2816G1/G5 OPERATING INSTRUCTIONS

Chameleon 02/2016

Fig. 1a - 2816G5, 5 Station Chameleon Kit

fig. 1b - 2816G1, Chameleon, Single Station

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UNPACKING

The 2816GX Chameleon Lab System(s) was thoroughly tested before shipment. When packed, it was in perfect working order. Unpack with care being sure to remove all packing material. Follow the in-structions carefully in order to assure long, trouble-free service.

Any damage found upon receipt should be reported immediately to the transport carrier for claim. It is important to save the shipping container and all evidence to support your claim. Be sure to read all operating instructions thoroughly before operating the unit.

WARRANTY & LIABILITY

Soilmoisture Equipment Corp. (SEC) warrants all products manufactured by SEC to be free from defects in materials and workmanship under normal use and service for twelve (12) months from the date of invoice provided the section below has been met.

Soilmoisture Equipment Corp. (SEC) is not liable for any damages, actual or inferred, caused by misuse or improper handling of its products. SEC products are designed to be used solely as described in these product operating instructions by a prudent individual under normal operating conditions in applications intended for use by this product.

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The Chameleon is an accurate and fully automated laboratory system for measuring saturated hydraulic conductivity (Ksat). The Chameleon is capable of performing Ksat measurements according to both the Falling-Head and Constant-Head Methods. Thanks to the Monitor® Precision Pressure Transducer, and the Chameleon Software Application, both measurement methods are fully automated.

The Chameleon uses standard Soilmoisture Tempe Cells (5.7 cm diameter, 6 cm height) and comes with all the required components (a computer is required, but is not included in the standard kits).

Applications

Laboratory hydraulic conductivity measurement is a very common measurement method used in several important areas including Industrial Soil Physics, Education, Agricultural Research, Irrigation Projects, Construction Projects, Mining Sites, Oil Industry, Environmental Studies, and Geological Studies.

Specifications

- Minimum Head-height: 1 cm
- System Resolution: 1 mm of change in water height (2.01 ml of water consumption).
- Standard Reservoir Inside Diameter: 5.13 cm (2.02″)
- Standard Reservoir Height: 48.26 cm (19.00″)
- Standard Reservoir Cross-Sectional Area: 20.67 cm^2 (3.20 sq. inches)
- Standard Reservoir Volume: 1 liter (0.26 gallon)
- Soil Core Inside Diameter: 5.38 cm (2.12″)
- Soil Core Height: 6.0 cm (2.36″)
- Soil Core Cross-Sectional Area: 22.73 cm^2 (3.52 sq. inches)
- Soil Core Volume: 136.40 cm^2 (21.14 sq. inches)
- Pressure Transducer: Monitor Precision Transducer (-15 to +15 psi). Please refer to the Monitor product manual for further specifications.
- Monitor Transducer Software Application: Please refer to this product manual for specifications.

System Options

- Model 2816G1: Single Unit
- Model 2816G5: Five Independent Units (*)

(*) The Chameleon software application (for PC) can control up to 20 independent Chameleon units simultaneously.

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Software Installation

Open Windows Explorer, go to the USB drive and run the “setup.exe” file (Fig. 2).

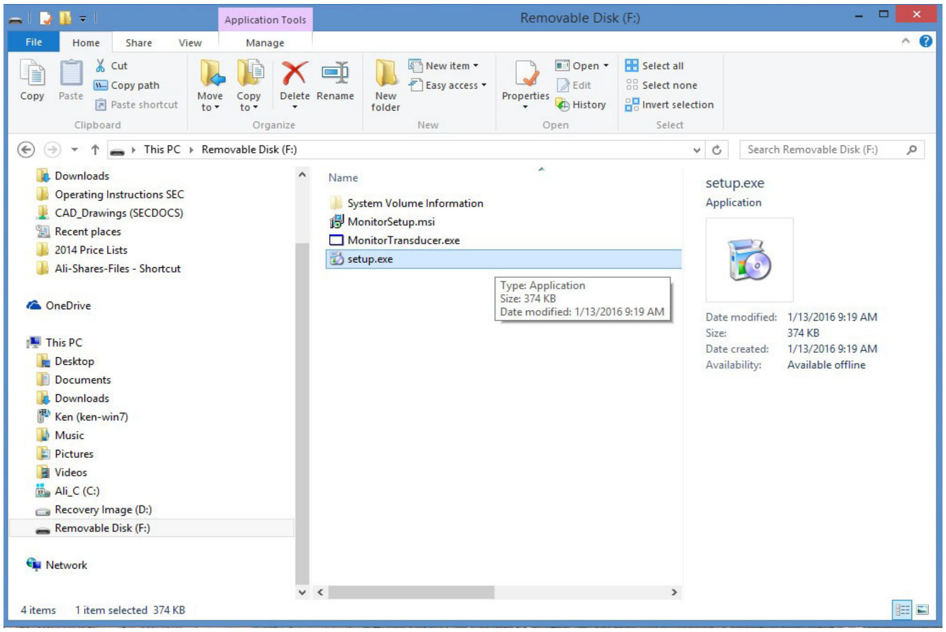

Fig. 2

Click “Next” in the “Monitor Transducer” window (Fig. 3).

Fig. 3

Click the “Browse” Button in the “Select Installation Folder” window to select the installation folder. We recommend the default folder “C:\SEC\Monitor\”. Click “Disk Space” to see a list of your drives and space available on each of them. Select “Everyone” if you would like other people to access to the program. Otherwise select “Just me” option. Click “Next” when you are done (Fig. 4).

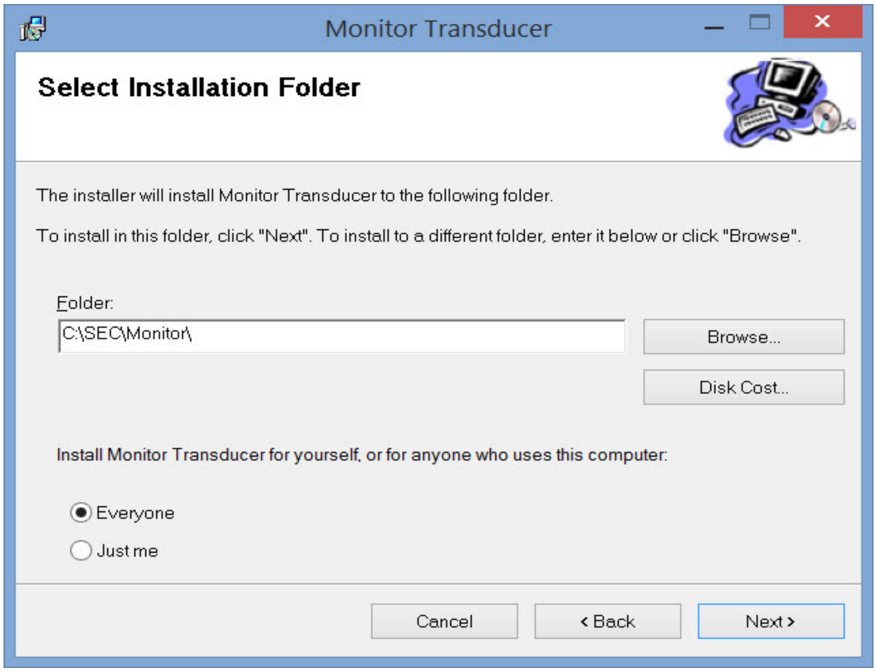

Fig. 4

Select “Next” in “Confirm Installation” to install the sofware on your computer (Fig. 5).

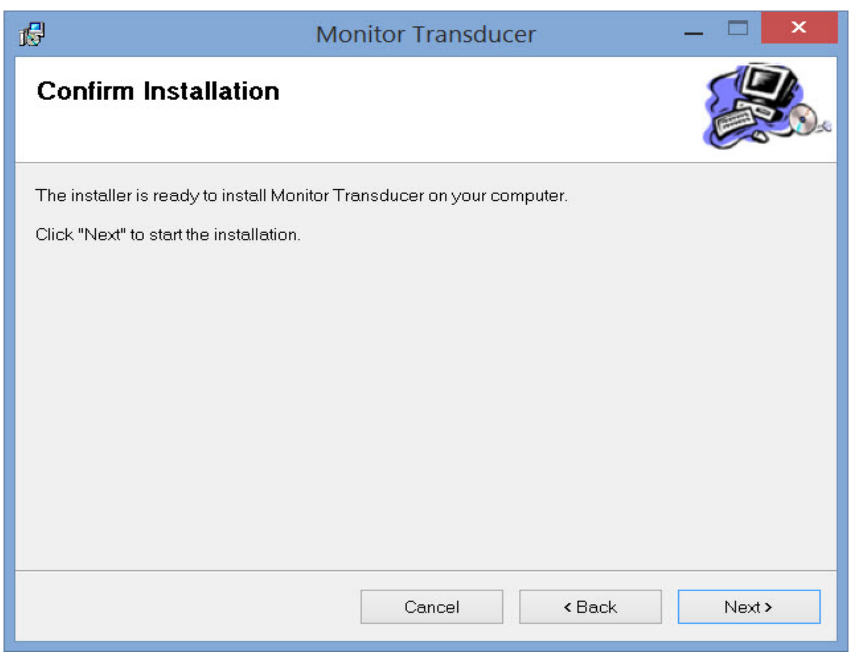

Fig. 5

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The following window pops up (Fig. 6). Please wait. The installation process should not take longer than a couple of minutes.

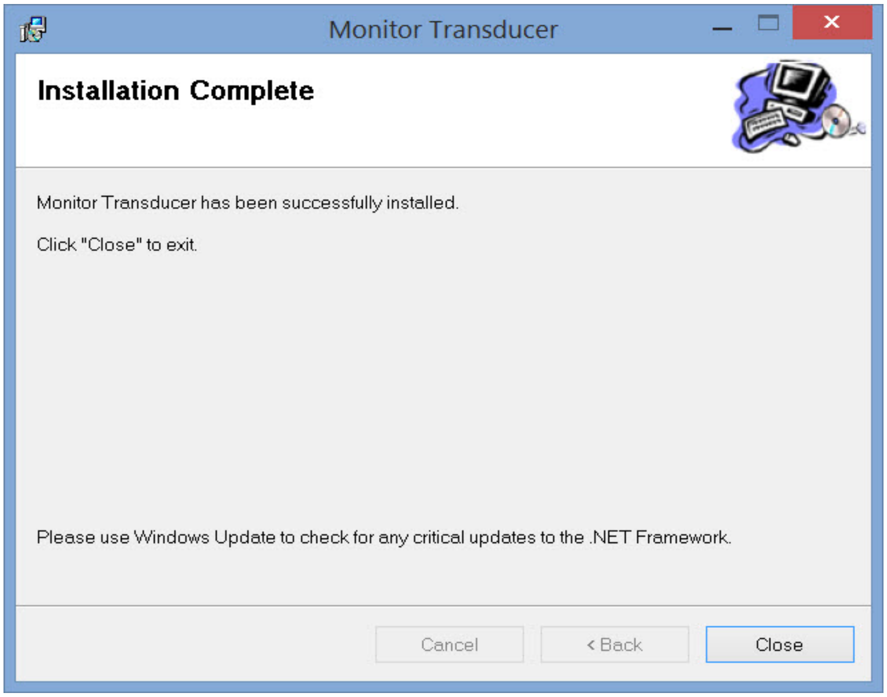

Fig. 6

Click “Close” in “Installation Complete” window. A Windows Shortcut (Monitor Transducer) will be created on your computer Desktop (Fig. 7).

