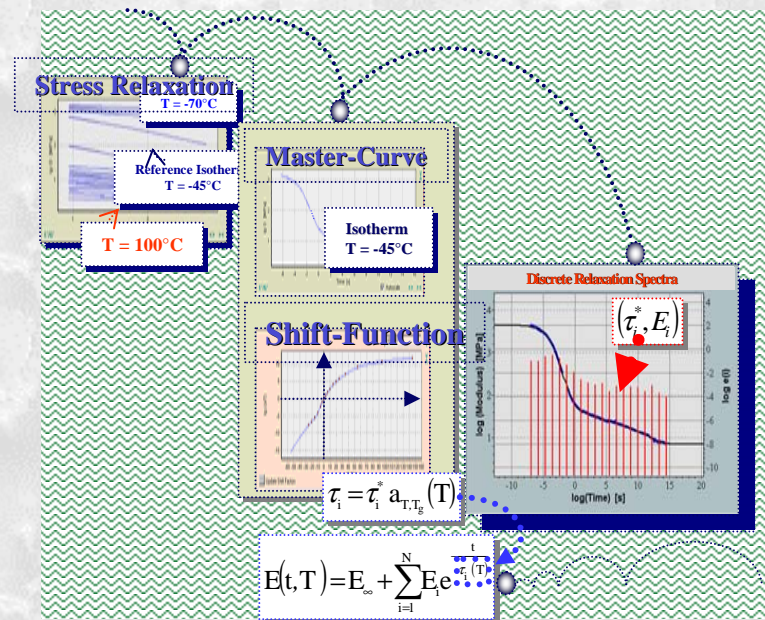


ViscoData_NEWS



Conception:
IBH

1

Preface

About this ...

2

What is ViscoData

Short Introduction

3

Output is compatible
with MSC.Marc Input

shown by using the
viscoelastic option in
MSC.MARC

Preface

Physical Evaluation Services ...about this ...

- This “**Bulletin**” provides NEWS about **ViscoData** software: how it is used in new applications or in connections with other high quality technical software tools.

INFO

ViscoData : An Introduction

The *ViscoData* software is a rapid user-friendly method to analyze data from frequency sweep or relaxation experiments to determine viscoelastic properties of engineering materials

ViscoData has been specifically developed for material developers and CAE-experts working in the field of soft materials like polymers (plastics and elastomers) needing a rapid and comprehensive evaluation procedure.

Master-curves of stiffness or compliance measurements in either time or frequency domain can be generated by the so-called preprocessor *ViscoShift*, an auxiliary software delivering appropriate data to be further evaluated by the main software, *ViscoData*. *ViscoData* is able to determine a discrete line spectra of relaxation time constants from master curves developed either from time domain experiments or frequency domain experiments. For example in the rubber industry often one needs informations about the peculiar viscoelastic properties to estimate the suitability of a given compound for a certain application. In the plastics industry, dynamic mechanical data is used for understanding the complex behavior of polymers over a wide range of frequencies/times.

The *ViscoData* software allows users to rapidly evaluate the data and to develop the interrelationship with ease. CAE-experts often need constitutive parameters to be able to perform complex Finite-Element Analysis of components made out of elastomers or plastics. The shifted master curves (done by *ViscoShift*) are fitted (done by *ViscoData*) using a novel algorithm, derived from so-called "Evolutionary-Strategy" concepts. This is accompanied by numerical analysis calculating the discrete relaxation and retardation spectra. The user has the choice to change the number of relaxation modes used in the analysis (Maxwell-Elements) when the fitness is not sufficient. A maximum of 40 relaxation modes can be calculated for the data sets.

This program has been developed as a general tool for performing visco-elastic analysis of a wide variety of materials that behave according to linear visco-elastic theory.

An appropriate manual provides a functional explanation of the programs working and does not fully explain the background research. Reference sources are given on which this software is based upon.

INFO

... the benefits of ViscoData

The greatest value of the software system presented with this is a quick and liable determination of the parameters of a discrete relaxation spectra of rubbers and plastics (called a Prony-series). Although the method used are generally restricted to non-cristalline polymers, applications to cristalline materials is possible within restricted temperature domains.

Last but not least it is needless to say that the concept of a Prony series is also applicable to other than polymer materials. For example metals, ceramics, glasses etc. are also candidates for the proposed concept, because they are as well visco-elastic materials in nature. For those materials usually the relaxation spectra is narrower (only few relaxation time constants are needed to represent the viscoelastic behavior of those materials) compared with elastomers. But never the less visco-elastic properties may be also important, especially under higher temperatures.

visit us at www.ViscoData.de

What are the benefits???

- ... For **MSC.Marc** Users it is now very easy to make use of the “**Viscoelastic**” option in **MARC**, because **ViscoData** provides directly the data needed for that material modelling options in **MARC**. On the following slides you may get an impression how easy it is done.
- ...the only thing you need is **ViscoData**, which provides you with all the required parameters. Of course you have your material's raw-data for example from a Stress-Relaxation Experiment (SRE) or from a Dynamical Mechanical Analysis (DMA) .Using those data in **ViscoData** you will be able in less than 10 minutes to continue your analysis with **MARC** having the right constitutive parameters without any further trouble.

ViscoData- NEWS(Bulletin)

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Window given by MSC.MARC/MENTAT

Chosen Material-Model

Neo-Hookean Constant (Glassy Value)

Command > *draw
Command > *material_type mechanical:mooney
Command > *material_value mooney:c10
Enter value for 'c10' : 500
Enter value for 'c01' : |

ViscoData_NEW

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Window given by MSC.MARC/MENTAT

MATERIAL PROPERTIES (CONT.-1)

NEW REM READ

NAME material1

COPY PREV NEXT EDIT

MORE MECHANICAL MATERIAL TYPE

- ◆ MOONEY
- ◆ OGDEN
- ◆ FOAM
- ◆ ARRUDA-BOYCE
- ◆ GENT
- ◆ SOIL
- ◆ POWDER
- PREVIOUS

MOONEY PROPERTIES

C10	373	TABLE
C01	0	TABLE
C11	0	
C20	0	
C30	0	
MASS DENSITY	1	
BULK MODULUS	0	

◆ DAMPING

◆ THERMAL EXP.

RATE EFFECTS

DAMAGE EFFECTS

◆ VISCOELASTIC

◆ RUBBER

◆ PHI

RESET REMOVE OK

EXPERIMENTAL DATA FIT TABLES

■ SHOW MODEL SHOW COMPOSIT

ID MATERIALS ORIENTATIONS

ELEMENTS ADD REM 0

ALL SELECT VISIBL OUTLINE

EXIST UNSEL INVIS SURFACE

SELECT SET END LIST (#)

RETURN MAIN

UNDO SAVE DRAW FILL RESET VIEW TX+ TY+ TZ+ RX+ RY+ RZ+ ZOOM IN SHORTCUTS

UTILS FILES PLOT VIEW DYN. MODEL TX- TY- TZ- RX- RY- RZ- BOX OUT HELP

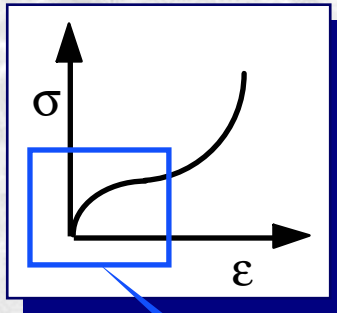
VISCOELASTIC option is also chosen

*ViscoData*_NEW

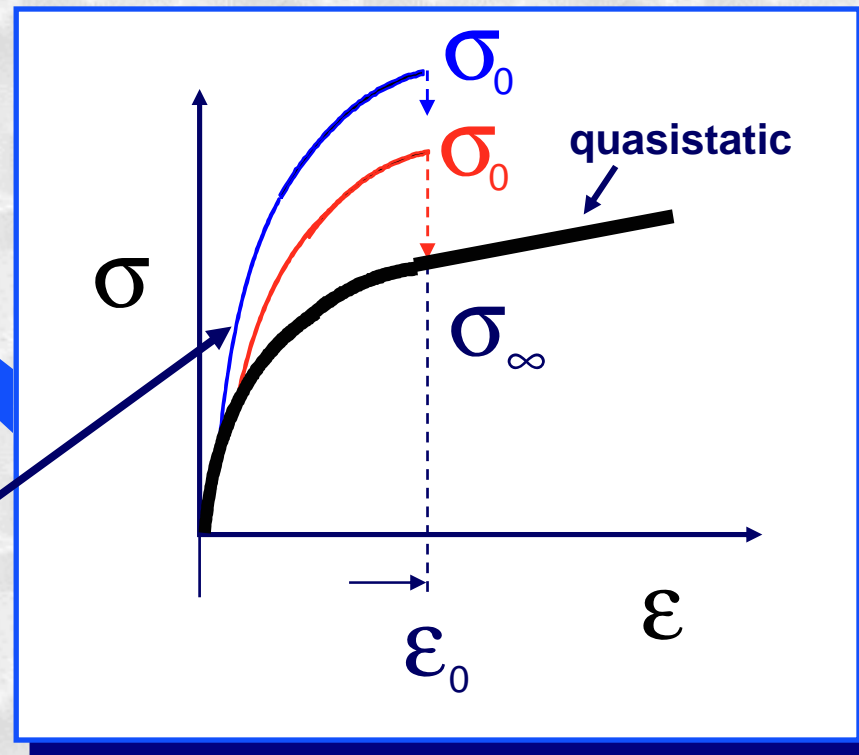
```
Command > *draw
Command > *material_type mechanical:mooney
Command > *material_value mooney:c10
Enter value for 'c10' : 500
Enter value for 'c01' : |
```

