Kibron Inc.

AquaPi

User´s Guide

Kibron AquaPi
A Portable Microtensiometer
User´s Guide

May 19, 2009
Revision E

Read this manual before unpacking the instrument and setting it into operation. Damage due to improper use is not covered by warranty.

Note that the warranty becomes effective only when Kibron receives the attached **warranty registration** -sheet within (10) after receiving the product. This form should be emailed or faxed to Kibron. Alternatively you will find the registration form at www.kibron.com/warranty

There are no user serviceable parts inside the electronic unit or sensor arm. Do not under any condition open them. Warranty and obligation for repair by Kibron Inc. will immediately expire if opened without prior written authorization by Kibron Inc.

To request warranty repair for this product: Contact Kibron Customer Service by telephone, fax or e-mail. We suggest that you keep the original aluminum case in case you need to ship the unit.

Preface

Congratulations for your purchase of AquaPi. This manual will acquaint you with the basic features of the instrument, setup and maintenance. Should you have any questions or other queries related to this product, please contact Kibron by phone, regular mail, fax, or e-mail:

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Document Conventions

This manual uses the following typographic conventions:

Example	Description
	This icon alerts the user to the presence of important operating and maintenance (servicing) instructions
	This icon indicates a warning or caution.

Revision History

Revision	Date	Changes
A	1/2004	First Release
B	5/2005	Generic
C	12/2007	Added test data and detailed measurement principle
D	5 / 2009	Microsoft Word version
E	2 / 2010	Added manual calibration procedure and example data

CONTENTS

INSTALLATION OF THE INSTRUMENT 5

Unpacking 5

Getting started 5

Charging the battery 6

Installing the DyneProbe 6

Calibrating the instrument 6

MEASURING WITH THE AQUAPI 8

Measuring step-by-step 8

Outdoor measurements 8

MAINTENANCE AND TROUBLESHOOTING 8

Cleaning the DyneProbe 8

DyneCup sample cuvette 8

MEASUREMENT PRINCIPLE 8

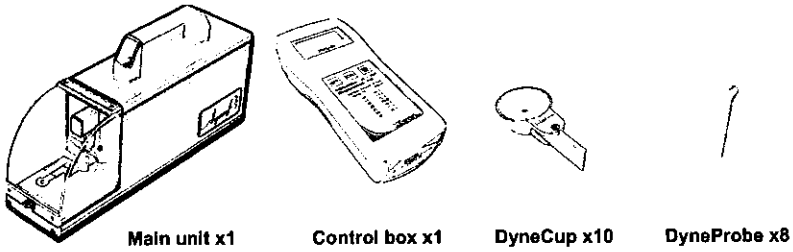
EXAMPLE DATA 8

Installation of the instrument

Unpacking

The instrument is shipped in an aluminum case, which includes the following standard items:

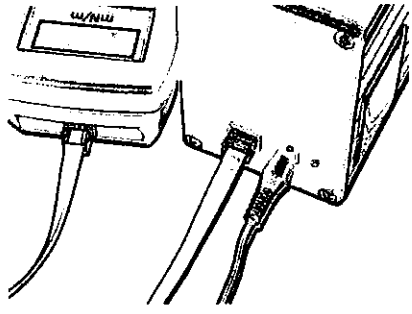
- The instrument
- The control box
- Interface cable to connect the instrument and the control box
- Power supply 100 - 240 V, also used for recharging the battery of the AquaPi
- Set of eight (8) measurement needles (DyneProbes)
- Set of ten (10) sample cuvettes (DyneCups)
- User's guide



Please check that all are included.

Getting started

To install AquaPi connect the instrument and the control box with the flat, gray cable provided. Connect also the power supply.



The sensors of the instruments have been carefully calibrated at Kibron. This means that the control box and the instrument must be operated in pairs. This must be taken into account if the user has several AquaPi instruments.

Charging the battery

When the power supply is connected to AquaPi it starts charging the battery (if the battery is not full). The LED next to the connector shows red. During charging the LED turns to orange and finally green, indicating a full charge. A full charge cycle takes about 10 hours. You may operate the AquaPi while charging. With full battery one can operate AquaPi continuously for at least 24 hours.

