A ‘Highly’ Flexible Carbon Fiber Research Facility

Intertech PIRA  GOCarbonFiber 2011
October 5, 2011
Agenda

• Introduction of Harper International
  • Background
  • Relationship to Oak Ridge National Laboratory (ORNL)
    – Carbon Fiber Technology Facility (CFTF) Project

• ORNL – CFTF Project
  • Technical Features
  • Equipment
    • Overview – General Arrangement and Layout
    • Advanced Oxidation Oven Technology
    • Pre-Carbonization & Carbonization
  • Material Feed Types
    • Tow and Bulk Material Handling
    • Traditional and Next Generation Pre-Cursors
  • ORNL Carbon Fiber Consortium
Harper International
Background &
Core Competencies
Harper Technical Profile – Core Skills

Scale up of New or Challenging Processes
- 300°C to 3000°C
- Atmospherically Controlled
- Continuous Processing

Construction Techniques in
- Metallic > Ceramic > Graphitic
- Integrated Systems Design – Plant Supply
- Complex Flows of Advanced Materials
- Precise Control of Gas - Solids Interactions

Broad Experience Base in a Range of Carbon Processes
- PAN based C-fiber
- Pitch based C-fiber
- Rayon based C-fiber
- Alternative Precursor Development
- Carbon Fiber Recycling
Harper International
Typical Services to Carbon Fiber Industries

- Equipment Supply (~40 Years)
  - LT, HT and UHT Furnaces
  - Oxidation Ovens
  - Surface Treatment & Drying
  - Mass Transport
- Complete System Supply (~15 Years)
- Research and Development
- Retrofits, Revamps & Upgrades
- Business Development: Feasibility Studies & Modeling
- Training & Optimizations
Proven Supplier of Complete Carbon Fiber Systems
with
Multiple References
## Carbon Fiber Systems
### Scale of Operations

<table>
<thead>
<tr>
<th>Scale</th>
<th>Size Range (mm Width)</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>1000mm - 4200mm</td>
<td>100tpy to More Than 2000 tpy</td>
</tr>
<tr>
<td>Industrial Scale Pilot</td>
<td>300mm - 1000mm</td>
<td>20tpy - 100 tpy</td>
</tr>
<tr>
<td>Micro Scale (University, Institute)</td>
<td>&lt;100mm</td>
<td>Less Than 1 tpy</td>
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Carbon Fiber Conversion Process

Carbon Fiber Conversion

Pretreatment

Oxidation 300C

Low Temperature Carbonization 800-1000C

High Temperature Carbonization 1600-1800C

After Treatment: Stage 1

After Treatment: Stage 2

Online Winding

Precursor (typically PAN)

Nitrogen
CW
Energy
Natural Gas
Oils & Electrolytes
Resins
DI Water

Waste Gases
CO, CO₂
N₂ gases (HCN, Nox NH₃)
Sox, Tars, Misc.

Reject Heat & CW

Wastewater
Spent Aq. Soln.
Spent Agents

Online Winding

Carbon Fiber
Oak Ridge National Laboratory
Carbon Fiber Technology Facility

Unique Features & Functions
Bridges Gap Between R&D and Commercialization

Existing research focus

- Alternative precursors
- Advanced conversion processes

CFTF will scale the R&D results to semi-production scale.
ORNL Carbon Fiber Technology Facility

Background and History

- Project Launch (Request for Tenders) July 2010
  - Establish Industrial Scale Pilot Plant based on ‘Convention’ Processing
  - Prepare ‘Next Generation’ Advanced Conversion Technologies

- System Description:
  [http://www.ornl.gov/adm/contracts/CFSL%20Spec%20Final%20R0.pdf](http://www.ornl.gov/adm/contracts/CFSL%20Spec%20Final%20R0.pdf)

- System Available for Use in First Quarter 2013
- Collaborative Based Research Facility
- Primary Contact:
  [CFTF@ORNL.GOV](mailto:CFTF@ORNL.GOV)
ORNL Carbon Fiber Technology Facility

