Sapflow-Measurement

Sap flow measurement instruments and systems to fit your requirements!

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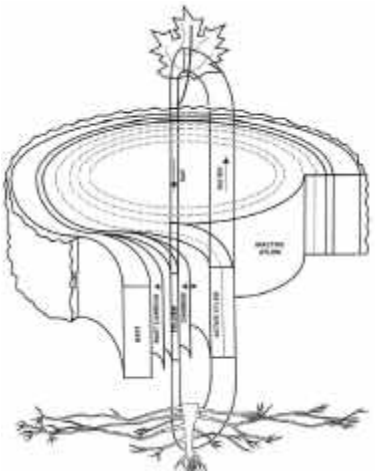
UP Umweltanalytische Produkte GmbH offers the latest technology in measuring sap flow and has more than 10 years of experience in manufacturing sensors using the thermal-dissipation technique (see Literature 1).
Measuring sap flow is important for understanding plant water relations and therefore is often used for studies of

- irrigation
- agronomy
- tree water use
- water stress
- etc.

UP offers single sensors, customized sensors and turn-key solutions including dataloggers and power-supply.

1. Theory of the Transpirationflux

The sap flow transports nutrients to the leaves and to active cells (LARCHER 1984). The big water-potential difference between the soil, the plant and the atmosphere as well as capillar power cause the sap flow from the roots to the leaves (ASKENEY, JOLY,DIXON 1894/95).

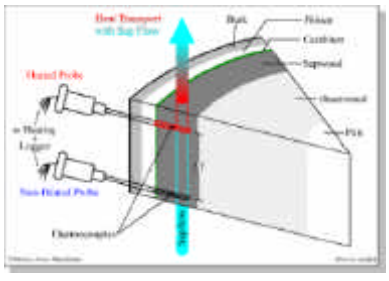


Picture 1: scheme of waterflow

Transpiration depends on the water-potential in the leaves and meteorological parameters (Wind, Radiation, Humidity and Temperature) as well as on soil moisture. Sap flow/Transpiration starts in the early morning hours and has maximum values about midday. At predawn hours sap flow is almost null. Measuring sap flow is a key technique in understanding and regulating plant water relations.

2. Principle of Measurement

Each sensor consists of two identical manufactured needles with copper-constantan-thermocouples (Type T) and a special heating wire. Both thermocouples are connected in a way, that the signal corresponds directly with the temperature difference of both sensor elements. The two needles are installed one above the other into the sapwood. The top needle is heated using a constant current source. This results in a temperature difference between both needles depending on the sap velocity. High flux transports the heat upwards and shows a low signal, various low flux (e.g. at night) causes the highest temperature difference (about 10-13 °C). This measurement principle was developed in 1985 from Dr. André Granier at INRA, Nancy (see Literature 1+2).



Picture 2: scheme of a sensor (a pair of needles)

Picture 3: Sensors installed

2.1 Data acquisition

The favourable price of the sensors allows the use of quite a lot of sensors. Any Data-logger, which is able to measure µV Signals with a resolution of at least 10µV, i.e. 0.25 °C (copper-constantan-thermocouples), can be used to record the readings.

UP offers a wide range of Dataloggers like Skye datahogs (1-16 channels) and the Delta-T logger type DL-2e (15 - 60 channels).

For the conversion of microvolts into temperature you can use a mean value of 40µV per degree Celsius - if you do not measure the ambient temperature you will have to do this anyway.

As sap velocity can vary around the circumference of a tree, more than one probe may be installed. The following list may be useful:

- 1 sensor for trunks or stems of about 70mm diameter
- 2 sensors for trunks from 125mm diameter on
- 4 sensors for trees greater than 200mm

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However, for uniform trees in a closed canopy, only one probe per tree is needed.

NOTE: The sensors should be powered continuously and a typical data-collection interval of 10min is recommended - the sensors need at least 30 minutes after installation and heating to show an equilibrium. The sensors need 1 differential input at the datalogger!

2.2 Constant current source (ccs)

We offer a special constant current source which provides the required heating performance (84mA constant current output, temperature stabilised!). You can connect max. 3 sensors to 1 power-supply unit.

All sensors are connected in series. If you do not connect three sensors to one current supply, you have to use UP blind-connectors with a bridge installed inside.

2.3 Supplement Kits

UP offers two types of supplement-kits which have to be ordered separately!!

Kit 1 (Installation), Art.Nr: X612

- 2 drillers, 2.1mm diameter
- tools for preparing the stem for the installation
- UP insertion tool for aluminium-tubes
- 10 spare aluminium-tubes
- heat sink compound

Kit (Isolation), Art.Nr: X614

- radiation-protection-shield with elastic bands
- Terostat (special sealant, permanently plastic and kneadable)

Blindconnector Art.Nr: X602 4 BS

A special connector for replacing re-moved sensors with necessary bridges inside – no changes inside the constant current source necessary!!

please note: only plugged connectors are weatherproof.

