



TGA THERMOSTEP

THERMOGRAVIMETRIC ANALYZER



TGA THERMOSTEP

THERMO- GRAVIMETRIC ANALYSIS

Thermogravimetric analysis is used to determine the mass loss of a sample as a function of the temperature. Suitable instruments include standard laboratory ovens and muffle furnaces with a fixed temperature and subsequent weighing, as well as TGA analyzers with integrated balance and a variable temperature range.

ELTRA's TGA Thermostep combines the drying and ashing process with integrated weighing. For the determination of various thermogravimetric parameters in one analysis cycle, the software allows to define different temperatures and gases (e. g. oxygen or nitrogen) for each analysis step.

TGA THERMOSTEP

RELIABLE AND FLEXIBLE

ELTRA TGA analyzers are an ideal alternative to standard laboratory ovens and muffle furnaces for thermogravimetric analysis. Thanks to a programmable furnace that is connected to an integrated balance, heating and weighing are combined in one instrument. This saves time-consuming manual work and allows for high sample throughput. In addition, typical parameters such as moisture, ash and volatiles can be determined in one analysis run.

The TGA Thermostep processes up to 19 different samples, typically weighing between 500 mg and 5 g, in one analysis cycle. The surrounding atmosphere and temperature of up to 1,000 °C within the

heating chamber can be freely defined by the user during analysis to create a standard operating procedure. The crucible lids, covering of the samples, can be raised or lowered at each stage of the analysis, thus allowing for safe and ASTM-compliant determination of volatiles in coal samples.

TYPICAL SAMPLE MATERIALS

Coal, coke, secondary fuels, gypsum, flour, plastics, ceramics and many more.

BENEFITS TGA THERMOSTEP

- I Measurement of up to 19 samples in one analysis
- I Sample weights of up to 5 g
- I Fast heating rates, accurate temperature control
- I High-performance, precise weighing cell
- I Automatic placing and lifting of crucible covers
- I Robust design allows for use in laboratories and production



PRECISE RESULTS

HIGH-PERFORMANCE ANALYSIS TECHNOLOGY

The TGA Thermostep is a powerful thermogravimetric analyzer characterized by robust design, high precision and flexibility. It is possible to apply different atmospheres and to use sample weights of up to 5 g. The Thermostep reliably and efficiently measures parameters such as moisture, ash and volatiles according to a user-defined SOP.

PURGING GAS

The TGA Thermostep is very flexible with regards to the purging gas used. At each stage of the analysis either nitrogen, oxygen or surrounding atmosphere can be selected. In the latter, the surrounding atmosphere penetrates into the TGA Thermostep, gently oxidizing the samples.

TEMPERATURE CONTROL

The furnace temperature is monitored by two thermocouples which are not encapsulated. One thermocouple monitors the temperature inside the furnace, the other monitors the temperature within the heating element. Due to the absence of the encapsulation the heating can be controlled quickly and precisely.

NEW: ENCAPSULATED WEIGHING CELL

The latest TGA Thermostep generation features an encapsulated weighing cell with 0.1 mg resolution providing highly precise measurements. The encapsulation isolates the weighing cell from the ambient atmosphere and is extremely stable. The weighing cell is connected to the furnace by a ceramic spindle with pedestal on which the crucibles are placed.



HIGH-CAPACITY HEATING ELEMENTS

The latest TGA Thermostep generation utilizes three heating elements with an improved capacity of 1800 W each (5400 W total power). The result is a faster heating rate and improved stability, especially at high temperatures. The heating elements, located in the upper and lower furnace, provide homogeneous temperature distribution.



COOLING

At the end of each analysis cycle, the cool down process starts. It is possible to program the automatic opening of the TGA furnace lid as a function of the temperature to support the cool down process. For example, the Thermostep can be programmed to open the furnace lid at 650 °C halfway and at 500 °C completely. In addition, at 300 °C an integrated fan is automatically started.

