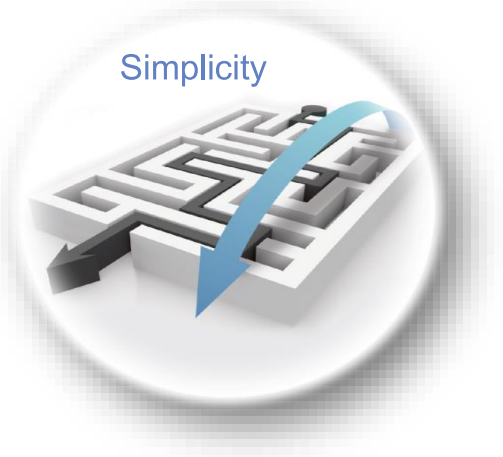
FlashSmart: THE Elemental Analyzer

SciSpec

Kantima Sitlaothaworn

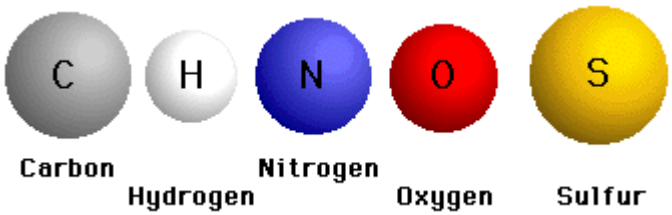
Overview



- Principle of the OEA
- Components
- Application Fields

What OEA analyzer?

Organic Elemental Analyzer “OEA” is a simultaneous technique to determination of



contained in organic and inorganic materials in solid liquid and gas form.

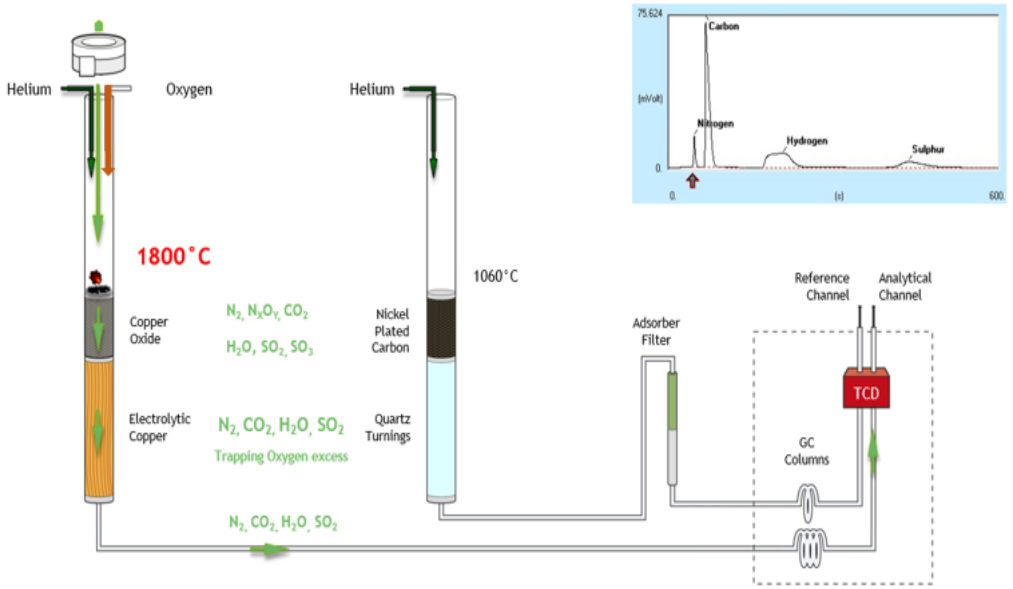
Quantification of the sample	Weighing
Quantitative oxidation of the sample	Combustion
Reduction of combustion gases	Reduction
Separation of the oxidation gases	Chromatography
Generation of signal	Detection

Principle of operation for CHNS

1. Organic and inorganic, solid or liquid are weight in a tin capsule
2. Introduced into the combustion reactor by and auto sampler
3. Inserted in the special furnace heated at 900 – 1000 ^{o}C
4. A small volume of pure oxygen is added to the system and helps to burn the sample
5. Reduction “using Copper” converting the sample into element gases
6. A separation column and TCD detector allows the user to determine elements

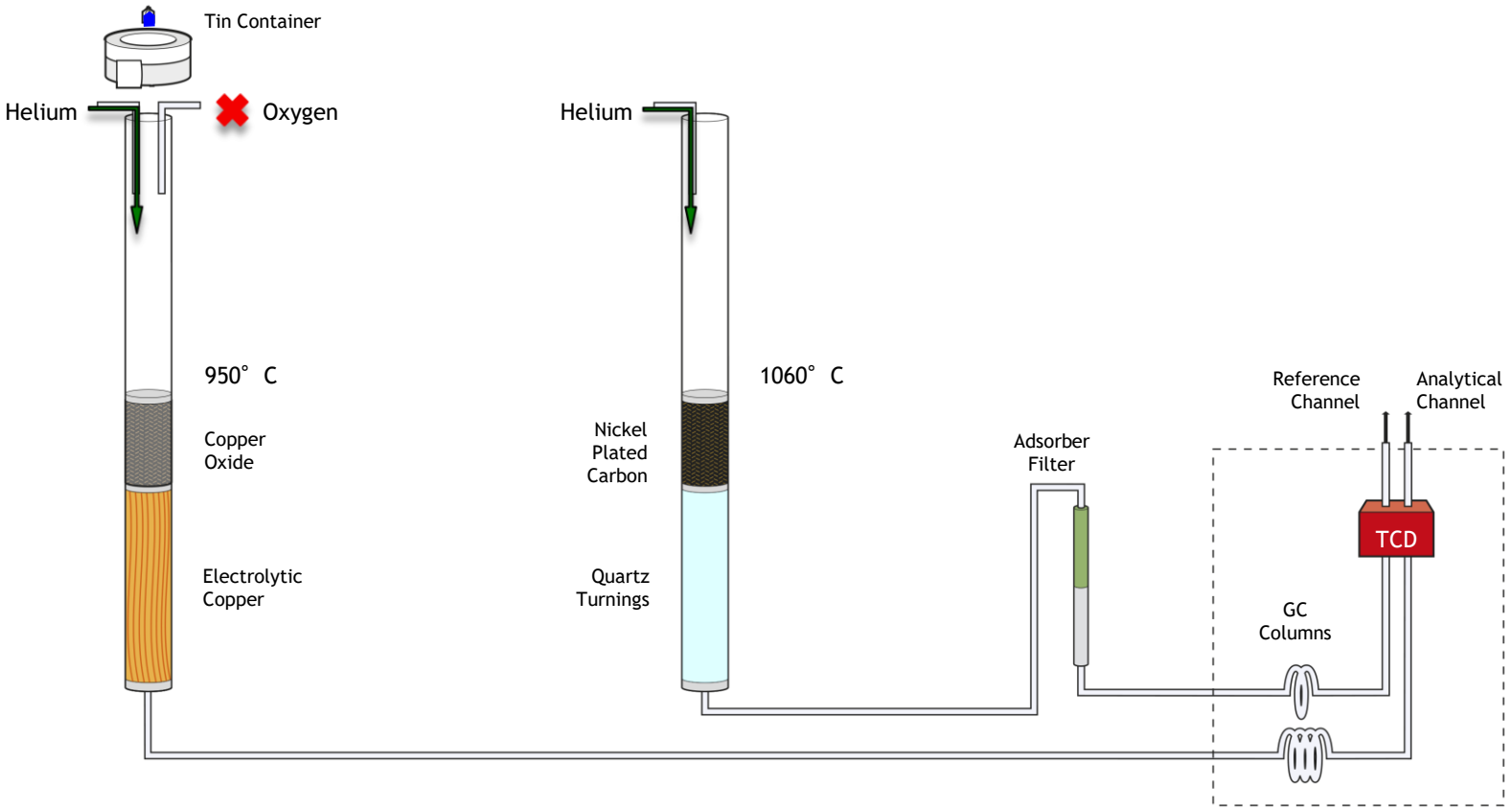
$$O_2 + Sn \Rightarrow SnO_2 + 1800\ ^{o}C$$

$$C_nH_mN_xS_y + aO_2 \Rightarrow CO_2, N_2, NO_x, H_2O, O_2, SO_x$$



ThermoFisher SCIENTIFIC

CHNS-O Analytical configuration CHNS Analysis



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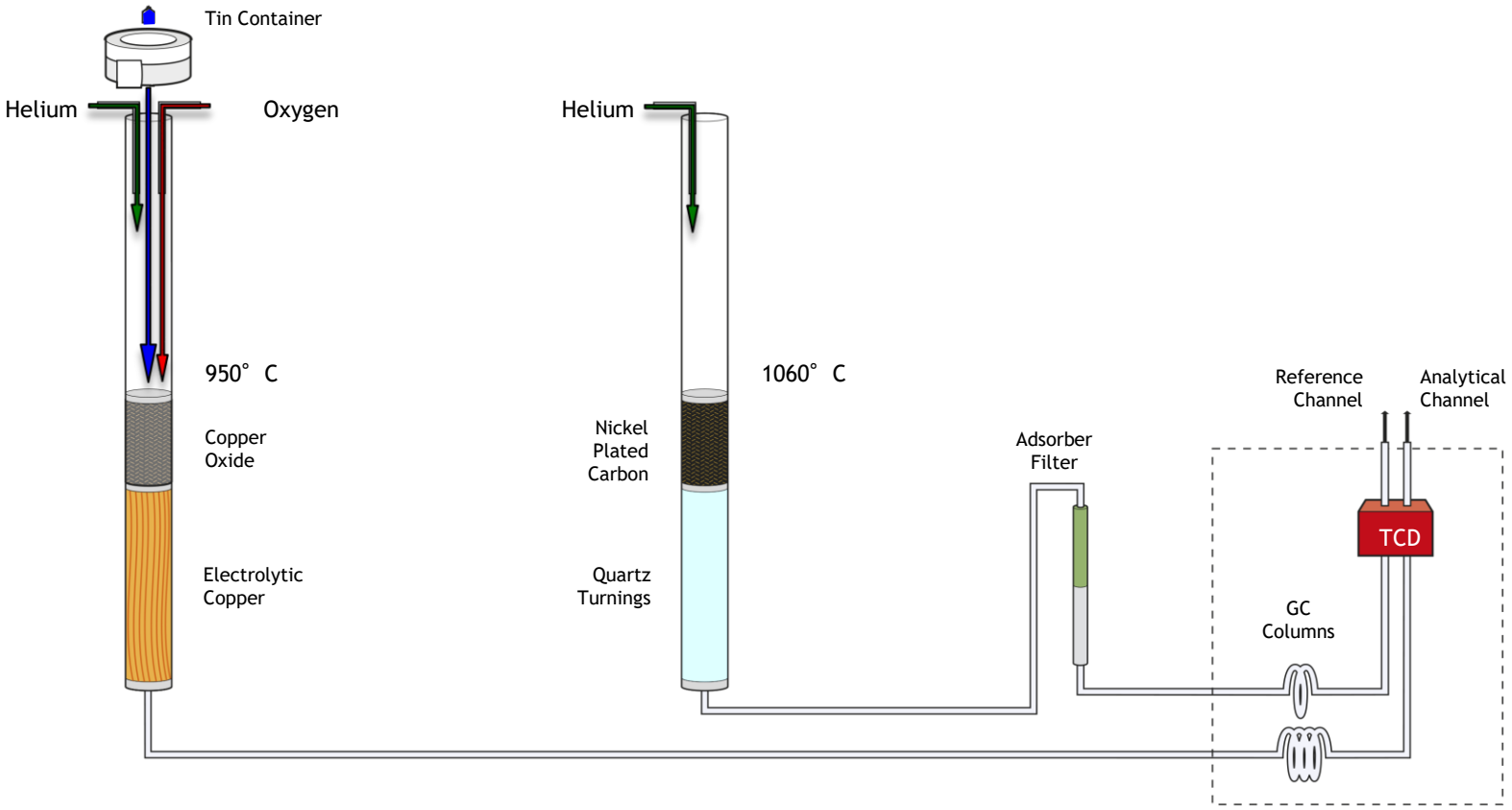

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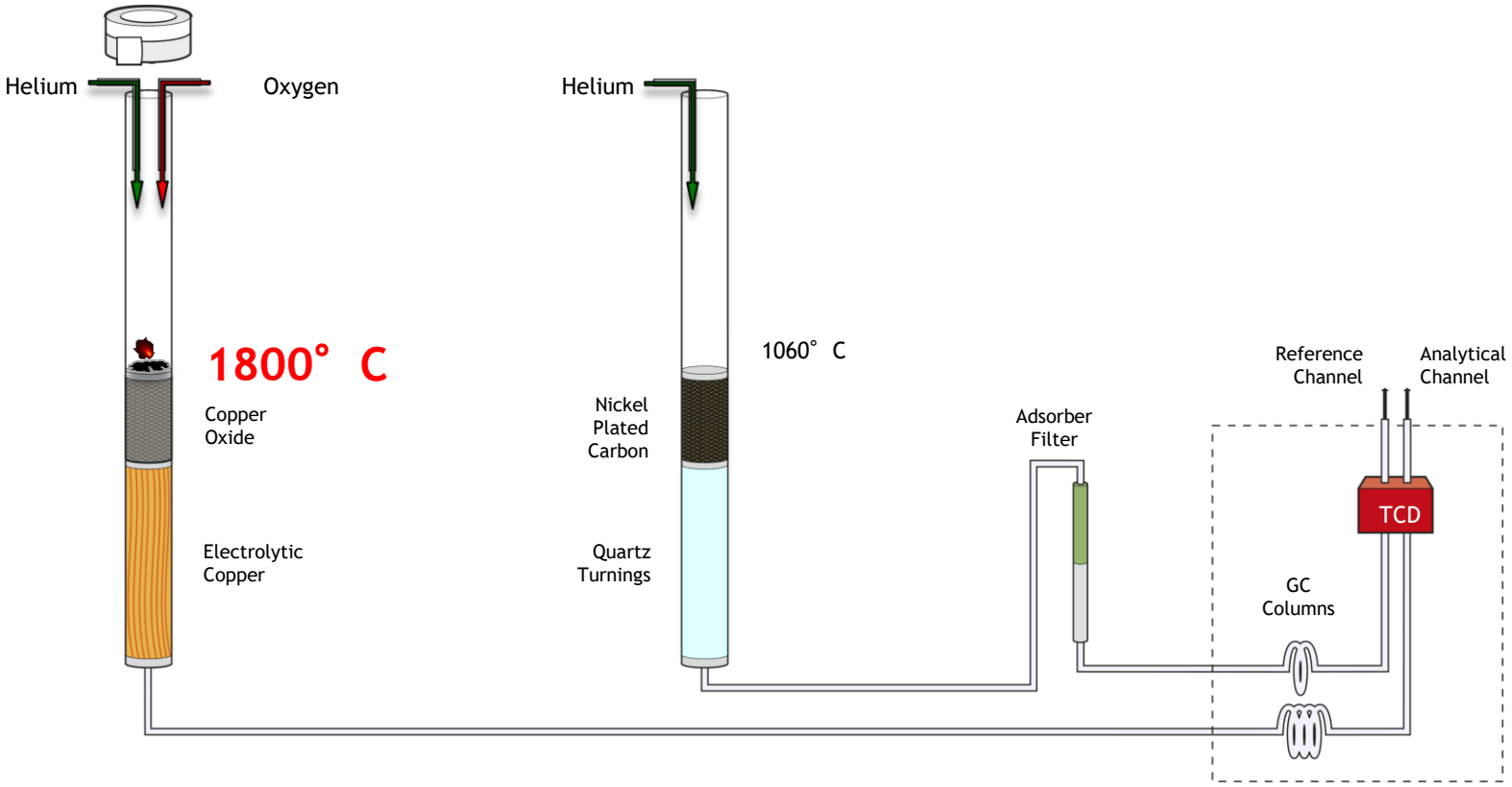

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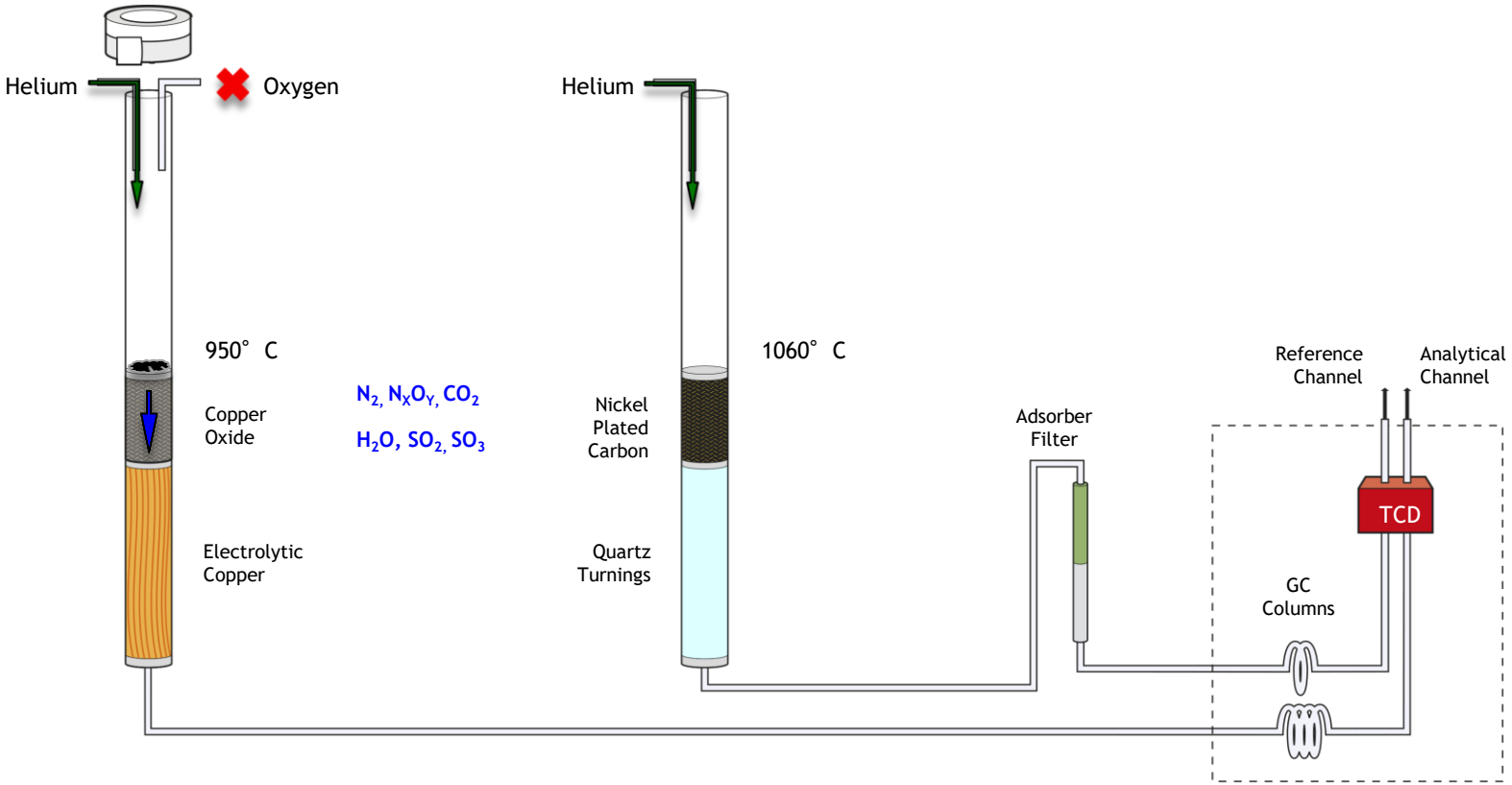

