

## Enclosure:

1 x Instructions for Use for „Liquid-in-glass thermometers“

## Fields of application

The Aspiration Psychrometer, Assmann Type, serves for the exact determination of the temperature and humidity of air. According to the range of the built-in thermometer it can be used within the temperature range from approx. -5 to + 60 °C or from approx. -30 to + 40 °C respectively. Solar or other thermal radiations do not influence the measuring results if the suction openings of the encasing tubings are held properly. Measurements below 0 °C should be carried out with special care. The instrument should be protected against continuous precipitation.

## Description

Two mercury-in-glass thermometers, having as far as possible the same dimensions, are used as measuring elements. A piece of a textile wick is put on the mercury vessel of one of the thermometers and tied on both sides. The wick can absorb a lot of water which is required for the moistening of the vessel and which is sufficient for the period of one measurement at least. The second thermometer will always be kept dry. Its mercury vessel is, therefore, not provided with a wick. The intermediate part is arranged between the thermometers. It bears at the head end an aspirator and at the base - after having been divided in two legs with the same inside diameter - two thermal insulation rings. Each two thin-walled short tubes, which are thermal insulated against each other by an intermediate ring, are screwed coaxially to the two insulation rings. The vessel of the thermometers penetrate concentrically into the short tubes. For a better air conduction the external tubes are trumpet-shaped expanded in the lower part. Above, all four pieces of the tubes are in connection with the intermediate part by means of corresponding bores.

The aspirator contains the wind wheel consisting of 4 vanes and within a separated place the spring clockwork mechanism which drives the wind wheel. The covering of the cylindrical aspirator casing is provided with slots and the air sucked in will be thrown out through these slots by means of the fan blade.

By means of the two lateral bars which are united at the lower end, the thermometers are protected against mechanical damages and to a small extent against thermal radiation. These bars reach furthermore over the encasing tubings of the thermometer vessels - without touching them - thus offering an additional protection for the relatively easily fragile thermal insulation rings. At the superior end the protective bars are fastened to the superior thermometer bracket by means of screws. All parts of the Aspiration Psychrometer, Assmann Type, are burnished and chromium-plated, so that arriving thermal radiation will largely be reflected.

## Mode of operation

The basis of the psychrometric humidity measurement is the constant exchange of water vapour between water or ice respectively on the one side and the surrounding atmosphere on the other side whereby perceptible heat will be converted into latent heat - vaporization - or vice versa, i.e. latent heat will be converted into perceptible heat - condensation - . Psychrometers are, therefore, humidity measuring instruments the



function of which is based on the thermodynamic principle.

The psychrometers are equipped with two thermometers having the same heat capacity, one of which is kept dry whereas the vessel of the second thermometer covered with an absorbent textile wick will be wetted. Apart from rarely occurring extreme cases, water from the wet surface will change into the gaseous phase. The required heat will be extracted from the ambient air and the moistened thermometer bulb will cool down. Its temperature will fall until there is an equilibrium between the perceptible quantity of heat added by the surrounding air and the latent quantity of heat led off with the water vapour. Consequently the state of the equilibrium depends on the heat of vaporization of the water and on the heat capacity of the surrounding air, i. e. upon the water vapour content, temperature, and pressure of the air. The heat of vaporization of the water is known. Temperature and pressure can be determined by means of the dry thermometer or with a barometer so that the temperature at the wet bulb - in consideration of the other specified values - is a measure for the water vapour content of the tested air.

Due to inevitable reasons which depend on the handy construction of the psychrometer, even the air velocity prevailing at the thermometer bulbs will enter into the measuring results. Only if air velocities are higher than 2 m/sec., this influence is steady so that it may be considered by a constant (which has been determined by experiments) in the Sprung formula which has been established for the evaluation of the psychro-

metric readings. This influence is of such an importance that a minimum air velocity of 2 m/sec. should carefully be adhered to in case of exact psychrometric measurements, at least at temperatures up to 60 °C. The thermometer vessels of the Aspiration Psychrometer, Assmann Type, will be artificially ventilated to a sufficient extent by means of the aspirator, which works along the principle of a centrifugal force fan. The spring clockwork mechanism or the universal motor respectively will cause a rotation of the wind wheel and thus of the air in the sphere of the vane wheel. Following the centrifugal force, the air goes out through the casing of the aspirator. The pressure gradient arising between outside air and axis of rotation of the wind wheel effects that air with a velocity of more than 2 m./sec. flows in the center part and then into the aspirator passing the thermometer vessels as well as the interior and exterior encasing tubes.