BENEFITS TGA THERMOSTEP

- | Precise measurements
- | Long-term stability
- | Low maintenance
- | Long operating life

Encapsulated weighing cell





TGA THERMOSTEP

SIMPLE OPERATION YIELDS QUICK RESULTS

Operation of the TGA Thermostep is simple, convenient and safe. After selecting the Standard Operating Procedure (SOP) in the PC, the sample ID's can be entered into the software. The samples are then weighed in the crucible at the position assigned to the sample ID in the carousel. After one sample has been weighed, the carousel automatically rotates to the next position and the next registered sample can then be weighed in the crucible. Alternatively, a carousel filled with samples which has been weighed externally, can be placed into the analyzer.

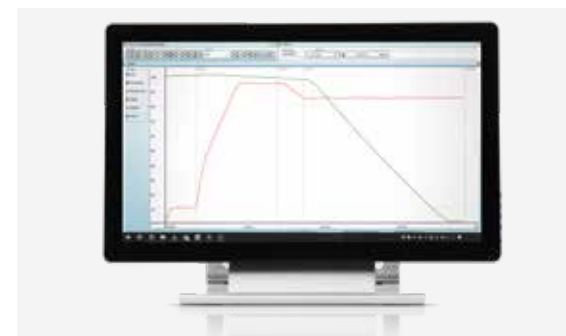
It is also possible to position a second carousel with crucible lids above the crucibles. Once the analysis is finished, a new cycle can be started after a short cool-down period.



Weighing the sample



Option: Crucible lids



Display of analysis results

TGA THERMOSTEP

WORKING IN COMPLIANCE WITH STANDARDS

The ELTRA TGA Thermostep complies with the following international standards, among others:



Norm	Material	Name
D7582 - 12	Coal, coke	Standard Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis
D7348 - 08e1	Combustion residues	Standard Test Methods for Loss on Ignition (LOI) of Solid Combustion Residues

THE TGA APPLICATION INSTRUCTIONS

In order to determine thermogravimetric parameters with the TGA Thermostep, an application instruction must be created once. For this purpose, the general conditions for the individual analysis steps are defined once in the Thermostep software. An application for complete coal analysis consists, for example, of the determination of moisture, volatile components and ash. An analysis step includes the specification of start and end temperature, the purging gas to be used, the heating rate and the end criterion.

Both time and mass stability can be selected as criteria for the end of an analysis step. In addition, it can be specified in each analysis step whether the crucible lids are to be put on.



THE ELTRA APPLICATION LABORATORY

For many applications (e.g. TGA analysis of plastics) there are no standards for automated thermogravimetric analysis. However, in order to guarantee a safe and reliable measurement, the ELTRA laboratory in Haan is available for application advice and free trial measurement using the complete analyzer range (TGA, as well as C/S and O/N/H analysis).

Our participation in round robin tests (e.g. ASTM Powder Metallurgy) and in the certification of reference materials (e.g. ECRM 268-1; ECRM 049-1) ensure a consistently high analysis quality.

TGA THERMOSTEP

INTELLIGENT CRUCIBLE MANAGEMENT

SAMPLE CAROUSEL AND REFERENCE CRUCIBLE

The sample carousel accepts up to 19 ceramic crucibles. The material of the carousel can be either metal or ceramic. Position no. 20 is reserved for the reference crucible which is part of every measurement. It is used to compensate for weight loss in the crucible, a physical effect which could lead to measurement errors at high temperatures.



Sample carousel and sample weighing



Weighing the crucible



PC-controlled application of crucible lids / crucibles open



PC-controlled application of crucible lids / crucibles closed

SAMPLE WEIGHING

The samples are weighed automatically in the TGA Thermostep. The analyzer allocates the positions of the crucibles in accordance with the number of samples to be measured to ensure the best possible stability during weighing. The software then connects to every occupied position and weighs one sample after the other.

Optionally, an external weighing station is available. Thus it is possible, for example during the final stages of cooling down of the TGA Thermostep, to weigh in a new sample carousel and introduce it to the analyzer with one single movement. This procedure helps to reduce waiting times between two analysis cycles.

