

TenuPol-5
Instruction Manual

Table of Contents	Page
User's Guide.....	1
Reference Guide.....	25

Always state *Serial No* and *Voltage/frequency* if you have technical questions or when ordering spare parts. You will find the *Serial No.* and *Voltage* on the type plate of the machine itself. We may also need the *Date* and *Article No* of the manual. This information is found on the front cover.

The following restrictions should be observed, as violation of the restrictions may cause cancellation of Struers legal obligations:

Instruction Manuals: Struers Instruction Manual may only be used in connection with Struers equipment covered by the Instruction Manual.

Service Manuals: Struers Service Manual may only be used by a trained technician authorised by Struers. The Service Manual may only be used in connection with Struers equipment covered by the Service Manual.

Struers assumes no responsibility for errors in the manual text/illustrations. The information in this manual is subject to changes without notice. The manual may mention accessories or parts not included in the present version of the equipment.

The contents of this manual is the property of Struers. Reproduction of any part of this manual without the written permission of Struers is not allowed.

All rights reserved. © Struers 2000.

Struers A/S
Valhøjs Allé 176
DK-2610 Rødovre/Copenhagen
Denmark
Telephone +45 36 70 35 00
Fax +45 38 27 27 01

TenuPol-5
Instruction Manual



TenuPol-5 Safety Precaution Sheet

To be read carefully before use

1. The operator should be fully instructed in the use of the equipment and the electrolytes.
2. Be sure that the actual voltage corresponds to the voltage stated at the back of the control unit. The equipment must be earthed.
3. The equipment must be placed on a safe and stable support table.
4. Do not run the pump without having electrolyte or water in the electrolyte container.
5. If required, the polishing unit can be placed in a fume cabinet.
6. Never try to open the polishing unit during polishing.
7. Observe the current safety regulations for handling, mixing, filling, emptying and disposal of the electrolytes. (Please refer to chapter 3, Handling and Safety Precautions).
8. Always use gloves, goggles or other recommended protective clothing.

The equipment is designed for use with consumables supplied or recommended by Struers. If subjected to misuse, improper installation, alteration, neglect, accident or improper repair, Struers will accept no responsibility for damages to the user or the equipment.

Demanting of any part of the equipment, during service or repair, should always be performed by a qualified technician (electromechanical, electronic, mechanical, etc.).

Warning

Do not touch



The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

1. This document is intended for use by the following personnel:

- Personnel responsible for the safety of the equipment.
- Personnel responsible for the maintenance of the equipment.
- Personnel responsible for the operation of the equipment.

2. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

3. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

4. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

5. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

6. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

7. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

8. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

9. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

10. The following information is provided for your reference only. It is not intended to be used as a substitute for professional advice. Please consult your local health and safety regulations for more information.

User's Guide

Table of Contents	Page
1. Getting Started	
Checking the Contents of Packing	3
Box with Control Unit	3
Box with Polishing Unit	3
Placing the TenuPol-5.....	3
Control Unit	3
Placing the TenuPol.....	3
Polishing Unit	3
Getting Acquainted with TenuPol-5.....	4
TenuPol-5	4
Supplying Power	5
Changing the Voltage	5
Selecting the Mains Cable	5
Connecting the Polishing Unit	6
Setting up the Polishing Unit.....	6
Software Settings.....	7
Configuration Menu.....	7
Setting the Language.....	8
2. Basic Operations	
Using the Controls	9
Front Panel Controls of TenuPol-5.....	9
Groups of Keys	9
Acoustic Signals	9
Location of Main Switch	9
Front Panel Controls	10
Reading the Display.....	11
Sleep Mode	11
Changing/Editing Values.....	12
Numeric Values	12
Alphanumeric Values	13
Electrolytic Preparation	14
Pre-treatment of the specimen	14
Thinning options	14
Pre-thinning.....	14
Blanking	14
Final Thinning.....	15
Choosing a Method	16

TenuPol-5
Instruction Manual

Filling the Container with Electrolyte	17
Mounting the Jet Holders.....	17
Mounting the Specimen in the Specimen Holder	18
Starting the Thinning Process.....	18
Stopping the Process.....	18
Post Treatment of the Specimen	19
Emptying the Container of the Electrolyte	19
Cleaning the Polishing Cell	19
Calibration of the Pump	20
Calibration Certificate.....	20
Using the Calibration Tube.....	20

3. Handling and Safety Precautions

Electrolytes in General.....	22
Perchloric Acid in Particular	22
Training of Operators	22
Mixing the Solution	23
Storage of Perchloric Acid or Solution.....	23
Fire and Explosion Hazards	23
Disposal.....	23

1. Getting Started

Checking the Contents of Packing

Box with Control Unit

TenuPol-5 is delivered in two boxes, one for the control unit and one for the polishing unit. The boxes contain the following items:

- 1 TenuPol-5 control unit
- 2 Mains cable
- 1 Set of Instruction Manuals
- 1 Connection adapter
- 1 Thermometer, electronic +35/-50°C

Box with Polishing Unit

- 1 TenuPol polishing unit
- 1 Thermometer pocket
- 1 Specimen holder for 3 mm dia. specimens
- 1 Jet holder, inside diameter 1 mm, set with 2 pcs
- 1 Protection casing
- 1 PVC-reservoir, insulated
- 1 PVC-reservoir, uninsulated
- 2 8 mm dia. tube for cooling coil, 1 m
- 1 Jet holder with ascending tube
- 1 Return tube

Placing the TenuPol-5 Control Unit

The TenuPol-5 control unit should be placed on a stable and plane table with an adequate working height.

Placing the TenuPol Polishing Unit

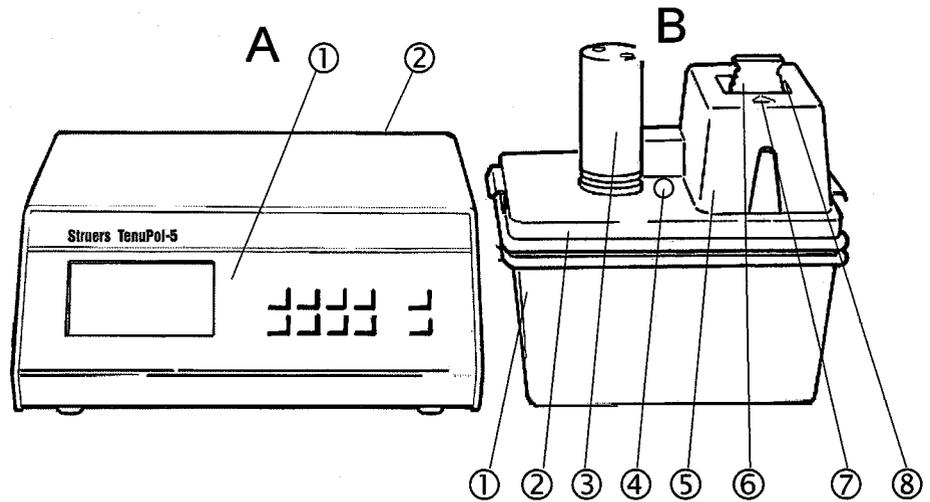
The TenuPol polishing unit should be placed on a stable and plane table resistant to chemicals with an adequate working height, preferably in a fume cabinet. The unit should be placed close to the water supply or to a separate cooling unit.

TenuPol-5
Instruction Manual

**Getting Acquainted with
TenuPol-5**

TenuPol-5

Take a moment to familiarise yourself with the location and names of the TenuPol-5 components.



A Control unit

- ① Control unit, front panel/front panel control(s)
- ② Main switch

B Polishing unit

- ① Insulated reservoir
- ② Base plate
- ③ Pump
- ④ Hole for thermometer
- ⑤ Protection casing
- ⑥ Specimen holder
- ⑦ Polishing cell
- ⑧ Jet holder

Supplying Power

IMPORTANT
Check that the mains voltage corresponds to the voltage setting of the control unit.

TenuPol-5 can be used at the following voltages:

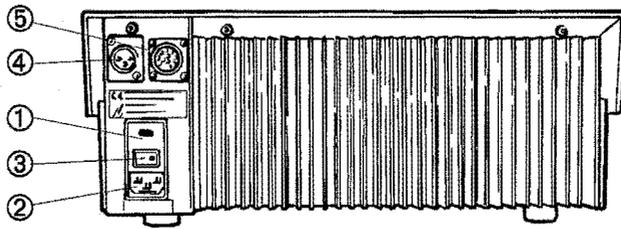
115V: covering 100-120V/50-60Hz

230V: covering 220/240V/50-60Hz (factory setting)

If the power supply in your country is between 100 - 120V the setting has to be changed.

Changing the Voltage

- Open the cover of the fuse holder at the back of the control unit using a small, flat screwdriver.
- Pull out the fuse holder, turn it 180° and reinsert it.



① Fuse holder ② Socket for power supply ③ Main switch ④ Socket for polishing unit ⑤ Socket for electronic thermometer

Selecting the Mains Cable

- Select the correct mains cable. The 230V cable is equipped with a male “Schuko” plug, common in most European countries. The 115V cable is equipped with a flat blade male attachment plug.
- If the attached plug has not been approved for local use it has to be replaced.

The leads have to be connected as follows:

Yellow/green: earth

Brown: phase

Blue: neutral (60Hz black)

- Insert the female plug of the power cable into the socket at the back of the control unit.
- Connect the male plug to the power supply.

Connecting the Polishing Unit

Connect the cable from the polishing unit to the adapter packed with the control unit, connect it to back of the control unit and secure the plug by turning the retaining ring.

Setting up the Polishing Unit



- Place the base plate with pump and cooling coil on the insulated PVC reservoir.
- Insert the electronic thermometer in the drilled hole between the polishing cell and the pump motor. The electronic thermometer should always be used during polishing.
- Connect one of the included tubes with one end to the cooling coil and with the other end to the water mains. Connect the other tube to the other side of the cooling coil and lead it to the drain.

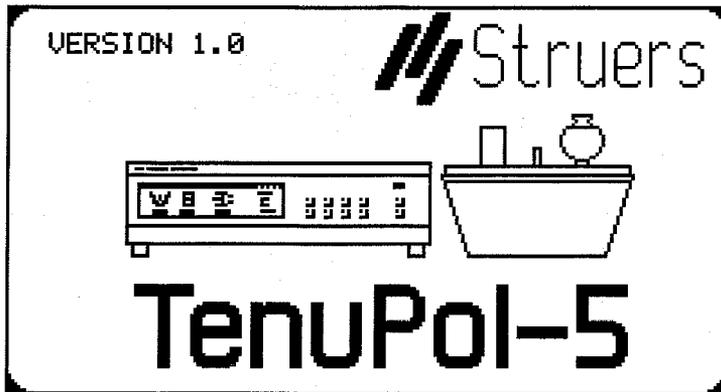
When working with an external cooling unit select suitable insulated tubes and connect them between the cooling unit and the cooling coil. Please see the manual of your external cooling unit for suitable tubes.

- *Alternatively:* if cooling of the electrolyte cannot be obtained by using cooling water or an external cooling unit, cooling down the electrolyte can be carried out by using the uninsulated PVC reservoir placed in an ice bath.