ViscoData- NEWS(Bulletin)

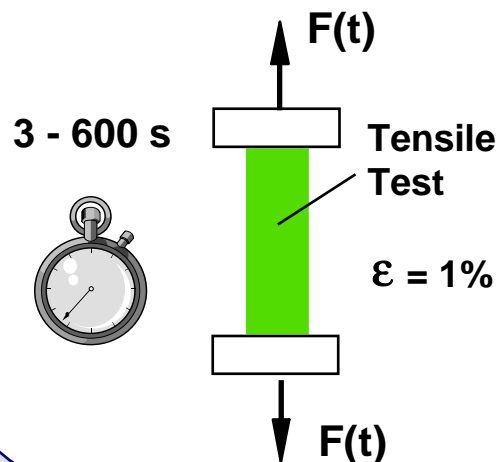
1. Quasistatic Loading



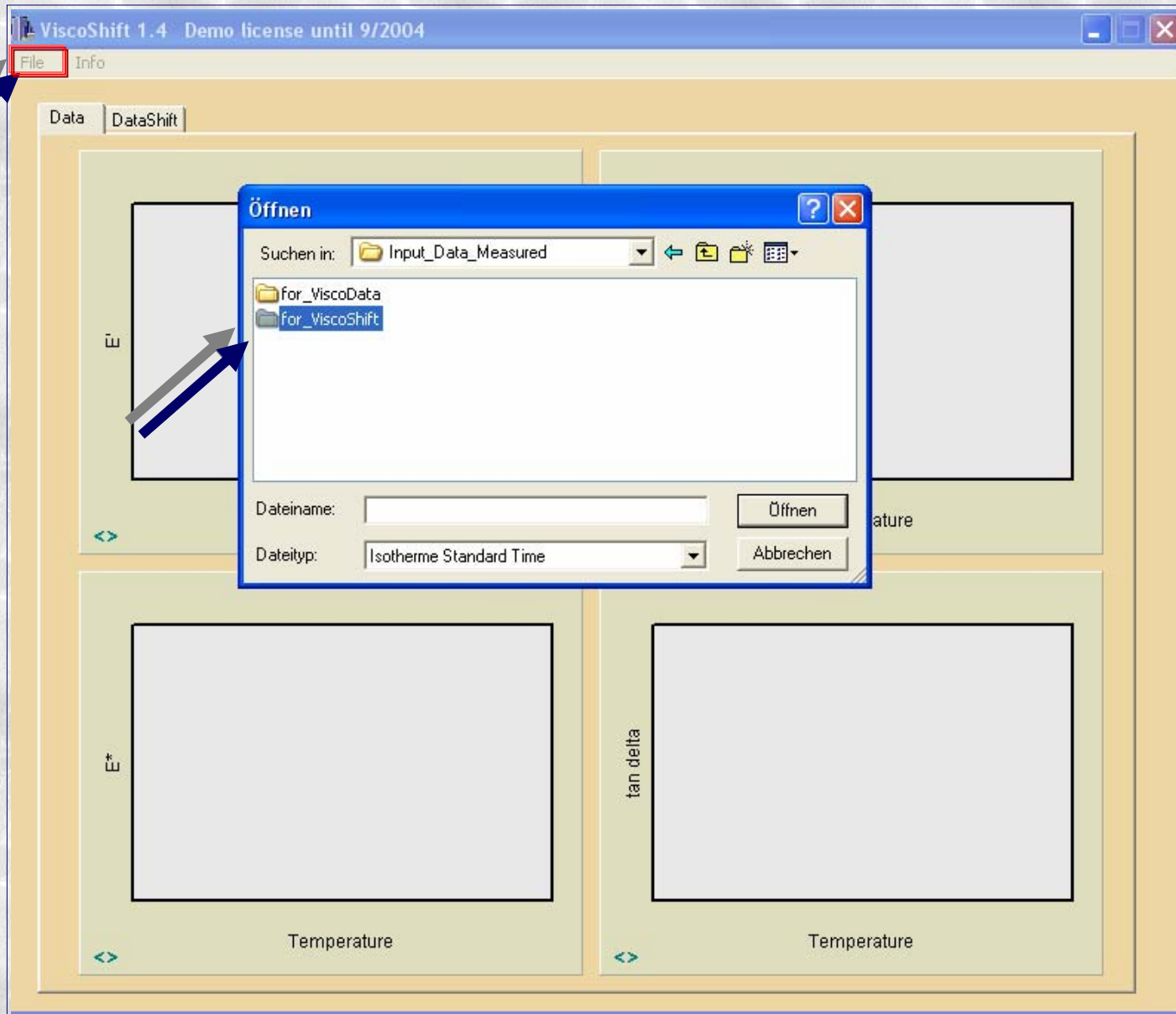
2. Relaxation after sudden loading



