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Ruggedized, High-Performance Fiber Optic Cables Bring Greater Communication Bandwidths into the Factory (13298)

Forget the polo shirt, slacks and Rockports. Today's user of high-speed communication links is likely to wear overalls, a hard hat and boots. With a need to collect and move data at Gigabit speeds in industrial applications, high performance fiber optic cable is increasingly migrating from the cool confines of air-conditioned office buildings and data centers into the hothouse, rough and tumble environment of steel mills, oil refineries and chemical plants.

Under such harsh conditions, the ruggedness and durability of previous-generation fiber optic cables come into question. Whereas typical loose-tube or "indoor" tight-buffered cables can suffice for some simple, non-critical applications, today's plant managers are now demanding no less than the performance advantages that the highest-quality, abuse-resistant tight-buffered fiber optic cables offer. With exceptional bend, crush, impact, and chemical resistance—across a broad thermal operating range—ruggedized tight buffered cables are speeding installation, reducing attenuation loss, and maximizing "up time."

"I was involved in one of the first wastewater treatment plants that ever used fiber optic cable, recalls Charlie Motz, a senior engineer with Control Instruments, Inc. (C2i) of Smyrna, Georgia. "But we don't bother with loose-tube stuff anymore. Instead, we now use high-quality, ruggedized, tight-buffered cable because it's quicker to install, more reliable, and of greater value in the long run."

Low cost means high risk Almost as old as glass fiber itself, loose-tube fiber optic cable still finds use in some commercial and industrial enterprise applications and for many long-haul backbones—if only because of its relatively low cost. This same niche

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also allows for inexpensive, low-quality indoor-rated, tight-buffered cables. But when juxtaposed against the demanding needs of today's industrial plant, which calls for utmost durability and fail-safe operation, then any temporary cost differentials vanish in the economic consequences of interrupted processes or halted manufacturing runs caused by data loss or cable failure. As the cost of cabling represents a small fraction of a communication system (when factoring in the expensive network equipment, cable connectivity hardware, and installation and testing), a 10-20% price premium for ruggedized tight-buffered cable amounts to only a few percentage points increase. On the other hand, skimping on cable quality may end up costing many thousands of dollars per minute in system downtime, especially for critical applications.

Ruggedized, tight-buffered fiber optic cable derives much of its reliability and performance advantages from its basic design. As opposed to loose-tube designs, which only have one thin coating surrounding each optical fiber, ruggedized tight-buffered fibers have two. In loose tube cable designs, the fiber coating is only 62 microns thick, providing minimal mechanical and environment protection to the glass fiber during cable handling and stress. In addition to the primary fiber coating, each tight buffered fiber has a secondary buffer that, together with the primary coating, reaches "heavy weight" proportions such as 387 microns. This is over 6 six times thicker than the primary coating alone. Several of these individual buffered fibers are then tightly bundled within a sturdy cable jacket to create a highly ruggedized unit that is highly water resistant by virtue of the tight bundling and special fiber coatings.

For exceptionally demanding applications, some cable manufacturers customize the cable with additional jacketing and strengthening of each fiber subunit prior to final cable jacketing (i.e. breakout cables) further enhancing the design's ability to exhibit low-loss in the face of extreme operating temperature ranges and extraordinary mechanical stress.

Of course, loose-tube designs—with their fragile, thinly-coated fibers contained in a rigid hollow tube—can't begin to compete in the harsh environments often encountered in today's factory settings. Being relatively stiff

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and inflexible, loose-tube cables can develop jacket splits and breaks from flexure and abrasion which can allow water penetration, ultimately damaging the fiber. Tight bends or kinks in the tube can actually collapse the cable and break the fibers. Even some indoor-rated tight buffered cables can suffer from degradation or failure, caused by both long-term abuse and installation assaults.

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Finding fiber optic cables that can withstand the mistreatment handed out by manufacturing plants, petrochemical refineries, oil and gas platforms, mining sites, seismic testing facilities, military operations, remote video broadcasts, and transportation and security systems now requires taking a magnifying glass to even tight-buffered cables. Identifying the subtle differences that allow one cable design to succeed, while another fails, over the life of the installation begins by taking into account the two most common stresses that fiber optic cable finds itself subject to: installation stress, and long-term environmental and mechanical stress.

Installation hazards Unlike some long haul-applications, where the cable is basically dropped into the ground and covered with dirt with minimum connectorization, the placement of fiber within a factory requires countless bends, pulls and connections. All of this poses a risk to the cable. Here, loose tube designs can quickly fail. Even low-quality tight-buffered cable can break while being pulled through and around the multiple walls, ceilings, gantries, tanks, and material handling systems commonly found in industrial sites. In the face of such obstacles, only ruggedized tight-buffered cables can stand up to the stress.