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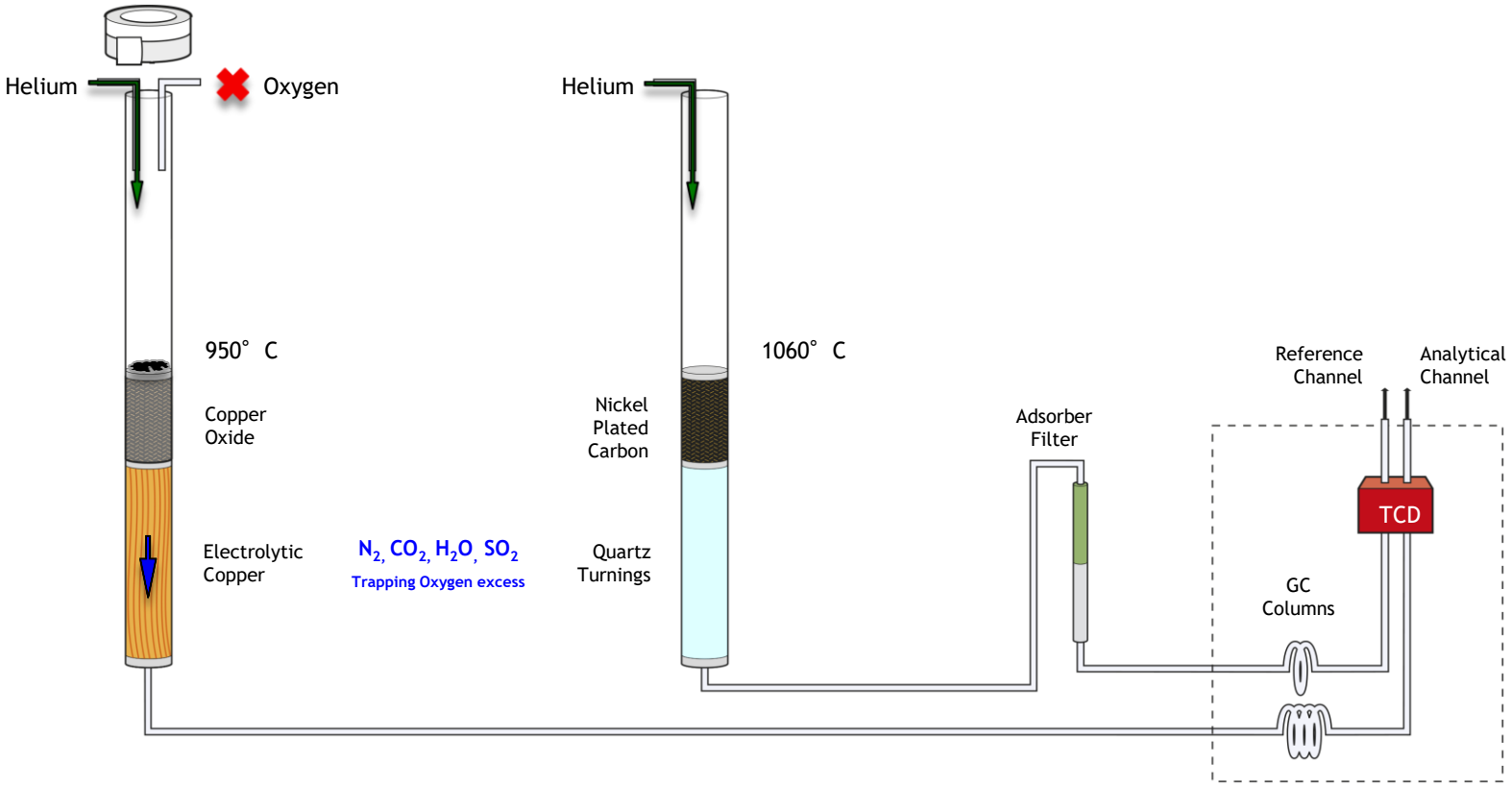

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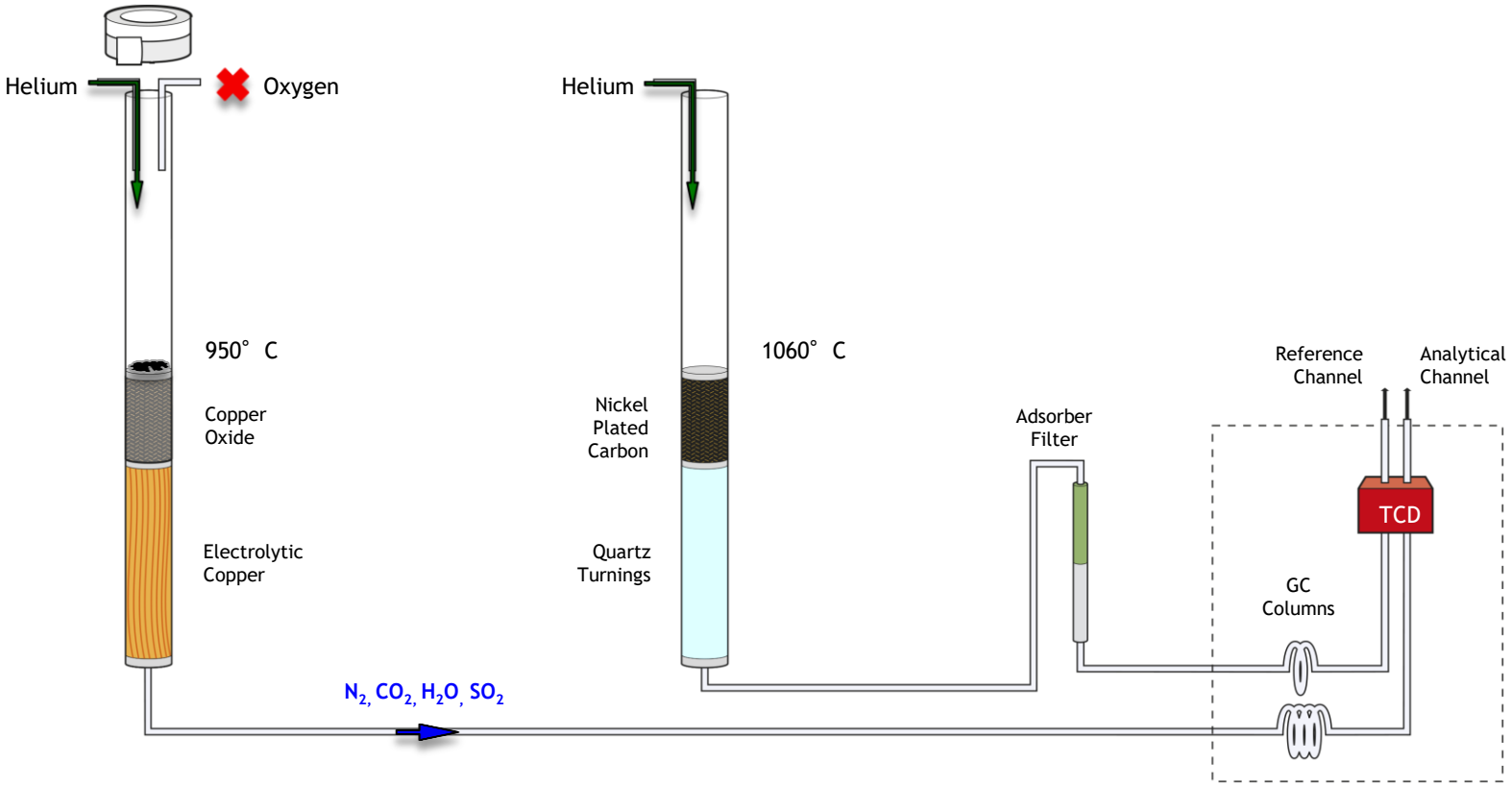

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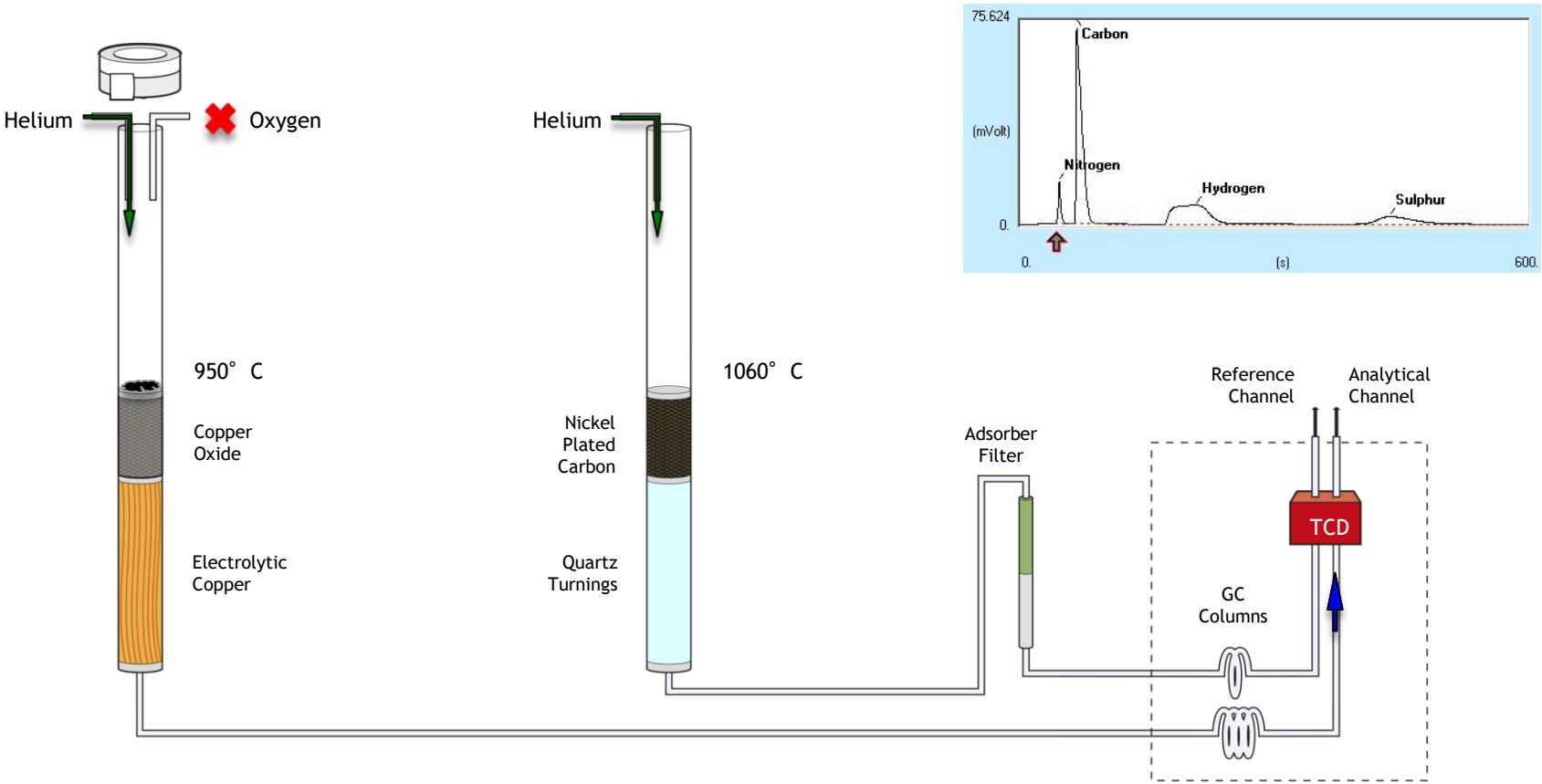
CHNS-O Analytical configuration CHNS Analysis



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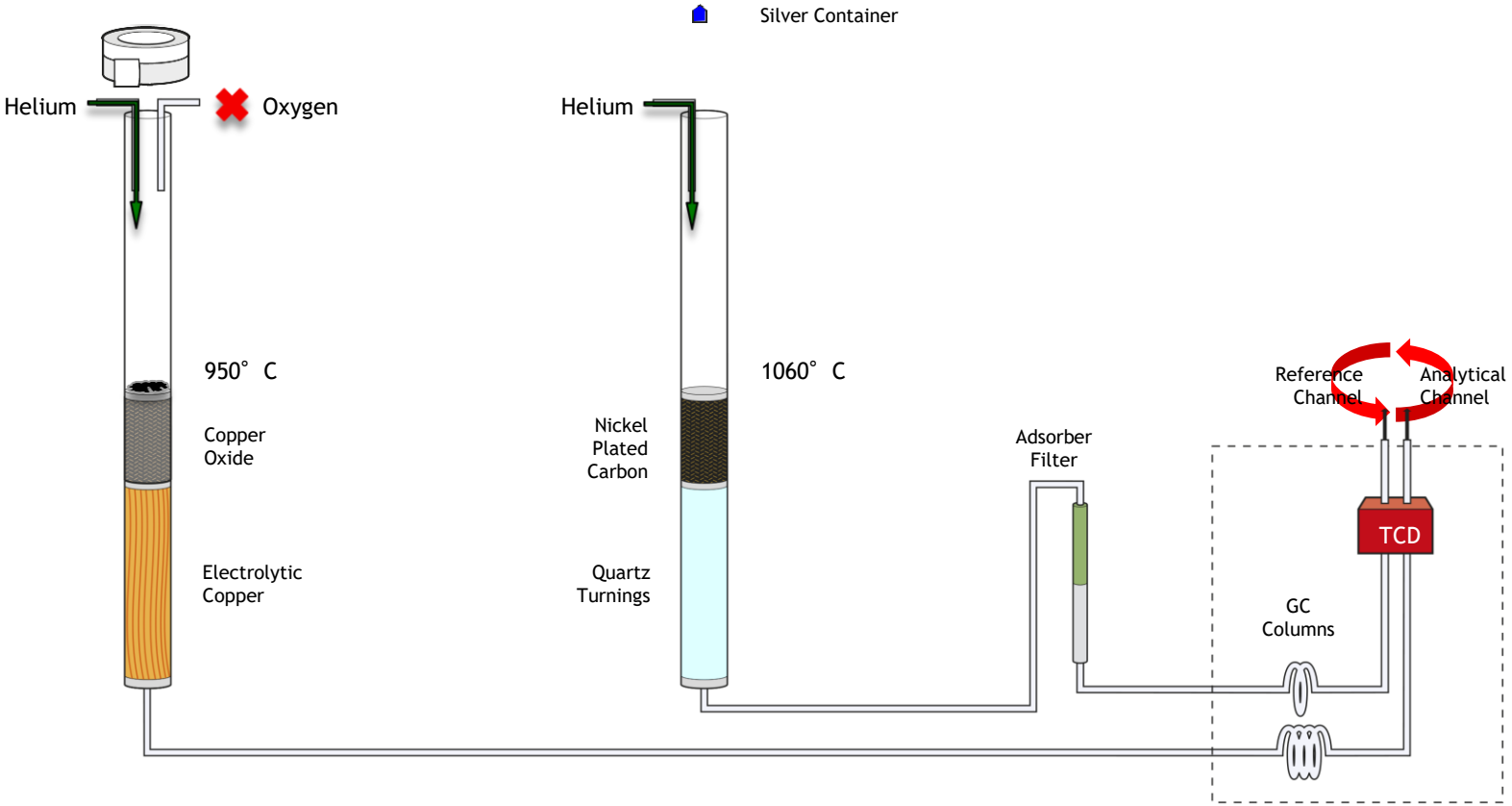
Principle of operation for Oxygen

- The system operates in pyrolysis mode.
- Samples are weighed in silver containers and introduced into the pyrolysis reactor from the auto-sampler.
- The reactor contains nickel coated carbon maintained at high temperature (1060 ^{o}C).
- The oxygen present in the sample, combined with carbon, forms carbon monoxide which is then chromatographically separated from other products and detected by the TCD Detector.

$$O_2 + 2C \rightarrow 2CO$$

Basic prerequisite: all Oxygen must be converted to CO

-Oxygen Analytical configuration



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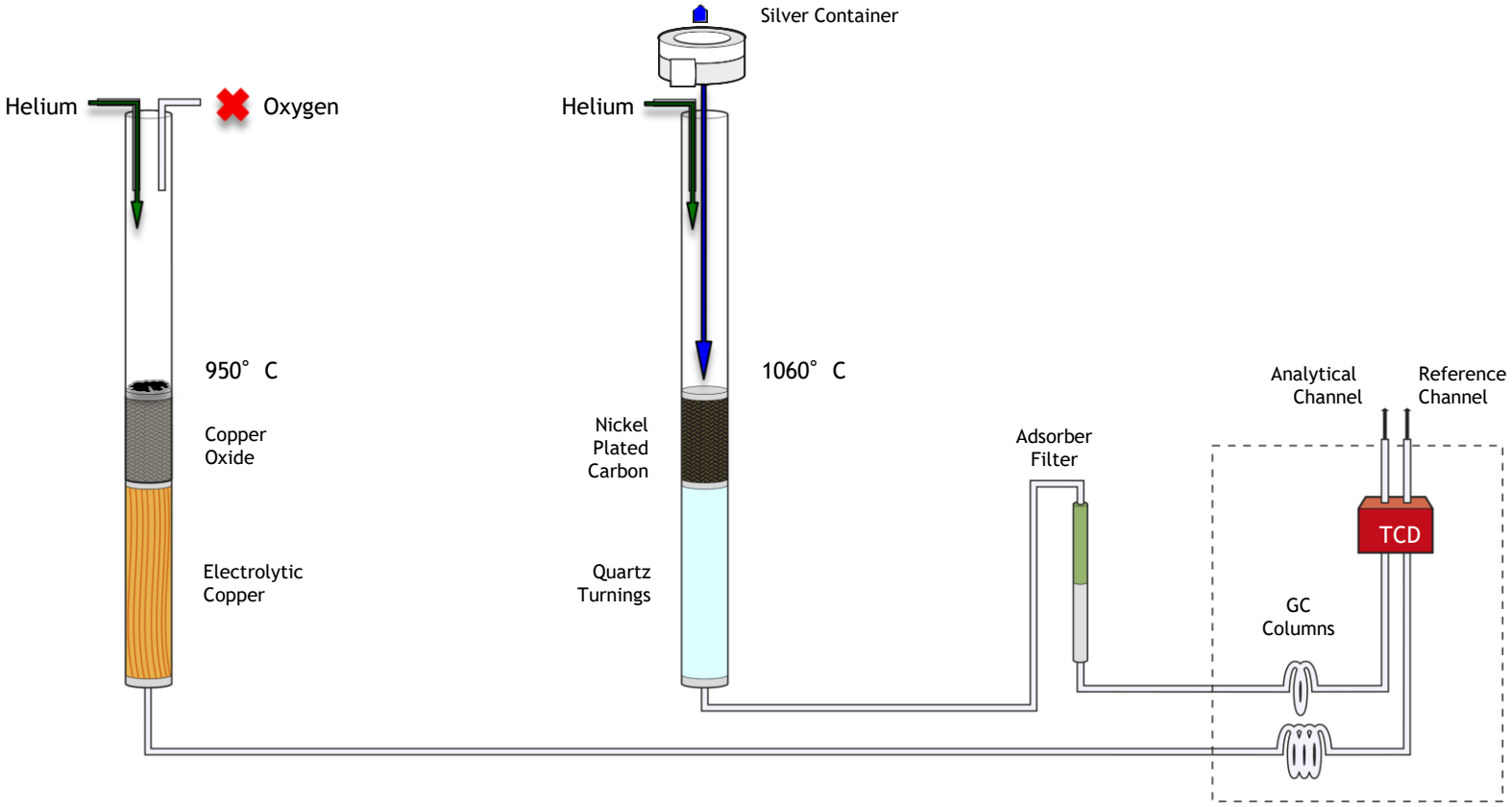
-Oxygen Analytical configuration



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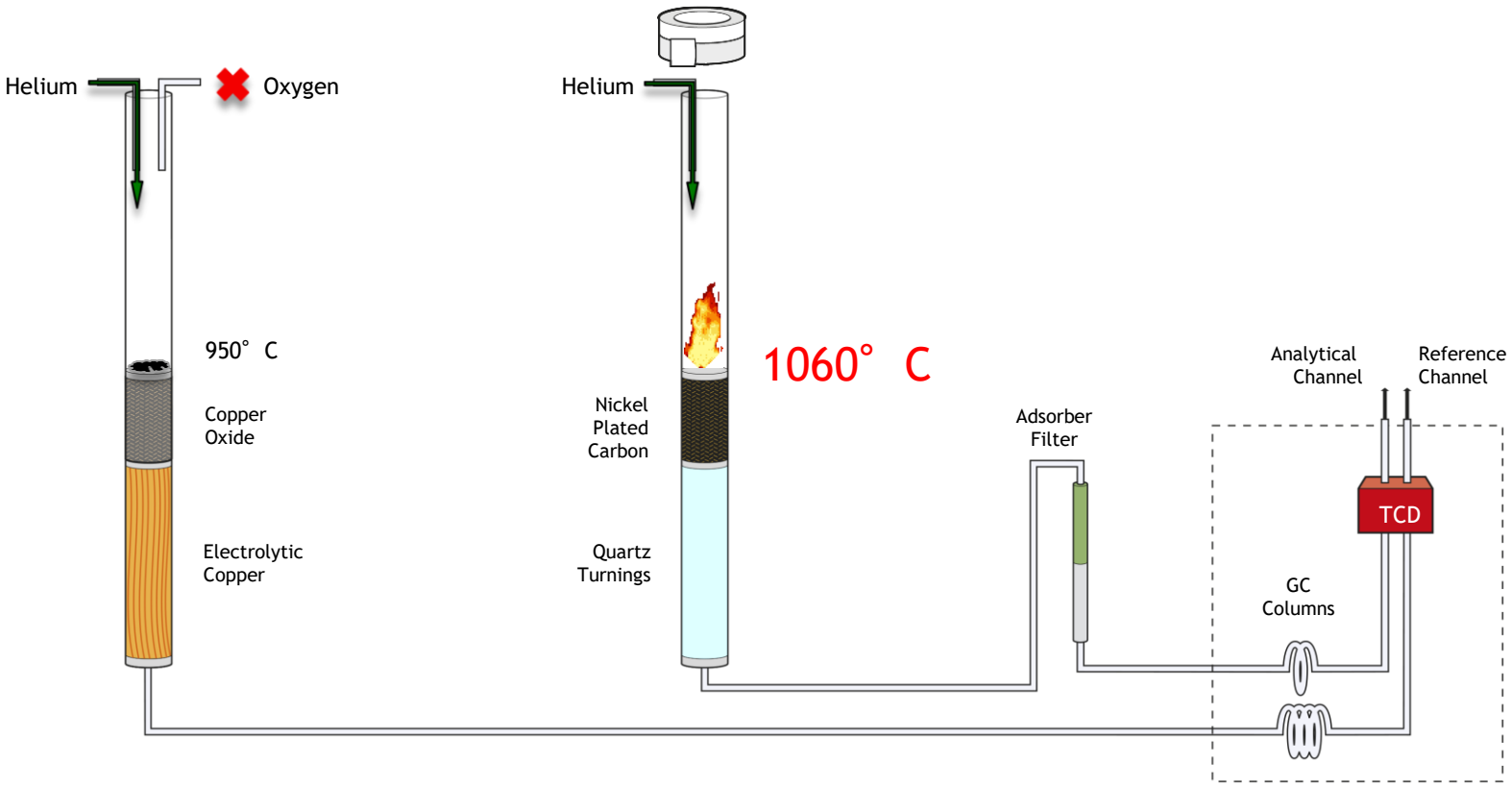

