Summary Specification

HIGHLY FLEXIBLE FIBER MELT SPINNING SEMI-PRODUCTION LINE

June 4, 2010, Rev. 2

1. The Oak Ridge National Laboratory managed and operated by UT-Battelle, LLC, has a requirement for a highly flexible fiber Melt Spinning Semi-Production Line (MSSL). This specification summarizes the requirements for the MSSL, which is intended to be capable of spinning precursor fibers, for carbon fiber production, from various materials including lignin, polyolefins, and pitches.

2. The MSSL shall be highly instrumented and capable of spinning and handling several kinds of precursor fibers including those based on lignin, polyolefins, and pitches in tow, nonwoven mat, or discontinuous, loose fiber form. It shall be capable of spinning fiber diameters of about 0.05 to 1.5 denier (about 5 to 15 micron). Additionally, it shall be capable of spinning fibers of varied morphology, including the ability to incorporate 2 (bi-component) or 3 (tri-component) components into a fiber to create diverse structures within the fiber. The melt spinning line shall be rated at >= 120,000 kg (264,000 lb) of annual production based on 24k polyethylene (PE) tow with 1.25 dpf and 6,000 annual operating hours. The Seller shall deliver and install a fully integrated line, including all compounding equipment for production of pelletized feedstock for the melt spinning equipment; all fiber melt spinning equipment; all material conveyance equipment; tensioning and fiber drawing equipment; effluent treatment equipment; and data acquisition and control hardware and software. Data acquisition and control shall be centralized in a dedicated control center. The MSSL shall be installed in a new building that is currently in design.

3. The MSSL shall satisfy the following system requirements:

A. Main Features:
   1. Capability to produce lignin, polyolefin, and pitch precursor filament webs and tows.
   2. Twin screw extruder, compounding/pelletizing line with capacity of at least 60 kg/hour (132 lb/hour); controlled, gravimetric dry or wet feeding of powders/pellets/liquids for precursor compounding and master batch preparation under nitrogen blanket. Capable of pelletizing lignin, polyolefin, and pitch precursor materials.
   3. Melt spinning capacity of at least 20 kg/hour (44 lb/hour) and appropriate tow winding equipment.
   4. Spun-bond, non-woven web capability, 600 mm width (24 inch), 200 m/min (600 ft/min).
   5. Operation temperatures from 150 to 350°C for compounding and fiber spinning. Capability to later upgrade heaters for 450C operation highly desirable.
   6. 3124 filaments per spinning position with up to 4 spinnerets per position.
   7. 0.5 to 1.5 denier per filament (about 10-15 micron diameter for lignin filaments).
   8. Ability to produce filaments with highly controlled and varied morphology, including bi- and tri-component capability.
   10. Heated 3-stage godet drawing rolls with controlled heating to 200°C and denier control.
   11. Metered finish application, cutter-aspirators.
   12. Tow interlacing station with capability of variable tension and span control.
   13. Pyrolysis oven and ultrasonic bath for cleaning the equipment and spinnerets.
   14. Suitable high precision control and data logging systems required for compounding, melt spinning, and spun-bond operations.
B. Specifications - Compounding & Pelletization Equipment
1. Drying oven capacity of 50 kg/hour (110 lb/hour) at moisture levels up to 20 wt% (wet basis), with nitrogen blanket.
2. Compounding/pelletization of up to three components (separate feed/drying/conveying system for each).
3. Vacuum conveying system from bulk packages of components (lignin, etc.).
4. Gravimetric feeder with nitrogen blanket.
5. Liquid ingredient metering system (2).
6. Twin screw compounding extruder, 48:1 L/D, with capacity of at least 60 kg/hour (132 lb/hour), modular barrel and screw elements, drive system, feed ports (2) for solid and liquid ingredients, vent ports (2) for removal of volatiles, temperature and pressure control systems. Capability to pull screws from rear (drive) end of extruder highly desirable.
7. Melt pump to meter polymer blend into strand die, temperature and pressure control systems.
8. High surface area, heated screen changer (manual) with temperature control system.
   Filters capable of removing non-melting particles ≤ 1 micron diameter.
9. Heated strand die (0.125” diameter strand) with removable heaters, temperature control system.
10. Re-circulating water bath system with heat exchanger and air knife for drying strands.
11. A separate dry, nitrogen gas blanketed strand cutting system required for pelletizing lignin materials.
12. Pelletizer with feed rolls, rotor cutting system, and housing.
13. Control system (PLC with PC-based HMI).
15. Installation and on-site start-up assistance.
16. Vendor to specify required utilities, including required electric power services.
17. Vendor to provide estimate of quantity of heat released from equipment (to facilitate sizing of HVAC system for equipment operation).

