Welcome to TruTech Training!

We’ll be starting in just a few moments......

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OK, What does this thing do besides calculate furnace efficiency anyway?

An Introduction
to the
Testo 327 Combustion Analyzer
Who are we?

• Experienced professionals delivering CEU training to the HVAC and related trades
• 45+ years combined experience
• Practical, related and hands-on training
• Learn while you earn
  – BPI Recognized CEUs on other TTT classes
Agenda

• Importance of Combustion Analysis
• Analyzer Overview
• Main Menu Overview
• Measuring Menu
• Flue gas test measurement
• Adjustment Menu
• Set up menu
• Fuel Selections
• Diagnostics
• Calibration
• Filters & Probes
• Pumps & Printers
• Closing thoughts
Why is combustion analysis important?

• Verification of the safety of the appliance before and after servicing and or weatherization
• Calculation of the combustion efficiency
• Monitor the pollution the appliance is producing
• To verify conformance with manufacturers’ guidelines
• To minimize warranty issues and assure equipment longevity
Complete Combustion

OXYGEN → HEAT
FUEL → HEAT

HEAT → CO₂
HEAT → H₂O VAPOR
INCOMPLETE COMBUSTION

- **AIR**
- **FUEL**
- **HEAT**

- **HEAT**
- **SOOT**
- **CO$_2$**
- **CO**

- **H$_2$O VAPOR**

- **AIR**

- **TOXINS**
  - NOx
  - SOx
  - Acids
Combustion Analysis

Combustion analysis involves understanding the relationship of the gasses and the combustion process to determine proper operation and make adjustments as required for safety and efficiency.

The efficiency calculated by the combustion analyzer is a modified equation that considers combustion efficiency and stack losses.

• Part thermal
• Part combustion efficiency
Complete Combustion Analysis

- Involves testing all appliances
- The venting system
- The combustion air zone
- The building envelope
- And ..... Worst case testing

You cannot just stick the probe in the stack and push buttons!!!

TruTechTools also offers advanced training!
Testo
327 at a glance
Simply one of the best analyzers on the market for the money

• Designed for residential and light commercial markets
• Easy to use
• Long sensor life
• Customizable menus
• Field serviceable sensors • NEED FIRMWARE version 1.14+
• Incorporates NOx filters
• Can measure differential pressure
• Can measure differential temperature
• Can print results w/optimal printer

Overview Basic Features
Testo 327 at a glance

- Condensate Trap
- Power Button
- Condensate Trap Drain
- IR output for printer
- Charger Port
- REMOVABLE Ambient/air temp probe
- Exhaust Vent
- Combustion gas inlet
- Manometer (+)
- Manometer (-)
Testo 327 at a glance

- Strong Magnets
- Access Door
- Manufacturer’s Label
  - Model No.
  - Serial No.
  - Date Code
- Battery
- Pressure Sensor (Manometer)
- Pump
- O₂ Cell
- CO cell /NOx filter
When CO readings matter...

...never* measure without a NOx filter
– Comes standard on all Testo!
– Lasts the life of the CO cell
– Without it errors of 40 to 80 PPM (high) possible

*And CO always matters!
Main Menu Overview

• Measuring
  – This is where all tests are performed
• Adjust
  – For field or factory calibrations
• Setup Mode
  – For configuring the analyzer
• Fuel Select
  – For fuel selection
• Diagnostic
  – For troubleshooting meter operation
Measuring
The 327 makes the following stand-alone tests:

- **Flue Gas**
  Properties of the flue gasses both measured and calculated. Used for field diagnostics by the technician.

- **Draft**
  Measurement of the pressure in the stack with regards to the combustion air zone (CAZ) pressure. (Stored)

- **CO Air Free**
  Measurement of the ambient CO with reference to oxygen ($O_2$) remaining in the flue gasses. Typically used with Ovens/stoves (Stored)

- **Smoke / Oil Derivative**
  User input smoke spot number derived from manual smoke spot test. (averaged and stored)

- **Differential Pressure**
  Pressure difference between stack probe and (-) pressure port. Can also be used with an adapter for static pressure (0554 1203) for CAZ pressure measurement or static. (Stored)

- **Delta Temperature**
  Temperature difference between stack temperature thermocouple and ambient air probe. This difference is also net stack temperature if measuring flue gas with combustion probe. (stored)

