



## ***Rheo F4***

**User's manual**

07/2015

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#### WARNING

The technical elements that constitute this manual (text and illustrations) are not contractual, their only target being to bring assistance for using the *Rheo F4*.

Use, duplication or disclosure of subject data, for any purpose other than relating to the use or servicing of the equipment, is strictly prohibited without the written authorisation of CHOPIN Technologies.





## DECLARATION OF CONFORMITY

We CHOPIN Technologies, address as below,  
declare under our sole responsibility that the following Apparatus :

### Rheo F4

When installed and used in accordance with the instructions in the Product Manual,  
is in conformity with the following standards :

- the EEC directive "Electromagnetic compatibility" 2004/108/EEC,
- the EEC directive "Low Voltage" 2006/95/EEC.



Emmanuel LECOMTE  
Conformance officer  
CHOPIN Technologies

Date :

09/2013



# 1 Introduction

## 1.1 Measurement principle

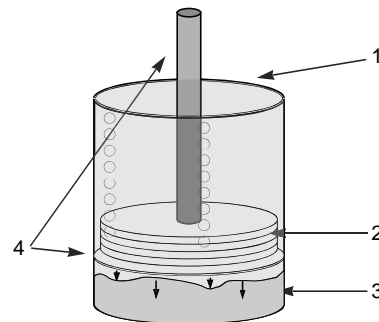
Development of wheat and rye products during baking depends both on the quantity of CO<sub>2</sub> in the dough aqueous phase and on the rheological properties of the actual dough.

This development depends both on the capacity of the protein network to be deformed under gas pressure and on the capacity of the dough to retain this internal pressure until thermal denaturation of the proteins and starch gelling. Measurement of flour proofing ability is thus linked to the quality of the dough protein network during its development.

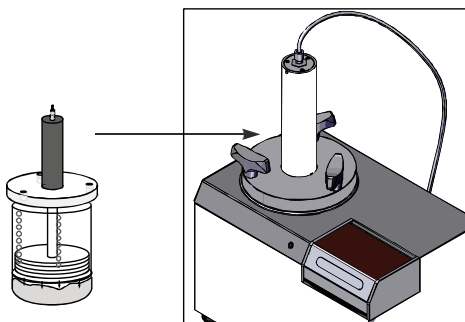
## 1.2 Operating principle

The Rheo F4 analyses the development of a dough sample placed in a test bowl and that will ferment under the conditions imposed by the protocol used (temperature, weights placed on it, etc.).

*Place the piston on the dough, which will rise progressively as it ferments. According to the test type conducted, the piston is loaded by weights.*



- |                   |          |
|-------------------|----------|
| 1 Proofing basket | 2 Weight |
| 3 Dough           | 4 Piston |

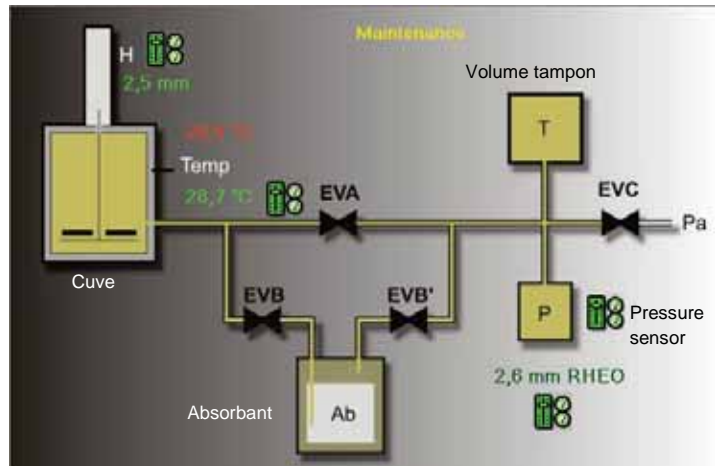


The piston is directly connected to a height sensor that will measure dough development. Moreover, the device bowl is connected to a pressure sensor by means of a pneumatic circuit that measures the pressure increase of the fermenting dough. The result of a test is thus made up of two plots: the dough development curve and the gas release curve.

The dough development curve is obtained by measurements taken at regular intervals by the dough development sensor.

To plot the gas release curve, the pneumatic circuit runs pressure measurement cycles. These pressure measurements are converted into flow rates by the microprocessor.

The cycle principle consists in measuring total gas release and gas release less its carbon dioxide trapped in the soda lime cartridge. The difference between the two gas release curves gives the quantity of carbon dioxide given off by the dough during the test.



● **Cycle description:**

1. Direct cycle

Electrovalves B and B' isolating the absorbent (soda lime cartridge) in the direct circuit are closed, as well as circuit bleed electrovalve C. Direct circuit isolation electrovalve A is open. Pressure increase due to swelling of the fermenting dough is measured by the electronic sensor.

2. Bleed cycle

Once the pressure measurement has been recorded, electrovalves A,B,B' are closed and electrovalve C opens to bleed the circuit and set it to atmospheric pressure. Electrovalve C then closes.

3. Indirect cycle

Direct circuit isolation electrovalve A and bleed electrovalve C are closed. Electrovalves B and B' isolating the soda lime cartridge and the indirect circuit are open. The increase in pressure due to dough swelling is measured without the carbon dioxide that has been trapped by the soda lime.

4. Bleed cycle

A new bleed cycle is run just as described in point 2.

5. A direct cycle is then activated and so on until completion of the time programmed in the protocol.



## 1.3 Device characteristics

### ● General characteristics

- Power supply: 220/240 Vac - 50 /60 Hz - 150 W
- Noise level: < 70 dB
- Dimensions: Width x Depth x Height: 415 x 265 x 545 mm
- Net weight: 12 kg
- Gross weight: 20 kg

### ● Fuse

Fuse 5x20 T 1.6A 250 V

### ● Environment

- Indoor use
- Storage temperature: – 25 to + 55° C
- Device usage temperature: 10 to 35° C

*Use: laboratory ambient temperature 3°C less than that of the protocol used.*



- Hygrometry: RH<85% at 20° C
- Fluctuation in supply voltage: < ± 10%
- Degree of pollution as per EN 61010: 2
- Installation category as per EN 61010: II (overvoltage category)
- Supply source characteristics:  
Connection by 2P + earth / 16A power socket  
The electrical network must comprise, upstream from the Rheo, an RCD with a sensitivity ≤ 30mA, class AC.

## 2 Installation and start-up

### 2.1 Unpacking

The device is protected by a specific packaging. We strongly recommend that you keep this packaging for transfers from workstation to workstation or for return for service (re-dispatching to CHOPIN Technologies or your distributor).



This packaging contains the Rheo F4 with its accessories.

## 2.2 Part lists

The Rheo F4 package contains the following parts in addition to the device:



Soda lime cartridge



500 gr weights and standard support piston assembly



Proofing basket



Power cable



Dough development sensor cable



Cable to computer



Bowl tightening nut



Temperature control support



Dough development sensor



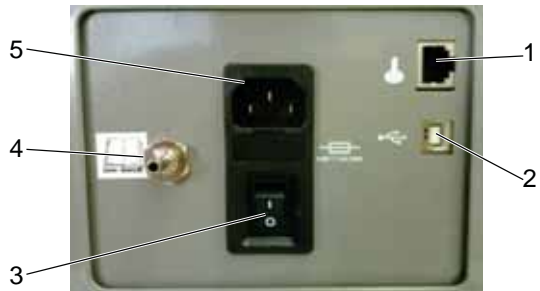
Pump



USB memory stick (user's manual and software)

## 2.3 Connections

The Rheo F4 has the following connections.



- |                                 |                           |
|---------------------------------|---------------------------|
| 1 Dough development sensor port | 2 Computer port           |
| 3 I/O switch                    | 4 Pneumatic circuit bleed |
| 5 Power supply port             |                           |



Connect the power cable to the supply port (5)



Connect the dough development sensor cable to the Rheo F4 using port RJ (1), then connect the other side of the cable to the dough development sensor.



The device must also be connected (2) to a computer.




Once all the connections have been made, press the I/O switch.

Please wait for the Rheo F4 peripheral to be fully installed, this can take a few minutes.



*If the installation is incomplete, double click the executable on the CDROM of the instrument.*

 CDM v2.12.00 WHQL Certified.exe

## 2.4 Installing the software

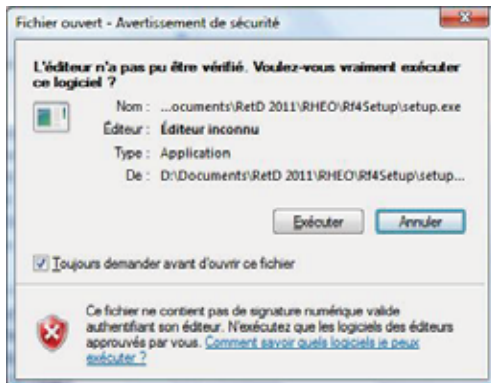


Before installing the software, please refer to the file "Read me first" available on the USB stick provided.

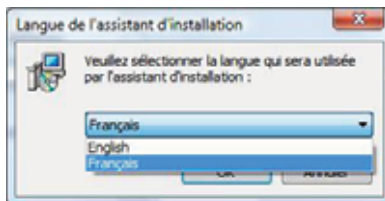
Plug the USB stick supplied with the Rheo F4 on your computer. Click on the software icon and then on setup.exe.



setup.exe  
Rheo F4 Chopin Setup  
Chopin Technologies



Click on [Exécuter].



Choose the installation wizard language and click on [OK].



Installation starts, click on [Next].



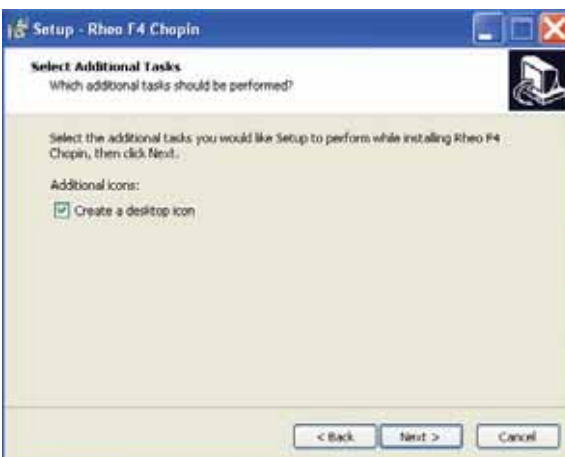
Accept the license agreement and click on [Next].



