

Fiber Optic Cable Production Process: Problems and Solutions

Li Hanyu¹, Suchada Sitjongsataporn^{2,*} and Athikom Roeksabutr²

¹The Electrical Engineering Graduate Program, Faculty of Engineering and Technology
Mahanakorn University of Technology International College (MUTIC)

Mahanakorn University of Technology, Bangkok, Thailand

²School of Electrical and Electronic Engineering (SEE)

Mahanakorn University of Technology, Bangkok, Thailand

Email: ssuchada@mut.ac.th

Abstract: With the advancement of technology, people's living standards have significantly improved, and the emergence and application of optical fibers have accelerated this progress. The use of optical fibers is extensive; this stable and cost-effective technology is driving rapid technological development. For example, the AI technology being vigorously developed globally, submarine cables spanning oceans, or drones and space communication devices that use fiber-optic signals to prevent signal interference in modern warfare. The objective of this work is to collect the problems in fiber optic cable production line in manufacturing. Problems and solutions of fiber optic cable production in practice have been described.

Index Terms—Optical fiber technology, Infrastructure development, Fiber optic cable production process

I. INTRODUCTION

Fiber optic production refers to the process of manufacturing optical fibers, which is a highly technical process that requires precise control of factors such as temperature, speed, and chemical composition to ensure the performance of the final product [1]-[2]. Optical fibers play a crucial role in modern communication due to their advantages of high bandwidth, low loss, and resistance to electromagnetic interference. However, ensuring the normal production of optical fibers without problems is the common basis for ensuring the production of different optical fiber products [3].

The objective of this work is to collect the problems in fiber optic cable production line in manufacturing. This paper is organized as follows. Problems in fiber optic cable production are explained in Section 2. Solutions in fiber optic cable production are presented in Section 3. Finally, the conclusion is summarized in Section 4.

II. PROBLEMS IN FIBER OPTIC CABLE PRODUCTION

The steps of fiber optic cable production process are shown in Figure 1. First, the bare fiber is unwound from the spool and undergoes electrostatic dust removal. Then, it passes through an extruder and a fiber gel injection device [3]. Next, it enters a hot water bath and a warm water bath, followed by cooling through a paper-guided cold water bath. Afterwards, it dried using air blowing. The fiber is inspected using a diameter detector and then wound onto a spool.

The interested factory that need to employ an integrated OVD perform preparation and extrusion coating process, equipped with fiber drawing equipment, extruders, and supporting diameter detection and OTDR optical performance testing systems. The production process strictly adheres to the EN 60794-1-2 international standard and the ISO 9001 quality management system. It is located in a tropical coastal industrial zone, surrounded by rubber plantations and rice paddies, with a superior ecological environment. However, the region has a high average annual temperature and high relative humidity, which can easily lead to production problems such as raw materials absorbing moisture and gel forming bubbles.

Received: 21 February 2026

Revised: 1 March 2026

Accepted: 25 March 2026

*Corresponding author: Assoc.Prof. Dr. Suchada Sitjongsataporn,
Department of Electronic Engineering, School of Electrical and Electronic
Engineering (SEE), Bangkok, Thailand. (Email: ssuchada@mut.ac.th).

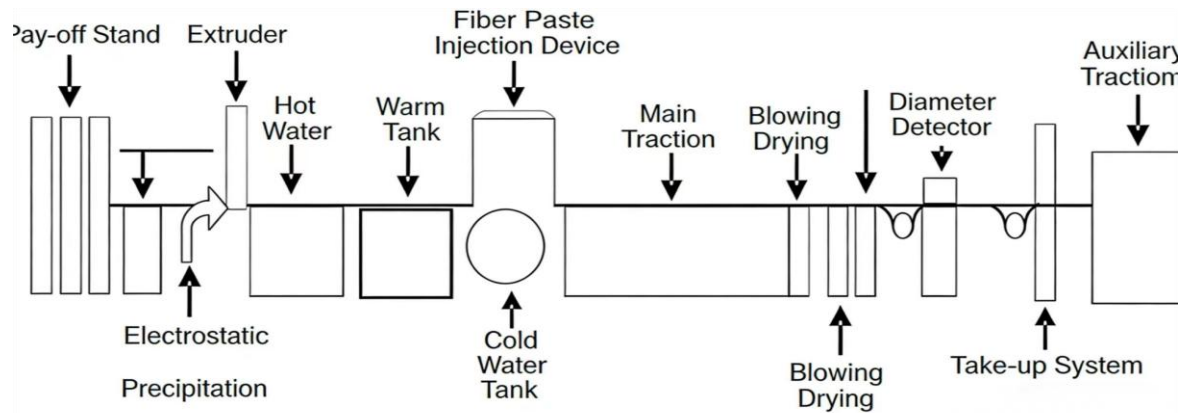


Figure 1 Optical Fiber Production Process

At the same time, in order to balance heat dissipation and air circulation in the workshop, the production workshop adopts a semi-enclosed design. Local sparrows, spotted munias and other birds often fly in during the morning and evening hours, which may cause interference such as mold contamination and wire reel entanglement.