Software Settings

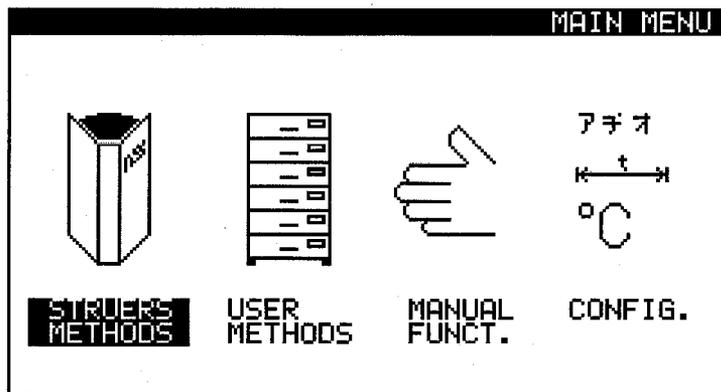
Configuration Menu

Switch on the power at the main switch located at the back of the control unit. The following display will appear briefly:



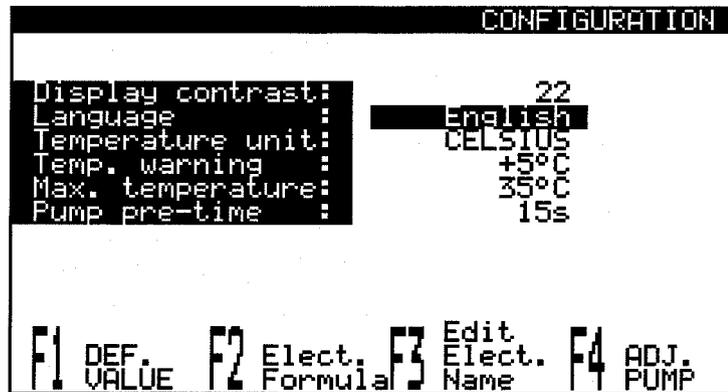
Afterwards the display will change to the last screen shown before TenuPol-5 was switched off, usually a method for electrolytic thinning. When switching TenuPol-5 on for the first time, the display to appear should be the MAIN MENU. If the heading in the display is different, press Esc, until the MAIN MENU appears (a long beep can be heard)

The MAIN MENU is the highest level in the menu structure. (See also the Menu Overview, Section 7). From here you can go to the pre-defined Struers methods, your own methods, manual functions or the configuration menu.



↓
 Press MENU DOWN  to select CONFIGURATION

↓
 Press ENTER  to activate the CONFIGURATION menu



Setting the Language

 Press MENU UP/DOWN ▲▼ to select Language



 Press ENTER ↵ to activate the Language pop-up menu



 Press MENU UP/DOWN ▲▼ to select the language you prefer.



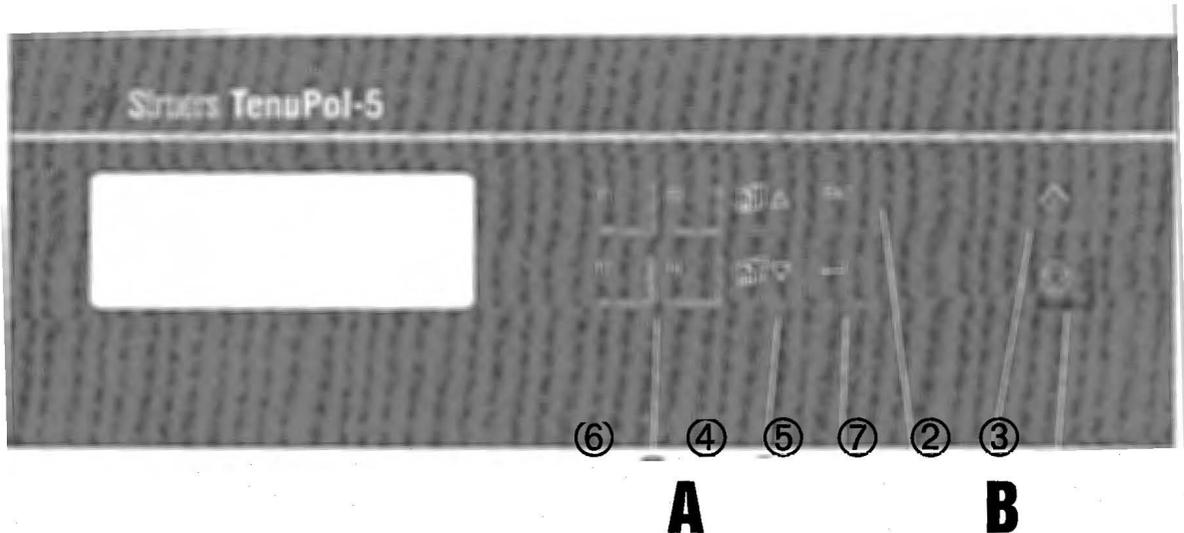
 Press ENTER ↵ to accept the language.

The CONFIGURATION Menu now appears in the language you have chosen.

2. Basic Operations

Using the Controls

Front Panel Controls of TenuPol-5



Groups of Keys

- A** Programming and monitoring functions.
- B** START \diamond /STOP ∇ of TenuPol-5

Acoustic Signals

- bell *Short Beep*: when a key is pressed, a short beep indicates that the command has been accepted.
- bell *Long Beep*: a long beep indicates that the key is inactive at the moment.

Location of Main Switch

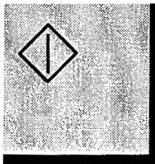
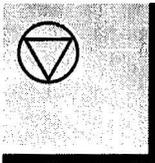
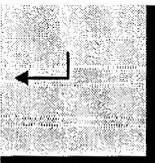
The main switch is located at the back of the control unit.

Please Note...

The contents of the program memory are not lost when the main switch is turned off.

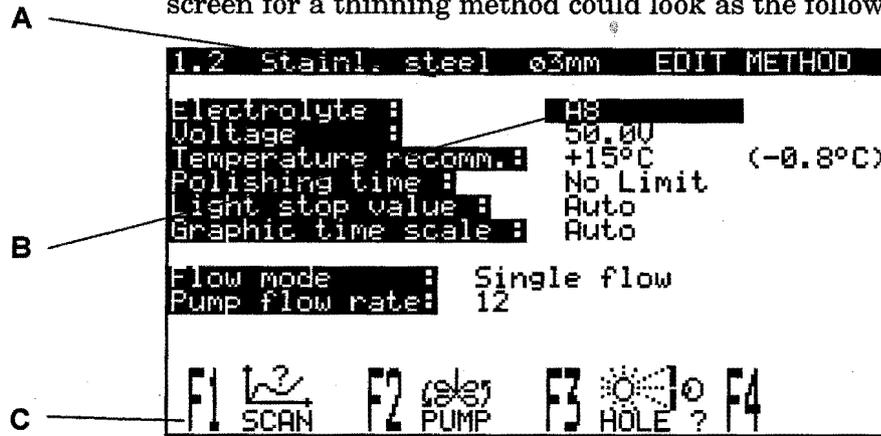
TenuPol-5
Instruction Manual

Front Panel Controls

Name	Key	Function	Name	Key	Function
① MAIN SWITCH		The main switch is located at the back of the control unit.			
② START		Starts the thinning process according to the pre-set method.	⑥ FUNCTION KEY		Controls for various purposes. See the bottom line of the individual screens.
③ STOP		Stops the thinning process.	⑥ FUNCTION KEY		Controls for various purposes. See the bottom line of the individual screens.
④ MENU		Scrolls up in the menu tree structure of TenuPol-5. When setting a parameter the value increases.	⑥ FUNCTION KEY		Controls for various purposes. See the bottom line of the individual screens.
④ MENU		Scrolls down in the menu tree structure of TenuPol-5. When setting a parameter the value decreases.	⑥ FUNCTION KEY		Controls for various purposes. See the bottom line of the individual screens.
⑤ ENTER		Accepts a marked parameter value or chooses a menu.	⑦ ESC		Leaves the present menu or aborts functions/changes.

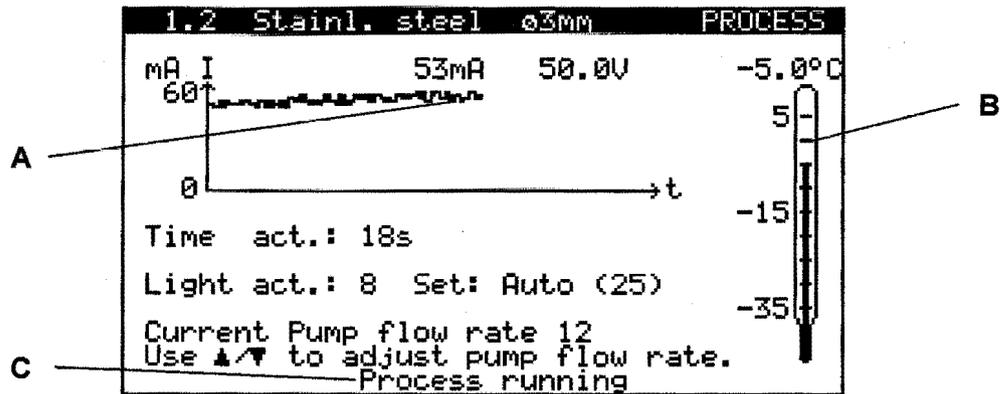
Reading the Display

The display can show various kinds of information, for example parameters of a thinning method or the ongoing process. The screen for a thinning method could look as the following example:



- A Heading.
- B Inverted text: cursor position
- C Function key options.

During the process the screen could look as follows:



- A Current-time graph.
- B Display of the electrolyte temperature.
- C Process status.

Sleep Mode

To increase the lifetime of the display, the backlight is automatically switched off if TenuPol-5 has not been used for 30 min. Press any key to re-activate the backlight.

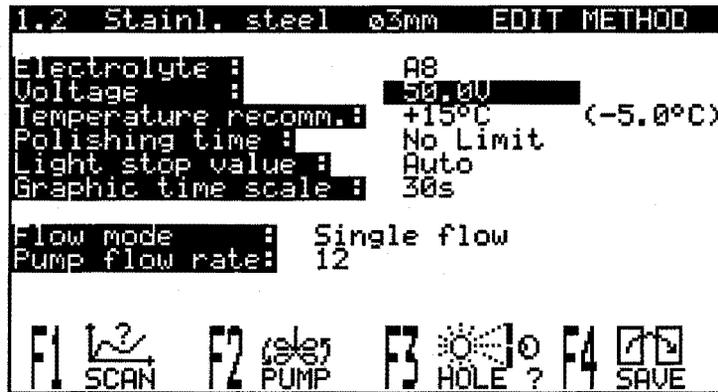
Please Note

The sample screens in this Instruction Manual show a number of possible texts. The actual display screen may differ from the samples in this Instruction Manual.

Changing/Editing Values

Numeric Values

Depending on the type of value, there are two different ways of editing.



Press MENU UP/DOWN ▲▼ to select the numeric value you want to change, e.g. Voltage:



Press ENTER ↵, to edit the value.



Two square brackets [] appear around the value.



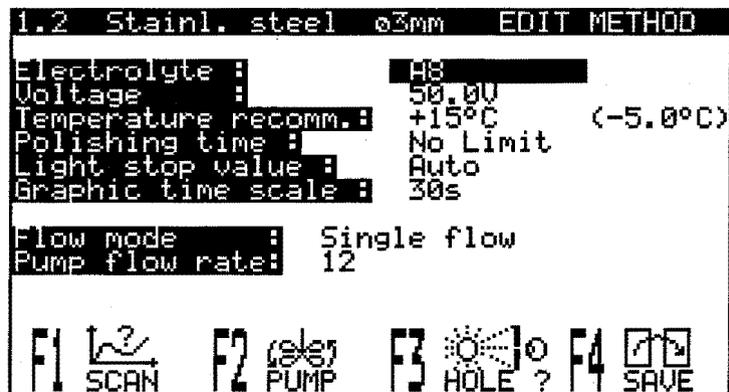
Press MENU UP/DOWN ▲▼ to increase or decrease the numeric value.