Choose the installation folder and click on [Next].



Choose the folder where the icon will appear in the start menu and click on [Next].



You can choose to create an icon on the desktop by ticking the box. Click on [Next] to validate installation.

## 2.5 Conditions of use

The Rheo F4 must be installed on a flat, clean and tidy bench.

The device must not be installed close to a water source (taps).

The device must not be exposed to sunlight or heat sources.



*Ambient temperature must be at least three degrees below the temperature of the protocol used.*

## 2.6 Start-up of the Rheo F4



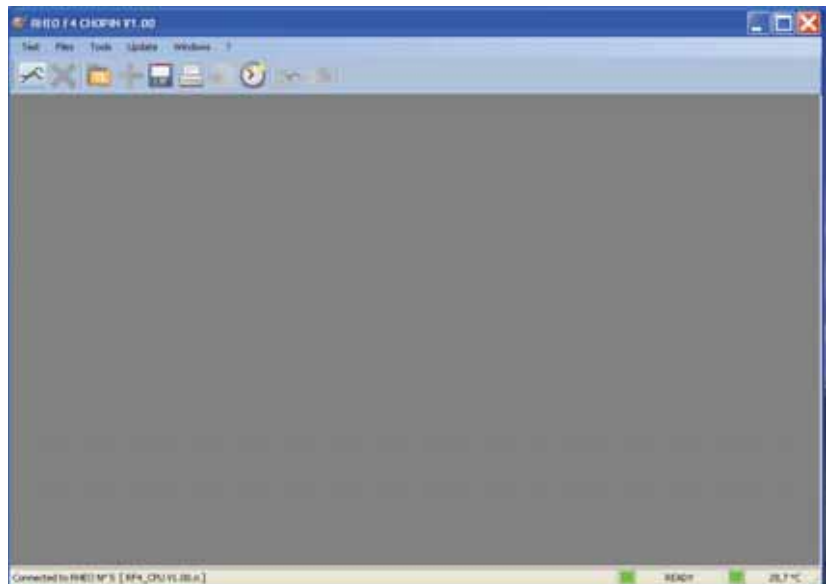
*The Rheo F4 is a measurement device.*

*To display and interpret results, it must be connected to a computer.*

Switch on the computer to which the Rheo F4 is connected. Once the operating system has been launched, start the software by clicking on the icon:



The software opens:



**Check that the device is connected to the computer.**

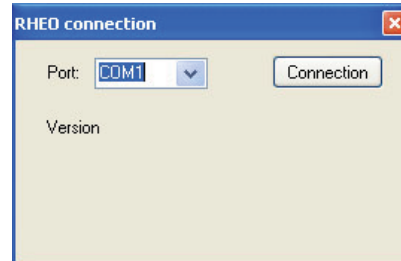


To access the connection configuration menu, click on the icon:



[Connection]

The following window is displayed:



Select the COM port corresponding to the connection of your device.



*If you do not know your connection port, you can try them one by one until the device is connected.*

Once connected to the device, the software displays the message at the bottom of the screen and enables the machine status LEDs.



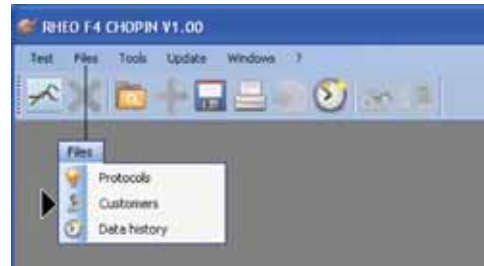
**The device is now ready to perform the tests.**

### 3 Use

#### 3.1 Preliminary parameter settings for running a test

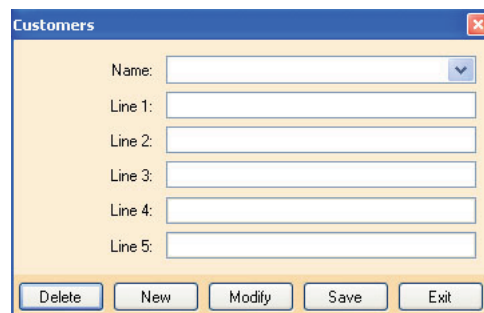
When using the software for the first time, we recommend you check the following parameters: customers, protocols and configuration.

- **Customer parameters**



To access customer parameters, click on the tab [Files] followed by [Customers].

The following window is displayed:



You can thus define your various customers by clicking on [New].



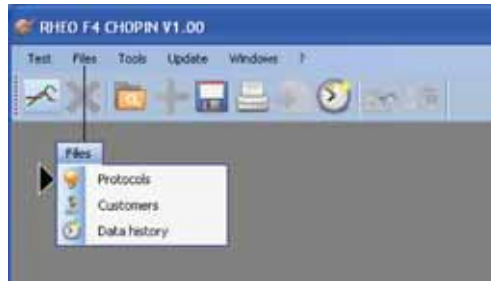
Enter the customer name and click on [OK]. You can now enter customer data using the 5 lines.

Click on [Save] then [Exit] once data entry is complete.



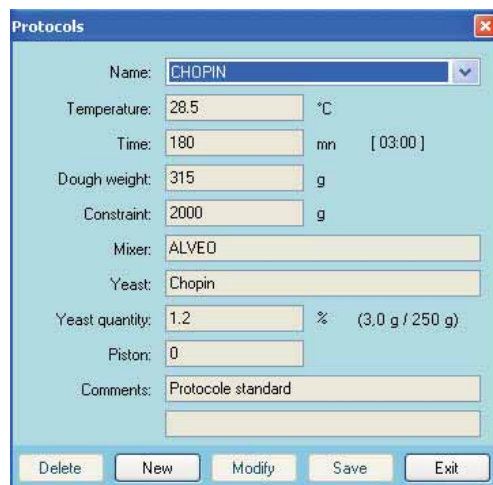
*Existing customer file can be deleted or modified using this window.*

● Protocol parameters



To access protocol parameters, click on the tab [Files] followed by [Protocols].

The following window is displayed:



You can thus define your own protocols by clicking on [New].



Enter the protocol name and click on [OK]. You can now enter the protocol values. These values are (in order):

- Test bowl temperature,
- test duration in minutes,
- weight of the dough sample used for the test in grams,
- load weight placed on the sample in grams,
- type of mixer used for dough kneading,
- type of yeast used,
- quantity of yeast in %.

Once the protocol values have been entered, press [Save] to save the protocol. Once the protocols have been entered, you can click on [Exit].



Existing protocols file can be deleted or modified using this window.



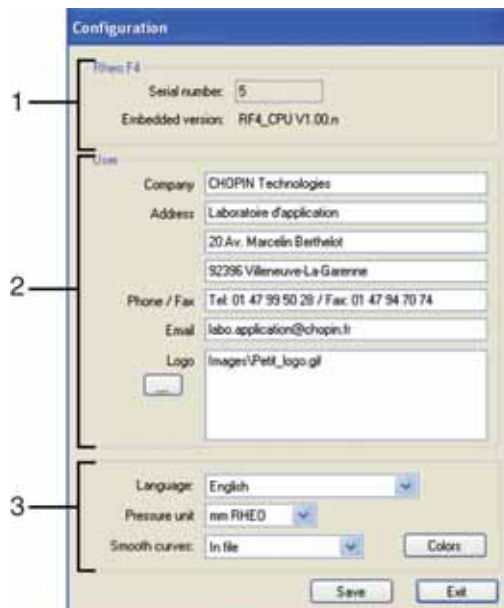
You cannot edit the CHOPIN protocol. When this protocol is selected in the drop-down menu, you cannot click on [Delete] or [Modify]

● Configuration parameters



To access the configuration parameters, click on the tab [Tools] followed by [Configuration].

The following window is displayed:



The Rheo F4 section (1) gives the device serial number and the version of the embedded software.

The User section (2) lets you enter your personal information such as your address, phone and fax numbers, and lets you choose a picture for the logo.

Section (3) lets you choose the software language, the pressure unit, and the curve smoothing process.



You can also change the curve colors by clicking the button [Colors].

The window (*opposite*) summarises the list of curves and their color.

Click on the curve colors box to bring up the color selection window. You can choose the color you want for each curve.



Once you have entered and/or selected the configuration parameters, press [Save] then [Exit].

### 3.2 Preparing the test



First check that the soda lime cartridge is not saturated. The marking indicates the saturation level limit in CO<sub>2</sub>. (See [4.1 Replacing the soda lime cartridge](#)).



Prepare the dough as per the relevant protocol (e.g. CHOPIN, see [Appendix 3](#)) then place it at the bottom of the basket and manually pack it down at regular intervals. Height in the basket must be even, just below the first lower holes.



Then place on the piston the load weight defined by the protocol, i.e. 2kg for the CHOPIN protocol.



Place the piston and the weights on the dough.



Place the dough development sensor and hermetically close the assembly. The lid must be closed with nuts in a regular and balanced manner.

