



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.

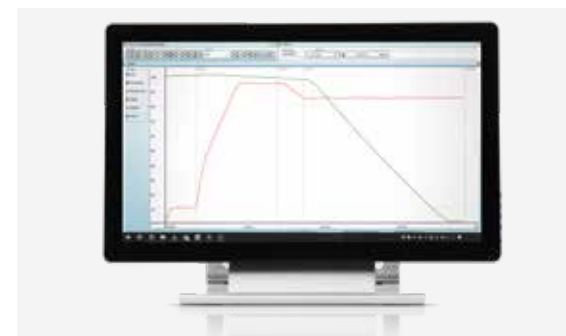
It is also possible to position a second carousel with crucible lids above the crucibles. Once the analysis is finished, a new cycle can be started after a short cool-down period.



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

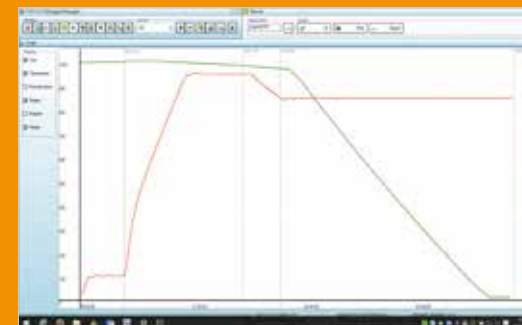
PC CONTROL WITH WINDOWS®-BASED SOFTWARE

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	150	1.5	...
3	200	1.8	...
4	250	2.1	...
5	300	2.4	...
6	350	2.7	...
7	400	3.0	...
8	450	3.3	...
9	500	3.6	...
10	550	3.9	...
11	600	4.2	...
12	650	4.5	...
13	700	4.8	...
14	750	5.1	...
15	800	5.4	...
16	850	5.7	...
17	900	6.0	...
18	950	6.3	...
19	1000	6.6	...
20	1050	6.9	...
21	1100	7.2	...
22	1150	7.5	...
23	1200	7.8	...
24	1250	8.1	...
25	1300	8.4	...
26	1350	8.7	...
27	1400	9.0	...
28	1450	9.3	...
29	1500	9.6	...
30	1550	9.9	...
31	1600	10.2	...
32	1650	10.5	...
33	1700	10.8	...
34	1750	11.1	...
35	1800	11.4	...
36	1850	11.7	...
37	1900	12.0	...
38	1950	12.3	...
39	2000	12.6	...
40	2050	12.9	...
41	2100	13.2	...
42	2150	13.5	...
43	2200	13.8	...
44	2250	14.1	...
45	2300	14.4	...
46	2350	14.7	...
47	2400	15.0	...
48	2450	15.3	...
49	2500	15.6	...
50	2550	15.9	...
51	2600	16.2	...
52	2650	16.5	...
53	2700	16.8	...
54	2750	17.1	...
55	2800	17.4	...
56	2850	17.7	...
57	2900	18.0	...
58	2950	18.3	...
59	3000	18.6	...
60	3050	18.9	...
61	3100	19.2	...
62	3150	19.5	...
63	3200	19.8	...
64	3250	20.1	...
65	3300	20.4	...
66	3350	20.7	...
67	3400	21.0	...
68	3450	21.3	...
69	3500	21.6	...
70	3550	21.9	...
71	3600	22.2	...
72	3650	22.5	...
73	3700	22.8	...
74	3750	23.1	...
75	3800	23.4	...
76	3850	23.7	...
77	3900	24.0	...
78	3950	24.3	...
79	4000	24.6	...
80	4050	24.9	...
81	4100	25.2	...
82	4150	25.5	...
83	4200	25.8	...
84	4250	26.1	...
85	4300	26.4	...
86	4350	26.7	...
87	4400	27.0	...
88	4450	27.3	...
89	4500	27.6	...
90	4550	27.9	...
91	4600	28.2	...
92	4650	28.5	...
93	4700	28.8	...
94	4750	29.1	...
95	4800	29.4	...
96	4850	29.7	...
97	4900	30.0	...
98	4950	30.3	...
99	5000	30.6	...
100	5050	30.9	...
101	5100	31.2	...
102	5150	31.5	...
103	5200	31.8	...
104	5250	32.1	...
105	5300	32.4	...
106	5350	32.7	...
107	5400	33.0	...
108	5450	33.3	...
109	5500	33.6	...
110	5550	33.9	...
111	5600	34.2	...
112	5650	34.5	...
113	5700	34.8	...
114	5750	35.1	...
115	5800	35.4	...
116	5850	35.7	...
117	5900	36.0	...
118	5950	36.3	...
119	6000	36.6	...
120	6050	36.9	...
121	6100	37.2	...
122	6150	37.5	...
123	6200	37.8	...
124	6250	38.1	...
125	6300	38.4	...
126	6350	38.7	...
127	6400	39.0	...
128	6450	39.3	...
129	6500	39.6	...
130	6550	39.9	...
131	6600	40.2	...
132	6650	40.5	...
133	6700	40.8	...
134	6750	41.1	...
135	6800	41.4	...
136	6850	41.7	...
137	6900	42.0	...
138	6950	42.3	...
139	7000	42.6	...
140	7050	42.9	...
141	7100	43.2	...
142	7150	43.5	...
143	7200	43.8	...
144	7250	44.1	...
145	7300	44.4	...
146	7350	44.7	...
147	7400	45.0	...
148	7450	45.3	...
149	7500	45.6	...
150	7550	45.9	...
151	7600	46.2	...
152	7650	46.5	...
153	7700	46.8	...
154	7750	47.1	...
155	7800	47.4	...
156	7850	47.7	...
157	7900	48.0	...
158	7950	48.3	...
159	8000	48.6	...
160	8050	48.9	...
161	8100	49.2	...