## **SETTING TO WORK AND MEASUREMENT**

### **Choice of the measuring place**

Due to its practical construction it is possible to measure the humidity of the air by means of the Aspiration Psychrometer, Assmann Type, at any place and under all conditions which might arise in the practice - even in case of intense heat absorption. Attention should, however, be paid to the fact that the instrument determines the temperature and the humidity of that air which is surrounding the lower openings of the encasing tubes. For these reasons it should be avoided that bodies having another temperature than the ambient temperature will be arranged close by these openings. The very heat of the observer's body or objects which have been warmed up by solar radiation can lead to uncontrollable measuring errors.

When effecting measurements in the open air or in rooms having a certain draft, the psychrometer should be directed towards the wind with stretched hand, if necessary, the handle should be used. It is advisable to incline the instruments slightly so that the openings of the encasing tubings are to some extent turned towards the wind, thus supporting the efficiency of the aspirator. The psychrometer can furthermore be suspended by means of the supplied wood screw which should be fastened at eye-level. Even in this case any thermal influence of the surroundings should be avoided. Therefore, the instrument should be arranged at the side of the tree or mast which is turned towards the wind - windward side - whereas the reading of the thermometers should be taken from the lee.

### **Moistening of the wet bulb thermometer**

Before taking a measurement, the right thermometer covered with a wick should be moistened by means of the moistening device attached to each instrument. For this purpose, the left hand opens the spring clip of the moistening device which is nearly completely filled with distilled water. The right hand presses the rubber ball until the water within the glass tube ascends up to a locating mark arranged underneath the opening. Now the spring clip should be closed so that the water column within the tube is locked. Overflowing water should be wiped off the external walls of the glass tube, otherwise the thermometer vessel as well as the interior encasing tube would be wetted. Hereafter the glass tube of the moistening device should be introduced into the interior encasing tube of the wet thermometer up to boss limitation formed by the bulge of the tube. After some seconds the wick on the vessel of the wet thermometer is sucked full of water and the spring clip

should now be opened again without drawing the tube, so that the superfluous moistening water can return into the rubber ball. Finally the glass tube should be removed from the interior encasing tube.

The water store held by the wick is sufficient for the moistening of the thermometer vessel during approx. 15 minutes when effecting measurements in dry air with normal temperatures. If the wick is desiccated - this can be observed by a sudden quick increase in the wet bulb temperature - the moistening should be repeated. In case of high temperature the wetting should be carried out more frequently than in case of low temperatures.

### **Measurement**

The spring of the aspirator will be cocked by clockwise rotation of the winding key of the Psychrometer. Thus the psychrometer is ready for the measurement. If the natural temperature of the psychrometer - before taking a measurement - was similar to the temperature of the air, the first utilizable reading can be taken 3 minutes after the starting of the aspirator. If the psychrometer shows, however, a temperature which deviates considerably from the temperature of the ambient air, it should be ascertained first of all by means of several trial readings if a further alteration of the thermometer readings will not take place. The first utilizable temperatures can, in general, be read only after approx. 5 minutes. The same period of time is required in case of wet temperatures below 0 °C. When reading the thermometers it should be avoided that ventilating air of the observer reaches the openings of the encasing tubes. It is advisable to hold a piece of cardboard before mouth and nose while taking a reading where an approach to the instrument cannot be avoided. Both thermometers should be read within the effective running time of the aspirator immediately one after the other and without parallax as soon as they have obtained a steady position.