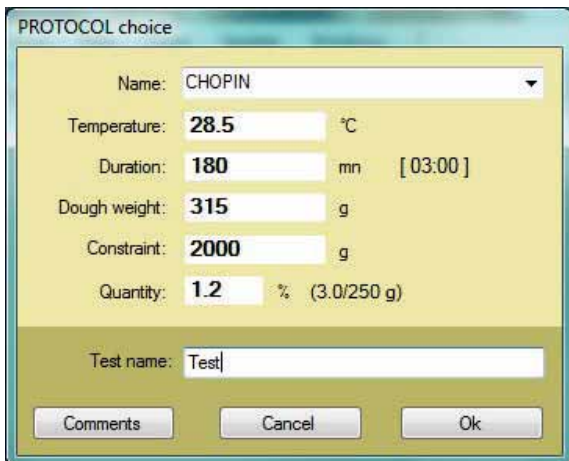
**The sample is ready to be analysed.**

### 3.3 Starting the test

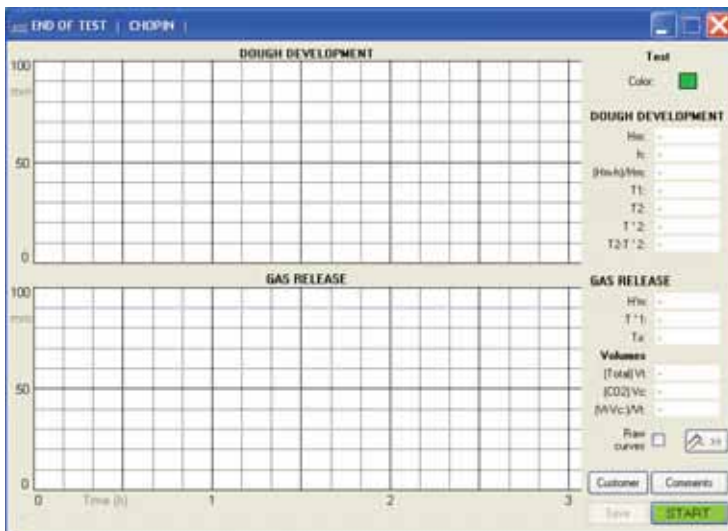


To access the test window, go to the tab [Test] then click on [Start].

You can also access it directly by clicking on:

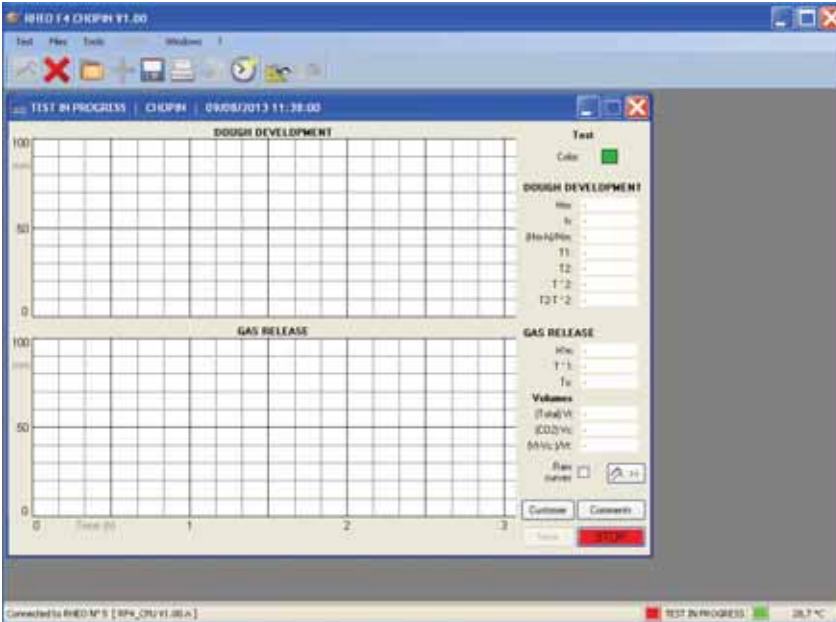


The following window lets you choose the test protocol, and gives its main parameters, as well as name the test and enter a comment. Click on [OK] to access the test window.



The test window is displayed. To start the test, click the [START] button.

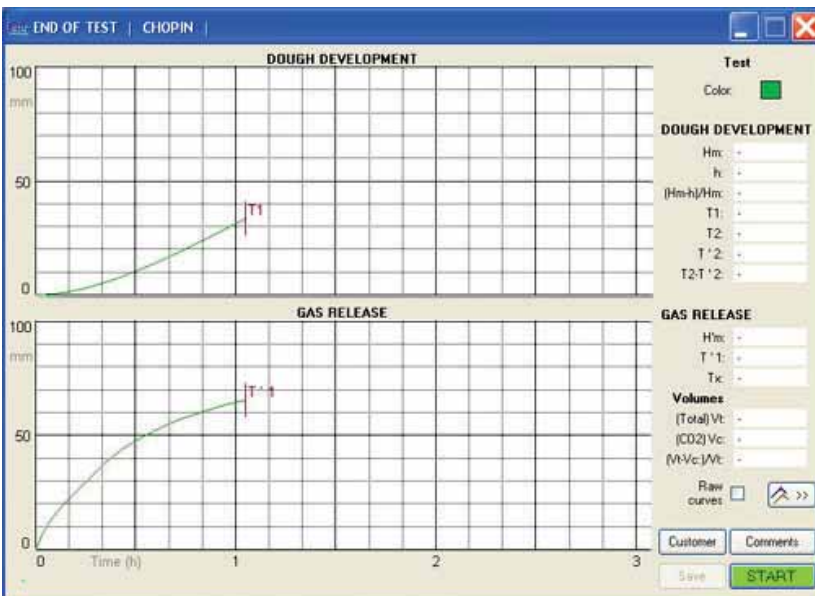
The test starts, the [START] button becomes the [STOP] button and changes from green to red. The first LED in the bottom right-hand corner of the software screen moves to red and indicates that the device is in the test process.



### 3.4 Checking the test procedure

During a test, you can display:

- The results in real time.
- Process progression.



You can monitor pending test in real time on the curve.

To compare pending test with a reference curve, click on:

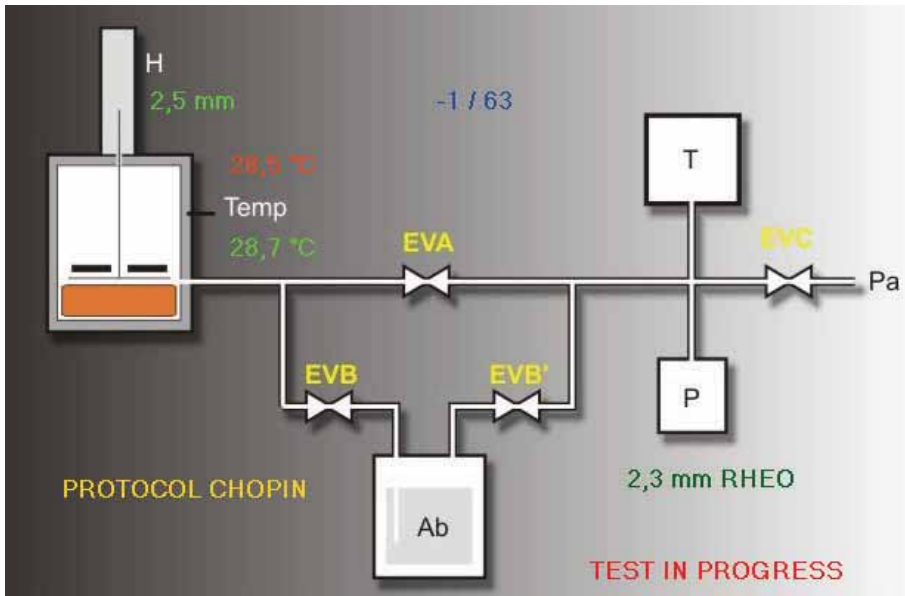




To display the test process diagram, click on the button:



[Display]



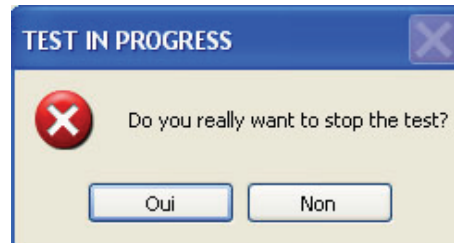
This window displays the operation of the Rheo F4.

You can display the current cycle, temperature stability, electrovalve status, etc.

You can stop the test at any time by clicking the button:



[Stop]



Confirm the stop and let the pneumatic system bleed.



The "empty bowl" window is automatically displayed at the end of each test. Click on [OK].

### 3.5 End of test and cleaning of the Rheo F4

The Rheo F4 will bring up a warning screen to inform you that the test is finished. You can save the test by clicking the button:

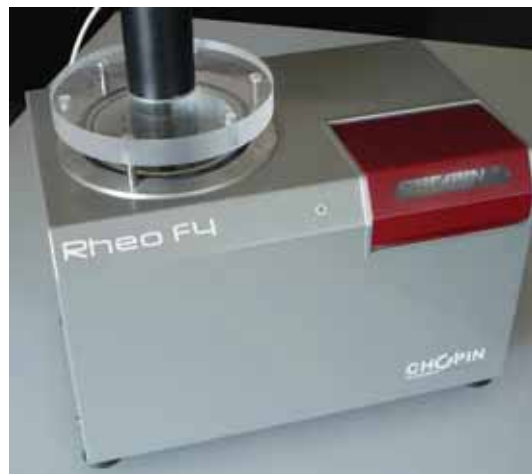


After the test and before conducting a new test, you must clean the Rheo F4.

The bowl, the perforated basket and the weights must be kept clean at all times. After each test, clean the basket and the weights using a damp sponge. The bowl must be cleaned using a damp cloth to prevent water entering the pressure tap at the bottom of the bowl. In particular thoroughly clean the bowl rubber seal and the lid surface.