- **Ambient CO**
  Ambient CO level of the air with respect to an $O_2$ concentration of 20.9%. (Stored)
Draft

Upon start Draft will zero for 5 seconds

BEFORE EVERY TEST
(no pressures across sensor/out of stack & hoses still)

Stack draft can be measured in "H20 or Pascals (Pa)
(amongst other units or measure)

Temperature records hot spot in the flue-a
repeatable measuring location

Draft Test here
(2x the diameter past the hood)

Diluted flue gasses (-)

Dilution air (-/+)

Undiluted flue gasses (+)

Combustion test here!
CO Air Free

CO AirFree uses the O2 sensor and the CO sensor to calculate an undiluted CO sample

Used on ovens, stoves, and vent free appliances

Until O2 starts to drop below about 18% no calculation is made.

When test is stopped, value is recorded.

The Testo 327 must be zeroed in fresh outdoor air prior testing if this is your first combustion test during a power cycle.
Smoke
Oil Derivative

A smoke test can be recorded for an oil burning appliance if desired.

Smoke number is read by the technician and manually input into the instrument

If desired, multiple smoke tests can be recorded

Oil Derivative testing is commonly performed in Europe. You insert the answer (yes/no) if you saw a spot develop, per the test described on the next page.
PER DIN 51402-2

If heating oil is not burned completely, flue gases can include oil derivatives, an environmental pollutant.

Oil derivatives are organic substances (not volatile) that become visible by means of Acetone application to the filter paper.

The TEST:
1 Apply drops of Acetone close to the Smoke Spot on the Smoke paper.
2 If a distinct yellow to brown color spreads from the spot, unburned oil is present in the flue gas
3 If the color is not present or weak the sample is OK
Differential Pressure

With an accessory adapter*, differential pressure can be recorded across filters, heat exchangers, pressure switches, coils or any other device

Upon start Diff Press will zero for 5 seconds

**BEFORE EVERY TEST**

*(no pressures across sensor/out of stack & hoses still)*

When **Stop** is pressed, the reading is recorded

* You can also simply slip a hose over the end of the probe (covering all slots) instead of using an adapter.
Delta Temperature

Differential temperature can be used for temperature rise of furnaces or boilers, calculating net stack temperatures or any other differential temperature application.

Surface temperature and clamp/Velcro® type probes are available as accessories for better measurements.
Ambient CO

Ambient CO is used for checking the CAZ* environment, and/or the rest of the building.

The Testo 327 must be zeroed in fresh outdoor air prior testing if this is your first combustion test during a power cycle.

Use stack probe during measurement

* Combustion Air Zone- the surroundings from which the combustion equipment gets its air
Flue Gas Measurement Test

1. Stack Temperature
2. Oxygen (O2)
3. Carbon Monoxide (CO)
4. Carbon Monoxide air free (Coaf)
5. Efficiency (%eff)
6. Excess Air (%ExAir)
7. Dew Point Temperature (°F, °C Dew point)
8. Draft
9. Ambient Temperature
10. Instrument Temperature
11. Delta Temperature
12. Differential pressure
13. CO ambient

The Testo 327 must be zeroed in fresh outdoor air prior testing if this is your first combustion test during a power cycle.

Stack temperature (°F)
- Gross stack temperature (Ambient + stack temperature)

Oxygen (O2)
- % of oxygen left in the flue gas after combustion (ambient = 20.9%)

Carbon Monoxide (CO)
- Raw CO measurement, not corrected for dilution. What the CO sensor sees

Carbon Monoxide air free (CO-AF)
- Corrected Stack CO, taking into account dilution by excess air

Efficiency (%Eff)
- Estimated efficiency of the appliance taking into account thermal and combustion efficiency

Excess Air (%ExAir)
- Percent of oxygen that has gone through the combustion process without being consumed

Dew Point Temperature (°F, °C Dew point)
- Calculated temperature at which the flue gasses will start to condense.
Flue Gas Measurement Test Continued

Draft (Pa, InH20)
Draft recorded during draft test

Ambient Temperature
Temperature of the CAZ.

Instrument Temperature
Internal Temperature of the instrument

Delta Temperature
Temperature difference recorded during differential temperature measurement.

Differential pressure
Pressure difference recorded during differential pressure measurement.