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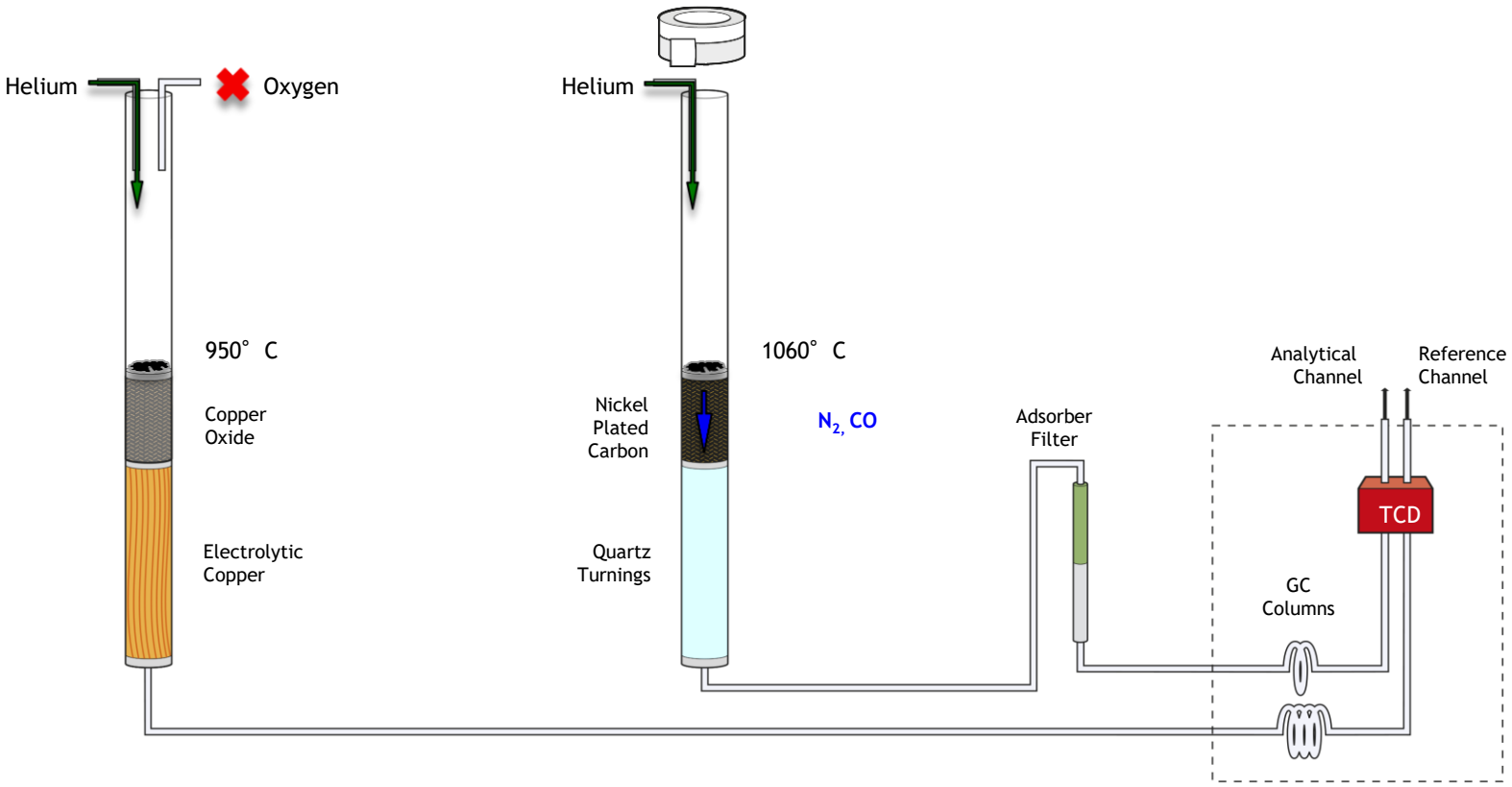

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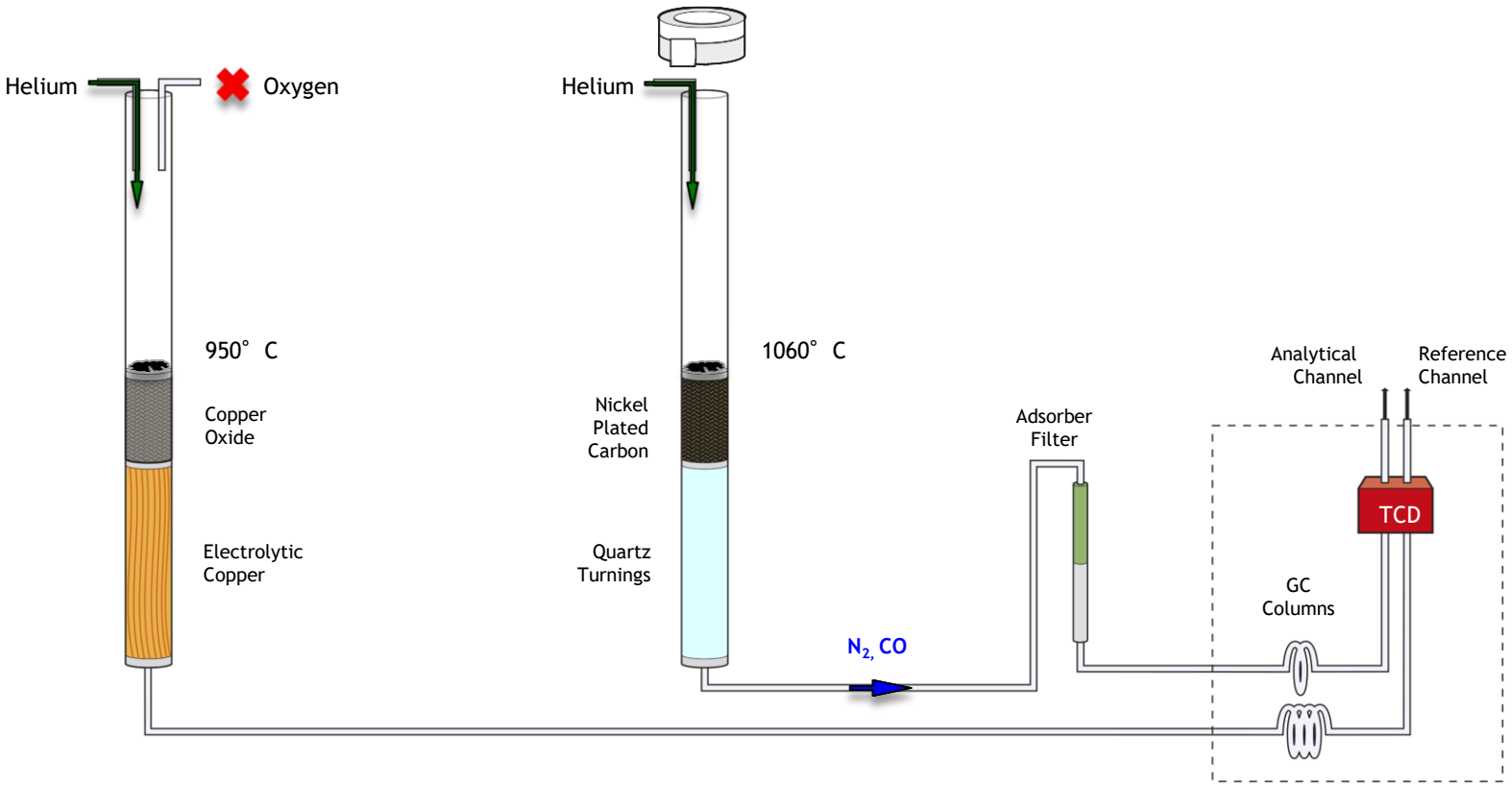

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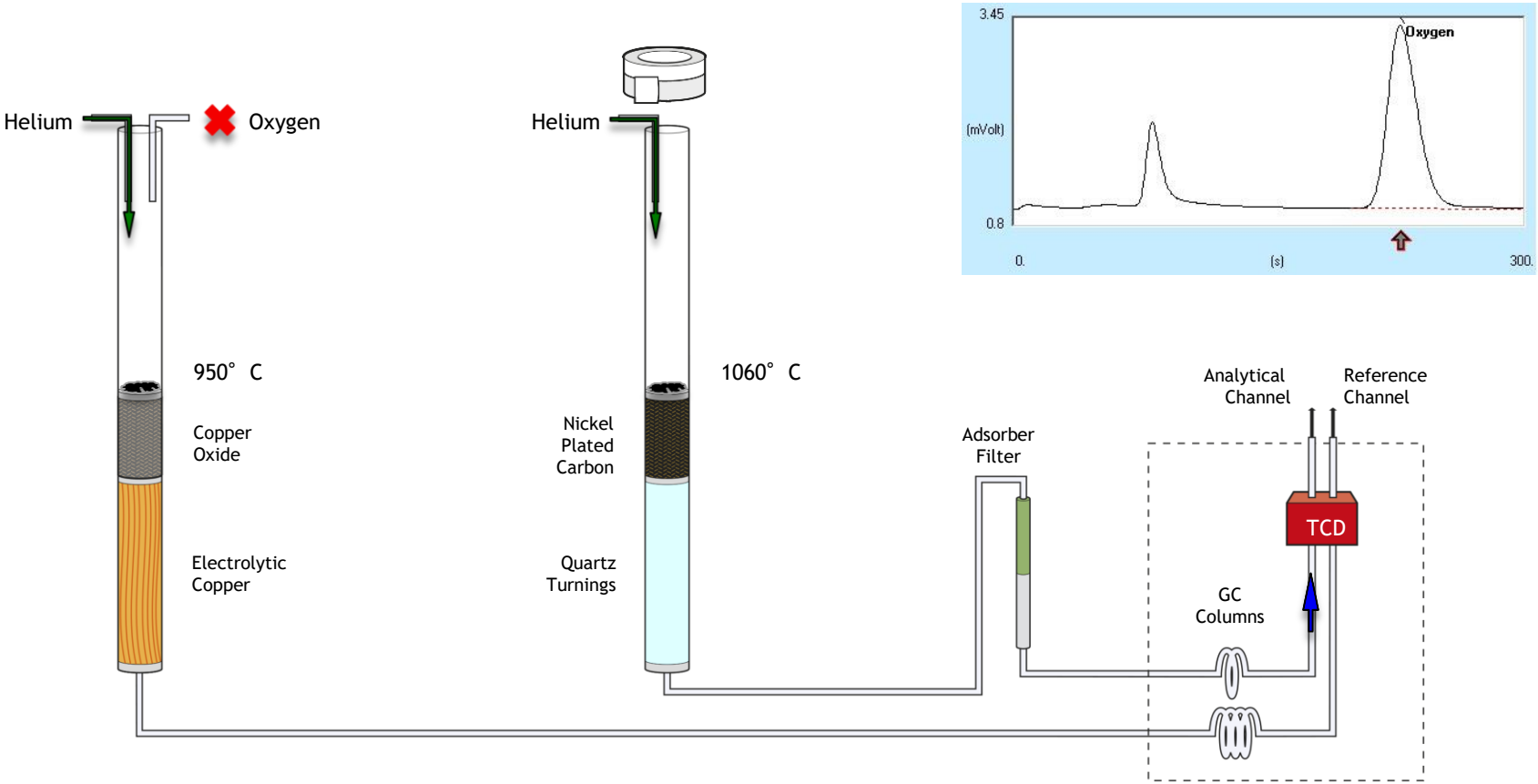

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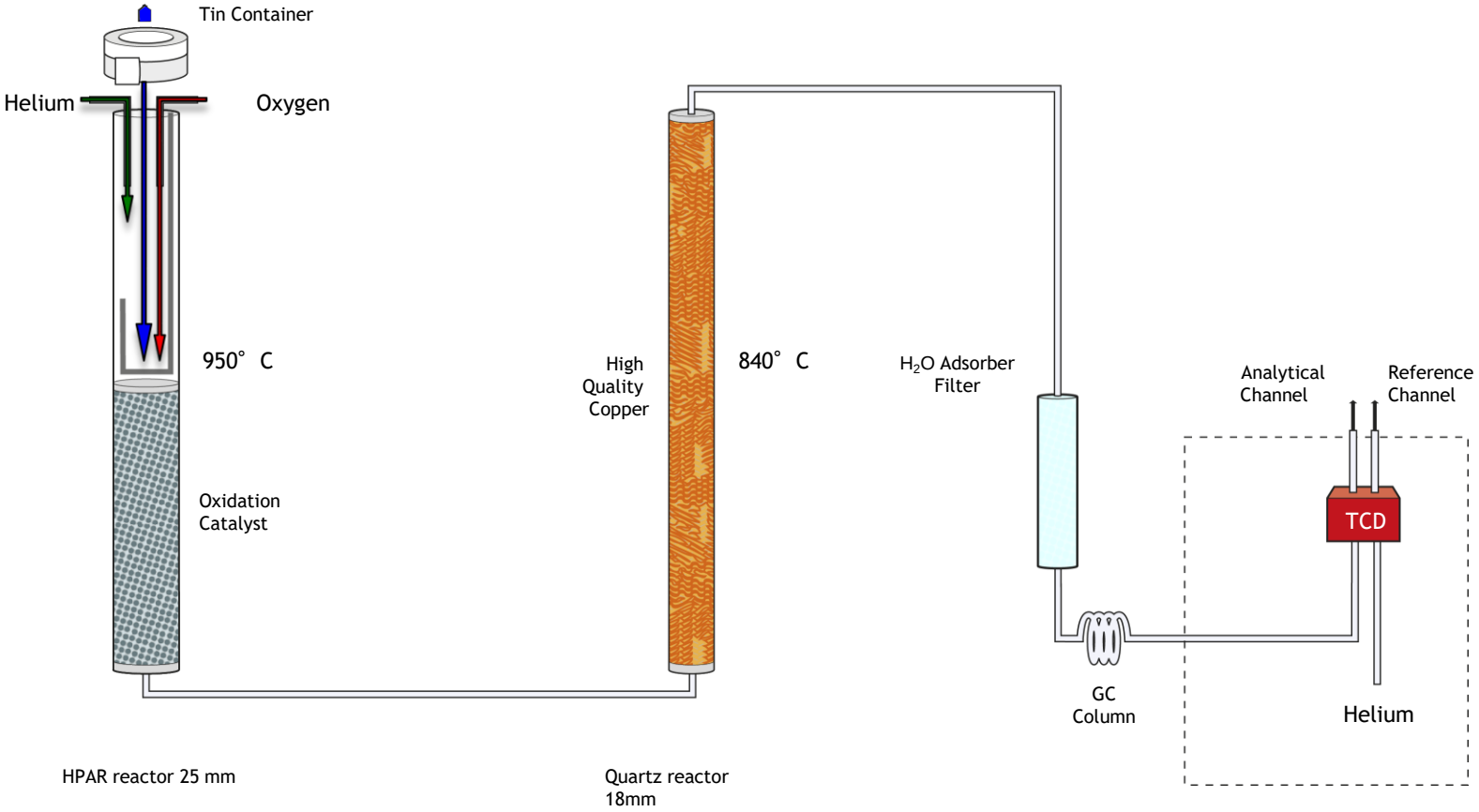
Nitrogen Carbon configuration



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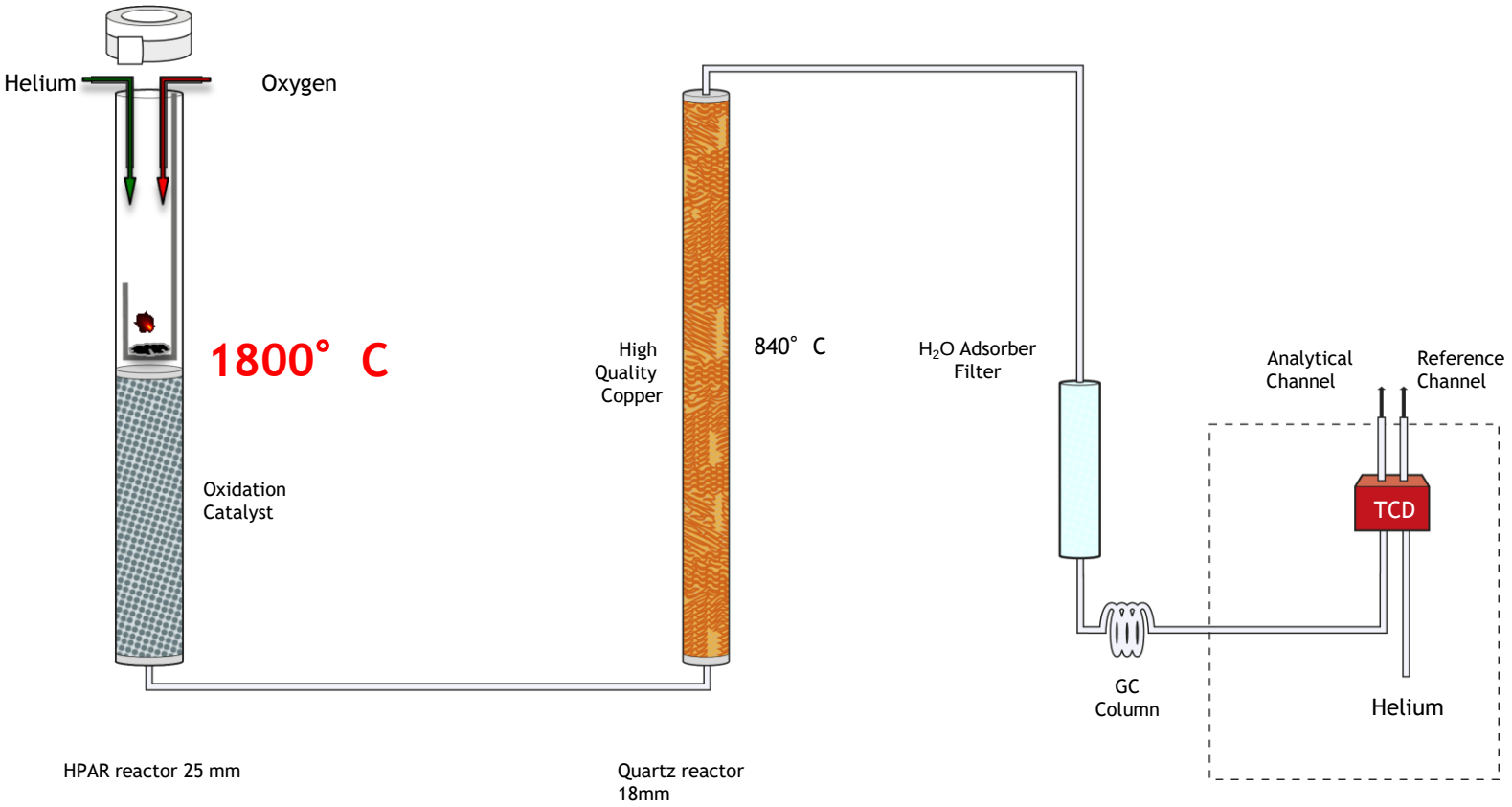