Press ENTER ↵, to accept the new value.

Pressing Esc, aborts the changes, preserving the original value.

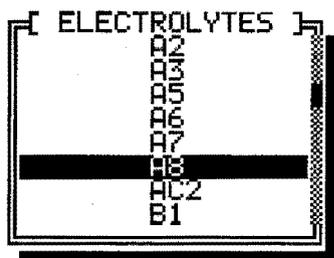
Alphanumeric Values



↓
 Press MENU UP/DOWN  to select the alphanumeric value you want to change, e.g. Electrolyte

↓
 Press ENTER , to edit the value.

↓ A pop-up menu appears



↓
 Press MENU UP/DOWN  to select the correct electrolyte.

↓
 Press ENTER , to accept the new electrolyte and to return to the previous screen.

Pressing Esc, preserves the original electrolyte, returning to the previous screen.

Electrolytic Preparation

Pre-treatment of the specimen

Prior to electrolytic thinning, discs of 3 mm (2.3 mm) diameter and a thickness of 0.1 to 0.5 mm have to be prepared. For that, methods such as spark-machining or mechanical turning and cutting are well known.

However, this pre-thinning (see below) can also be carried out on the TenuPol-5, the original sample being a cut-off disc, thickness max. 1 mm, diameter max. 21 mm. Such a disc may be cut on e.g. an Accutom precision cut-off machine. The cut-off disc is now ground down on SiC paper, e.g. on a LaboPol or RotoPol grinding/polishing machine. It is recommended to fix the disc to a plane block of metal using double-adhesive tape. It is ground first on one side, then on the other on the rotating disc, finished with # 1000 SiC-paper and should then be max. 1 mm thick.

The Accustop (see Accessories) can be used for plane-parallel grinding of specimens.

When the specimen has been made ready for preparation, it is important to avoid oxidation of the specimen as this may cause the specimen not to be satisfactorily polished in TenuPol-5.

If the specimen has been punched out of a foil, it must also be fine-ground on both sides to remove any oxidation before preparation on TenuPol-5.

Thinning options

Three different ways of electrolytic thinning can be carried out on TenuPol-5.

Pre-thinning

The cut-off and possibly pre-ground specimen can be pre-thinned using the specimen holder (TETMA) allowing to polish an area of 10 mm diameter from both sides. To fit the specimen holder, the specimen must not be more than 1 mm thick and not more than 21 mm in diameter. 2.5 mm jets are used (extra equipment TETET). The polishing should not be carried on to perforation. Depending on the original thickness the polishing time will vary and must be established from case to case. After pre-thinning the thickness should be 0.1-0.5 mm. Instead of using the light stop value, the polishing time has to be set to an appropriate value.

Blanking

When equipped with the 2.5 mm jets (TETET), TenuPol-5 may be used for cutting out 3 mm (2.3 mm) specimens electrolytically in the 10 mm specimen holder (TETMA). The larger specimen, which should be 0.1-0.5 mm thick, is first degreased in alcohol. One side of the specimen is covered completely with a special acid-resistant tape, having an acid-resistant adhesive. On the other side are stuck 1-4 discs of tape of 3 mm (2.3 mm) diameter within a circle of 10 mm diameter. The tape is available as a kit (accessory: TENKI). The tape must be pressed securely against the metal. The specimen is now placed into the specimen holder, so that there is a free area, which can be removed during

polishing, around the small tape discs. When the holder has been set into the polishing cell, the cathode on the side where the specimen is completely covered, is disconnected by pulling out the banana plug. The specimen is then polished in the usual way until the exposed area has disappeared. The 3 mm (2.3 mm) metal specimens will now be present under the tape discs. They are disengaged, washed and are ready for the final thinning. The standard supplied jet holders have jets with an inside diameter of 1 mm. For thinning and electrolytic blanking with the 10 mm specimen holder, however, jets with an inside diameter of 2.5 mm have to be used. When using highly viscous electrolytes it may be necessary to use 2.5 mm jets (TETET) also in connection with 2.3 mm and 3 mm specimen holders.

Final Thinning

This will normally consist in polishing of 3 mm (2.3 mm) diameter specimens with the 1 mm jets. The polishing is carried on until a small hole appears and will usually be stopped using the light stop value, reacting as soon as a hole is established. By adjusting the light stop value, the hole size can be changed. As soon as the thinning is finished, the current is interrupted, a beeper sounds and the specimen holder must be taken out and opened in a small bath of e.g. ethanol or distilled water, kept ready close to the polishing cell, to stop chemical etching. From this the specimen is transferred to a bath of e.g. ethanol by means of a pair of tweezers. It may then be laid on a piece of filter paper, where it dries in a couple of seconds and is ready for examination or storing.

Thinned specimens may be kept under vacuum in a desiccator with silicagel. In most cases they can also be kept in glycerol, which will protect them against the action of the atmosphere.

Choosing a Method

In the Main Menu, select STRUERS METHODS and press ENTER ↵. The following screen will appear:

STRUERS METHODS			
0.1	Stainl. steel	Ø10mm	A8 ☉
0.2	Stainl. steel	Ø3mm	A8 *
0.3	Low C-steel	Ø10mm	A2 ☉
0.4	Low C-steel	Ø3mm	A2 *
0.5	Low C-steel	Ø3mm	A8 *
0.6	Impax 45HRC	Ø10mm	A2 ☉
0.7	Impax 45HRC	Ø3mm	A2 *
0.8	Impax 45HRC	Ø3mm	A8 *
0.9	Titanium	Ø10mm	A3 ☉
0.10	Titanium	Ø3mm	A3 *

+
F1 COPY F2 F3 F4

Two different types of methods are displayed for each material. The methods for pre-thinning and blanking, a total of 8 methods, are shown with Ø10 mm and a small symbol for a clock next to the electrolyte name:

0.1 Stainl. steel Ø10mm A8 ☉

The methods for final thinning, a total of 10 methods, display Ø3 mm and a small symbol for a light source next to the electrolyte name.

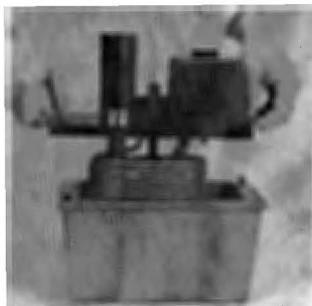
0.4 Low C-steel Ø3mm A2 *

Select the appropriate method using MENU UP/DOWN ⬆️⬇️⬆️ and press ENTER ↵. The following screen will appear:

0.4 Low C-steel Ø3mm VIEW METHOD	
Electrolyte :	A2
Voltage :	43.0V
Temperature recomm.:	+5°C (-5.0°C)
Polishing time :	No Limit
Light stop value :	Auto
Graphic time scale :	Auto
Flow mode :	Single flow
Pump flow rate:	20
(START: Start process Esc:Abort)	

The method contains all parameters for final thinning.

Filling the Container with Electrolyte



Please refer to the section on Handling and Safety Precautions before handling the electrolytes.

- Remove the base plate with pump and cooling coil from the insulated electrolyte container.
- Fill the (insulated/ uninsulated) electrolyte container with electrolyte. A minimum of 1 litre is requested, 1½ litres are recommended.
- Place the base plate with pump and cooling coil back on the container filled with electrolyte.

IMPORTANT

Funnel, gloves, ventilation as well as all other prescribed equipment must be used during emptying.

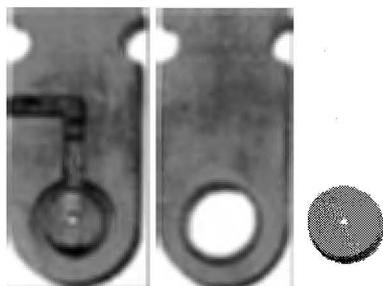
Mounting the Jet Holders



- Place one jet holder in the polishing chamber and slide the sleeve into the groove until the holder fits tightly against the back wall of the chamber.
- Mount the other jet similarly at the other side of the chamber.
- Connect the two banana plugs in the corresponding sockets in the jet holders.
- Place the protecting casing over the polishing cell.



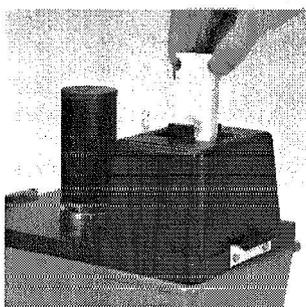
Mounting the Specimen in the Specimen Holder



Specimens to be mounted in the specimen holder should be of a diameter of 3 mm and of a thickness of 0.1-0.5 mm.

- Take the two grey halves of the specimen holder apart. (This can be facilitated by turning one half away from the other like the two hands of a watch)
- Remove the white diaphragm from one part. Click the two grey halves back together again (a click is heard). The diaphragm must not be inserted.
- Place the specimen holder with the cut-out part being turned upwards.
- Place the specimen over the hole of the platinum strip.
- Press the diaphragm carefully down into the cut-out until it fits tightly against the specimen.

Starting the Thinning Process



- Make sure that the correct type and amount of electrolyte has been filled in the electrolyte container.
- Place the specimen holder in the polishing cell so that the contact piece of the specimen holder confronts the contact piece of the polishing cell.
- Select the correct method
- Check the temperature of the electrolyte.
- Press \blacklozenge START.

Stopping the Process

- When the light stop value is used the process is automatically stopped, when a hole is made in the specimen. This is normally used for the final thinning.
- When the timer is used the process is stopped when the pre-set time has run out, no matter if a hole has been made or not. The timer is used for pre-thinning and blanking.
- The process can be stopped at any time during operation by pressing \blacktriangledown STOP.

Post Treatment of the Specimen As soon as the thinning is finished, the current is interrupted, a beeper sounds and the specimen holder must be taken out and opened in a small bath of e.g. ethanol or distilled water, kept ready close to the cell, to stop chemical etching. From this the specimen is transferred to a bath of e.g. ethanol by means of a pair of tweezers. It may then be laid on a piece of filter paper, where it dries in a couple of seconds and is ready for examination or storing.

Emptying the Container of the Electrolyte

- Remove the base plate with pump and cooling coil from the insulated electrolyte container.
- If the electrolyte is to be used again pour the electrolyte carefully back into the electrolyte bottle.
- If the electrolyte is not to be used again it should be filled into a container suitable for disposal. Please observe the local regulations and instructions for disposal.

IMPORTANT

Funnel, gloves, ventilation as well as all other prescribed equipment must be used during emptying.

Cleaning the Polishing Cell

After emptying the reservoir from electrolyte, the polishing unit should be cleaned with water by pumping water through the polishing cell instead of electrolyte.

- Fill the reservoir with water.
- Select **Cleaning** in the **Manual Functions** menu and follow the instructions on the display.

Calibration of the Pump

To calibrate the polishing unit and to make sure the flow rate settings in the Struers methods are correct, the pump has to be adjusted before it is being used for the first time. When TenuPol-5 is started for the first time the following screen will appear:

```
ADJUST PUMP
The pump must be adjusted.
ADJUST WITH TUBE      ADJUST WITH NUMBERS
Use ▲/▼ to select adjust procedure.
(↵: Select           Esc: Abort)
```

You can now either adjust the pump with the tube or with the numbers indicated on the enclosed Calibration Certificate.