C. Specifications - Melt Spinning Line
1. Polymer handling system, with dryer, feed chute, vacuum loading, purge hoppers, feed station, gravimetric additive loaders, and nitrogen blanket.
2. Tri-component capability; 3 extrusion systems, each 30:1 L/D, one (1) 2 inch diameter, two (2) 1.5 inch diameter, corrosion-resistant screws. All three extruders must feature real pull screws and venting ports (2).
3. Provision for screen changer on each extruder.
4. Spun-bond capability 600 mm width (24 inch), 200 m/min (600 ft/min).
5. Adjustable-height web former, guide and compaction rolls, tensioning and winding system required. Interleaf capability for product winding highly desirable.
6. Overall capacity of at least 20 kg/hour (44 lb/hour).
7. Extruder drives, with gearboxes, feed hoppers (nitrogen blanket), pressure and temperature control systems, water cooling and flow controls. Suitable over-torque prevention system required.
8. Electrically heated (and removable) transfer pipes (Hastelloy or equivalent), with temperature control and insulation.
9. Corrosion-resistant tri-component spin head assembly, with pump block, pack adapters, wear and purge plates, heating jacket, pump well extensions and covers, temperature and pressure control systems.
10. Corrosion-resistant metering pumps (4-stream), with installation tool.
12. Suitable platform/lift system for access to spin pack for maintenance and removal to be provided.
13. Spun-bond pack assembly, with pack tops, screen support plates, spinnerets, cross flow plates, sheath cores, and all associated hardware.
14. Filament pack assembly, with pack tops, screen support plates, spinnerets, and cross flow plates, and all associated hardware.
15. Spin pack and extruder heaters shall feature separate control and monitoring thermocouples.
16. Quench assembly, with two-side (removable) cabinet, air control valves, blow motor and drive, reducing valve and controller, feed and return ducts, splitter and damper, and all associated hardware.
17. Lifting system for quench and fume, with all associated hardware.
18. Separate, removable heated tube assembly (6" i.d., 5-6' length) for operation up to 250°C. To be used in place of quench assembly for additional heating of lignin fibers.
19. Central vacuum system for collecting spin scrap (during flushing and startup).
20. Air handler and chiller; 10-ton, with filter, coil, and fan modules, piping or coil, instrumentation, and all associated hardware.
21. Main platform, with stairs, landing, handrails and safety equipment, equipment sled, leg brace, main platform section, and all associated hardware and fasteners.
22. Aspirator (for mounting to web former), with all necessary hardware.
23. Web former, height adjustable, with all necessary hardware.
24. Metered finish assembly, with all necessary hardware.
25. Denier stand assembly, with heated roll and motor, wrap guard, inverter drive, temperature control system, rolling frame, and all associated hardware.
26. Draw stand assembly (0-3000 m/min), with induction-heated godet assembly, dual roll drives, temperature control system, inverter drives, and all associated hardware.
27. Tow interlacing capability with suitable tension and span control and mounting system required (details to be determined).
28. Pack and inspection equipment, with burn-out oven, ultrasonic cleaning bath, pack and spinneret inspection systems, and all associated hardware.
29. Cabinets for all control systems, with HMI.
30. Sensitive electronics and motors sealed or protected from exposure to airborne conductive carbon filaments potentially generated in adjoining facilities.
31. All approved safety guards and alarms for rotating equipment and high temperature exposure points to be furnished by vendor.
32. List of recommended spare parts compounding and melt spinning equipment.
33. Documentation.
34. Installation and on-site start-up assistance.
35. Vendor to specify required utilities, including required electric power services.
36. Vendor to provide estimate of quantity of heat released from equipment (to facilitate sizing of HVAC system for equipment operation).