4 Software description

This description is valid for Software Version 0.92 under WINDOWS 95,98. For higher versions see „info.txt“

The WINDOWS-Software Version 0.92 and higher can only used for the Drop-Volume Tensiometer TVT 2
Drop-Volume Tensiomete TVT 1 cannot be driven by this software
(for upgrade to TVT 2 please contact LAUDA or your local representative)

4.1 TVT 2 Software Installation

4.1.1 Before starting....

If the PC has been delivered together with the TVT 2, the software has been preinstalled by **LAUDA**. Also in this case installations of software-updates have to be done by the user.

4.1.2 Check of requirements for PC and printer

A check is only necessary using an PC or printer not delivered by LAUDA. Before software installation the following specifications have to be fulfilled:

PC:

Processor:	min. Pentium I or higher recommended
Operating system	WINDOWS™ 95, 98, NT
RAM:	min. 8 MB (16 MB or more recommended)
Hard disk space:	min. 2 MB needed
Floppy Disk:	at least 1 drive 3,5 "
Interfaces:	RS232-Port COM1 or COM2 free (Mouse (connected to PC-bus)
Monitor:	VGA, 14" (15" and larger recommended)

Printer:

Any printer supported by WINDOWS™ can be used. Take care that the appropriate software driver has been installed (for installation refer to manual of WINDOWS™ or printer).

4.1.3 Program disk

One 3.5" disks with the software LDTM 4013 in two languages (german,english) language is delivered. The disk has the following imprint:

LAUDA

Drop Volume Tensiometer TVT 2
Setup disk
(c) LAUDA DR.R.Wobser GMBH&CO.KG
LDTM 4013 Rev. ....

Fig. 4.1. Imprint on program disk

Using Explorer (WINDOWS™ 95/NT) it is possible to display the contents of the disk. The following file has to be on the disk (the number may change based on the software version):

Fig. 4.2. TVT 2 program file on disk

This file contains the installation program in a compressed format which includes the real measuring program „TVT.EXE“ together with all accessory and parameter files and specific software optional modules *.DLL.

4.1.4 Setting up the software

1. Put the TVT 2 program disk into a 3,5“ disk drive
2. On the disk start the program TVT.EXE
3. Follow the instructions of the installation program

Please enter as much as possible all requested data into the program. These data are stored into the file TVT.INI and can be used for determination of the correct configuration, e.g. for future software updates and for the trouble shooting. For this please send the file TVT.INI via e-mail or a printout via FAX to LAUDA.

The measuring program communicates with the TVT 2-System only if the program was not installed in the DEMO-mode (➪ Fig. 3.12)! With the DEMO-Mode the TVT 2 system is NOT working really but the measuring operation is simulated.

Fig. 4.3. TVT program installation

The program system will now be decompressed and transferred to the hard disk into the selected directory and group. If If you have created a new group a window with the TVT 2 icon will be shown. In addition a program link will be placed onto the desktop.

Fig. 4.4. TVT 2 program icon

Now the TVT 2 software is installed and ready to use. After this please remove the disk from the PC and store it. It is possible to install further DEMO-versions at different PC’s e.g. at your working space for documentation of measured data or presentation of software functions.

A distribution of the original disk or a copy of it to third persons is not allowed (➪ software license).

4.1.5 How to start the TVT 2 software

The TVT 2-program works only under WINDOWS™*! User has to be familiar with the basics of* WINDOWS™.

The TVT 2 measurement program has to be started in the following way:

1. Start WINDOWS™ .
2. Activate Icon "TVT 2" in TVT 2 program group by mouse double click or using "execute...."
3. Main screen of the TVT 2 Software appears.

4.2 The TVT 2 main window

Immediately after the start of the TVT 2-program the „main window“ opens with the buttons for the handling of TVT2 and for the presentation of the results and the status of the measurement.

Fig. 4.5. Main window

4.2.1 Components

4.2.1.1 Heading Line

Besides of the common WINDOWS™ specific buttons (for description see WINDOWS™-manual) this line contains the number of the actually running TVT 2 program version

4.2.1.2 Pull-Down-Menu-Line

By selection of the items shown in this line drop-down menus will be opened, which enable to use the functions of the TVT 2 program

In the standard program version the following pull-down-menus can be opened:

File Measurement TVT 2 Service Window Help

The selection inside the menu can be done as usual by the mouse or by pushing the iconsusing the short cuts shown below:

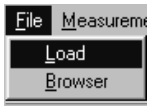
4.2.1.3 Working field

On the working field all menus, windows tables and graphs are displayed during and after measurement. Before activating any drop down or icon function this field is empty (background: **LAUDA**-Logo)

4.2.1.4 Icon field

A faster entry for the most important functions accessible via the pulldown menus is possible via clicking of the icon buttons in the icon line:

4.2.2 Loading results (stored separetely)



or

All the saved results from the single result files can be reloaded and displayed. They are characterised by the extension **<name>.tvt**. All the available result files are listed. After clicking on the file it will be loadaed as result set in the software (max. 5 sets can be laoded together)

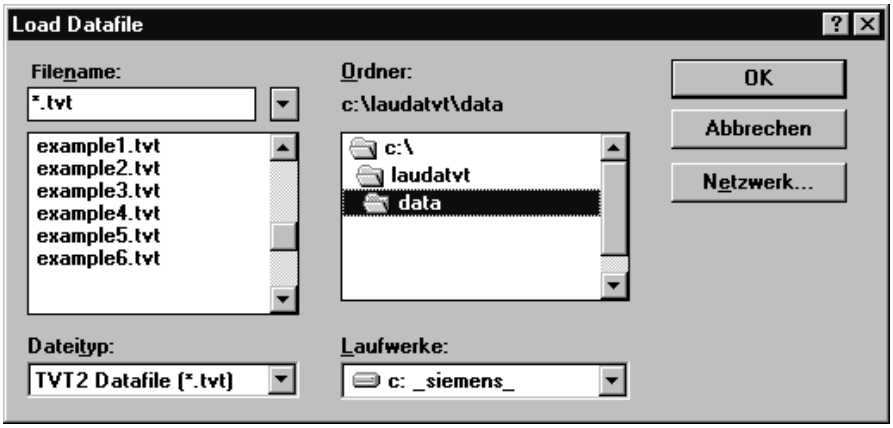
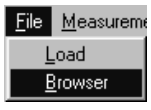


Fig. 4.6. Selection window for single result files *.tvt

The desired measurement is selected by mouse click. The button "Load" opens a result and evaluation window and displays the loaded file.

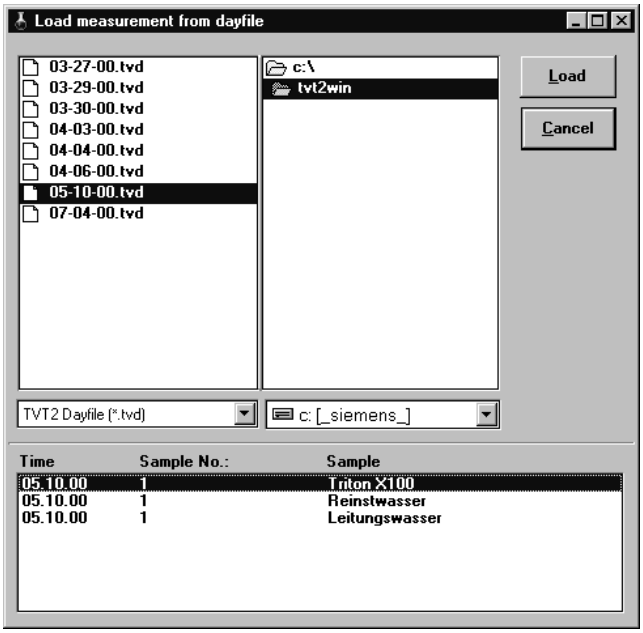
Note: The Windows-Filemenager Routine is used for this function! The windows text appears in the language of the WINDOWS-installation (here: german)

4.2.3 Loading results from daily protocol files



or

All the saved results from the daily protocol result file can be reloaded and displayed. The following file selection window is opened:



The protocol files are composed by distinction is made through the extension *.**tvd**. All the available daily result files are listed. After clicking on the file marked with the date, the lower field shows the times and the sample identification of all the measurements performed on that day.

The protocol file names are constructed out of the digits of the actual date and the extension "**.tvd**":

"**MM-DD-YY.tvd**"

MM: Month;
DD: Day;
YY: Year

e.g: **11-30-99.tvd**)

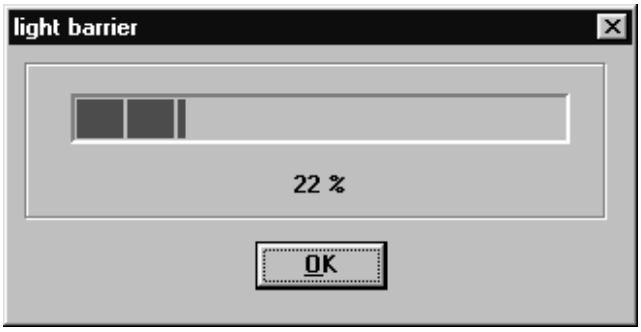
(File stored at 30. Nov. 1999)

Fig. 4.7. Selection window for daily protocol files *tvd

4.2.4 Light barrier control

or

Displays a window indicating the actual status of the light barrier



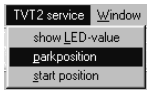
In this window the actual light intensity needed to pass the drop cuvette with or without liquid getting a constant recording level at the light receiver. For empty cuvette cells the level should be around 20%. For dark liquids in the cuvette cell, as possible in case of interfacial tension tests, this value can be considerable larger.

Note that some seconds are needed for the actualization of the status!

Fig. 4.8. Light barrier level indicator window

If light barrier level approaches 100% no drop detection and hence a measurement is possible!
A) because the liquid in cuvette cell is too opaque for the light beam
B) because the light beam is blocked by dirt or not accurately adjusted
C) lamp or receiver of light barrier is defect

4.2.5 Control of the compression barrier



or 

Moves the compression barrier up to the superior position (Intitialization)
At this position the syringes can be removed for recharging or cleaning

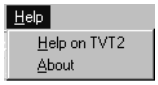
or 

Moves the compression barrier down to the measurement position. Barrier movement stops immediately after the first detaching drop is detected by the light barrier.

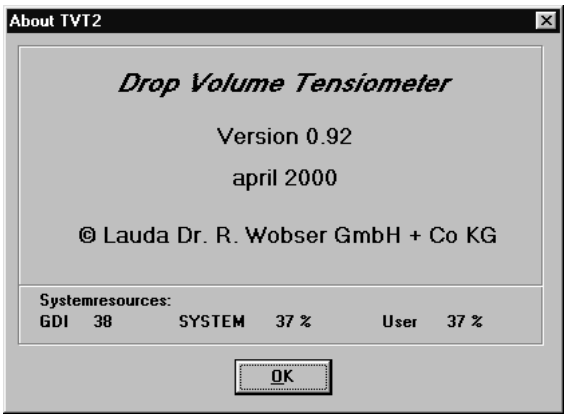
4.2.6 Arrangement of result windows

Tables and graphs of up to five measurements can be displayed and rearranged, cascaded or tiled using the functions this pulldown menu.

