



Biomass
Syngas
Flame at
Sunrise in
Colorado

Thermo Conversions Gasification (TCG) Technology

TCG Global, LLC

8310 S. Valley Hwy Suite 285, Englewood CO 80112

(303) 867-4247

www.TCGenergy.com

TCG Global, LLC

- TCG Global was formed in 2010 to further the commercialization of the TCG patented gasification technology.
- The company utilizes the technology use rights of one of the inventors, Marcus A. Wiley of Wiley Consulting, LLC. Founded in 1981 as Wiley Engineering, Inc., the consulting and engineering company has provided over 30 years of mining consulting services, working on projects in the U.S. and internationally with a specialization in coal and clean coal technology. Developing and constructing gasification plants has been the recent focus of the company. Red Lion Bio-Energy, Toledo, Ohio purchased the initial plant constructed by Wiley in 2007. www.wileyconsulting.net
- TCG Global, LLC utilizes patents, and pending patents of Thermo Technologies, LLC exclusively licensed to Thermo Conversions, LLC which under agreement provides rights to TCG Global, LLC to design, build, own, operate, and market gasification plants using the technology. www.thermotechnologiesllc.com
- Find us on the web: www.TCGenergy.com

1st of 7 US Patents Issued: December 29, 2009

Effective Date: April 11, 2006

Patent number: US 7,638,070

Additional U.S. and international patents pending



(12) **United States Patent**
Johnson et al.

(10) **Patent No.:** US 7,638,070 B2
(45) **Date of Patent:** Dec. 29, 2009

(54) **METHODS AND APPARATUS FOR SOLID CARBONACEOUS MATERIALS SYNTHESIS GAS GENERATION**

(75) **Inventors:** Dennis E. J. Johnson, Colorado Springs, CO (US); Grigori A. Abranov, Littleton, CO (US); Richard A. Klelake, Commerce City, CO (US); Marcus A. Wiley, Highlands Ranch, CO (US)

(73) **Assignee:** Thermo Technologies, L.L.C., Centennial, CO (US)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) **Appl. No.:** 12/246,337

(22) **Filed:** Oct. 6, 2008

(65) **Prior Publication Data**
US 2009/0119991 A1 May 14, 2009

Related U.S. Application Data

(63) Continuation of application No. PCT/US2007/066456, filed on Apr. 11, 2007, and a continuation of application No. 12/796,202, filed as application No. PCT/US2007/066456 on Apr. 11, 2007.

(60) Provisional application No. 60/951,401, filed on Apr. 11, 2006.

(51) **Int. Cl.**
H01L 19/00 (2006.01)
C01B 3/02 (2006.01)

(52) **U.S. Cl.** 252/373; 48/61; 48/69; 48/99; 48/101; 48/97 R; 48/202; 48/210

(58) **Field of Classification Search** 252/373; 48/210, 202, 197 R, 61, 89, 99, 101
See application file for complete search history.

(56) **References Cited**

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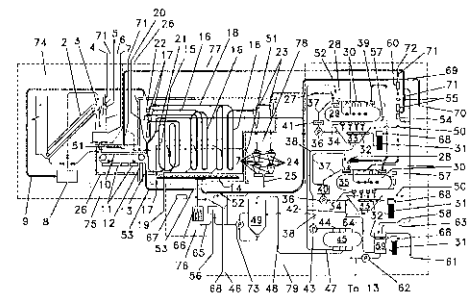
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Primary Examiner Wayne Langel
(74) *Attorney, Agent, or Firm* - Santiago Law Offices, P.C.

(57) **ABSTRACT**

Methods and apparatus may permit the generation of consistent output synthesis gas from highly variable input feedstock suitable carbonaceous materials. A stoichiometric objective stoichiometric environment may be established to stoichiometrically control carbon content in a solid carbonaceous materials gasifier system. Processing of carbonaceous materials may include oxidative pyrolytic decomposition, and multiple solid carbonaceous reformulation. Dynamically adjustable process determinative parameters may be utilized to refine processing, including process utilization of negatively electrostatically enhanced water species, process utilization of fine gas (9), and adjustment of process flow rate characteristics. Recycling may be employed for internal reuse of process materials, including recycled negatively electrostatically enhanced water species, recycled fine gas (9), and recycled contaminants. Synthesis gas generation may involve pre-determining a desired synthesis gas for output and creating high yields of such a predetermined desired synthesis gas.