Calibration Certificate

On the enclosed calibration certificate the values for maximum and minimum pump flow for each specific polishing unit can be found. Instead of running the actual calibration, the values can simply be entered in the respective categories.

Using the Calibration Tube

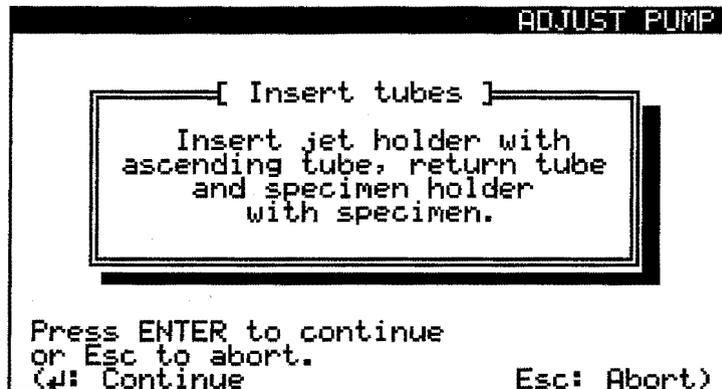
The following routine has to be followed. Press ENTER ↵ to proceed to the next screen.

```
ADJUST PUMP
[ Insert container ]
Please insert a container
filled with 2 litre water.
Add a drop of detergent.
Press ENTER to continue
or Esc to abort.
(↵: Continue           Esc: Abort)
```

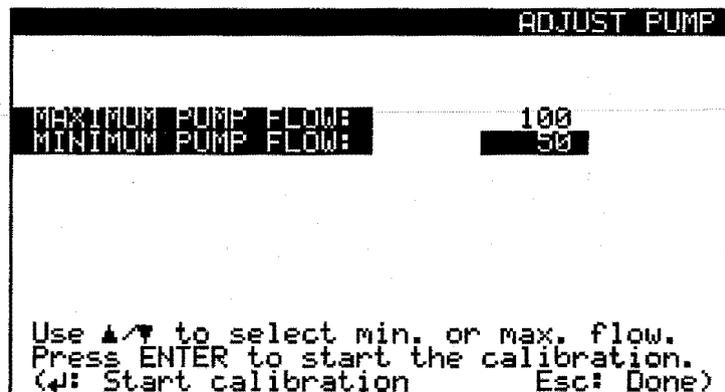
Make sure to fill the PVC-reservoir with the stated amount of water, then add one drop of detergent to release the surface tension of the water.

After following the instruction, press ENTER ↵, and the following message will pop up.

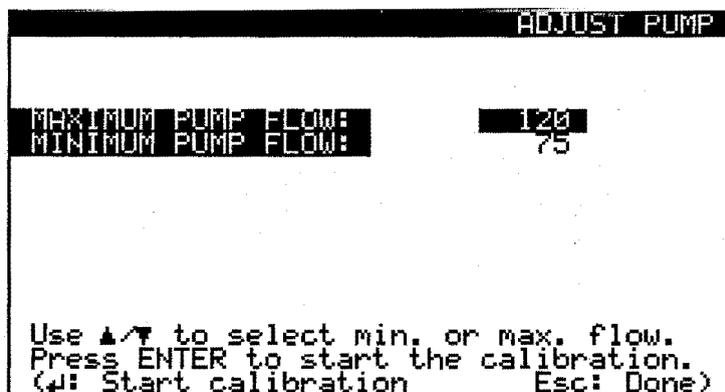
TenuPol-5
Instruction Manual



Follow the instructions on the screen, then press ENTER ↵ to proceed to the next screen.



From this screen both the minimum and the maximum flow of the electrolyte are adjusted. Select maximum pump flow and press ENTER ↵ to start the pump.



Press MENU UP/DOWN ▲▼ to adjust the water level to the upper mark. Press ENTER . | to save the value. Then repeat the procedure for minimum pump flow. The values should be in the neighbourhood of 120 for the maximum flow and around 75 for the minimum flow. Press Esc when done with the calibration.

3. Handling and Safety Precautions

Electrolytes in General

When using electrolytes all necessary safety measures should be taken. Apart from the safety precautions listed in the following, a material Safety Data Sheet for each of the electrolytes used should be requested from the supplier.

- It is essential that the user(s) is/are fully instructed in the work procedure of these electrolytes.
- TenuPol-5 is designed for use with electrolytes recommended by Struers. Other electrolytes, e.g. electrolytes containing strong bases or acids, may harm the construction or endanger the safety of the user.

NOTE

Many electrolytes contain alcohol or other inflammable solvents. Make sure that all safety precautions are followed when using such electrolytes.

- Struers electrolytes are not marketed in the US. The chemical compounds needed for the electrolyte must be purchased independently.

NOTE

Be sure to request Material Safety Data Sheets for each chemical acquired.

- When cleaning the apparatus after use, make sure that no electrolyte is allowed to dry and/or crystallise inside the apparatus or on the polished material.
- It is essential that the user is fully trained in the use of TenuPol-5 and electrolytes involved.

Perchloric Acid in Particular

Electrolytes from Struers (and those suggested for use by Struers) with the prefix A consist of approx. 1 l stock solution to which 15 to 90 ml perchloric acid (60%) should be added. Before mixing the perchloric acid to the stock solution it is of great importance that the following safety precautions are carefully observed. Furthermore a Material Safety Data Sheet for the perchloric acid in question can be supplied upon request.

Training of Operators

- All personnel involved in the mixing, use, storage, transportation, and disposal of the electrolyte or its components, should be thoroughly trained in the precautions for handling perchloric acid.
- Great importance must be attached to precautions against inhalation of vapours of the solution or its components, against skin contact, mixing and overheating, and concerning storage and disposal methods.

Mixing the Solution

- Place the solvent/water mixture in a water bath with temperature control. Carefully add the perchloric acid to the solvent/water mixture, stir continuously.
- The mixing must take place in a ventilated chemical fume hood designed for perchloric acid use.
- The operator(s) must use the listed protective clothing or devices: full face shield or splash goggles, rubber gloves and lab coat or coveralls.
- Avoid the use of any combustible or carbonaceous containers, reaction vessels, spill pans, storage shelves, or materials of this type when dealing with the acid.

Storage of Perchloric Acid or Solution

- Do not permit any acid to crystallise on bottle necks, caps, or anywhere else.
- Store in a secure, cool, and ventilated area with a metal, glass, or ceramic spill catch pan.
- Store away from other chemicals, combustible and organic materials.
- Do not, under any circumstances, permit solutions to dry out.

Fire and Explosion Hazards

- 60% perchloric acid is a strongly corrosive and oxidising product. Heating may cause an explosion and contact with combustible material may cause fire.
- Fire fighting should be done from a protected location. Extinguish with water spray only. Do not use dry chemicals or carbon dioxide.
- Do not produce anhydrous perchloric acid, either from its salts or from aqueous solutions, e.g. by heating with high boiling acids or dehydrating agents, such as sulphuric acid or phosphorous pentoxide. In addition to spontaneous explosion, the anhydrous acid explodes instantaneously on contact with oxidizable organic materials.
- The use or storage of perchloric acid should be limited to quantities less than 500g per hood.

Disposal

Follow local regulations for disposal of spillage and waste. Dilution and/or neutralisation are the normally recommended methods of disposal of the electrolyte.

TenuPol-5
Instruction Manual

Reference Guide

Table of Contents	Page
1. Advanced Operations	
Configuration Menu.....	27
Display contrast.....	28
Language.....	28
Temperature unit.....	28
Temperature warning.....	28
Maximum temperature.....	28
Pump pre-time.....	28
F1, Default value.....	28
F2, Electrolyte Formula.....	28
F3, Edit Electrolyte Name.....	28
F4, Adjust pump.....	29
Method Options.....	31
Copying a Method.....	31
Pasting a Method.....	33
Resetting a Method.....	33
Renaming a Method.....	34
Name Editing Principles.....	35
Saving a Method.....	35
Method Parameters.....	37
Electrolyte.....	37
Voltage.....	37
Recommended temperature.....	37
Polishing time.....	38
Light stop value.....	38
Graphic time scale.....	38
Flow mode.....	38
Single flow.....	38
Dual flow, step mode.....	39
Dual flow, ramp mode.....	39
Pump flow rate.....	39
Establishing New Methods.....	40
Scanning.....	40
Scanning Result.....	41
Ideal Current Density Curve.....	43
Defining the Polishing Voltage.....	43
F1 Re-scan.....	44
Saving a Scan.....	44

Optimising the Results	45
Problem Areas.....	45
Geometric conditions	45
Type of Electrolyte	45
Flow Rate	45
Temperature	45
Electrical Conditions	45
Polishing Defects	45
Defective Polishing	46
Hole too Large.....	46
Manual Functions	47
Change Electrolyte.....	48
Cleaning	48
Pump	49
Pre-treatment of the Specimen	49

2. Accessories

TenuPol-5 PC Interface	50
Installation of Communication Software.....	50
Saving screens	50
Scan functions.....	51
Switch Box for TenuPol-5	51
Connecting the Switch Box.....	51

3. Consumables

Electrolytes	53
--------------------	----

4. Trouble-Shooting

Electrolyte	54
Polishing circuit	54

5. Maintenance

Daily Service	55
Polishing Unit	55
Control Unit	55

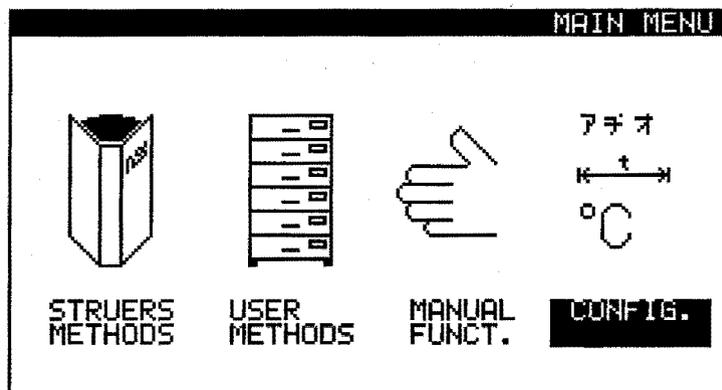
6. Technical Data

7. Menu Overview

1. Advanced Operations

Configuration Menu

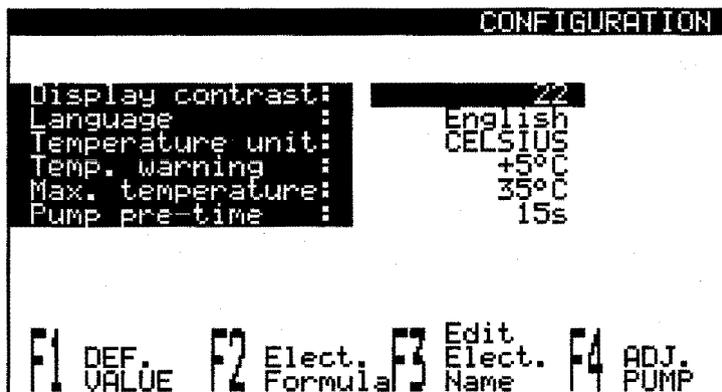
Press Esc until you reach the Main Menu (a long beep can be heard).