4.2.7 Help



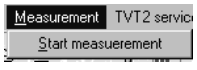
"**Help on TVT 2**" acivates the ON-LINE Help functions (not implemented in the current versions). After activating „**About**“ the general program information window will be shown. For this also the "**LAUDA**"-button can be used.



Here general information about the current version and to the used system ressources is given.

Fig. 4.9. Program-Information window

4.2.8 Measurement parameters



or 

A measurement is initiated by one of these entrys. For this an input window for the measuremnet description and parameters opens.

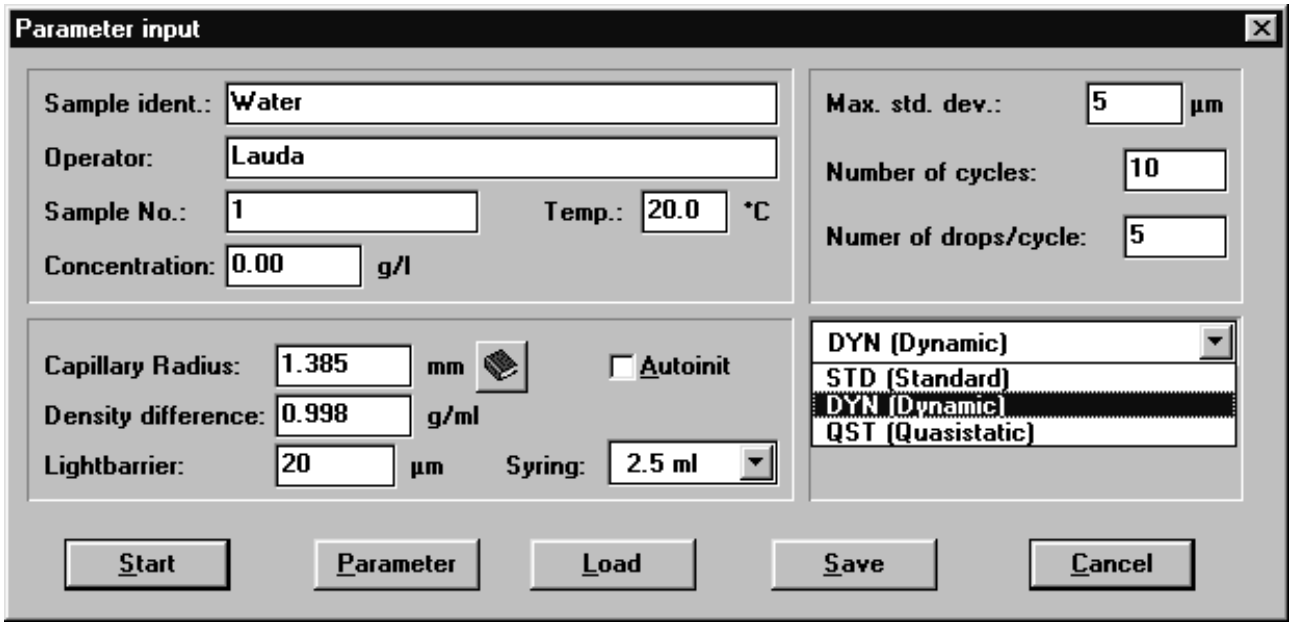


Fig. 4.10. Input window for sample description, measuring parameters and conditions

Immediately prior to starting a measurement the relevant parameters have to be defined.

All parameters shown in the white fields can be modified by the user. As usual under WINDOWS the white fields can be toggled by using <TAB>- key to go to next input field, <shift> <tab> to go back to the preceding input field or by selection of input fileds and clicking with mouse.

4.2.8.1 Sample description

Sample Ident.:

In this field an alphanumerical text can be entered in or edited with a max. length of ca. 25 characters. This text should contain a description of sample composition and/or other sample related information.

Sample Number:

In this field an additional sample number given by the user can be entered or edited. This number should allow unique identification of the sample.

4.2.8.2 Operators name

Operator:

In this field an alphanumerical text can be entered or edited with a max. length of ca. 25 characters. This text should contain operator's name, company name or sample related information.

4.2.8.3 Temperature

Temp:

The temperature of the sample during measuremnt has to be entered here for documentation. If not measured directly using a temperature, put in the temperature displayed at the thermostat.

For higher temperature there can be a considerable difference between actual temperature and the temperature displayed at thermostat

Permissible range: 0 –95°C *Default: 20° C*

4.2.8.4 (Surfactant) concentration

Concentration of solution:

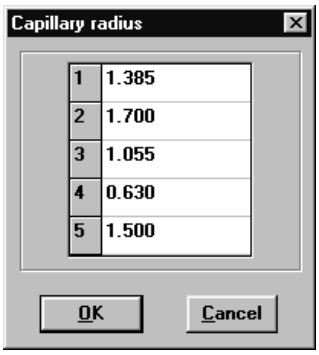
Here the sample's i.e. the surfactant concentration in g/l is entered in a separate field to allow the results representation as function of concentration.

4.2.8.5 Defining the Capillary radius

Capillary radius

From equation Eq (8) Part V it becomes evident that the capaillary radius is directly needed for the calculation of surface or interface data. Accurate knowledge of the wetting radius at the tip of the capillary is necessary and has to be entered or modified..

This can be done directly or selected out of pre given radii which are presented in the selection window by pushing the booklet icon.



In this window the radii of up to five needles can be selected and redefined. The radii are determined by LAUDA and noted on top of the needle. Diameter of the needle tips are determined using a micrometer to 0.01 mm accuracy (e.g 0.005 of radius).

Note:

always enter radius (= half of diameter)!

Regular checks of the radii should be done by the customer in order to maintain the absolute accuracy

Fig. 4.11. Selection and input window for capillary radii

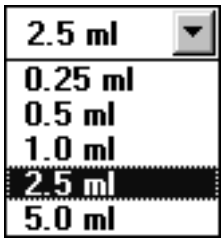
4.2.8.6 Autoinitialization of barrier

Autoinit

If activated (✓) the compression barrier moves back in its initial position automatically after the end of each measurement for rechargement the sample. If not activated the barrrier stops at the end of a measurement to, enable an or more additional measurements with the residual sample in the syringe.

4.2.8.7 Selection of Syringe

Syringe



For specific applications particularly in case of interface tension measurements a syringe with larger or smaller volumes then the standard syringe (2.5 ml) is more appropiate concerning number of measuring points and/or accuracy. In this case the volume of the used syringe has to be selected out of the five volumes presented in a pulldown menu opened by pressing . The actual chosen one is displayed in the menu header. The fields cannot be reedited.

Fig. 4.12. Selection window for syringe volumes

4.2.8.8 Density or density difference

Density difference:

Into this field the density difference of the sample against air (for surface tension) or against the second liquid at the temperature of measurement has to be entered.

Permissible range: 0.1 - 10

Light barrier

To be sure that each drop passing the light barrier is only counted one time although both menisci of each drop are detected it is necessary to disable the light barrier after the first meniscus of a drop had passed.This in case of falling drops the lower meniscus, in case of rising drops, the upper one. The value to be entered here is the distance the piston (e.g. compression barrier) is moving forward during the light barrier is disactivated (here 20 µm), allowing the passing of drop without detecting the second meniscus . After reaching this stroke the ligt barrier is activated to detect the next drop.

For nearly all surface tension measurements the default value of 20 µm is approrpiate!

*For interface tension on large and slowloy moving drops higher values are required (100 –500 µm). In this case adjust this value to be nearly half of the stroke of one drop (= 0.5 * stroke per drop)*
Example: stroke per drop = 1000 µm, light barrier setting 500µm

Permissible range: 5 – 999 *Default 20 µm*

4.2.8.9 Maximum permissible deviation

Allowed standard deviation :

In this field a numerical value defining the largest allowed standard deviation for the strokes per drop in µm is entered. The standard deviation (S.D.) is calculated over a predefined number of sequential time measurements. If the S.D. is not met an the last drop cycle is repeated rejecting the drop data of the previous cycle.

Meaningful Range (5 – 1500 µm) *Default value 20 µm*

Frequent reason for widely differing measurement times are dirty capillaries or syringes, temperature drifts particles or fibres in the samples or samples not sufficently dissolved!

4.2.8.10 Number of measuring points

Number of cycles:

The number of surface/interface tension measuring points (cycles) have to be entered here. Each cycle consists of several drops which are created under the same conditions (e.g. drop formation rate) and which mean value of strokes per drop and formation time are calculated. From this mean values the drop volume, surface /interface tension and the related mean drop formation time is evaluated. The accuracy of the values is determined by the standard devation over the drops collected druing these cycles.

Range: (1 - 255) *Recommended values:*
10 (for DYN); 50 (for QST); 5 for STD

4.2.8.11 Number of drops per measuring point

Drops per cycles

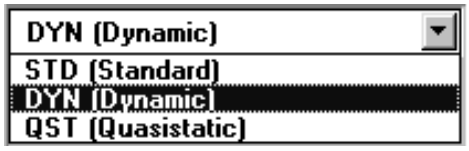
The number of the drops used for one surface / interface tension evaluation has to be entered here. This number has no direct effect on the calculation but can influnce the accuracy of the results significantly. A

large number of drops increases the confidence but simultaneously restricts the number of measuring points (cycles) because of the limited syringe volume especially at large drop volumes e.g. at interface tension measuremnts and for small syringes. Generally 5 drops are sufficient for evalauation and statitics.

Range (3 - 9) *Recommended value: 5*

4.2.8.12 Selection of measuring modes

The head line of this menu shows the mode to control and evaluate the measurement selected by the user. The required input data and the way the measurement runs depends on the selected mode.



The button opens a pull down menu where all evaluation and measurement modes actuallly implemented appear and can be selected by clicking.

For description of the different modes see part II and part V.

Fig. 4.13. Pull down menu with a selection of measuring modes

4.2.8.13 Start button

This button is used to start the drop formation (measurement). According to the selected mode different procedures are activated.

Before starting check again that all conditions for the measurement are fulfilled and all parameters and descriptions are entered completely and correctly.

4.2.8.14 Mode related parameters

An input window for specific parameters relevant to the selected measurement mode opens. (see below)

4.2.8.15 Defining and storing of parameter sets

All descriptions, parameters and measuring modes for a specific sample type or procedure can be saved and reloaded. The parameter sets are stored with extension „.**par**“ as ascii files with user defined names into the subdirectory **„/para**“ or a other user defined subdirectory at the PC’s harddisc.

Opens the file manager window for loading parameter data.

*Note: Because of compatibilty also parameter files created by previous DOS program versions with extension *.**TVP** can be loaded.*

Opens the file manager window for storing new parameter data.

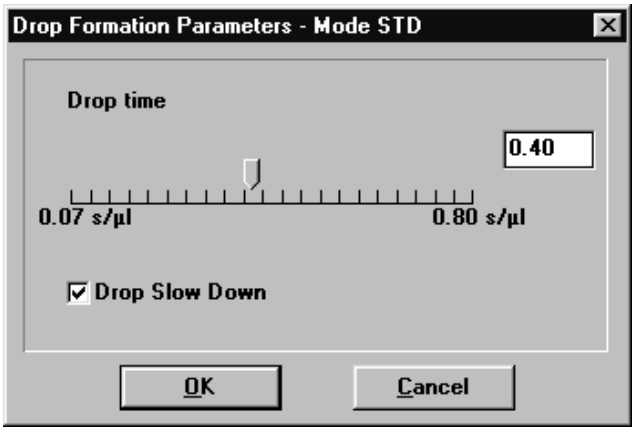
Note: Parameter files created here are not compatible to previous DOS program versions.