146 Claims, 22 Drawing Sheets



South African Patent Issued: December 30, 2009

Effective Date: April 11, 2007

SA Patent number: 2008/09580

Additional U.S. and international
patents pending



CERTIFICATE

In accordance with section 44 (1) of the Patents Act, No. 57 of 1978, it is hereby certified that

Thermo Technologies, LLC

has been granted a patent in respect of an invention described and claimed in complete specification deposited at the Patent Office under the number

2008/09580

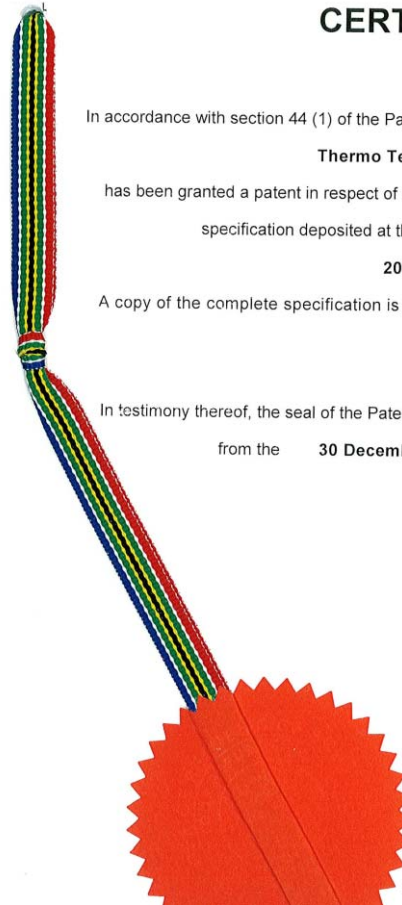
A copy of the complete specification is annexed, together with the relevant Form P2.

In testimony thereof, the seal of the Patent Office has been affixed at Pretoria with effect