CRUCIBLE LIDS

For applications such as the precise and ASTM-compliant analysis of volatiles in coal or of very reactive sample materials, it is essential to cover the crucibles. The TGA Thermostep is equipped not only with a sample carousel but with a second carousel for the crucible lids.

A software-controlled mechanism integrated in the carousel holder lifts and lowers the lids without interrupting the analysis by opening the TGA.

BENEFITS

- | A maximum of 19 samples plus 1 reference crucible
- | Automatic, integrated weighing
- | Separate carousel for crucible lids

CLEARLY STRUCTURED AND CONVENIENT

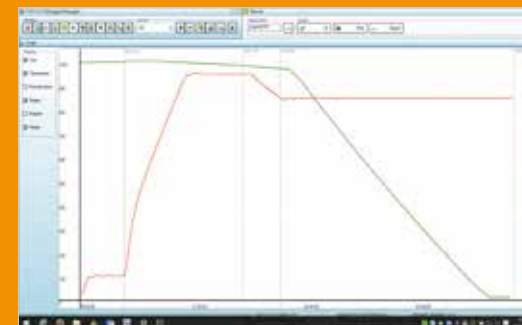
PC CONTROL WITH WINDOWS®-BASED SOFTWARE

ELTRA's instrument software ensures convenient control and operation of the analyzers. It is multilingual, easy to understand and provides the following features:

- | Custom layouts: user-defined display of windows and storage of different layouts
- | User profiles with multi-level access: creation of different hierarchy levels with different authorizations
- | Storage of analysis results in data base:
- | The data of each analysis is stored and can be called up later
- | Graphic display of temperature profile and mass loss
- | Individual, customer-specific calculations based on the raw data
- | Retrieval of sample-related information from any given time during analysis
- | LIMS communication and data export
- | Applications memory and display of maintenance intervals: individual configuration of maintenance intervals
- | Extensive diagnostics function

CUSTOMIZED VISUALIZATION OF MEASUREMENT RESULTS

- | Display of measurement results after each analysis step
- | Individual calculations possible
- | Ash content can refer to dry or moist samples
- | Export and printing of measurement results



Simultaneous display of temperature (red) and loss in weight (green)