162	8150	49.5	...
163	8200	49.8	...
164	8250	50.1	...
165	8300	50.4	...
166	8350	50.7	...
167	8400	51.0	...
168	8450	51.3	...
169	8500	51.6	...
170	8550	51.9	...
171	8600	52.2	...
172	8650	52.5	...
173	8700	52.8	...
174	8750	53.1	...
175	8800	53.4	...
176	8850	53.7	...
177	8900	54.0	...
178	8950	54.3	...
179	9000	54.6	...
180	9050	54.9	...
181	9100	55.2	...
182	9150	55.5	...
183	9200	55.8	...
184	9250	56.1	...
185	9300	56.4	...
186	9350	56.7	...
187	9400	57.0	...
188	9450	57.3	...
189	9500	57.6	...
190	9550	57.9	...
191	9600	58.2	...
192	9650	58.5	...
193	9700	58.8	...
194	9750	59.1	...
195	9800	59.4	...
196	9850	59.7	...
197	9900	60.0	...
198	9950	60.3	...
199	10000	60.6	...
200	10050	60.9	...
201	10100	61.2	...
202	10150	61.5	...
203	10200	61.8	...
204	10250	62.1	...
205	10300	62.4	...
206	10350	62.7	...
207	10400	63.0	...
208	10450	63.3	...
209	10500	63.6	...
210	10550	63.9	...
211	10600	64.2	...
212	10650	64.5	...
213	10700	64.8	...
214	10750	65.1	...
215	10800	65.4	...
216	10850	65.7	...
217	10900	66.0	...
218	10950	66.3	...
219	11000	66.6	...
220	11050	66.9	...
221	11100	67.2	...
222	11150	67.5	...
223	11200	67.8	...
224	11250	68.1	...
225	11300	68.4	...
226	11350	68.7	...
227	11400	69.0	...
228	11450	69.3	...
229	11500	69.6	...
230	11550	69.9	...
231	11600	70.2	...
232	11650	70.5	...
233	11700	70.8	...
234	11750	71.1	...
235	11800	71.4	...
236	11850	71.7	...
237	11900	72.0	...
238	11950	72.3	...
239	12000	72.6	...
240	12050	72.9	...
241	12100	73.2	...
242	12150	73.5	...
243	12200	73.8	...
244	12250	74.1	...
245	12300	74.4	...
246	12350	74.7	...
247	12400	75.0	...
248	12450	75.3	...
249	12500	75.6	...
250	12550	75.9	...
251	12600	76.2	...
252	12650	76.5	...
253	12700	76.8	...
254	12750	77.1	...
255	12800	77.4	...
256	12850	77.7	...
257	12900	78.0	...
258	12950	78.3	...
259	13000	78.6	...
260	13050	78.9	...
261	13100	79.2	...
262	13150	79.5	...
263	13200	79.8	...
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274	13750	83.1	...
275	13800	83.4	...
276	13850	83.7	...
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281	14100	85.2	...
282	14150	85.5	...
283	14200	85.8	...
284	14250	86.1	...
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293	14700	88.8	...
294	14750	89.1	...
295	14800	89.4	...
296	14850	89.7	...
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299	15000	90.6	...
300	15050	90.9	...
301	15100	91.2	...
302	15150	91.5	...
303	15200	91.8	...
304	15250	92.1	...
305	15300	92.4	...
306	15350	92.7	...
307	15400	93.0	...
308	15450	93.3	...
309	15500	93.6	...
310	15550	93.9	...
311	15600	94.2	...
312	15650	94.5	...
313	15700	94.8	...
314	15750	95.1	...
315	15800	95.4	...
316	15850	95.7	...
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318	15950	96.3	...
319	16000	96.6	...
320	16050	96.9	...
321	16100	97.2	...
322	16150	97.5	...
323	16200	97.8	...
324	16250	98.1	...
325	16300	98.4	...
326	16350	98.7	...
327	16400	99.0	...
328	16450	99.3	...
329	16500	99.6	...
330	16550	99.9	...
331	16600	100.2	...
332	16650	100.5	...
333	16700	100.8	...
334	16750	101.1	...
335	16800	101.4	...
336	16850	101.7	...
337	16900	102.0	...
338	16950	102.3	...
339	17000	102.6	...
340	17050	102.9	...
341	17100	103.2	...

