

Fiber Optic Cable Termination: Anaerobic Adhesive or No-Polish Cleave & Crimp

Loss Budgets in Fiber Optic Systems - A Brief History

A fiber optic system consists of a transmitter, receiver, cable, connectors, patch cords, and shelves. The difference between the transmitter output and the receiver sensitivity is what is referred to as the channel power budget. In the early years of multimode fiber system deployments, the fiber optic networks operated at fairly low data rates and had the luxury of operating with relatively large power budgets, which allowed for the use of less than optimal fiber, fiber cable and components. By the late 1990s, the industry had moved toward higher speed technologies, such as 1Gbps and later 10Gbps.

This migration to higher speed networks dramatically reduced the overall power budgets - with some budgets dropping as much as 78% for multimode systems. The luxury of using less-than-optimal fiber and connectors or termination processes has diminished. While most of the industry has pushed forward with much better fiber and cable designs, the one weak link now lies with the choice of connectors and the process for terminating those connectors to the fiber cable.

The Importance of Proper Termination

To complete the path between the fiber optic transmitter and its receiver, technicians must install connectors at both ends of a fiber optic cable. Any problems with a connector, such as poor installation, can greatly reduce the amount of power reaching the receiver. Such problems can render the fiber optic system inoperative. Understanding connectors and their installation are key elements in a reliable fiber optic network.

The Importance of Connectors

Fiber optic connectors provide an easy way for technicians and end users to easily connect and disconnect an optical fiber link without the use of special tools. To work properly, the connector end-faces must be finely polished to ensure proper alignment of the fibers within the connectors. These ends can be polished in the field by the technician or at the factory by an automated machine.

Methods for Installing Connectors

A fiber end that is stripped (that is, the buffer coating has been removed) can be attached to the connector ferrule with either an adhesive or a mechanical crimp. Either of these two methods for attaching the fiber ends to the connector ferrule will help to maintain physical contact of the fibers for proper alignment and optimal power throughput. Either of these two methods for installing connectors can be used to achieve high-quality, low-loss connections. The first method uses a two part chemical bond, referred to as anaerobic, and a field polish. The second method utilizes a factory terminated and polished fiber stubbed ferrule, which mates up to the field fiber using a locking and/or crimping mechanism to secure the fiber.

When choosing an installation method, installers should consider costs for tools, time required to perform connections, the level of technician training necessary, the long-term reliability of that connection, and the overall performance gained by the installation method.

Anaerobic Adhesive Method

Anaerobic adhesive is one of the most common methods of connector installation. The anaerobic process utilizes an adhesive and primer which when combined cures in 20-30 seconds without the use of UV or heat curing devices. Once the chemicals have cured, the fiber stub is scored, cleaved and polished to yield a low loss physical contacting endface. The anaerobic process has many benefits, such as:

- The lowest total installed cost method
- The best insertion loss performance
- High yields, low percentage of reworks
- Higher tensile loads, which helps reduce the number of accidental disconnects
- Requires only moderately trained personnel

No-Polish Cleave and Crimp Method

The No-Polish Cleave and Crimp method is another method used to terminate the fiber cable. These connectors have been prepared at the factory with a pre-polished fiber stub installed in the ferrule. The quality of the polish is typically more consistent than when it is performed in the field.

Cleave and crimp connections are fast and can be performed in minutes. While the no-polish cleave and crimp connectors install faster than a typical anaerobic adhesive connector, the connectors are more expensive than the adhesive type, and the labor savings is still not enough to offset the material cost difference. The no-polish cleave and crimp connectors have the following benefits:

- Fast installation time (typically 1-2 minutes)
- Requires moderately trained personnel
- Does not require the use of chemicals
- Can be re-terminated to improve performance (if connector has not been crimped)
- Yields a more consistent polish



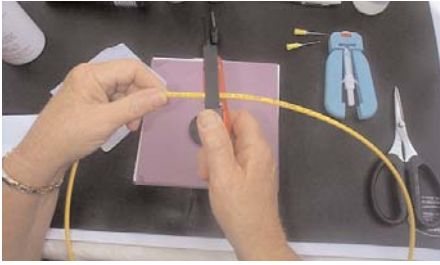
Total Installed Cost

The cost model below shows a comparison of the total installed cost for both the anaerobic process and the no-polish crimp process. When evaluating the cost of consumables, connectors, number of terminations per hour and the labor rate, the cost model reveals that even with a 2:1 ratio of no-polish crimp connectors to anaerobic connectors per hour, the increased material cost of the no-polish crimp on connectors can not be overcome until the labor rate reaches \$130.00 per hour. In reality, assuming the technician has the same confidence level for both procedures, the number of terminations per hour will depend more on the environment in which the terminations are occurring. If multiple fibers are being terminated in one room, then the overall difference in connectors per hour between the two processes will be very small. If on the other hand only a couple of fibers are being terminated at multiple locations, then the no-polish crimp method might approach a 2:1 ratio.