Key Features

- Highly instrumented, highly flexible conventional carbon fiber line for “any precursor in any format”
- Melt-spun fiber line to produce precursor fibers
- Provisions for additional future equipment
- Produce up to 25 tons/year of carbon fibers
- Demonstrate technology scalability
- Train and educate workers
- Grow partnerships with US industry
- Demonstrate LCCF technology scalability
- Produce quantities of Low-Cost Carbon Fiber needed for evaluations & prototyping
Features and Functions

- Flexible Carbon Fiber Conversion Line
  - Rating for 25 TPY of PAN Conversion
  - Capable of Processing Alternative Materials (Pitch, PAN, Lignin)
- Ability to Handle Bulk Materials
  - Belts in all Thermal Process Units (Ovens, LT, HT)
  - Enables Processing a Range of Alternative Precursors
- Upstream In-Line Melt Spinner (by Others)
  - Continuous Melt Spin Processing Without Re-Spooling
- Atmospheric Control in All Thermal Process Units
  - Enables Processing a Range of Alternative Precursors
- Instrumented for Research with an Integrated Control System and Data Collection
ORNL Carbon Fiber Technology Facility

Features and Functions

• Oxidation Ovens
  • Multi-Flow Allowing Comparison of all major oxidation flow techniques
  • Compatible with Sulfur Off Gassing
  • Continuous Bulk Materials Processing
  • Belt System through lower chambers – 4 zone belt processing

• LT Furnace
  • Enabled up to 1000 Degrees-C
  • Allows for Multiple Atmospheres, N2, CO, H2O
  • Continuous Belt System for Bulk Materials

• HT Furnace
  • Enabled up to 2000 Degrees-C
  • Allows for Multiple Atmospheres, N2, Ar
  • Continuous Belt System for Bulk Materials
Oak Ridge National Laboratory
Carbon Fiber Technology Facility
General Arrangement & System Layout
ORNL - CFTF Overview

Forecast to commence operations in Feb 2013

42,000 square feet of production, lab, office, and support areas

Images
Courtesy of ORNL
ORNL - CFTF
General Arrangement / Layout

Update -- Approximately 375 feet in length
ORNL - CFTF
General Arrangement / Layout
ORNL - CFTF
General Arrangement / Layout

Oxidation Ovens System
With Belt System for
Bulk Materials Processing

Oxidation Ovens
ORNL - CFTF
General Arrangement / Layout

Oxidation Ovens Stack
Installed with Belt System for Bulk Materials Processing

Oxidation Ovens
ORNL - CFTF
General Arrangement / Layout

- End Seal for Continuous Filamentary (Tow) Operation
- Lay-Down Feed Belt & Exit Belt
- Oxidation Ovens Ends Seals, Belts
ORNL - CFTF
General Arrangement / Layout

LT Furnace
Installed with Belt System for Bulk Materials Processing
And in Proximity to Thermal Oxidizer

LT Furnace
ORNL - CFTF
General Arrangement / Layout

LT Furnace with Multiple Atmosphere Capabilities

Lay-Down Feed Belt & Exit Belt

LT Furnace
ORNL - CFTF
General Arrangement / Layout

HT Furnace installed with belt system for bulk materials processing and in proximity to thermal oxidizer.

Space allocation for future addition of UHT furnace.
Traditional Surface Treatment System
Installed with Space Reserved for Future Addition of Advanced Surface Treatment Techniques
ORNL Carbon Fiber Consortium

- ORNL has created a Consortium for Carbon Fiber research structured around the CFTF Project
- Inaugural Meeting – September 2011
- Harper has joined the Consortium with the Following Objectives
  - To Participate in ongoing discussions around the use of the CFTF
    - Help users meet specific and distinct processing needs
    - Customization of process equipment
  - Emerging Processing (Future) Techniques are likely to be structured around Specific Needs of Materials Programs
  - Access to Broad Value Stream From Material Producers to End Users

- For More Information Visit: http://www.cfcomposites.org/index.shtml or contact CFTF@ORNL.GOV
Thank You for Your Attention