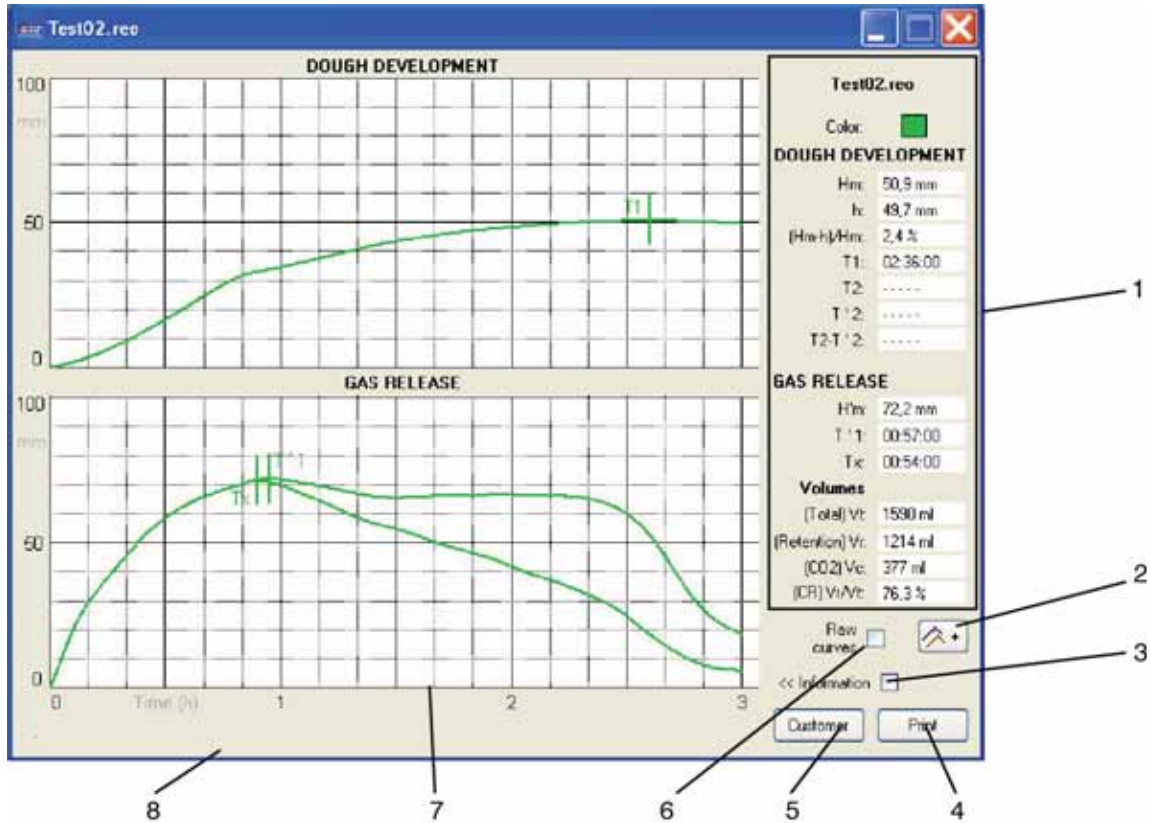


**After each test, use a dry cloth to wipe all potentially damp parts that could prevent the device from operating properly. Check that the soda lime in the absorption cartridge is not saturated (blue color). For more information, refer to the maintenance manual. When the device is not in use, never hermetically close the bowl. To avoid condensation, let the lid rest on the studs.**



### 3.6 Test analysis

Based on the test conducted or on recorded tests, you can display the results and compare several tests.

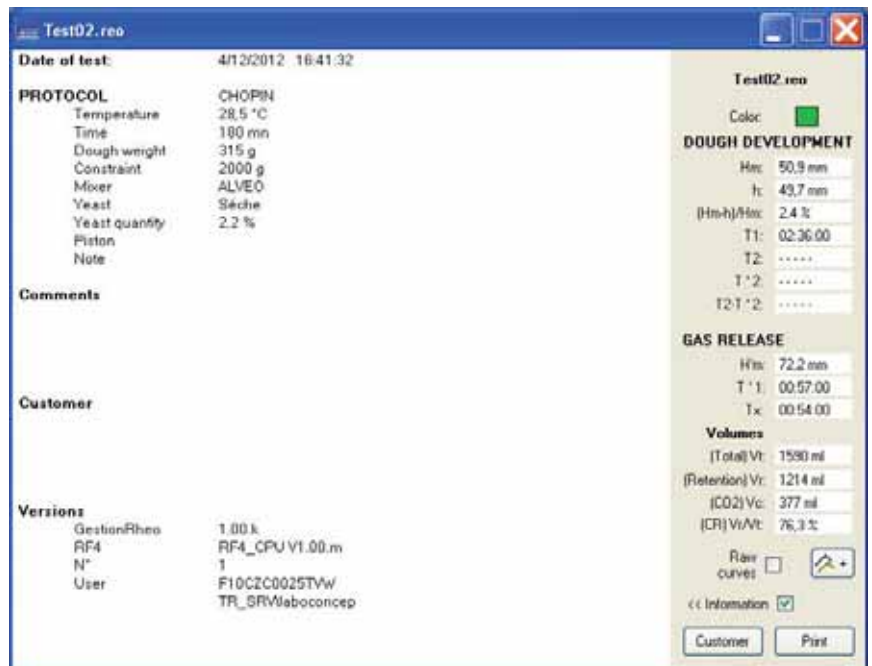


- 1 Curve characteristics
- 2 [Comparison] button
- 3 [Information] tick
- 4 [Print] button
- 5 [Customer] button (see page 18)
- 6 [Raw curves] tick
- 7 Time pointer
- 8 Time pointer values

By displaying a test, you display both its curve and the characteristic values of the curve (1). You can also obtain the curve values at any time by placing the pointer on the curve and holding down the mouse left click button. You will thus bring up the time pointer (7) and the values (8) at the time when it is positioned. This only works for the main test.

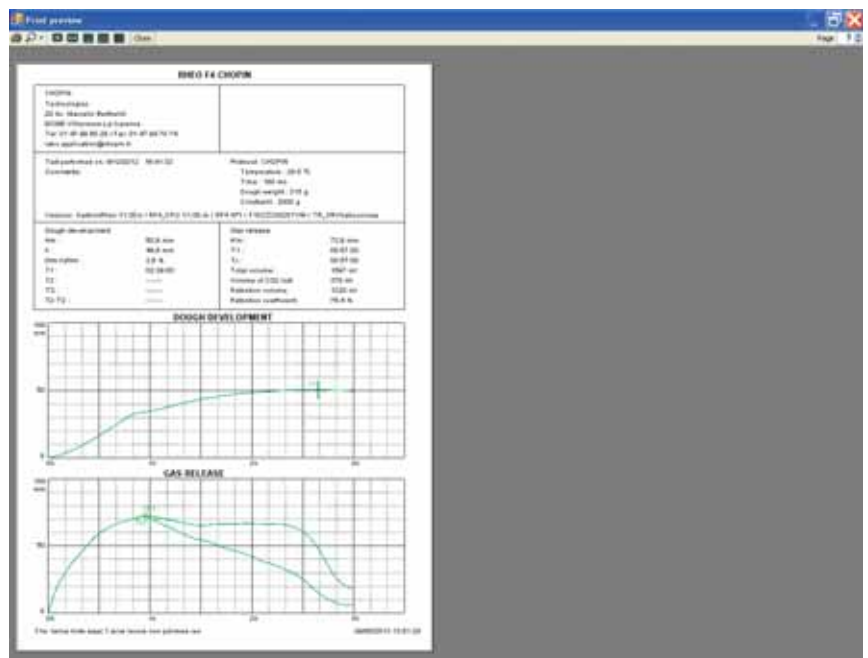
By clicking the [Comparison] button (2), you can compare up to 5 tests. If your test is in process, you can only compare it with one other test.

By clicking the [Information] button (3), you will bring up the information for the open tests, such as the protocol used, the customer, and the embedded software version.



By clicking the [raw curves] button, you will bring up the points that were used to plot the curve.

By clicking the [Print] button, you will bring up the print window:



To print, press the button:



[Print]

### 3.7 Other functions

- **Update**

The update function is to update the program embedded in the Rheo F4.

Click on the tab [Update] followed by [Embedded program].

This function is reserved for accredited persons

- **Maintenance**

The maintenance function is for access to the calibration functions. To access them, click on the tab [Tools] followed by [Maintenance].



A code is required to access maintenance. (**Agent or distributor only**)

- **Data history**

The "Data history" function gives the list of tests conducted on the device. To access it, click on the tab [Files] followed by [Data history] or on the icon:



[Data history]



Date	Start	End	Protocol	Customer	Note	File
18/10/2012	10:12:27	10:15:42	ALAN	CHORN TECHNOLOGIES		Simulation2.res
18/10/2012	10:12:27	10:15:42	ALAN	CHORN TECHNOLOGIES		Simulation2.res
18/10/2012	10:22:26	10:25:40	ALAN	CHORN TECHNOLOGIES		Simulation2.res
29/10/2012	12:40:22	10:49:41	ALAN			alan 8 - Faine forte.res
31/10/2012	09:25:46	12:25:04	ALAN			alan 9 - Faine forte.res
31/10/2012	13:00:01	16:09:20	ALAN			alan 10 - Faine forte.res
01/11/2012	10:18:15	13:19:34	ALAN			alan 11 - Faine forte.res
06/11/2012	09:58:45	13:06:03	ALAN			alan 12 - Faine forte.res
06/11/2012	14:18:51	17:28:10	CHOPIN			alan 13 - Faine forte.res
07/11/2012	14:11:14	17:18:13	CHOPIN			alan 15 - Faine forte.res

To access a test, click on it.

The test will be opened in the test window.

- **Export**

The export function converts the test data to a text file (.txt).

To access it, click on the icon:

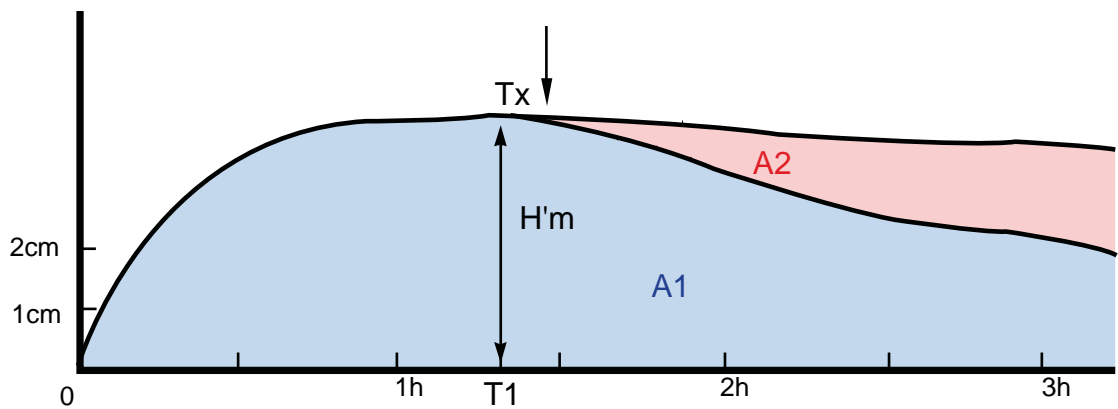


[Export]

Choose a name and an access path and validate to create the file.