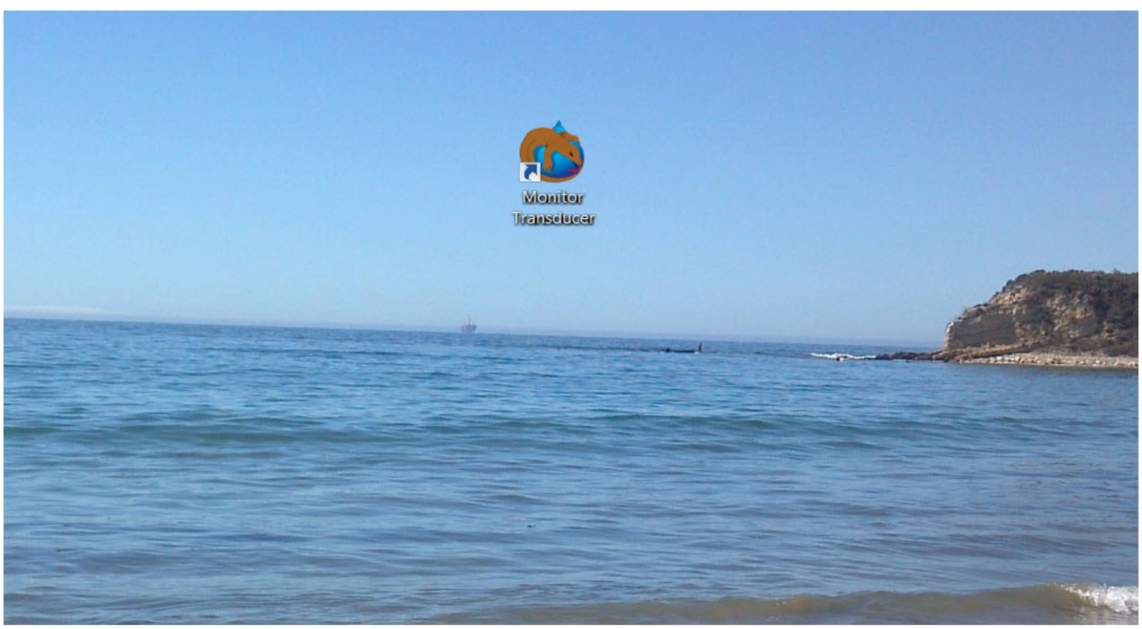

Fig.7

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Acquaint Yourself With The Parts

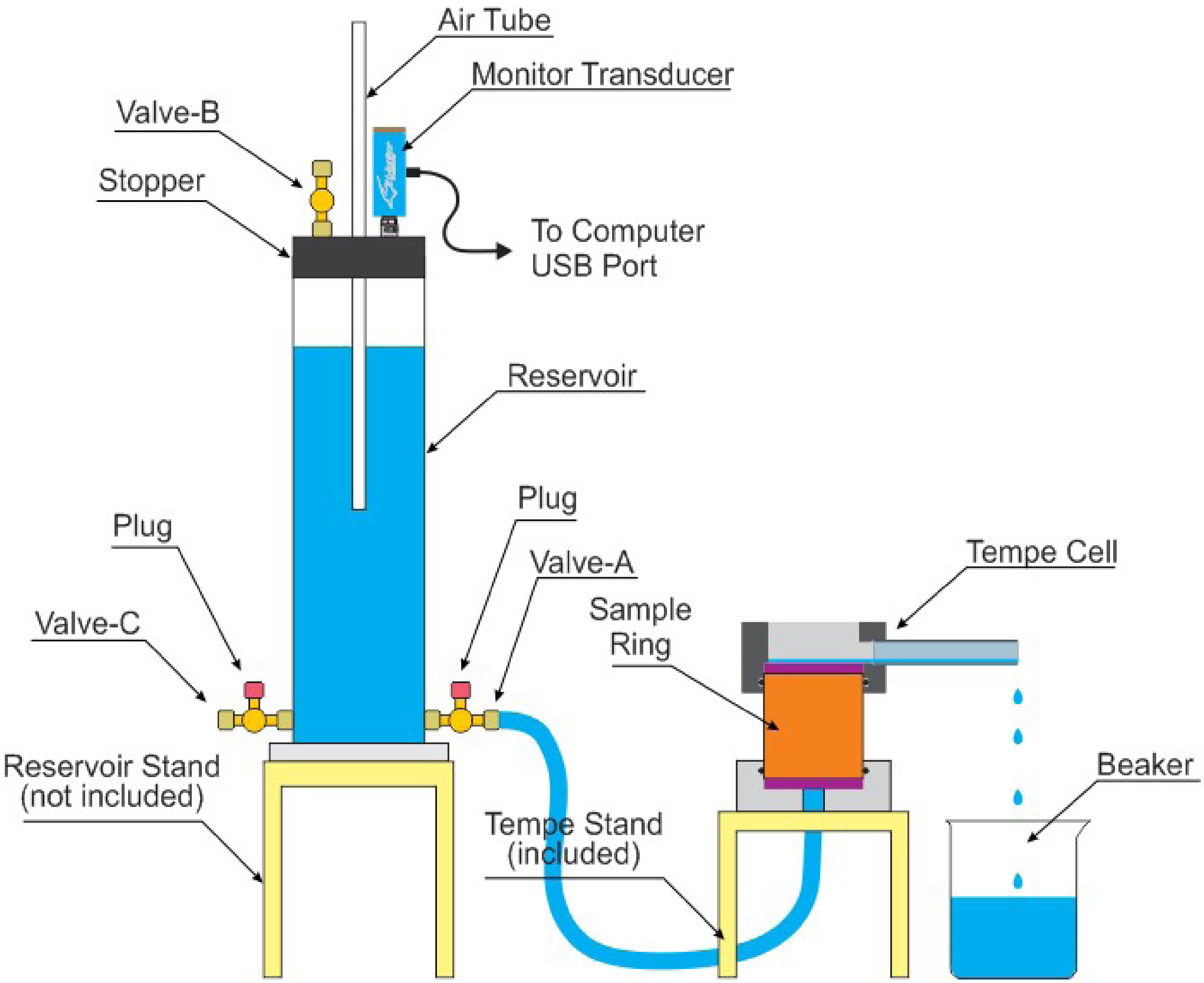

Fig. 8 Chameleon Setup

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SOILMOISTURE

Saturate Soil Core Samples

Using Soilmoisture' 0200 Soil Core Sampler, take 6 cm long Soil Cores.

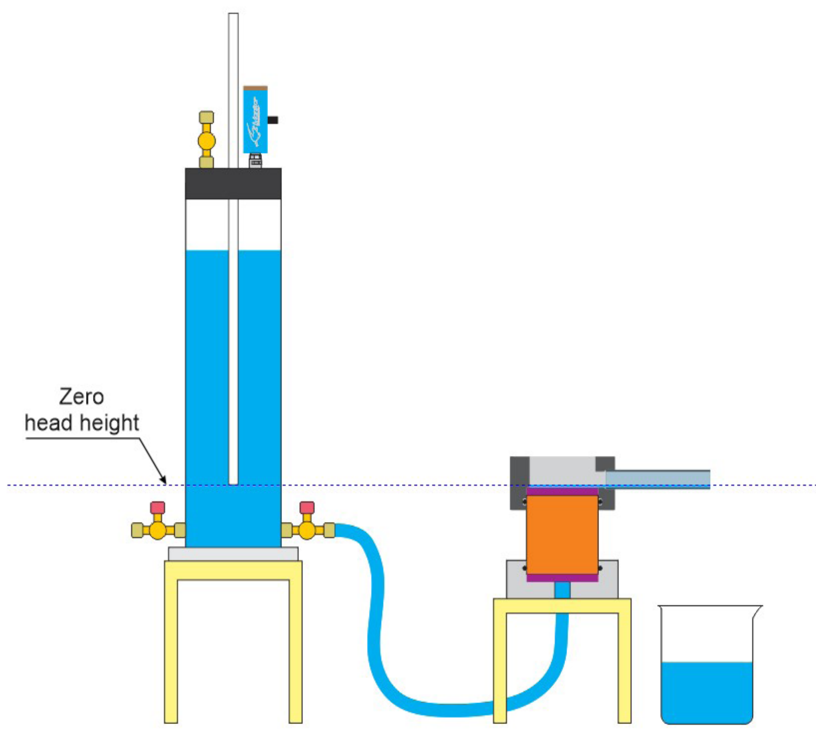
Create Zero Head Height

In order to saturate your samples and also determine the Zero Point of your system you need to place and align the system components to create a zero head height. In other words, the bottom of Air Tube and the top of Soil Sample Ring have to be at the same height. Please note that at this point, the Sample Ring needs to be empty (contain no soil sample).

Set up the system according to the schematic below (Fig. 9). You will not need the Monitor® Transducer or your computer at this point.

- Close Valve B.
- Close Valve C.
- Open Valve A. Wait until Tempe Cell starts dripping in the Beaker and the Air Tube starts bubbling.
- Now lower the Air tube until the Tempe Cell stops dripping and the Air Tube stops bubbling. Raise and lower the Air Tube until you make sure that your Air Tube's bottom is right at Zero Head Height.
- Read the height of the Air Tube bottom (Zero Head Height) from the Reservoir Scale. Record the Zero Head Height.
- Close Valve A. Your system is now on Zero Position.

Fig. 9. Constant Head setup. Air Tube at "zero head height" position.



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Saturate the Sample (Fig. 10)

- Set your system on Zero Position.
- Remove the Tempe Cell Cap.
- Remove the empty Sample Ring.
- Gently open Valve A until the Tempe Cell Base is filled with water.
- Close Valve A.

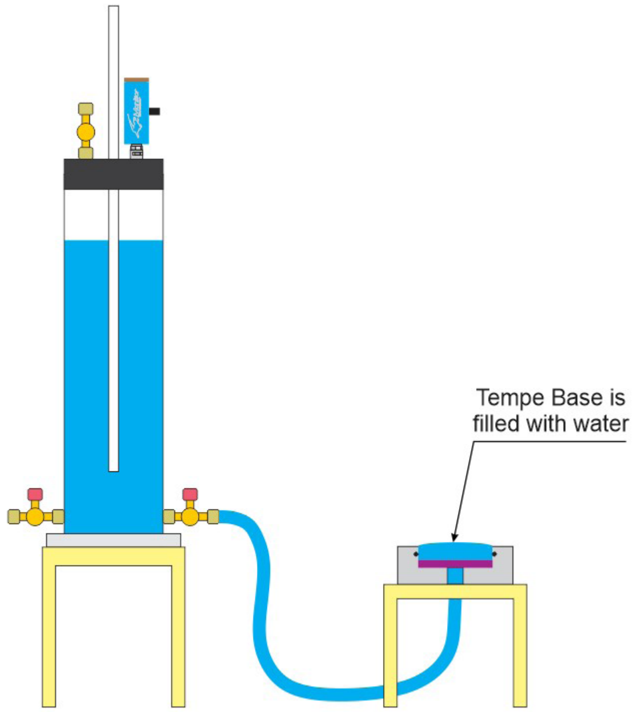

Fig. 10

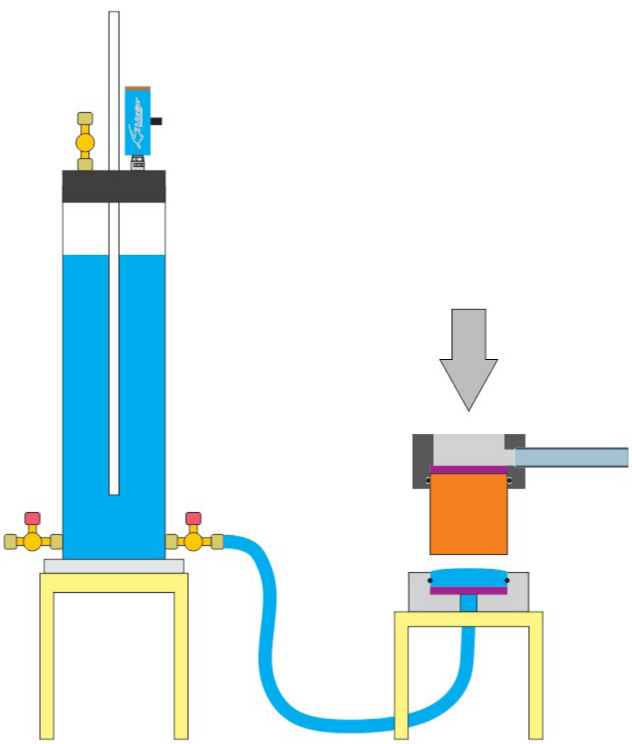

Fig. 11

Place the Tempe Cell Cap over the Sample Ring and then place it over the Tempe Cell Base (Fig. 11). Please note that the air stone at the top of the sample needs to be dry; otherwise air bubbles may get trapped at the bottom of it. Make sure no bubble is trapped at the bottom of the sample. Push the sample down to make sure that it is secure in place.

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Open Valve A, place a Beaker under the Tempe Cell Drain Pipe and let the sample saturate (Fig 12). Depending on soil type, the saturation process may take several minutes (coarse sand) to several weeks (heavy clay).