CO ambient
Ambient CO level of the air with respect to an \( O_2 \) concentration of 20.9% recorded during ambient CO test.
Adjust Menu

• CO adjust
• O₂-Cal

For factory or authorized service center use only
Setup Mode

• Display
• Date/time
• Language

Display
Allows user configuration of the display.
  – Organize what is important to you.
  – Eliminate measurements you do not use.
  – Order on screen sets order on print out
  – **REMEMBER TO SAVE SETTINGS**
    • MUST SEE Message: Info Accepted

Date/Time
Allows the user to set the date and time.
  – Prints out with the optional printer and becomes part of a legal record of service (along with meter serial number).
  – Make sure it is set correctly.

Language
Can be configured for English or French
  – Currently TruTech Tools can only support instruments configured in English.
Fuel Selections

Fuel selections are important for efficiency calculations. Each fuel has a specific and measurable heat content that is referenced from this variable.

- Nat gas
- BioHeat 5 (oil)
- Propane
- Oil#2
- Oil#5
- Oil#6
- Kerosene
- Wood
Diagnostic

- Info
- Error
- Battery

Info provides information on:
- Instrument Model
- Instrument Serial
- Instrument temperature (°C only)
- Number of hours of run time

Error provides information on:
- Device errors, record two digit number switch off analyzer and contact service

Battery
- Shows battery voltage Nominal voltage is 3.7 volts DC
- Continuous run time about 4 hours
- Charge time 5-6 hours

INSIDE INFO
- The meter tracks run time and sensor Overrange and is read by factory authorized service.
Combustion Analyzers

Taking care of your investment and your results

- Calibration (~1 per year)
- Service
  - Pumps, filters and probes
- Storage temperature limits
  - Condensation
- Fresh Air Purge
- Sensor Range (CO)
  - Exceeding range can limit sensor life
  - Automatic over-range protection available in some models
Care of Combustion Analyzers - The Basics

• Batteries
  – Proper type (Alkaline, battery packs or rechargeables)
  – New or fresh
  – Leakage
  – Do not mix old and new
  – Power supplies and rechargeables

• Cold storage
  – Impact on sensors
  – LCD displays
  – Batteries
  – Remaining condensate

• High temperature exposure
  – Analyzer body
  – Probes
Filters

• Condensate and water trap
  – Emptying
  – Cleaning
  – Maintaining
  – Changing
  – Air tightness

• Particulates and filters
  – Cleaning
  – Maintaining
  – Changing
Probes

• Thermocouples
  – Temperature exposure
  – Mechanical damage
  – Straining wires and plugs
  – Thermocouple connections
  – - wear and tear

• Hoses
  – Temperature exposure
  – Cracks and holes
  – Leak testing
  – Hose connections, seals, o-rings, lubes
Pumps & Printers

• **Pumps**
  – Break down
  – Clogging
  – Cleaning diaphragms
  – Change out

• **Printers**
  – Fresh batteries
  – Proper paper loading
  – High temp exposure of printer paper (fade to black)
  – Use of "office supply" brands
  – Longer life papers (up to 10 years)
Using your head!

• Read the manual
  – Familiarize yourself with analyzer before using – re-read before season starts
• What to look for if readings do not look right
  – Eg. An unusually high O2 or low CO2 reading is likely a sampling system leak, torn hose assembly, etc.
  – Do not lose faith in the unit.
• You can understand it!
Additional Probes and Accessories

Some things to consider......

0554 1203  Adapter for pressure readings
0554 1202  Hose Extension 9’
0600 9787  Combustion air temperature probe 7.5”
0600 9791  Combustion air temperature probe 12”
0600 9797  Combustion air temperature probe 2.4” w 13’ cable
0554 0549  Fast IR printer

Cases and printers and DIGITAL and mechanical smoke pump tests are available
Combustion Testing Results

- Saves money
- Saves time
- Avoids callbacks
- Limits liability
- Maintains equipment warranty
- Provides confidence
- Provides increased comfort
- Provides increased safety
- Increases energy efficiency
- Lowers environmental emissions (Pollutants)
Thank you for your time and attention!

Get a $10 TTT Gift certificate for completing a PRODUCT REVIEW of this webinar on our site.

See more from TruTech on YouTube

The “jimbergmann3” channel

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