Press MENU DOWN  to select CONFIGURATION



Press ENTER  to activate the CONFIGURATION menu



TenuPol-5
Instruction Manual

- Display contrast* The contrast settings of the display can be adjusted accordingly.
- Language* The language can be set to either English, German, French or Japanese.
- Temperature unit* The temperature can be displayed in either Celsius or Fahrenheit.
- Temperature warning* The temperature can be pre-set in each individual method. *Temperature warning* is used to give an indication that the electrolyte temperature has increased to a certain value above the temperature set in the method. That could be due to insufficient cooling. The *temperature warning* value can be adjusted between 0-10°C / 0-18°F, or it can be set to NO WARNING.
- Maximum temperature* The absolute maximum temperature of the electrolyte can be set. If this value is reached during the process, TenuPol-5 will shut off automatically.
The maximum values can be set to between -50 to 35°C / -58 - 95°F.
- Pump pre-time* Running time of the pump before the current is applied. This is used to achieve an even flow of electrolyte from the very start of the process. The pump pre-time can be adjusted between 5 - 20 seconds.
- F1, Default value* The factory setting of every single value can be restored by pressing the function key F1 when the appropriate value is highlighted.
- F2, Electrolyte Formula* The formulas and mixing conditions of all Strucrs electrolytes can be found here.
- F3, Edit Electrolyte Name* If you are using your own electrolytes, the names can be changed from User X to a more descriptive name of your own choice. Press F3 to start the editing function, select the name and follow the guidelines described in the chapter Advanced Operations, Name Editing Principles, to change the name of the electrolyte.

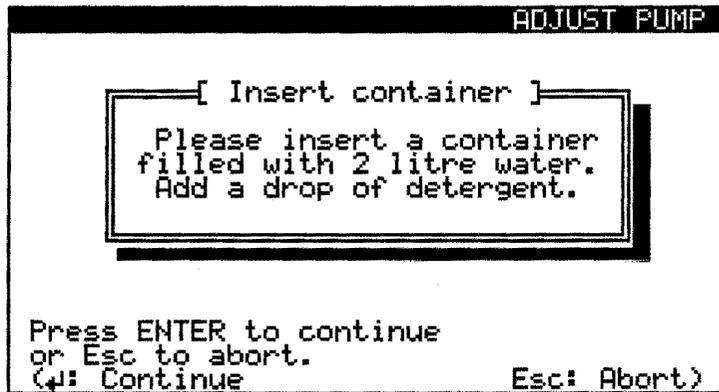
Important

When the name of a user defined electrolyte is changed, it will also be changed automatically in all the methods where this electrolyte is used.

F4, Adjust pump

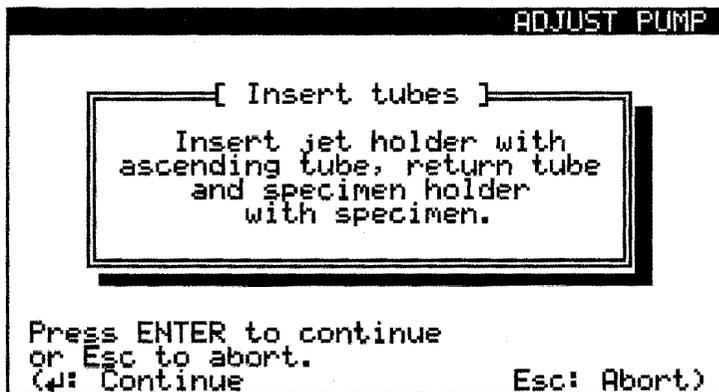
To calibrate the polishing unit and to make sure the flow rate settings in the Struers methods are correct, the pump has to be adjusted before it is being used for the first time (see Users Guide, Calibration of the Pump). Also for subsequent checking of the pump this function can be used.

To carry out the adjustment, press F4 and the following screen appears.



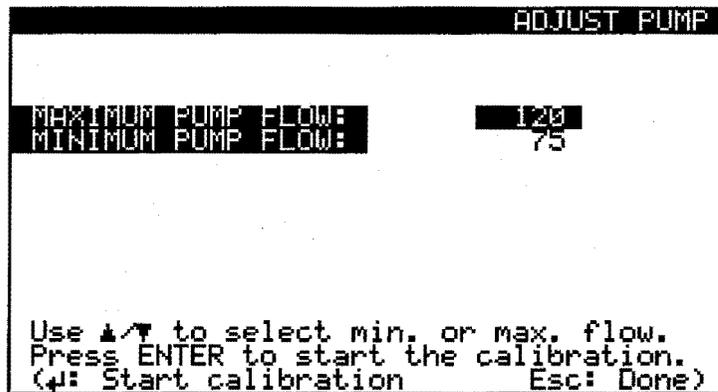
Make sure to fill the PVC-reservoir to the maximum mark with water and add one drop of detergent to release the surface tension of the water.

After following the instruction, press ENTER ↵, and the following message will pop up.

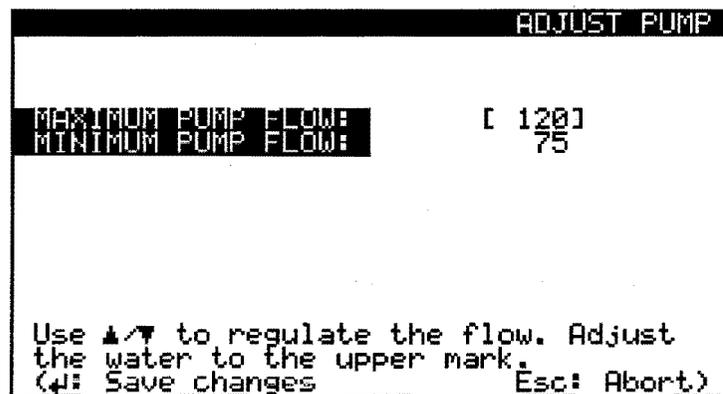


Follow the instructions on the screen, then press ENTER ↵ to proceed to the next screen.

TenuPol-5
Instruction Manual



From this screen both the minimum and the maximum flow of the electrolyte are adjusted. Select maximum pump flow and press ENTER ↵ to start the pump.



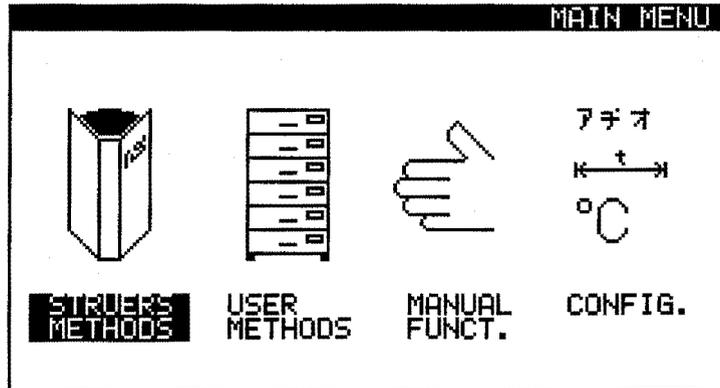
Press MENU UP/DOWN  ▲▼ to adjust the water level to the upper mark. Press ENTER ↵ to save the value. Then repeat the procedure for minimum pump flow. The values should be in the neighbourhood of 125 for the maximum flow and around 75 for the minimum flow. Press Esc when done with the calibration.

Method Options

There are several different possibilities when working with methods. As the Struers methods can not be changed, the first step will usually be to copy a Struers method into the User methods database.

Copying a Method

In the Main Menu select STRUERS METHODS.



Press ENTER ↵ to activate the STRUERS METHODS menu



Select the correct method and press F1: COPY.



A pop-up menu will appear.

TenuPol-5
Instruction Manual



↓ When you are asked for confirmation,

 Press ENTER ↵.

↓ The method is now resident in the buffer. To save the method in a different location:

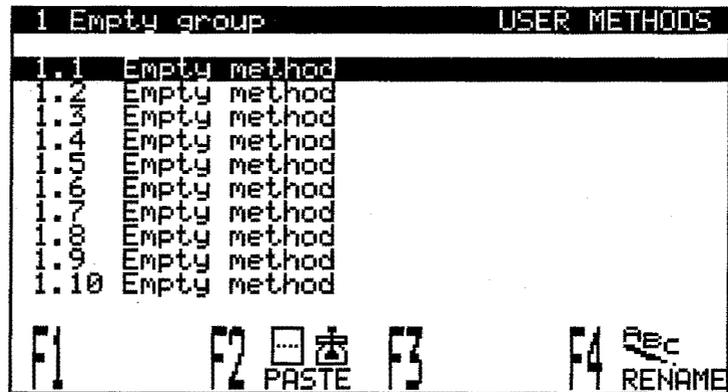
 Press Esc to return to the Main Menu.

↓ In the Main Menu select USER METHODS.

 Press ENTER ↵ to activate the USER METHODS menu.

↓

Pasting a Method

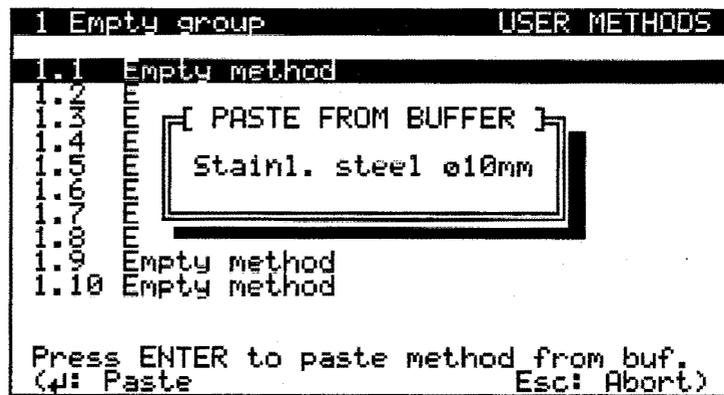


↓ Select where (group and method) you want to paste the method from the buffer.

F2 Press F2:PASTE.

↓ When you are asked for confirmation,

 Press ENTER ↵.



Resetting a Method

If a method is not used anymore it can be reset to the default values.

↓ Select the method you want to reset.

F3 Press F3:RESET

↓
 Press ENTER ↵ to confirm the resetting of the method.

Renaming a Method

The names of the methods in the User methods database can be edited and changed. After copying a method from the Struers methods the name can be changed to a name of your choice.

↓ Select the method you want to rename.

F4 Press F4:RENAME

↓ The following screen will appear:



↓ Use F1 or F3 to select the character to change

 Press MENU DOWN  to move to the character set.

↓

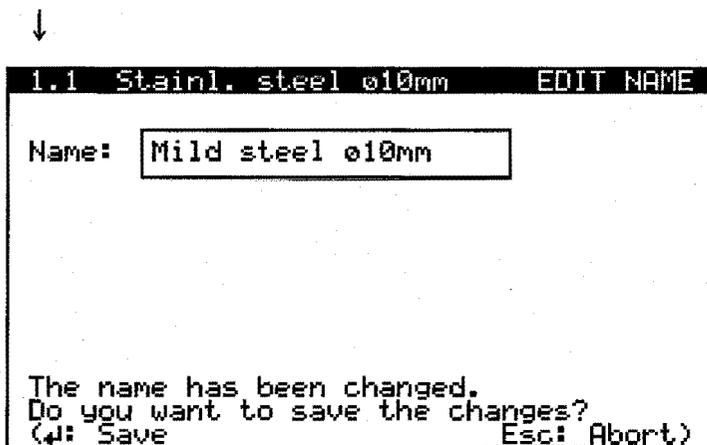
Name Editing Principles

- Place the main cursor on the character you want to change, using F1:LEFT or F3:RIGHT. Use MENU UP/DOWN to move to the character set in the next line. An auxiliary cursor in the text line shows the position in the method name.
- Write the new name using the following keys:
 - F1 Moves the cursor to the left
 - F2 Deletes one character in the text
 - F3 Moves the cursor to the right
 - F4 Inserts a space in the text
- ↳ ENTER places the new character in the method name and moves the auxiliary cursor in the name to the right. Repeat the procedure for each character.