### 3.8 Interpreting the results

● Gas release curve

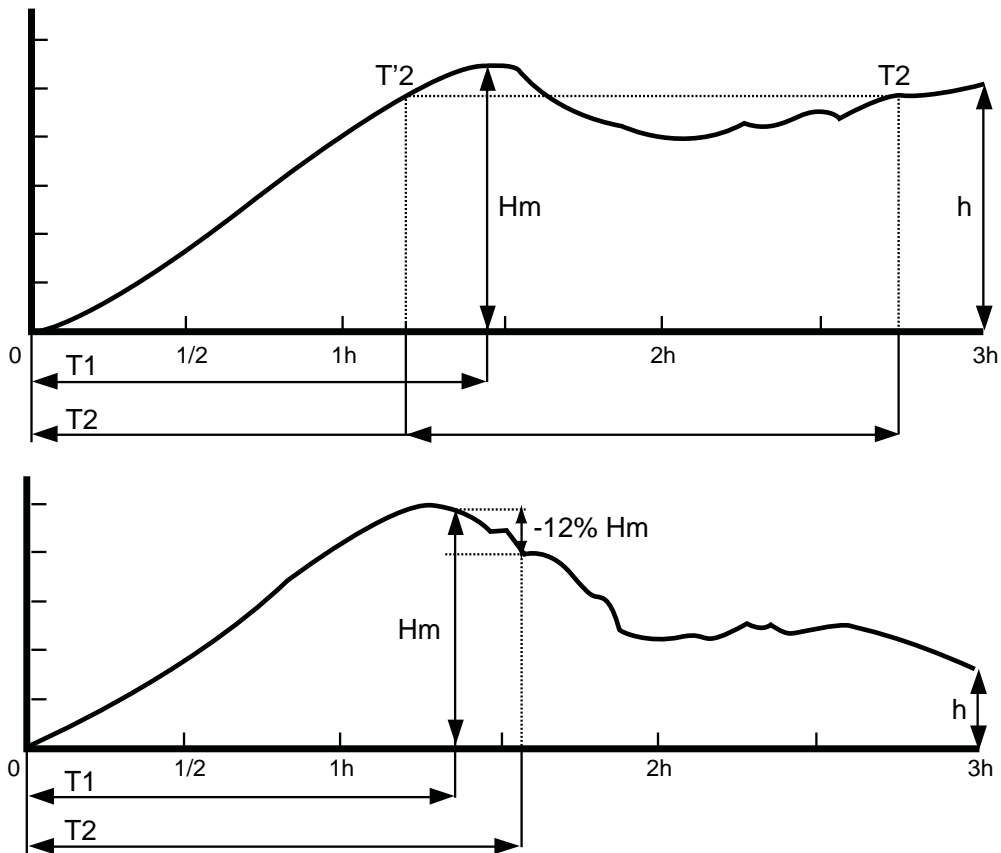


- H'm: maximum height of the gas release curve.
- T1: time required to obtain H'm
- Tx: dough porosity time (time when the dough starts to lose CO<sub>2</sub>).
- Total volume: total volume of gas release in ml (A1+A2 of the curve).
- volume of CO<sub>2</sub> lost: carbon dioxide volume in ml that the dough has lost during proofing (A2).
- Retention volume: carbon dioxide volume in ml still retained in the dough at the end of the test (A1).

The gas release curve is used to determine the retention coefficient R. It is defined as the ratio in % of the volume retained in the dough over the total volume of gas produced during the test. R is very close to 100 with the flours extracted from healthy grain almonds. It may drop to 50 for flours derived from the outer layers of the endosperm (end of grinding or reduction in the milling diagram) or for flours extracted from damaged or poorly stored grains. It is clear that prolongation of CO<sub>2</sub> release in time is a crucial factor. Moreover, as measures are taken at temperatures between 27°C and 30°C, action of the fungal enzymes is highly visible with the Rheo F4.

To see reference curves, refer to [the Appendix 1 page 36](#)

● Dough development curve



- T1: maximum dough development time in hours and minutes.
- Hm: maximum dough development height under stress, formulated in mm.
- T2 and T'2: relative stabilisation time at the maximum point located at a height of  $0.88H_m$  without being lower than  $H_m - 6\text{mm}$ .
- $\Delta T_2 = T_2 - T'2 =$  dough tolerance
- h: dough development height at the end of the test (T:3 hours for a complete test with CHOPIN protocol, or T: x for a manually interrupted test with another protocol).
- $(H_m - h)/H_m$ : % of drop in development after 3h (case of the CHOPIN protocol) compared with T1

The measurement and combination of these five values provide essential information for dough quality assessment. T1 and  $(H_m - h)/H_m$  indicate the best times for dough kneading. However, time T1 is very closely linked to yeast "speed" and activity. Height Hm is linked to bread volume. T2 is an indicator of dough tolerance during proofing.

To see reference curves, refer to [the Appendix 1 page 36](#)

## 4 Maintenance

This chapter describes the basic servicing and maintenance operations to be performed on the Rheo F4

The servicing operations:

The first thing to check is saturation of the soda lime cartridge. This occurs roughly every 50 tests. It is easy to identify thanks to a blue color. Replacement of soda lime is described [on page 33](#). This then requires checking of pneumatic circuit tightness. This procedure is described [on page 35](#).

Update of the embedded software:

CHOPIN Technologies can propose updates for the software embedded in the device. The installation procedure is described [on page 34](#)

The malfunctions:

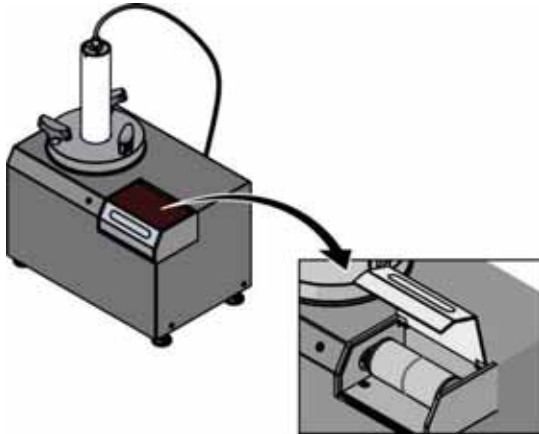
If the Rheo F4 no longer communicates with the computer or refuses to attain the setpoint temperature, check the fuse. The procedure is described [on page 34](#).



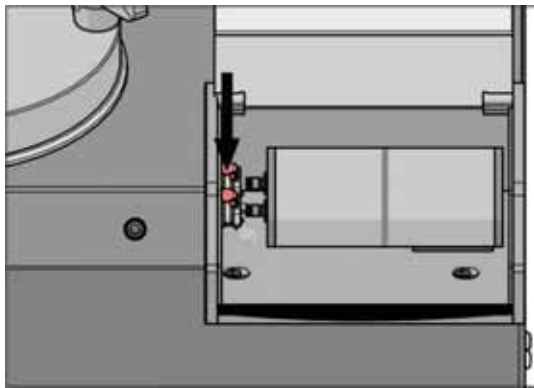
## 4.1 Replacing the soda lime cartridge

When the bluing of the soda lime reaches the mark, this means it is saturated in CO<sub>2</sub>, and must be replaced. On average, one cartridge is good for approximately 50 tests

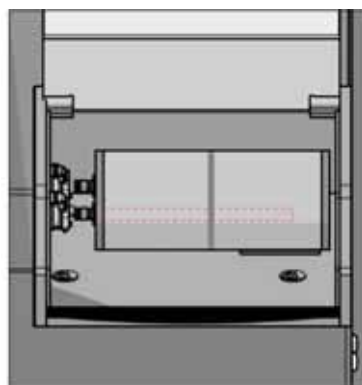
● **Procedure:**



Open the cartridge lid



Then press on the two (shown in red) connection clips by pulling on the cartridge.



In the same way as you have taken off the cartridge, put it back by pressing on the clips.



**Check that if you are opposite the Rheo F4, the cartridge metal tube is positioned as shown opposite.**

Close the cartridge lid.



**Once the cartridge has been filled, you must check the tightness of the pneumatic circuit by following the instructions in the "Leak test" chapter, page 35.**

## 4.2 Updating

The update function is to update the program embedded in the Rheo F4.

Click on the tab [Update] followed by [Embedded program].

This function is reserved for accredited persons.

## 4.3 Replacing the fuse



**Before starting, check you have disconnected the machine mains lead.**

### ● Procedure:



Insert a screwdriver, and then lever to extract the fuse compartment.



Extract and replace the fuse.

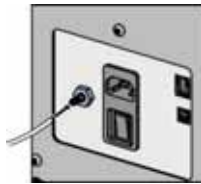
#### 4.4 Leak test

The leak test principle is simple. The pneumatic circuit is pressurised using the pump. Then the Rheo F4 will monitor this pressure for at least 15 minutes. The procedure consists in monitoring the entire circuit first. Then if there is a leak, the two sub circuits will be used to locate the leak.

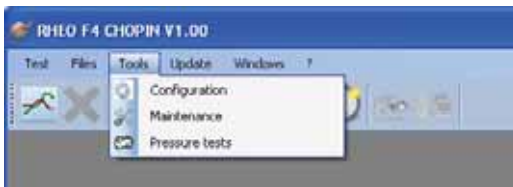


**Before starting the test, ensure that the bowl is hermetically closed (tighten the nuts correctly as for a test).**

● **Procedure:**

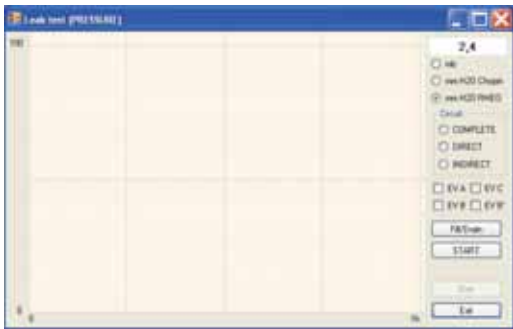


Install the pump on the pneumatic circuit bleed.



Click on the tab [Tools] followed by [Pressure tests (leaks)].

The leak test screen is displayed:



Click on [Fill/Empty].

Press the pump until bowl pressure is greater than 70 mm.

Click again on [Fill/Empty].