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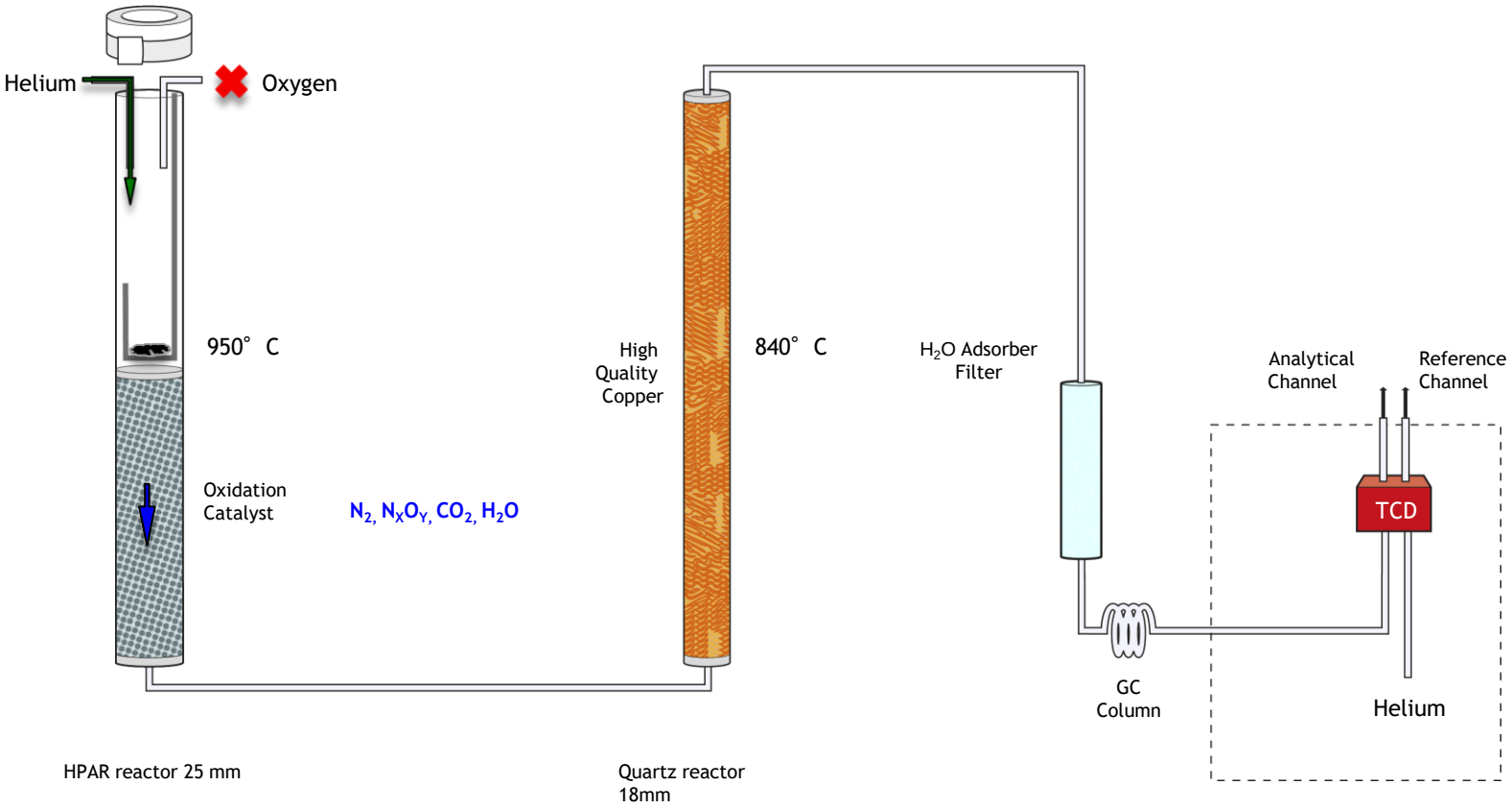

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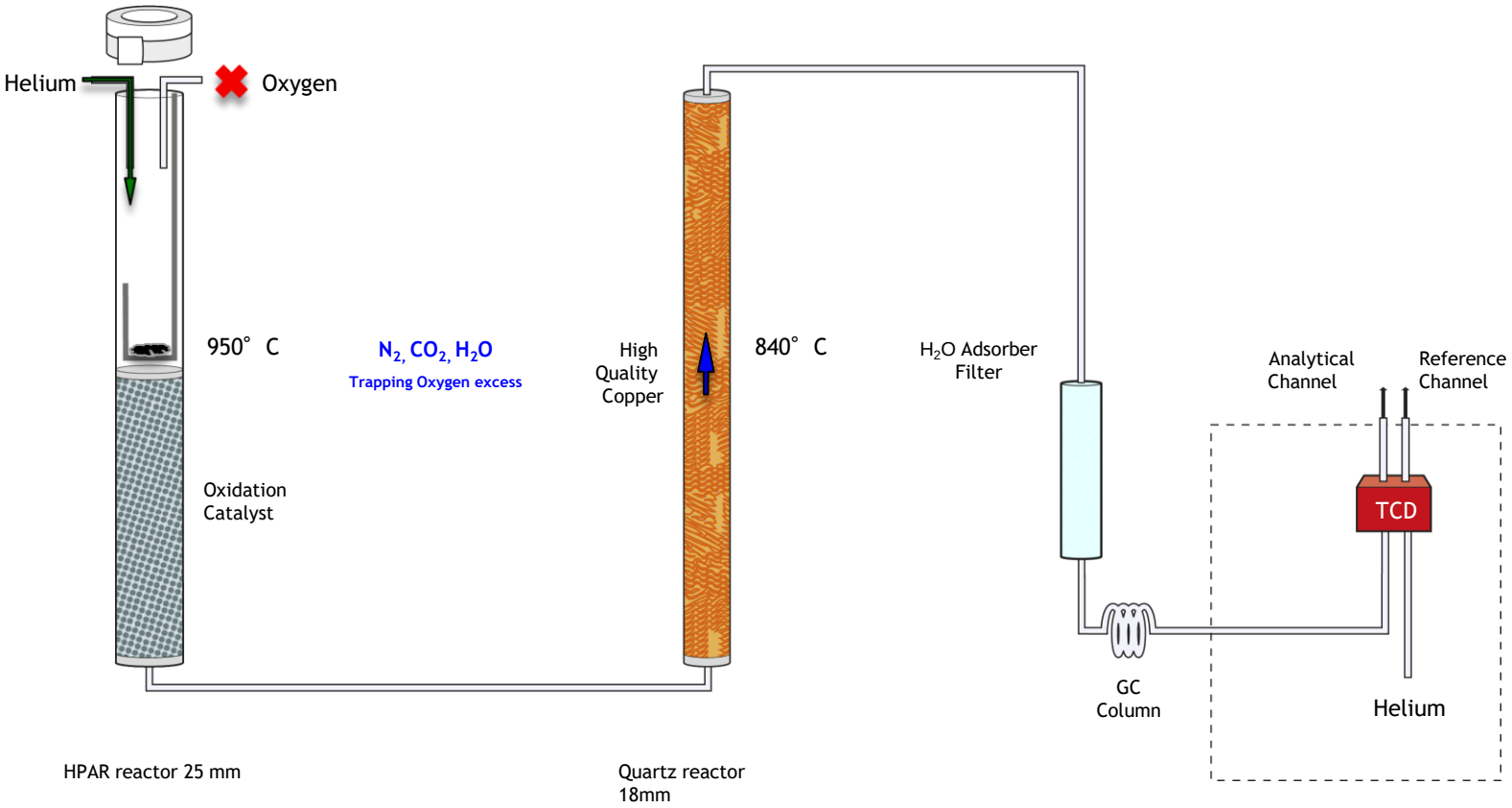
Nitrogen Carbon configuration



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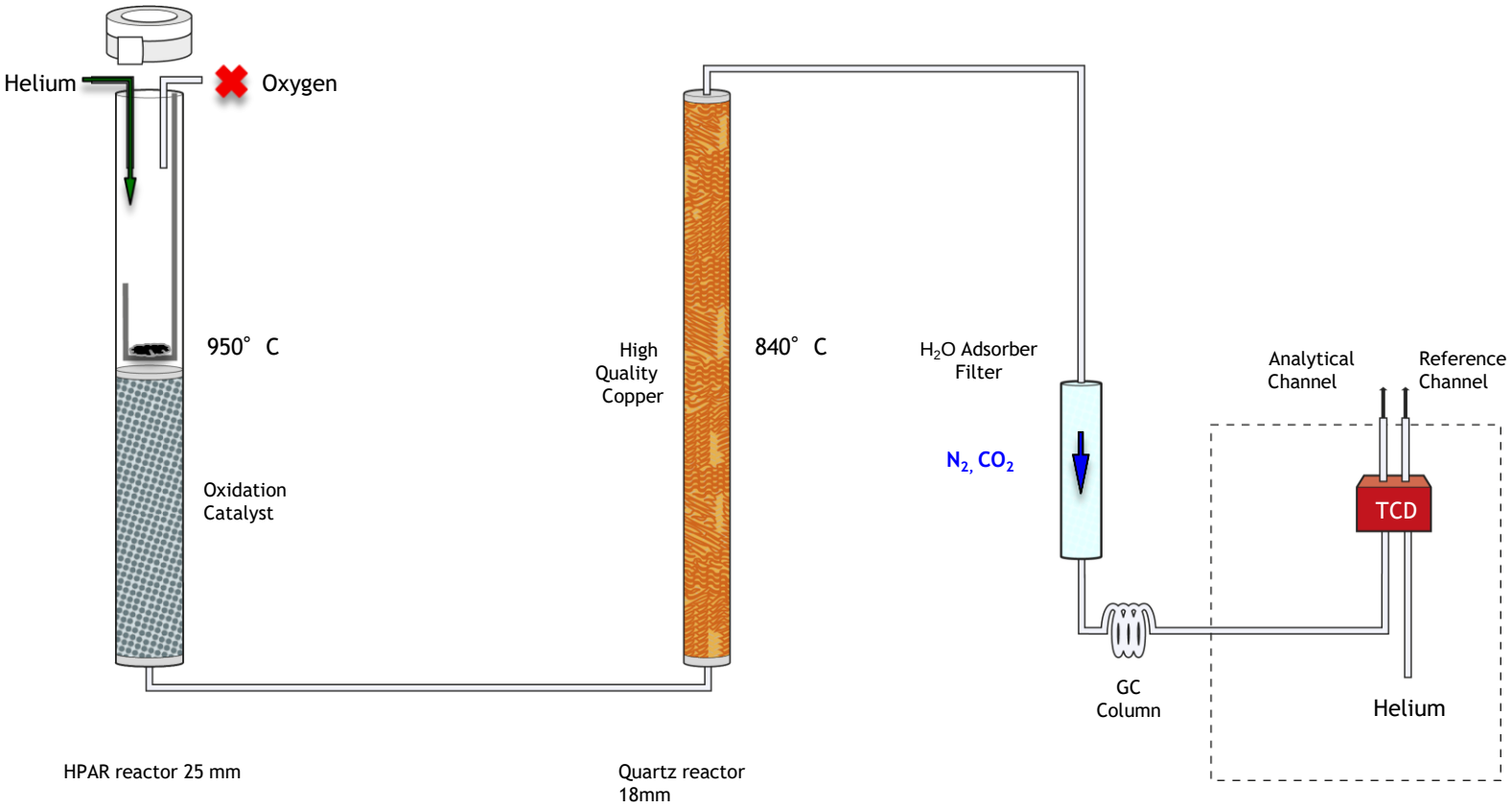

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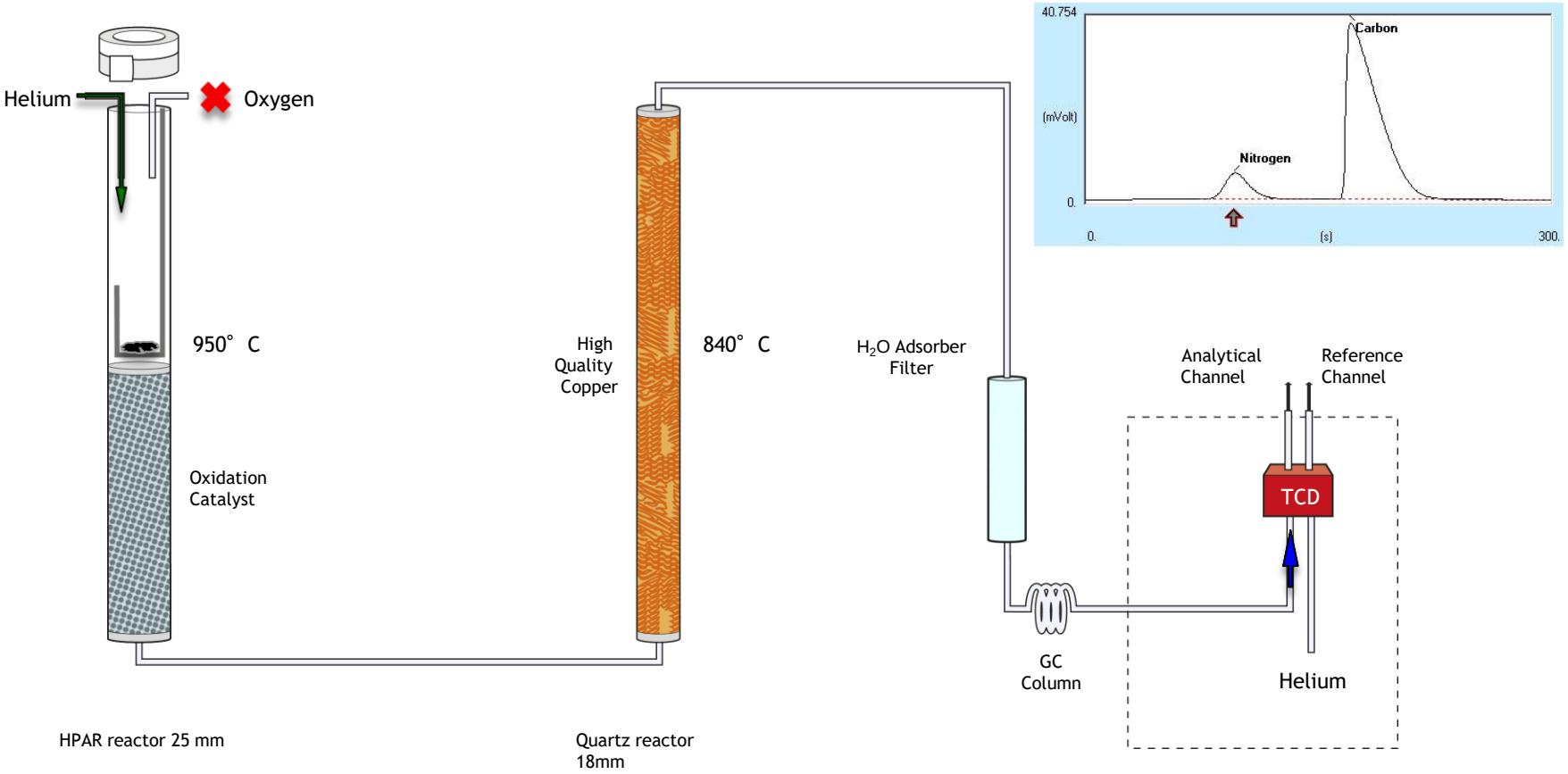

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Characteristics

Measuring range	0.01 % (100 ppm) to 100 % for solid	
Sample Size	CHN, CHNS, NCS, CHN/O, CHNS/O, CHN/CHN, CHNS/CHNS	0.01-100 mg (according to the sample nature)
	N Org, NC org	0.01-300 mg (according to the sample nature)
	N Lubricant	5-20 mg (according to the sample nature)
	NC Soil	1 mg to 1 g (according to the sample nature) Nominal size for soil material (NC det.) : 50-100 mg (if the material contains low C% such as sand, the weight can increase up to 1 g)
	N/Protein, N Brew	10 mg to 1 g (according to the sample nature)

Characteristics

Analysis Time	CHN, CHNS, NCS, CHN/O, CHNS/O, CHN/CHN, CHNS/CHNS	CHN less than 7 mins CHNS and NCS less than 10 mins Oxygen less than 5 mins
	N Org, NC org	Less than 5 mins
	N Lubricant, N Brew	Less than 6 min (according to the sample nature)
	NC Soil	Less than 5 min (according to the sample nature)
	N/Protein	Less than 5 min (according to the sample nature)

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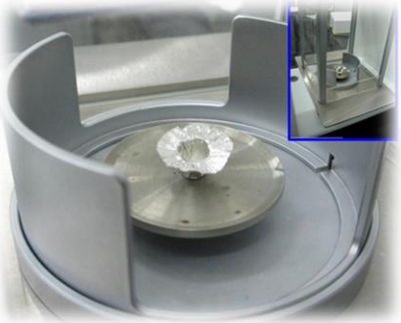
Containers