from the **30 December 2009**



Registrar of Patents



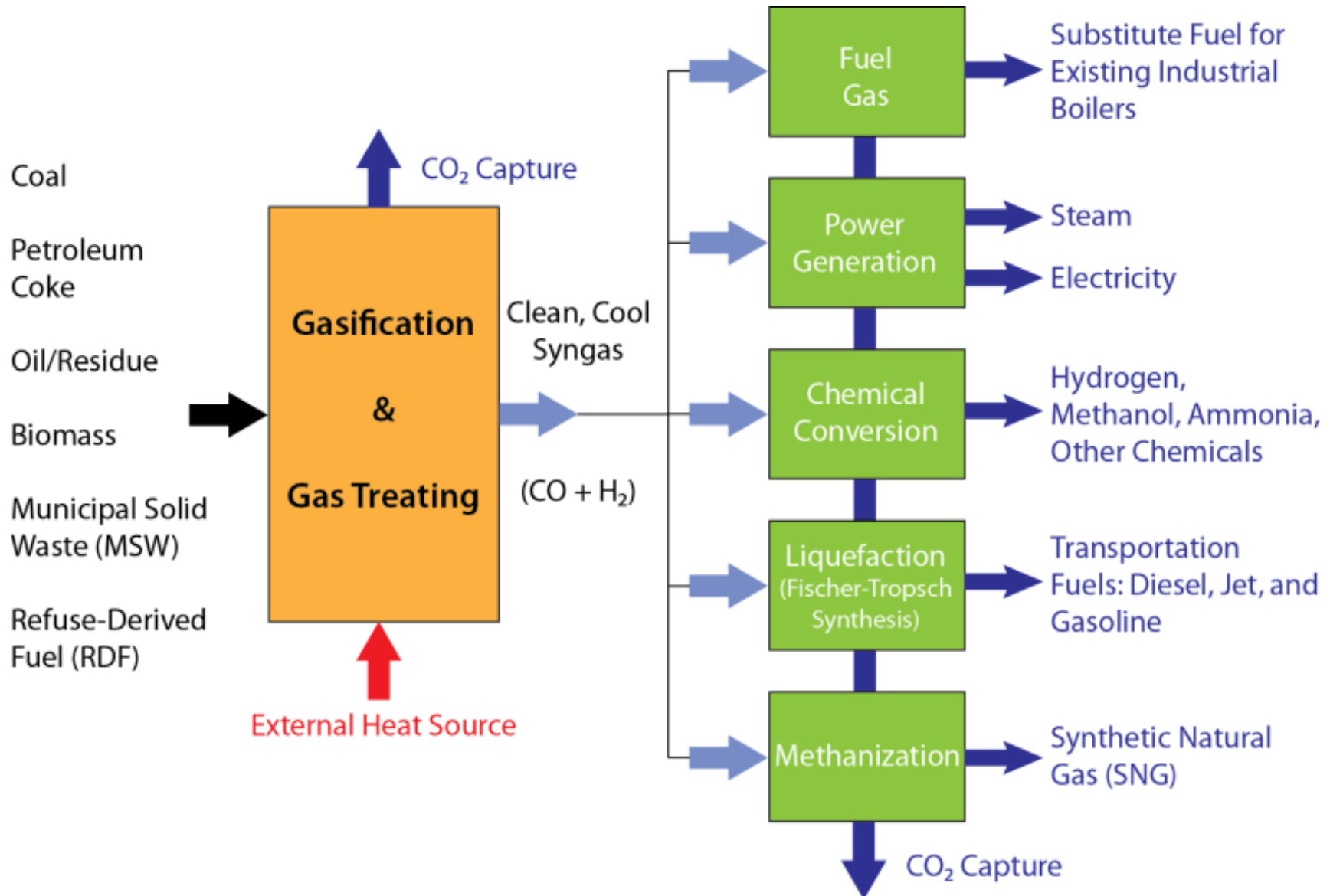
Gasification Plant in Denver, CO



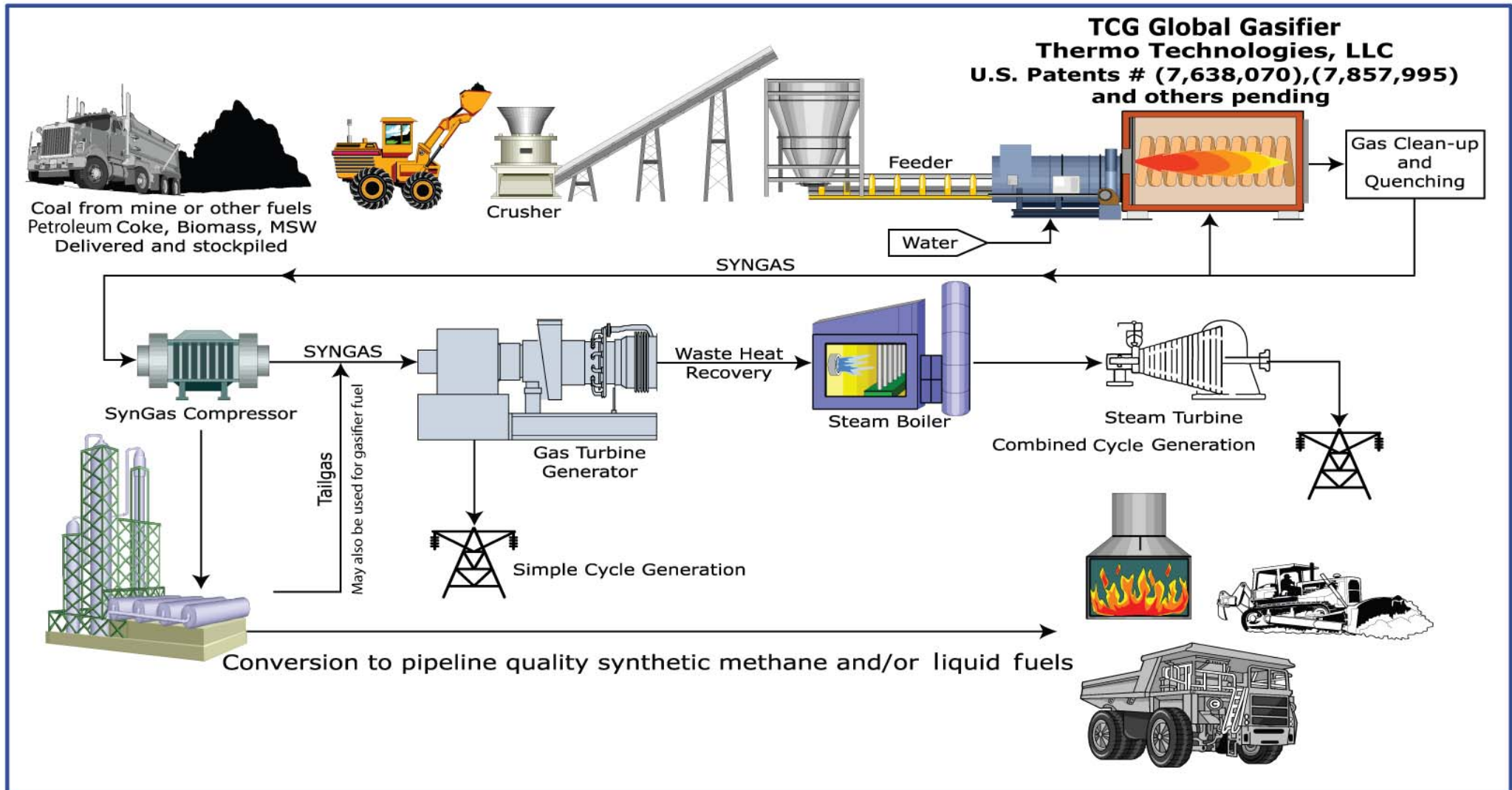