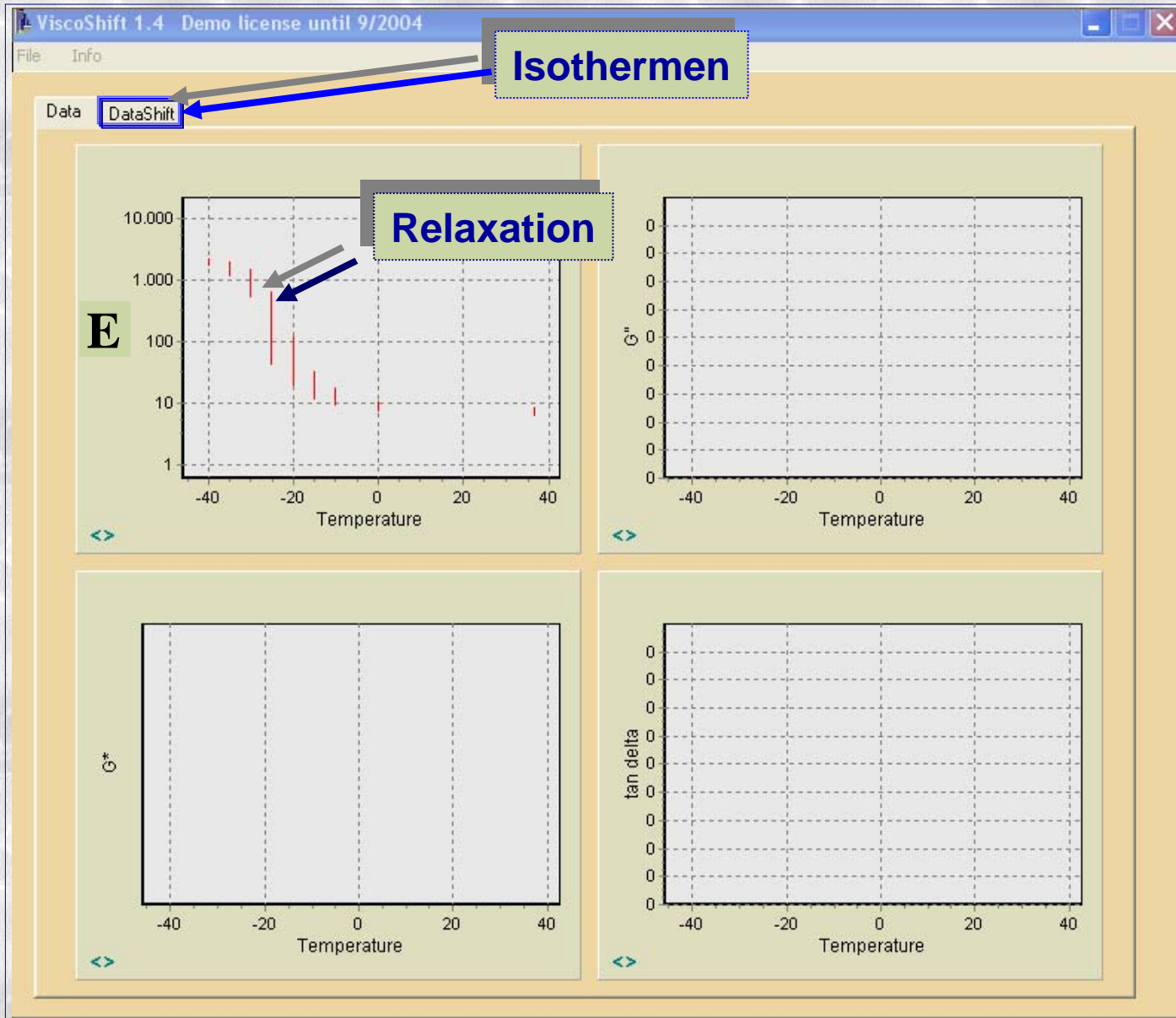
Relaxation Experiment



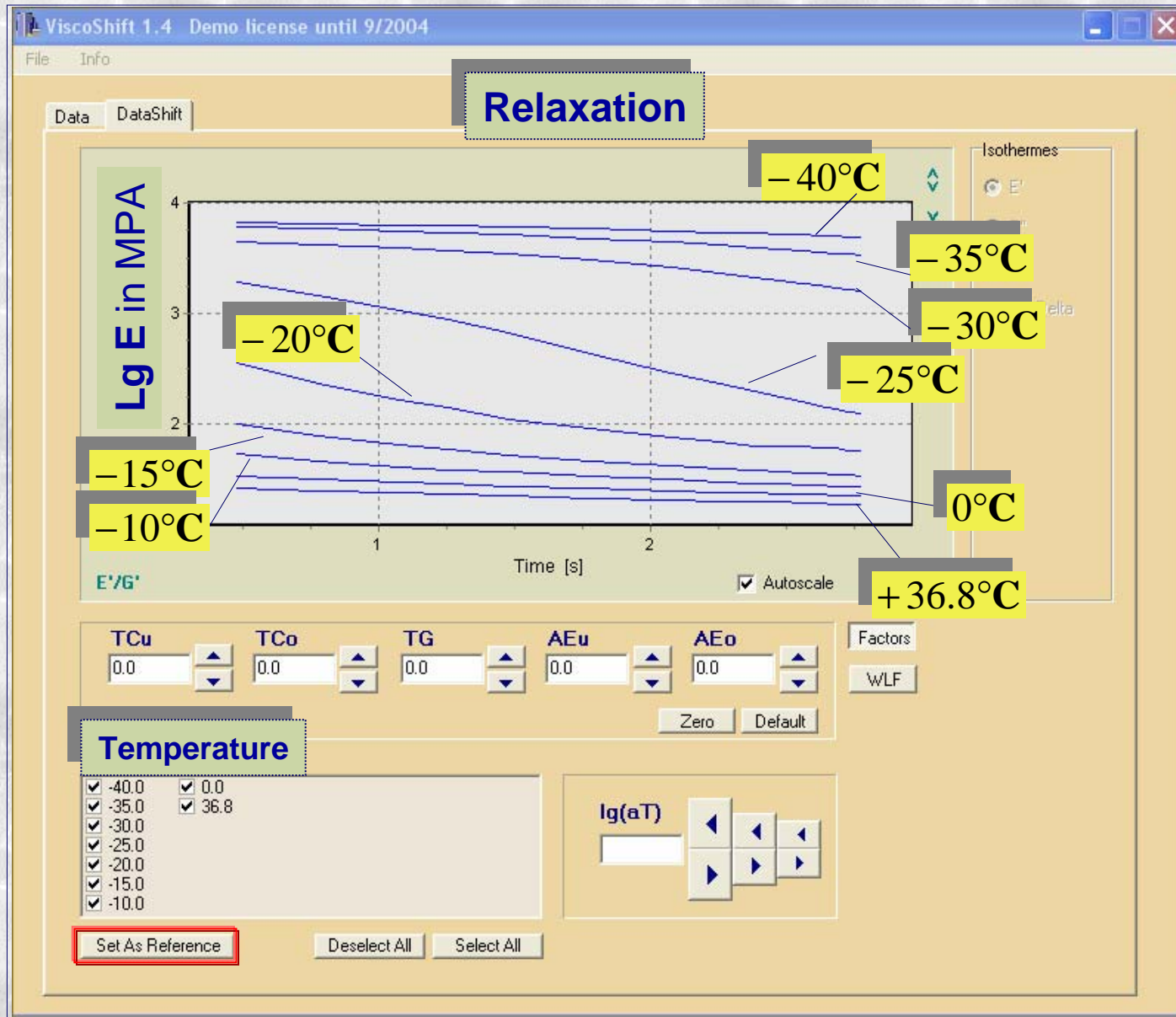
ViscoData- NEWS(Bulletin)



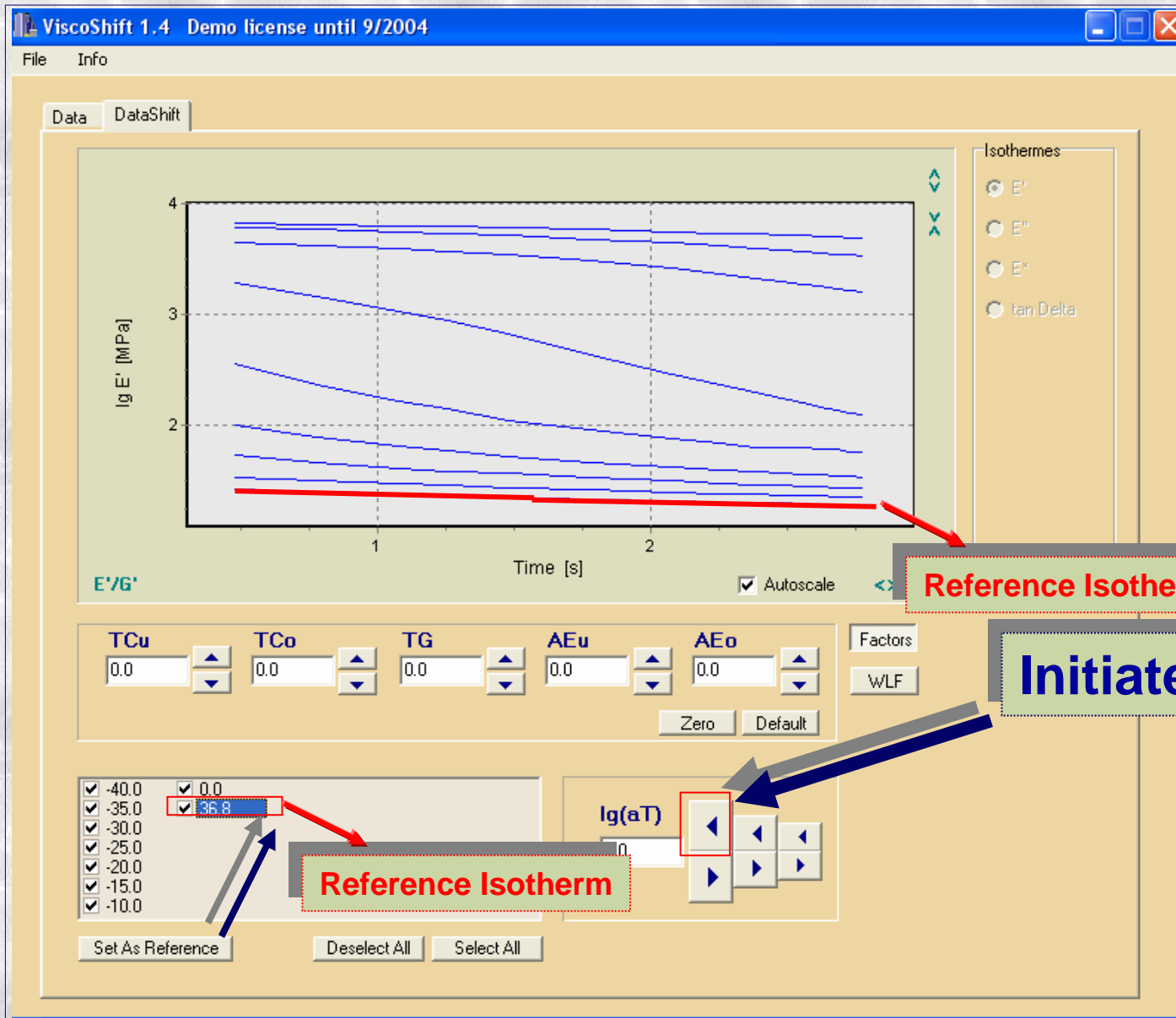
ViscoData- NEWS(Bulletin)