Soft Tin

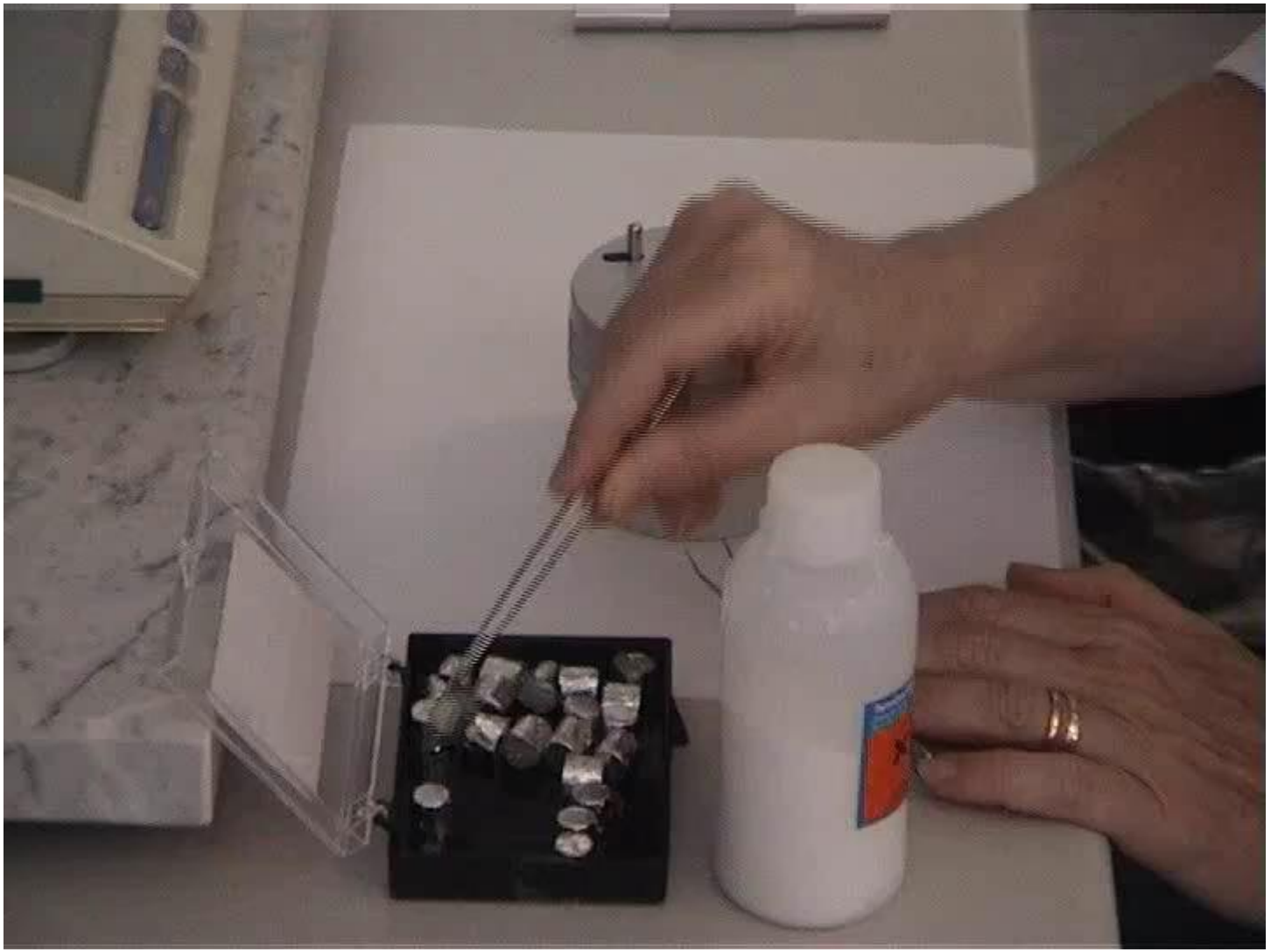
Soft Silver

Sealing Device for LargeTin Containers

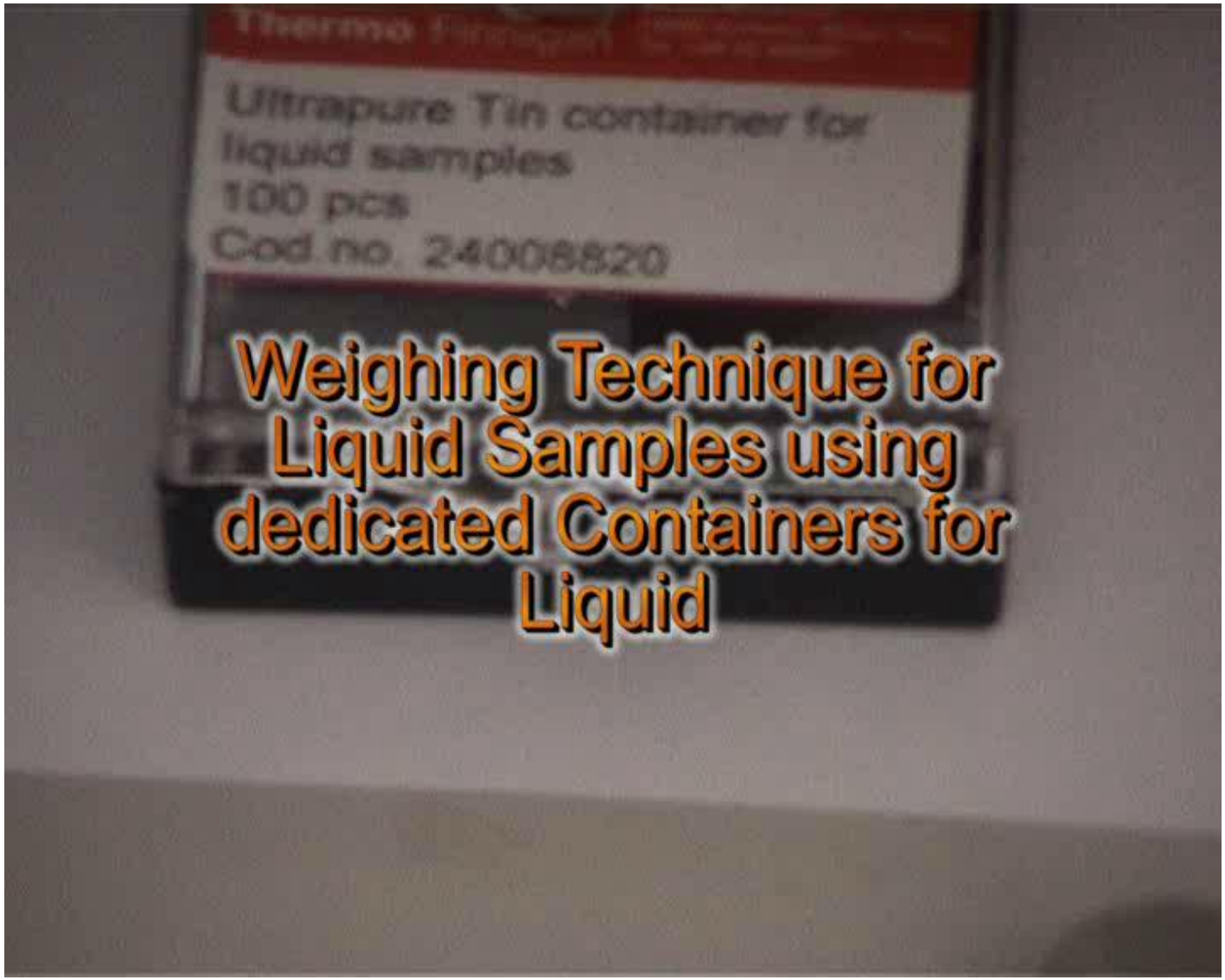


Solid

Liquid



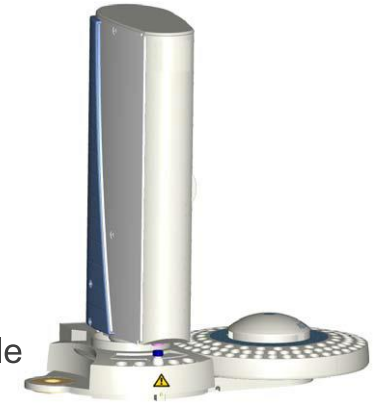
Liquid



Components of OEA - Autosampler

32-125 samples

Liquid sample



FLASHSMART

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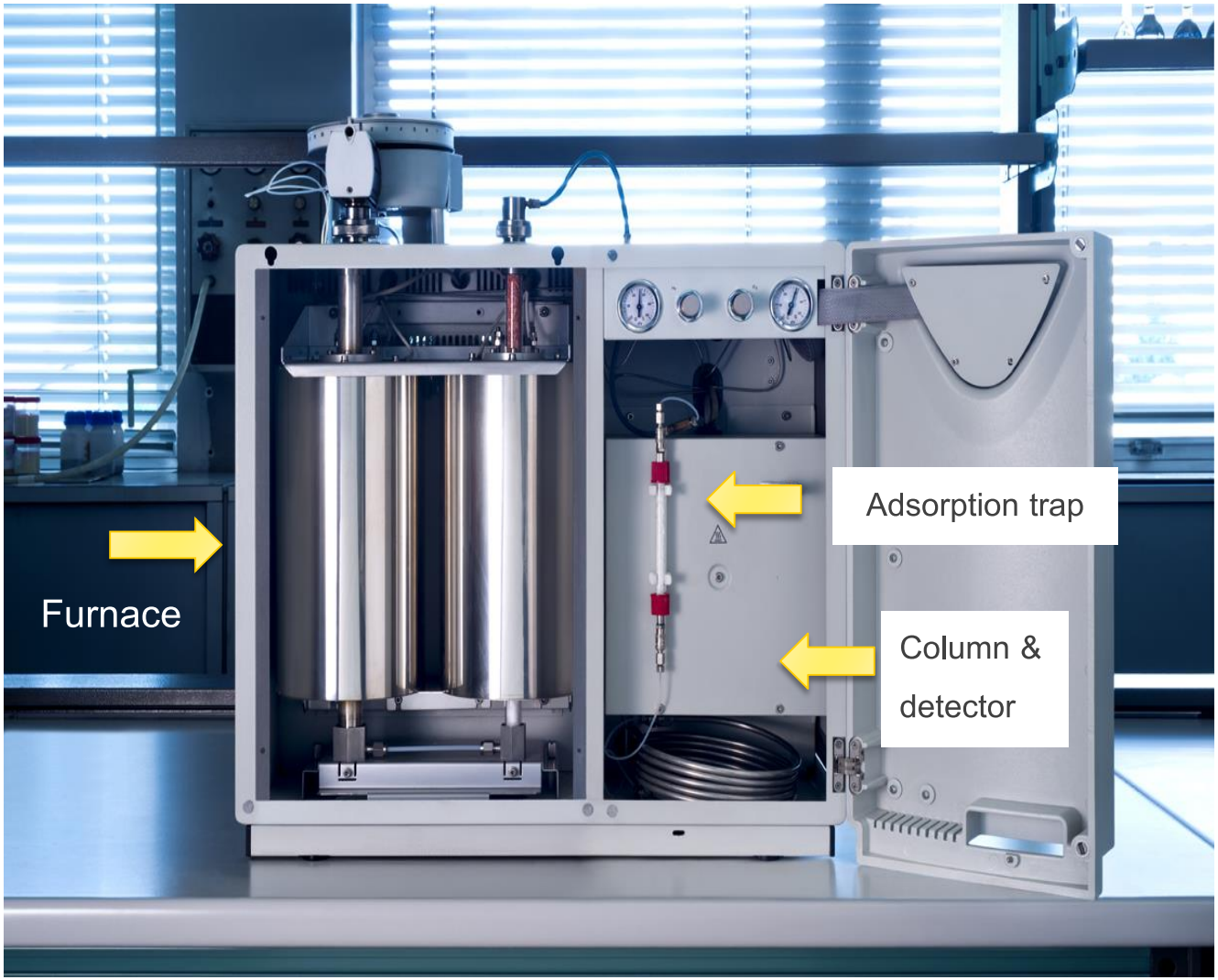
Furnace



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Furnace

- One or two totally independent furnaces
- Maximum temperature of 1100 °C
- Furnace design: fast heating
- Decrease by 50% of the furnace temperature in Stand-By Mode
- Unique serial number for each furnace
- For oxygen determination (by pyrolysis), the same furnace is used
- 15-year warranty under standard operational conditions
- Easy to install
- Easy to use

Label with the Serial Number

Reactors and traps

- The reactors can be quartz tubes or special steel tubes.
- Pre-packed tubes for most configurations
- “Quick Connector” : no more tools needed
- Computer guided maintenance schedule

Pre-packed CHN reactor (Argon sealed)

EASY TO USE AND SIMPLE TO MAINTAIN

Reactors and traps

Type of Catalysts:

CuO (for CHNS, NCS, S, N, NC),

Cr_2O_3 (for CHN),

Mix of Copper oxide and Pt on alumina

(for N Lubricant, N/Protein, NC Soil)

Type of Copper:

Electrolytic Copper for CHNS / NCS / S configurations

Copper in small wires for all the other

configurations.

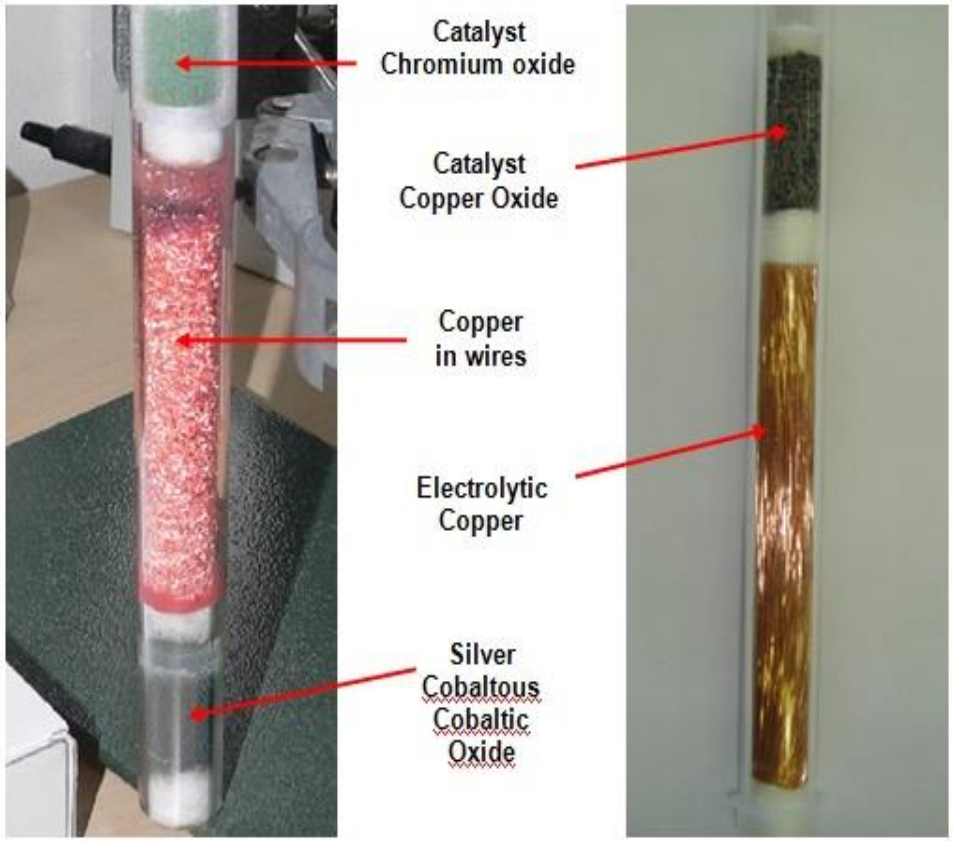
Silver cobaltous-cobaltic oxide

(for CHN, N, NC).

Trap the Sulfur and halogens (except fluorine)

CHN

CHNS



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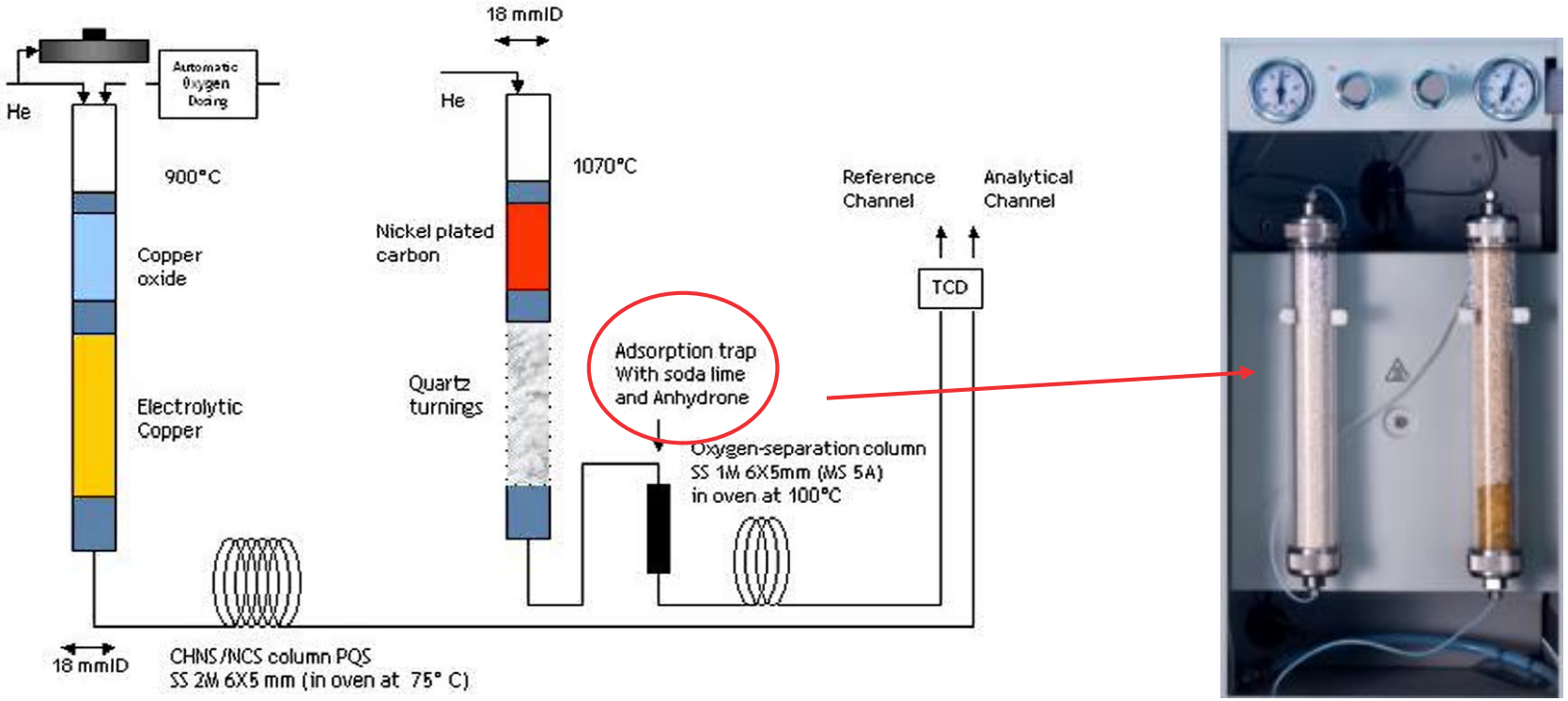
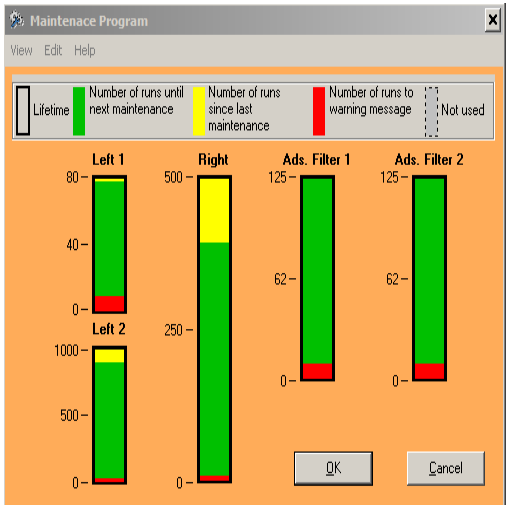
Reactors and traps



1. Anhydrone (Magnesium perchlorate)
2. Soda Lime
3. Molecular Sieve 3 A^{o} / Silica Gel plus indicator

Lifetime Reactors according to the configuration (number of analysis)

Configuration	CHN, CHNS, NCS, S Oxygen	N org, NC org double reactors	N Lubricant double reactors	NC Soils double reactors	NC single reactor	N/Protein double reactors	N/Protein single reactor
Reactor	250 - 300	Comb. 400 - 500 Red. 400 - 500	Comb. ≥ 3000 Red. ≥ 1500	Comb. ≥ 1000 Red. 400 - 500	≥ 400	Comb. ≥1000 Red. 500 - 1000	≥ 550
Traps	H_2O Trap 120 - 150	CO_2 Trap ≥ 120 H_2O Trap ≥ 120	CO_2 Trap ≥ 200 H_2O Trap ≥ 200	H_2O Trap ≥ 120	H_2O Trap 90 - 150	CO_2 Trap ≥ 120 H_2O Trap ≥ 120	CO_2 Trap 150 - 170 H_2O Trap 150 - 170



Note: the lifetime depends of the sample nature and sample weight

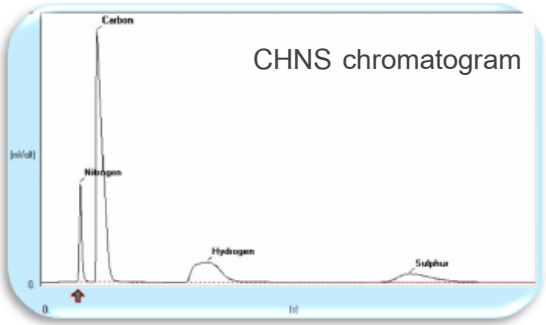
GC Columns and Detectors

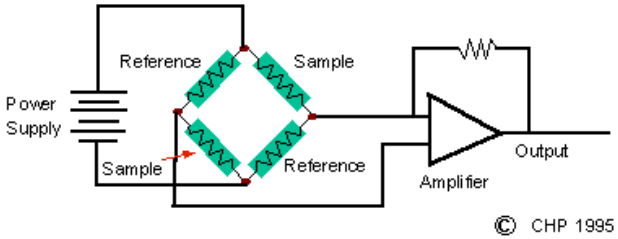
- The Column can be kept at room temperature or it can be placed in the thermostatic chamber of the TCD
- Maintenance free, Long lifetime GC column operating for years without the need for replacement

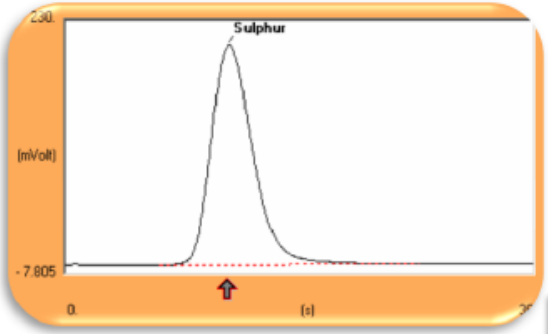
CHNS-O / CHN-O

	Characteristics				Analytical Determination														
	Material	Length (cm)	OD (mm)	ID (mm)	CHNS	CHN	NCS	S (TCD)	S (FPD)	O	N	N/Protein	N-Brew	NC	NC-Soil	NC-Sediments	NC-Filters	IRMS (NC)	HT (NC)	HT (O/H)
Columns	Steel	100	6	5						✔										✔
		200	6	5										✔	✔	✔	✔			
		300	6	5														✔	✔	
	PTFE	15	6	4					✔											
		50	8	6							✔	✔								
		80	6	4				✔												
		100	8	6									✔							
		200	6	5	✔	✔	✔													

GC Columns and Detectors





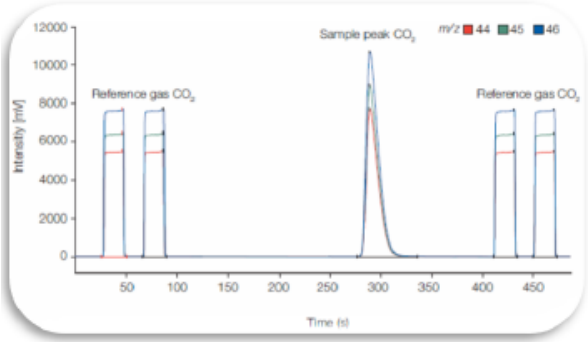


Trace Sulfur chromatogram

TCD

FPD

IRMS



Isotope chromatogram

Total Sulfur determination at very low level (5-10 ppm)

The chromatogram works as an **"open window"**, giving information on what is happening inside the analyzer in real-time.