Sample	Temp	Weight	...
1	100	1.2	...
2	110	1.5	...
3	120	1.8	...
4	130	2.1	...
5	140	2.4	...
6	150	2.7	...
7	160	3.0	...
8	170	3.3	...
9	180	3.6	...
10	190	3.9	...
11	200	4.2	...
12	210	4.5	...
13	220	4.8	...
14	230	5.1	...
15	240	5.4	...
16	250	5.7	...
17	260	6.0	...
18	270	6.3	...
19	280	6.6	...
20	290	6.9	...
21	300	7.2	...
22	310	7.5	...
23	320	7.8	...
24	330	8.1	...
25	340	8.4	...
26	350	8.7	...
27	360	9.0	...
28	370	9.3	...
29	380	9.6	...
30	390	9.9	...
31	400	10.2	...
32	410	10.5	...
33	420	10.8	...
34	430	11.1	...
35	440	11.4	...
36	450	11.7	...
37	460	12.0	...
38	470	12.3	...
39	480	12.6	...
40	490	12.9	...
41	500	13.2	...
42	510	13.5	...
43	520	13.8	...
44	530	14.1	...
45	540	14.4	...
46	550	14.7	...
47	560	15.0	...
48	570	15.3	...
49	580	15.6	...
50	590	15.9	...
51	600	16.2	...
52	610	16.5	...
53	620	16.8	...
54	630	17.1	...
55	640	17.4	...
56	650	17.7	...
57	660	18.0	...
58	670	18.3	...
59	680	18.6	...
60	690	18.9	...
61	700	19.2	...
62	710	19.5	...
63	720	19.8	...
64	730	20.1	...
65	740	20.4	...
66	750	20.7	...
67	760	21.0	...
68	770	21.3	...
69	780	21.6	...
70	790	21.9	...
71	800	22.2	...
72	810	22.5	...
73	820	22.8	...
74	830	23.1	...
75	840	23.4	...
76	850	23.7	...
77	860	24.0	...
78	870	24.3	...
79	880	24.6	...
80	890	24.9	...
81	900	25.2	...
82	910	25.5	...
83	920	25.8	...
84	930	26.1	...
85	940	26.4	...
86	950	26.7	...
87	960	27.0	...
88	970	27.3	...
89	980	27.6	...
90	990	27.9	...
91	1000	28.2	...
92	1010	28.5	...
93	1020	28.8	...
94	1030	29.1	...
95	1040	29.4	...
96	1050	29.7	...
97	1060	30.0	...
98	1070	30.3	...
99	1080	30.6	...
100	1090	30.9	...
101	1100	31.2	...
102	1110	31.5	...
103	1120	31.8	...
104	1130	32.1	...
105	1140	32.4	...
106	1150	32.7	...
107	1160	33.0	...
108	1170	33.3	...
109	1180	33.6	...
110	1190	33.9	...
111	1200	34.2	...
112	1210	34.5	...
113	1220	34.8	...
114	1230	35.1	...
115	1240	35.4	...
116	1250	35.7	...
117	1260	36.0	...
118	1270	36.3	...
119	1280	36.6	...
120	1290	36.9	...
121	1300	37.2	...
122	1310	37.5	...
123	1320	37.8	...
124	1330	38.1	...
125	1340	38.4	...
126	1350	38.7	...
127	1360	39.0	...
128	1370	39.3	...
129	1380	39.6	...
130	1390	39.9	...
131	1400	40.2	...
132	1410	40.5	...
133	1420	40.8	...
134	1430	41.1	...
135	1440	41.4	...
136	1450	41.7	...
137	1460	42.0	...
138	1470	42.3	...
139	1480	42.6	...
140	1490	42.9	...
141	1500	43.2	...
142	1510	43.5	...
143	1520	43.8	...
144	1530	44.1	...
145	1540	44.4	...
146	1550	44.7	...
147	1560	45.0	...
148	1570	45.3	...
149	1580	45.6	...
150	1590	45.9	...
151	1600	46.2	...
152	1610	46.5	...
153	1620	46.8	...
154	1630	47.1	...
155	1640	47.4	...
156	1650	47.7	...
157	1660	48.0	...
158	1670	48.3	...
159	1680	48.6	...
160	1690	48.9	...
161	1700	49.2	...
162	1710	49.5	...
163	1720	49.8	...
164	1730	50.1	...
165	1740	50.4	...
166	1750	50.7	...
167	1760	51.0	...
168	1770	51.3	...
169	1780	51.6	...
170	1790	51.9	...
171	1800	52.2	...
172	1810	52.5	...
173	1820	52.8	...
174	1830	53.1	...
175	1840	53.4	...
176	1850	53.7	...
177	1860	54.0	...
178	1870	54.3	...
179	1880	54.6	...
180	1890	54.9	...
181	1900	55.2	...
182	1910	55.5	...
183	1920	55.8	...
184	1930	56.1	...
185	1940	56.4	...
186	1950	56.7	...
187	1960	57.0	...
188	1970	57.3	...
189	1980	57.6	...
190	1990	57.9	...
191	2000	58.2	...
192	2010	58.5	...
193	2020	58.8	...
194	2030	59.1	...
195	2040	59.4	...
196	2050	59.7	...
197	2060	60.0	...
198	2070	60.3	...
199	2080	60.6	...
200	2090	60.9	...
201	2100	61.2	...
202	2110	61.5	...
203	2120	61.8	...
204	2130	62.1	...
205	2140	62.4	...
206	2150	62.7	...
207	2160	63.0	...
208	2170	63.3	...
209	2180	63.6	...
210	2190	63.9	...
211	2200	64.2	...
212	2210	64.5	...
213	2220	64.8	...
214	2230	65.1	...
215	2240	65.4	...
216	2250	65.7	...
217	2260	66.0	...
218	2270	66.3	...
219	2280	66.6	...
220	2290	66.9	...
221	2300	67.2	...
222	2310	67.5	...
223	2320	67.8	...
224	2330	68.1	...
225	2340	68.4	...
226	2350	68.7	...
227	2360	69.0	...
228	2370	69.3	...
229	2380	69.6	...
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233	2420	70.8	...
234	2430	71.1	...
235	2440	71.4	...
236	2450	71.7	...
237	2460	72.0	...
238	2470	72.3	...
239	2480	72.6	...
240	2490	72.9	...
241	2500	73.2	...
242	2510	73.5	...
243	2520	73.8	...
244	2530	74.1	...
245	2540	74.4	...
246	2550	74.7	...
247	2560	75.0	...
248	2570	75.3	...
249	2580	75.6	...
250	2590	75.9	...
251	2600	76.2	...
252	2610	76.5	...
253	2620	76.8	...
254	2630	77.1	...
255	2640	77.4	...
256	2650	77.7	...
257	2660	78.0	...
258	2670	78.3	...
259	2680	78.6	...
260	2690	78.9	...
261	2700	79.2	...
262	2710	79.5	...
263	2720	79.8	...
264	2730	80.1	...
265	2740	80.4	...
266	2750	80.7	...
267	2760	81.0	...
268	2770	81.3	...
269	2780	81.6	...
270	2790	81.9	...
271	2800	82.2	...
272	2810	82.5	...
273	2820	82.8	...
274	2830	83.1	...
275	2840	83.4	...
276	2850	83.7	...
277	2860	84.0	...
278	2870	84.3	...
279	2880	84.6	...
280	2890	84.9	...
281	2900	85.2	...
282	2910	85.5	...
283	2920	85.8	...
284	2930	86.1	...
285	2940	86.4	...
286	2950	86.7	...
287	2960	87.0	...
288	2970	87.3	...
289	2980	87.6	...
290	2990	87.9	...
291	3000	88.2	...
292	3010	88.5	...
293	3020	88.8	...
294	3030	89.1	...
295	3040	89.4	...
296	3050	89.7	...
297	3060	90.0	...
298	3070	90.3	...
299	3080	90.6	...
300	3090	90.9	...
301	3100	91.2	...
302	3110	91.5	...
303	3120	91.8	...
304	3130	92.1	...
305	3140	92.4	...
306			