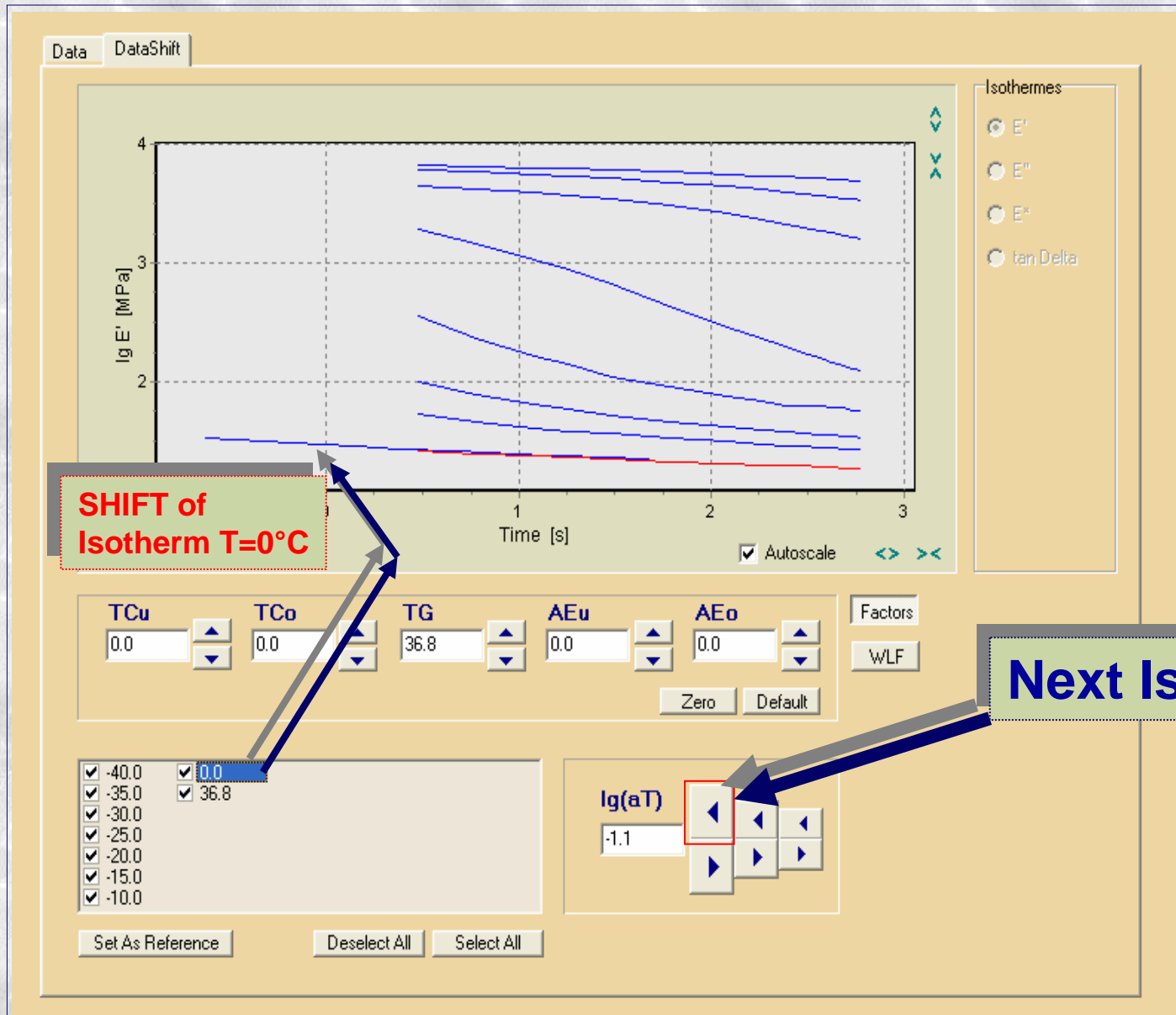
ViscoData- NEWS(Bulletin)



ViscoData- NEWS(Bulletin)



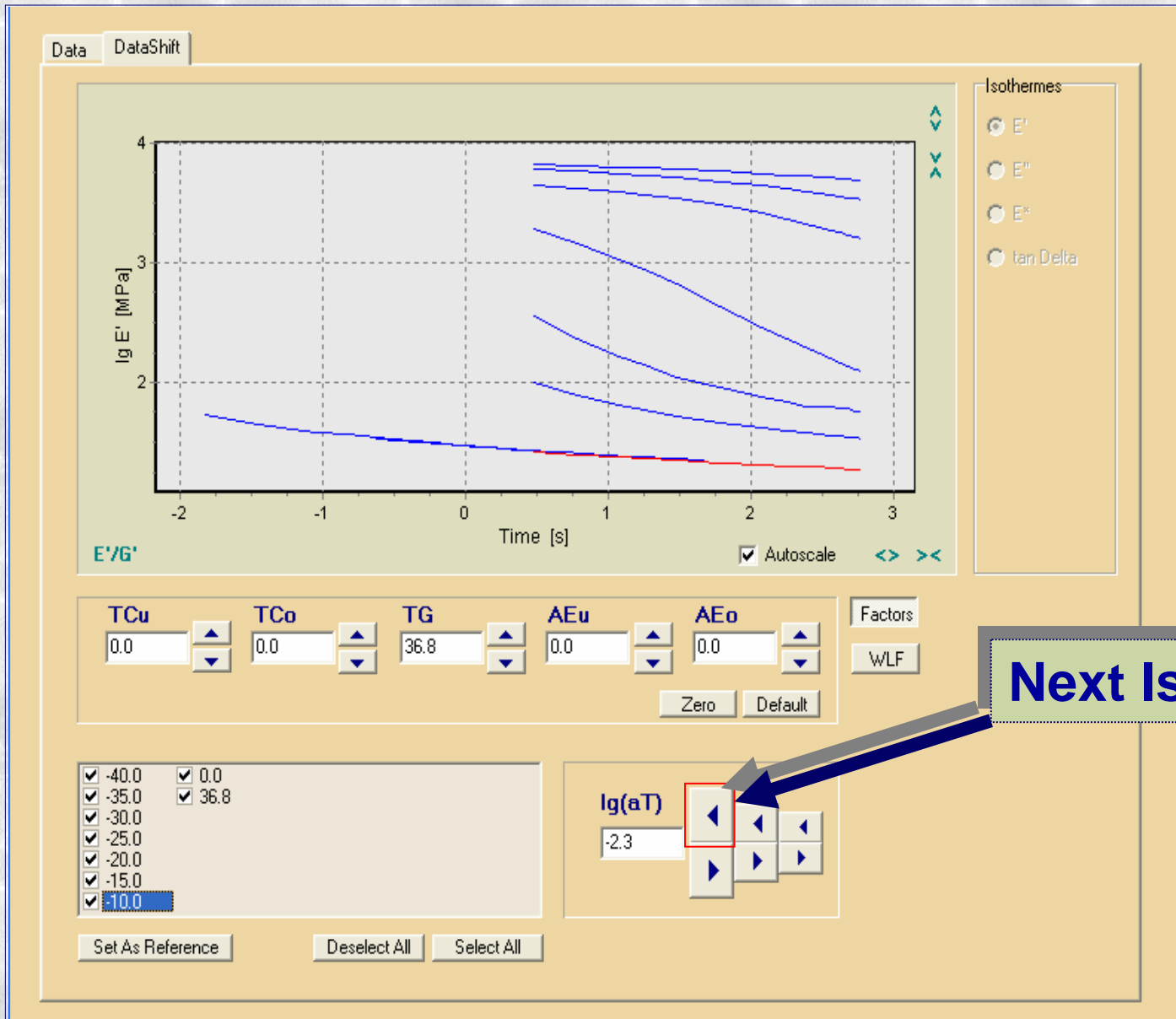
ViscoData- NEWS(Bulletin)



SHIFT of Isotherm T=0°C

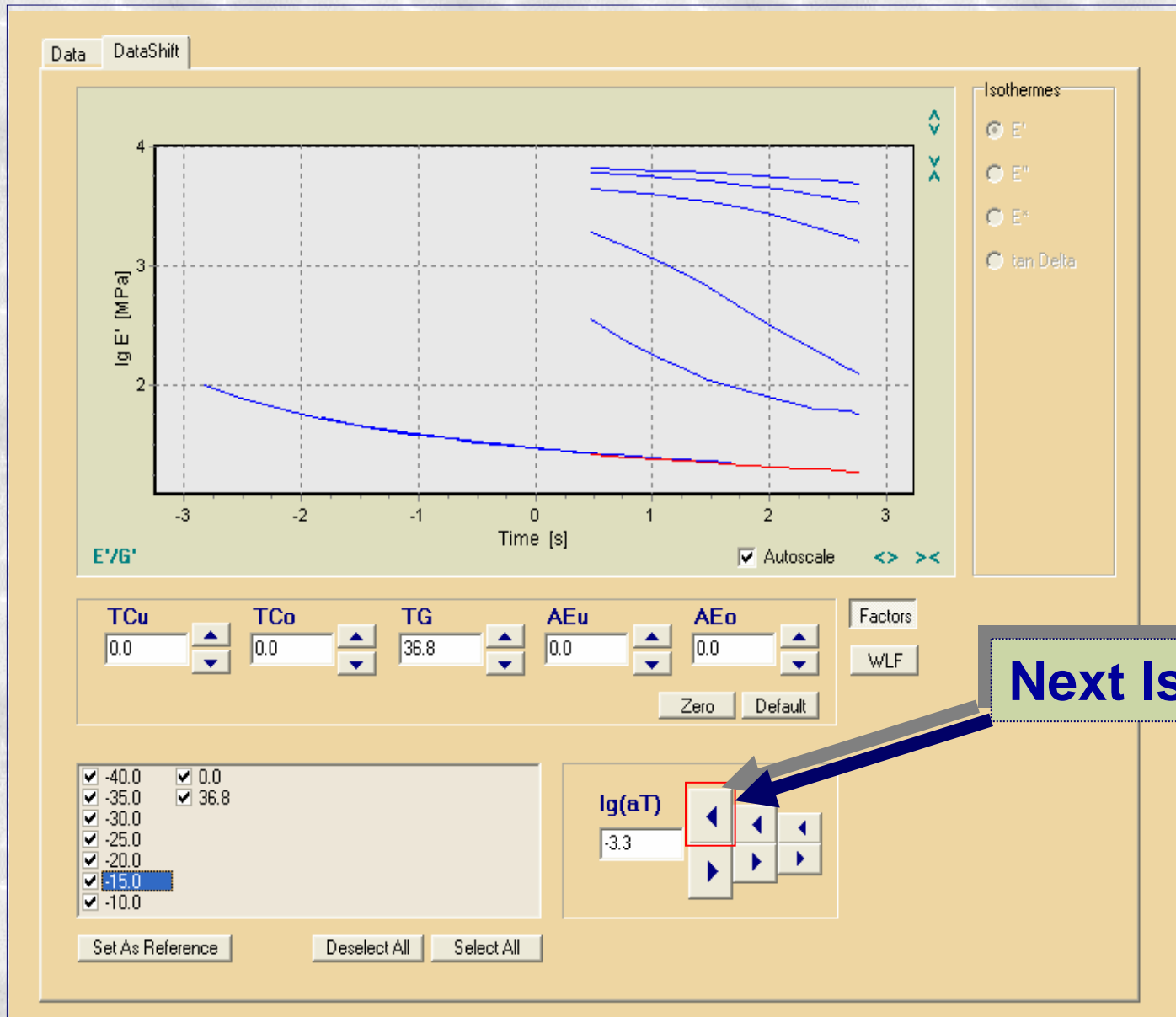
Next Isotherm

ViscoData- NEWS(Bulletin)