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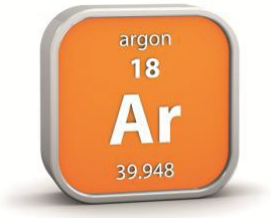
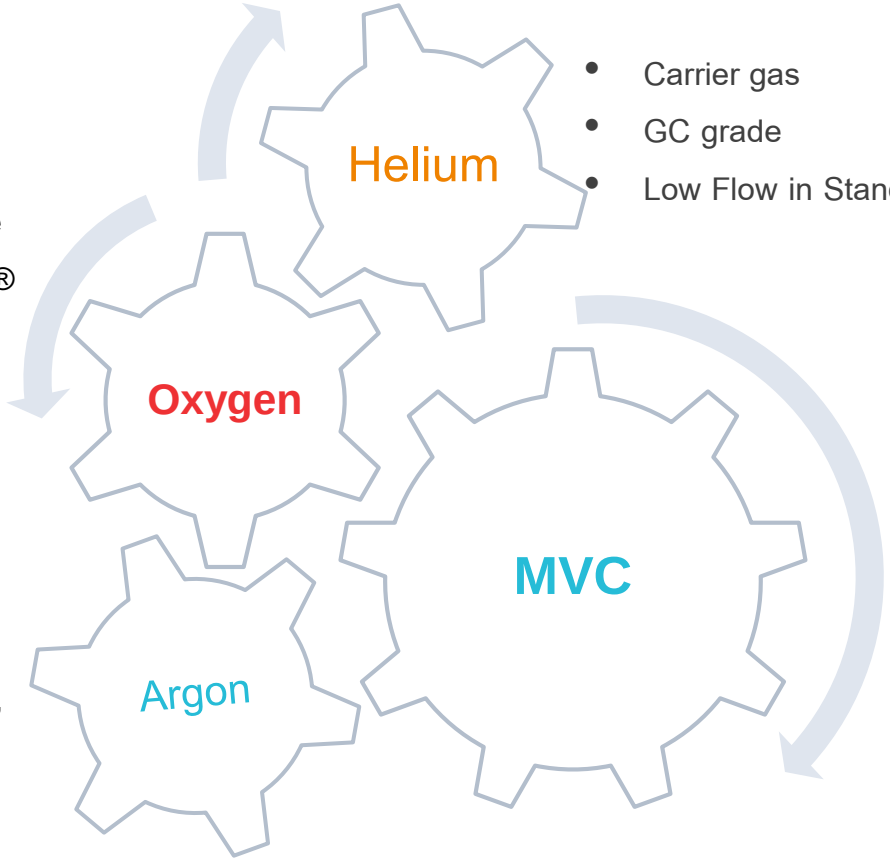
Gas system



- GC grade
- OxyTune®



- Carrier gas
- GC grade
- Low Flow in Stand-By Mode

- Switch from Left to Right
- Switch from He to N_2/Ar

- Carrier gas for N, NC, CHN det.
- For Stand-By Mode

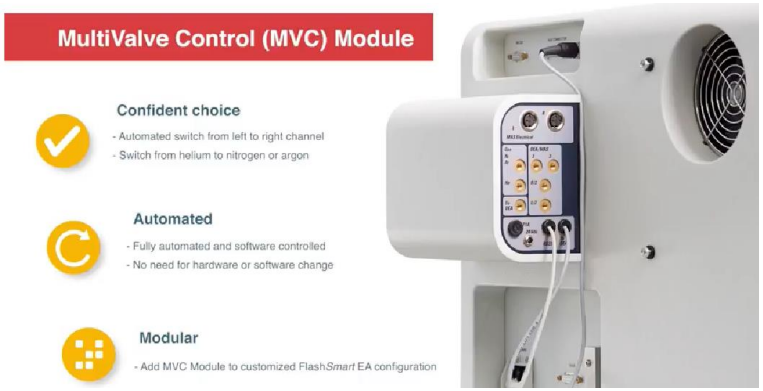
Helium Consumption : Carrier gas

Helium consumption	Always Ready	Option 1 Standby-mode	Option 3 MVC module (N_2 standby)	Option 4 Argon gas Carrier gas
Configuration	All	All	CHN/O, CHNS/O, CHNS/CHNS, CHN/S, NCS/O, NC/S	N org, N/Protein, NC org, NC soil, CHN
Per working day – 8 working & 16 Standby hours	345 L	134 L	115 L	0 L
Per one week - 5 working day	2149 L	729 L	576 L	0 L
Per month – 4 weeks	9676 L	2918 L	2310 L	0 L
Lifetime / week	~ 3	~ 9	~12	-

The analytical times are taken as **8 hours per day for 5 days** and all other time the Analyzer is in Stand-By Mode.

The values are calculated from a carrier gas flow of 140 ml/min and reference flow of 100 ml/min during analysis times and carrier gas flow of 10 ml/min and reference flow of 10 ml/min during Stand-By Mode.

Helium bottle 7,000 liters, 200 bar



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MVC function analysis

- ✓ Switching from Left to Right furnace or from Right to Left furnace automatically
- ✓ Reduce the consume of helium carrier gas switching to N_2 or Argon gases.
- ✓ Standby automatic function using He, N_2 or Argon gases
- ✓ Auto-Ready: return automatically to Helium as carrier gas if the system remained with N_2 or Argon gases in Standby

MVC Module

The only Fully automated OEA in the Market by Thermo Scientific

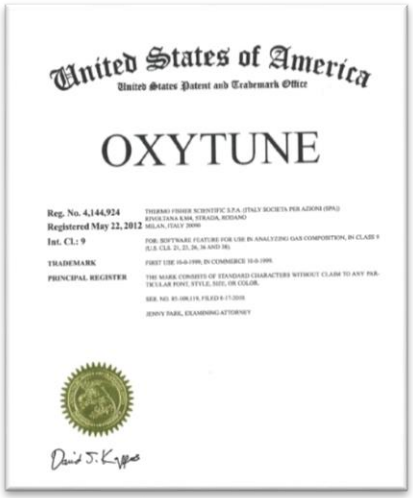
ThermoFisher SCIENTIFIC

OxyTune® Function

Oxygen

Oxygen cylinder lifetime based on a cylinder containing 7,000 liters, 200 bar

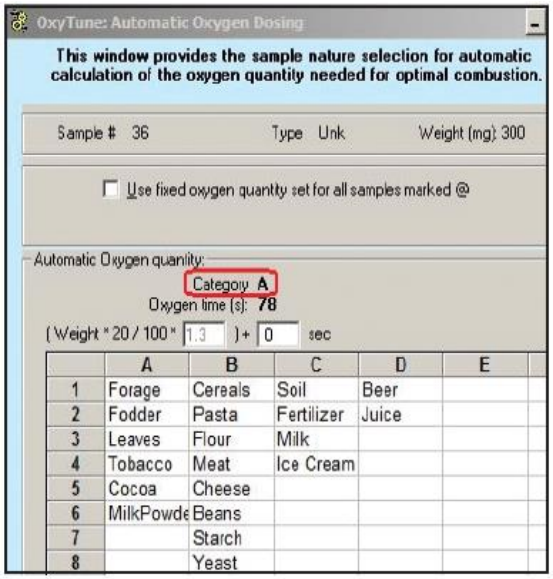
Configuration	CHN/CHNS/NCS	NC soils	N / Protein			
			Category A	Category B	Category C	Category D
Oxygen consumption / Day	12.083 L	9.167 L	31 L	27 L	15 L	9 L
Days per Oxygen bottle	579	763	225	259	466	777
Months per Oxygen bottle	~19	~25	~7	~8	~15	~25

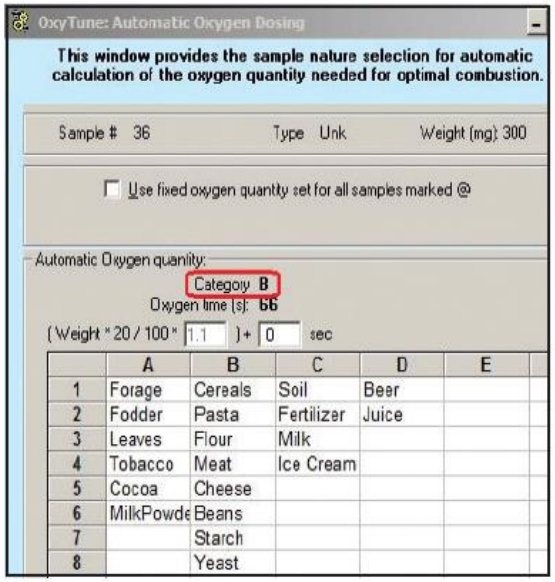

United States of America
United States Patent and Trademark Office

OXYTUNE

Reg. No. 4,144,924
Registered May 22, 2012
Int. Cl.: 9

TRADEMARK
PRINCIPAL REGISTER





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Application Fields

N/Protein in Food and Animal Feed

What are the typical Applications?

Cereals, malt, barley, beans and seeds

Milk and dairy products

Meat and meat products

Beverages

Animal feed

Food Supplements

What are the needs?

Easy to use and easy to maintain

Maximum flexibility

Automatism and Productivity

Low cost per analysis

Unattended operations

Comparable with Kjeldahl Method

Who is the user?

Universities & Res. Inst.

Quality Control

Food & Feed Producers

Contract Labs

Which Flash*Smart* configuration can we offer?

N / Protein

NC, CHNS/O, S

With or without MVC Module

AI/AS 1310 Liq Autosamplers

FPD detector

FlashSmart Features

Solids and liquid samples

High Automatism, Productivity & Modularity

Reduced consumption of Helium and Oxygen

Comparable with Kjeldahl Method

Kjeldahl method AOAC 981.10 - Crude Protein in meat

Method:

Weigh approx. 2 g of sample

Add catalyst: 7 g K_2SO_4, 0.25 g HgO

Add 15 ml H_2SO_4

Add 3 ml H_2O_2

Digestion at 410 ^oC for 45 min

Cool for 10 min

Add NaOH/ Na_2SO_3 solution

Steam distillation

Collect in H_3BO_3

Titrate with HCl

Kjeldahl user's nightmares !! SAFETY

Concentrated acids at boiling temp

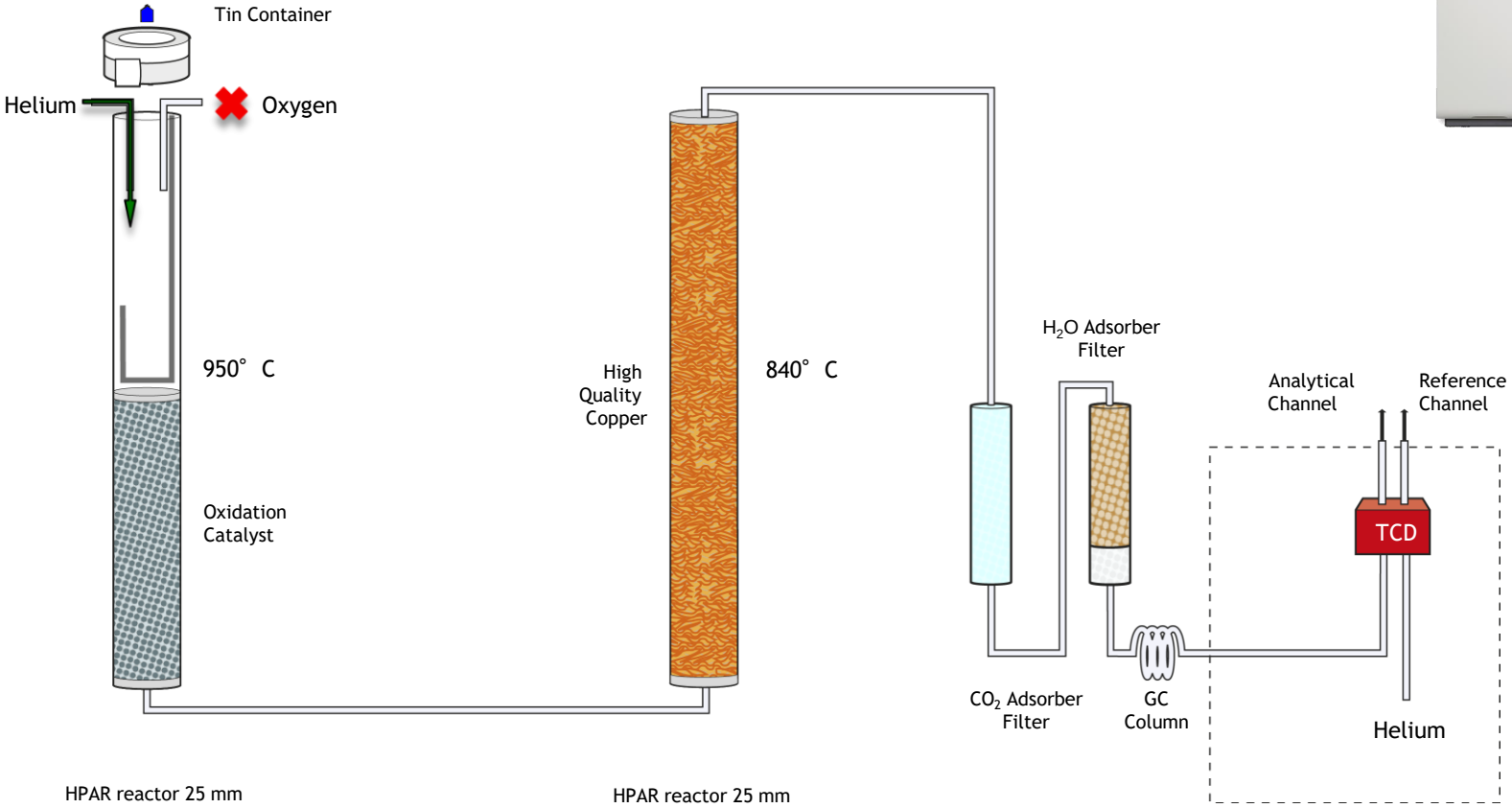
Toxic catalyst and chemicals

WASTE DISPOSAL

TIME CONSUMPTION

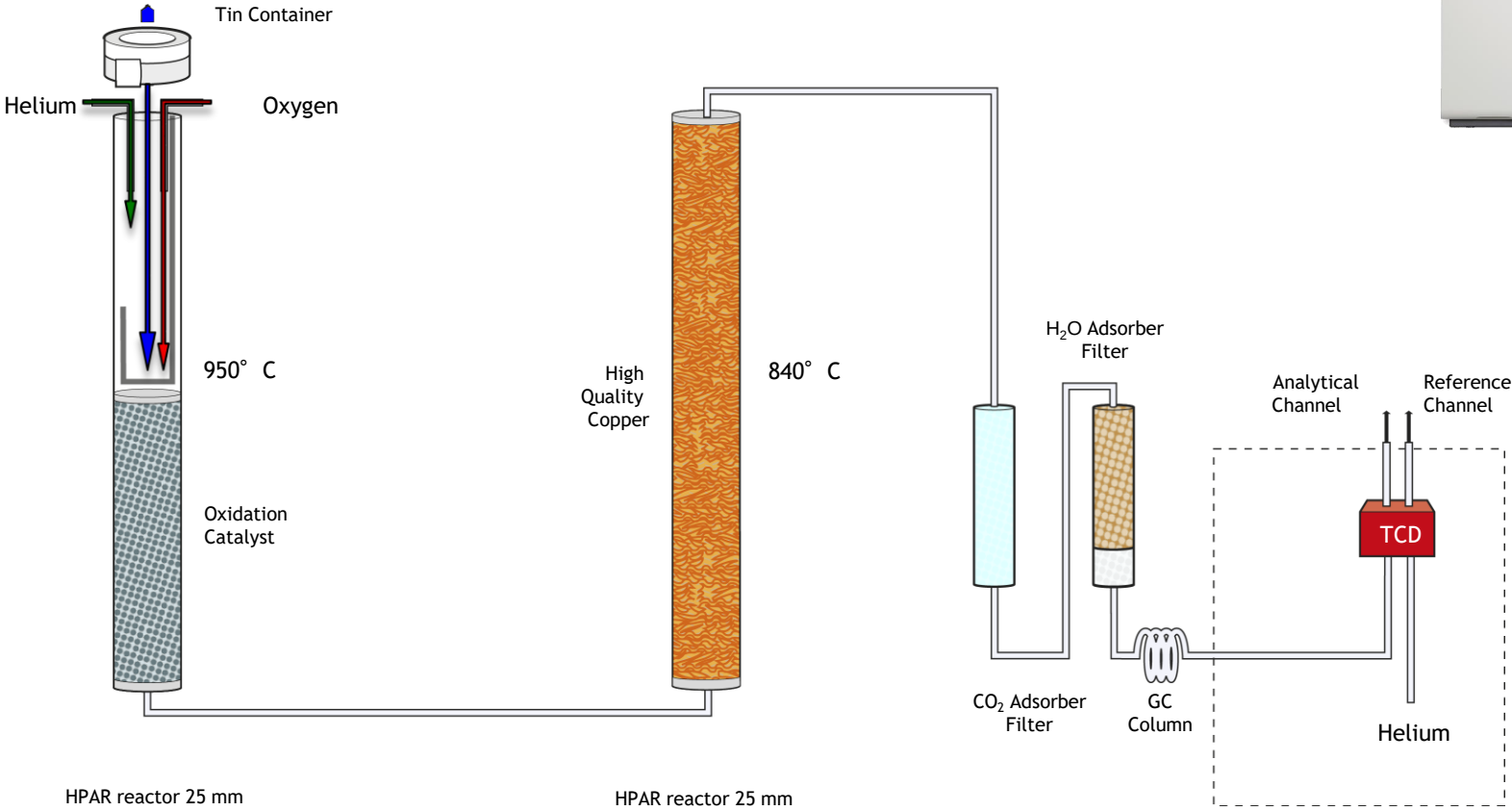
RELIABILITY OF RESULTS

Nitrogen/Protein configuration / double reactor



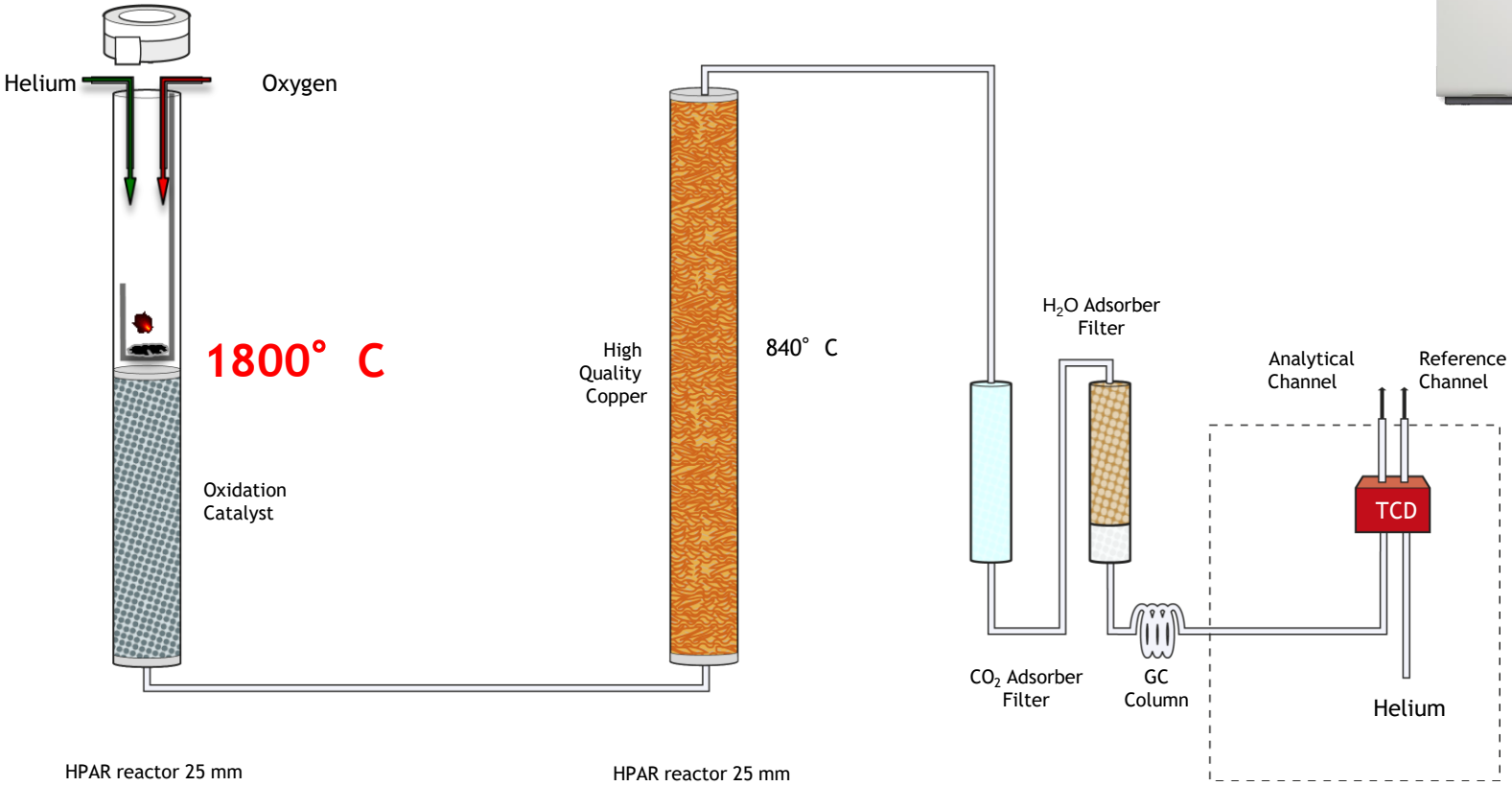
ThermoFisher SCIENTIFIC

Nitrogen/Protein configuration / double reactor



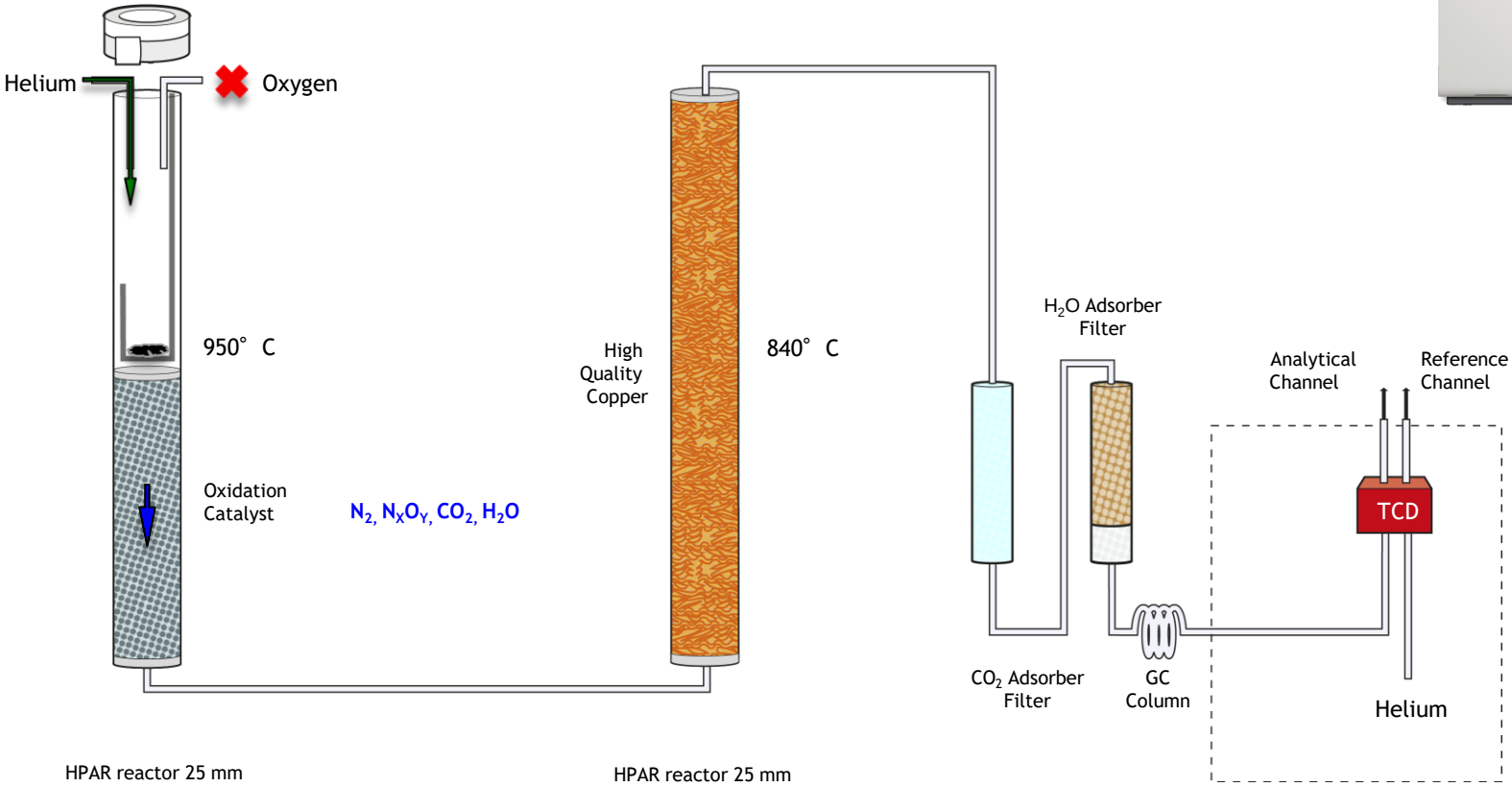
ThermoFisher SCIENTIFIC

Nitrogen/Protein configuration / double reactor

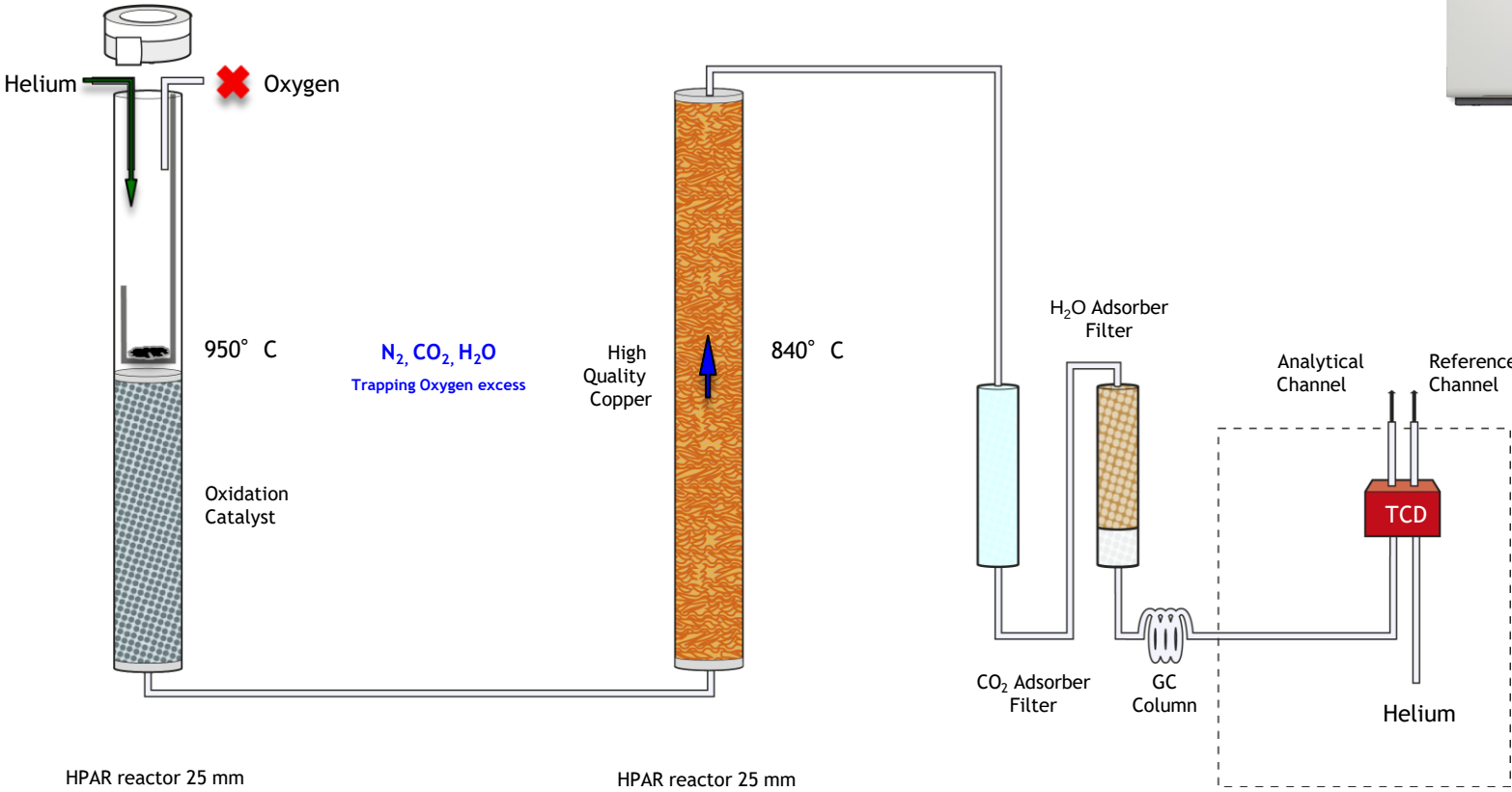


ThermoFisher SCIENTIFIC

Nitrogen/Protein configuration / double reactor

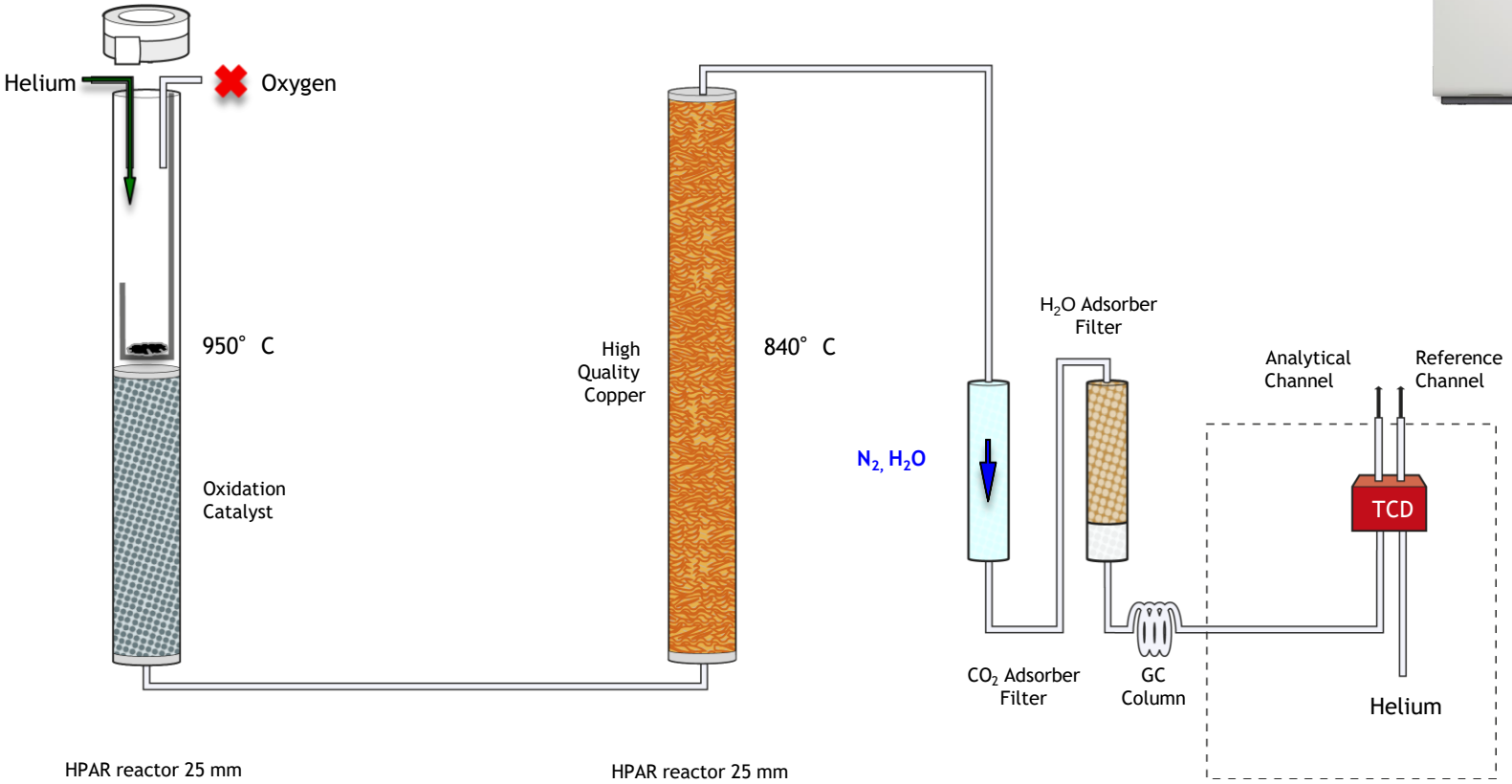


Nitrogen/Protein configuration / double reactor



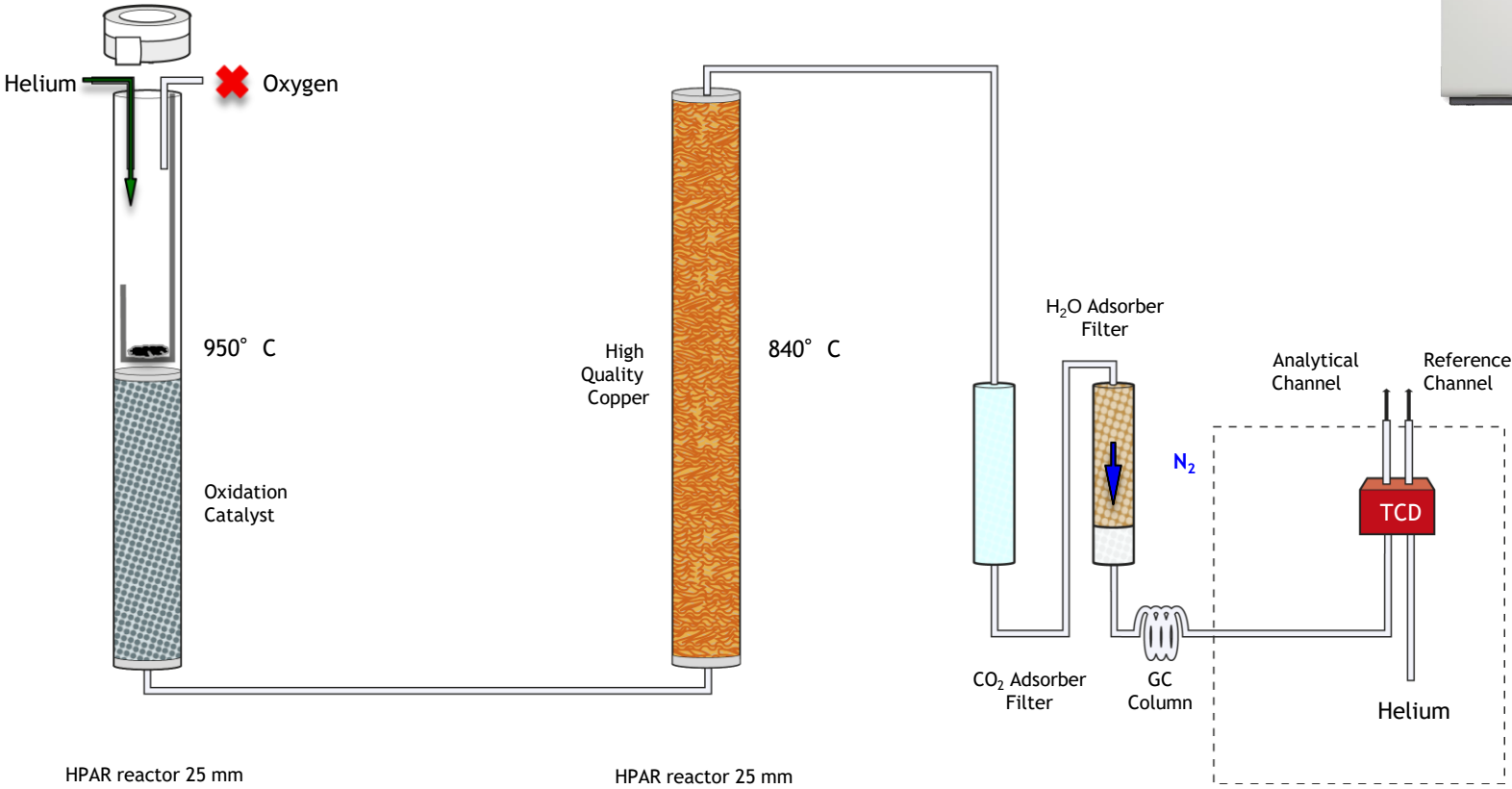
ThermoFisher SCIENTIFIC

Nitrogen/Protein configuration / double reactor



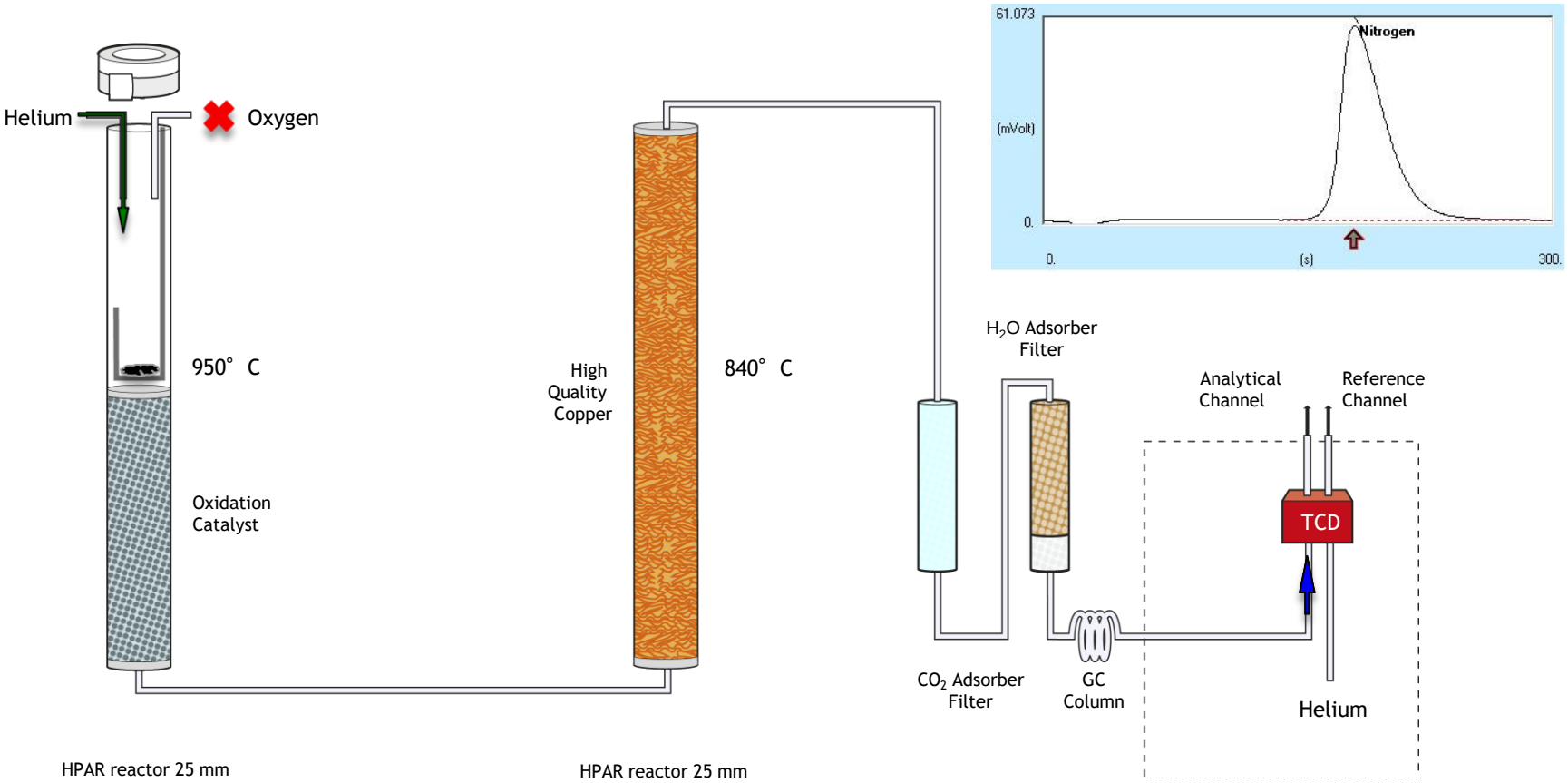
ThermoFisher SCIENTIFIC

Nitrogen/Protein configuration / double reactor



ThermoFisher SCIENTIFIC

Nitrogen/Protein configuration / double reactor



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OEA vs. Kjeldahl Method – Technical Comparison

Information	Kjeldahl method	OEA (Flash*Smart*)
Range of sample weight	500-1000 mg (2000 mg)	100-1000 mg (solid, viscous and liquid)
Procedure steps	Sample preparation Weighing –digestion –distillation –titration - Calculations - results	Sample preparation Weighing –Analysis- results
Timing		
Warming up	10-45 mins (once a day)	30 mins from standby mode Warming up is not needed using the wake-up automatic function
Preparation of reagent	10-20 mins	Filling of two reactors and two traps : 20 mins
Digestion	2-6 hrs	No
Cool down	20 mins – 2 hes	No
Nitrogen analysis time	10 mins	4-6 mins
Other steps	5-10 mins (distillation/titration, washing of distillation system)	No
Total time for one N determination	3-10 hrs	4-6 mins/sample (samples can be weighed during a sequence of analysis

OEA vs. Kjeldahl Method – Technical Comparison

Information	Kjeldahl method	OEA (Flash*Smart*)
Safety	High cost Concentration acids at boiling temp. Toxic catalyst and chemicals, corrosive Glass tubes Consumables : H_2SO_4 96-98%, NaOH 40% H_3BO_3 3%, HCl 0.1 N, $CuSO_4$5H2O, $ZnSO_4$, K_2SO_4 Damage	Low cost No fumes, acids and toxic reagents No atmospheric pollution Special stainless steel tubes Consumables : CuO, Pt on alumina, Copper, Soda lime, molecular sieve, quartz wool, silica gel The separation column is not a consumable
Lifetime of instrument	Moderate lifetime due to acidic environment Frequent serving every 3-4 months	Long lifetime of instrument
Leaking problems	Often rubber tubing breaks, leading to leaking	None. Automatic leak test is performed after maintenance
Maintenance	High	Low
Capacity	6-20 per day (the capacity is limited by the digestion time)	1 dum. for 32 samples and can up to 125 samples
Automation	No automatic sample loading/digestion/ distillation Manual protein calculation	Automatic MAS autosampler Automatic protein calculation

OEA vs. Kjeldahl Method – Analytical Comparison

Analysis of BIPEA (Bureau Inter Professionnel d'Etrudes Analytiques, France) Reference Material.

