use the original USB dongle when you first purchased the software. The USB dongles cannot be interchanged. Each dongle is specific to the software.

With one licensed copy, the program may be concurrently installed on more than one computer. However, the software will only run on the computer that has the USB dongle attached.

*A lost or damaged dongle is equivalent to losing the software. A replacement dongle can only be obtained at the full retail price of the software. In other words, the dongle costs as much as the software itself.*

## Getting Started

Before starting the installation process, close all running applications and turn off any virus checking software, if currently present on the hard disk. If you want to ensure that the program CD is free of any virus you may run the virus scanning software and check the program CD prior to starting installation.

### Step-1:

Insert the software CD into the CD-ROM drive. If *Autostart* is enabled on the CD-ROM drive, setup will start automatically. If not, from the **Start** button choose **Run**.

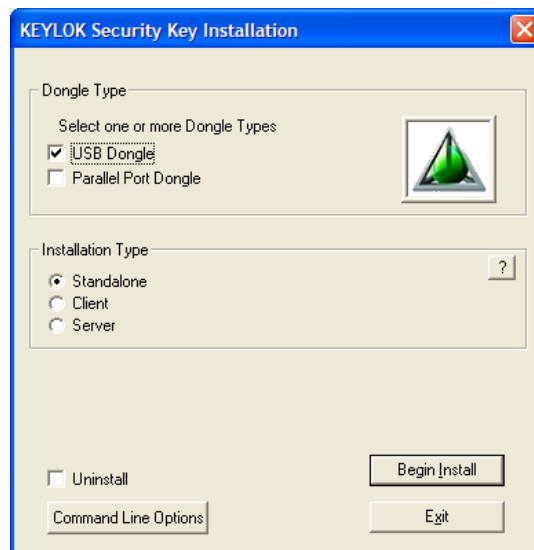
Type the following in the resulting screen: `G:\setup` and press Enter

Where G represents the drive letter for your CD-ROM drive.  
Follow the subsequent screen instructions to continue with the installation process.

### Step-2:

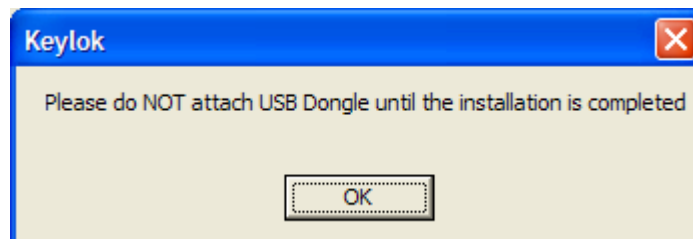
After the software is installed, the Dongle Installation will automatically start.  
**Do not attach the dongle until after the dongle installation step is completed.**

Initially, the screen below is displayed:



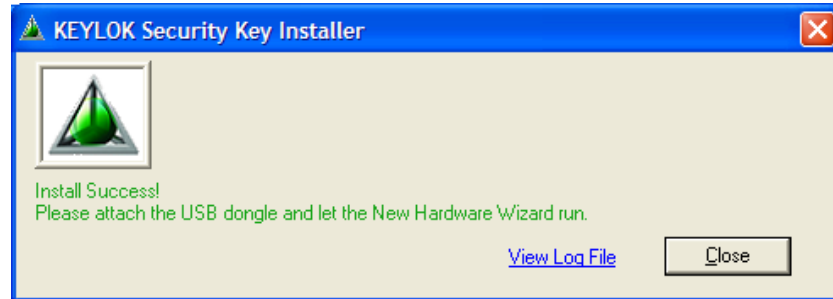
Choose the **USB Dongle** type and **Standalone** installation type as shown and click **Begin Install**.

Next, the following screen is displayed. Click OK to confirm.



## Getting Started

When the dongle installation is completed (may take a few minutes), and a message is displayed to this effect, you should attach the dongle to one of the USB ports as directed in screen below.



The computer will recognize the dongle and the software driver will be installed automatically.

After the setup is completed and you start LIQPROP software from the Windows Start button, the User Registration screen will prompt you to enter your name, company and the software serial number.

***The serial number found on the software CD container must be entered exactly.*** Otherwise the installation will be incomplete.

The Licensed User is eligible to receive **free** technical support for one year from the date of purchase. After this period, the User may sign up for an annual Software Maintenance Program.

***Put your original software CD-ROM away safely.***

### ***Manual Installation of dongle files***

***If for some reason the dongle installation does not start automatically then you must manually start the dongle program (Keylok.exe) from the Start/Run button as follows:***

***Keylok /B*** and press enter

*The above must be executed from the SYSTEK folder containing the Keylok.exe program. After this go back to Step 2 above to continue installation.*

## Getting Started

---

After the setup is completed, the **User Registration screen** will prompt you to enter your name, company name and the program serial number. ***The serial number found on the program CD container must be entered exactly.*** Otherwise the installation will be incomplete.

Once installation is completed, a program icon and program folder will be automatically created. You may launch the program from the Windows **Start** button. You may also create a shortcut to the program on your desktop.

### 2.2 Installation – Internet Authenticated Version

*Before starting the installation process, close all currently running programs and turn off any virus checking software, if present on the hard disk. If you want to ensure that the program CD is free of any virus you may run the virus scanning software and check the program CD prior to starting installation.*

Insert the software CD into the CD-ROM drive. If *Autostart* is enabled on the CD-ROM drive, setup will start automatically. If not, from the Windows **Start** button choose **Run**.

Type the following in the resulting screen:

G:\setup and press Enter

Where G represents the drive letter for your CD-ROM drive.

Follow the subsequent screen instructions to continue with the installation process.

After the setup is completed, the **User Registration screen** will prompt you to enter your name, company name and the program serial number. ***The serial number found on the program CD container must be entered exactly.*** Otherwise the installation will be incomplete.

*You must be connected to the Internet to register the program and obtain a license. Otherwise you will not be able to run the software after installation.*

Once installation is completed, a program icon and program folder will be automatically created. You may launch the program from the Windows **Start** button. You may also create a shortcut to the program on your desktop.