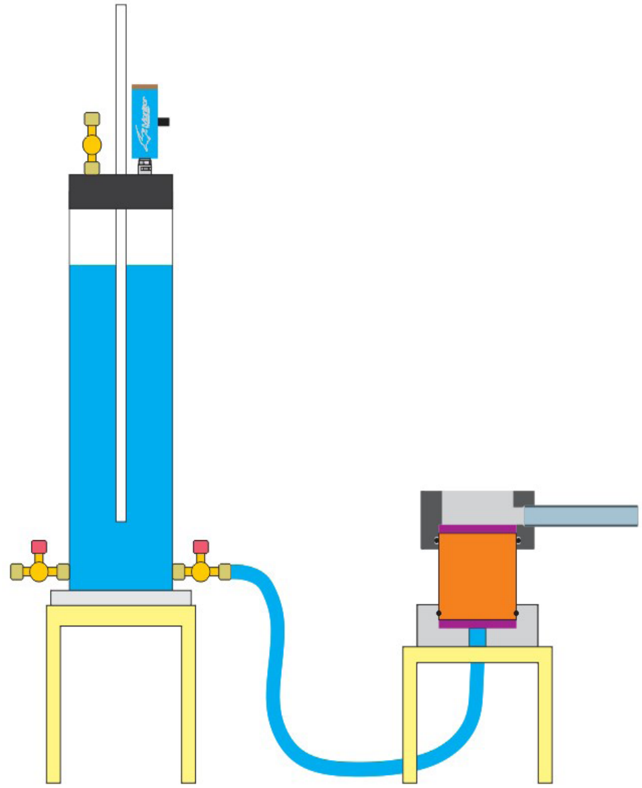

Fig. 12

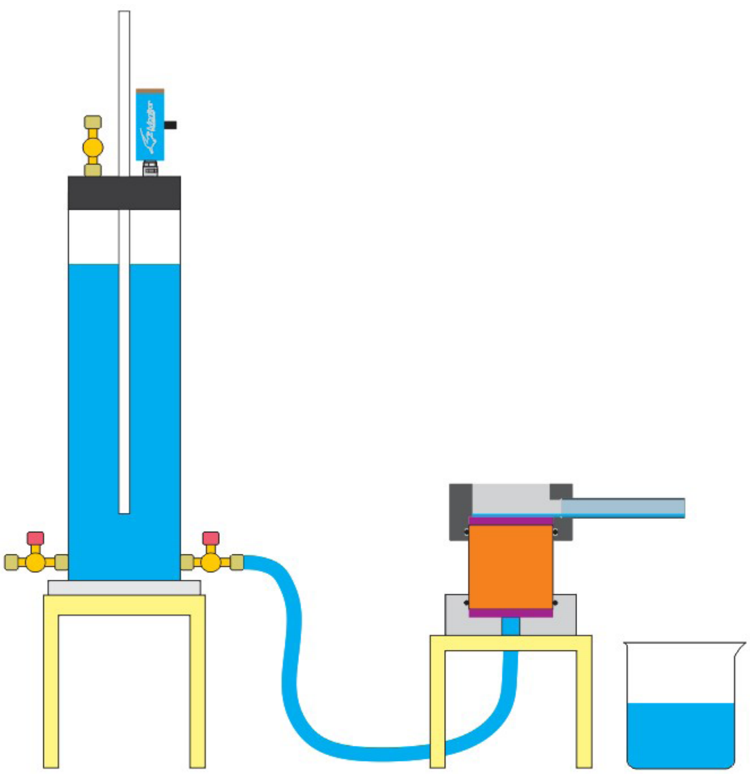

Fig. 13

Once the sample gets saturated (you should be able to see wetness evidences on soil surface), place the Tempe Cell Cap over the Sample Ring and secure it with Tempe Cell thread rods and wing nuts (Fig. 13).

- Close Valve A
- Close Valve C
- Open Valve B

Now you are ready to perform a measurement.

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CONSTANT HEAD METHOD

Performing a Measurement

If needed, use “Create Zero Head Height” procedure to put the system on zero head height. Con-

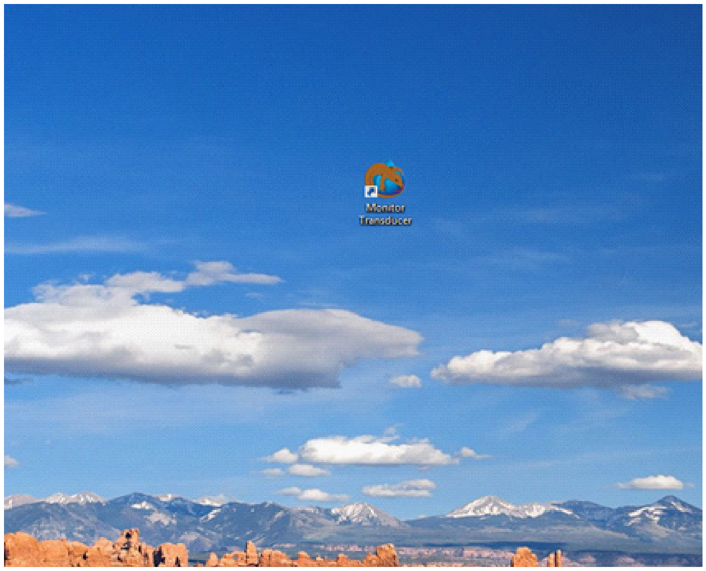

Fig. 14

nect the Monitor Transducer to your computer using the USB cable provided with the system. Open Monitor Transducer program (Fig 14).

Make sure that Valve B is open. This is to expose the pressure sensor to ambient air. If the Moni-

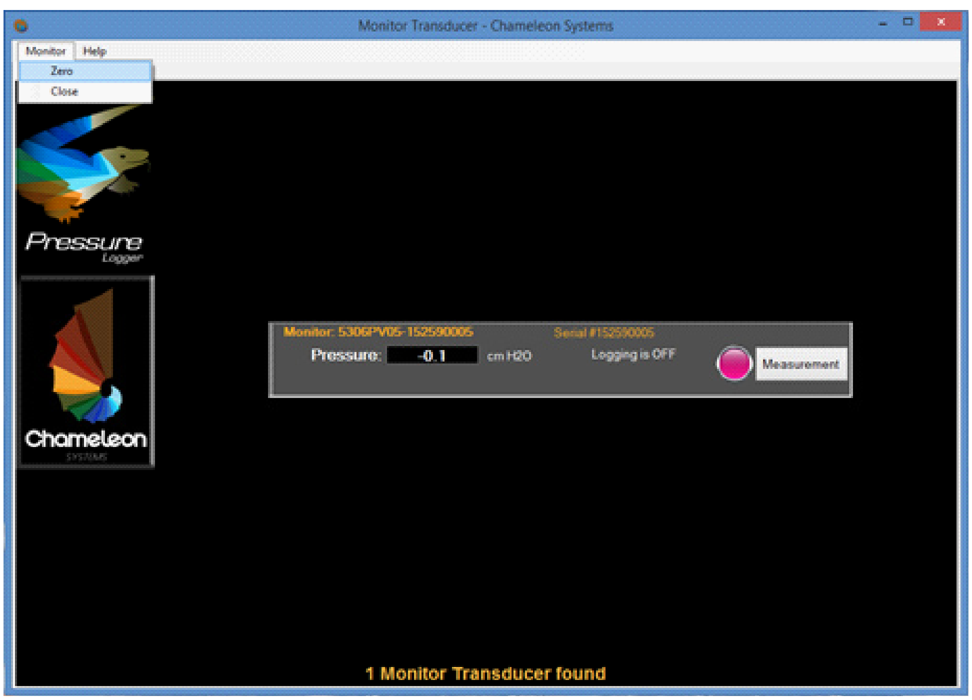

Fig. 15

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tor sensor reads a pressure other than zero, then go to the "Monitor" menu then click "Zero". The pressure reading should go to zero (Fig. 15).

Once the sensor is zeroed, click on the "Measurement" button to go to "Lab Saturated Hydraulic

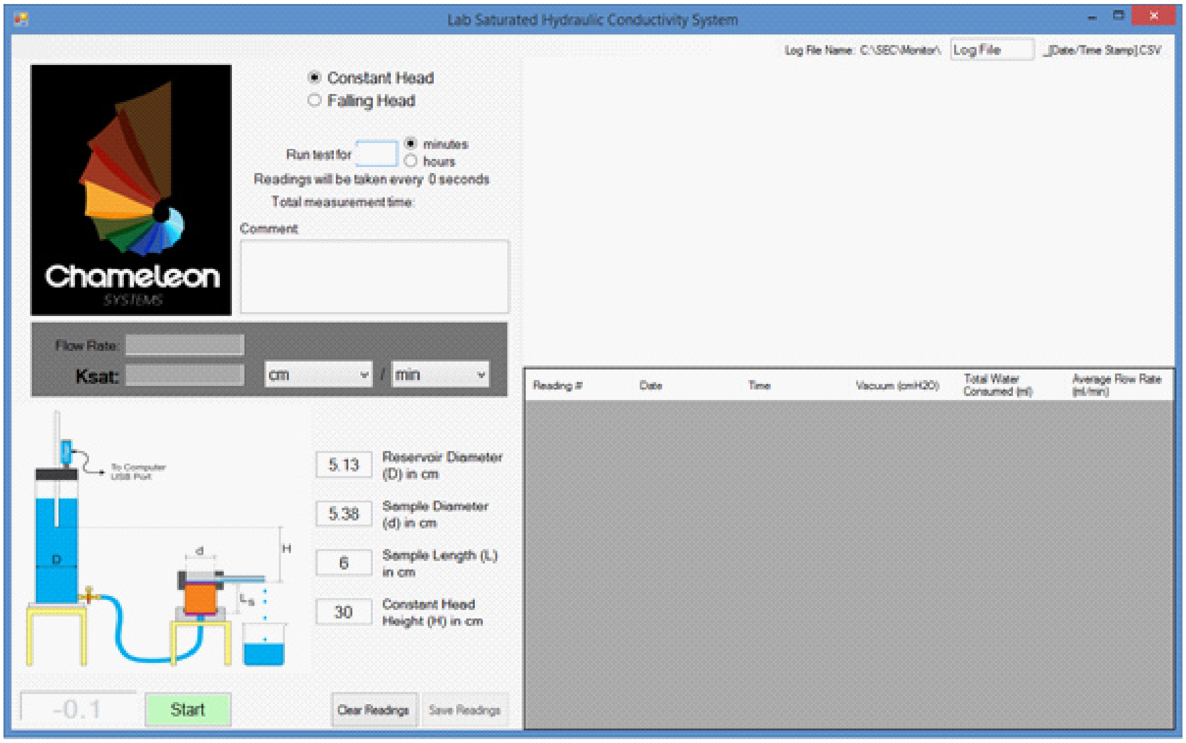

Fig. 16

Conductivity System" window. Here you can perform your measurement. Select the "Constant Head" method (Fig 16).

- In the "Log File Name" field, enter your log file name. This is the file that will contain your reading information.
- In the "Reservoir Diameter" field enter Reservoir inside diameter (D). Chameleon Reservoir inside diameter is 5.13 cm. Please also note that the outside diameter of the Air Tube is assumed to be 0.635 cm.
- In the "Sample Diameter" field enter the Sample Ring inside diameter (d). Inside diameter of Chameleon standard ring is 5.38 cm.
- In the "Sample Length" field enter the sample length (Ls). Chameleon standard sample ring is 6 cm long.
- Adjust the bottom of Air Tube on your desired head height (H). Use your recorded Zero Head

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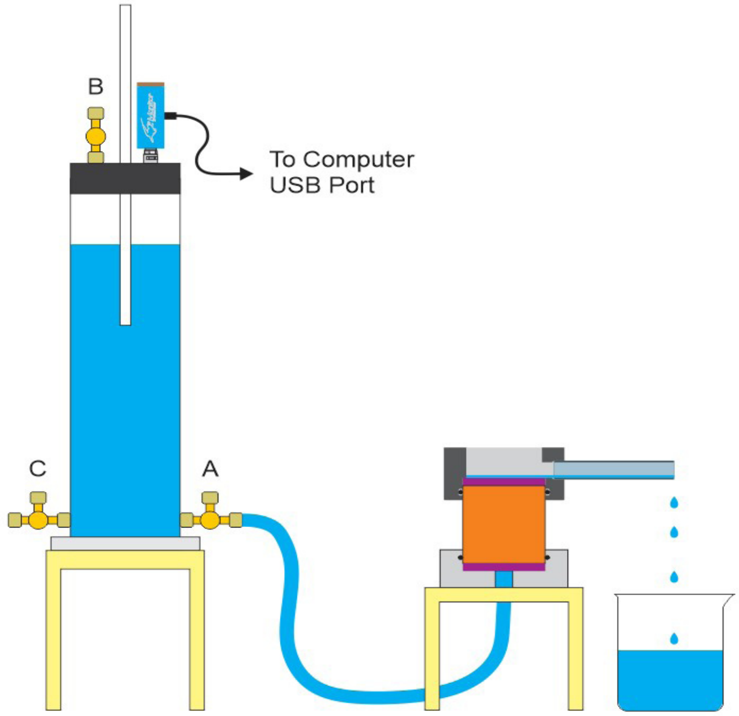

Height to do this. For example, if your desired head height is 10 cm and Zero Head Height is 6.7 cm, adjust the end of the Air Tube to 16.7 cm (see the figure on the next page).