For the most part, if major cable stress or damage occurs during the installation process, the contractor presumably knows about it right away and will quickly fix or replace the damaged link.

More insidious, though, is the "microbend," or residual stress, that can occur during or after installation. Often too small to notice initially, the cumulative stresses wreaked upon cable during rough handling can return to haunt the plant with higher-loss transmissions, missing data, and broken fibers. At worst, a complete shut down in the communications link can occur.

Additionally, instrumentation and control engineers are increasingly demanding 10-Gigabit transmission for certain links within the factory environment, requiring the latest 50 micron multi-mode OM-3 fiber, and in some cases, singlemode fiber. However, OM-3, 50 micron and singlemode fibers are much more bend-sensitive than the previous generation 62.5 micron fibers—hence requiring cable quality that goes well beyond minimum standards.

"We've never had a problem pulling Optical Cable Corporation's cable," says C2i's Charlie Motz. C2i is a nationwide system integrator of custom-engineered systems predominantly in the municipal water/wastewater market. "Other manufacturers don't offer the ruggedness and pull tensions that OCC's cables can withstand."

Optical Cable Corporation pioneered the design and production of tight-buffered cables for the most demanding military field applications. Its ISO 9001:2000 registered facility in Roanoke, Virginia, currently manufactures a broad range of fiber optic cables for the high bandwidth transmission of data, video, and audio communications, including cables for the most demanding commercial and industrial environments. Drawing on years of product development and cable design experience, Optical Cable Corporation's use of specially selected materials and its proprietary manufacturing processes contribute to the ruggedness of their products.

In-service abuse Once installed within a factory, the integrity of cable runs remains anything but static as harsh environments and even gravity can play havoc. If anything, today's use of 10-Gigabit communication links increasingly brings to light the fragility of all but the most sturdy of fiber optic cables. Even after installation, any kind of stress, whether minor mechanical loads or temperature extremes, can result in microbends or other fiber stress that in turn may lead to increased cable loss and transmission errors, or even eventual fiber failure and breakage.

For instance, having other heavy cables lying on top of the high-speed link within a cable-tray can cause cumulative trauma to the glass fibers. Even within vertical runs, cable

is subject to stress as gravity may cause axial migration that slowly weakens the fiber until a perfectly good installation degrades over time to the point where the link no longer functions.

Consider that 1 Gigabit lengths (distance-limited to about 300 meters) and OM3 10 Gigabit lengths (often used to extend 1 Gigabit links to over 1,000 meters) have less than 43 dB of total allowable channel insertion loss (as per the IEEE 802.3 Ethernet specification), and it becomes obvious that even the slightest increase in attenuation can sabotage the communication link.

All the more reason why only the best designed, tight-buffered, tight bound, ruggedized fiber optic cable will ultimately survive the longest in industrial applications.

"I've been using Optical Cable Corporation cable for about 15-16 years, and I feel their cables are better than anything else because we have used them under conditions that were above and beyond the expected, yet we've had absolutely zero failures," says Motz. "We had one instance where a guy in a back hoe accidentally dug up some buried cable. He brought it completely out of the ground before he noticed it. We thought it was broken, but it worked just fine."

In the case of Optical Cable Corporation, ruggedness is increased through the use of a pressure-extruded (Core-Locked™) or tightly bound outer jacket that firmly binds all the fibers together so that the cable moves as a single, solid, rope-like unit. Some of these cables greatly exceed minimum industry standard requirements with flex resistance of thousands of cycles, crush resistance of 2200 N/cm, the ability to withstand 1,000 impacts, and tensile load rating exceeding a ton.

Further qualifying themselves for industrial application, the latest generation of ruggedized fiber optic cables withstand environmental insults such as caustic and volatile chemicals, excessive moisture and fungus, UV exposure, and operating temperatures ranging anywhere from -55 to +124 Â°C.

"Keep in mind that our installations are far from 'primo' because of the nature of the

waterworks industry—there's submergence, abusive chemicals and sewage spills," says Motz. "Yet, after the cable has been installed, we've never had a failure because of degradation or anything like that."

Under such circumstances, the value of high-quality, ruggedized tight-buffered fiber optic cables helps industrial plants take advantage of the ultra high-speed links once reserved for white-collar campus networks and data centers.

For more information, contact Optical Cable Corporation; 5290 Concourse Drive; Roanoke, Virginia 24019, USA; 1-540-265-0690; fax 1-540-265-0724; or visit www.occfiber.com.

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