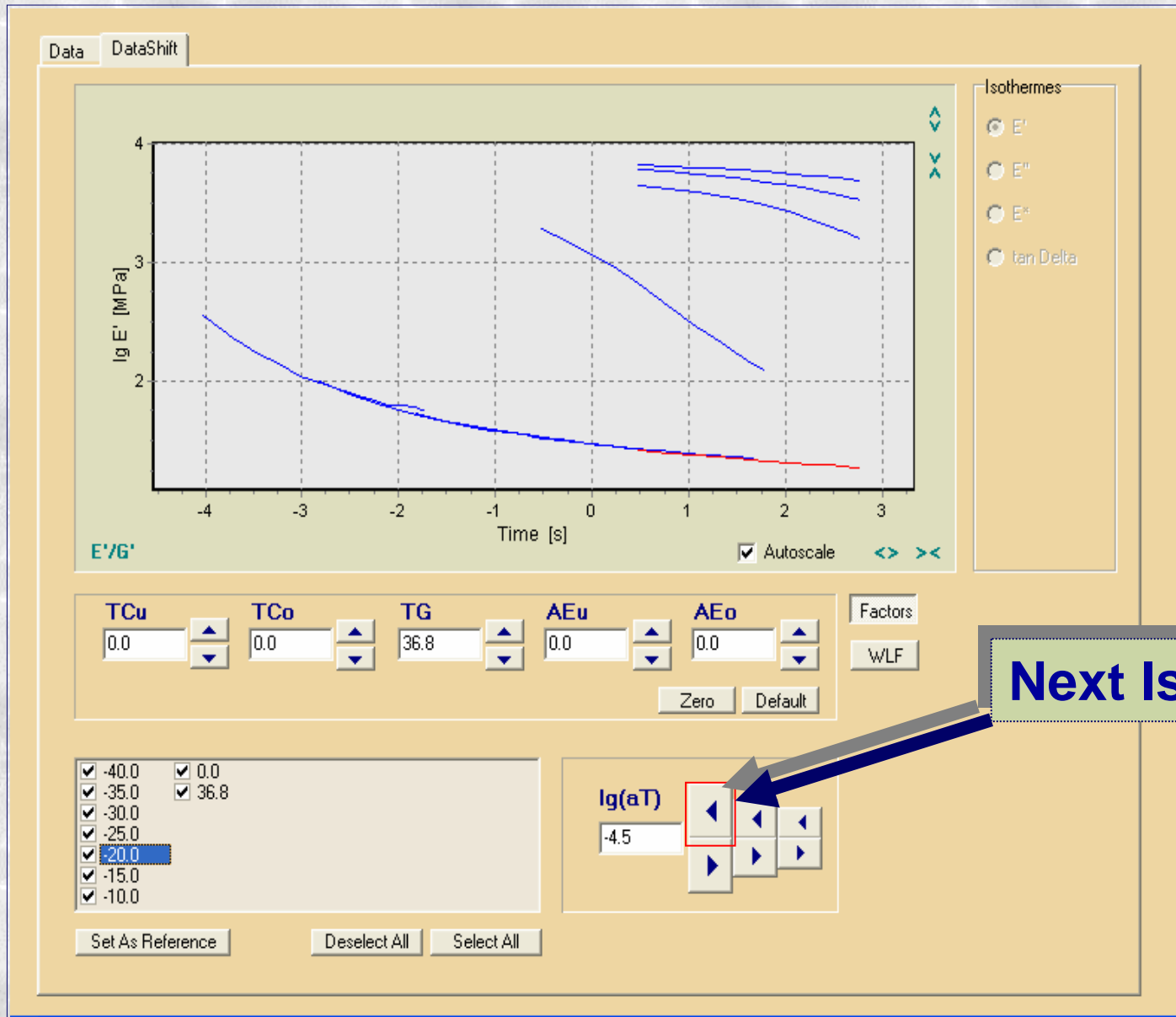
Next Isotherm

ViscoData- NEWS(Bulletin)



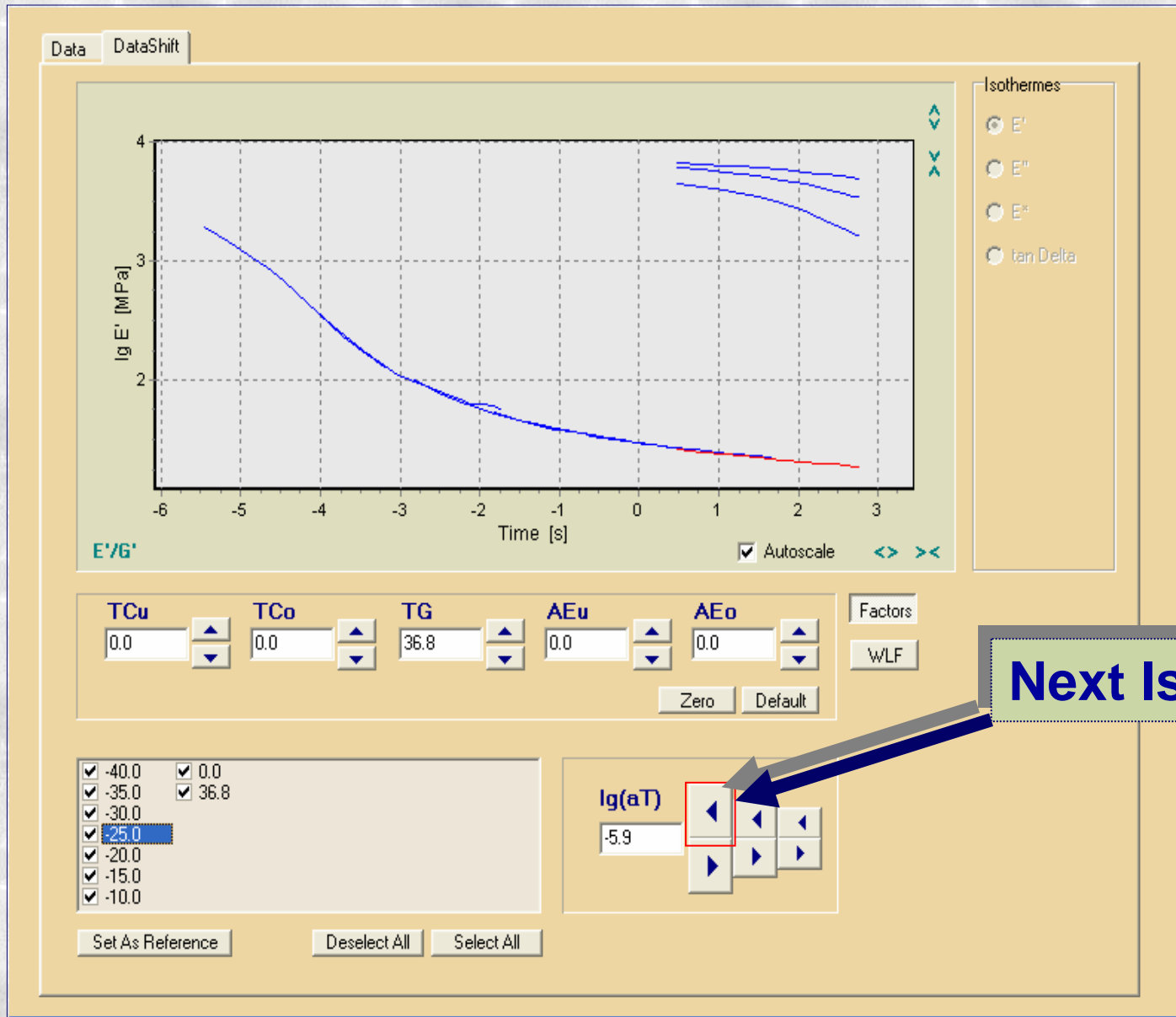
Next Isotherm

ViscoData- NEWS(Bulletin)