Adjusting the head height (example numbers. Schematic is not to scale).

In case the target head height is relatively high, you need to elevate the Reservoir (Fig. 17). Consequently, you would not be

Fig. 17

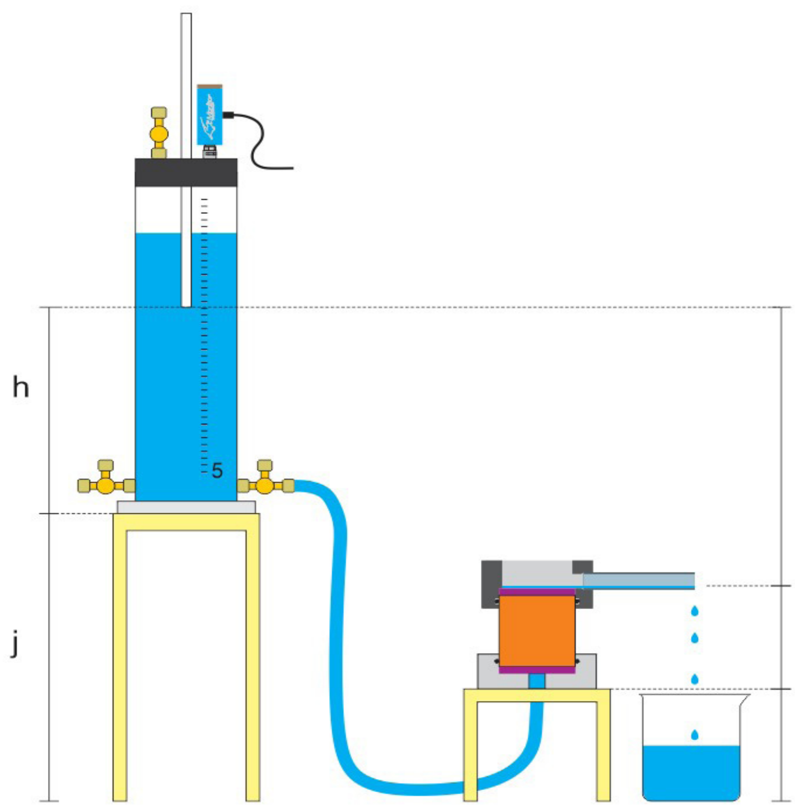

Fig. 18

Calculating head height in a system with an elevated Reservoir (schematic is not to scale).

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able to set the system on Zero Point and use it as a reference level. The following example shows you how to calculate the height of the Air Tube against the Reservoir Scale (Fig 18).
h: the height of the Air Tube against Reservoir Scale.
H: target water head height.
j: the height of the Reservoir stand (not included in the system).
s: the height of the Tempe Cell Stand. It is 6.00" (15.24 cm).
t: the height of the Tempe Cell outlet from the bottom of the Tempe Cell. It is 3.35" (8.51 cm).

$$h = H + s + t - j$$

Example:
Assume your target head height (H) is 60 cm and your Reservoir stand is 70.75 cm tall. Calculate the height of the Air Tube bottom against the Reservoir Scale.

$$h = H + s + t - j$$
$$h = 60 + 15.24 + 8.51 - 70.75$$
$$h = 13.00 \text{ cm}$$

So you need to adjust the bottom of Air Tube to 13 cm against the Reservoir Scale in order to create a 60 cm overhead pressure.

Select a unit for measuring Saturated Hydraulic Conductivity (Ksat) using the dropdown menus in front of Ksat.

In the “Run test for” field, enter the duration of your measurement. As a rule of thumb, finer soils (more clay) need longer measurement times,while coarser soils (more sand) generally require shorter measurement times. The table below (Fig. 19) provides suggested head height and measurement times for each type of soil.

Fig 19. Suggested Measurement Time for different Ksat levels. Please note that the table is created based on standard measurement parameters (D=5.13 cm, d=5.38, L=6.00cm).

Soil Texture		**Sand**			**Silt**			**Clay**	
Relative Permeability		**Semi-Pervious**					**Impervious**		
Aquifer		**Good**		**Poor**				**None**	
Unconsolidated Sand and Gravel		**Well Sorted Sand**		**Very Fine Sand, Silt, Loess, Loam**					
Unconsolidated Clay and Organic		**Peat**			**Layered Clay**			**Unweathered Clay**	
Consolidated Rocks		**Oil Reservoir Rocks**				**Fresh Sandstone**		**Fresh Limestone**	
K value (m/s)		**E-3**	**E-4***	**E-5**	**E-6**	**E-7**	**E-8**	**E-9**	**E-10**
Water Consumption Rate	Q (cm^3/min):	69.000	23.000	6.900	0.690	0.138	0.014		
Overhead Pressure	H (cm):	3.00	10.00	30.00	30.00	60.00	60.00		
	K (m/s):	1.01E-03	1.01E-04	1.01E-05	1.01E-06	1.01E-07	1.01E-08		
Measurement Time needed to see a change:	t (min):	0.0	0.1	0.3	2.9	14.5	144.9		
Suggested Measurement Time:	T:	1 min	1 min	5 min	15 min	1 hr	10 hr		
Reservoir Runs Empty	E (min):	13	39	130	1304	6522	65217		

Chameleon Parameters Table. Look up the suggested head height (H) and measurement time (T) based on the measured water consumption rate (Q). Please note that the table is created based on standard measurement parameters (D=5.13 cm, d=5.38, L=6.00cm).

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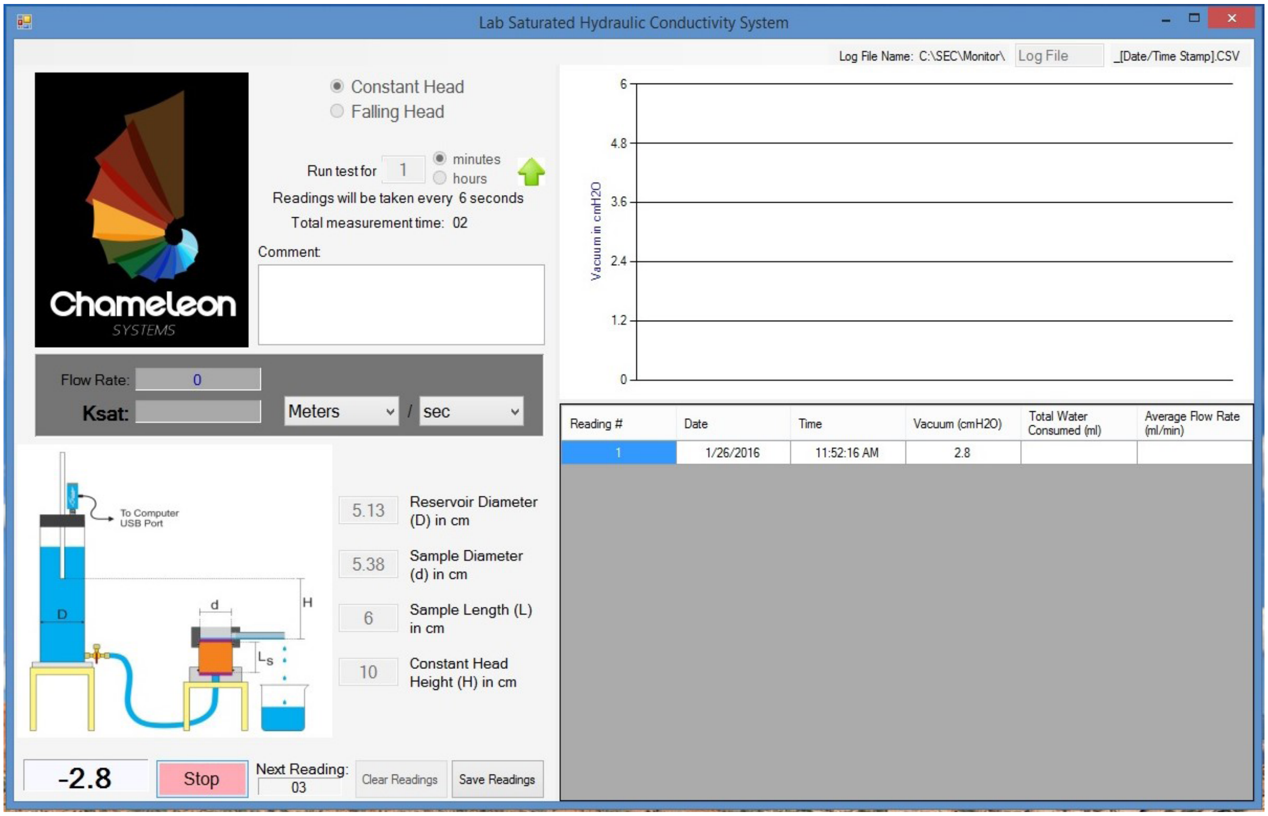

Fig. 20

Make sure that the system is set up correctly. Valves A, B and C should all be closed (Fig 21).

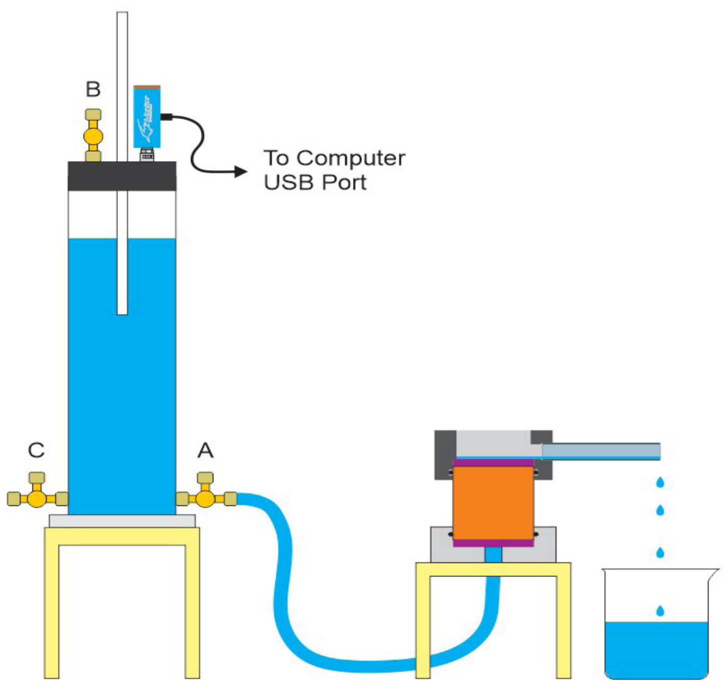

Fig. 21

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- Open Valve A.
- Wait until the Air Pipe starts bubbling
- Wait for 10 more seconds for the system to stabilize.
- Click the "Start" button to start a measurement (Fig 21).