The first table shows the average and range indicated in the relative Reference Materials Certificates.

The second table shows the N/ Protein data of the BIPEA samples analyzed in duplicate by the Flash*Smart* using a sample weight of about 200 – 300 mg.

BIPEA sample information available

Sample	Moisture	Fat	Carbohydrate	Kjeldahl Protein		Combustion Protein	
	%	%	%	Av.%	Tolerance	Av.%	Tolerance
Bipea - Feed for Sow	9.8	2.8	48.7	16.0	0.6	16.2	0.6
Bipea - Dehydrated Alfalfa	7.7		29.3	14.8	0.6	15.1	0.6
Bipea - Hyperproteic Powder		0.8		85.4	3.4	86.4	3.5

Reproducibility of Nitrogen / Protein determination in BIPEA Reference Materials

Sample	Bipea - Feed for Sow		Bipea - Dehydrated Alfalfa		Bipea - Hyperproteic Powder	
%	N %	Protein %	N %	Protein %	N %	Protein %
	2.60	16.25	2.45	15.31	13.65	85.31
	2.58	16.12	2.44	15.25	13.63	85.19
Average %	**2.59**	**16.185**	**2.445**	**15.28**	**13.64**	**85.25**
RSD %	**0.546**	**0.568**	**0.289**	**0.278**	**0.104**	**0.099**

Nitrogen / Protein determination in Milk Reference Material

Reference Material from Cetre d'Étude et de Controle des Analyses en Industrie Laitiére, France

Kjeldahl Method - Mean from the results of 5 laboratories: 0.5284 % N

FlashSmart data

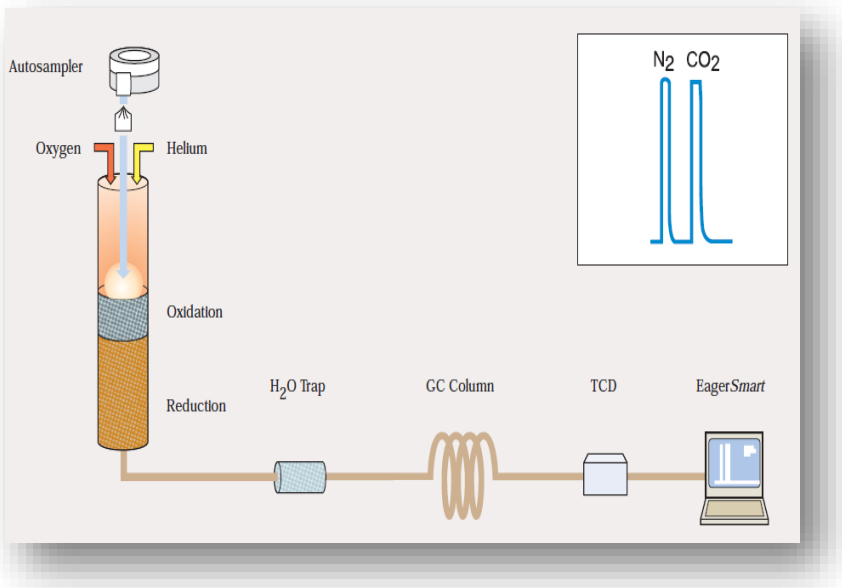
N %	Average N %	RSD %	Protein %	Average Protein %	RSD %
0.5312	0.5298	0.5604	3.3891	3.3800	0.5605
0.5286			3.3722		
0.5321			3.3948		
0.5339			3.4065		
0.5306			3.3854		
0.5251			3.3504		
0.5335			3.4035		
0.5264			3.3584		
0.5288			3.3735		
0.5276			3.3659		

OEA vs. Kjeldahl Method – Analytical Comparison

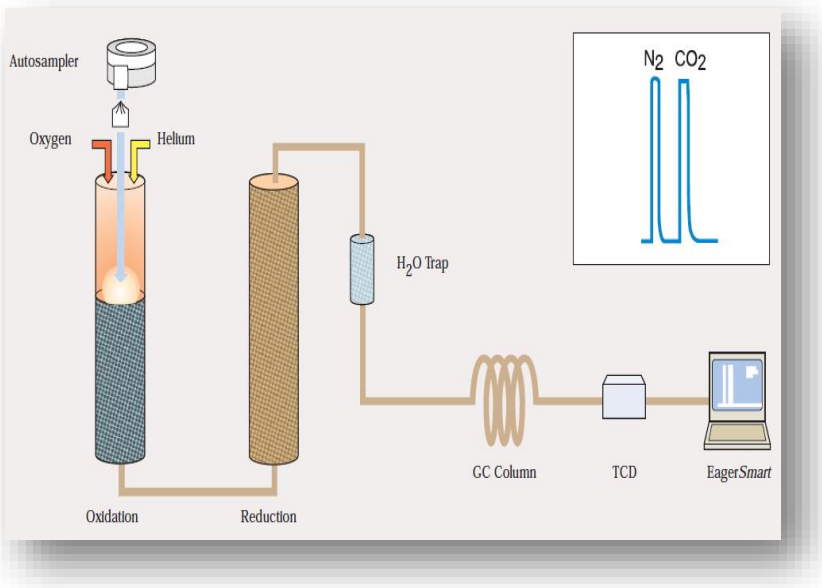
Sample	FlashSmart		Kjeldahl Method	
	N %	Protein %	N %	Protein %
Soya	6.27	39.20	6.27	39.18
Lentils	4.35	27.17	4.35	27.19
Rice	1.13	7.08	1.12	7.00
Wheat	1.75	10.91	1.74	10.89
Beans	3.74	23.35	3.74	23.38
UHT milk 1	0.53	3.38	0.53	3.37
UHT milk 2	0.50	3.19	0.49	3.17
Crude milk 1	0.57	3.65	0.57	3.66
Crude milk 2	0.47	3.03	0.47	3.02
Crude milk 3	0.41	2.65	0.42	2.66
Pasteurized milk 1	0.50	3.21	0.50	3.19
Pasteurized milk 2	0.46	2.96	0.47	2.99
Milk powder 1	4.32	27.56	4.30	27.43
Milk powder 2	4.18	26.64	4.19	26.73
Milk powder 3	5.46	34.83	5.43	34.64
Yoghurt	0.080	0.51	0.078	0.50
Mascarpone cheese	0.635	4.05	0.638	4.07
Grapes	0.52	3.25	0.51	3.19
Bacon (low fat)	2.73	17.06	2.70	16.86
Meat loaf	2.01	12.57	1.97	12.31
Ham	2.56	16.00	2.54	15.87
Biscuits 1	1.40	8.80	1.39	8.72
Biscuits 2	1.36	8.51	1.34	8.37
Flour	1.34	8.40	1.32	8.24

Single Reactor and Double reactors

Single reactor



Double reactors



Applications with MVC Module: N Protein Single Reactor. Comparison with Double Reactors

Sample	N/Protein Single Reactor			N/Protein Double Reactors		
	N %	Protein %	RSD %	N %	Protein %	RSD %
Layer Feed	2.72 2.72 2.70	17.02 16.98 16.84	0.56	2.73 2.72 2.70	17.06 17.02 16.88	0.56
Sheeps Food	2.94 2.96 2.96	18.36 18.51 18.35	0.49	2.99 2.97 2.97	18.66 18.59 18.56	0.28
Gluten Meal	11.21 11.22 11.22	70.07 70.11 70.13	0.04	11.29 11.25 11.27	70.57 70.32 70.47	0.18
Soybean Meal 1	7.73 7.75 7.74	48.31 48.42 48.36	0.11	7.71 7.70 7.72	48.20 48.10 48.25	0.16
Milk based powder	2.75 2.74 2.75	17.55 17.48 17.55	0.12	2.79 2.80 2.79	17.78 17.88 17.80	0.32
Milk based powder sucrose free	1.67 1.67 1.67	10.65 10.65 10.65	0.17	1.69 1.69 1.69	10.78 10.79 10.81	0.14
Milk based powder	2.50 2.50 2.49	15.95 15.95 15.89	0.32	2.50 2.50 2.51	15.97 15.96 16.00	0.13
Milk based powder sucrose free	2.35 2.34 2.32	14.99 14.93 14.80	0.64	2.34 2.33 2.34	14.90 14.89 14.92	0.11

Applications with MVC Module (CHN/O, CHNS/O, CHN/CHN, CHNS/CHNS, etc)

Sequence of analysis: 4 series / 5 days, each serie in duplicate. After each series on Left Reactor the Analyzer switch automatically to the Right Reactor via the MVC Module.

MORNING	SERIES 1
	SERIES 2
AFTERNOON	SERIES 3
	SERIES 4

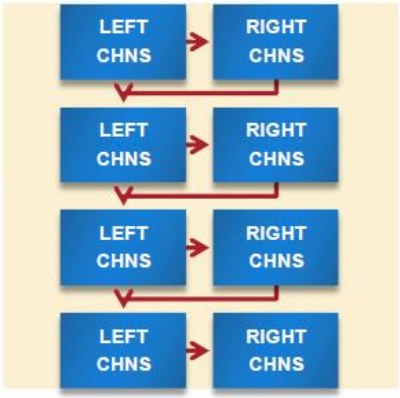


Table 3. CHNS average data on the left reactor.

Day/ Month	Sample name	Runs	N %	RSD %	C %	RSD %	H %	RSD %	S %	RSD %
14/04	Methionine	8	9.37	0.35	40.30	0.13	7.42	4.67	21.49	18.64
	Sulfanilamide	8	16.21	0.53	41.72	0.31	4.67	0.55	18.68	0.58
15/04	Methionine	8	9.36	0.41	40.42	0.24	7.40	0.47	21.49	0.50
	Sulfanilamide	8	16.27	0.31	41.85	0.21	4.68	0.56	18.70	0.33
18/04	Methionine	8	9.36	0.35	40.35	0.24	7.44	0.75	21.54	0.44
	Sulfanilamide	8	16.27	0.45	41.85	0.19	4.69	0.59	18.70	0.26
19/04	Methionine	8	9.35	0.37	40.32	0.26	7.43	0.83	21.49	0.50
	Sulfanilamide	8	16.28	0.40	41.76	0.13	4.65	0.13	18.64	0.39
20/04	Methionine	8	9.33	0.28	40.31	0.15	7.41	0.47	21.44	0.29
	Sulfanilamide	8	16.23	0.51	41.68	0.19	4.64	0.36	18.60	0.42

Table 4. CHNS average data on the right reactor.

Day/ Month	Sample name	Runs	N %	RSD %	C %	RSD %	H %	RSD %	S %	RSD %
14/04	Methionine	8	9.39	0.25	40.32	0.18	7.42	4.66	21.48	18.59
	Sulfanilamide	8	16.19	0.19	41.69	0.26	4.67	0.46	18.68	0.40
15/04	Methionine	8	9.35	0.33	40.28	0.28	7.43	0.65	21.48	0.21
	Sulfanilamide	8	16.23	0.75	41.63	0.13	4.69	0.48	18.65	0.24
18/04	Methionine	8	9.41	0.22	40.29	0.23	7.46	0.61	21.40	1.04
	Sulfanilamide	8	16.38	0.20	41.72	0.37	4.69	0.56	18.62	0.47
19/04	Methionine	8	9.40	0.64	40.20	0.43	7.38	1.07	21.53	0.41
	Sulfanilamide	8	16.25	0.32	41.81	0.38	4.65	0.31	18.67	0.45
20/04	Methionine	8	9.39	0.55	40.36	0.28	7.43	0.68	21.53	0.58
	Sulfanilamide	8	16.24	0.22	41.78	0.24	4.65	0.51	18.68	0.47

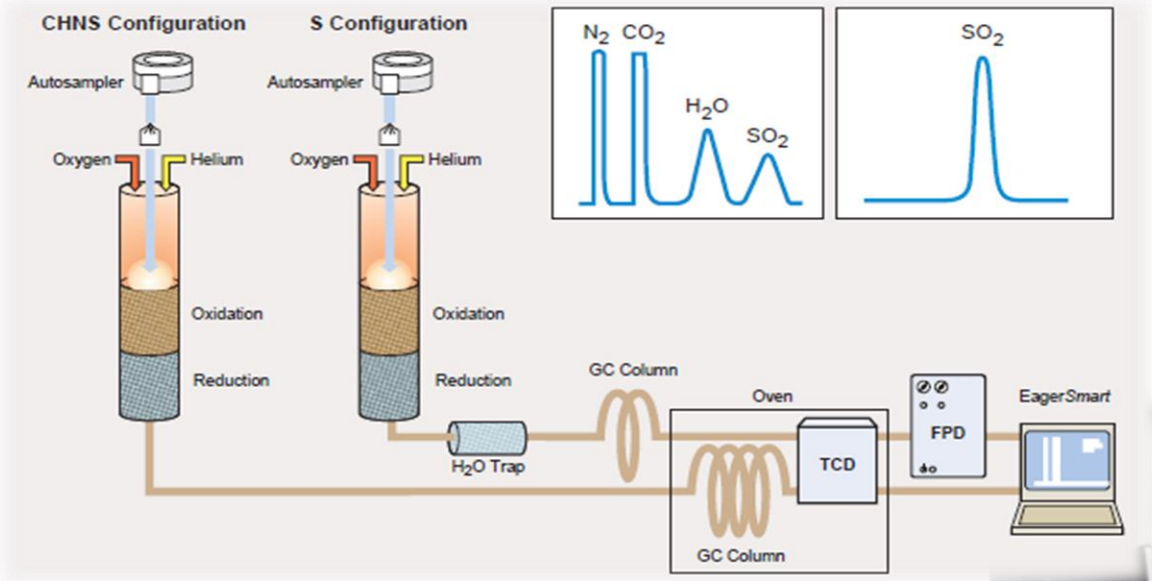
Accuracy, Precision, Repeatability, Stability

Pharma, University, Petrochemistry, Quality Control, Contract Labs

Configurations with MVC Module

Left CHNS by TCD Detector

Right S by FPD Detector



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Applications with MVC Module: CHNS by TCD / Sulfur by FPD

S%	RSD%
99.83 99.98 99.99	0.09

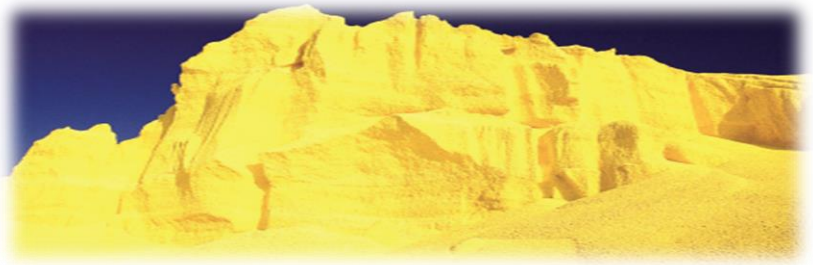
Sulfur Powder

(Aldrich, 99.98 S%, ±0.30)

S ppm	RSD%
5.1 5.1 5.3 5.1 5.2	1.73

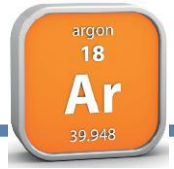
Reference Liquid Solution

(5 ppm S)



The Flash*Smart* EA can determine sulfur concentration in simultaneous CHNS and NCS mode, and also as sulfur measured on its own TCD Detector (100 ppm–100 S%). Additionally, with a simple upgrade, trace sulfur amounts can be measured when the Analyzer is coupled with a FPD Detector (5–500 ppm S).

OEA : Argon Gas Option



NC determination in Plants using Argon carrier gas

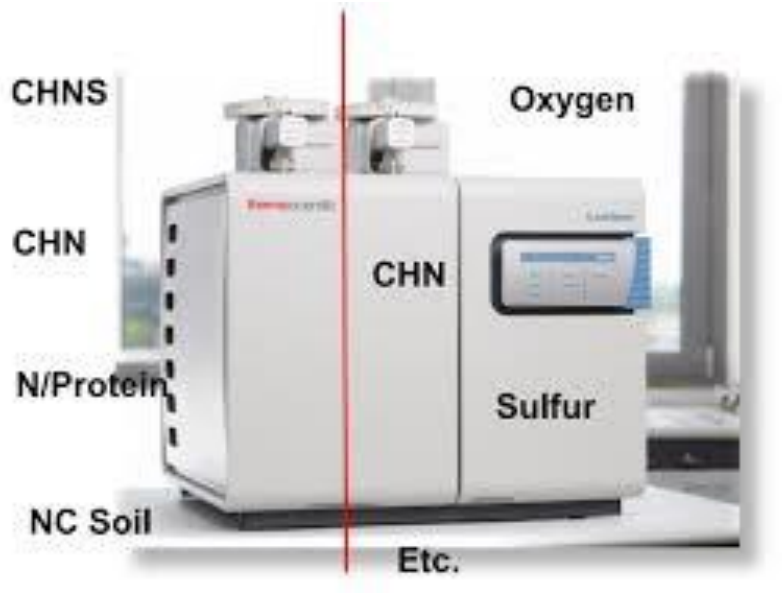
SAMPLE		ARGON AS CARRIER GAS (3 RUNS)			HELIUM AS CARRIER GAS (3 RUNS)		
		%	SD	RSD (%)	%	SD	RSD %
ALFALFA	N	2.96	0.020	0.67	2.96	0.0165	0.57
	C	43.70	0.179	0.41	43.63	0.0563	0.13
ORCHARD LEAVES DRIED	N	2.24	0.001	0.45	2.29	0.0017	0.08
	C	50.28	0.287	0.56	50.29	0.0513	0.10

- Standard: 14 – 15 mg Atropine (4.84 %N), EDTA (9.59 %N) and Aspartic acid (10.52 %N)
- Calibration method: Linear Fit
- Sample weight: 15 – 16 mg

A single CHNS/O, NC, N/Protein Analyzer handling all applications

Flash*Smart* can easily change to over 20 configurations in one system , according to their needs and application fields.

- CHN
- CHNS
- NC org
- NCS
- NC soil
- N lube
- N org
- N protein
- Oxygen
- Sulfur



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Accuracy

Accuracy for CHN, CHNS and O determinations

Theoretical Value	Experimental Value
0.01 % (100 ppm)	100 ppm ± 10
0.10 %	0.1 % ± 0.01
1.00 %	1.00 % ± 0.02
10.00 %	10.00 % ± 0.1
50.00 %	50.00 % ± 0.3
90.00 %	90.00 % ± 0.3

Conformance tested by pure organic elemental analysis standards

Summarize: All-In-One-Organic Elemental Analyzer

- Simplicity: Easy to Use and to Maintenance
- Modularity: over 20 Configurations, different auto-samplers and Detectors, MVC Module
- All type of sample matrix in every application fields
- Accuracy and Precision
- Repeatability and Reproducibility
- Complete conversion of all elements
- Productivity
- High Lifetime of gases and consumables

FLASHSMART

ThermoFisher SCIENTIFIC

Thank you for your OEAttention !!!