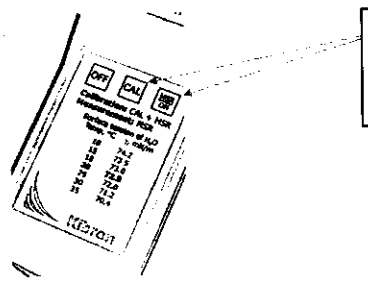
Installing the DyneProbe

Place the probe in the sensor loop by hand or using the forceps. You can additionally purchase a tool for attaching/removing the probe.

⚠ Be very careful when placing the probe to the loop. Excessive force exerted on the loop may permanently damage the sensor.

Calibrating the instrument

Calibration should be done once a day and always when the DyneProbe is changed. For calibration you need high purity water. Fill the DyneCup with DI-water and place it on the cuvette holder underneath the probe.



Start the calibration by pressing Cal and MSR/ON buttons simultaneously.

ⓘ The temperature of the water should be close to 20°C. If the temperature is different a correction factor must be calculated (see the image above for the relationship between surface tension and temperature with water). For example, if the temperature during the calibration is 25°C, the measured results have to be multiplied by a factor 72.0/72.8 = 0.989

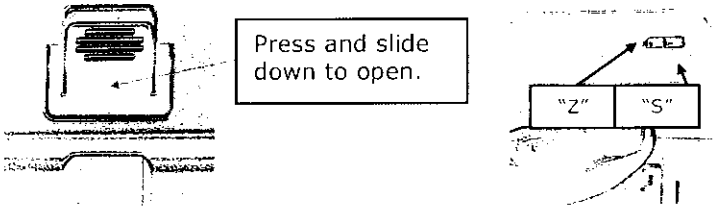
The cuvette holder starts going up and down several times while the sensor compares the minimum and maximum forces. Display shows values around -40 and +40 (arbitrary units). This may take over ten minutes. When the display starts showing values close to zero, the calibration is completed.

Manual calibration

Manual calibration is preferred when the operating temperature is other than 20°C. By calibrating this way you don't need any correction factors and the instrument shows always the real value.

1. First open the back cover of the control unit. There you can see two trimmers marked "Z" and "S". First press the "Meas" button and hold it down. While holding it down adjust the display to show zero using the trimmer "Z".

2. When the above is done, do a normal measurement. We know, that for example at 22°C the water surface tension is 72.5 mN/m. If your measured value is not 72.5, the turn trimmer "S". Make as many measurement and adjustments with "S" trimmer until your measurement shows 72.5 mN/m.



Measuring with the AquaPi

Measuring step-by-step

The operation of AquaPi/EZ-Pi is extremely simple. Please follow the following steps.

1. The temperature of the instrument should be approx. equal to the temperature of the environment where the measurements are to be performed. For this reason let the instrument stay at this temperature for approx. one hour.
2. Place AquaPi/EZ-Pi on a level, non-vibrating surface.
3. Introduce the sample as described earlier.
4. Press the "MSR/ON" button to initialize the measurement.
5. When "PKHOLD" appears on the display the measurement has been completed.
6. It is advisable to make another measurement for the same sample (simply press again "MSR/ON" button). This is advisable as the DyneProbe is originally dry and the first measurement wets the probe to ensure near zero contact angle between the sample and the probe (see Chapter Measurement principle).
7. Before measuring a new sample; use a different DyneCup and clean the DyneProbe.

 Note: If the humidity is very low, touching the plex cover may generate high static electricity to the cover. This will result strong disturbances to the measurement. Wiping the cover with wet cloth will remove the static electricity.

Outdoor measurements

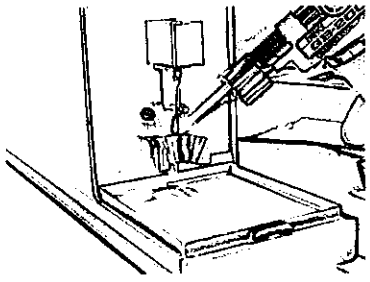
If you are making outdoor measurements, please note the following:

- Do not use AquaPi in direct rainfall.
- Make the measurements on a flat, level surface, preferably in shade. If the AquaPi is tilted sideways the results will not be correct.
- Take notice on the temperature of the sample. Surface tension is highly dependent on the temperature.
- Although AquaPi is not as fragile as conventional tensiometers, exercise reasonable caution when handling it outdoors.