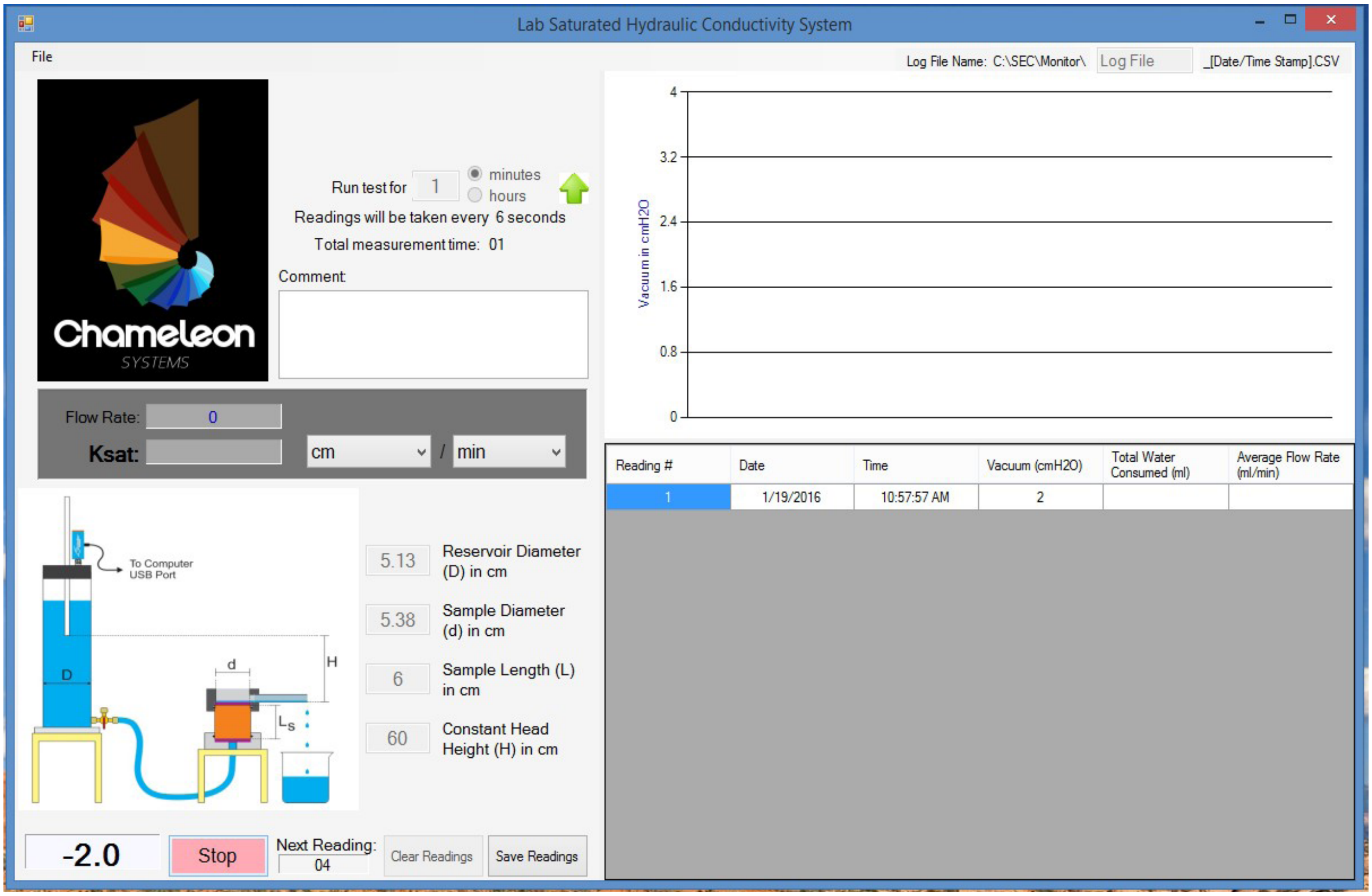

Fig. 22

The first reading is made immediately (Fig 22). The software then divides the reading period into 10 equal increments and makes a reading at the end of each time increment. If the increments are too short, the readings graph is going to have a "step-like" trend (Fig 23). In that case you may want to increase the measurement time.

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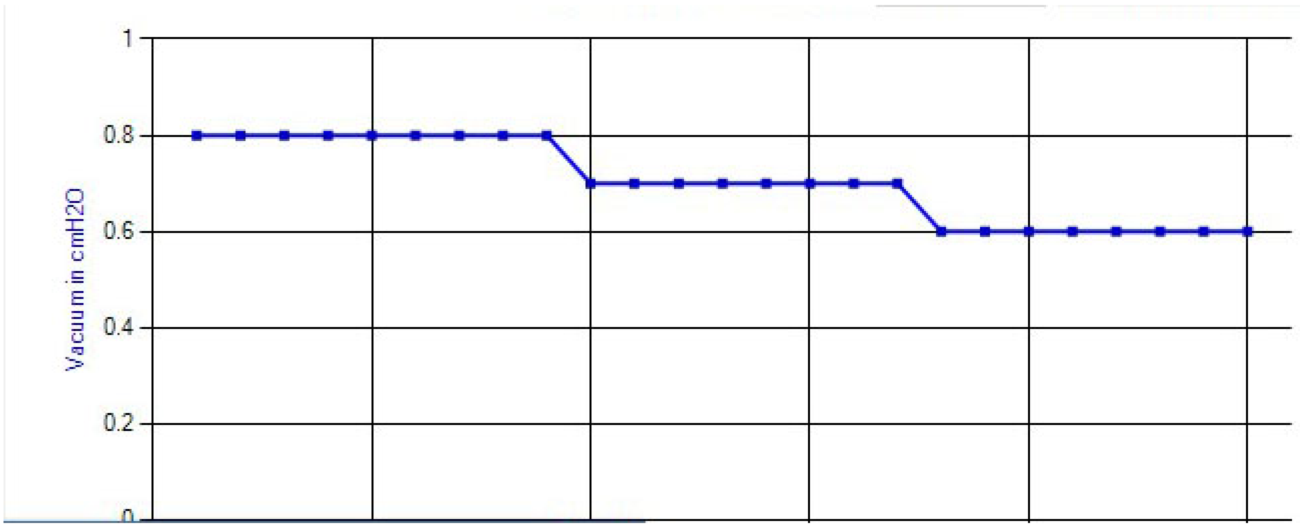

Fig. 23 - A step-like reading graph is an indication of a too short measurement time.

Once you get the first Average Flow Rate values, compare them with the Chameleon Parameters Table above (Fig. 22). If you need to readjust the head height or the measurement duration, do so and restart the measurement.

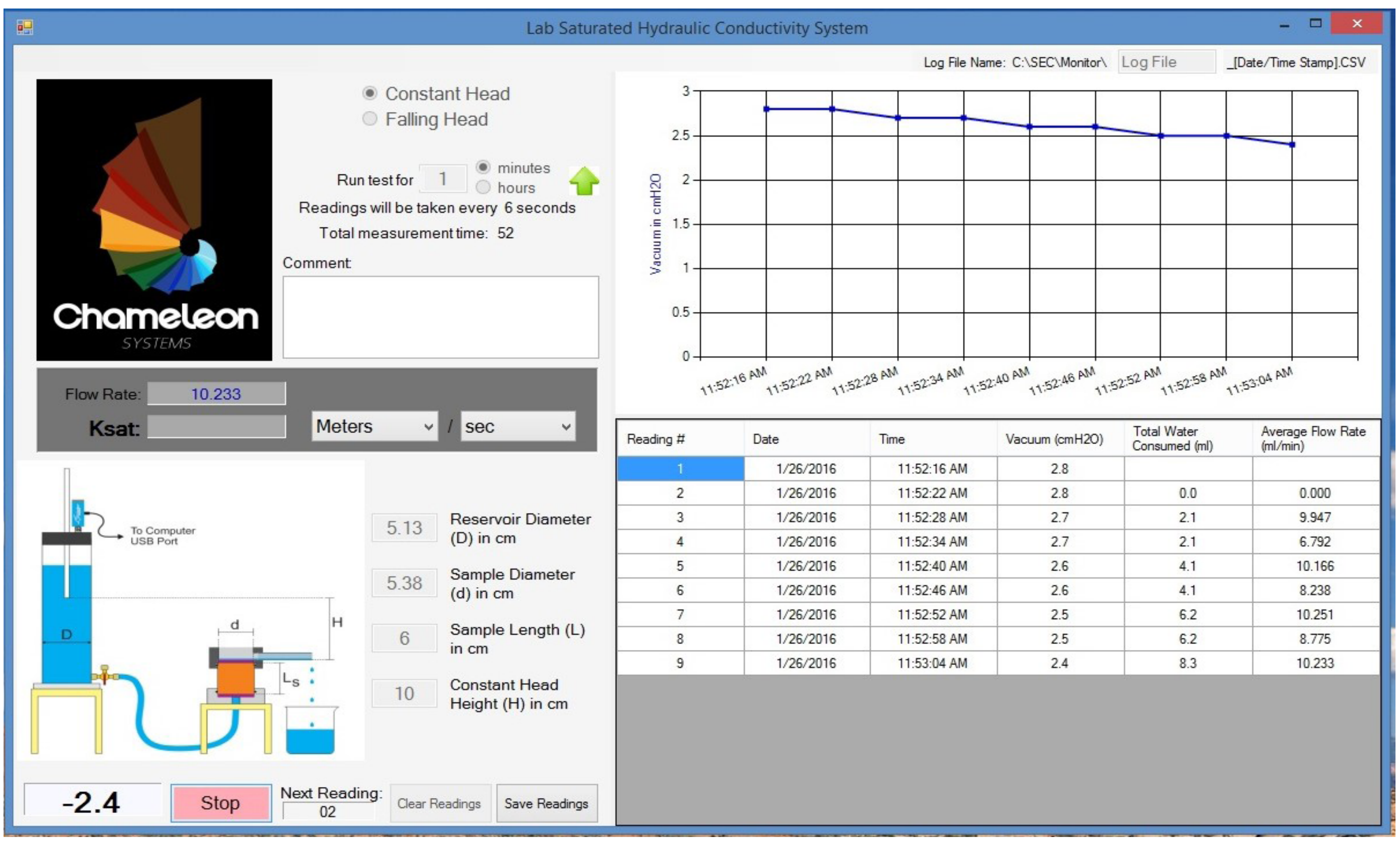

Fig. 24

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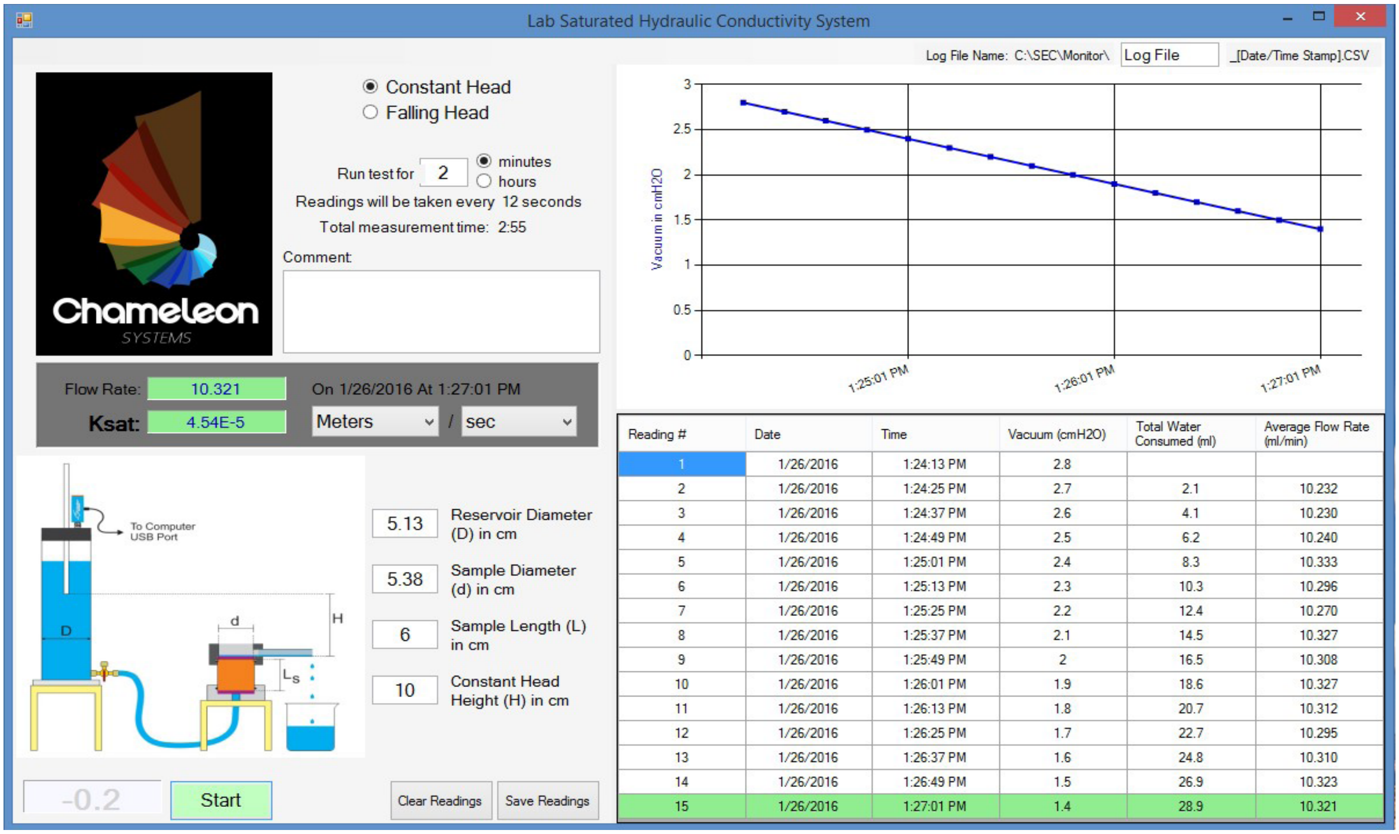
For example, looking at the reading graph in (Fig. 24), you are still able to see some "step-like" effect. In other words, some readings have similar Vacuum values. A Step-like graph suggests that perhaps longer measurement duration will give you a more accurate reading. Please note that a step-like graph does not mean that the measurement is wrong. We increased the measurement duration to 2 minutes for the same sample. See how readings trend improved (image below).