↓ Write the new name using the above name editing procedures.

Esc Press Esc to leave the editor again.



Saving a Method

TenuPol-5
Instruction Manual



Press ENTER → to save the new name.

While working with a user method, you can save the changes you have made in the database.

- As soon as a parameter is changed in a method, F4:SAVE will be shown on the bottom line of the display.

```
1.2 Empty method          EDIT METHOD
Electrolyte :             A2
Voltage :                 0.70
Temperature recomm.:     +0°C (-5.0°C)
Polishing time :         No Limit
Light stop value :      Auto
Graphic time scale :    Auto

Flow mode :              Single flow
Pump flow rate:         10

F1 [SCAN] F2 [PUMP] F3 [HOLE ?] F4 [SAVE]
```



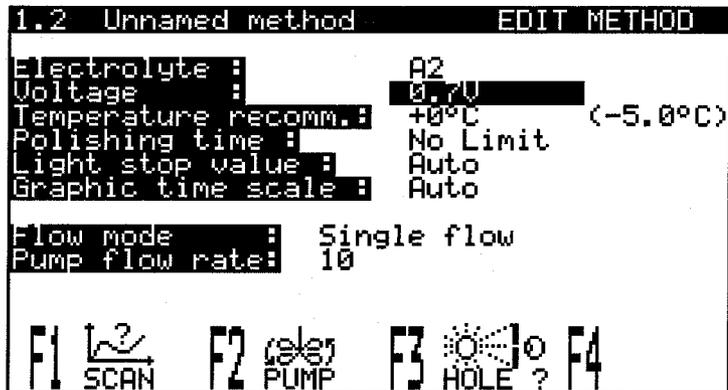
F4 Press F4:SAVE to save the changes after all necessary parameters have been altered.



↵ Press ENTER ↵ to confirm saving the modified method.

Unless you already have named the method, the name will automatically change from Empty method to Unnamed method. This will show that at least one parameter has been changed compared to a default method.



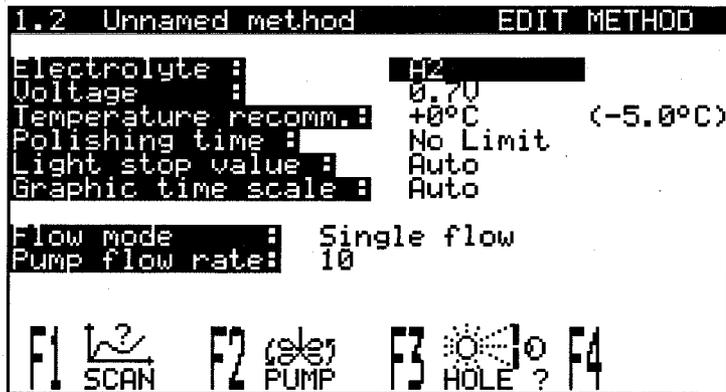


Important

When saving changes, the original method will be overwritten. If you want to keep the original method, you must make a copy of the original method and make the changes in the copy rather than changing the original method. See Copying a Method.

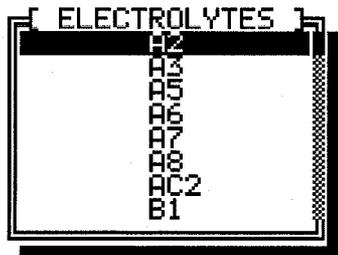
Method Parameters

For every method a series of parameters can be changed:



Electrolyte

Pressing ENTER, allows you to select between:



The standard Struers electrolytes are included, and additional 10 Users electrolytes are also available.

Voltage

The voltage can be set between 0.1 – 100.0 Volt in steps of 0.1 Volt.

Recommended temperature

The recommended temperature can be set to values between –50 to +35°C or –58 to +95°F. To the right of the recommended

TenuPol-5
Instruction Manual

temperature the actual temperature of the electrolyte can be seen. If low temperatures are recommended, an external cooling unit must be used to cool the electrolyte down to the required temperature. The 2 numbers displayed on TenuPol-5 are only for monitoring purposes, the actual electrolyte temperature can not be controlled from there.

Please see also the section Configuration on how to set *Temp. warning* and *Max. temperature*.

Polishing time

The time can be set and adjusted as follows.

	in steps of 1 sec.	In steps of 5 sec	In steps of 10 sec
No limit	0-30 sec.	30-60 sec.	1-30 min.

The setting No Limit must be used if the automatic mode, where the occurring hole is detected, is used.

Light stop value

The light stop value can be set to the following values:

	in steps of 1	in steps of 2	in steps of 5	in steps of 10	in steps of 25	in steps of 50
Auto	0-50	50-100	100-500	500-1000	1000-2000	2000-4096

Auto: The polishing unit is equipped with an infrared sensor, constantly measuring light emitted from an infrared light placed on the opposite side of the sample. As soon as the sample is thin enough to allow light to pass through, i.e. a hole has been made, the polishing process is stopped automatically and the reached value is displayed. As the holes sometimes develop very fast a relatively high value might be experienced.

Time setting: If the polishing process is stopped immediately, the hole might be too small. Therefore it is possible to set a light stop value manually. The set value should be bigger than the value reached with the Auto setting as this usually is the lowest value achievable with this material.

Graphic time scale

While the process is running the current-time graph is updated continuously. When the graphic time scale is set to Auto, the last three minutes of the process are displayed. If shorter or longer times should be displayed the setting can be changed. Times from 10 sec. to 30 min can be set.

Flow mode

There are three different flow modes, Single flow, Dual flow, step mode and Dual flow, ramp mode.

Single flow

The same flow rate is used throughout the polishing process

TenuPol-5
Instruction Manual

If the total polishing time is known, dual flow can be used to reduce the flow towards the end. This can minimise eventual damage of the very thin edges because of too high flow of electrolyte. There are two different possibilities:

Dual flow, step mode

The flow is reduced from the initial flow to the final flow in one step.

Dual flow, ramp mode

The flow is reduced gradually from the initial flow to the final flow.

Pump flow rate

The flow rate can be set between 0 - 50.

Establishing New Methods

If you are working with materials which are not covered by the standard methods in the database with the Struers methods there is another way in establishing parameters.

Scanning

Chose the method you want to use for the new material in the User database. (If necessary copy one from the Struers methods first.)

 Press ENTER  to show all the parameters of the method.



```

1.2 Mild Steel ø3mm          EDIT METHOD
Electrolyte :                A8
Voltage       :                50.0V
Temperature recomm.:        +15°C (+3.9°C)
Polishing time :                No Limit
Light stop value :                Auto
Graphic time scale :                Auto

Flow mode      :                Single flow
Pump flow rate:                19

F1  F2  F3  F4 
SCAN PUMP HOLE ? SAVE
    
```

↓ If necessary, the electrolyte has to be changed. Please find the correct electrolyte for your material in the section Consumables.

F1  Press F1 to go to the scanning function.



```

1.2 Mild Steel ø3mm          EDIT METHOD
Elec Volt Temp Pol Light Grap
                               [ SCAN ]
                               1. Set max. volt.: 50V
                               2. Set flow rate: 19
                               3. Start scan
                               5°C)
Flow Pump
Insert specimen holder with specimen.
Press ENTER to start the pump and set
the flow rate used during scanning.
    
```

↓ Set the maximum voltage that will be applied during scanning. Values between 10 - 100 V can be set.

↓ Adjust the flow rate to the correct value.

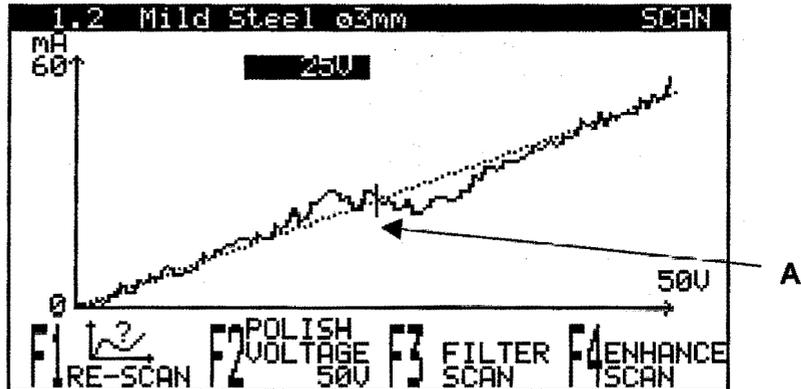
 Press START  to run the scan.

Scanning Result

After running the scan,



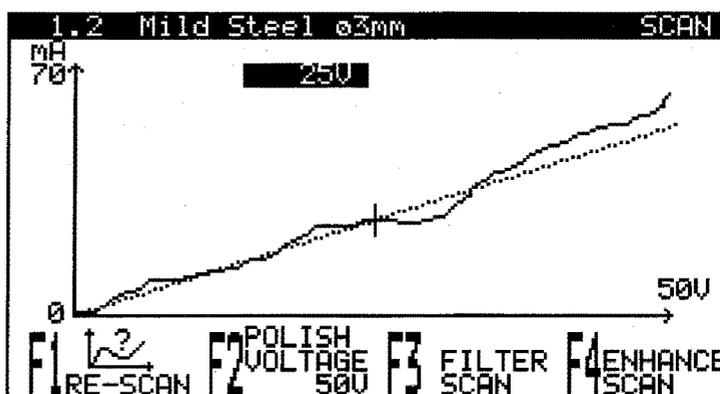
Press ENTER ↵ to see the current density curve.



This is an example of a possible scanning result. The graph shows the current density curve and can be used to define an approximate value for the polishing voltage. A tangent **A** is also displayed. After displaying the scan, the tangent is cutting the curve in the middle. This is not an indication for a possible definition of the polishing voltage, this has to be set by the user according to the instructions later in this chapter.