Gasification Plant in Denver, CO



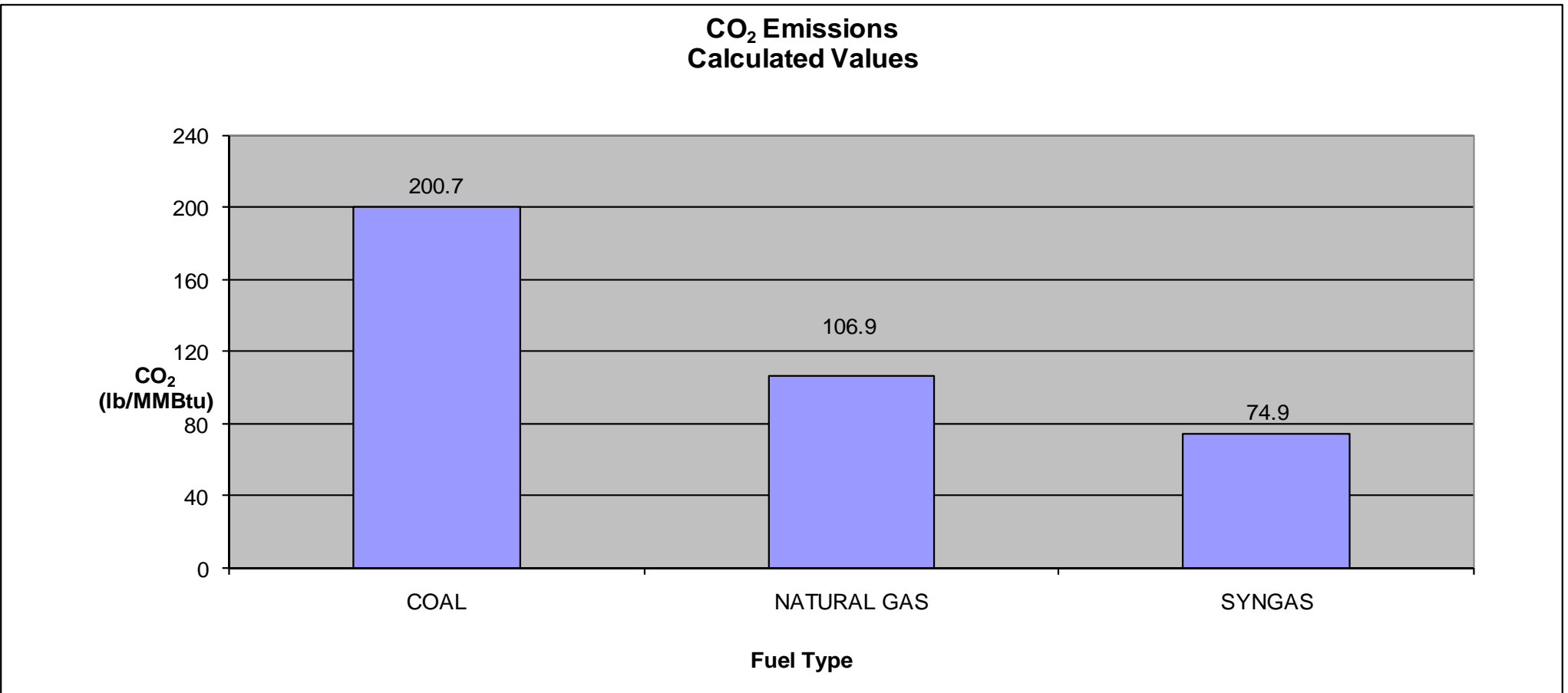
Syngas Applications



Full Process Schematic



Comparable CO₂ Emissions by Fuel Type