Cancel — Quits the actual menu to go back to main window without accepting the changes.

4.2.9 Measuring modes and related parameters

4.2.9.1 Standard Mode (STD)

STD (Standard)



The parameters shown here are influencing the course of the measurements but cannot be changed after start of measurement. The displayed values are either default values or these of a parameter set loaded previousely. The parameters can be modified by

⇒ dragging the slider with the mouse to the desired value shown in the numerical field

⇒ direct input of the value in the numerical field.

As usual the fields can be toggled by using the <TAB> or <shift><TAB> key. The buttons have the following functions:

Fig. 4.14. Drop formation parameters for mode STD

Drop time

Here the specific drop time (flow rate) has to be entered. Because in mode STD the drop formation is the same for all drops measured, only one specific drop time has to be entered.

The real dropping time cannot be known previousely because it depends on the unknown surface / interface tension. That is why the drop time is defined by a reciprocal flow rate in s/µl. The input ranges are limited by the technical possible speed of the compression barrier. Depending on volume the possible time range is different for each syringe type

Ranges: depending on syringe and „drop slow down mode“

Drop Slow down

If marked (✓) a special way of drop formation is activated: The flow rate during the creation of the single drop decreases during drop formation up to a factor of 20 immediately before the drop detachment. (corresponds to „Reduction mode“ in part II). This mode reduces hydrodynamic effects (sse parts V, II) due to the samples viscosity. But can lead to loss of reproducibility during the measurement

If not activated the single drops are formed continousely with constant flow rate.

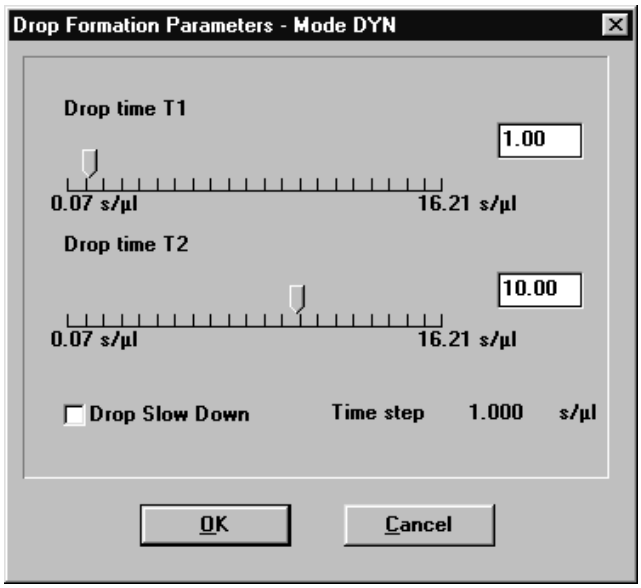
This mode should only be used for samples with high viscosity and/or short drop times (e.g. for Water t < 25 s)

Cancel — Quits the menu neglecting changes.

OK The new settings will be activated.

4.2.9.2 Dynamic Mode (DYN)

DYN (Dynamic



In the dynamic mode the surface / interface tension is measured as function of the drop age. Therefore a range of drop times have to be entered by defining the starting drop time T1 for the first measuring cycle and for the drop time T2 of the last measuring cycle (defined by the number of cycles).

The **Time step** between each cycle is displayed calculated by

Time step = (T2 – T1) / (Cycle Number –1)

Time T1 should be chosen to be smaller than T2. To chose T1 = T2 is equivalent to the mode STD and is not allowedin Mode !

Fig. 4.15. Drop formation parameters for mode DYN

Drop Time T1

Here the specific drop time (flow rate) of the first measurement cycle have to be entered here. The input ranges are limited by the technical possible speed of the compression barrier. Depending on volume the possible time range is different for each syringe type

Ranges: depending on syringe and „drop slow down“ mode

Drop Time T2

Here the specific drop time (flow rate) of the last measurement cycle have to be entered here. The input ranges are limited by the technical possible speed of the compression barrier. Depending on volume the possible time range is different for each syringe type

Ranges: depending on syringe and „drop slow down“ mode

Drop Slow Down

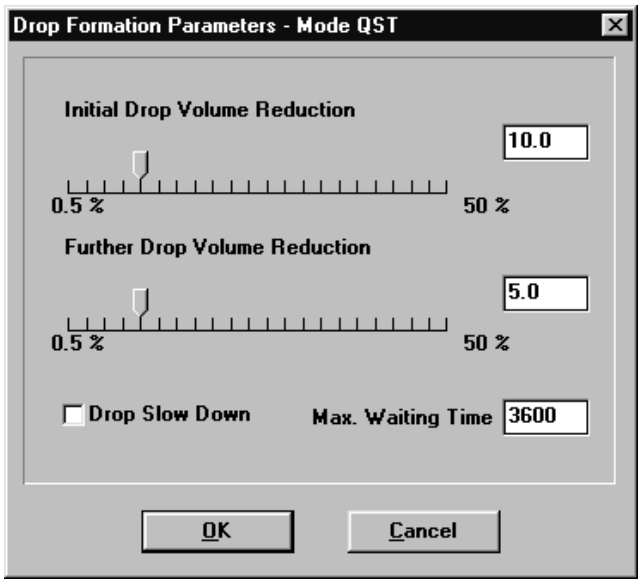
If marked (✓) a special way of drop formation is activated: The flow rate during the creation of the single drop decreases during drop formation up to a factor of 20 immediately before the drop detachment. (corresponds to „Reduction mode“ in part II). This mode reduces hydrodynamic effects (sse parts V, II) due to the samples viscosity. But can lead to loss of reproducibility during the measurement

If not activated the single drops are formed continousely with constant flow rate.

This mode should only be used for samples with high viscosity and/or short drop times (e.g. for Water t < 25 s)

4.2.9.3 Quasistatic mode (QST)

QST (Quasistatic)



In the quasistatic mode the surface / interface tension is measured as function of the detachment time of pending drops with different, pre-given volumes. Therefore the detaching volume of a droplet created with max. speed (T1) is measured during the first cycle defining the start volume V1.

For the second cycle drops are produced with an volume $\mathbf{V_2 = V_1 - dV_1}$ (here 10 %) and waited for detachment.

The volume of drops of the further cycles Vi are reduced by dV2 (here 5%) $\mathbf{V_i = V_{i-1} - dV_2}$ and waited for detachment. y

Volume step dV_1 should be chosen to be larger dV_2.

Initial Drop Volume Reduction

Here the first Volume reduction dV_1 step has to be defined in percent of the measured detachment volume of the first cycle only valid for cycle 2.

Further Drop Volume Reduction

Here the volume reduction steps dV_i for all further cycleshas to be defined in percent of the detachment volume valid for all cycles larger than No. 2.

Max. Waiting Time

The maxumum time for waiting until a detachment of a drop of a given volume has to be entered here. If during this time no falling drop is detected the measurement is stopped. Evaluation is done over all preceding cycles. All drops of the incompleted last cycles are neglected.

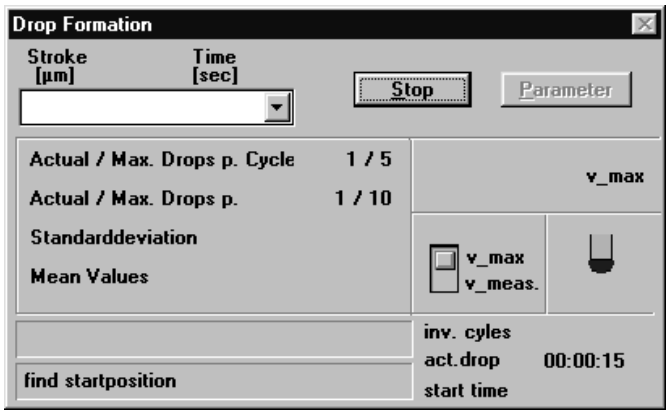
Drop Slow Down

This mode should NOT be used in Mode QST !

4.3 The course of a measurement

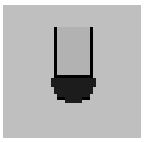
4.3.1 Starting a measurement

After the measurement parameters are specified (see above) the measurement procedure has to be switched on by using „start“ button.



Immediately after starting a measurement by pushing "start" button, the production of drops will start by moving the barrier down. The measurement window is opened as shown here.

Fig.4.16. Measurement window immediately after start



The capillary tip symbol starts to produce „drops“ as long as the measurement e.g. formation of droplets is running.

Note:
The dropping visualized here is only symbolic.
It does not correspond to the real drop formation

4.3.2 Initialization measurements

Before drops are formed which evaluated for the surface /interface tension evaluation, some initialization drops not taken into account for the evalaution are produced

The first one is formed with max. speed **(v_max)** to define the start position of barrier and to reset the distance encoder (Status: **find startposition**).

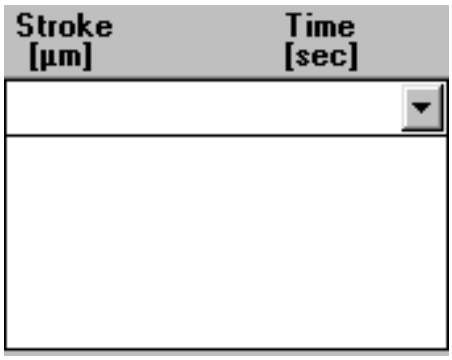
*If drop formation is to fast to produce separate drop the speed can be reduced to the drop time T1 as speciefeid in the drop fromation paramters by activating **v_meas.***

The next drops serve to to initialize the measurement (Status: **Initialization)**

The second drop is produced with a specified drop time (T1) without drop slow done mode to get an information of the drop volume. The third one is also formed with T1 but in the mode as defined by the parameters e.g. with drop slow down. Initialization is done until slow down mode is performed completely, which normally is finished after third drop.

4.3.3 Components of a measurement window

Each started stand opens an own window. This window contains the following run time information lines and function buttons to influence measurement:



Into this table the stroke and the formation time of the last drop of the actual cycle is displayed in the header immediately after detachment and detection of the drop by the light barrier. The strokes and times of all preceding drops of the actual cycle are displayed by opening the pulldown table using .

The table is cleared with the beginning of the next drop.

Fig. 4.17. Drop table with measured strokes and detachment times of the actual cycle

4.3.3.1 Current no. of drops per cycle

Actual / max. drops per cycle

The first number (here: 1) counts the detached drops including the current one of the actual cycle . The second number (here: 10) does not change and displays the maximum predefined number of drops per cycle..

4.3.3.2 Current no. of measuring point

Actual / max. Cycles

The first number (here: 1) counts the completed cycles (measuring points) including the current one. The second number (here: 5) does not change and displays the maximum predefined cycles

4.3.3.3 Current standard deviation of stroke and time

Standard Dev: #.##

Here the standard deviation of the strokes in µm is calculated from the already measured strokes per drop. The value is displayed, as soon as the number of drops exceed 2. For lower numbers 0.00 appears.

4.3.3.4 Current mean values stroke and time

Mean values ####.##

Here the arithmetic mean value of strokes and times of all drops detached inthe current cycle are shown, as soon as the number of drops exceed 2. For lower numbers 0.00 appears.