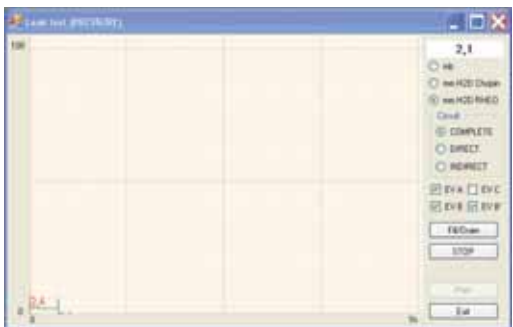
Remove the pump.

Start the test by pressing the [TEST] button. Select the COMPLETE circuit.

Wait 15s for pressure to stabilise.

The curve is displayed in real time. If there are no leaks in the circuit, the curve is a horizontal straight line. A leak is present when the pressure drop is greater than 10% after 15 minutes.

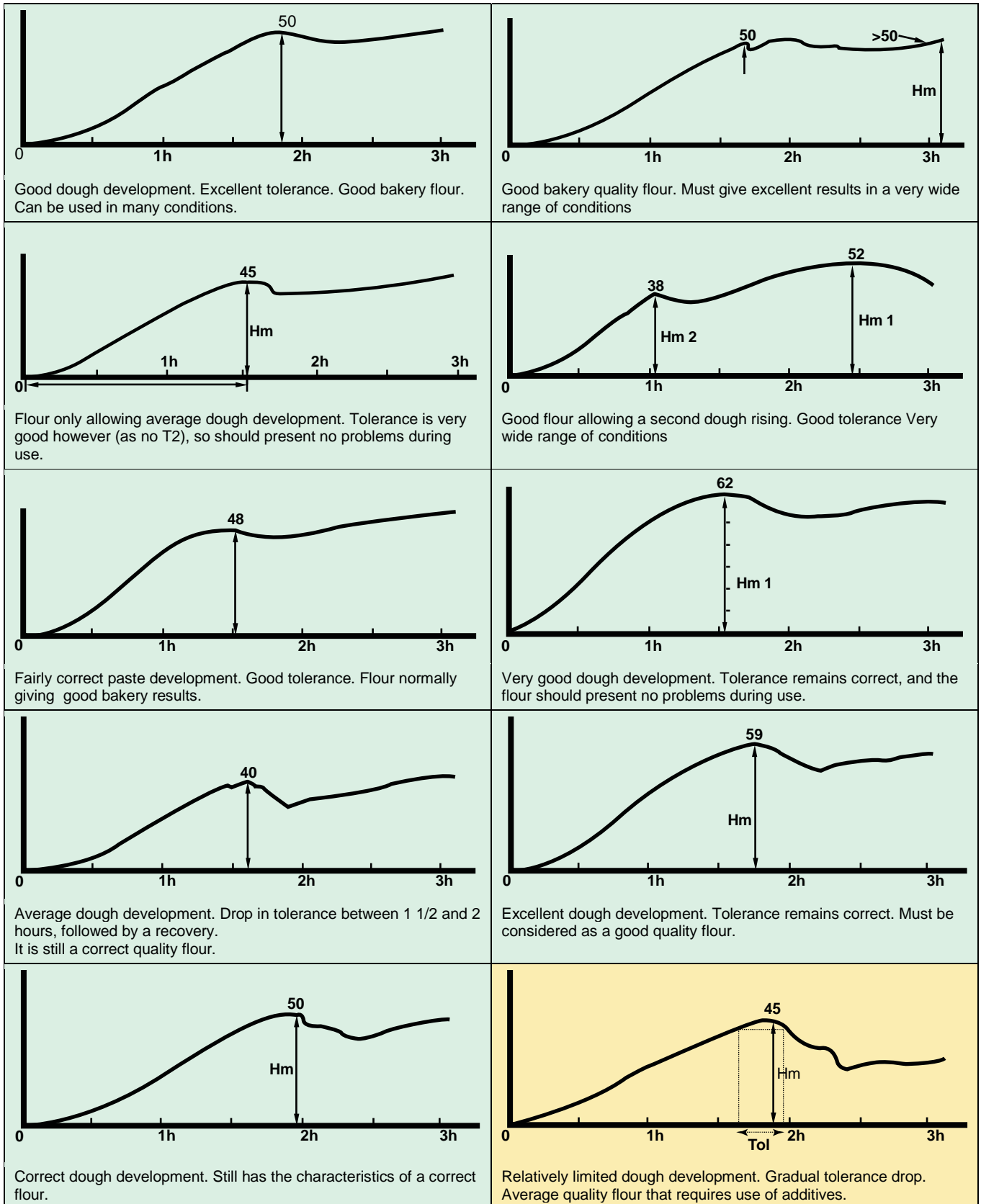
At the end of the test, click on [STOP] followed by [Fill/Empty] to discharge all the pressure introduced into the circuit.

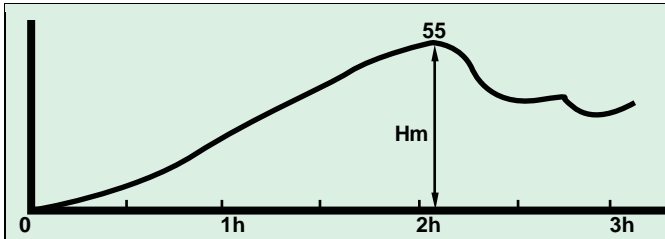


If the test shows a leak on a complete circuit, check the bowl seal and the soda lime cartridge lid. Then, contact CHOPIN Technologies.

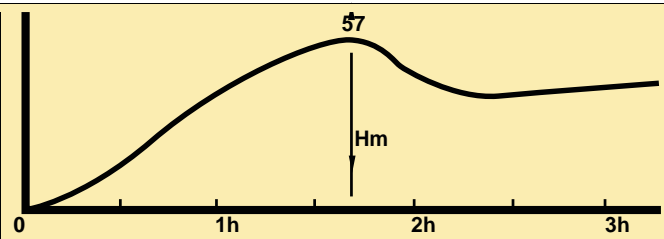
## APPENDIX 1: STANDARD CURVES

### A. Dough development (using the CHOPIN protocol)

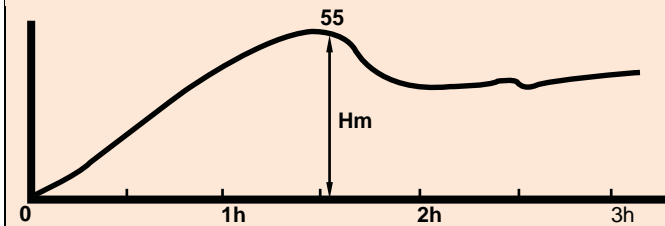




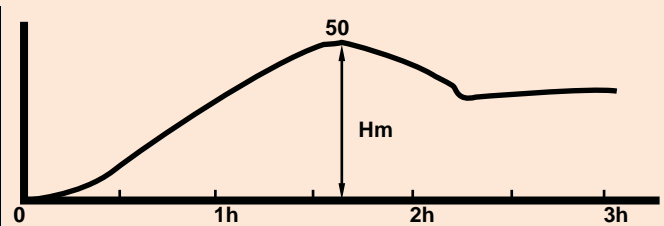
Good dough development. No problems before 2 hours. Followed by problems of use if longer proofing.



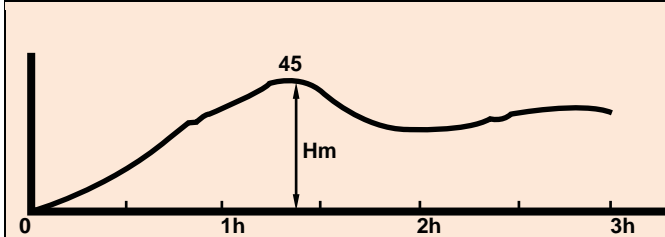
Good dough development. Average quality flour that should be used in bakeries with care, if not, it will be disappointing.



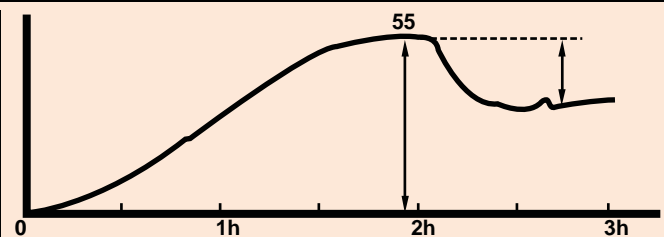
Good dough development. Flour that needs to be improved with gluten or ascorbic acid to ensure satisfaction in a wider range of conditions.



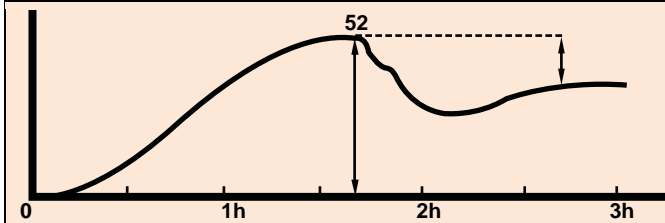
Average quality standard flour: Dough development and tolerance drop. Obviously better if improved with gluten and/or ascorbic acid.



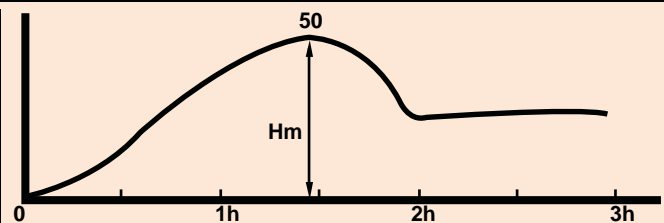
Standard flour of insufficient quality to satisfy the French bread-making industry (baguette).



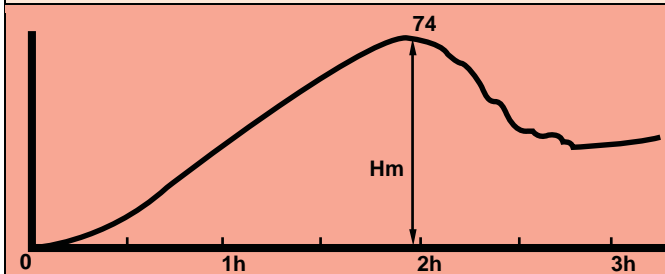
High dough development. Correct tolerance up to 2 hours. Will present problems after this.