The bulging problem that may in the production of optical fiber cable is shown in Figure 2. Bulging is very common in fiber manufacturing and significantly affects the lifespan of optical fibers. The causes of the bulging problem are as follows:

- 1) Raw materials are contaminated and contain impurities.
- 2) Oil needles and mold core or oil needle are bent.
- 3) There are a large number of bubbles in the gel or the vacuum pump is not working properly.
- 4) Machine drilling and machine head have not been cleaned for a long time.
- 5) Extrusion mold (mold core, mold cover, diverging cone) is damaged.
- 6) Water splashes onto the high-temperature housing of the first section of the nozzle.

The pay-off device is shown in Figure 3. The purpose of the pay-off is to protect the internal optical fibers from damage, and it is also the main step where bulging of the optical fiber outer sheath occurs [3].

The jacketing step in the fiber optic production process is shown in Figure 4. This step is intended to protect the fiber during manufacturing. The unwinding step is shown in Figure 3. Because a bulge occurred during the unwinding step, it caused the outer coating of the fiber to be damaged during the jacketing step.

Another problem is that the material particles outside the production fiber may be damp, so the bonding is not tight, bulge and falling off. Secondly, the spinning wheel in the production process may have slipped track or knot. In the process of mechanical uniform motion production, the spinning wheel will produce amplitude, resulting in vibration in the production step, the outer layer is not strict

or uncoated, of course, this situation will also appear when receiving external force factors. Because the factory is not a fully closed factory, and the geographical location of the factory is located in Thailand, the surrounding ecological environment is good, and birds often fly into the factory, of course, we cannot exclude the improper operation in the production process resulting to product problems. Secondly, most of the spinning wheel accumulation or knot occurs in the process of spinning wheel production, but the use of raw materials in the production of optical fiber is relatively direct, and it is difficult to exclude the occurrence of this situation [4].

III. SOLUTIONS IN FIBER OPTIC CABLE PRODUCTION

For the solution to the problem of raw materials being wet, the following suggestions should be considered:

About the moisture-proof methods of raw materials:

- 1) Add moisture-proof agent in the production of raw materials.
- 2) Drying, which was performed before using the raw materials.
- 3) Improve the storage environment and check the moisture conditions regularly.
- 4) Prevent moisture absorption of products during transportation.
- 5) Add dehumidifying desiccant.
- 6) The hopper of the injection molding machine is equipped with a continuous drying device, and the temperature is maintained at 80-100°C.
- 7) Anti-hydrolysis agent is added to block the hydrolysis reaction and add hydrophobic filler or coupling agent to reduce the hygroscopic rate.
- 8) Optimize the exhaust groove design to avoid water bubbles.
- 9) Spray the waterproof paint, physical shielding to block the water vapor.

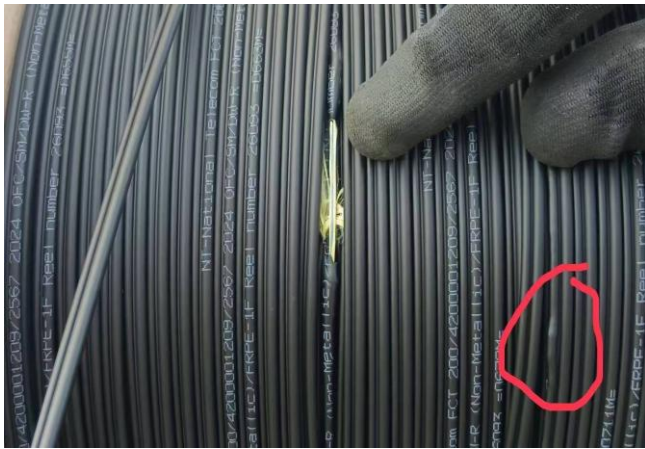


Figure 2 Example of Bump condition

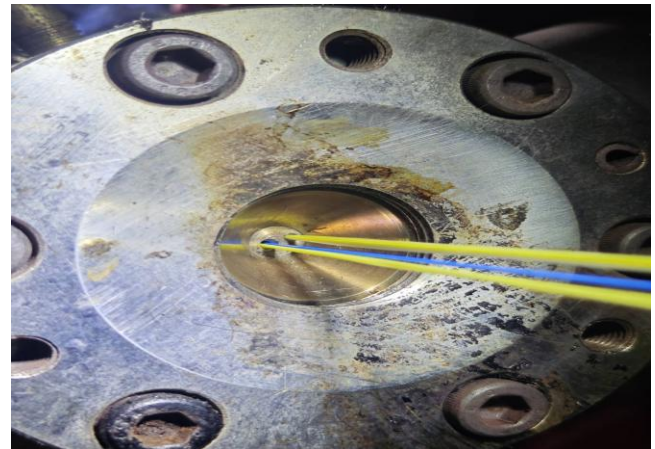


Figure 3 Pay-off device

- 10) Design the anti-water accumulation structure, increase the ventilation and heat dissipation holes, and reduce the internal humidity of the components.
- 11) To prevent this, check whether the moisture content of raw materials meets the requirements before production