CO₂ emissions are lower than natural gas due to the high hydrogen content of syngas

Gasification = “Greener” Coal

Coal Fired Power Plant - Coal Consumed (tons)



Coal Fired Power Plant - CO₂ Emitted (tons)



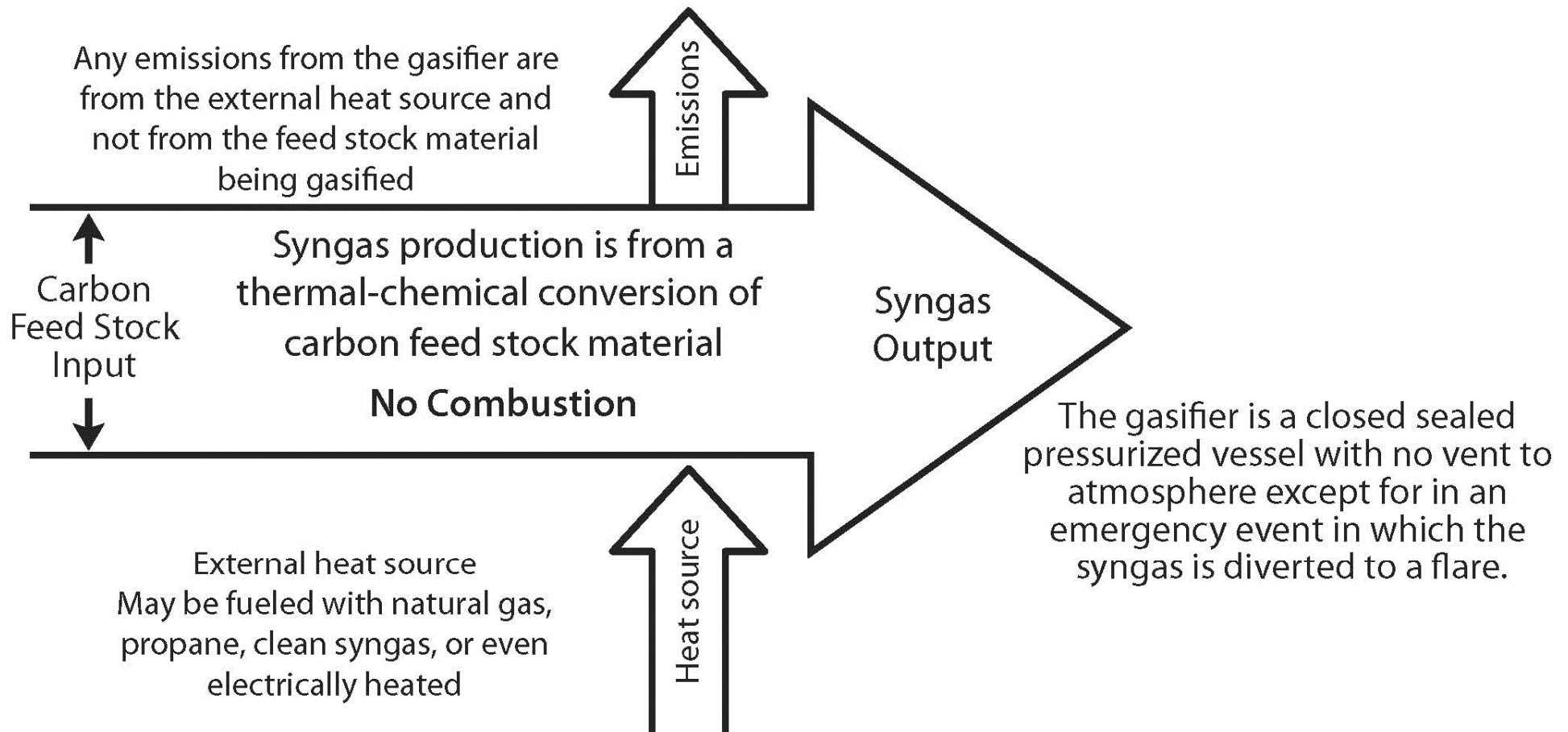
Gasification Plant with Coal Feedstock - Coal Consumed (tons)