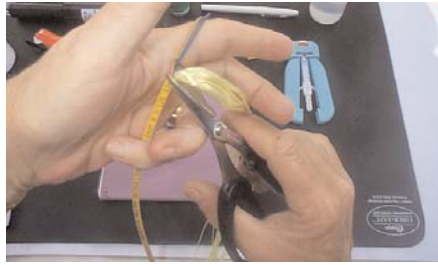
The other factors not accounted for in the cost model are the cost of tools required for each process and the overall yield rate of both processes. If comparing tool kit costs, the anaerobic tool kits range from \$500 to \$900, while the no-polish crimp kits range from \$1,200 to \$5,500. The overall yields of both processes will vary depending on how tight the insertion loss specifications are written and the overall proficiency of the technician. In general, the lower the insertion loss specification (i.e. 0.3dB per mated pair versus 0.75dB per mated pair), the lower the yield on no-polish crimp on connectors, which leads to more remakes and added cost. With the anaerobic process, the average insertion loss across the board is around 0.3dB per mated pair, so the overall yields tend to be higher.

Termination Options	Anaerobic (3 Minutes)	No-Polish Crimp-on (1.5 Minutes)	Anaerobic % Difference in Cost/Connector	Crimp-on % Difference in Cost/Connector
Connector Cost	\$5.00	\$10.00		
Consumable Cost	\$2.00	\$0		
Total Material Cost	\$7.00	\$10.00	0.00%	30.0%
Connectors/hour	20	40		
Labor Rate/hour	Cost/Connector	Cost/Connector		
\$20.00	\$8.00	\$10.50	0.00%	23.8%
\$30.00	\$8.50	\$10.75	0.00%	20.9%
\$40.00	\$9.00	\$11.00	0.00%	18.2%
\$50.00	\$9.50	\$11.25	0.00%	15.6%
\$60.00	\$10.00	\$11.50	0.00%	13.0%
\$70.00	\$10.50	\$11.75	0.00%	10.6%
\$80.00	\$11.00	\$12.00	0.00%	8.3%
\$90.00	\$11.50	\$12.25	0.00%	6.1%
\$100.00	\$12.00	\$12.50	0.00%	4.0%
\$120.00	\$13.00	\$13.00	0.00%	0.0%
\$140.00	\$14.00	\$13.50	3.57%	0.0%

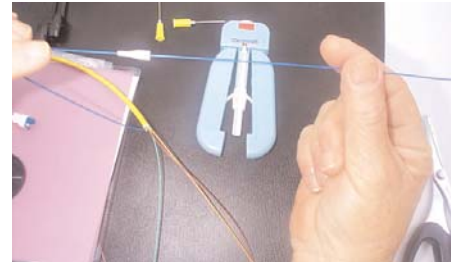
Installation Steps for Anaerobic Connectors



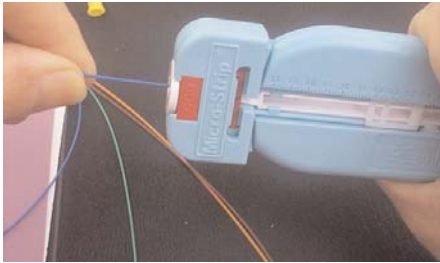
Remove cable jacket



Trim aramid yarn



Place boot/hardware on fiber



Remove the 900 micron buffer and acrylate coating from the fiber



Inject adhesive into connector



Insert fiber into the connector and allow adhesive to cure



Scribe and cleave the fiber



Air polish to remove the fiber stub



Polish the connector using the appropriate "puck" and polish paper(s)



Inspect the connector face for any defects - be sure to clean prior to inspection



Finished connectors

Installation Procedures

Installation Steps for Anaerobic Adhesive	Installation Steps for No-Polish Cleave & Crimp
Step 1. Remove cable jacket	Step 1. Remove cable jacket
Step 2. Place boot/hardware on fiber	Step 2. Place boot/hardware on fiber
Step 3. Strip individual fiber buffers and coatings	Step 3. Insert connector into crimping mechanism
Step 4. Clean the fibers	Step 4. Verify connector housing is in the open position
Step 5. Apply primer and/or adhesive to the fiber and connector	Step 5. Connect the visual fault locator, if present
Step 6. Insert fiber into the connector and allow adhesive to cure	Step 6. Strip individual fiber buffers and coatings
Step 7. Score and Cleave the fiber stub	Step 7. Clean the fiber
Step 8. Polish connector ferrule	Step 8. Cleave the fiber
Step 9. Clean the connector	Step 9. Insert fiber into connector
Step 10. Inspect the connector	Step 10. Verify fiber is properly seated and physically mated with internal fiber stub
Step 11. Test the fiber link	Step 11. Lock the fiber in place and crimp connector
	Step 12. Remove fiber and connector from crimp housing
	Step 13. Clean the connector
	Step 14. Test the fiber link

Conclusions

As technology continues to evolve and higher data rates are utilized on fiber optic networks, the associated lower power budgets will dictate a more comprehensive and conservative approach to selecting components and procedures. We no longer have the luxury of utilizing processes and components which tend to yield higher insertion losses and lower reliability. As stated earlier, the connectors and termination procedures are becoming a more vital part of the overall performance of the fiber optic networks. While there are different processes for terminating the fiber connectors, one must evaluate all the pros and cons before making a choice. While the no-polish crimp process does yield a more consistent polish and typically a higher number of connector terminations per hour, the higher installed cost and higher insertion loss performance may make it a less desirable choice. In contrast, the evidence shows that for overall performance and cost savings the anaerobic process will be the preferred method.



Corporate Office

1100 CommScope Place SE P.O. Box 1729

Hickory, North Carolina (USA) 28603-1729

Tel 828.459.5000 800.544.1948 Fax 828.459.5099

www.uniprisesolutions.com

© 2006 CommScope Inc. All Rights Reserved