4.3.3.5 Current status of measurement

Find startposition

In the message line the actual status (here: **find startposition)** of the measurement and error messages are displayed

Message	Status
Find startposition	Barrier is moving down to press out the first drop in order to reset the distance encoder to define the start postion for the measurement. find the e
Adjustment measurements	The next drops serve to to initialize the measurement (drops are not evaluated
Drop formation	formation of drops needed for the measurement are running according to the specified mode
Waiting for drop detachment	Only mode QST: Barrier maovemnt stopped. System waits for detachment of the actual pending drop. Time until detachment is counted.
Measurement finished	Measurement had been completed, terminated by the user or by the system (Syringe is empty)

4.3.3.6 No. of invalid measuring cycles

Inv cycles

Invalid cycles: The number shown here counts the number of measuremnt cycles, where the straggling of the strokes had been exceeding tzhe predefined **Max. Std. Deviaiton** and therefore had been repeated.

4.3.3.7 Current age of atual drop

„Act drops

Current age of the drop actually beeing formed at the tip is displayed here

4.3.3.8 Start time of measurement

Start time

The clock time when the measuremnt had been activatet (pressing „start“) is shown here.

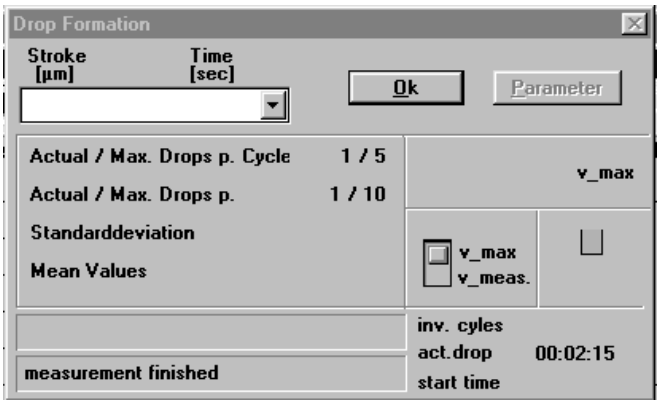
4.3.4 End of measurement

Measurement can be terminated by the user at each time.

Only completed cycles are stored taken into account for evaluation

Measurement is terminated by the system:

1. If the predefined number of measurement caycles are completed
2. If the syringe is empty (compression barrier touches the lower end switch)



In the drop fromation window the message: measuremnt finished appears.

Start changes to OK

➪ Dropping visualization stops

Fig.4.18. Drop formation window after the end of the measurement

OK

After confirmation the measurement is closed and the data are tried to be evaluated according to the different methods by the software (see below).

Without confirmation a further measurement is not possible

4.4 Display and storing measurement results

4.4.1 Final evaluation

OK

The evaluation of the measured data is initiated automatically after confirmation (ok) of the last measurement or activated via „calculator“ of the result set actually loaded or measured before.

4.4.2 Evaluation results of modes DYN and QST

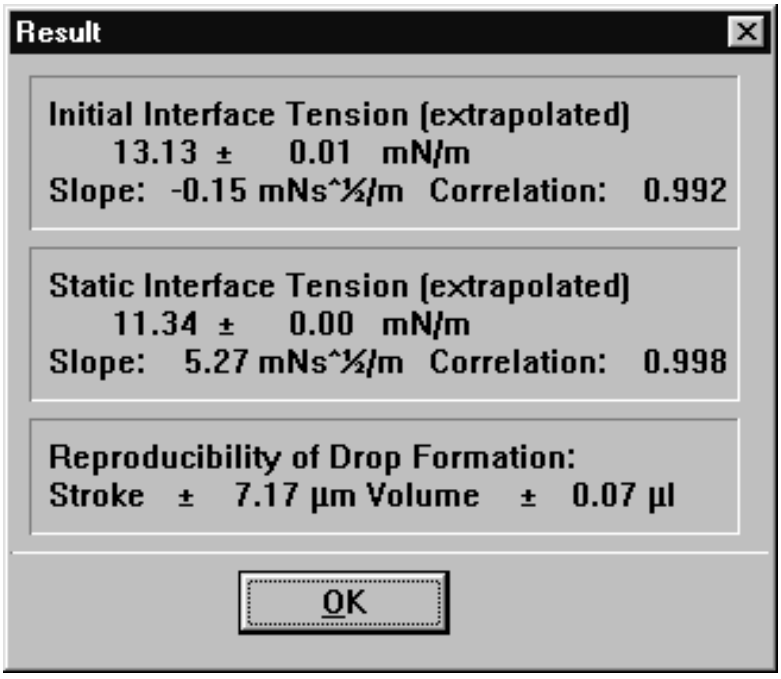


Fig. 4.19. The evaluation window in case of modes DYN and QST

4.4.2.1 Surface / interface tension for drop age zero

Initial Interface tension (extrapolated):

Here the a virutell „initial“ surface / interface is calculated using linear regression analysis of the measured data points (cycles) over a representation of the measured data as:

$\sigma(X) = Slope * X + \sigma(0);\ X = SQRT(Drop\ age).$

The intercept to the **σ–** axis defines the intial value of surface / interface tension. In many cases (i.e. for low surfactant concentrations a linear relation is given in this representation, which is caused by diffusion controlled adsorption kinetics (short time approximation, see also part V)

An extrapolation calculation is only performed if

a) there are enough data points for evaluation (min. 4)

b) correlation coefficient is good enough (i.e. data points behave a linear)

4.4.2.2 Surface / interface tension for infinit drop age

Static Interface tension (extrapolated):

Here the the „static“ surface / interface (i.e. the value apr estimatedcalculated using linear regression analysis of the measured data points (cycles) over a representation of the measured data as:

$\sigma(X) = Slope * X + \sigma(0);\ X = 1/\ SQRT(Drop\ age);$ i.e.: Drop age ⇨ ∞

The intercept to the **σ–** axis defines the value of surface / interface tension corresponding to an infinite age, the so called static value in thermal equilibrium of the surface / interface tension. In many cases (i.e. for medium surfactant concentrations a linear relation is given in this representation, which is caused by diffusion controlled adsorption kinetics (long time approximation, see also part V)

An extrapolation calculation is only performed if

⇒ there are enough data points for evaluation (min. 4)

⇒ correlation coefficient is good enough (i.e. data points behave a linear)

If one or more ofthese conditions are NOT fulfilled one or more error -messages appear! An evalutaion is not performed („0“-values in the evaluation window appear)

4.4.3 Evaluation results of mode STD

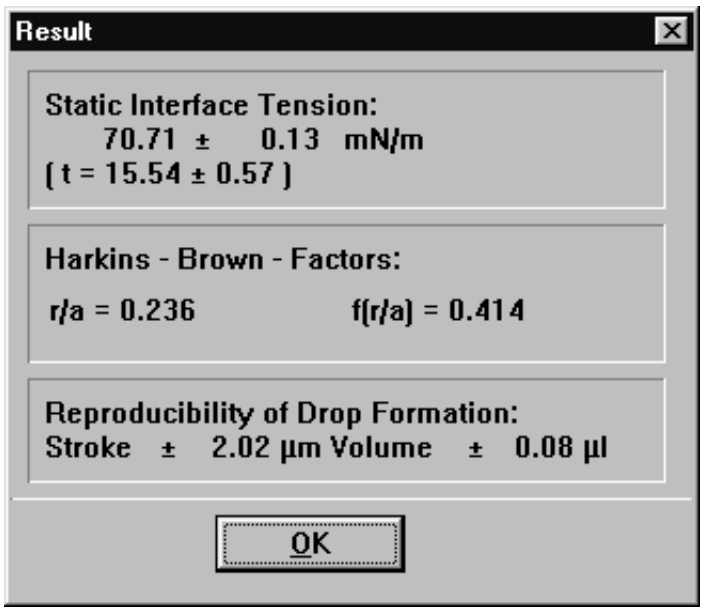


Fig. 4.20. The evaluation window in case of mode STD

4.4.3.1 Mean surface / interface tension

Static Interface tension:

Here the mean value of the surface / interface tension is calculated form the measured volumes according to formula (8) in part V. This value belongs to drop age t determined from the mean value of measured dropping times. For both value the standard deviation according to the straggling of the measuring points (cyles). This calculation is always performed.

4.4.3.2 Correction factors

Harkins – Brown - Factors

Also shown here are the factors r/a anf f(r/a) for the Harkins-Brown correction (see part V) as mean values over all cycles. With this information it is possible to recalculate surface tension from drop volume and capillary radius

4.4.3.3 Reproducibility of drop formation

Reproducibility of drop fromation

The accuracy of the measurement depends drastically on the precision of the barrier driving spindles. The straggling of the differnet strokes in drop production is independent from syringe volume, drop volume and capillary radius and is limited by mechanical tolerances, which are in LAUDA quality control to be less than 2.5 µm. The volume straggling which is aslo shown depends however on the syringe volume corresonding to the straggling of interface tension. The larger syringe volume, the smaller the accuracy and vice versa.

Result table

The results are preesented „on-line“ during the course of the measuremnt in a table or if selected in differnet graphical representations:

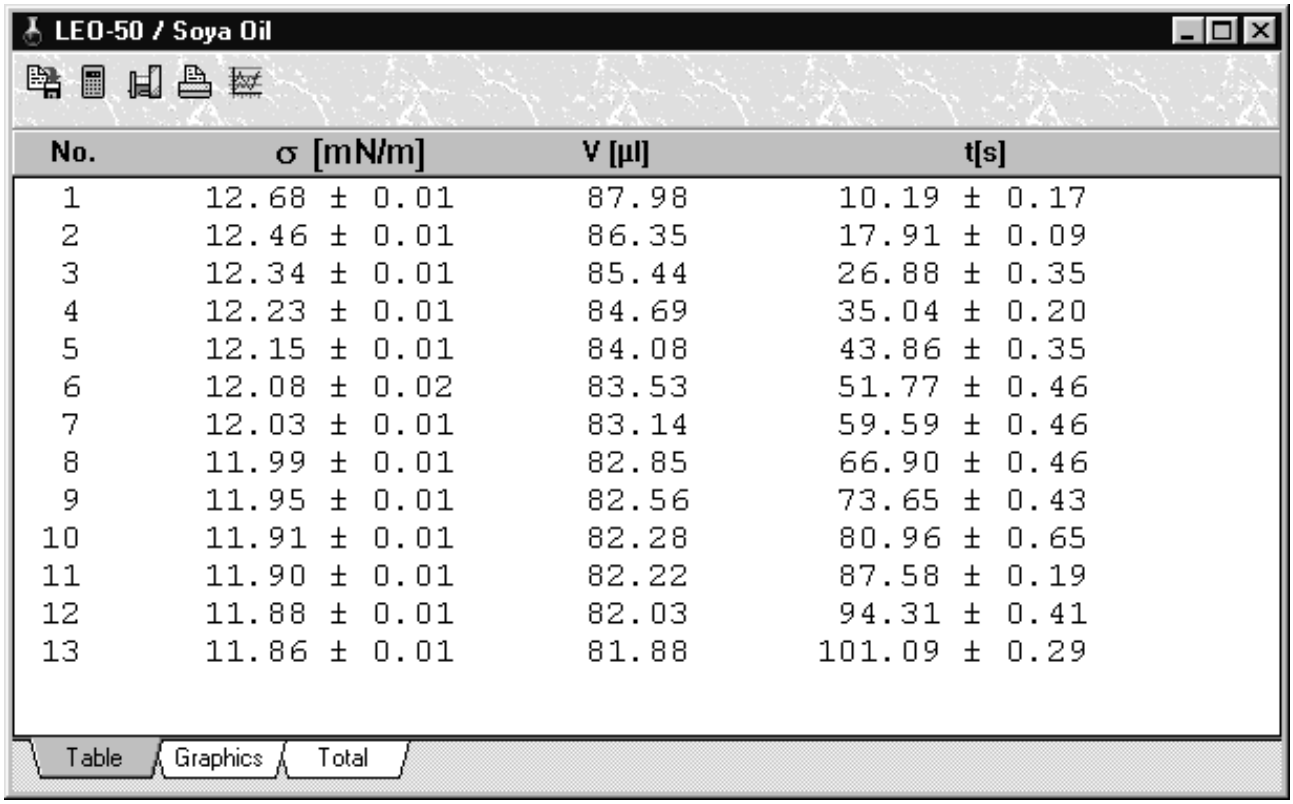


Fig. 4.21. Result Table of an interface tension measurement using mode DYN

All measuring points evakuated from each cycle of the speciefied number of drops are collected in this table. These are:

No.	Current number of measuring cycle
σ [mN/m	Surface or interface tension ± standard deviation evaluated from mean drop volumes
V [µl]	Mean drop Volumes per cycle determined from mean value of strokes of a cycle
t [s]	Mean drop formation time ± standard deviation determined by the light barrier

These values cannot changed. Complete cycles however can be disabled for evalaution

4.4.4 Heading line

This field contains the sample description as entered in the input parameter menu

4.4.5 Evaluation of end results

With this icon an (re) evaluation of actually measured ore preliminary loaded result files is performed depending on measuring mode (see above). If there are any changes (e.g. on density difference9 are specified in the „parameter-window“ (see below) these are taken into account.

4.4.6 Disabling measuring points

The points which should not be evaluated, can be marked in the result table simply by clicking. They will appear as shown below.

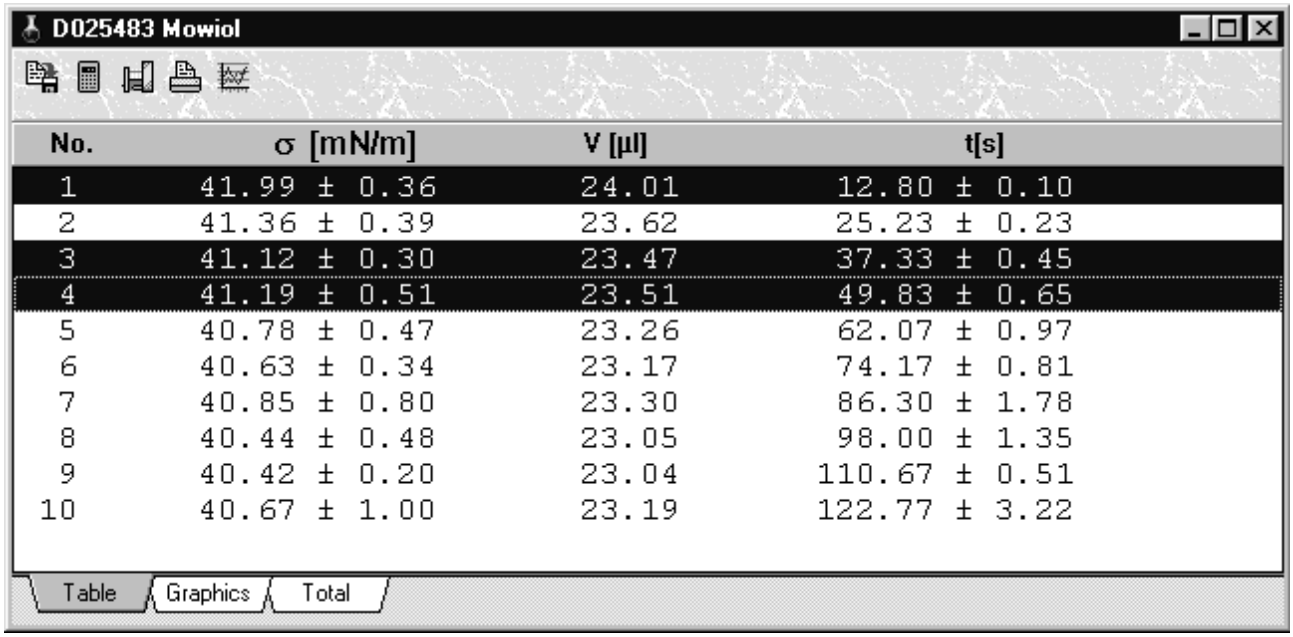


Fig. 4.22. Result table with disabled measuring cycles

The cycles with blue background are not taken into account when performing an evaluation as shown above. Evaluation of mean values incase of mode STD and extrapolated values in case of modes DYN and QST is done with cycles 2, and 5-10 in the example shown above.

4.4.7 Printing of result tables

The displayed result table and the measuring conditions are printed out on a connected printer. The printer and port defined by WINDOWS™ as standard printer is used. Printing formats are given below).

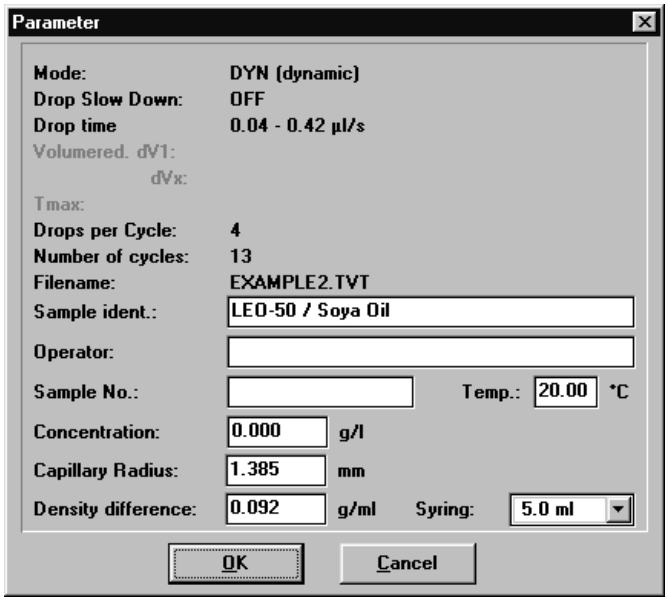
Be sure that the printer is switched on, the paper is loaded, mode is ON-LINE and correct driver is installed (for details see WINDOWS™ and printer manual)

4.4.8 Storing of results on storage medium

This button enables the storing of the results displayed in this window together with the most important parameters)

4.4.9 Parameters of a completed measuremnt

This icon gives an overview on the measuring conditions and parameters as specified in th parameter input window.



In this window all important parameters concerning the sample and measuring conditions are summarized. The parameters shown in the white fields can be reedited.

By pressing „ok“ they are accepted and will be taken into account for a new evalution (see above). They can be stored as new result file (Type *.TVT)

(Afterwards change of daily protocol foles (*. TVD) is not possible)

Fig. 4.23. Window with specification of a loaded or actually finished measurement-

4.4.10 Switching to graphical representation

Switches over to the graphical representation of the results (see below).

4.5 Graphical representation of results

The grapic mode offers a lot of powerful data treatment and evaluation featuers. The graphic window is opened during the course of the measurement and gives a continous survey of the results.

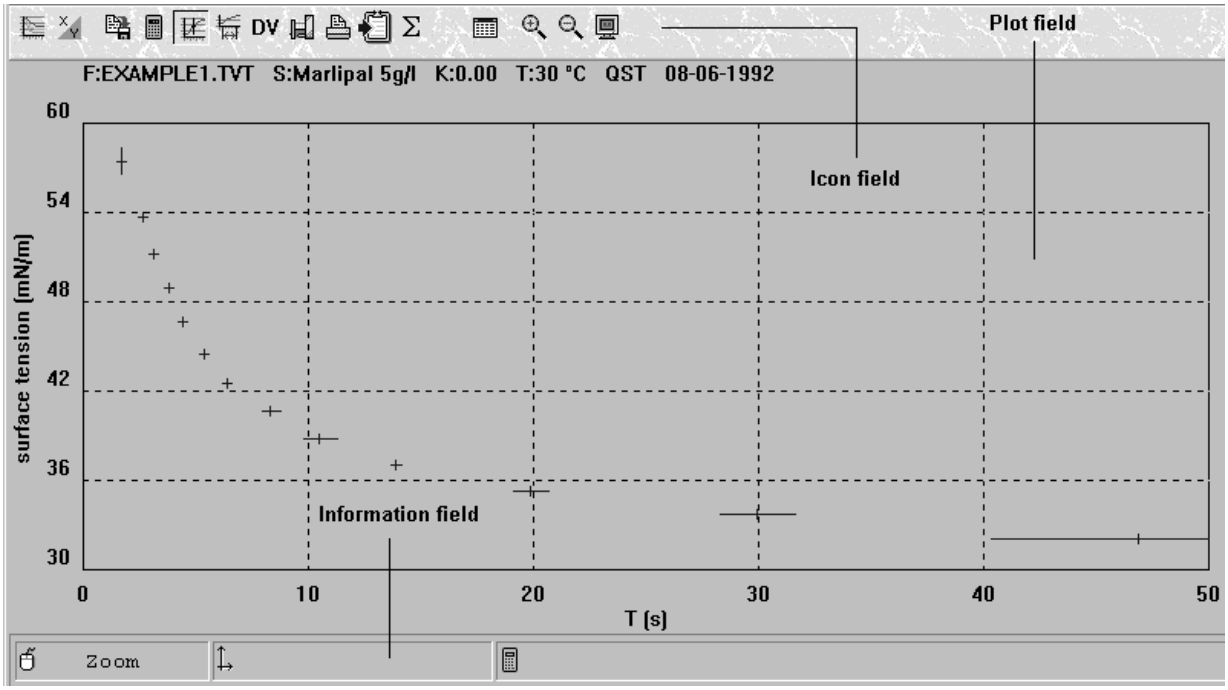


Fig. 4.24. Graphical representation of measurement results. Here interface tension [mN/m] as function of the drop age T [s].

4.5.1 Components of the graphic window

A graphic window is composed from

4.5.1.1 Icon field

From this are all functions of handling and modification of the graph available. (For specific functions see above)

4.5.1.2 Plot-field

Here the measuring points are plotted into a XY-graph, where Y is the surface tension and X is a function depending on drop time, as specified by the user.

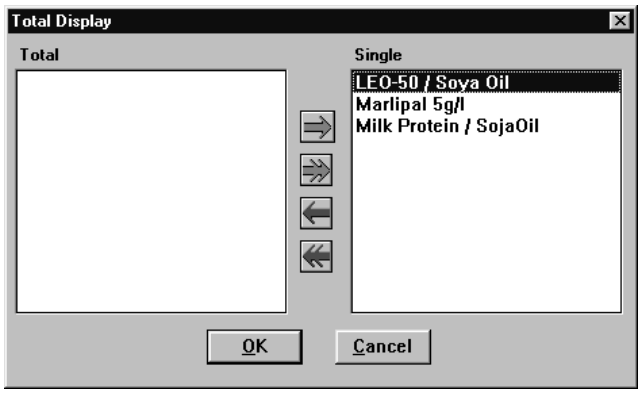
4.5.1.3 Information field

Here information concerning the active cursor function in the plot area, the cursor- coordinates and info about last mouse action is given.