Reading #	Date	Time	Vacuum (cmH2O)	Total Water Consumed (ml)	Average Flow Rate (ml/min)
1	1/26/2016	1:24:13 PM	2.8		
2	1/26/2016	1:24:25 PM	2.7	2.1	10.232
3	1/26/2016	1:24:37 PM	2.6	4.1	10.230
4	1/26/2016	1:24:49 PM	2.5	6.2	10.240
5	1/26/2016	1:25:01 PM	2.4	8.3	10.333
6	1/26/2016	1:25:13 PM	2.3	10.3	10.296
7	1/26/2016	1:25:25 PM	2.2	12.4	10.270
8	1/26/2016	1:25:37 PM	2.1	14.5	10.327
9	1/26/2016	1:25:49 PM	2	16.5	10.308
10	1/26/2016	1:26:01 PM	1.9	18.6	10.327
11	1/26/2016	1:26:13 PM	1.8	20.7	10.312
12	1/26/2016	1:26:25 PM	1.7	22.7	10.295
13	1/26/2016	1:26:37 PM	1.6	24.8	10.310
14	1/26/2016	1:26:49 PM	1.5	26.9	10.323
15	1/26/2016	1:27:01 PM	1.4	28.9	10.321

Fig. 25

The Ksat value appears on the screen once the reading time is over (in Fig. 25 above, after 2 minute). The first reading and the last reading (green highlight) are used for measuring Average Flow Rate and then Ksat.

The software keeps reading until you press "Stop". This is a handy feature when you decide to keep going with the measurement even after the designated measurement time is over. In case you need to increase the initial measurement time to a longer interval, use the green up arrow right beside the measurement duration field.

Click "Stop" whenever you would like to stop the reading process. The software gives you an option to use the very last reading as the end point of your measurement. Click "Yes" if you would like to do so.

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Click “Save” to save the readings and the results in a CSV file. The file address can be found at the top right corner of the measurement window. You can open the reading file in MS-Excel or other similar programs. Below (Fig. 26) is an example data file generated by Chameleon.

K23

	A	B	C	D	E	F
1	Chameleon Systems Constant Head Measurement					
2						
3	Monitor Name: 5306PV05-152590005					
4	Serial Number: 152590005					
5	Reservoir Diameter (D) in cm: 5.13					
6	Sample Diameter (d) in cm: 5.38					
7	Sample Length (L) in cm: 6					
8	Constant Head Height (H) in cm: 30					
9	Run test for: 1 minutes					
10	Comment:					
11						
12	Reading Number	Date	Time	Pressure (cmH2O)	Total Water Consumed (ml)	Average Flow Rate (ml/min)
13	1	1/19/2016	11:27:39 AM	1.1		
14	2	1/19/2016	11:27:46 AM	1	2.1	19.501
15	3	1/19/2016	11:27:51 AM	1	2.1	10.196
16	4	1/19/2016	11:27:58 AM	1	2.1	6.693
17	5	1/19/2016	11:28:04 AM	1	2.1	5.105
18	6	1/19/2016	11:28:10 AM	1	2.1	4.067
19	7	1/19/2016	11:28:15 AM	1	2.1	3.433
20	8	1/19/2016	11:28:22 AM	1	2.1	2.926
21	9	1/19/2016	11:28:28 AM	1	2.1	2.571
22	10	1/19/2016	11:28:33 AM	1	2.1	2.295
23	11	1/19/2016	11:28:40 AM	0.9	4.1	4.108
24	12	1/19/2016	11:28:45 AM	0.9	4.1	3.755
25	13	1/19/2016	11:28:52 AM	0.9	4.1	3.423
26	14	1/19/2016	11:28:58 AM	0.9	4.1	3.165
27	15	1/19/2016	11:29:04 AM	0.9	4.1	2.943
28	16	1/19/2016	11:29:09 AM	0.9	4.1	2.754
29	17	1/19/2016	11:29:15 AM	0.9	4.1	2.579
30	18	1/19/2016	11:29:21 AM	0.9	4.1	2.427
31	19	1/19/2016	11:29:28 AM	0.9	4.1	2.284
32	20	1/19/2016	11:29:33 AM	0.9	4.1	2.174
33						
34	Flow Rate: 2.174 ml/min	Ksat: 3.19E-6 Meters/sec				

Fig. 26

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Calculations

Since the soil sample is already saturated at the beginning of the measurement, the Average Flow Rate calculated at the end of the measurement can be considered as the steady flow rate (Q). At each time increment, Average Flow Rate is calculated using the first reading, the last reading and the elapsed time between the two readings:

$$Q = \frac{\Delta V}{\Delta t} = \frac{A_e \times \Delta h}{\Delta t} = \frac{A_e \times (h_n - h_0)}{(t_0 - t_n)}$$

Where Q is the steady-state flow rate (ml/min), V is the volume of water consumed (cm^3), Ae is the Reservoir effective cross-sectional area (cm^2), H0 is the vacuum reading at the beginning of the measurement (cmH_2O), H1 is the vacuum reading at the end of the measurement campaign (cmH_2O), t0 is the time at the beginning of the measurement (min), and tn is the time at the end of the measurement. Also Ae is:

$$A_e = A_c - A_a$$

Where Ac is the Reservoir cross-sectional area calculated from the Reservoir inside diameter and Aa is the Air Tube cross-sectional area calculated from the Air Tube outside diameter. Please note that Chameleon software assumes that the Air Tube outside diameter is 0.635 cm.

Once Q is calculated, Ksat can be calculated as:

$$K_{sat} = \frac{Q \times L}{A_s \times H}$$

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Where Ksat is saturated hydraulic conductivity, Q is the steady-state flow rate, L is the sample length, As is the sample cross-sectional area and H is hydraulic head difference applied to the sample.

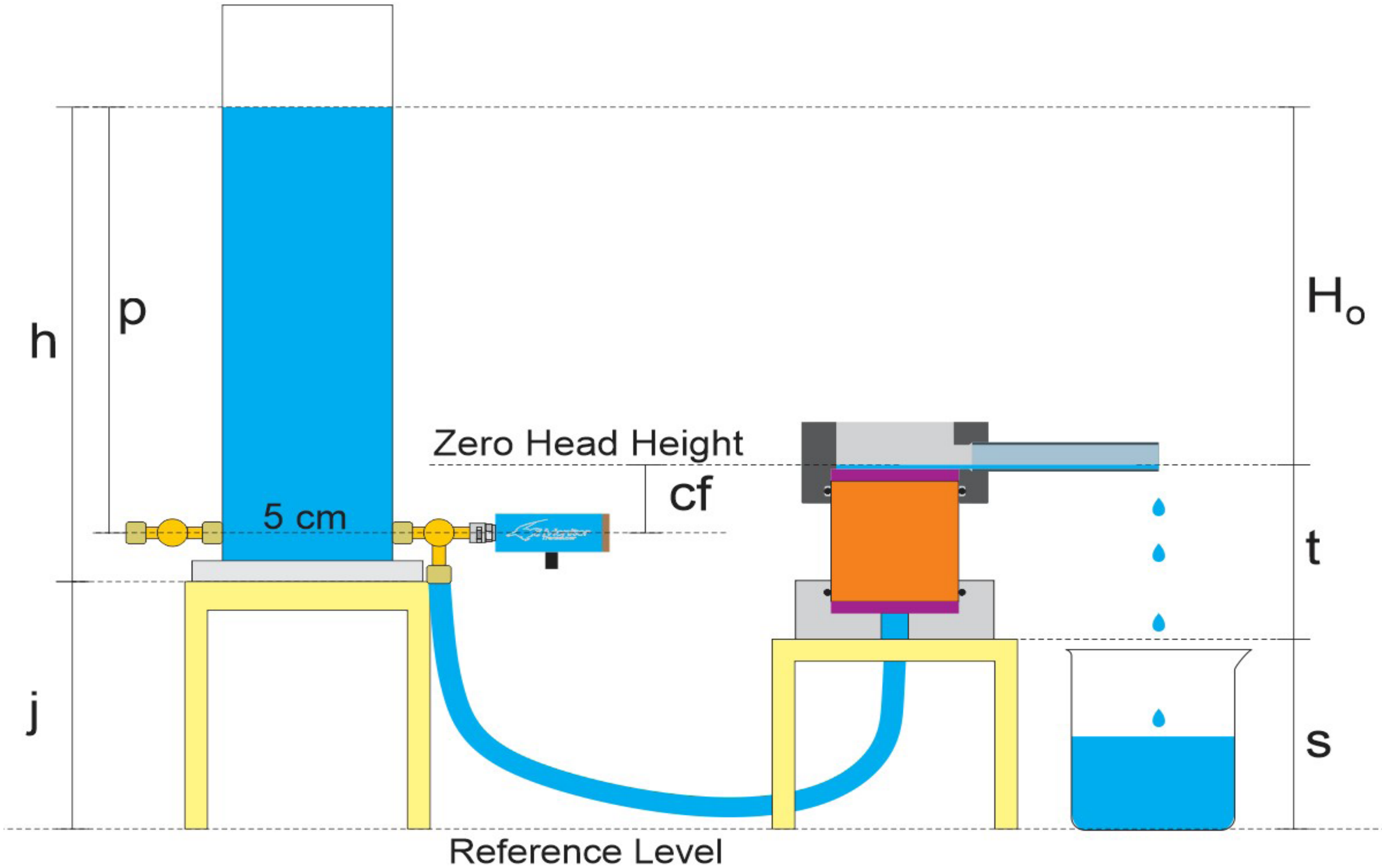

Fig. 27

Falling Head Method (Fig 27)

Determining the Correction Factor (cf)

Below is a schematic of Falling Head setup (Fig. 28)
h: the water level reading against Reservoir scale (cm).
j: the height of Reservoir Stand (cm).
p: the vacuum sensor reading (cm H_2O).
HO is overhead pressure (height difference between the water level in the Reservoir and the Tempe Cell water outlet) in cm H_2O.
s: the height of Tempe Cell Stand. It is 6.00" (15.24 cm).
t: the height of the Tempe Cell outlet from the bottom of the Tempe Cell. It is 3.35" (8.51 cm).
cf: pressure Correction Factor (cm H_2O).

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As evident in the schematic above, the Vacuum Sensor reading (p) is not necessarily equal to the actual overhead pressure (HO). Therefore, the Pressure Sensor reading (p) needs to be corrected:

$$HO = p + cf$$

The Correction Factor (cf) can be easily calculated from the formula below:

$$c = j - t - s + 5$$

It is recommended to set up the system in the way that the Pressure Sensor is located at or slightly (up to 5 cm) below the "Zero Head Height" level (schematic above). In that case the Correction Factor would be a negative number.

In case that you set up the system so the Vacuum Sensor is located above the "Zero Head Height" level, the Correction Factor would be positive (schematic below). This set-up is not recommended. The reason is that the measurement campaign has to be terminated before overhead pressure reaches to zero. Consequently, an important part of reading the data set will be lost.

The Schematic below illustrates why an important part of the readings is lost if the Vacuum Sensor is located above the Zero Head Height level.