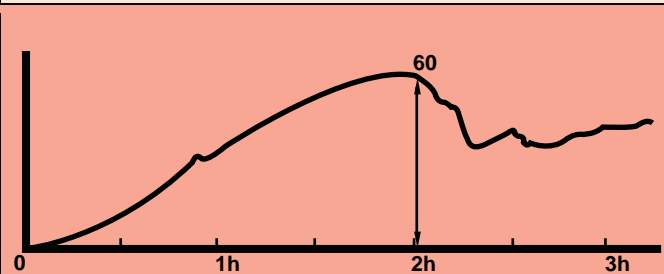
Correct development level, but sudden drop in tolerance after 1 1/2 hours. Flour that is hard to use and that will present problems during use.



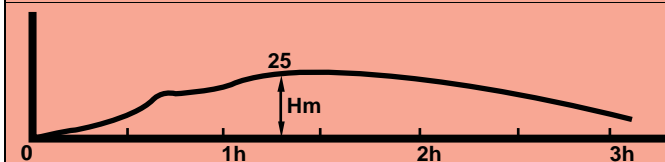
Correct dough volume but lacking tolerance. Flour that will systematically present problems during use.



Excellent dough development, but sudden large drop in tolerance. Flour that is tricky to use.

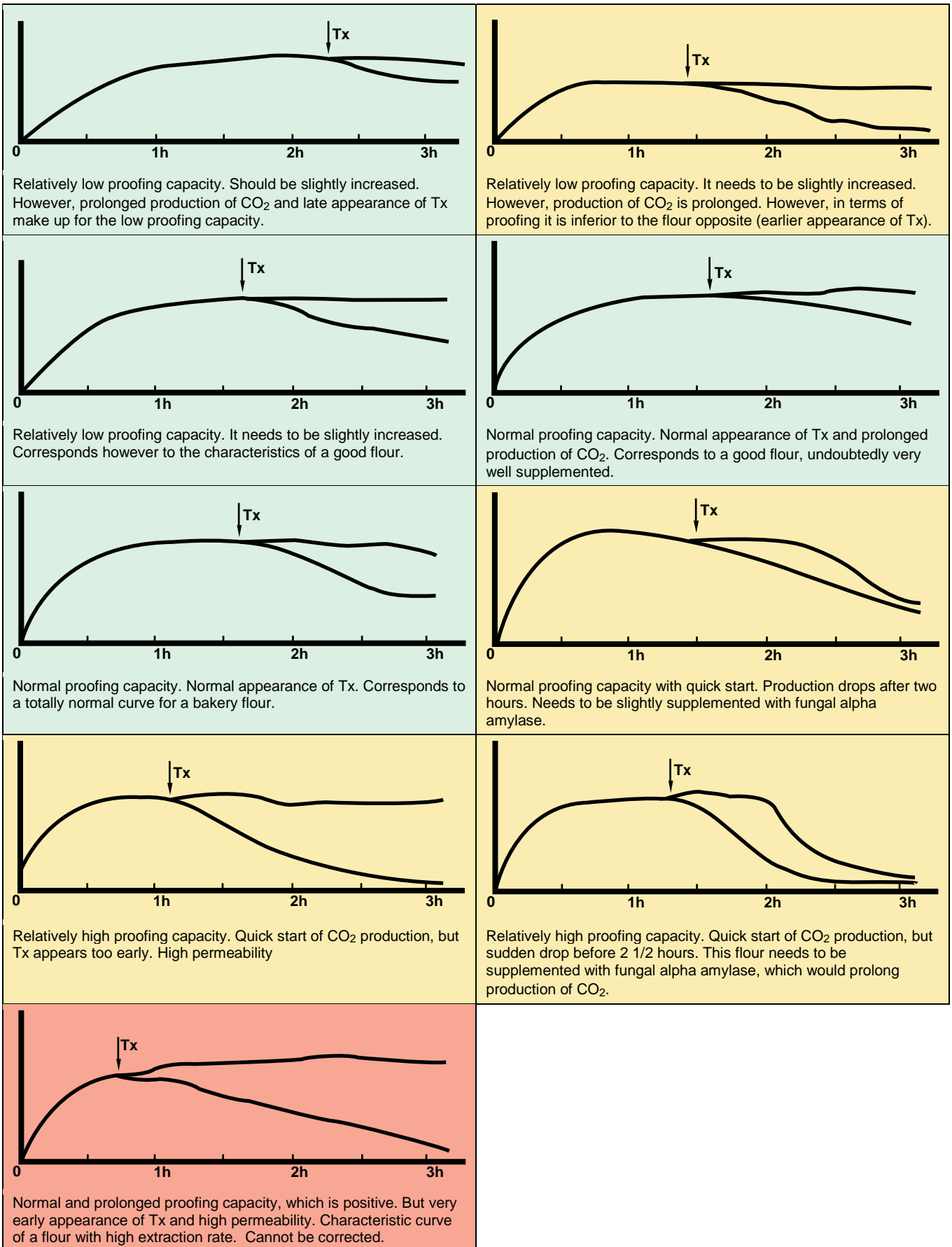


Very good dough development. Drop in tolerance after two hours. May give relatively correct results if it is used in appropriate conditions.



Abnormally slow development. Must be considered as not usable in conventional French bread-making.

**B. Gas Release (using the CHOPIN protocol)**



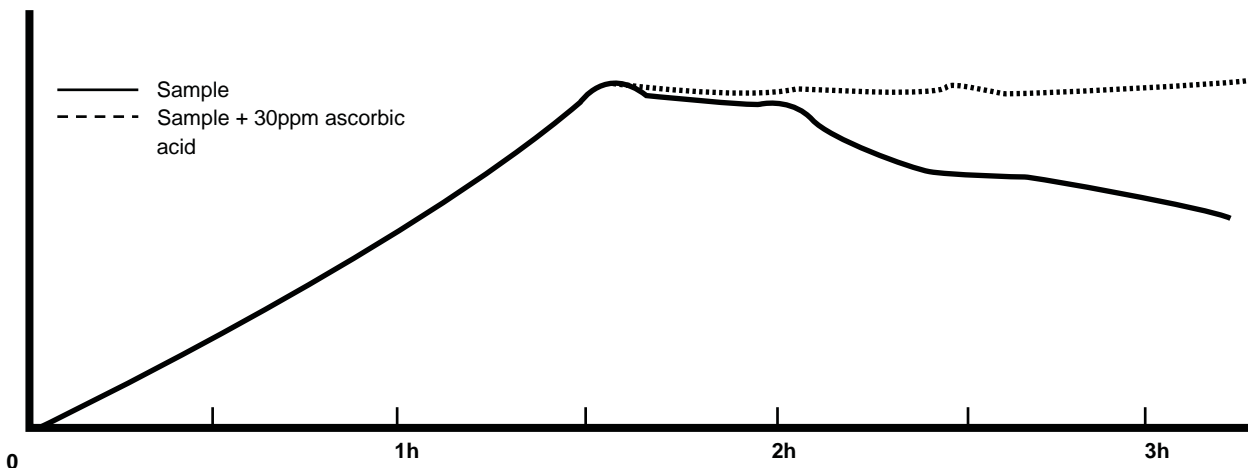
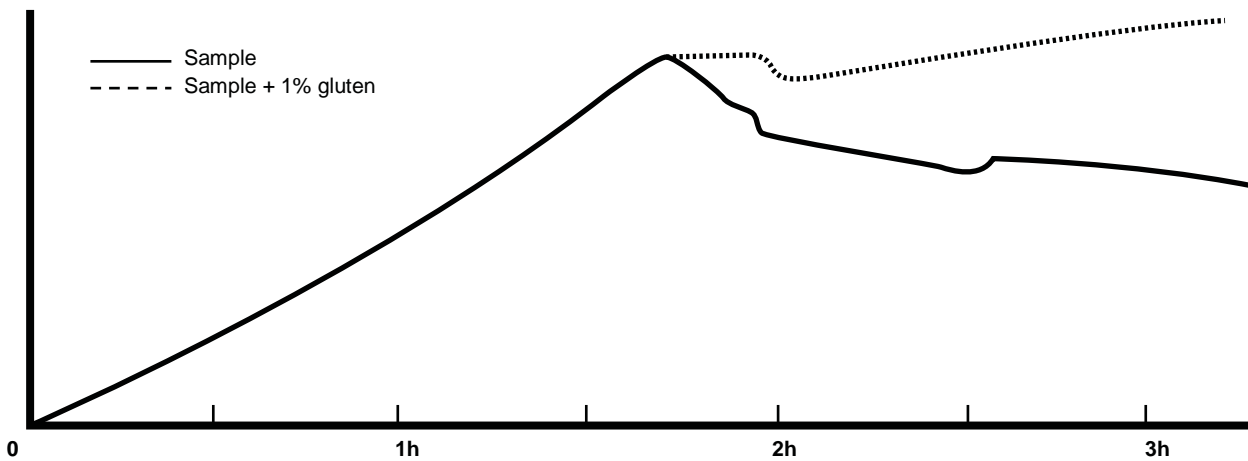
## APPENDIX 2: IMPROVING FLOUR QUALITY

Use of authorised additives: gluten, ascorbic acid, malt and fungal alpha amylase (with or without associated actions) is very common. Their use is justified by the baking industry needs and by the development of technology in this field. The Rheo F4 can assess the action of the various additives that are often used excessively.