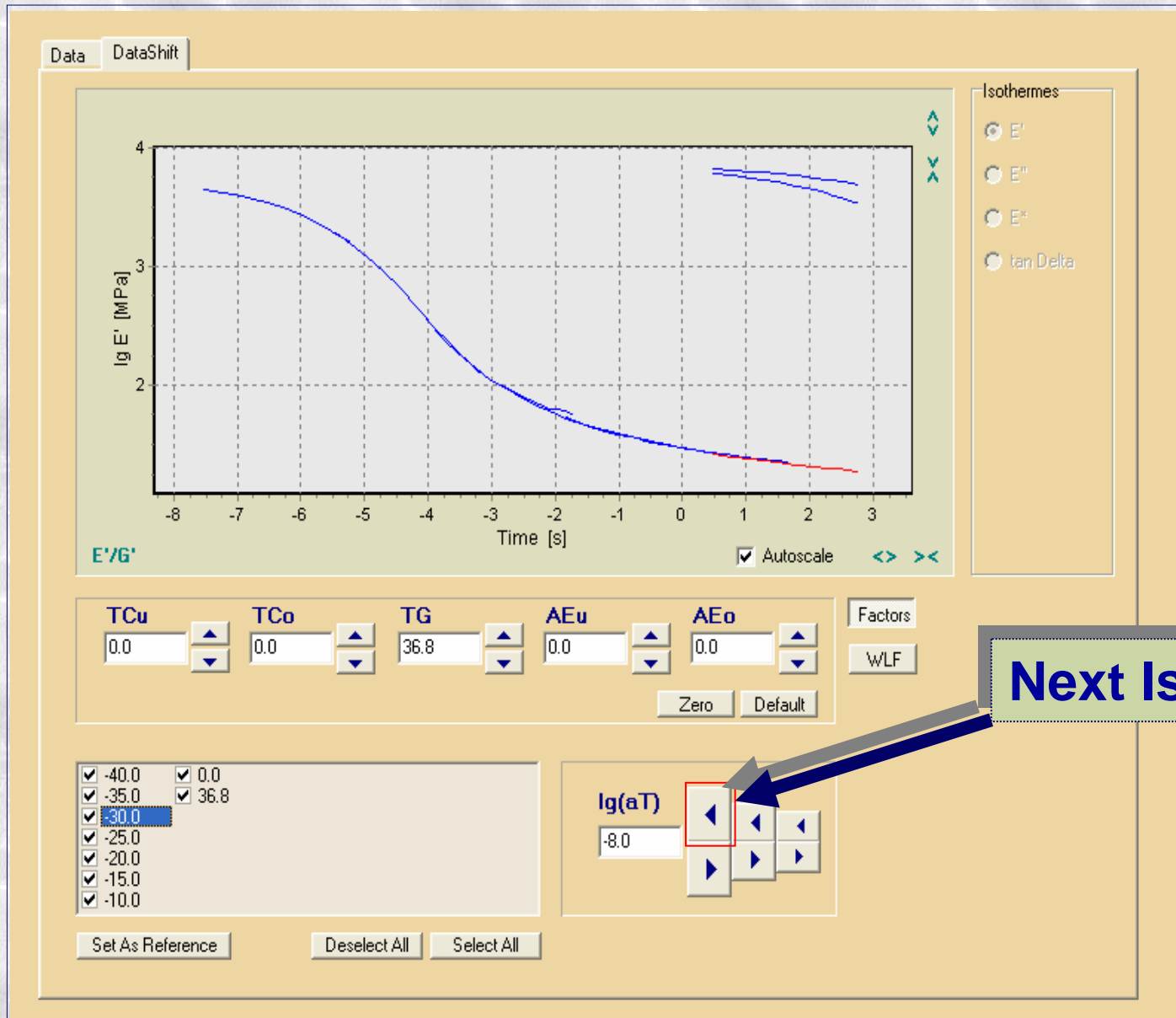
Next Isotherm

ViscoData- NEWS(Bulletin)

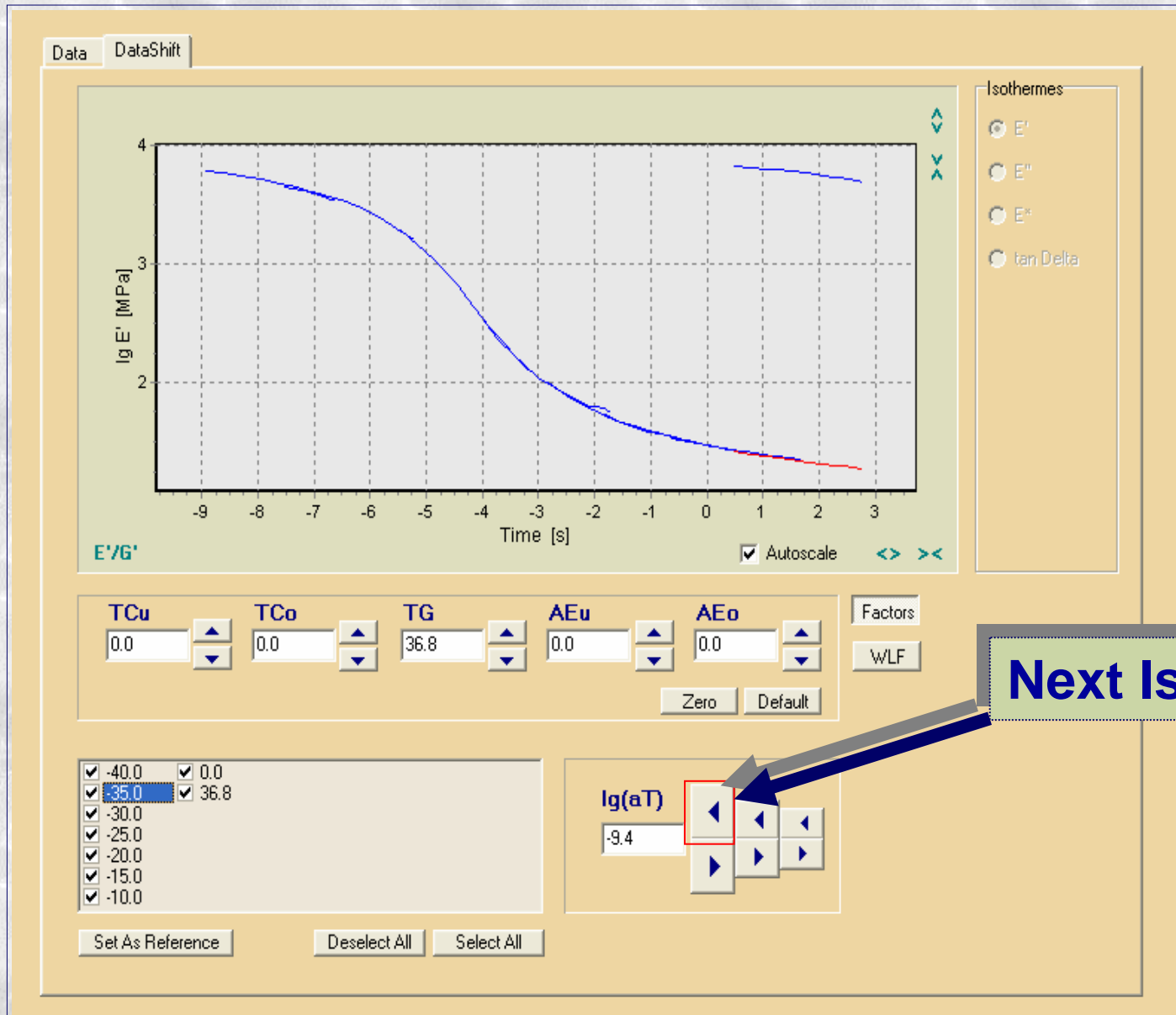


Next Isotherm

ViscoData- NEWS(Bulletin)



ViscoData- NEWS(Bulletin)

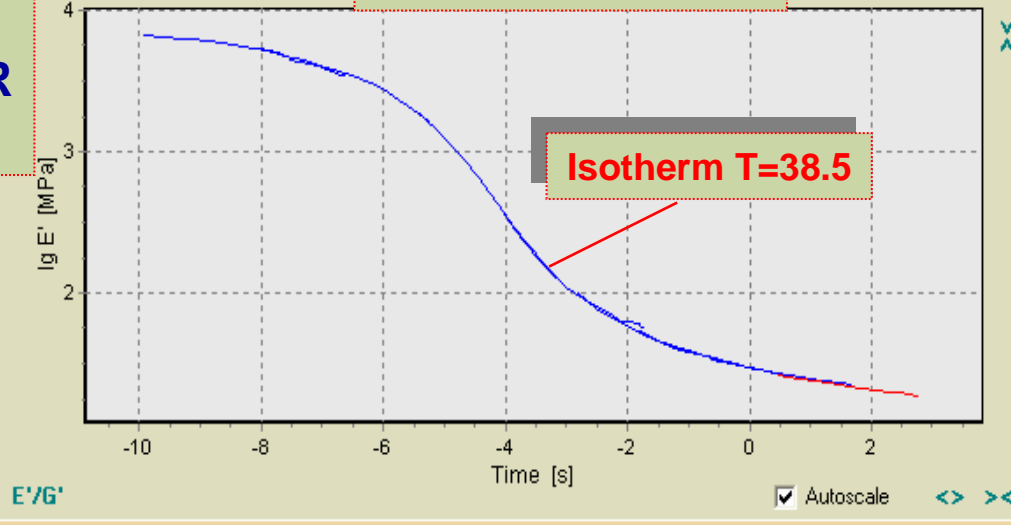


Next Isotherm

ViscoData- NEWS(Bulletin)