Gasification Plant with Coal Feedstock - CO₂ Emitted (tons) for equivalent Btu generation (62.5% reduction over conventional coal plant emissions)

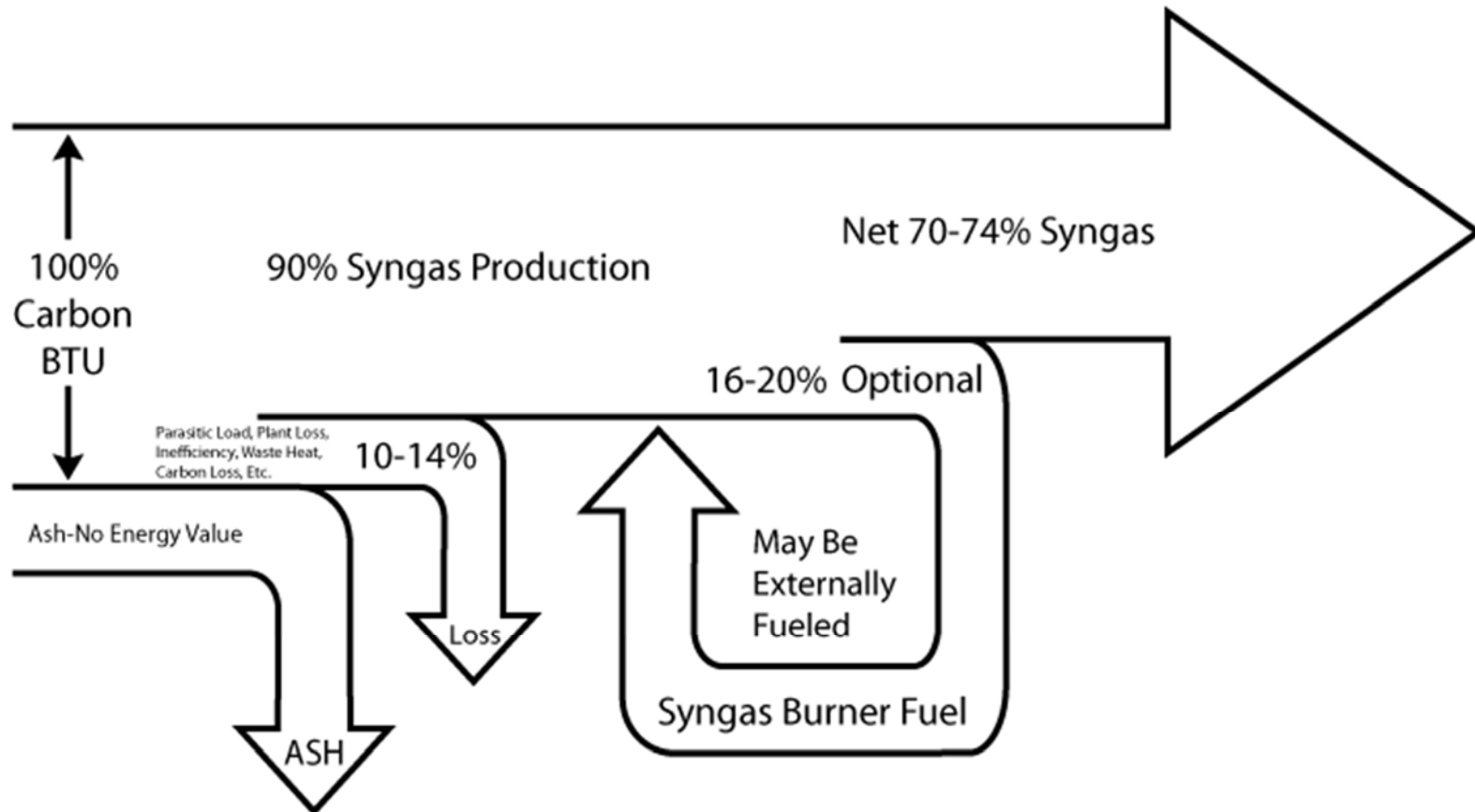


Overview of Design Advantages for Emissions Control



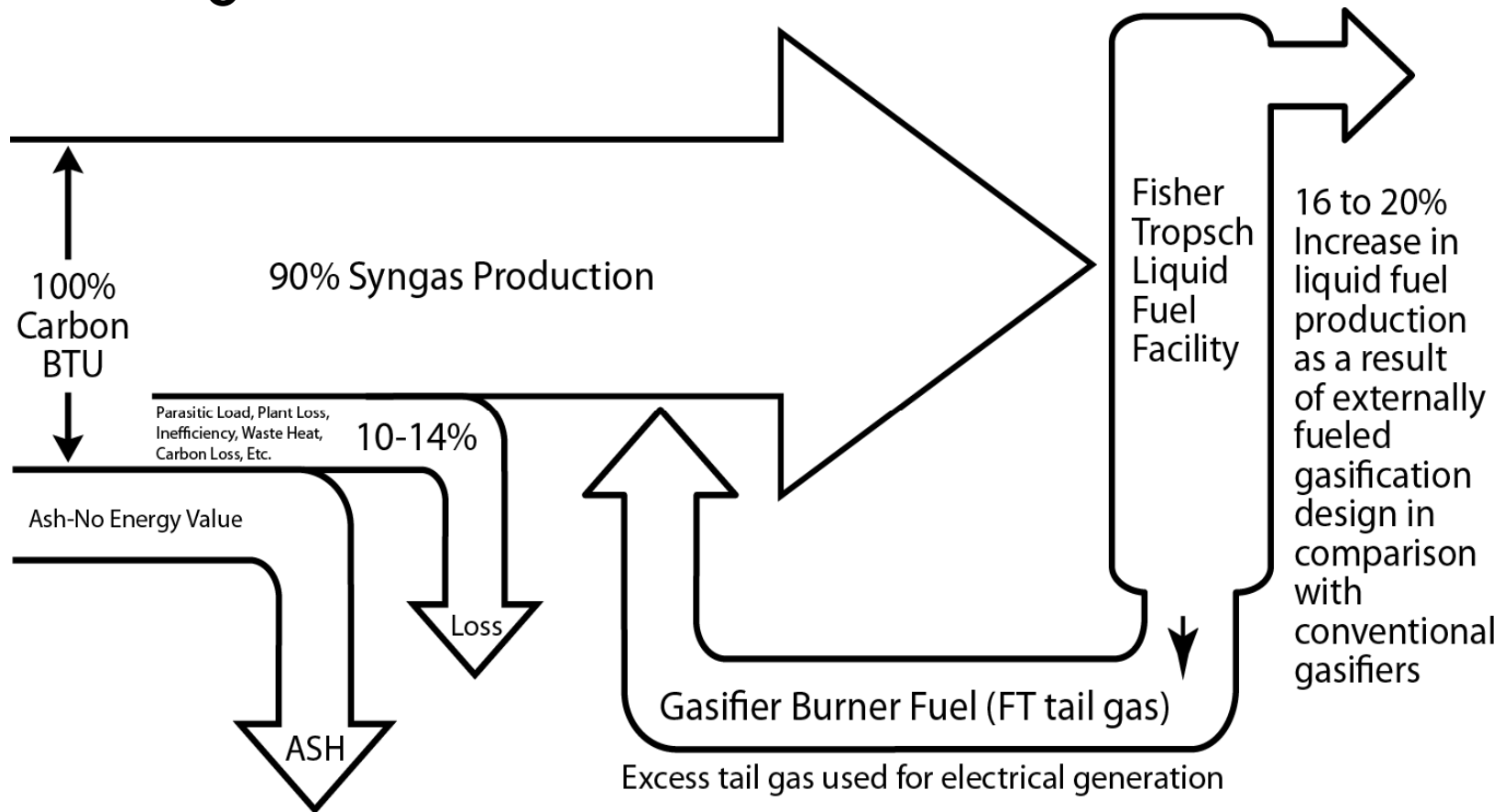
Thermal Mass Balance

Btu conversion cold gas efficiency of 70% to 74% (on a Btu basis)



Thermal Mass Balance w/ FT

Coupled with a Fisher Tropsch liquid fluid facility using the tail gas as burner fuel



How is TCG Technology Different?

- No oxidation → provides a number of efficiencies:
 - ▣ Cleaner Syngas, lower emissions
 - ▣ Flexible feedstock, no pulverization or slurry requirements
 - ▣ No Air Separation Unit
 - ▣ No ceramic refractory brick – better uptime, reliability
 - ▣ Recycle un-reacted carbon particles into reaction chamber
- Efficient operation achieved at a smaller scale → enables step-wise plant construction and capital investment
 - ▣ Modular, off-site construction
 - ▣ 12-month lead time, rapid implementation
 - ▣ Lower overall capital costs

TCG Advantages over Competitors

TCG gasification technology outperforms competitors on several levels:

- External heating (rather than combustion) delivers the highest quality Syngas demonstrated on a commercial scale
 - Preventing pollution is less complex and less costly than controlling it
- Modestly-scaled gasifier (~500 tons per day) makes TCG gasification a viable solution for a broad range of challenges
 - Small footprint and rapid deployment (15-18 months)
 - Multiple gasifier plants can be combined to achieve desired scale
- Deployable, redundant design saves capital and O&M costs

TCG Advantages (Cont.)

- Syngas production is capable of firing gas turbines and/or reciprocal engines
- Lead time on plant delivery is 12 to 18 months
- Feedstock rates (nominal)
 - 250-500 TPD coal and petcoke
 - 500-1,000 TPD wet biomass (i.e. wood chips, crop residue)
- Modular design promotes quick assembly/disassembly
- Small footprint 500 tpd (100'X100'X25')
- Well designed
 - Construction quality, assembly/disassembly, ease of maintenance
- If scale-up or more capacity is desired, combine additional modules
- Permanent U.S. patents issued and International and additional U.S. patents pending
- A COMMERCIAL SCALE REFERENCE PLANT DEMONSTRATING THIS TECHNOLOGY IS OPERATING IN TOLEDO, OHIO