The effective running time of the aspirator, i.e. that time during which an air velocity of more than 2 m./sec. is prevailing at the thermometer vessels, is indicated on the test certificate supplied with each instrument. After the expiration of this time, the spring of the clockwork mechanism should be cocked again. When taking measurements in the open air with the Psychrometer we recommend to leave the key in the instrument since its overlapping rim prevents the dust and rain from penetrating into the clockwork mechanism.

Beginning with wind intensity 3 - gentle breeze, i. e. when leaves and the twigs are in continuous movement - the instrument should be used with the wind shield, which has to be arranged on the windward side above the air-exit openings of the aspirator.

### **Particularities if the temperature of the wet thermometer is below 0 °C.**

As already mentioned before, special care should be put into measurements if the temperature of the wet thermometer is below 0 °C. This has to be attributed to the fact that the saturation pressure of the water vapour at the temperature of the moistened thermometer enters into the Sprung formula by means of which the psychrometric measurements will be evaluated.

The saturation pressure above a water surface which had been undercooled below 0 °C. is higher than that saturation pressure existing above an ice surface having the same temperature. Consequently another saturation pressure has to be taken into consideration in case of wicks covered with

ice than in case of wicks moistened with undercooled water. In both cases even the psychrometric constant contained in the evaluation formula will differ. For this reason, it should be ascertained during or subsequent to the measurements where the temperature of the wet thermometer sinks below 0 °C., whether the moistening water has been in solid or liquid phase. The undercooling of the moistening water can be recognized from the fact that the temperature of the wet thermometer sinks without remaining for a certain period at 0 °C. If the temperature reaches a steady position, both thermometers can be read. If, however, the temperature of the wet thermometer remains first of all at 0 °C. on account of the delivery of the smelting heat of the water or if it sinks constantly below 0 °C. but then rises again up to the freezing point and hereafter sinks anew, the water on the wick is solidified. Wait for the reading until a constant temperature indication is obtained. The required period of time is then, however, correspondingly larger owing to the higher thermal inertia of the coat of ice. For this reason, the further moistening should be executed with the necessary precaution.

If it was impossible to ascertain an ice information on the wet thermometer during the measurement, the wick should finally be touched with a non-contaminating object (such as a spike of a needle, blade of grass). If hereby the temperature increases suddenly to 0 °C, the water has been undercooled. This statement can be achieved, too, without touching the wick of the hand will be held below the suction tube of the wet thermometer. If there is undercooled water at the wick, the temperature rises steadily above the freezing point. In case of wicks covered with ice the temperature will first of all remain at 0 °C.

In case of frozen wick, the wet thermometer will indicate temperatures which are up to approx. 0.3 °C. higher than those of the dry thermometer if the vapour pressure of the air has its saturation value referred to water. In such a case, water vapour on the wet thermometer will condense owing to the lower saturation pressure above ice. The modification from latent heat in perceptible heat connected with this, causes an increase in the temperature of the wet thermometer.

It must be pointed out that the resulting psychrometric difference - i. e. the difference between dry and wet temperature will achieve with sinking temperature smaller and smaller values. Therefore an increasing accuracy of measurement is required for obtaining equivalent measuring results with sinking temperature.

**Evaluation of the measuring results**

The prevailing vapour pressure will be calculated from the read dry and wet temperature by means of the Sprung formula:

$$e = E' - A(t - t') \cdot \frac{b}{1006,6} \quad (\text{mbar})$$

The relative humidity is:

$$U = \frac{e}{E} \cdot 100 \quad (\%)$$

where:

- e = vapour pressure (mbar)
- E = maximum vapour pressure above water at the temperature of the dry thermometer (mbar)
- E' = maximum vapour pressure above water or above ice at the temperature of the wet thermometer (mbar)
- A = psychrometric constant =  $0,66$  in case of water,  $0,57$  in case of ice at the wet thermometer
- t = temperature of the dry thermometer (° C)
- t' = temperature of the wet thermometer (° C)
- b = atmospheric pressure (mbar)
- U = relative humidity (%)