### 2.3 Retaining/Releasing - Internet Authenticated Version

To launch the program, you will either use the Windows **Start** button or click the program icon from the Program menu. If the program is properly registered and the license obtained, you will be able to start the program.

When you quit the program, you will be prompted to either retain control or release control of the program in the event you want to use the current license on another computer. *This enables you to quit the program on your work computer, release control and restart the program on your home computer or on a laptop while traveling. However each time you quit the program you must release control if you want to run the program on another computer. Also, internet access is required to do this.*

Remember that once a program is registered and control is retained on the computer, the license can only be released from *that* computer. If you have multiple SYSTEK programs installed on your computer, you can use the utility program called **SYSTEK Control Panel** to release or retain control of selected SYSTEK programs. This program `ControlPanel.exe` is located in the LIQPROP folder.

### 2.4 Installation on a Network

If you are licensed to use the program in a network environment, the software may be installed on multiple workstations on your network. The software can then be run from any workstation on the network, subject to the maximum user limit programmed during the installation process and in accordance with your license. **PLEASE REVIEW SEPARATE DOCUMENTATION ON LAN/WAN INSTALLATION SUPPLIED WITH PROGRAM.**

### 2.5 Un-installation

Prior to uninstalling **LIQPROP**, save all data files (TOT files), Liquid properties database, and simulation reports that you may need for later use. To **uninstall** the software from the hard disk, go to the Windows **Start button** and choose **Settings**. Next select the **Control Panel** and click on **Add/Remove Programs**. Follow subsequent instruction to uninstall **LIQPROP**.

*You can no longer run the program, until you **re-install** it again as described in the Installation section.*

***Put your original program disk away safely.***

# 3. Features

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**LIQPROP** is used to calculate the specific gravity, viscosity, bulk modulus and compressibility factors of petroleum products at various temperatures and pressures.

The program also converts specific gravity to API gravity and vice versa, viscosity from centipoises, SSU and SSF to centistokes and centistokes to SSU. It calculates the specific gravity and viscosity of blended petroleum products and the compressibility factor at a specified temperature and API gravity.

LIQPROP is an easy to use program. Online HELP is available under menu item Help and the program has extensive error checking features.

*LIQPROP features include:*

- Create a database of liquid properties. Gravities, viscosities and temperatures can be input in a spreadsheet and saved for later use. As new product information becomes available, the database can be updated. LIQPROP uses this database to calculate the blended properties of a mixture of different liquids. In the individual data entry screens, default data pulled from the database can be overridden by entering new data.
- Calculates specific gravity or API gravity, given one or the other.
- Converts viscosity from SSU, SSF and centipoise to centistokes. Also converts from centistokes to SSU.
- Given two values of specific gravities at two different temperatures, the specific gravity at a third temperature can be calculated.
- Given two values of viscosities at two different temperatures, the viscosity at a third temperature can be calculated.

## Features

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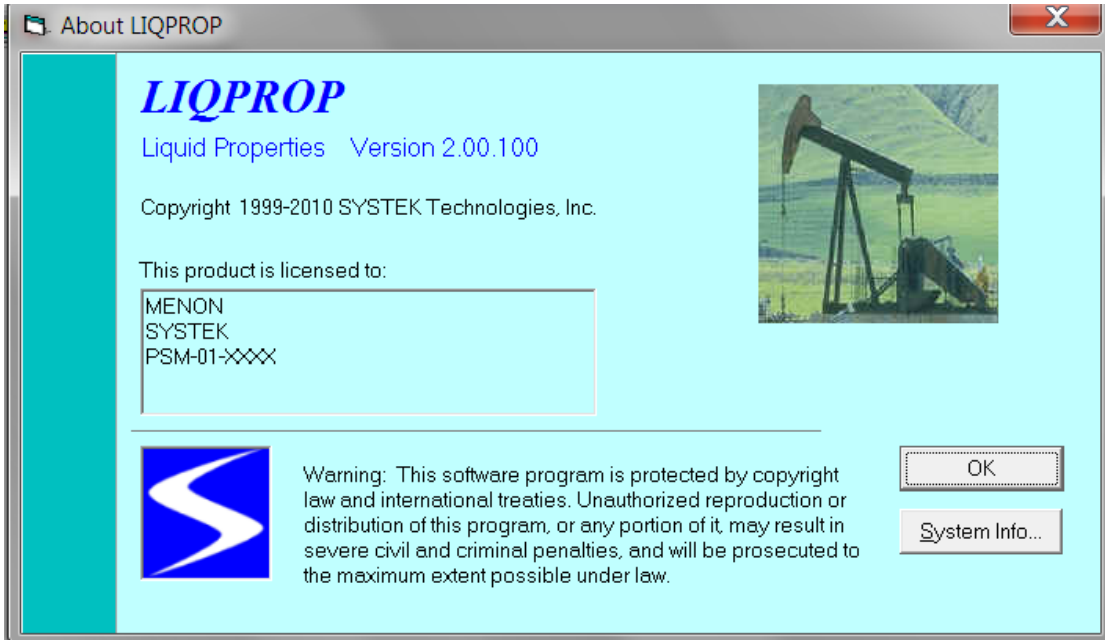
- For a mixture of up to ten different products, the specific gravity of the blended composition can be calculated, based upon the volume percent of each product and their specific gravities. If the blending occurs at different liquid temperatures, the final blended temperature and specific gravity of the blend are calculated, considering simple heat balance.
- For a mixture of up to ten different products, the viscosity of the blended composition can be calculated, based upon the volume percent of each product and their viscosities. If the blending occurs at different liquid temperatures, the final blended temperature and viscosity of the blend are calculated, considering simple heat balance.
- The Isothermal and Adiabatic Bulk Modulus of petroleum products can be calculated for given API gravity, pressure and temperature.
- The compressibility factor using the API method, can be calculated for petroleum products, for specified values of API gravity and temperature.

