Future-Proofing with Air Blown Fiber

Apr 1, 1999 12:00 PM, By Joseph R. Knisley, Senior Editorial Consultant

Specialized optical fiber system proves ideal in heavy industrial application.

Over the years, the engineering and maintenance departments developed a small local area network (LAN), with a conventional fiber-optic (FO) backbone supporting a Token Ring topology. For in-plant quality control and accounting communications, the National Cooperative Refinery Association (NCRA), a 275-acre facility in McPherson, Kans., was using a complex multiplexing coaxial system. However, it needed to expand the LAN to achieve optimum communications efficiency, while using a distributed control system (DCS). NCRA started planning a network to not only expand, but to also include the point-to-point communications the DCS requires.

Installing a novel version of FO cabling at NCRA helped the engineering department and management staff solve several challenges relating to plant operations. First, technology developments in refinery processes called for the most up-to-date communications networking systems. Secondly, OSHA 1910 Process Safety Management requirements called for compliance with a number of new federal regulations, centering on sophisticated sensing and reporting requirements.

In many cases, the distance between LAN nodes at the plant exceeded the capabilities of Cat. 5 unshielded twisted pair (UTP) cable. Thus, the engineering department selected FO as the primary DCS media, and as the backbone for a five-loop, (unshielded) twisted-pair copper LAN. The FO network would require running the optical fiber cables in PVC below ground and rigid metal conduit above ground to connect the entire facility and four remote buildings. More specifically, this design involves 10 junction points and 13 main terminations. Because initial future expansion needs were not clear, NCRA decided against a conventional FO. To achieve a long-term, onetime, cable solution to support this undefined network, NCRA chose a technology called air blown fiber (ABF).

Air blown fiber. ABF refers to the use of compressed air or nitrogen to literally blow lightweight optical fiber cables through a tube cable at up to 150 ft per minute. Standard blowing distances are 3300 ft for two to six fiber bundles and 1650 ft for 12 to 18 fiber bundles. However, if two sets of blowing equipment are used in tandem, you can double these distances.

Developed by British Telecom, this technology and its installation method, are under license for U.S. manufacturing. The technology is based on the installation of a tube cable before installing any fiber. A tube cable is composed of a flexible outer jacket containing individual flexible tubes, called cells. The number of individual cells (up to 19) depends on the diameter of the outer jacket. In this case, the outer jacket is similar to a 3-in diameter steel, aluminum, or plastic conduit, for example. An individual cell is similar to an innerduct, which is the standard conduit pathway usually used to hold optical fiber.

Each inner cell accepts a single-fiber cable, with a fiber count of your choosing. And you can quickly blow the fiber cable into or out of the cell.

At the start of the installation, you must establish an optical fiber path by connecting a number of tube cells into a linear fashion, using push-fit connectors. At specific locations, you use a tube distribution unit (TDU), or junction box, to route the fiber to different locations. The TDUs replace the traditional junction boxes, where mechanical or fusion splicing would ordinarily take place. In this case, the TDU provides an access point (like a pull box) from which to blow fiber in any direction, so the fiber run is completely splice-free from point to point.

The FO bundle jacket has a low coefficient of friction as the air flow pushes the bundle jacket's dimpled surface down the tube, eliminating all pulling force on the cable. The absence of splice points along the cable route eliminates the possibility of failures at these points.

The ABF cable design also eliminates the need for slack boxes, usually required in traditional FO installations. This is because when blowing ABF, you can easily wind the slack inside the terminal cabinet's fiber patch panel. Should you need to relocate enclosures, you can blow out the fiber, extend the tube cable, and reinstall the fiber.

Take care when installing the tube cabling in aboveground conduit systems, or at any location where the cable will see extreme temperature fluctuations. Since the tubes are constructed of high-density polyethylene (HDPE) material, its coefficient of expansion is 10 times greater than steel conduit. For example, a 100-ft-long tube can shrink or expand a total distance of 14 1/2 in. when exposed to a 120 DegrF to 120 DegrF change.

Strategically place tube cable distribution boxes within the conduit system to prevent tubing kinking and fiber damage. Anchor the tube cable periodically to prevent it from crawling in the conduit. With the use of explosion-proof seal fittings at one end of each run, NCRA accomplished this. Because of these difficulties and the inherent complexity of ABF systems, an ABF qualified engineer should prepare the system design and supervise the installation.

As NCRA recognizes, you install only the exact fiber type, counts, and routes needed. You can later place additional optical fiber without disturbing existing networks. Thus, you don't have to forecast add-ons, moves, and changes, other than the normal practice of installing backbone network or ring network tube bundles containing more cells than initially required . You can accommodate network reconfiguration and growth by reconfiguring or extending tube bundles from the nearest tube distribution unit, blowing additional fiber through vacant tube cells, or replacing exiting fiber bundle count with a larger quantity (i.e. replacing a six-fiber bundle with a 12-fiber bundle).

Project details. The entire project uses 8400 ft of laminated polyethylene (LAP) tube cables containing 4-, 7-, 18- and 19-tube cells (using six-fiber bundles exclusively, with a total of 32,622 ft installed in the network).

Once the tubing was in place, the six-strand fiber bundles were blown through the cells with pressurized nitrogen at 150 to 250 lb per sq in. (psi), depending on the length of the run. The average pressure was 175 psi for runs of 1200 to 1500 ft. The longest splice-free run at the refinery is 3185 ft.

Later this year, NCRA plans to make alterations in the network, involving changes in the LAN tubing locations and fiber count. The company is also installing a new backup DCS loop between its two main control rooms and its main office building.

Since the fiber-optic cables can be easily removed and replaced, reused after replacement, or rerouted to any new destination, the system offers complete flexibility, and the components are never rendered obsolete. With these features, along with the ease of installation and reduced cost, the blown-fiber technology gives NCRA realistic, future-proofing capability.

Sidebar: Benefits of ABF

• No need for additional electronics to compensate for a loss that numerous splices in a typical conventional fiber system can cause.

• Creates cash flow savings by deferring the cost of additional fibers until you need them.

• Eliminates replacement of conventional FO due to fiber out growth.

• Less need to overdesign by specifying large count fiber cable.

• Savings that come from being able to easily install new technology. For example, optical fiber with gigabit transmission speed will likely use 50-micron and not 62.5-micron multimode fiber.