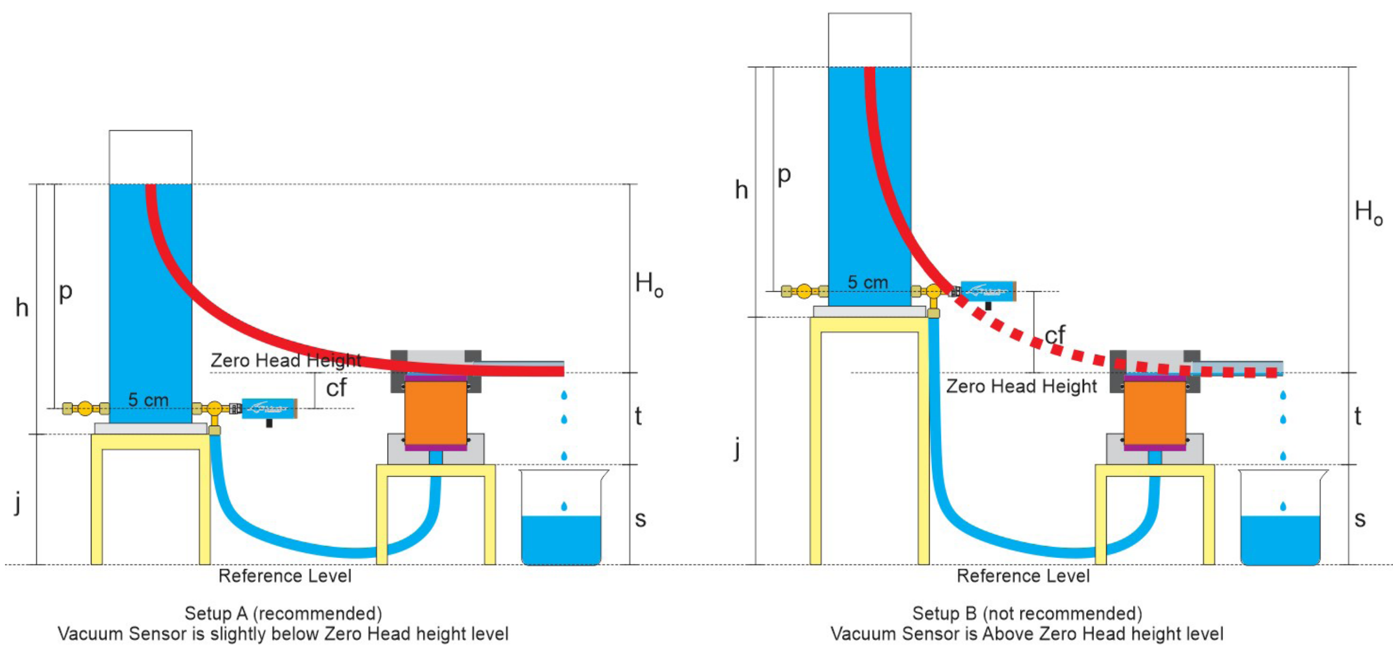

Fig. 28 - Falling Head Method system. Monitor Sensor is located above Zero Head Height level (not recommended).

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The red curves in the above schematics represent water level (overhead pressure) change against time in a Falling Head method measurement campaign (X axis is time and Y axis is water level). In Setup A, since the Pressure Sensor is located below the Zero Head Height level, overhead pressure can be measured all the way to zero overhead pressure (where the curve becomes horizontal). In Setup B, however, the doted curve represents the part of the curve that cannot be measured by the vacuum sensor (and will be lost). The reason is that once the water level falls below the Pressure Sensor level, it would not be possible for the sensor to measure pressure and therefore the measurement campaign has to be stopped.

Performing a Measurement (Constant Head Method)

Setup the system according to schematic below (Fig. 29).

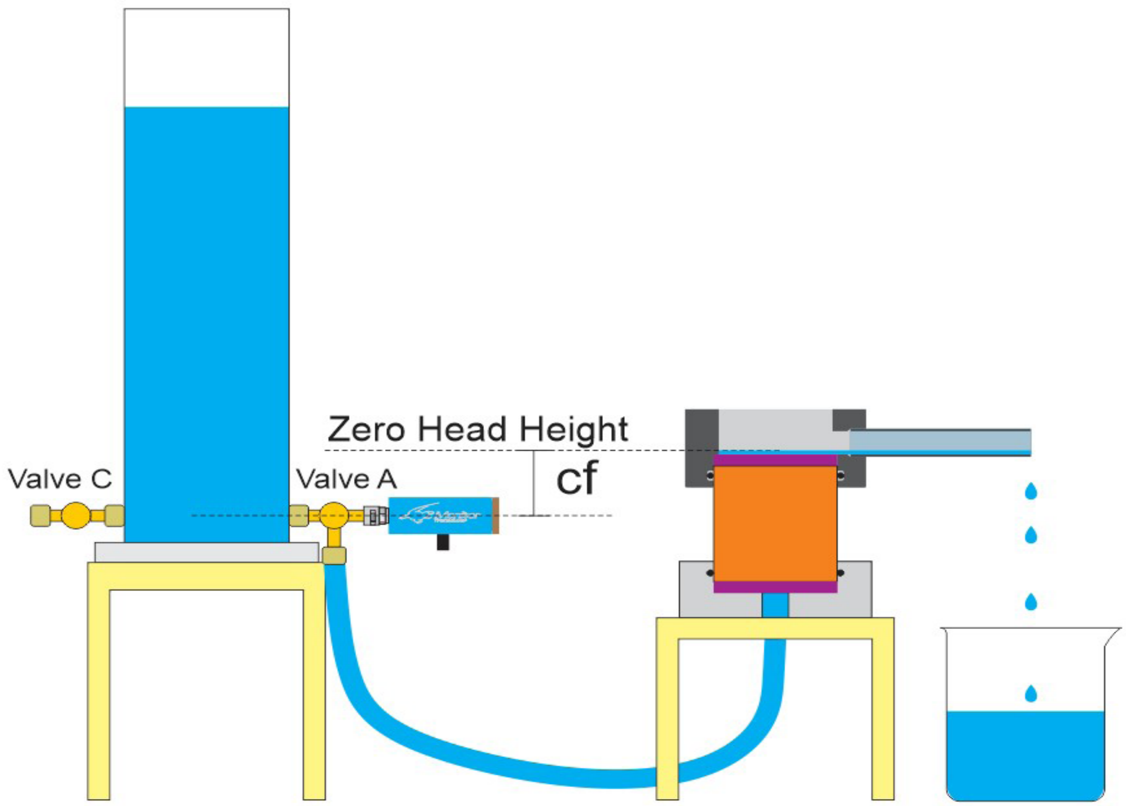

Fig. 29

- Make sure that Valve C is closed.
- Make sure the soil sample is saturated.
- Make sure there is no air bubbles trapped in the tubing or Tempe Cell.
- Make sure the Monitor sensor is zeroed.
- Connect the Monitor Transducer to your computer using the USB cable provided with the system.
- Open the Monitor Transducer program.

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Fig. 30

Select "Chameleon Systems" if it is not already selected (Fig. 30).

Click on "Measurement" on the corresponding sensor bar to go to the "Lab Saturated Hydraulic Conductivity System" window (Fig. 31). Here you can perform your measurement.

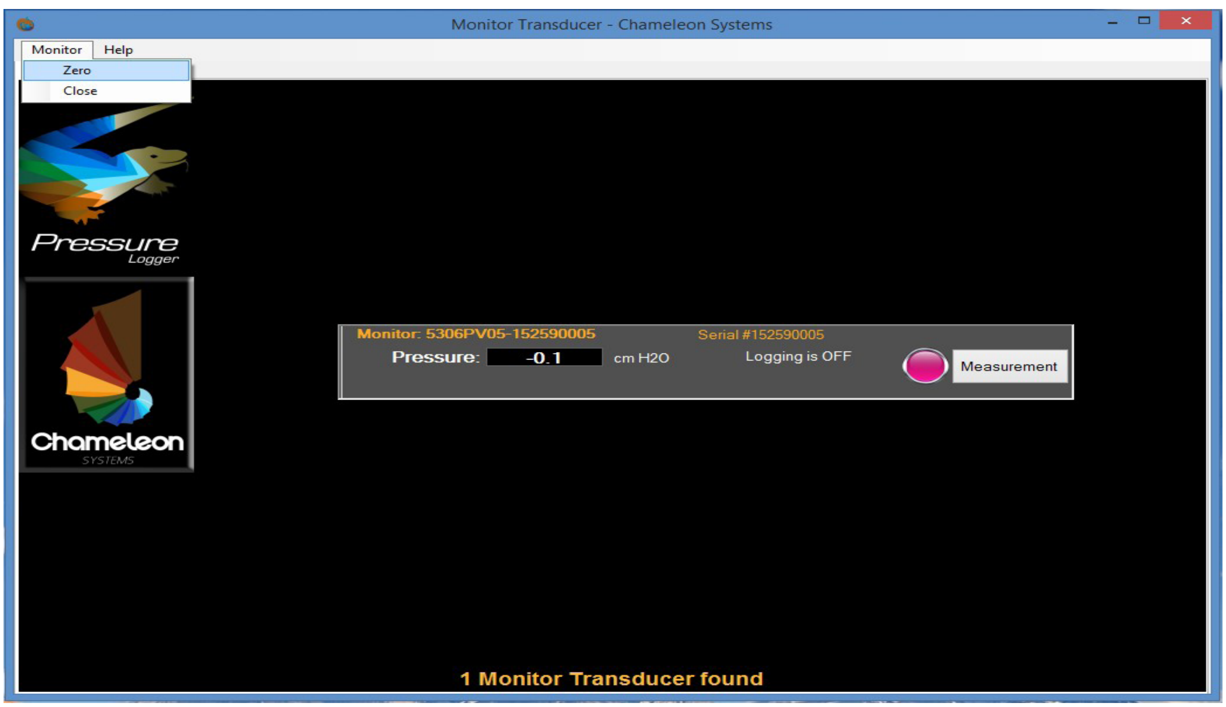

Fig. 31

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Select the “Falling Head” method (Fig. 32).

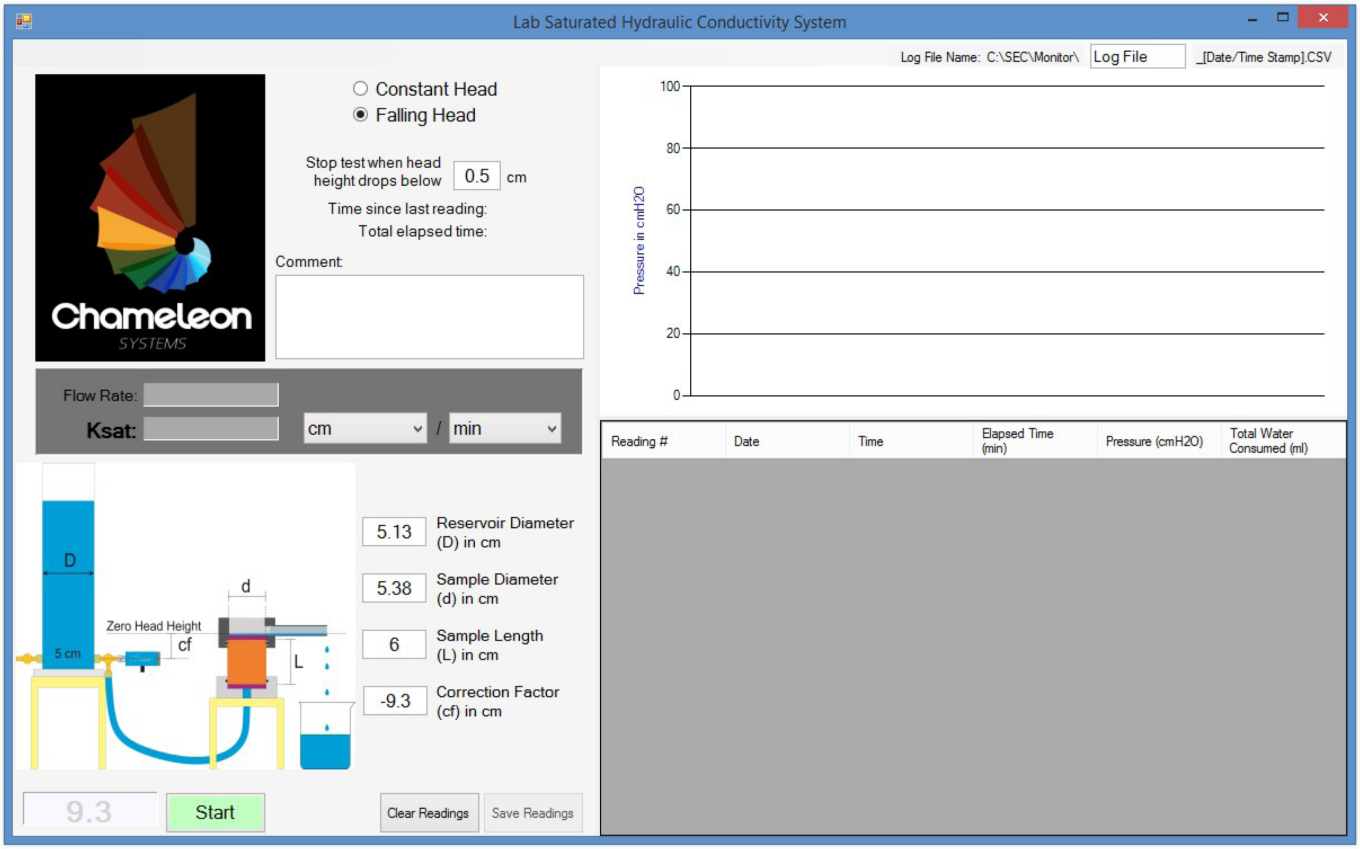

Fig. 32

- In the “Log File Name” field, enter your log file name. This is the file that will contain your reading information.
- In the “Reservoir Diameter” field enter the Reservoir inside diameter (D). Chameleon Reservoir inside diameter is 5.13 cm. Please also note that the outside diameter of the Air Tube is assumed to be 0.635 cm.
- In the “Sample Diameter” field enter Sample Ring inside diameter (d). Inside diameter of the Chameleon standard ring is 5.38 cm.
- In the “Sample Length” field enter your sample length (L). Chameleon standard sample ring is 6.00 cm long.
- In Correction Factor field, enter the Correction Factor (cf) you have calculated in the “Determining the Correction Factor (cf)” section.