## Running the Program

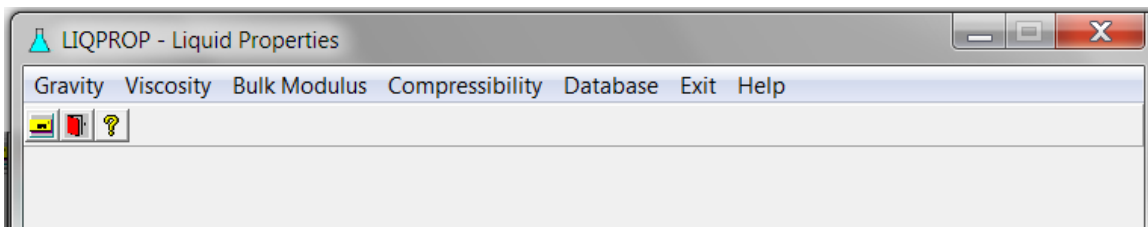
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To run the program, click the **LIQPROP** program icon or select **Start/Run** and type the appropriate sub-directory name and filename, such as: `C:\LIQPROP\LIQPROP.EXE` and press Enter.

The initial program screen will be momentarily displayed as follows:

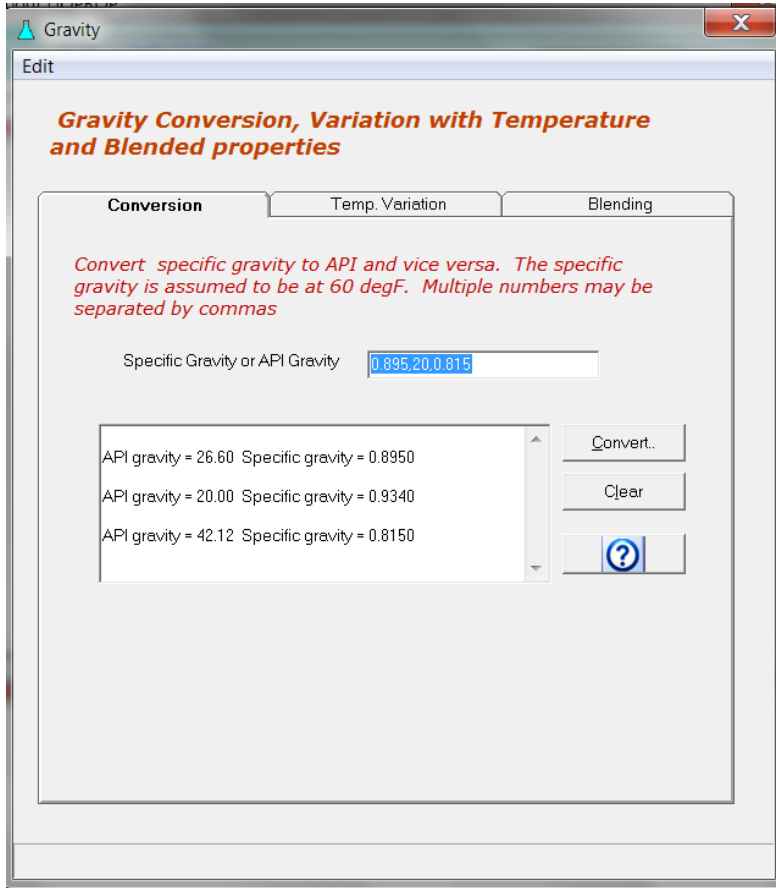


The pull down menus (such as Gravity, Viscosity) can be accessed by using the mouse or pressing the Alt together with the **underlined letter of each menu item** ( **G** for Gravity, **V** for Viscosity etc.).



## Running the Program

Click the menu item **Gravity** and the following screen opens up:

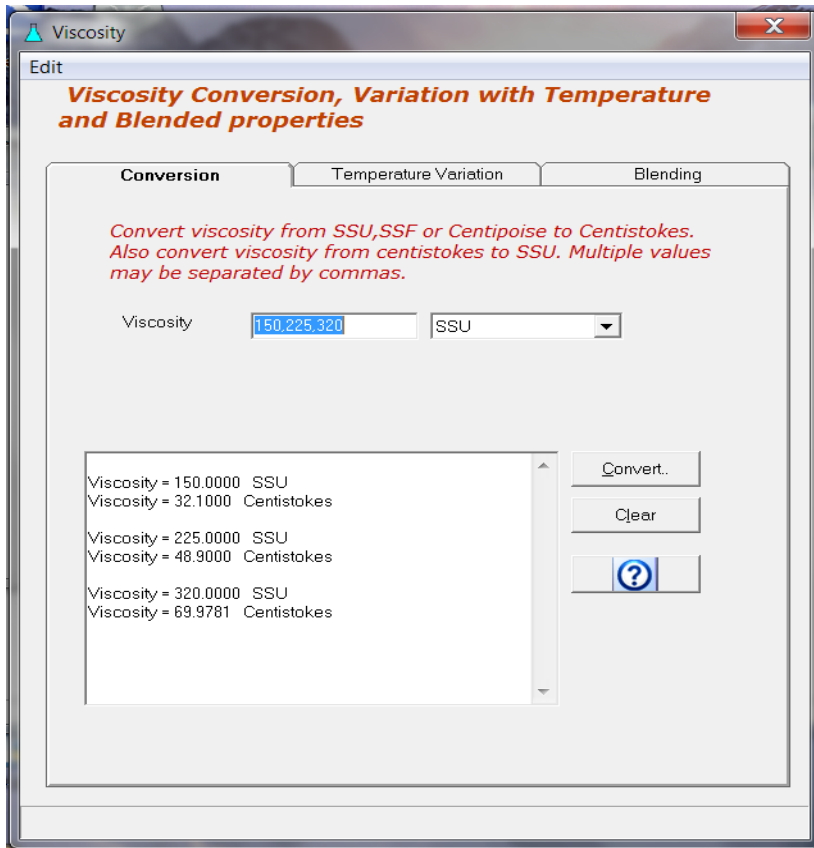


The tabbed screen above offers the following options:

- Conversion** - To convert API gravity to specific gravity and vice versa. Multiple numbers may be entered separated by commas.
- Temp. variation** - To calculate specific gravity at various temperatures.
- Blending** - To calculate the specific gravity of A mixture of two or more liquids.

## Running the Program

Click the menu item **Viscosity** and the following screen opens up:



The tabbed screen above offers the following options:

- Conversion**
  - To convert viscosity from SSU, SSF and centipoise to centistokes. Also converts from centistokes to SSU
- Temperature variation**
  - To calculate viscosity at various temperatures.
- Blending**
  - To calculate the viscosity of a mixture of two or more liquids.