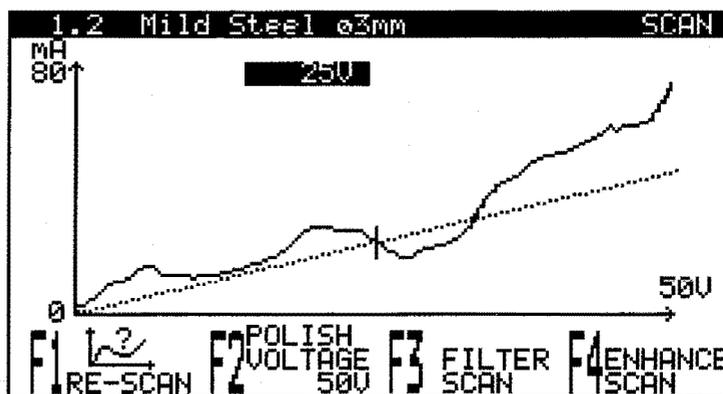
Filter Scan

Sometimes the scanning curve can display a lot of "noise", making it difficult to define the correct polishing voltage. Then F3: Filter Scan can be used to clean the scanning curve. The result will look somewhat like on the following screen:

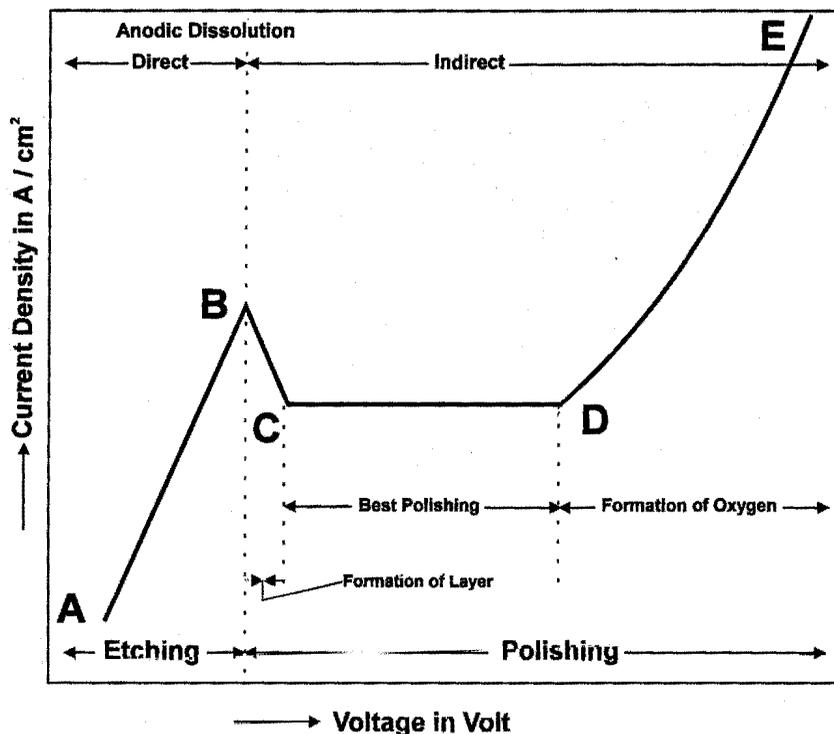


Enhance Scan

If it still is difficult to determine the correct polishing voltage F4: Enhance Scan may be used to amplify the scanning curve. The result might look like the following screen:



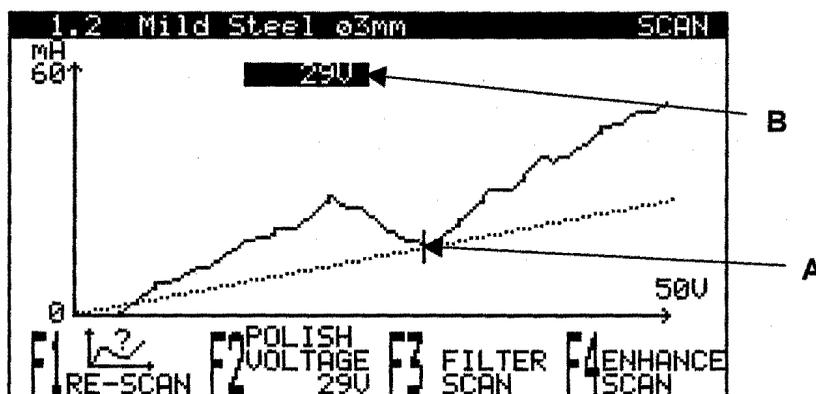
Ideal Current Density Curve



This is a graph showing an ideal current density curve.

Defining the Polishing Voltage

For best electrolytic polishing the formation of a viscous layer is necessary. The formation starts in area B - C, with area C - D being best for polishing. Our tests have shown that the thickest possible viscous layer is best for most uniform polishing results. The thickest viscous layer is found in the area C - D where the highest voltage / current ratio is found. The tangent can be used to define this point. Move the tangent along the current density curve in the area C - D, using MENU UP/DOWN \uparrow/\downarrow , until the tangent shows the smallest angle relative to the X-axis (point A). Then press F2 to record the polishing voltage in the method. The voltage where the tangent is touching the current density curve is displayed on the screen (B).





Esc Press Esc to return to the method.



The voltage value for polishing has been inserted in the method.

```
1.2 Mild Steel ø3mm EDIT METHOD
Electrolyte : 08
Voltage : 29.0V
Temperature recomm. : +15°C (-5.0°C)
Polishing time : 3m 0s
Light stop value : Auto
Graphic time scale : Auto

Flow mode : Single flow
Pump flow rate: 19

F1  F2  F3  F4 
```

To save the new settings for the voltage press F4 SAVE.

F1 Re-scan

To repeat the scan, simply press F1 Re-scan while still viewing the screen with the current density curve.

F3 Hole

To check the size of the obtained hole it can be re-measured after the thinning process. Press F3, the polishing chamber will be filled with electrolyte and the light value will be measured again.

Saving a Scan

With a PC-Interface kit it is possible to transfer the scan data to a PC. There it is possible to import the data into a spreadsheet, and to create graphs of the current density curves. These graphs can then be saved and compared if necessary. Please see the chapter on Accessories for details.

Optimising the Results

Problem Areas

If a sufficient high quality is not obtained in electrolytic polishing it will be necessary to alter the polishing conditions. There are five important parameters:

- the geometrical conditions
- the type of electrolyte
- the flow rate of the electrolyte
- the temperature
- the electrical conditions

Geometric conditions

In TenuPol-5 the geometrical conditions are fixed and can only be altered by changing or altering certain components. As to the other parameters the following will apply:

Type of Electrolyte

The chemical composition of the electrolyte is highly important for the quality of the polishing. An unsuitable electrolyte will cause inferior polishing, oxidised or etched surface, pittings or one-sided polishing, i.e. only one side of the specimen is polished, the other is black and oxidised. It is not at all certain that an electrolyte, which in other apparatus (e.g. the LectroPol-5) will polish a certain material, will also be suitable for thinning it on the TenuPol-5. In the literature numerous examples are cited of electrolytes suitable for thinning.

Flow Rate

The flow rate determines first of all whether a viscous anodic layer can be maintained during polishing. Jet polishing tends to remove the layer. The proper choice of flow rate is therefore mostly determined by the material to be polished and by the electrolyte. The best flow rate differs much from case to case and it is not possible to give general rules.

Temperature

In some cases a lower temperature will give better results. A lower temperature slows down the polishing and provides less etching and oxidation.

Electrical Conditions

The electrical conditions of course determined whether a polishing is at all obtained. The right conditions will only be present within a certain range of current densities.

Polishing Defects

With TenuPol-5, the polishing defects may be divided into the following classes:

- Defective polishing, i.e. wrong polishing conditions, so that a mirror-like finish is absent on one or both sides of the specimen. Pitting may be present.
- Polishing takes place, but no thin area is present at the edge of the hole.

Defective Polishing

Try to alter the electrical conditions. Perhaps the voltage was too low to reach the polishing range. Pittings may arise if the current was too high. A lowering of the temperature may make the polishing less sensitive to voltage changes. The flow rate should be altered. A too high flow rate may break up the polishing layer, which may be the cause of one side of the specimen not being polished. A slower flow may allow a polishing layer to be built up.

If nothing helps it can be concluded that the material in question cannot be polished by the electrolyte and another electrolyte should be tried.

Hole too Large

The hole may have grown too large, so that the thin foil first formed has disappeared. Just like electrolytic polishing will attack the tops of the asperities of the surface, it will attack the edge of the hole as being an asperity. Especially when the jet effect is strong it is very important to stop the process while the hole is small.

Adjustment of the flow rate may be helpful. A vigorous jet may attack a too small area. Another electrical current density should also be tried.

Set the Light Stop Value to Auto.

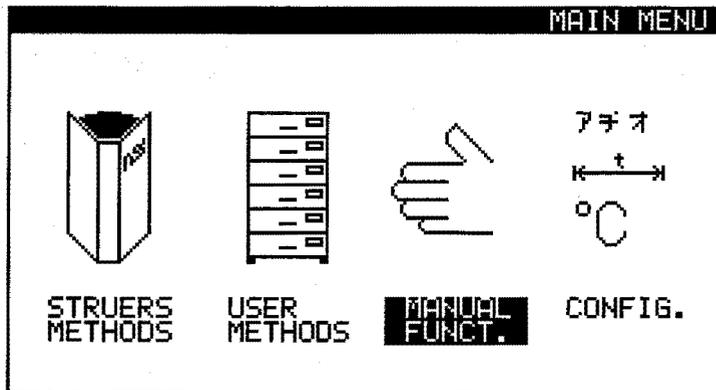
Sometimes a lower temperature will give a better profile around the hole, possible on account of a change of viscosity.

If nothing helps it is probable that the electrolyte is not suitable for thinning the material in question, although it will electropolish it. Try another electrolyte.

Manual Functions

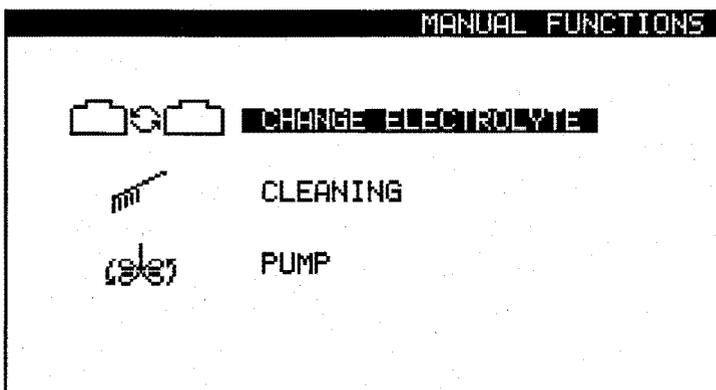
Several manual functions are included in the software of TenuPol-5.

Press Esc until you reach the Main Menu (a long beep can be heard).



↓
Press MENU UP/DOWN ▲▼ to select MANUAL FUNCTIONS

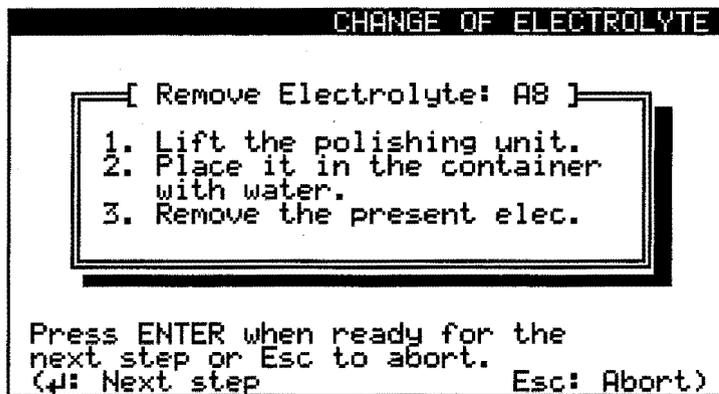
↓
Press ENTER ↵ to activate the MANUAL FUNCTIONS Menu



Change Electrolyte

When changing from a method with one electrolyte to a method with a different electrolyte, the electrolyte has to be changed. TenuPol-5 will automatically request that the electrolyte is changed and the system cleaned. However this function can also be started manually.