Via the menu icons the different features are available:

4.5.2 Overlaying different measuremtns

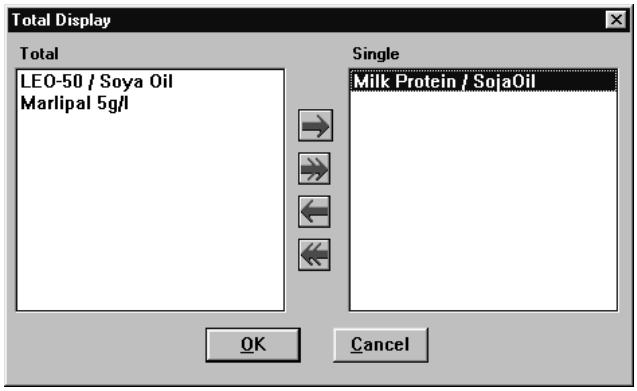
With this icon the results of up to five completet measurements can be plotted together in the same graph. Each measurement has different data point symbols and colors. The following selection window allows to note the data sets chosen for the common representation. These data sets have to be loaded before or had been measured previousely without closing them.



In the table „Single“ all result sets which are actually loaded or previousely measured and not overlaid up to now are listed, specified by the 25 first letters of the sample description.

To perform overalying select the result set by clicking and transfer selected sets to the „Total table by clicking 

If all data sets have to be overlaid click .



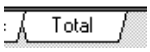
To remove data sets from the common view simpl y use for individual sets.

Use  to remove all sets from the total views.

Note:
The overlay icon is only available on the graphic window of the first result set.

Fig. 4.25. ***Selection window for overlaying result sets***
upper picture: no results sets overlaid, three are loaded
lower picture: two result sets overlaid, one other available

4.5.3 The overlay graphic



With this function the page with the graphics showing the selected result sets in one picture is opened.
Note: „Total" is only active from the graphic window of the first result set and if more than one result set had been loaded.

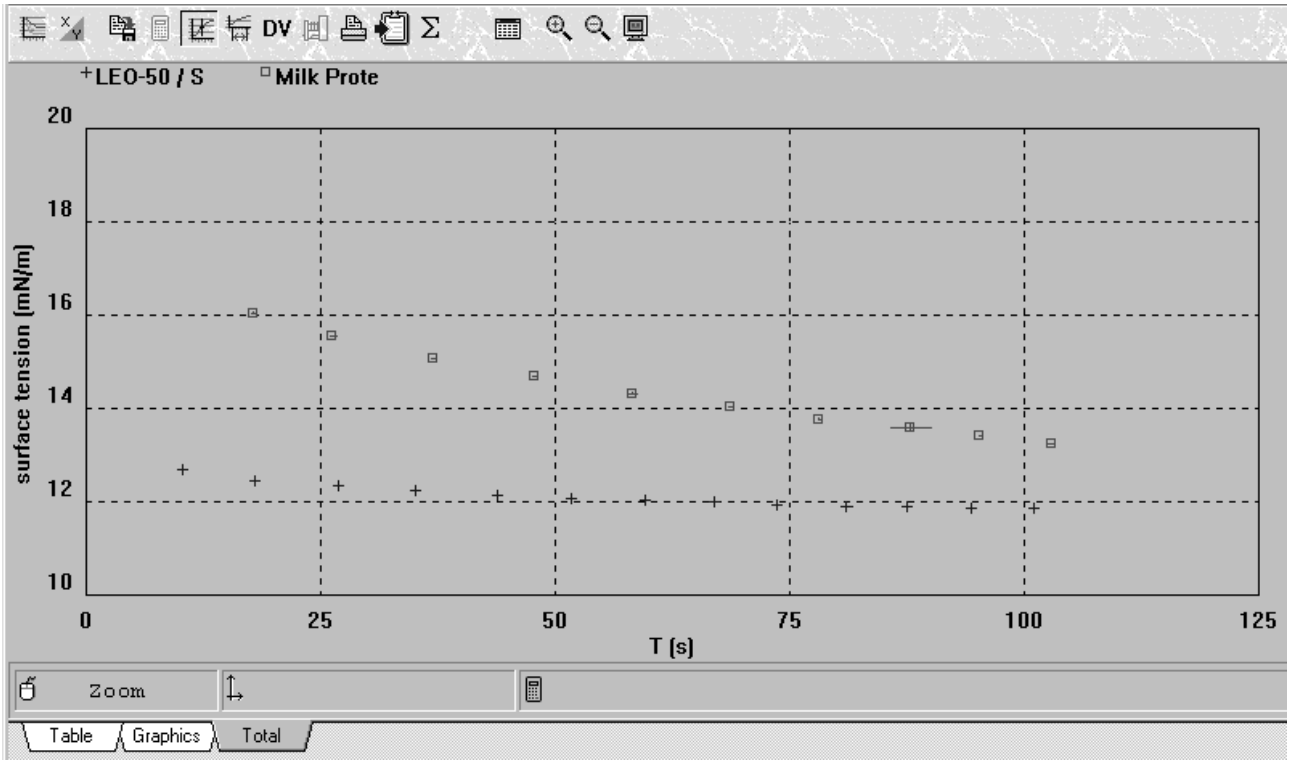
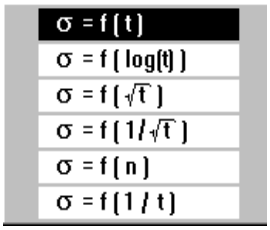


Fig. 4.26. ***Common graphical representation of two result sets***

In the heading line here the data point symbols of each result set together with the first 10 letters of the sample description is shown.

4.5.4 Select different Scales

With this icon a drop down menu will be opened to select different scales of the graph.



The possible representations of the X-Axis are shown here and can be selected by the user.

Here **t** means always the measured, non corrected drop formation time (drop age), (for specific scalings see below)

n means the number of cycles.as Activated here is the default representation (linear in t).

4.5.5 Showing Errorbars

This icon switches the display of error bars equivalent to the standard deviation in the result table on (error bar shown on icon) or off (error bar not shown on icon)

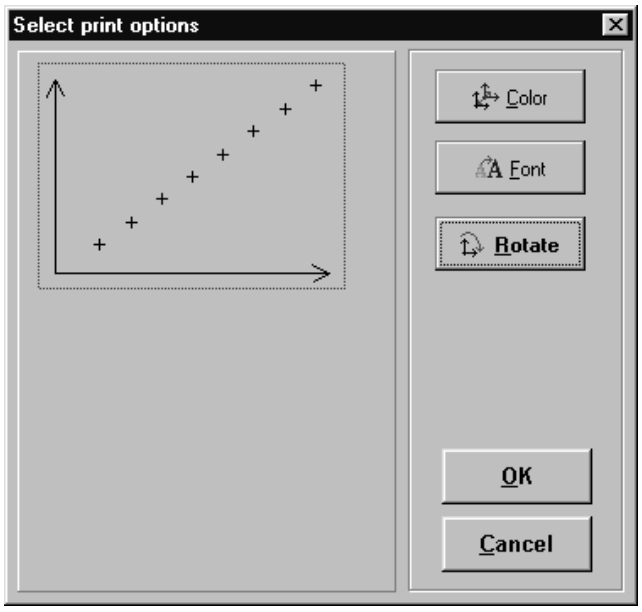
4.5.6 Show disabled measuring points

With this icon measuring points or data sets which not have taken into account for evaluation (dsiabled points) selected previousely in the table or in the graphic can be shown (if pushed) or not (if not pushed).

4.5.7 Printing of result graphic plots

The displayed result plot and the descrition header is printed out on a connected printer. The printer and port defined by WINDOWS™ as standard printer is used.
.

Be sure that the printer is switched on, the paper is loaded, mode is ON-LINE and correct driver is installed (for details see WINDOWS™ and printer manual)
If storage needed for printing is too large (error message) reduce printer resolution to 300 dpi



Before printing starts this window opens asking for selection or confimation of printing options as:

⇒ Relativ position and dimensions (can be changed using left mouse key)

⇒ Color of symbols

⇒ Font

⇒ Plot layout can be rotatet between portrait and landscape format.

Pushing OK initiates the printing.

Fig. 4.27. Window with options to modifie the printout of the result plot

4.5.8 Transfering results to clipboard

With this icon the actual result plot is copied and transferred to the clipboard. From here it is available as object from other WINDOWS programs.

4.5.9 Polynom fitting

For a mathematical descritpion of the functional dependence of the surface tension results over the drop age in the pre-given scaling a polynom of an order up to eight can be fitted:

This icon allows the selection of an x-axis range of the measured data to be taken into account for the fit. A cursor with a dashed vertikal line appears at the plot.

Procedure:

1. push left mouse key at the cursor to define the first limit.
2. Sweep with the cursor with pushed mouse key over the range to be fitted.
3. Release the mouse key at the end of the fit range

Now the fitting is performed and shown as a blue or red curve in the graph.

The number of points to be in the range of fit has to be always larger than the polynom degree! If not error an message appears

With this icon the a window opens (see below) where the fitting result (polynom coefficients and correlation coefficient) of the fit is listed.in tt

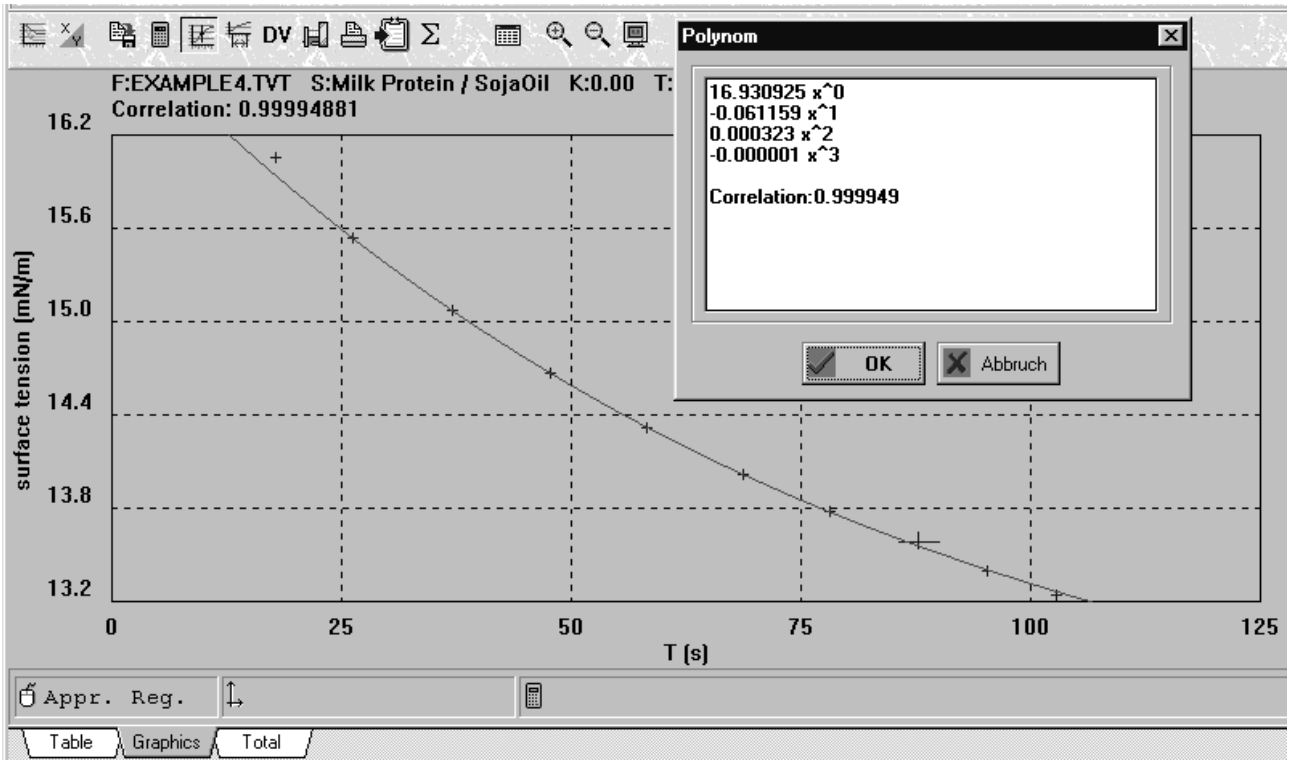


Fig. 4.28. ***Example of a fit using a polynom of 3. Order . The window with polynom coefficients is shown also.***