Store
MASTER
Curve

MASTER Curve



- Isothermes
- E'
 - E''
 - E''
 - $\tan \Delta$

TCu: 0.0 TCo: 0.0 TG: 36.8 AEu: 0.0 AEo: 0.0

Factors WLF

Zero Default

- 40.0
 - 35.0
 - 30.0
 - 25.0
 - 20.0
 - 15.0
 - 10.0
- 0.0 36.8

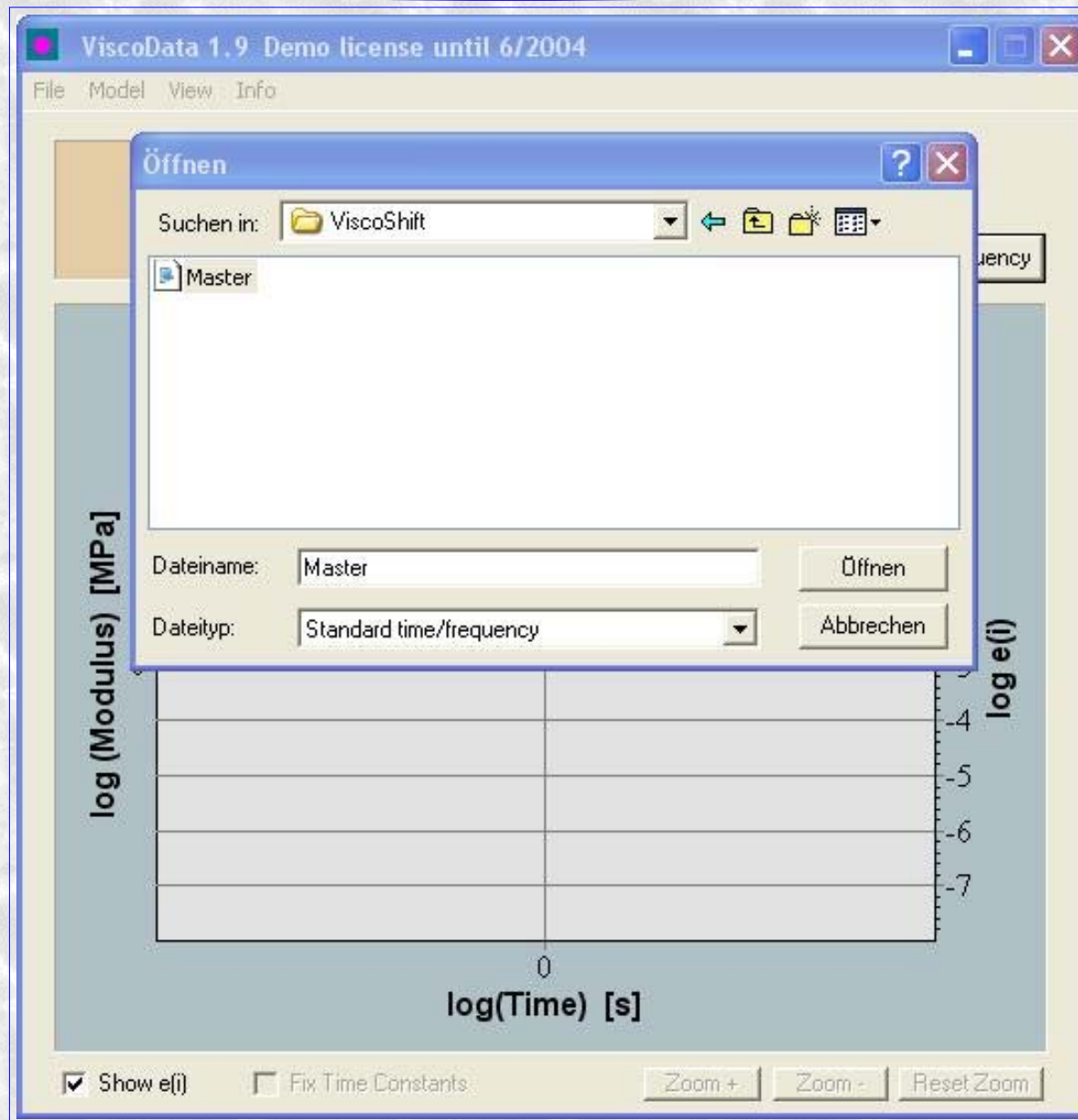
$\lg(aT)$

-10.4

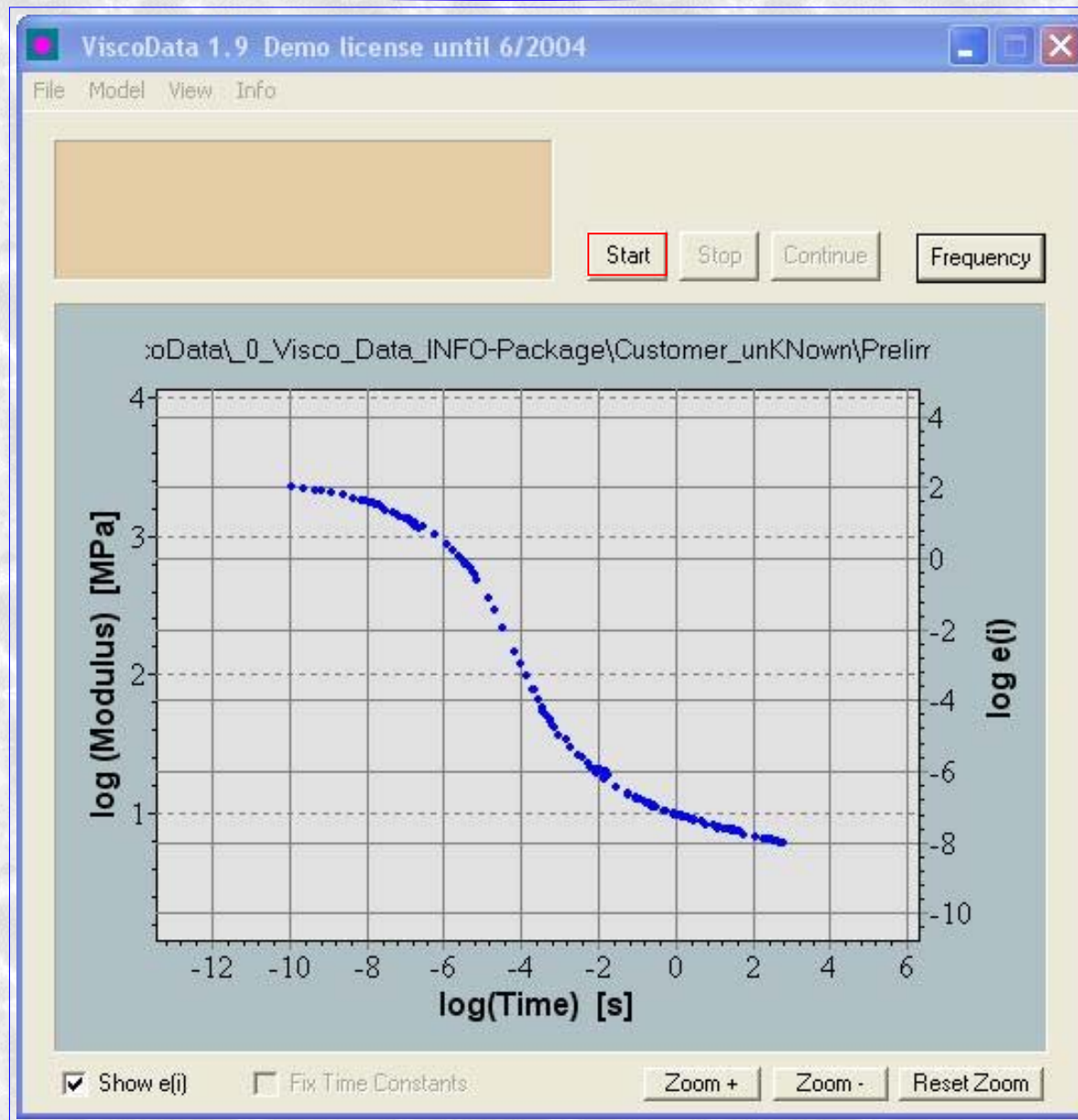
Set As Reference Deselect All Select All

Shifting
Completed!