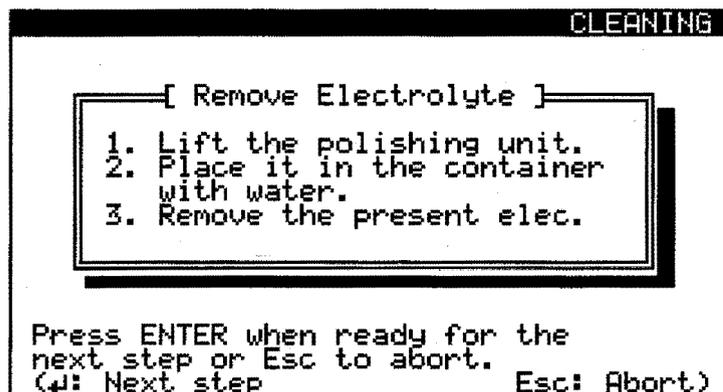
After selecting CHANGE ELECTROLYTE and pressing ENTER ↵, the following screen will appear:



Just follow the instructions and press ENTER ↵ when ready for the next step. There are a total of 5 screens guiding you through the complete sequence. The process can be stopped and aborted at any time by pressing Esc.

Cleaning

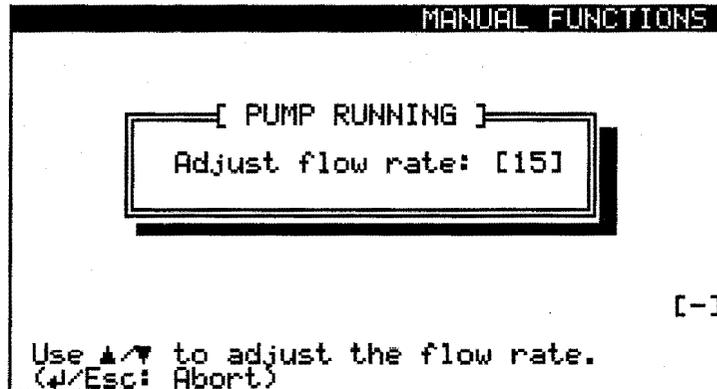
After working with TenuPol-5 is finished the system has to be cleaned. Cleaning is the first part of the above procedure. After selecting CLEANING and pressing ENTER ↵, the following screen will appear:



Just follow the instructions and press ENTER ↵ when ready for the next step. There are a total of 4 screens guiding you through the complete sequence. The process can be stopped and aborted at any time by pressing Esc.

Pump

This is the manual activation of the pump.
After selecting PUMP and pressing ENTER ↵, the following screen will appear:



Use MENU UP/DOWN ⏮▲▼ to adjust the flow rate.
ENTER ↵ and Esc will stop the pump again.

Pre-treatment of the Specimen

The purpose of pre-treatment is to prepare discs of 3 mm (2.3 mm) diameter thickness 0.1 to 0.5 mm. Methods such as spark-machining or mechanical turning and cutting are well known.

The preparation can also be done on the TenuPol-5, the original sample being a cut-off disc, thickness max. 1 mm, diameter max. 21 mm. Such a disc may be cut on e.g. an Accutom precision cut-off machine. The cut-off disc is now ground down on abrasive paper, e.g. on Knuth-Rotor. It is recommended to fix the disc to a plane block of metal by double-adhesive tape. It is ground first on one side, then on the other on the rotating disc, finished with grain 1000 paper and should then be max. 1 mm thick.

The Accustop (see Accessories) can be used for plane-parallel grinding of specimens.

When the specimen has been made ready for preparation, it is important to avoid oxidation of the specimen as this may cause the specimen not to be satisfactorily polished on TenuPol-5.

If the specimen has been punched out of a foil, it must be fineground on both sides to remove any impurities before preparation on TenuPol-5.

2. Accessories

TenuPol-5 PC Interface

Installation of Communication Software.

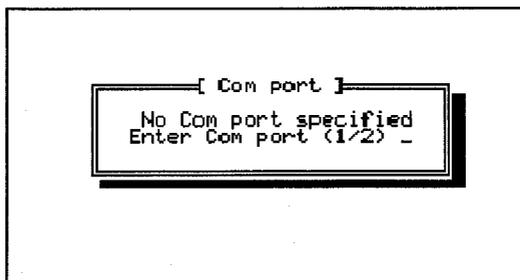
Insert the diskette labelled Struers PC Interface Software V 1.0 into the PC, change to drive a: (your diskette drive) and type INSTALL.

The necessary file PCIF.EXE will be copied into a newly created directory called Struers on your c:\drive.

If you do not want this directory to be created, simply copy the file PCIF.EXE into your preferred directory.

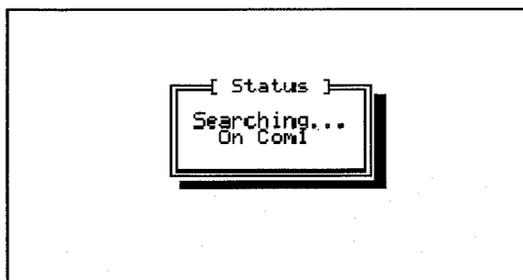
Then change to that directory and type PCIF to start the programme.

As a next step you are asked to specify the Com port you have connected TenuPol-5 to. This can either be Com1 or Com2.



Press 1 or 2 to specify the Com port you are using.

The Software then checks the connection to TenuPol-5 and will start downloading all the necessary information from TenuPol-5.



Saving screens

All functions can then also be controlled from the PC, and the individual screens can be saved as bitmap (.BMP) files by pressing ALT and D at the same time. When saving screens successively the .BMP files will be numbered consecutively starting with SCREEN0.BMP

Scan functions

When using the Scan Function on TenuPol-5 the values obtained can be sent to the PC. Immediately after the Scan is finished, press the F5 key on your PC, and the numbers will be saved in a file called SCAN.DAT. This file can be imported into any spread sheet (Please see the manual for your spread sheet on details of how to import comma separated files), and used to create graphs of the current density curves. These graphs can then be saved and compared if necessary. As this file is generated in TenuPol-5 it will always have the same name. To save several Scans please remember to rename the first file before starting the second scan. Otherwise the file will be overwritten. It is also important to save the file directly after the scan, as soon as you go back to the method the data are lost.

Switch Box for TenuPol-5

TenuPol-5 can be used to control two polishing units. A Switch Box is available as an accessory.

Connecting the Switch Box

- Remove the plug from the polishing unit at the back of the control unit.
- Connect the plug from the Switch Box instead.
- Connect the cables from the polishing units to the Switch Box and secure the plug by turning the retaining ring.

Place the Switch Box in a convenient position.
Turn the selector switch to position 1 or 2 to swap between polishing units.

TenuPol-5
Instruction Manual

Specification	Code
<i>Specimen holders</i>	
For \varnothing 3 mm specimens	TETRI
For \varnothing 2.3 mm specimens	TETTO
For pre-thinning, diaphragm aperture \varnothing 10 mm	TETMA
<i>Jet holders</i>	
\varnothing 1 mm (for TETRI and TETTO)	TETOR
\varnothing 2.5 mm (for TETMA)	TETET
<i>Tape Kit</i>	
For electrolytic blanking of 3/2.3 mm specimens	TENKI
TenuPol-5, polishing unit	TENPO
Switchbox for connection of two TenuPol-5 polishing tables to a TenuPol-5 Control Unit	LECBO
PCB Connection Kit for data transfer between TenuPol-5 and a PC	LECPC
Accustop, specimen holder for accurate removal of material by manual grinding.	ASTOP
Insert for Accustop, For thinning of 3 mm dia. specimens. For electrolytic thinning on TenuPol.	ASTEN

3. Consumables

Electrolytes

Specification	
Electrolyte A2	Aluminium Iron Nickel Silver Steel Tin Titanium
Electrolyte A3	Martensitic Steel Molybdenum Titanium Vanadium Zirconium
Electrolyte A8	Stainless Steel Chromium Hafnium Nickel Titanium
Electrolyte AC2	Cast Iron Magnesium Nickel Steels
Electrolyte D2	Brass Copper Gold
Electrolyte E5	Brass Bronze Carbon Steel Cast Iron Materials with strongly varying structural elements

4. Trouble-Shooting

Error Messages or Problems		
The supply voltage is too low	The mains voltage is too low compared to the setting on the back of the control unit.	See section "Supplying power" on how to change the voltage settings.
No cell connection	There is no connection to the polishing unit.	Make sure that the plug from the polishing unit is connected to the back of the control unit.
Temperature above max. limit	The electrolyte temperature is above the pre-set limit.	Connect TenuPol-5 to tap water or to an external cooling unit and wait until the temperature is below the specified limit.
TenuPol-5 is switched on but the display is blank	The backlight of the display has been switched off, TenuPol-5 is in Sleep Mode.	Press any key to re-activate the backlight.

Electrolyte

- Check the age of the mixed electrolyte. The mixture should not be more than 3 months old.
- Check the number of polishings made with the electrolyte. The electrolyte can be worn out by too many polishings.
- Check that the correct combination of material and electrolyte is used.
- Check that the electrolyte is sufficiently cooled during operation.

Polishing circuit

- Check that all plugs are properly connected.
- Check that the stainless specimen holder contact part is intact and connected to the platinum strip.
- Check that the specimen holder is connected to the polishing chamber spring contact when mounted in the chamber.
- Check the voltage over the spring contact and the jet holder banana plugs (or the platinum wire in the jets).

5. Maintenance

Daily Service

Clean TenuPol-5 every day when you are finished working.

Polishing Unit

Residuals of the electrolyte used previously may spoil the following polishing. Therefore it is recommended to rinse the polishing cell and pump thoroughly before filling in a new electrolyte and at the end of every day.

- Go to **MANUAL FUNCTIONS** in the **MAIN MENU**.
- Select **CLEANING**.
- Follow the instructions on the screen.
- After the cleaning program has finished, use a damp cloth to wipe all accessible surfaces of the polishing unit including the inside where the electrolyte container is stored.
- Thoroughly wash all the specimen holders which have been used.

WARNING!

Do not use acetone or similar solvents.

TenuPol should not be left filled with electrolyte for an unnecessarily long time, as the submerged parts may be attacked.

Especially A-8 will shorten the life of the metal parts. Never turn the polishing unit upside down, particularly not when there is electrolyte in the pump, as this may trickle from the pump up to the motor and cause the axle to stick. Take care that the motor housing does not come in contact with the electrolyte.

If copper or copper alloys have been thinned, some copper may have deposited on the cathodes. This may be removed with a few drops of nitric acid before the rinsing.

Control Unit

Avoid spilling electrolyte on the cabinet or front plate of control unit. Clean the front plate with a damp cloth after use.

6. Technical Data

Subject	Specifications		
Safety Standard	IEC 204-1 / EN 60204-1 (VDE 0113)		
Software and Electronics	<i>Display:</i> 128 x 240 dots (16 x 40 characters) <i>Controls:</i> touch pad <i>Database:</i> 18 Struers methods + 200 user definable methods (non volatile)		
Power Supply	50/60Hz (max. load 4A) 50/60Hz (max. load 2A)	1 x 100V / 120V 1 x 220V / 240V	
Output voltage/current	Polishing	0 - 100V (0.1V steps) / 2.5A	
		Control unit	Polishing unit
Dimensions and Weight	Width	385 mm / 15.2"	270 mm / 10.6"
	Depth	350 mm / 13.8"	180 mm / 7.1 "
	Height	160 mm / 6.3"	276 mm / 10.9"
	Weight	14.7 kg / 32.4 lbs.	3.8 kg / 8.4 lbs.

7. Menu Overview

TenuPol-5
Menu Structure