## Running the Program

The pull down menu under **Bulk Modulus** provides an input screen for calculating the adiabatic and isothermal bulk modulus of the liquid, based upon, the pressure, temperature and the API gravity of the liquid as shown below:

**Bulk Modulus**

Edit

*To calculate the Isothermal and Adiabatic Bulk Modulus, enter API Gravity, Temperature and Pressure*

	Product	API Grav	Temp.	Pressure
1	ANSCRUDE	26.6	85	1200
2				
3				
4				

Units:  degF  degC

Units:  psig  kPag

API = 26.6 Temperature = 85 F Pressure = 1200 psig  
Isothermal Bulk Modulus = 204,825.97 psig  
Adiabatic Bulk Modulus = 259,037.71 psig

Calculate..  
Print  
Clear  
?

Click the **Print** button for a hard copy of the calculated results.

## Running the Program

On choosing the menu item **Compressibility**, the following screen is displayed. Enter the temperature and API Gravity and the compressibility factor is calculated and displayed in a spreadsheet format.

The screenshot shows a software window titled "Compressibility Calculation" with a standard Windows-style title bar (minimize, maximize, close buttons). Below the title bar is a menu bar with "Edit". The main area contains a red instruction: "To Calculate the Compressibility Factor, Enter Temperature and API Gravity".

Below the instruction is a spreadsheet table with two columns: "Temperature" and "API Grav". The first row is highlighted in purple and contains the values "78" and "36". The second, third, and fourth rows are also highlighted in purple but are empty. To the right of the table is a "Units:" section with two radio buttons: "degF" (which is selected) and "degC".

At the bottom of the window, there is a text area displaying the results: "Temperature = 78.00 degF API gravity = 36.00" and "Compressibility factor = 0.5410". To the right of the text area are three buttons: "Calculate..", "Clear", and a help button with a question mark icon.

	Temperature	API Grav
1	78	36
2		
3		
4		

Units:  
 degF  
 degC

Temperature = 78.00 degF API gravity = 36.00  
Compressibility factor = 0.5410

Buttons: Calculate.., Clear, ?

## Running the Program

Clicking the menu item **Database** displays the following screen.

Database of Liquid Properties

File Edit

*Enter Liquid Properties in this Database. For each product, specific gravity and viscosity data must be entered at two distinct temperatures.*

	Product	API Grav	Temp-1	SpGrav-1	Temp-2	SpGrav-2	Temp-1	Visc-1	Temp-2	Visc-2	Visc-U
1	ABCCrude	34.9706	60	.85	110	0.820	80	10	120	45	Centistok
2	ANSCrude	26.6	60	.895	100	.825	60	43	100	15	Centistok
3	Diesel		60	0.83	100	0.78	60	3.3	100	2.5	Centistok
4	Gasoline	61.02	60	0.735	100	.71	60	0.8			Centistok
5	HvyCrude	21.473	60	.925	120	.814	60	500	120	215	Centipois
6	JetFuel		60	0.82	100	0.80	60	3.0	100	2.8	Centistok
7	Myprod1		75	.8795	120	.8002	60	120	150	78.5	Centipois
8	MyProd2		70	.7548	110	.7124	65	100	150	63.2	Centistok
9	XYZ Crude	35	75	0.8	100	0.75	60	5.0	100	25.0	Centistok
10											
11											
12											

Close Print Save

Product name

This shows a table of liquid properties, such as API Gravity, Specific Gravity and Viscosities at different temperatures and units of viscosity used. This spreadsheet is editable and you can add or delete to create your own collection of liquid properties.

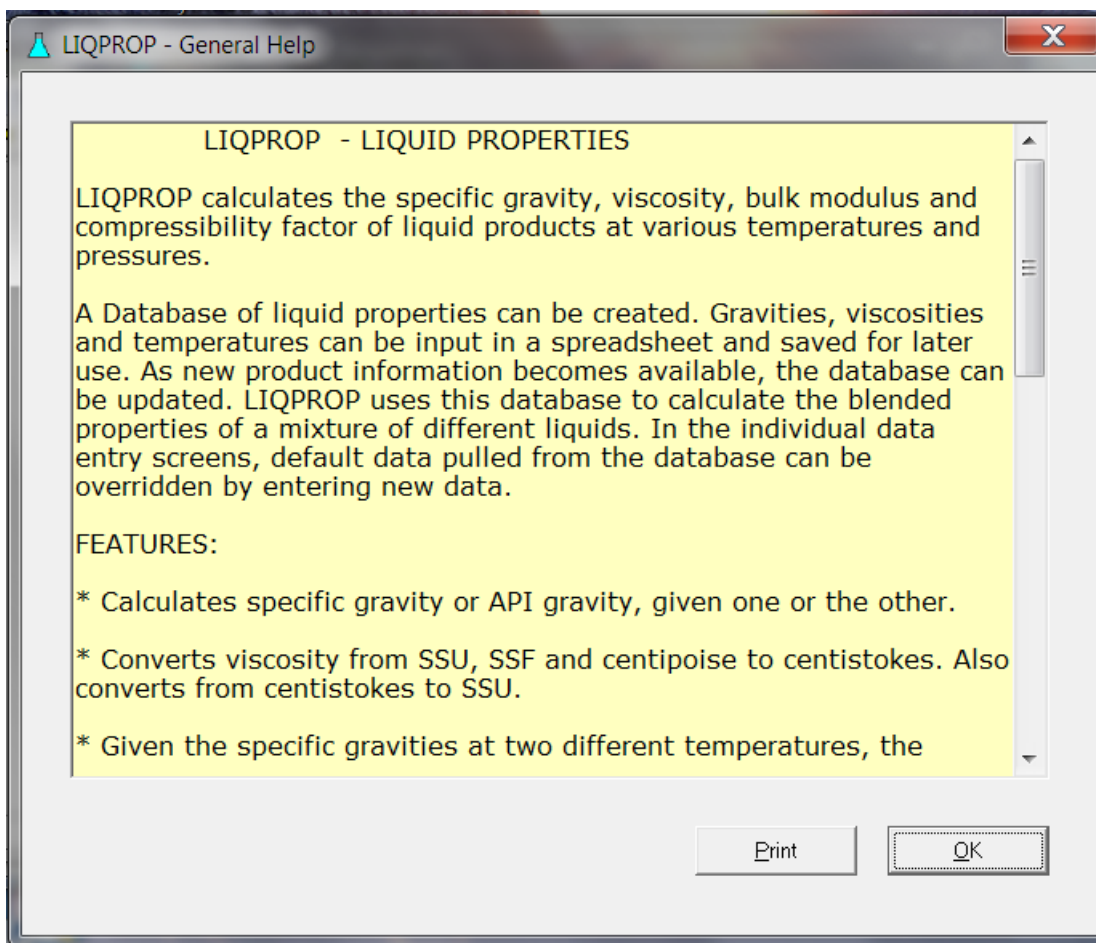
Click the **Print** button for a hard copy of the database.