4.5.10 Switching back to result table

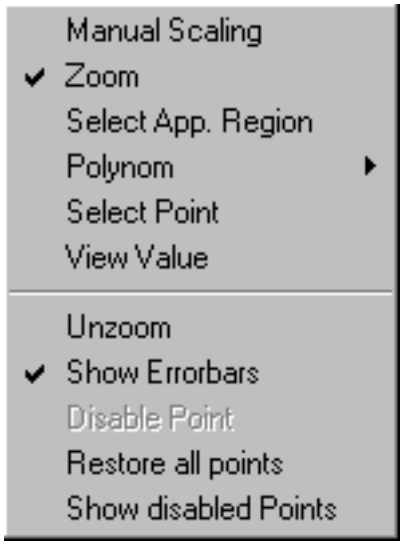
Swtiches back to the result table
Graphic and table cannot be displayed simultaneously.

4.5.11 Zooming

Using thes icons a section of the graph, selected with pushed left mouse key, can be enlarged or restored again. A scaling according to given values is also possible (see below).

4.5.12 More display options

With this icon a pulldown menu with further features is opened.



In this pulldown menu some functions are enabled which are available also by icons of the graphic window, these are:

(Un) Zoom:

Select App.Reg.

Show Error bars

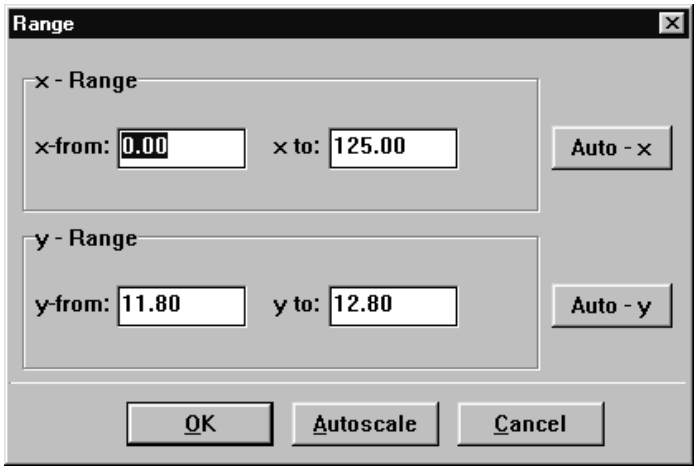
Show disable Points DV

The other functions are only available via this menu:

4.5.12.1 User defined scale ranges

Manual scaling

A window opens which allows the redefinition of the scale ranges of the graphics either as defined by the user or using autscaling functions.



X – Range:

In these input fields the range of the x-Axis has to be entered

(x-Axis can have different prespecified time scalings (see above) or be the number **n** of cycles)

y – Range:

In these input fields the range of the y-Axis (surface tension) has to be entered

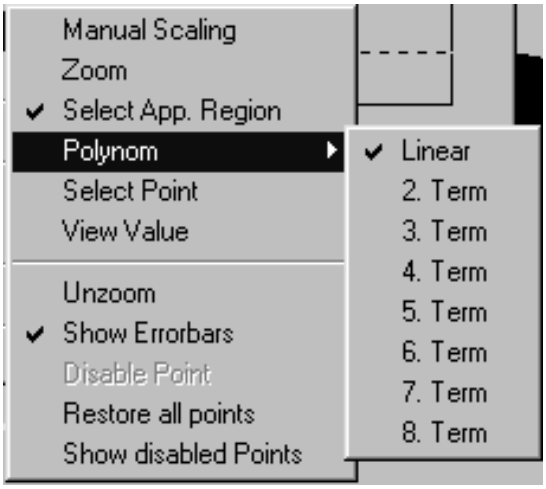
Fig. 4.29. Window for selecting the scale ranges either as defined by user or scaled automatically

Auto - x Automatically determines a scale range of the x – axis fitting to all measuring points

Auto - y Automatically determines a scale range of the y – axis fitting to all measuring points

Autoscale Automatically determines a scale range of both axis fitting to all measuring points

Selecting the polynom degree



On moving the cursor to Polynom, a drop down menu opens where the type of the mathematical function used for a least square fitting to the measuring points can be specified.

Functions available are straight lines (Linear,, shown as blue line in graph) and polynoms up to 8 th order (2. ....8. Term, shown as red line in graph)

4.5.12.2 Selecting single measuring points

Select Point

If this mode is activated the user can select with the mouse a single measuring point in the graph. Therefore the cursor has to be moved using the mouse near to this point and marked by clicking left mouse key. The marked points appear into a small circle. The values of the last marked point is displayed in the info line.

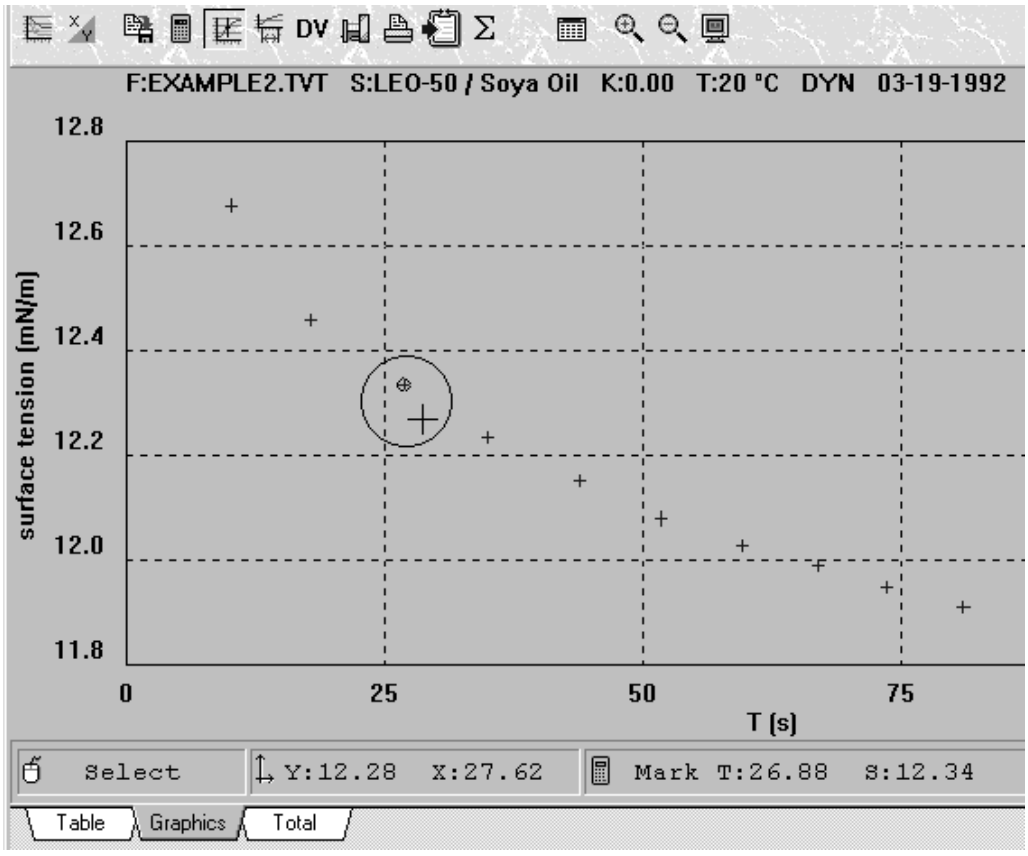


Fig. 4.30. Selecting and marking a measuring point in the graph

The Info field shows mouse status „Select“, the actual coordinates of the cursor-cross and the measuring values of the measuring point marked with the small circle above. In the result table the related measuring point is marked by blue background (see below)

Clicking at a marked point removes the marking.

4.5.12.3 Removing of measuring points

Disable Points

All measuring points marked via the select point function (see above) are not shown in the graph and not taken into account for further evaluations.

4.5.12.4 Recovering disabled points

Restore all points

With this functions all points marked previousely are resetted to be taken into account for further evalautions. The the points appear again.

4.5.13 Further icons

The following functions are also available from the result table and have the same functions explained above)

Icon for evaluation (see above)

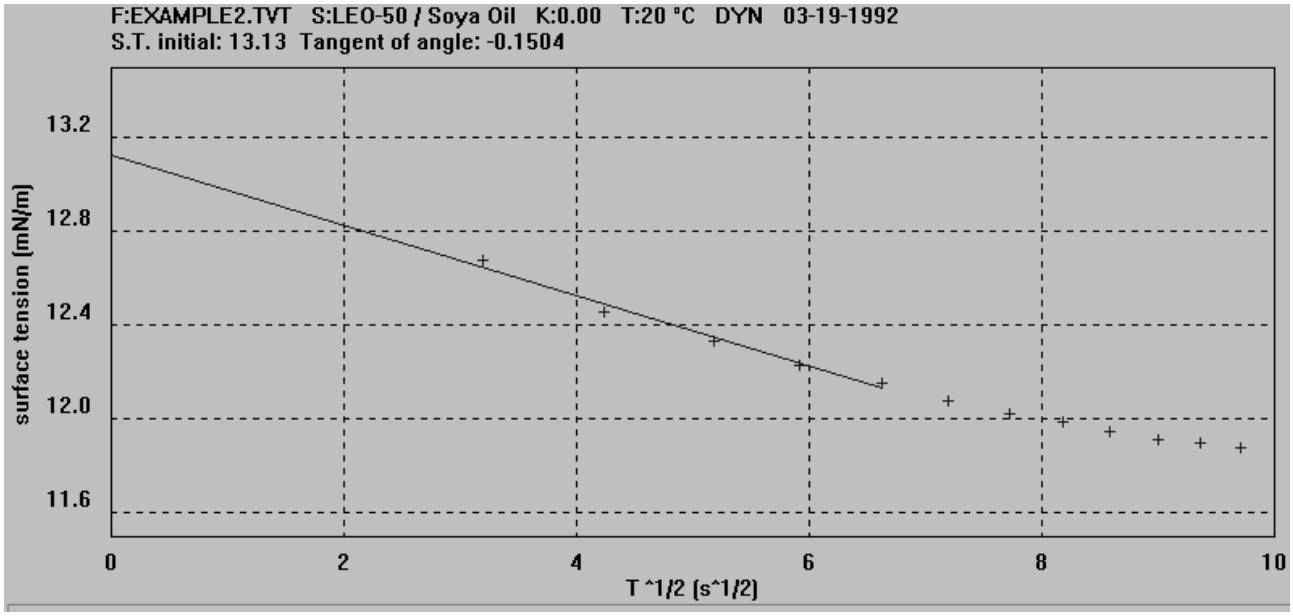
storing of the results

Display of parameters

4.5.14 The σ ($\sqrt{t}$-) representation

This is a specific representation to evaluate adsorption kinetics of surfactant systems in the short surface age limit ($t \rightarrow 0$). For details see part V. Many low concentrated surfactant solutions show a linear behaviour at short drop ages, which can be attributed to a diffusion controlled adsorption process.