The saturation pressure of the water vapour can be gathered from respective tables. The evaluation of the results by means of the graphic psychrometer table supplied with each instrument is more practical since the relative humidity of the air which is in most cases of interest can directly be read. These tables have been calculated by referring to an atmospheric pressure of 1006,6 mbar. At this atmospheric pressure the Sprung formula will adopt a particularly simple form:

$$e = E' - A(t - t') \quad (\text{mbar})$$

The neglect of the atmospheric pressure in case of measurements at sea-level and up to 200 m. above sea-level at the regularly existing atmospheric pressure changes gives rise to errors which are smaller than 3 % relative humidity if the temperatures are higher than 10 °C. In case of pressure and temperature values deviating therefrom, as well as in case of higher demand as to the measuring accuracy, the correction of the atmospheric pressure should be taken into consideration by computation, or the graphical psychrometer table according to D. Sonntag No. 768 G should be used for the evaluation. This table indicates the correction of the atmospheric pressure in a special nomograph.

**ATTENDANCE**

It is important that distilled water only will be used for the wetting of the psychrometer wick. In general, rain-water is not recommendable since it contains - especially in the neighbourhood of industrial plants - impurities which cause a change of the saturation pressure. Calcareous water gives rise to an incrustation of the wick and thus to a reduction of the absorptive capacity. Incrusted wicks should be replaced.

The high mirror finish of the psychrometer's surface should be retained in all parts, particularly on the encasing tubes of the thermometers. Consequently, the instrument should be cleaned with a soft piece of cloth after every use. Mechanical or chemical acting detergents should not be employed.

A plastic case serves for the storage of the psychrometer. After use the instruments should be preserved in these containers. They are not suitable for constant stay in the open air. It is recommendable to store the instrument during winter



in a dry unfired room thus avoiding dew precipitation on the instrument which might arise if the cold instrument will be transported to a warm room.

If the replacement of the wick on the wet thermometer or the exchange of the thermometers becomes necessary, first of all the aspirator has to be screwed off the intermediate part. The thermometers may then be easily removed upwards eventually after having loosened the lateral fixation screws of the protective bar. The assembly should be made in reversed sequence.

At certain intervals which depend on the use of the psychrometer, the rotation speed of the spring case should be controlled. This rotation speed is a measure for the air velocity prevailing at the thermometer vessels. For this purpose, the clockwork of the instrument No. 761 will be wound up and the identification mark on the spring case should be controlled as to its rotation time through the control window.

As soon as the arrowshaped identification mark of the spring case is visible at the control window, the speed of the aspirator fan can be reduced by cautious introduction of a paper stripe in the openings of the aspirator. The vane should be brought to a standstill if the vertical lines coincide. The clockwork will be wound up again and after having removed the paper stripe the time should be measured which the spring case required during its run for a complete rotation. If this time is less than 90 seconds, the produced ventilation speed is sufficient. Decisive is, however, in any case the control time stated in the test certificate. If this changes considerably, a cleaning and oiling of the bearings is necessary. This time should be less than 65 seconds. In this case too, the control time stated in the test certificate is decisive. In case of a considerable modification the aspirator should be cleaned and oiled. When using this psychrometer type, it is merely necessary to control at intervals of one year the condition of the carbon brushes of the collector which are easily accessible after having screwed off the superior protective cap of the aspirator.



**Please note the loss of warranty and non-liability by unauthorised manipulation of the system. You need a written permission from LAMBRECHT meteo GmbH for changes of system components. These activities must be operated by a qualified technician.**

#### The warranty does not cover:

1. Mechanical damages caused by external impacts (e. g. icefall, rockfall, vandalism).
2. Impacts or damages caused by over-voltages or electromagnetic fields which are beyond the standards and specifications in the technical data.
3. Damages caused by improper handling, e. g. by wrong tools, incorrect installation, incorrect electrical installation (false polarity) etc.
4. Damages which are caused by using the device beyond the specified operation conditions.



Quality System certified by DQS according to  
DIN EN ISO 9001:2008 Reg.No. 003748 QM08

Subject to change without notice.

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