## Running the Program

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The menu item designated as **Exit** is used to exit the program.

The menu item on the extreme right titled **Help** provides information about the program, such as version number, licensed user and General Help on the program.



# 4. Tutorial

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This section leads you through the program, using illustrative examples. See the **Reference** section for an explanation of the symbols and formulas used.

Several sample problems below illustrate the calculation of liquid properties. In each case **LIQPROP** is used to calculate the specific gravity, viscosity and the compressibility factors at specified temperatures and pressures. Each known liquid data is first created in the spreadsheet database and saved for later use.

## Sample Problem 1:

(a) Convert 25 API gravity to specific gravity and a specific gravity of 0.815 to API gravity.

(b) Calculate the blended viscosity of the following mixture:

Liquid 1 (25%) - 15 cSt

Liquid 2 (44%) - 29 cSt

Liquid 3 (31%) - 64 cSt

Assume that each liquid is at the same temperature.

(c) Calculate the viscosity at 75 °F for a liquid with a viscosity/temperature data as follows:

Viscosity at 60 °F : 600 cSt.

Viscosity at 100 °F : 120 cSt.

(d) Calculate the adiabatic and isothermal bulk modulus for a liquid 35 API gravity at 1000 psi pressure and 90 °F temperature.

## Solution

### Problem 1:

(a) Convert 25.0 API gravity to specific gravity and a specific gravity of 0.815 to API gravity.

Gravity Conversion, Variation with Temperature and Blended properties

Convert specific gravity to API and vice versa. The specific gravity is assumed to be at 60 degF. Multiple numbers may be separated by commas

Specific Gravity or API Gravity: 25.0,815

API gravity = 25.00 Specific gravity = 0.9042  
API gravity = 42.12 Specific gravity = 0.8150

Buttons: Convert., Clear, ?

	SpGrav	API Grav
1	0.9042	25.0000
2	0.8150	42.1196
3		
4		
5		
6		
7		

Buttons: Print, Clear

## Solution

(b) To calculate the blended viscosity of the three products, we choose Blending from the Viscosity menu and enter the liquid data as below:

The screenshot shows the 'Viscosity' software window with the 'Blending' tab selected. The window title is 'Viscosity' and it has a standard Windows-style title bar with a close button. The main area is titled 'Edit' and contains the subtitle 'Viscosity Conversion, Variation with Temperature and Blended properties'. Below this, there are three tabs: 'Conversion', 'Temperature Variation', and 'Blending', with 'Blending' being the active tab. A red italicized instruction reads: 'Choose each product and its percentage by volume in the blend. Enter the temperature of each product, if using the database properties. Alternatively, ignore the database and perform simple blending, considering same temperatures.' Below the instruction is a table with the following data:

	Product	Viscosity	Units	Percent	Temperature
1	ABCCRUDE	15	Centistokes	25	
2	ANSCRUDE	29	Centistokes	44	
3	MYPROD2	64	Centistokes	31	
4					
5					

Below the table is a checkbox labeled 'Use liquid properties from Database' which is unchecked. To the right of the table are buttons for 'Calculate..', 'Print', 'Clear', and a help icon (a question mark in a blue circle). Below the checkbox is a text area containing the following text:

ABCCRUDE-25% by volume ANSCRUDE-44% by volume  
MYPROD2-31% by volume  
Blended Viscosity = 30.2245 Centistokes

Note that it is immaterial what product is chosen in the first column, since we have to enter the given viscosity data for the three products. To override the Database properties of the products in the first column, uncheck the box below the spreadsheet as shown. Also leave the temperature column blank, since all products are at the same temperature.

## Solution

(c) To calculate the viscosity at 75 °F, choose Temperature Variation from the Viscosity menu and enter the viscosity and temperature data as shown below:

The screenshot shows the 'Viscosity' software window with the 'Temperature Variation' tab selected. The interface includes a title bar, a menu bar with 'Edit', and a main content area with a title 'Viscosity Conversion, Variation with Temperature and Blended properties'. Below this are three tabs: 'Conversion', 'Temperature Variation', and 'Blending'. A red instruction text reads: 'Choose product from database and enter temperature at which viscosity is desired. You may also ignore the database and enter different values of viscosity-temperature data'. The 'Temperature Variation' tab contains a dropdown menu for 'Product name' set to 'ABCCRUDE', a checked checkbox for 'Use liquid properties from Database', and input fields for 'Visc-1' (600), 'Temp-1' (60), 'Visc-2' (120), and 'Temp-2' (100). A 'Temperature Units' section has radio buttons for 'degF' (selected) and 'degC'. A 'Temp at which Viscosity is required' field is set to 75. At the bottom, a text box displays the results: 'Product name: ABCCRUDE', 'Temperature: 60 (degF) Viscosity: 600 Centistokes', 'Temperature: 100 (degF) Viscosity: 120 Centistokes', and 'Temperature = 75 (degF) Viscosity = 306.3751 Centistokes'. To the right of the text box are buttons for 'Calculate..', 'Clear', and a help icon.