Maintenance and troubleshooting

Cleaning the DyneProbe

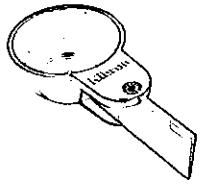
To clean the DyneProbe use a butane-welding torch. It is a standard item available from any store selling electronic components, such as Radio Shack. You may leave the probe hanging from the loop when flaming. Alternatively, you may remove the probe from the sensor loop and flame the probe outside the instrument.

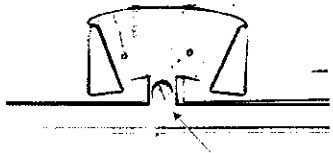


⚠ To avoid damage to the sensor, only the tip of the probe should be flamed.

DyneCup sample cuvette

The sample cuvettes for AquaPi are disposable. We strongly recommend not re-using them as many surface-active compounds are hard to clean, and the presence of any residues/ contaminants will yield distorted results. Also, use of laboratory gloves is recommended when handling the DyneCups. The volume of the sample liquid should be around 1- 3 ml. If the Dyneprobe doesn't reach the liquid surface, or goes too deep into the liquid, the position of the cuvette holder can be adjusted by loosening the screw below the holder. The optimal depth of immersion is about three (3) millimeters.





Loosen the screw and adjust the height by hand

Status and error codes

The following status and error icons may appear during the measurement.

Status code	Explanation
PK HOLD	The measurement has ended successfully
HIGH OL	This message may appear during the measurement and can be neglected. If the message appears during the calibration either one of, or all three the water, the DyneProbe, or the DyneCup needs to be changed/checked for purity.
LOW OL	See above.
	Battery is running low. Plug the charger to continue measuring and charging the battery.

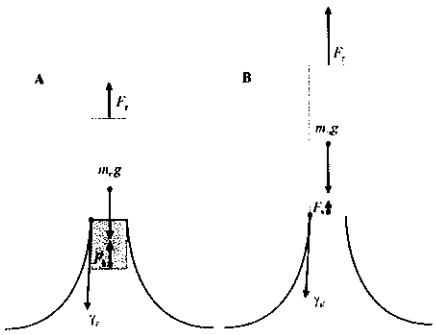
Specifications

The table below shows the specifications for the AquaPi.

Feature	Specification
Measuring range	0-100 mN/m
Accuracy/sensitivity	0.1 mN/m
Precision	CV < 0.1 % (water at 20°C)
Weight	2.2 kg
Dimensions	32 x 8 x 16 cm
Cuvette volume	1-3ml
Average time per measurement	less than 30 seconds
Battery life time	6-10 years

Measurement principle

The surface tension measurement used in the AquaPi is based on the Du Nouy/maximum pull force method, i.e. the maximum force exerted by the surface tension is recorded as the probe is withdrawn from the solution. In short, the cuvette tray is first raised up so that the probe becomes immersed into the sample. Subsequently, the tray is lowered while the maximum force pulling the probe is being recorded.



The force acting on the probe can be divided into two components:

i) Buoyancy stemming from the volume displaced by the probe, and
ii) The mass of the meniscus of the liquid adhering to the probe.

$$2\pi r_p \gamma \cos\theta = m_m g$$

where, r_p is the perimeter of the probe, γ is the surface tension and mm the weight of the meniscus under the probe. In the situation considered here the volume displaced by the probe is included in the meniscus. θ is the contact angle between the probe and the solution that is measured, and is negligible for the majority of solutions with Kibron's probes. Thus, the force measured by the balance is given by

$$F_p = m_m g + F_{buoyancy} = 2r_p + F_{buoyancy}$$

where, F_p is the force acting on the probe and $F_{buoyancy}$ is the force due to buoyancy. At the point of detachment the volume of the probe immersed in the solution vanishes, and thus, also the buoyancy term. This is observed as a maximum in the force curve, which relates to the surface tension through

$$\gamma = \frac{F_{\max}}{2\pi r_p}$$

The above derivation holds for ideal conditions. Non-idealities, e.g. from defect probe shape, are partly compensated in the calibration routine using a solution with known surface tension.

Example data