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

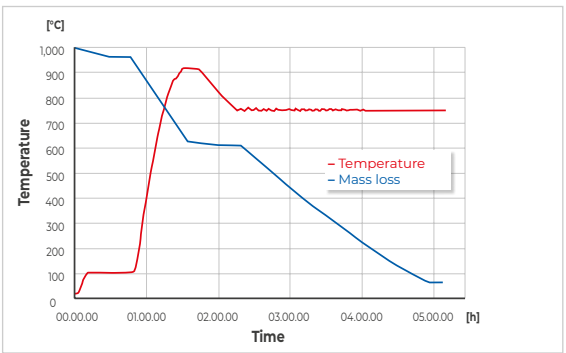
Average weight

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

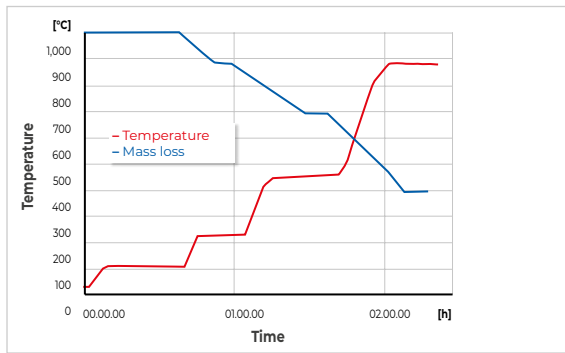
Average weight

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

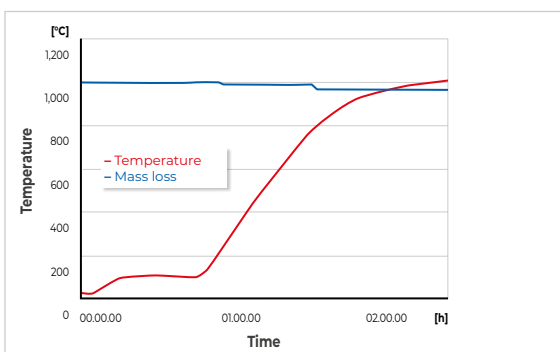
Average weight

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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