Viscosity

Edit

**Viscosity Conversion, Variation with Temperature and Blended properties**

Conversion    **Temperature Variation**    Blending

*Choose product from database and enter temperature at which viscosity is desired. You may also ignore the database and enter different values of viscosity-temperature data*

ABCCRUDE     Use liquid properties from Database

Visc-1    600    Temp-1    60

Visc-2    120    Temp-2    100

Centistokes

Temperature Units:  
 degF     degC

Temp at which Viscosity is required    75

Product name: ABCCRUDE  
Temperature: 60 (degF) Viscosity: 600 Centistokes  
Temperature: 100 (degF) Viscosity: 120 Centistokes  
Temperature = 75 (degF) Viscosity = 306.3751 Centistokes

Calculate..  
Clear  
?

## Solution

(d) To calculate the adiabatic and isothermal bulk modulus, choose the Bulk Modulus menu and enter the product data as below:

The screenshot shows a software window titled "Bulk Modulus" with a close button (X) in the top right corner. Below the title bar is a tab labeled "Edit". A message in orange text reads: "To calculate the Isothermal and Adiabatic Bulk Modulus, enter API Gravity, Temperature and Pressure".

	Product	API Grav	Temp.	Pressure
1	ANSCRUDE	35	90	1000
2				
3				
4				

Below the table are two "Units:" sections. The first section has radio buttons for "degF" (selected) and "degC". The second section has radio buttons for "psig" (selected) and "kPag".

At the bottom left, a text box displays the calculated results:

```
API = 35 Temperature = 90 F Pressure = 1000 psig  
Isothermal Bulk Modulus = 176,830.12 psig  
Adiabatic Bulk Modulus = 223,724.33 psig
```

At the bottom right, there are four buttons: "Calculate..", "Print", "Clear", and a help button (question mark icon).

Note that it is immaterial what product is chosen in the first column, since we have to enter the given API gravity and temperature data for the given product. The entered data will override the properties of ANSCrude taken from the Database.

### Sample Problem 2:

Determine the compressibility factors for the following petroleum products:

Product	API gravity	Temperature(°F)
Crude-A	26.7	85
Crude-B	21.5	70
Crude-C	19.5	64
Crude-D	35.4	59

### Solution:

Choose the Compressibility menu and enter the properties of the four products given as below:

The screenshot shows a software application titled "Compressibility Calculation" with an "Edit" menu. The main window contains a table for input data and a "Calculate.." button. Below the table, the calculated compressibility factors are displayed for each product.

	Temperature	API Grav
1	85	26.7
2	70	21.5
3	64	19.5
4	59	35.4

Units:  degF  degC

Temperature = 70.00 degF API gravity = 21.50  
Compressibility factor = 0.4210

Temperature = 64.00 degF API gravity = 19.50  
Compressibility factor = 0.4020

Temperature = 59.00 degF API gravity = 35.40  
Compressibility factor = 0.5020

The secondary window, titled "Results - Compressibility Factors", displays the following data:

	Temp-degF	API Grav	ComprFact
1	85.0000	26.7000	0.4760
2	70.0000	21.5000	0.4210
3	64.0000	19.5000	0.4020
4	59.0000	35.4000	0.5020
5			
6			
7			

### Sample Problem 3:

A sample of Gulf Coast crude is described below. Calculate the viscosity of this crude at 100 °F and the blended gravity and viscosity of a mixture of 40% of this crude and 60% of Product-A described below, at a common temperature of 80 °F.

#### Gulf coast crude:

API gravity: 22  
Specific gravity at 60 °F: 0.9218  
Specific gravity at 70 °F: 0.890  
Viscosity at 60 °F: 2000 SSU  
Viscosity at 120 °F: 450 SSU

#### Product-A:

API gravity: 35  
Specific gravity at 60 °F: 0.8498  
Specific gravity at 70 °F: 0.815  
Viscosity at 60 °F: 150 SSU  
Viscosity at 110 °F: 50 SSU

#### Solution:

We could create the two product data in the **Database** first and then use the **Temperature Variation** and **Blending** options to calculate the viscosity at 100 °F and the blended properties.

The **Database** requires that you specify the specific gravity and viscosity at two distinct temperatures. From the given API gravity, we can calculate the sp. gravity at 60 °F, by using the **Conversion** option. This gives us the following values for the two products:

Product	API	Specific gravity at 60 °F
Gulf coast crude	22.0	0.9218
Product-A	35.0	0.8498

We now have the specific gravity for the crude at 60 °F and 70 °F and the two viscosities at 60 °F and 120 °F.

Similarly, for Product-A, we have the specific gravity at 60 °F and 70 °F and the two viscosities at 60 °F and 110 °F. Next we add the two product data to the **Database. Solution**

After adding the product data and saving the **Database**, the sorted screen is shown below.

Database of Liquid Properties

File Edit

Enter Liquid Properties in this Database. For each product, specific gravity and viscosity data must be entered at two distinct temperatures.

	Product	API Grav	Temp-1	SpGrav-1	Temp-2	SpGrav-2	Temp-1	Visc-1	Temp-2	Visc-2	Visc-U
3	Diesel		60	0.83	100	0.78	60	3.3	100	2.5	Centistok
4	Gasoline	61.02	60	0.735	100	.71	60	0.8			Centistok
5	GulfCoastCrude	22	60	0.9218	70	0.89	60	2000	120	450	SSU
6	HvyCrude	21.473	60	.925	120	.814	60	500	120	215	Centipois
7	JetFuel		60	0.82	100	0.80	60	3.0	100	2.8	Centistok
8	KRH		100	.962	140	.95	100	2402	120	840	Centistok
9	Myprod1		75	.8795	120	.8002	60	120	150	78.5	Centipois
10	MyProd2		70	.7548	110	.7124	85	100	150	63.2	Centistok
11	Product-A	35	60	0.8498	70	0.815	60	150	110	50	SSU
12	XYZ Crude	35	75	0.8	100	0.75	60	5.0	100	25.0	Centistok
13											
14											

Close Print Save

Product name

Using the **Temperature Variation** option under the **Viscosity** menu, viscosity of the GulfCoast Crude at 100 °F is as follows:

Viscosity

Edit

Viscosity Conversion, Variation with Temperature and Blended properties

Conversion Temperature Variation Blending

Choose product from database and enter temperature at which viscosity is desired. You may also ignore the database and enter different values of viscosity-temperature data

GULFCOASTCRUDE  Use liquid properties from Database

Visc-1 2000 Temp-1 60

Visc-2 450 Temp-2 120

SSU

Temperature Units:  degF  degC

Temp at which Viscosity is required 100

Calculate..