Literature

Granier, André (1985): Une nouvelle méthode pour la mesure du flux de sève brute dans le tronc des arbres, Ann.Sci.For., 1985, 42 (2), 193-200.

Granier A (1987): Mesure du flux de sève brute dans le tronc du Douglas par une nouvelle méthode thermique. Ann.Sc.For., Seichamps, 44

Schulze ED, Hall AE (1982): Stomatal responses, water loss and CO2-assimilation rates of plants in contrasting environments. In: Lange OL, Nobel PS, Osmond CB, Ziegler H (eds.) Encyclopedia plant physiol, vol 12B. Springer Verlag Berlin Heidelberg New York, pp 181-230.

Ordering details see following page!

Technical Data

Power consumption:	0.2 W +/-5% when using the UP ccs (voltage drop over each sensor Typ M 2.8 V)
Heating:	0.2 W heating effect, about 34.5 Ohm +/-0.5 Ohm total resistor
Signal-output:	about 40µV/K between 20...40deg C ambient temperature, copper-constantan thermocouple (Type T)
Heating wire:	special material, ultra-thin, completely covered with isolating varnish for absolute smooth surface
Needle-length:	33mm standard, other lengths 10 …63 mm available on request
Heating-zone:	20mm from top of the needle, needle marked with yellow-band, other lengths 5…60 mm on request
Sample-size:	the sensors may be used for trees from 70mm diameter on, special sensor-configurations for smaller plants are available
Needle-distance:	up to 15cm, vary distance dependend on type of plant/tree, check with calibration if standard calculation is suitable for your measurements
Cable:	70cm, 4- wire PUR-cable (Halogene-free!) with special connectors
ConstantCurrentSource ccs2:	supplies 84mA for maximum three sensors in serial connection, robust IP68 alu-housing. Input Uv= 12Vdc

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Art.Nr. X600M_BS:
Sapflow-Sensor SFS2 Typ M, incl. 2 alutubes, output (thermocouple Cu/Constantan) 40uV/°C, heating-wire completely covered with varnish for smooth surface, incl.70cm cable ending in IP67-connector. Please order elongation cable to ccs seperately!

Art.Nr. X604_xm_BD:
Cable for connection from Sapflow-Sensor to power-supply box. (fill order-no x = 5, 10, 15 or 20m). Material: PUR, shielded: best suitable for outdoor-use.

Art.Nr. X602_4_BS:
Blindconnector to bridge missing or damaged sensors.

Art.Nr. X602-ccs2:
Constant Current Source for Sapflow-Sensors ccs2 (output 84mA) in IP65 housing, for up to 3 sensors, Input 12Vdc! (battery not included), please order battery and loggercable seprerately.

Art.Nr. X612:
Supplement kit 1 for the Installation of Sapflow-Sensors: 100g Silikonfat, 2x Special -Driller (2,1mm), Insertiontool for Aluminium tubes, 10 Aluminium tubes, special tools for cleaning the measurement-place. Needed once per measurement site/customer.

Art.Nr. X614:
Supplement kit 2 for Sapflow-Sensors, consisting of: radiation shield, ca. 60x40cm, (Styropor-/Aluminium-folia on a robust wire-case, with elastic bands for fitting the shield around the tree),

Art.Nr. X614_T100 Terostat IX, 100g, to protect the sensors from incoming water and to fit the top of the radiation shield to the tree. (recommended for every sensor!)

Art.Nr. X618_BAS Basic Sap-System consisting of 3x sapflow sensors, 3 x 10m cable elongation, 1 x ccs2 finished with 2m batterycable and 2m logger cable

Art.Nr. X618_M1:
UP sapflow-measuring system M1 consisting of: 4 channel-logger, sapflow-powersupply, 3x Sapflow-Sensors, IP65-case, 2x batteries (12V, 28Ah) with charger (all mount in weatherproof housing), 1x Supplement Kit 1, 3 x Supplement Kit 2, 3x 10m cable between sensor and powersupply; 1x PAR-Sensor with 10m cable, levelling and mounting unit for PAR-Sensor, RS-232 cable. incl. Sapflow-calculation Software ProSA. System ready-to-go.

Art.Nr. X620:
PROSA Software for calculation of sapflow density and sapflow out of logger raw data.

Other loggers with more input-channels etc are available. Please complete our questionnaire at www.sapflow.com to ask for detailed quotations.

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