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- You can set up the system so it stops automatically when head height drops below a certain pressure. Please note that the number you are entering in the corresponding field is the corrected (actual) head height.
- Raise the Reservoir water level to your desired height.
- Open Valve A; wait for 10 seconds and then click “Start” (Fig. 33).

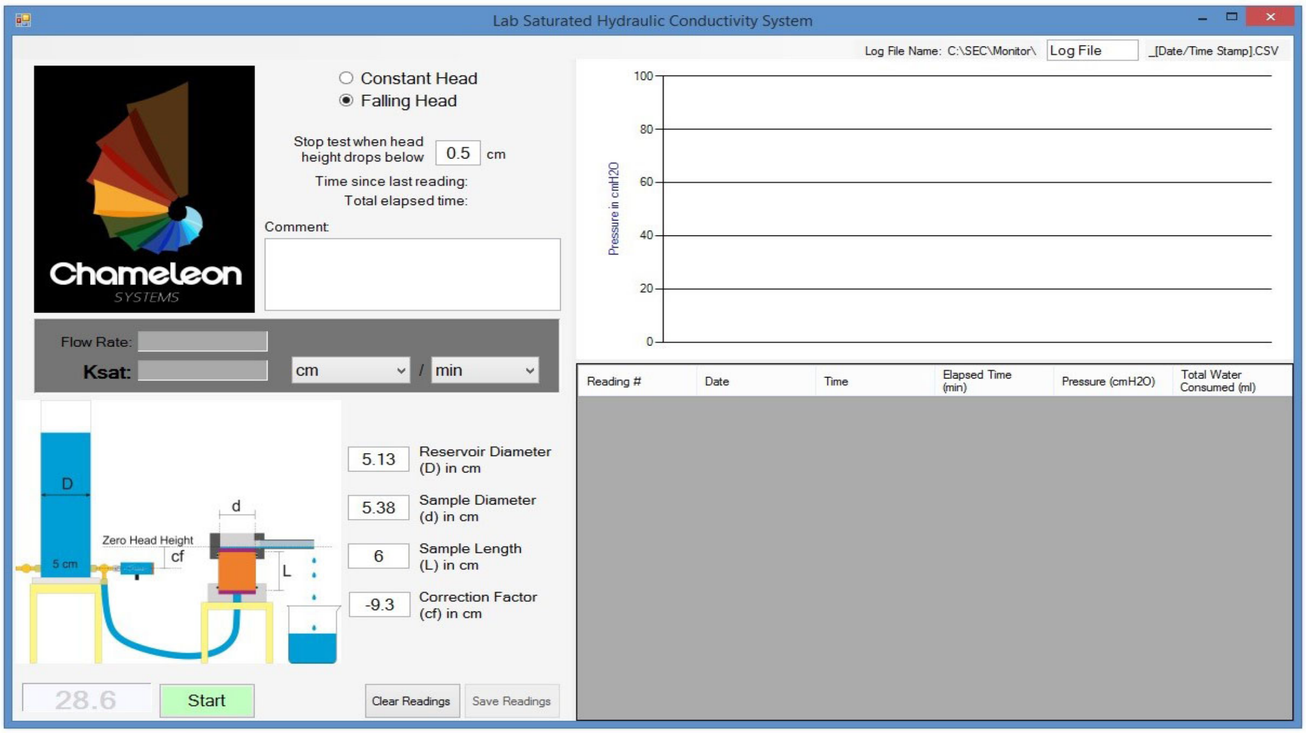

Fig. 33

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You can change the target water head to terminate the reading earlier. In this example we have changed the number from 0.5 cm to 2 cm. Readings are recorded once pressure level drops below a detectable value. Therefore reading intervals are not equal and become longer towards the end of the reading campaign.

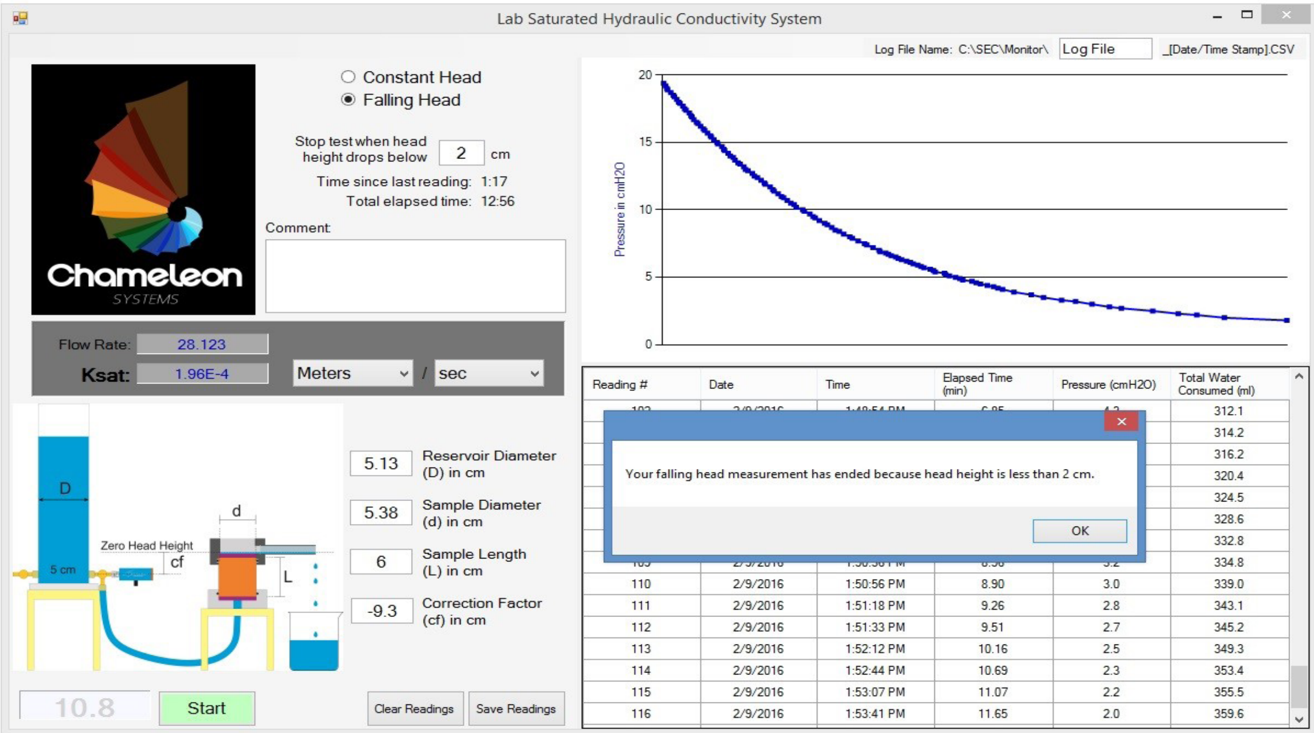

Fig. 34

Ksat value appears on the screen once the overhead pressure drops below the designated value (2 cm in this example). A pop up window prompts the user that the reading campaign is ended (Fig. 34).

Click “Save” to save the readings and the results in a CSV file. The file address can be found at the top right corner of the measurement window. You can open the reading file in MS-Excel or other similar programs. Below is an example data file generated by Chameleon for a falling head reading campaign (Fig 35).

Calculations

Overhead pressure (water height) variation over time has an exponential trend:

$$H_t = a.\exp(-b.t)$$

Where Ht is overhead pressure at time t and a and b are coefficients of the exponential function.

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Fig. 35

	A	B	C	D	E	F
1	Chameleon Systems Falling Head Measurement					
2						
3	Monitor Name: 5306PV05-152590005					
4	Serial Number: 152590005					
5	Reservoir Diameter (D) in cm: 5.13					
6	Sample Diameter (d) in cm: 5.38					
7	Sample Length (L) in cm: 6					
8	Correction Factor (cf) in cm: -9.3					
9	Stop test when head height falls below: 2					
10						
11						
12	Reading #	Date	Time	Elapsed Time (min)	Pressure (cmH2O)	Total Water Consumed (ml)
13	1	2/9/2016	3:25:36 PM	0.01	10.3	
14	2	2/9/2016	3:25:37 PM	0.03	10.2	2.1
15	3	2/9/2016	3:25:44 PM	0.14	10	6.2
16	4	2/9/2016	3:25:50 PM	0.24	9.9	8.3
17	5	2/9/2016	3:25:52 PM	0.27	9.7	12.4
18	6	2/9/2016	3:26:01 PM	0.42	9.5	16.5
19	7	2/9/2016	3:26:04 PM	0.49	9.4	18.6
20	8	2/9/2016	3:26:13 PM	0.62	9.2	22.7
21	9	2/9/2016	3:26:19 PM	0.73	9	26.9
22	10	2/9/2016	3:26:23 PM	0.8	8.9	28.9
23	11	2/9/2016	3:26:31 PM	0.93	8.7	33.1
24	12	2/9/2016	3:26:38 PM	1.05	8.5	37.2
25	13	2/9/2016	3:26:41 PM	1.09	8.4	39.3
26	14	2/9/2016	3:26:48 PM	1.22	8.2	43.4
27	15	2/9/2016	3:26:56 PM	1.34	8	47.5
28	16	2/9/2016	3:27:05 PM	1.49	7.9	49.6

Saturated Hydraulic Conductivity then can be calculated as:

$$K_{sat} = \frac{A_c}{A_s}.L.b$$

Where Ksat is saturated hydraulic conductivity, Ac is Reservoir cross-sectional area, As is sample cross-sectional area, L is sample length and b is coefficient of the fitted exponential function. Coefficients a and b can be calculated using the following procedure:

$$a = \frac{\sum_{i=1}^{n}(x_i^2\, y_i)\sum_{i=1}^{n}(y_i \ln y_i) - \sum_{i=1}^{n}(x_i\, y_i)\sum_{i=1}^{n}(x_i\, y_i \ln y_i)}{\sum_{i=1}^{n} y_i \sum_{i=1}^{n}(x_i^2\, y_i) - \left(\sum_{i=1}^{n} x_i\, y_i\right)^2}$$

$$b = \frac{\sum_{i=1}^{n} y_i \sum_{i=1}^{n}(x_i\, y_i \ln y_i) - \sum_{i=1}^{n}(x_i\, y_i)\sum_{i=1}^{n}(y_i \ln y_i)}{\sum_{i=1}^{n} y_i \sum_{i=1}^{n}(x_i^2\, y_i) - \left(\sum_{i=1}^{n} x_i\, y_i\right)^2}.$$

To fit a functional form

$$y = A\, e^{B\,x},$$

where $B \equiv b$ and $A \equiv \exp(a)$

Where y is overhead pressure, x is time and i is reading number.

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PARTS LIST

0209	Soil Core Cylinder Cap,For 0200
1425F1	Tempe Cell Manifold Stand (holds 5 Tempe Cells)
1430B01M3	1 Bar Hi Flow Porous Ceramic 2.375" Dia. For
1430SD	2.375" Dia Flow Cell Support Disc
1440CF1	Univ. Flow Cell Stand, 1 Cell, W/ Marriott Stand
1510-005PKG100	Filter Paper Pack Of 100
2816-1000	Graduated Cylinder Assembly
2816-2000	Flow Cell
5306PV15	Transducer Pressure Or Vacuum 15 Psi.
6911PCT07-PA	7-inch Hipstreet Tablet
8013SDS01	Chameleon Software
MFJ012PK	1/4 Ounce Silicone Grease Kit
XCNLU-FFPP	Female To Female Luer Connector Polypropylene
XCNLU-MMABS	Male To Male Luer Connector Abs
XCNLU3/16B-MLNY	3/16 Barbed Connector To Male Luer
XCNLUPLUG-FLPP	Female Luer Plug Polypropylene
XCNLUPLUG-MLPP	Male Luer Plug Polypropylene
XCNLUSC-MFPC	Female Luer To Male Luer Stopcock
XCNLUSC=MMMPC	4 Way Three Male Swivel Stopcock Luer
XLABBEAKER250PP	Polypropylene Beaker 250 ml
XPVCEXC3/16-5/16	3/16" ID x 5/16" OD Clear PVC Tubing
Z1400-100	Tempe Cell Top Cap Assembly, 2.25 Inch

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