# Determination of Carbon and Sulfur in Cast Iron

*LECO Corporation; Saint Joseph, Michigan USA*


## Instrument: CS844 Series

### *Introduction*

The following application note outlines the settings and steps required to determine the carbon and sulfur levels in cast iron with the CS/C/S844 series of elemental analyzers. Carbon is the main alloying element in cast iron at levels greater than 2%. Sulfur is typically a contaminant in cast iron, and will prevent the formation of graphite, thus making the cast iron harder. Most foundries maintain sulfur at levels less than 0.15%. With its simultaneous carbon and sulfur detection capability and easy-to-use touch-screen interface, the CS844 carbon and sulfur by combustion analyzer makes the perfect addition to any foundry laboratory.

### *Sample Preparation*

Refer to ASTM E1806 for proper sampling of cast iron.

### *Accessories*

528-018 or 528-018HP Crucible (preheated*); LECOCEL II (502-173) or (501-008); Iron Chip (502-231) or (501-077) Accelerator; Metal Scoop (773-579); Tongs (761-929).

**For optimal precision, ceramic crucibles must be preheated in a muffle or tube furnace (LECO TF4) at ≥ 1250 °C for a minimum of 15 minutes or at ≥ 1000 °C for a minimum of 1 hour. Crucibles must be handled with clean tongs to avoid contamination. The crucibles are removed from the furnace, allowed to cool for 1 to 2 minutes, and then are transferred to a desiccator for storage. Crucibles should be reheated if not used within four hours.*

### *Calibration*

Cast Iron Powder Reference Materials: 501-024, 501-105, 501-994, 501-999, 502-698, 502-899; other suitable Reference Materials may be used as well.

### *Method Parameters*

*Analysis Parameters*

| | |
|---|---|
| Purge Time | 5 s |
| Analysis Delay | 10 s |
| Sample Cool Time | 0 s |
| Furnace Mode | Constant |
| Furnace Power | 100% |
| Furnace Ramp Rate | 0 |

| *Element Parameters* | *Carbon* | *Sulfur* |
|---|---|---|
| Integration Delay | 0 s | 0 s |
| Starting Baseline | 2 s | 2 s |
| Use Comparator | No | No |
| Integration Time | 60 s | 60 s |
| Use Endline | Yes | Yes |
| Ending Baseline | 2 s | 2 s |
| Range Select | Auto | Auto |
| Range Lower Limit | 800 | 800 |
| Range Upper Limit | 950 | 1200 |
| Significant Digits | 5 | 5 |

### *Procedure*

1. Prepare instrument for operation as outlined in the operator's instruction manual.
2. Determine the instrument Blank.
   a. Login a minimum of three Blank replicates.
   b. Add one 773-579 Scoop (~1.2 g) of LECOCEL II and one 773-579 Scoop (~0.8 g) iron chip accelerator to a 528-018 or 528-018HP Crucible.
   c. Place the crucible on the furnace pedestal (or appropriate autoloader position if applicable), and initiate analysis.
   d. Repeat steps 2b through 2c a minimum of three times.
   e. Set the blank by following the procedure outlined in the operator's instruction manual.
3. Calibrate/Drift Correct
   a. Login a minimum of three standard replicates.
   b. Weigh ~0.5 g of 501-024 Cast Iron Reference Material or other suitable calibration/drift material into a 528-018 or 502-018HP Crucible and enter the mass and identification of the Reference Material.
   c. Add one scoop (~1.2 g) of LECOCEL II and one scoop (~0.8 g) iron chip accelerator on top of the Reference Material.
   d. Place the crucible on the furnace pedestal (or appropriate autoloader position if applicable) and initiate analysis.
   e. Repeat steps 3b through 3d a minimum of three times for each calibration/drift Reference Material intended for calibration/drift.
   f. Calibrate/drift correct by following the procedure outlined in the operator's instruction manual. Linear force through origin calibration is recommended.
4. Sample Analysis
   a. Login a Sample with appropriate number of replicates.
   b. Weigh ~0.5 g of cast iron sample into the crucible and enter the mass and identification.
   c. Add one scoop (~1.2 g) of LECOCEL II and one scoop (~0.8 g) iron chip accelerator on top of the sample.
   d. Place the crucible on the furnace pedestal (or appropriate autoloader position if applicable), and initiate analysis.

Inorganic Application Note

Delivering the Right Results

## *Typical Results*

| *Sample* | *Mass (g)* | *% Carbon* | *% Sulfur* |
|---|---|---|---|
| 502-698 | 0.4993 | 2.15 | 0.012 |
| Lot: 1008 | 0.4982 | 2.15 | 0.012 |
| 2.16 ± 0.03 % C | 0.4980 | 2.15 | 0.012 |
| 0.013 ± 0.002 % S | 0.4977 | 2.15 | 0.012 |
| | 0.4983 | 2.14 | 0.012 |
| | 0.4956 | 2.15 | 0.012 |
| | 0.4991 | 2.14 | 0.012 |
| | 0.5000 | 2.15 | 0.011 |
| | 0.4990 | 2.16 | 0.012 |
| | 0.4982 | 2.15 | 0.012 |
| | ***Avg=*** | ***2.15*** | ***0.012*** |
| | ***s=*** | ***0.004*** | ***0.0003*** |
| | | | |
| 501-024 | 0.4999 | 3.29 | 0.040 |
| Lot: 1032 | 0.5011 | 3.30 | 0.041 |
| 3.33 ± 0.03 % C | 0.5027 | 3.32 | 0.041 |
| 0.043 ± 0.003 % S | 0.4986 | 3.32 | 0.040 |
| | 0.5260 | 3.33 | 0.042 |
| | 0.5018 | 3.32 | 0.043 |
| | 0.5022 | 3.31 | 0.041 |
| | 0.4987 | 3.30 | 0.041 |
| | 0.5041 | 3.30 | 0.041 |
| | 0.5073 | 3.32 | 0.043 |
| | ***Avg =*** | ***3.31*** | ***0.041*** |
| | ***s =*** | ***0.01*** | ***0.001*** |
| | | | |
| 501-994 | 0.4984 | 3.75 | 0.113 |
| Lot: 1001 | 0.5009 | 3.76 | 0.109 |
| 3.78 ± 0.05 % C | 0.4972 | 3.76 | 0.110 |
| 0.115 ± 0.006 % S | 0.4951 | 3.76 | 0.116 |
| | 0.4987 | 3.77 | 0.115 |
| | 0.5003 | 3.78 | 0.112 |
| | 0.4961 | 3.76 | 0.114 |
| | 0.4978 | 3.76 | 0.114 |
| | 0.4981 | 3.76 | 0.114 |
| | 0.4991 | 3.73 | 0.113 |
| | ***Avg =*** | ***3.76*** | ***0.113*** |
| | ***s =*** | ***0.01*** | ***0.002*** |

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Form No. 203-821-537 5/17—REV0