Clear

?

Product name: GULFCOASTCRUDE  
 Temperature: 60 (degF) Viscosity: 2000 SSU  
 Temperature: 120 (degF) Viscosity: 450 SSU  
 Temperature = 100 (degF) Viscosity = 694.9742 SSU

## Solution

Next, for the blended gravity and viscosity of a mixture of 40% of GulfCoast crude and 60% of Product-A, by volume, at a common temperature of 80 °F, we use the **Blending** option under **Gravity** and **Viscosity** menus, as below:

Gravity blending:

The screenshot shows the 'Gravity' software window with the 'Blending' tab selected. The window title is 'Gravity' and it has an 'Edit' button in the top left. The main heading is 'Gravity Conversion, Variation with Temperature and Blended properties'. Below this are three tabs: 'Conversion', 'Temp. Variation', and 'Blending'. The 'Blending' tab contains the following text: 'Choose each product and its percentage by volume in the blend. Enter the temperature of each product, if using the database properties. Alternatively, ignore the database and perform simple blending, considering same temperatures.'

	Product	API Grav	SpGrav	Percent	Temperature
1	GULFCOAST	22	0.9218	40	80
2	PRODUCT-A	35	0.8498	60	80
3					
4					
5					

Use liquid properties from Database

GULFCOASTCRUDE-40% by volume at temperature: 80 (degF)  
PRODUCT-A-60% by volume at temperature: 80 (degF)

Final temperature of blended product = 79.96 (degF)

Blended Gravity at final temperature = 0.8115

Buttons: Calculate.., Print, Clear, ?

The final blended temperature is 79.96 °F, close to the initial common temperature of 80 °F. The reason for the slight difference in temperature is due to round-off error. The heat balance calculation uses specific heat calculated from the specific gravity at 60 °F. Due to the slight difference in the two specific heats of the liquids blended, the final temperature is slightly different from the initial temperature, even though both products were initially at the same temperature of 80 °F. For all practical purposes, we can assume the final temperature is 80 °F.

## Solution

Viscosity blending:

Using the **Blending** option under the **Viscosity** menu, the viscosity of the mixture is calculated as below:

**Viscosity**

Edit

**Viscosity Conversion, Variation with Temperature and Blended properties**

Conversion    Temperature Variation    **Blending**

*Choose each product and its percentage by volume in the blend. Enter the temperature of each product, if using the database properties. Alternatively, ignore the database and perform simple blending, considering same temperatures.*

	Product	Viscosity	Units	Percent	Temperature
1	GULFCOAST	2000	SSU	40	80
2	PRODUCT-A	150	SSU	60	80
3					
4					
5					

Use liquid properties from Database

GULFCOASTCRUDE-40% by volume at temperature: 80 (degF)  
PRODUCT-A-60% by volume at temperature: 80 (degF)

Final temperature of blended product = 79.96 (degF)

Blended Viscosity at final temperature = 39.5869 Centistokes

.....

Calculate..

Print

Clear

?

**Sample Problem 4:**

- (a) Two crude oils (from the Database) at different temperatures are blended to yield a mixture. Determine the final blended temperature and the specific gravity of the mixture, from the data below:

ANSCrude	20%	100 °F
HvyCrude	80%	120 °F

- (b) Calculate the blended viscosity of the mixture.

**Solution:**

- (a) Gravity blending:

**Gravity**

Edit

**Gravity Conversion, Variation with Temperature and Blended properties**

Conversion      Temp. Variation      **Blending**

*Choose each product and its percentage by volume in the blend. Enter the temperature of each product, if using the database properties. Alternatively, ignore the database and perform simple blending, considering same temperatures.*

	Product	API Grav	SpGrav	Percent	Temperature
1	ANSCRUDE	26.6	0.895	20	100
2	HVYCRUDE	21.473	0.925	80	120
3					
4					
5					

Use liquid properties from Database

ANSCRUDE-20% by volume at temperature: 100 (degF)  
 HVYCRUDE-80% by volume at temperature: 120 (degF)

Final temperature of blended product = 115.87 (degF)

Blended Gravity at final temperature = 0.8168

Calculate...  
 Print  
 Clear  
 ?

(b) Viscosity blending:

**Viscosity Conversion, Variation with Temperature and Blended properties**

Conversion      Temperature Variation      **Blending**

*Choose each product and its percentage by volume in the blend. Enter the temperature of each product, if using the database properties. Alternatively, ignore the database and perform simple blending, considering same temperatures.*

	Product	Viscosity	Units	Percent	Temperature
1	ANSCRUDE	43	Centistokes	20	100
2	HVYCRUDE	500	Centipoise	80	120
3					
4					
5					

Use liquid properties from Database

ANSCRUDE-20% by volume at temperature: 100 (degF)  
 HVYCRUDE-80% by volume at temperature: 120 (degF)

Final temperature of blended product = 115.87 (degF)

Blended Viscosity at final temperature = 101.2548 Centistokes

.....

Buttons: Calculate.., Print, Clear, ?

# 5. Reference

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This section provides an explanation of formulas and variable names used.