In these cases the selection of this representation allows an extrapolation to the surface /interface tension at the beginning of the adsorption process i.e. the value of the „pure“ system.



The software supports this representation and automatically performs a least square fit of a straight line taking into account the 5 shortest drop times by default.

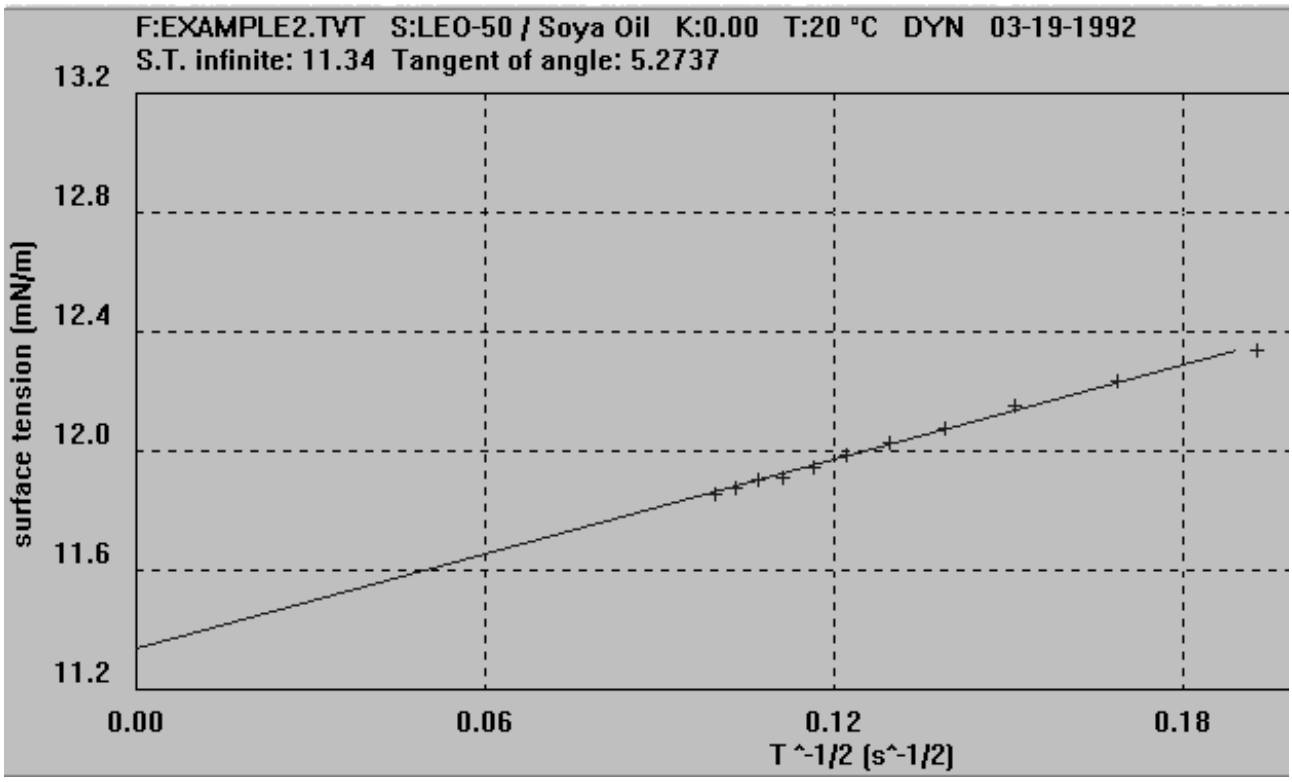
The results of the fit i.e. Initial surface/interface tension value (here 13.13 mN/m) and the slope (as tangent of angle) are displayed in the second line of header of the plot.

Extrapolated values are NO measuring values! They only allow an estimation and are valid under certain conditions about adsorpion kinetics

4.5.15 The σ (1/√t-) representation

This is aspecific representation to evaluate adsorption kinetiks of surfactant systems in the long surface age limit (t ➪ ∞). For details see part V. Many surfactant solutions with medium concentrations (around the critical micellar concentration) show a linear behaviour in ($1/\sqrt{t}$) ➪ 0 at long drop ages, which can be attributed to a diffusion controlled process.

In these cases the selection of this representation allows an extrapolation to the surface /interface tension at the beginning of the adsorption process i.e. the value of the „pure“ system.



The software supports this representation and automatically performs a least square fit of a straight line taking into account the 5 longest drop times by default .

The results of the fit i.e. Infinit „static“ surface/interface tension value (here 11.34 mN/m) and the Slope (as tangent of angle, here) are displayed in the second line of header of the plot.

Extrapolated values are NO measuring values! They only allow an estimation and are valid under certain conditions about adsorpion kinetics

If more points or another fit range want to be fitted use icon:  and select new range with mouse. To remove points (outlayers) from fit area disable them before (see above).

4.6 Appendix

4.6.1 Single file *.tvt formats

The results and parameters are stored as alphanumeric data in ASCII-Format in daily protocol files or separate files. The measuring results are arranged as a table the parameters in a sequential way. The data can be edited by any word processing system or transferred to any calculation programs like EXCEL etc. The data files have the following structure:

Lauda TVT2 0.92		➪ **Software Version**			
L783 Surfactant		➪ **Sample description**			
Hofmann		➪ **Operator**			
1		➪ **Drop slow down: OFF**			
03.30.2000	30.03.00	➪ **Date**			
30.000		➪ **Temperature**			
DYN		➪ **Measuring Mode**			
2.500		➪ **Syringe**			
1.385		➪ **Capillary**			
1.002		➪ **Density Difference**			
3.000					
0		➪ **Concentration**			
1.000		➪ **Drop Time t1 (Vol. Red. dV1 for QST)**			
10.000		➪ **Drop Time t2 (Vol. Red. DV2 for QST,= t1 for STD)**			
σ [mN/m]	**Δσ**	**V[µl]**	**t [s]**	**Δt**	
33.972	0.217	19.497	20.800	0.200	1
32.327	0.203	18.478	38.900	0.557	1
31.775	0.635	18.137	58.000	1.249	1
31.091	0.125	17.715	75.233	0.569	1
30.479	0.639	17.338	91.700	2.166	1
30.221	0.299	17.179	108.633	1.002	1
30.037	0.715	17.067	126.500	3.208	1
29.603	0.399	16.800	145.233	2.146	1
29.279	0.564	16.602	159.567	3.384	1
29.163	0.597	16.531	178.700	3.934	1
END					
0.94	➪ **Reproducibilityof single drops / volume [µl]**				
22.54	➪ **Reproducibilityof single drops /stroke [µm]**				
0.1631	➪ **Harkins-Brown constant a**				
0.1921	➪ **Harkins-Brown constant f**				
36.813	➪ **Initial (mean) Interface tension [mN/m]**			**(mean: STD**	
0.053	➪ **Standarddeviation**				
-0.666	➪ **Slope √t**			**(not for STD**	
0.989	➪ **Correlation Factor √t**			**(not for STD**	
25.758	➪ **Static Interface tension [mN/m]**			**(not for STD**	
0.025	➪ **Standarddeviation**			**(not for STD**	
46.039	➪ **Slope 1/√t**			**(not for STD**	
0.994	➪ **Correlation Factor 1/√t**			**(not for STD**	

Fig. 4.31. File format for single result files *.TVT"

4.6.2 Daily protocol file format (*.tvd)

The format is the same as the in case of *.tvt files (see above). The data of the different measurements are separated by:

```
################## Lauda TVT 2.0 ##################
```

4.6.3 The configuration file „TVT 2.INI“

In this chapter it is shown how to change configuration parameters to allow some user specific default values or functions. These parameters are stored as ASCII data in the set-up file "TVT 2.INI". It is not possible to change them with the TVT 2-program. Changes can only be done by editing the "TVT 2.INI"-File with an appropriate editor program (e.g. Notepad.exe, see WINDOWS™ manual).

The settings defined in the file TVT 2.INI are indispensable for the faultless function of all system components.

Changes must only be done after request to LAUDA or authorized representatives.

Parameter	I/O Status	Effect
[Application]		
DecimalChar=.	. or ,	editable	Defines decimal character for result files
Language=US	US, GER		Langage english or german (setted by installation
DayFilePath=....	[path]	Editable	Defines the path to store the daily protocol files
ParamFilePath=..	[path]	Editable	Defines the path to store the parameter files
ComPort=1	1, 2	Editable	Used Port for RS232
Demo=1	1, 0	Editable	1: Software runs in DEMO mode 0: Software in measuring mode
[Parameter]			
File1=para1.par File2=para2.par File3=para3.par File4=para4.par File5=	<filename>.par	Display	Names of default parameter files, specified in Software
[Capillaryradius]			
R1=1.385 R2=1.700 R3=1.055 R4=0.630 R5=1.500	Floating point value [#.###]	Display	Radii of the capillaries as specified in software
[Demo]			
Tme1=10.19 Time2=17.91 Time3=26.88 Drop1=87.89 Drop2=86.35 Drop3=85.44	Floating point value [####.##]	Editable	Values used for DEMO
Demomode=ON	ON, OFF	Editable	Activation of Demomode

Parameter		I/O Status	Effect
[Evaluation]			
Sigma_Type=0	0, 1	Editable	Evaluation mode 0: Wilkinson Correction, 1: Gunde
g[cm/s*s]=981	###.#	Editable	Earth accelaration. Change only if deviation > 0.001
Syringeconst=	0.06	fix	Have not to be changed if using LAUDA-Syringes
Divisionfactor=	308	fix	Motor gear factor
MaxstddevQST=500	500	fix	Measure control parameter
VmeasureQST=	2500	fix	Measure control parameter
Prefact=2	2	fix	Measure control parameter
RedVol=0	0,1,2	editable	Slow down reference: 0: each preceding drop; 1: last drop of last cycle
[Correction]			
Mode=EXP	EXP, STD	editable	Protection modes: EXP: all inputs unprotected STD: inputs partly protected
[History]			
SaveData0=TEST.TVT SaveData1=..... SaveData2= LoadData0= SavePara0= SavePara2= LoadPara0=	<Name>.tvt	display	Files names of the last files saved or loaded are registered here
[PrnConfig]			
PrnBottom=54 PrnRight=81 PrnLeft=5 PrnTop=2 PrnRotate=False PrnFontName=System PrnFontSize=10 PrnFontStyle=1 PrnColor=False ShowAlways=False PrnFontSise=10		display	Defines settings of the printout. Cannot be changed
[Registration]			
Name=LAUDA Company=LAUDA Phone=004993435030		display	Customers registration as entered during installation