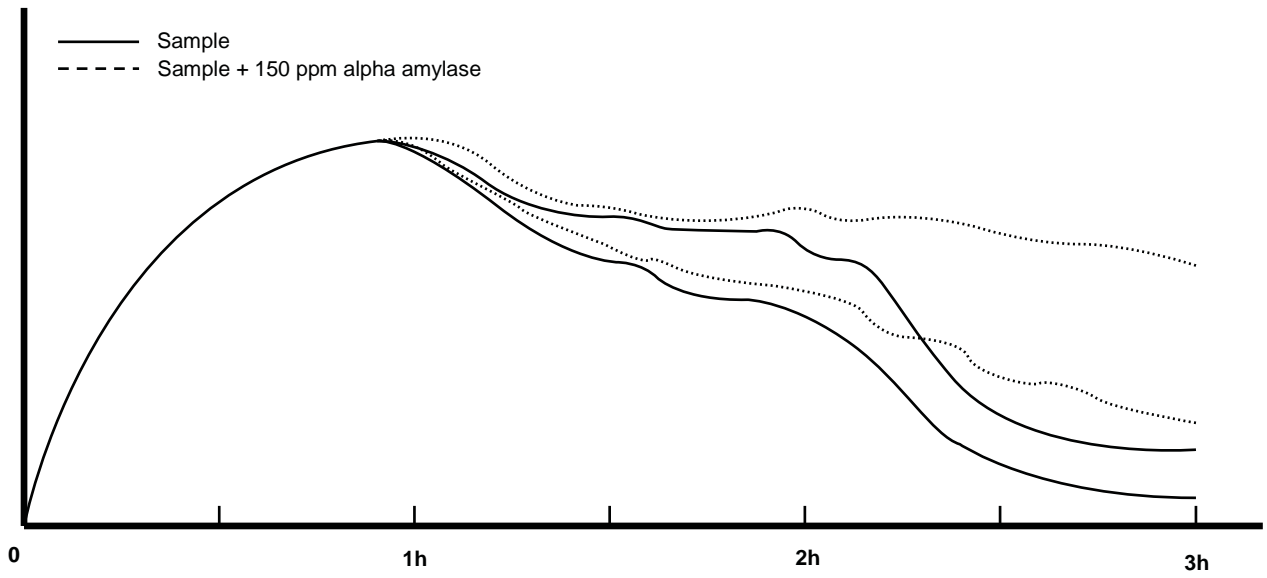
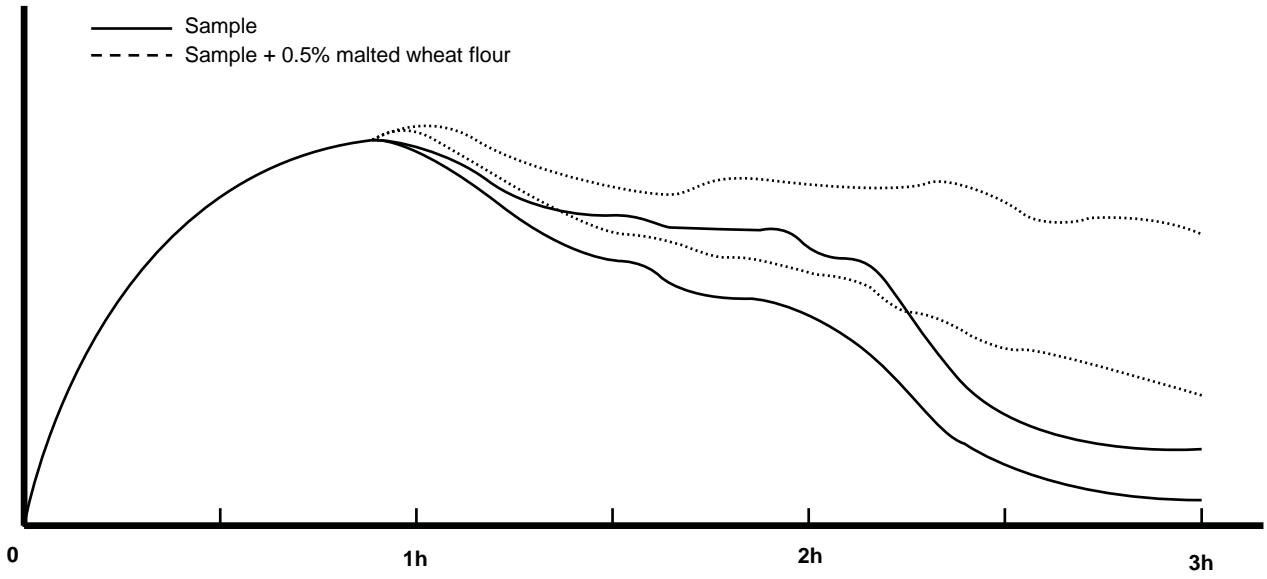


**Excessive and uncontrolled use of additives is extremely costly for millers and does not always gives the expected results. The Rheo F4 allows the correct percentage of additives to be added at the right cost, thus ensuring a quick return on investment.**

### ● Effect of the various additives on dough development.



● Effect of the various additives on gas release.





## APPENDIX 3: CHOPIN PROTOCOL



*The CHOPIN protocol is the standard protocol for using the Rheo F4. It is essential to follow this protocol when preparing the samples for analysis.*

### Preparing the dough

All mixers with a monitored bowl temperature can be used to prepare the dough. Mix homogeneity must, however, be ensured. The ALVEOGRAPH mixer is particularly suitable.

Dough consistency has a great effect on tests using the Rheo F4. This is linked to the amount of water added to the dough. It is understood that consistency varies according to the target aims, the products manufactured, and local customs.

To control hydration of your dough, we propose the use of the ALVEOGRAPH.

The two tables below are used to adapt dough consistency while considering both flour moisture content and dough strength.

- **Amount of water to be added during mixing according to flour moisture content (Table 1).**

Moisture content %	Water volume ml	Moisture content %	Water volume ml
11.6	140.1	14.2	128.6
11.8	139.2	14.4	127.7
12.0	138.3	14.6	126.8
12.2	137.5	14.8	125.9
12.4	136.6	15.0	125.0
12.6	135.7	15.2	124.1
12.8	134.8	15.4	123.2
13.0	133.9	15.6	122.3
13.2	133.0	15.8	121.4
13.4	132.1	16.0	120.6
13.6	131.2	16.2	119.7
13.8	130.3	16.4	118.8
14.0	129.4	16.6	117.9

● Amount of water to be removed or added (Table 2).

P	Qty H2O(ml)
20	-15.61
21	-15.1683
22	-14.7292
23	-14.2927
24	-13.8588
25	-13.4275
26	-12.9988
27	-12.5727
28	-12.1492
29	-11.7283
30	-11.31
31	-10.8943
32	-10.4812
33	-10.0707
34	-9.6628
35	-9.2575
36	-8.8548
37	-8.4547
38	-8.0572
39	-7.6623
40	-7.27
41	-6.8803
42	-6.4932
43	-6.1087
44	-5.7268
45	-5.3475
46	-4.9708
47	-4.5967
48	-4.2252
49	-3.8563
50	-3.49
51	-3.1263
52	-2.7652
53	-2.4067
54	-2.0508
55	-1.6975
56	-1.3468
57	-0.9987
58	-0.6532
59	-0.3103

P	Qty H2O(ml)
60	0.03
61	0.3677
62	0.7028
63	1.0353
64	1.3652
65	1.6925
66	2.0172
67	2.3393
68	2.6588
69	2.9757
70	3.29
71	3.6017
72	3.9108
73	4.2173
74	4.5212
75	4.8225
76	5.1212
77	5.4173
78	5.7108
79	6.0017
80	6.29
81	6.5757
82	6.8588
83	7.1393
84	7.4172
85	7.6925
86	7.9652
87	8.2353
88	8.5028
89	8.7677
90	9.03
91	9.2897
92	9.5468
93	9.8013
94	10.0532
95	10.3025
96	10.5492
97	10.7933
98	11.0348
99	11.2737
100	11.51
101	11.7437
102	11.9748
103	12.2033
104	12.4292
105	12.6525
106	12.8732
107	13.0913
108	13.3068
109	13.5197

P	Qty H2O(ml)
110	13.73
111	13.9377
112	14.1428
113	14.3453
114	14.5452
115	14.7425
116	14.9372
117	15.1293
118	15.3188
119	15.5057
120	15.69
121	15.8717
122	16.0508
123	16.2273
124	16.4012
125	16.5725
126	16.7412
127	16.9073
128	17.0708
129	17.2317
130	17.39
131	17.5457
132	17.6988
133	17.8493
134	17.9972
135	18.1425
136	18.2852
137	18.4253
138	18.5628
139	18.6977
140	18.83
141	18.9597
142	19.0868
143	19.2113
144	19.3332
145	19.4525
146	19.5692
147	19.6833
148	19.7948
149	19.9037
150	20.01
151	20.1137
152	20.2148
153	20.3133
154	20.4092
155	20.5025
156	20.5932
157	20.6813
158	20.7668
159	20.8497

P	Qty H2O(ml)
160	20.93
161	21.0077
162	21.0828
163	21.1553
164	21.2252
165	21.2925
166	21.3572
167	21.4193
168	21.4788
169	21.5357
170	21.59
171	21.6417
172	21.6908
173	21.7373
174	21.7812
175	21.8225
176	21.8612
177	21.8973
178	21.9308
179	21.9617
180	21.99
181	22.0157
182	22.0388
183	22.0593
184	22.0772
185	22.0925
186	22.1052
187	22.1153
188	22.1228
189	22.1277
190	22.13
191	22.1297
192	22.1268
193	22.1213
194	22.1132
195	22.1025
196	22.0892
197	22.0733
198	22.0548
199	22.0337
200	22.01

**Example:**

Flour H<sub>2</sub>O=14.6%; Alveographic P<sub>max</sub>=55 at 14.6% water content corresponds to 126.8ml of water.

As the correction to be made according to P is -1.69ml, flour hydration should be: 126.8ml-1.69ml=125.11ml.

### ● CHOPIN protocol

#### The CHOPIN protocol characteristics are:

- test temperature of 28.5°C
- dough composition: 250g of flour, 3g (1.2%) of quick-rising dry yeast (or 7g of baker's fresh yeast), 5g of salt, hydration as per tables 1 and 2;
- dough weight: 315g;
- weight applied on the sample: 2kg;
- test duration: 3h.

#### Preparing the dough

Mix the quick-rising dry yeast with the 250g of flour in the mixer bowl (if fresh yeast is used, disperse it in the hydration water) set to 27°C.

After one minute, stop the mixer and, using a spatula, check that all the flour particles have been properly hydrated and contribute to dough formation.

Then start up the mixer again for the six minutes. Salt will be blended in progressively right at the start of this six-minute period.

After mixing, take out all the dough and take a 315g sample.