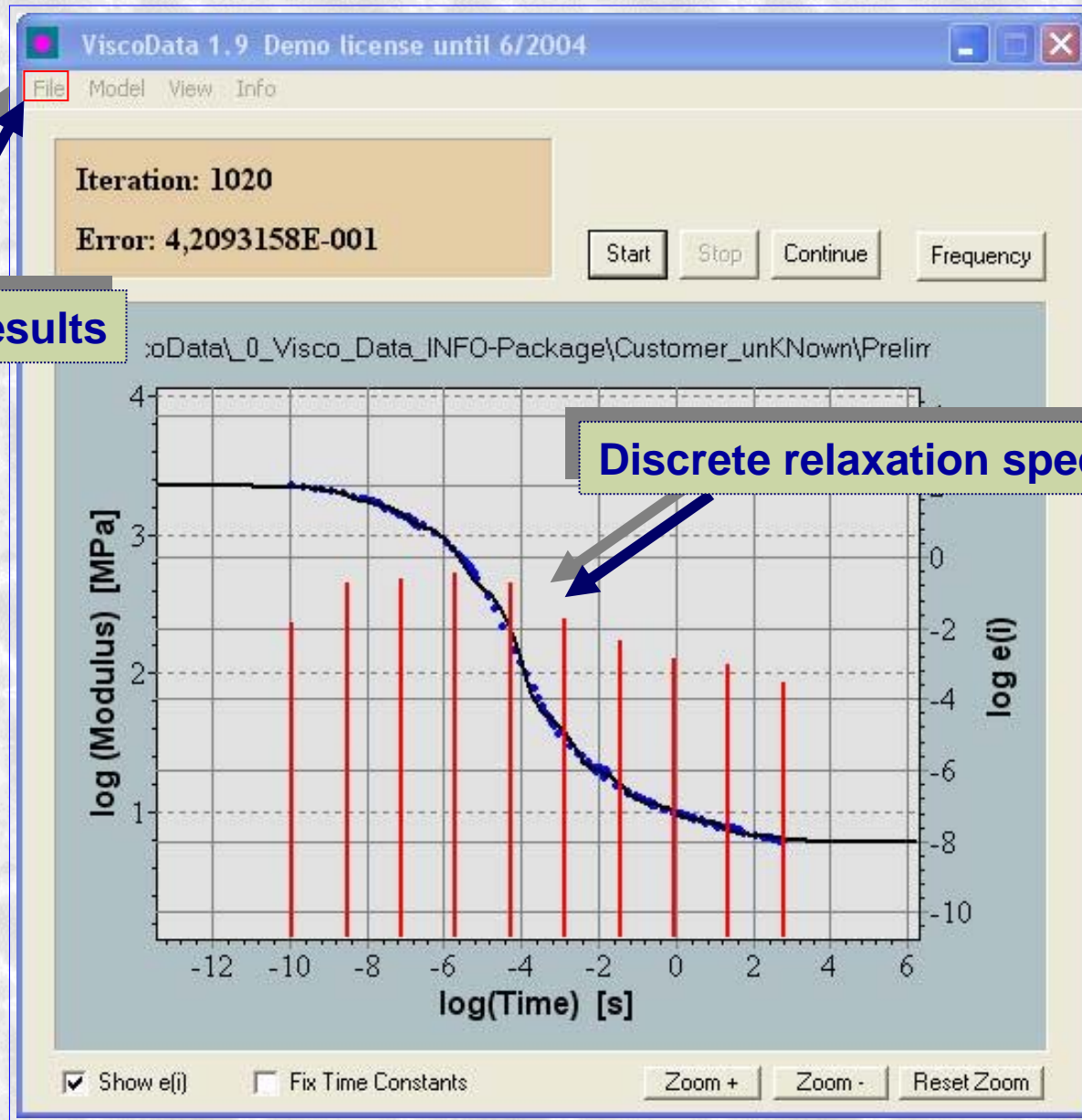
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ViscoData- NEWS(Bulletin)



ViscoData- NEWS(Bulletin)



Store the results

Discrete relaxation spectra

ViscoData- NEWS(Bulletin)

```
PRONY_n10 - Editor
Datei Bearbeiten Format Ansicht ?
G(zero)=2C10(t=0)=745 MPa      G(infinite)=2C10(t->unendlich)=2,06 MPa

Time constants      Coefficients
t(1)=1,89287E-10    e(1)=1,20280E-02
t(2)=4,63580E-09    e(2)=1,87549E-01
t(3)=1,13535E-07    e(3)=2,35016E-01
t(4)=2,78055E-06    e(4)=3,78165E-01
t(5)=6,80980E-05    e(5)=1,61590E-01
t(6)=1,66778E-03    e(6)=1,59418E-02
t(7)=4,08452E-02    e(7)=4,31039E-03
t(8)=1,00033E+00    e(8)=1,40865E-03
t(9)=2,44990E+01    e(9)=9,40013E-04
t(10)=6,00000E+02   e(10)=2,78267E-04
```


ViscoData- NEWS(Bulletin)

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Window given by MSC.MARC/MENTAT

MOONEY PROPERTIES

LARGE-STRAIN VISCOELASTIC PROPERTIES

TERMS 10

	TIME	ENERGY FUNC.	MULT.
1	1.89287e-010	1	0.012028
2	4.6358e-009	2	0.187549
3	1.13535e-007	3	0.235016
4	2.78055e-006	4	0.378165
5	6.8098e-005	5	0.16159
6	0.00166778	6	0.0159418
7	0.0408452	7	0.00431039
8	1.00033	8	0.00140865
9	24.499	9	0.000940013
10	600	10	0.000278267
11	0	11	0
12	0		
13	0		
14	0		
15	0	15	0

THERMO-RHEOLOGICALLY SIMPLE

RESET REMOVE OK

10 PRONY
Parameters are
used

Time constants	Coefficients
t(1)=1,89287E-10	e(1)=1,20280E-02
t(2)=4,63580E-09	e(2)=1,87549E-01
t(3)=1,13535E-07	e(3)=2,35016E-01
t(4)=2,78055E-06	e(4)=3,78165E-01
t(5)=6,80980E-05	e(5)=1,61590E-01
t(6)=1,66778E-03	e(6)=1,59418E-02
t(7)=4,08452E-02	e(7)=4,31039E-03
t(8)=1,00033E+00	e(8)=1,40865E-03
t(9)=2,44990E+01	e(9)=9,40013E-04
t(10)=6,00000E+02	e(10)=2,78267E-04

THERMO-RHEOLOGICALLY SIMPLE
Material option is used !

ViscoData_NEW

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MATERIAL PROPERTIES (CONT.-1)

NEW REM READ

NAME material1

COPY PREV NEXT EDIT

MORE MECHANICAL MATERIAL TYPE

- ◆ MOONEY
- ◇ OGDEN
- ◇ FOAM
- ◇ ARRUDA-BOYCE
- ◇ GENT
- ◇ SOIL
- ◇ POWDER
- PREVIOUS

EXPERIMENTAL DATA FIT TABLES

■ SHOW MODEL □ SHOW COMPOSITE

□ ID MATERIALS ORIENTATIONS

ELEMENTS ADD REM 0

ALL SELECT VISIBLE OUTLINE

EXIST UNSEL INVIS SURFACE

SELECT SET END LIST (#)

RETURN MAIN

MOONEY PROPERTIES

LARGE-STRAIN VISCOELASTIC PROPERTIES

TERMS 10

	TIME	ENERGY FUNC. MULT.
1	1.89287e-010	1 0.012028
2	4.6358e-009	2 0.187549
3	1.13535e-007	3 0.235016
4	2.78055e-006	4 0.378165
5	6.8098e-005	5 0.16159
6	0.00166778	6 0.0159418
7	0.0408452	7 0.00431039
8	1.00033	8 0.00140865
9	24.499	9 0.000940013
10	600	10 0.000278267
11	0	11 0
12	0	12 0
13	0	13 0
14	0	14 0
15	0	15 0

◆ THERMO-RHEOLOGICALLY SIMPLE

RESET REMOVE OK

UNDO SAVE DRAW FILL RESET VIEW TX+ TY+ TZ+ RX+ RY+ RZ+ ZOOM IN SHORTCUT'S

UTILS FILES PLOT VIEW DYN. MODEL TX- TY- TZ- RX- RY- RZ- BOX OUT HELP

```
Command > *material_value thermo_rheologic:wlf_c1
Enter value for 'wlf_c1' : 17.44
Enter value for 'wlf_c2' : *material_value thermo_rheologic:wlf_c2
Enter value for 'wlf_c2' : 51.6
Command >
```

ViscoData_NEWS

ViscoData- NEWS(Bulletin)

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Window given by MSC.MARC/MENTAT

MATERIAL PROPERTIES (CONT.-1)
NEW REM READ
NAME material1
COPY 1 THERMO-RHEOLOGICALLY SIMPLE PROPERTIES

MOONEY PROPERTIES
LARGE-STRAIN VISCOELASTIC PROPERTIES

SHIFT FUNCTION
WILLIAMS-LANDEL-FERRY
POWER SERIES
NARAYANASWAMY
USER SUB. TRSFAC

REF. TEMPERATURE 38.5

WILLIAMS-LANDEL-FERRY
C1 17.44
C2 51.6

POWER SERIES Ci	RELAXATION TIMES	WEIGHTING FACTORS
1 0	1 0	1 0
2 0	2 0	2 0
3 0	3 0	3 0
4 0	4 0	4 0
5 0	5 0	5 0
6 0	6 0	6 0
7 0	7 0	7 0
8 0	8 0	8 0

POWER SERIES
C0 0
TERMS 1

NARAYANASWAMY
ACTIV ENERGY / GAS CONST 0
STRUCT RELAX REF TEMP 0
FRACTION PARAMETER 0
ABS TEMPERATURE SHIFT 273.15
TERMS 1

RESET REMOVE OK

Command > *material_value thermo_rheologic:wlf_c1
Enter value for 'wlf_c1' : 17.44
Enter value for 'wlf_c2' : *material_value thermo_rheologic:wlf_c2
Enter value for 'wlf_c2' : 51.6
Command >

Chosen Reference Temperature

Constants of the Shift-Function (may be fitted by Shift-Factors or alternatively applied as universal constants as done here)

ViscoData_NEW

...**Viscoelastic Option in MARC** may be more often applied

...when an **easy to perform tool** like “**ViscoData**” is available !

ViscoData **NEWS**

... For further reference
Contact us

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Dr.-Ing. Michael Herdy

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D-14057 Berlin

Germany

e-mail: ViscoData@Herdy.de

<http://www.ViscoData.de>

visit us at www.ViscoData.de