## Formulas

The formulas used in LIQPROP are as follows:

1. Gravity and Viscosity conversion:

$$\text{Specific gravity} = 141.5 / (131.5 + \text{API})$$

$$\text{Viscosity, cSt} = 0.226(\text{SSU}) - 195 / (\text{SSU}) \text{ for } \text{SSU} \leq 100$$

$$\text{cSt} = 0.220(\text{SSU}) - 135 / (\text{SSU}) \text{ for } \text{SSU} > 100$$

$$\text{cSt} = 2.24(\text{SSF}) - 184 / (\text{SSF}) \text{ for } 25 < \text{SSF} \leq 40$$

$$\text{cSt} = 2.16(\text{SSF}) - 60 / (\text{SSF}) \text{ for } \text{SSF} > 40$$

2. Gravity and Viscosity blending:

$$S_m = (S_1(\%1) + S_2(\%2) + S_3(\%3) + \dots) / 100$$

$$H = 40.073 - 46.414 \text{ Log Log}(V+B)$$

$$B = 0.931 (1.72)^V \text{ for } 0.2 < V < 1.5$$

$$B = 0.6 \text{ for } V \geq 1.5$$

$$H_m = (H_1(\%1) + H_2(\%2) + H_3(\%3) + \dots) / 100$$

3. Gravity and Viscosity versus temperature:

$$\begin{aligned}
 A1 &= 141.5/S-131.5 \\
 St &= S/(1+E1(T-60)) \\
 E1 &= 0.00035 \text{ for } A1 < 14.9 \\
 E1 &= 0.0004 \text{ for } 14.9 \leq A1 < 34.9 \\
 E1 &= 0.0005 \text{ for } 34.9 \leq A1 < 50.9 \\
 Z &= V + 0.7 + \text{EXP}(-1.47-1.84(V)-0.51(V^2)) \\
 Z &= a - b \text{ Log}(T) \\
 Y &= Z - 0.7 \\
 V &= Y-\text{EXP}(-0.7487-3.295(Y)+0.06119(Y^2)- \\
 &\quad 0.3193(Y^3))
 \end{aligned}$$

4. The specific heat SpHt(T) at temperature T °F is related to the liquid specific gravity at 60 °F, as follows:

$$\text{SpHt}(T) = [ 0.403 + 0.000405 * (T - 32) / 1.8 ] / \sqrt{(\text{SpGr}60)}$$

5. Bulk modulus versus temperature:

$$\begin{aligned}
 T &= (\text{Temp } ^\circ\text{F}) + 459.67 \\
 Ka &= 1286000 + 13.55(P) - 41220(T^{0.5}) \\
 &\quad - 4530(\text{API})-10.59(\text{API}^2) + 3.228(T)(\text{API}) \\
 Ki &= 2619000+9.203(P)- 141700(T^{0.5}) +73.05(T^{1.5}) - 341(\text{API}^{1.5})
 \end{aligned}$$

6. The compressibility factor for liquids is based upon the API method, as follows:

$$\text{Density, Rho} = 141.36/(\text{API} + 131.5)$$

$$\text{RhoSqr} = \text{INT}(\text{Rho}*\text{Rho}*100000 -0.5)*0.00001$$

Compressibility factor:

$$F = \text{Exp}(- 1.99470+0.00013427*T+ 0.79392/\text{RhoSqr}+0.0023260*T/\text{RhoSqr})$$

## Symbols

---

API,A1	API gravity.
S	Specific gravity.
cSt,V	Viscosity in centistokes.
SSU	Viscosity in Saybolt Universal Seconds.
SSF	Viscosity in Seconds Furol.
S1,S2,S3...	Specific gravities of liquids 1,2,3.....
Sm	Specific gravity of blended mixture.
%1,%2,%3...	Percentage of liquids 1,2,3..... in blended mixture.
H,H1,H2	Blending index of liquids.
Hm	Blending index of mixture.
B	Constant in Blending Index Equation.
St	Specific gravity at temperature t °F
E1	Constant in specific gravity equation.
Z,Y	modified viscosities.
a,b	Constants in viscosity/temperature equation.
T	Temperatures in degrees Kelvin.
Ka	Adiabatic bulk modulus, psi.
Ki	Isothermal bulk modulus, psi.
P	Pressure, psi.

## **Bibliography**

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1. The Properties of Petroleum Fluids, William D. McCain, Jr., Petroleum Publishing Company, Tulsa, Oklahoma, 1973.
2. API methodology for Compressibility calculations, Chapter 11, Physical Properties Data, Section 11.2.1.5.2.

## 6. Troubleshooting

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**LIQPROP** is a powerful software for calculating properties of liquid mixtures. Despite the complexity of the program it is very user friendly. Online HELP is available and the program has extensive error checking features. However, there is always a possibility that some extraneous or invalid data was entered and the program may hang up. In such cases, try quitting the program by using the **Exit** menu item or click the **Exit** icon on the toolbar. If this does not work, you have no choice but to perform a hard re-boot and re-start the **LIQPROP** program.

If you cannot get **LIQPROP** to run properly even after following the steps outlined in the *Getting Started* section of this manual, please check the following *before* you call Technical Support. Have your program disk serial number and program version number handy to facilitate quick response.

If you are using a dongle version of the program, ensure that you have the hardware dongle plugged in, prior to running the program. If the key is not in place, a message similar to the following is displayed.

**PROGRAM NOT AUTHORIZED!  
Check to ensure keylok is in place!**

*After attaching the dongle you may still have to re-boot the computer in order to run the program.*

### **Error Messages:**

In addition to the KEYLOK error message above, following are some errors that you may encounter while running **LIQPROP**:

#### **1. Divide by zero error**

This is generally due to some data input value that is zero. Check all input data for zero values.

#### **2. Illegal Function call**

This is generally due to some illegal mathematical operation such as trying to extract the square root of a negative value. Ensure that there are no inadmissible negative values, such as a negative value for viscosity or specific gravity.

#### **3. File not found**

A common error when a file specified cannot be located on the hard disk or does not exist. When specifying liquid properties, make sure the file is present in the sub-directory or folder containing LIQPROP. Otherwise, ensure that the file name is typed in correctly, including the full path.

If the above problems persist or you cannot successfully install the software on your hard disk, contact SYSTEK Technical Support.

# 7. Technical Support

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*Please read the Troubleshooting section of this manual before you call us for technical support.*

Free Technical Support is provided for registered users of this software for a period of one year from the initial purchase date. *After that period, Technical Support can be provided only if an annual software maintenance and support plan has been purchased. Contact SYSTEK for details.*

*In order to facilitate quick response, please have your program CD serial number and program version available when you call us.*

## **How to contact us:**

You may contact SYSTEK in any of the following ways:

Phone/Fax: (928) 453-9587

E-mail: [support@systek.us](mailto:support@systek.us)

Web site: [www.systek.us](http://www.systek.us)