APPLICATIONS

ANALYSIS OF COAL

The determination of moisture, ash and volatiles in coal is a routine application in coal-fired power plants. This can be done manually with various muffle furnaces or in a TGA Thermostep. The optional automated crucible lid management of the Thermostep ensures reliable determination of volatile components. In contrast to analyzers of other manufacturers, it is not necessary to open the Thermostep or run a second analysis cycle to determine the volatiles.

The TGA Thermostep meets the requirements of, for example, **ASTM Norm D7582**.



COAL CALIBRATION STANDARD

Number of samples

19 samples

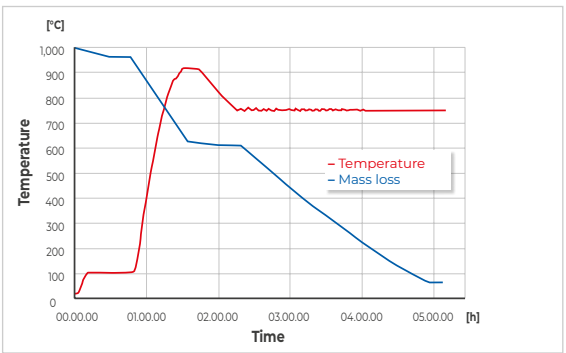
Average weight

1.1 g coal

Analysis time

5 hours

Parameters	Mean value	Standard deviation
Moisture	0.32 %	0.08
Ash	6.6 %	0.05
Volatiles	9.1 %	0.3



ANALYSIS OF CHEMICALS

The TGA Thermostep is ideally suited to determine the various degrees of decomposition of chemicals at different temperatures.

The example shows calcium oxalate; the moisture content was analyzed at 105°C, the mass loss at 200°C, 450°C and 850°C.



TYPICAL RESULTS CALCIUM OXALATE

Number of samples

10 samples

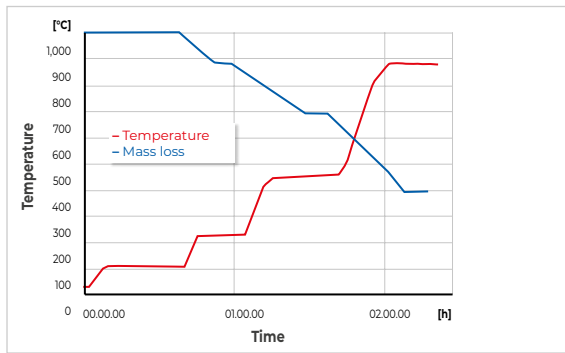
Average weight

500 g

Analysis time

2.5 hours

Temperature	Mean mass loss	Standard deviation
105 °C (moisture)	0.2 %	0.01
200 °C	12.2 %	0.02
450 °C	18.9 %	0.05
850 °C	29.8 %	0.03



ANALYSIS OF CEMENT

The **LOI test (loss on ignition)** is particularly important for inorganic materials. For this test the sample is quickly heated to a defined high temperature. This method is used to rapidly determine the volatile components without modifying the sample characteristics too much.

To determine residual moisture in cement an intermediate step at 105°C was added to the LOI test at 1,000°C. The total analysis time for both parameters in a 1 g sample was 70 minutes.



TYPICAL RESULTS CEMENT

Number of samples

10 samples

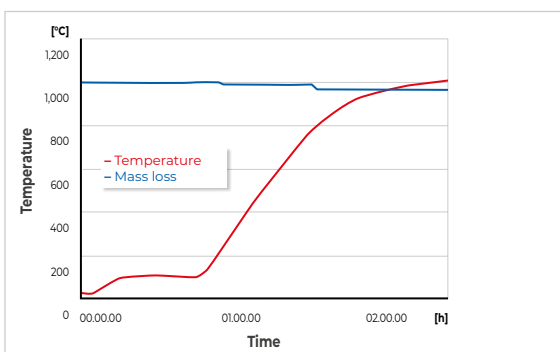
Average weight

1 g

Analysis time

70 minutes

Parameters	Cement 1	Cement 2
Moisture (105 °C)	0.07 ±0.01 %	3.0 ±0.02 %
LOI (1,000 °C)	0.08 ±0.01 %	1.9 ±0.01 %



TECHNICAL DATA

Sample weight	up to 5 g
Number of samples	19 (+ 1 reference sample)
Number of sample carousels	2 (crucibles and lids)
Material of sample carousel	can be either metal or ceramic
Precision	0.02 %
Resolution of balance	0.1 mg
Furnace temperature	From room temperature to 1,000 °C
Temperature control	Precision: 2 % or ±2°C / stability: 2 % or ±2°C
Gas flow rate	Adjustable from 1 to 10 l/min
Gas pressure	Air 5 – 6 bar (75 – 90 psi) / nitrogen 2 – 4 bar (30 – 60 psi) / oxygen 2 – 4 bar (30 – 60 psi)
Gas purity	Compressed air 99.5 % (oil and fat free) / nitrogen (99.9 %); oxygen (99.9 %)
Operating temperature / humidity	10 – 35 °C / 20 – 80 % humidity (not condensating)
Exhaust air	Connection to required / fan included in delivery scope / 4 m³ per minute / diameter of: 100 mm
Power supply	230 V (±10 %) / one phase / 50/60 Hz / 32 A (analyzer) 230 V (±10 %) / one phase / 50/60 Hz / 2 A (PC, fan)
Weight	65 kg
Dimensions (B x H x T)	55 x 52 x 62 cm
Interfaces	serial and USB
Accessories	Computer, monitor, printer (exact specifications on request)

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