Some suggestions are following for the possible problems:

- 1) Cultivate professional knowledge, conduct regular training, consolidate the rules and regulations and the standardization of operation.
- 2) Set up bird driving tools around the factory to prevent birds from flying into the factory and having an impact on the production line.
- 3) Before using the spinning wheel, check whether the yarn is detached from the wheel and has obvious bulge.

On the mechanical and optical properties of optical fibers in fiber optic production [4]. On the mechanical properties: The mechanical performance test of the communication optical cable is an important step to ensure that the optical cable can withstand various mechanical stresses and environmental conditions during the installation and use process. EN 60794-1-2 As the international standard of communication optical cable industry, it stipulates the mechanical performance test methods and requirements of communication optical cable to ensure the reliability and durability of optical cable.

The EN 60794-1-2 standards mainly include the following contents:

- 1) Tensile performance test: test the endurance of the optical cable under tensile stress by applying tension. This test ensures that the cable is not subjected to excessive tensile force during installation, thus ensuring its stability and reliability.

- 2) Flattening performance test: The flattening stress resistance of the optical cable is tested by applying pressure. This test can ensure that the optical cable can maintain its original transmission performance when being squeezed or pressed under other objects, and avoid the attenuation of optical signals or transmission interruption.
- 3) Twisting performance test: The ability of optical cable to withstand twisting stress is tested by applying twisting force. This test can ensure that the optical cable can maintain the original signal transmission ability when twisted or bent, and avoid fiber damage or abnormal transmission.
- 4) Bending performance test: test the bearing capacity of optical cable under bending stress by applying bending force. This test will ensure that the cable maintains its transmission performance when bent, avoiding breakage or signal transmission.
- 5) Impact performance test: by simulating external impact, the ability of the optical cable to withstand impact stress. This test can ensure that the optical cable can protect the internal fiber when subjected to external impact, avoiding fracture or damage.
- 6) Tension relaxation performance test: test the endurance of optical cable through the cycle of applying tension and relaxation force under the tension relaxation stress. This test will ensure that the cable does not break in the tension and relaxation cycle, thus ensuring the durability and durability of the cable.



Figure 4 Coating process

The implementation of EN 60794-1-2 standards not only ensures the stability and reliability of communication optical cables under various environmental conditions but also provides manufacturers with a reference standard for product quality. Through these mechanical performance tests, manufacturers can identify and address potential issues in advance, ensuring that the cables meet the expected quality requirements before delivery to customers [6].

About optical performance: The detection of optical performance includes many aspects, such as the optical time domain reflectometer (OTDR) experiment.

The OTDR works on the following principles that is simply a device to measure and analyze the backscattered light in the optical fiber, the backscattered light at the defect point and the optical fiber information carried by the reflected light on the end surface.

OTDR is the use of light ray scattering in the optical fiber transmission and Fresnel reflection backscatter and precision of photoelectric integration instrument, it is widely used in cable line maintenance, construction, can be optical fiber length measurement, the distance between two optical fibers, fiber transmission attenuation, joint attenuation and fault positioning [5].

As shown in Fig 5, the optical time-domain reflectometer (OTDR) injects a high-power narrow pulse of light into the fiber under test (FT-D) and then detects the scattered and reflected light returning along the same end of the fiber. As the optical pulse propagates through the fiber, scattering and reflection occur due to the fiber's inherent characteristics, connectors, joints, bends, or other similar conditions. Some of the scattered and reflected light returns to the OTDR. This process is repeated multiple times, and the results are averaged to display the intensity of the echo signal throughout the fiber as a trajectory graph. The pulse generator drives the laser diode of the photoelectric converter to output an optical pulse, which then enters the FT-D through a directional coupler. Reflected light



Figure 5 OTDR for measuring fiber optic performance

generated in the fiber or Fresnel reflection generated at the fiber end is received by the avalanche photodiode of the photoelectric converter. Since the received signal is weak, multiple reflected signals need to be amplified and averaged to improve the signal-to-noise ratio before display.

Due to the uneven density of optical fiber materials, their inherent defects and non-uniform doping components, when light pulses travel through the fiber, Rayleigh scattering occurs at every point along the fiber length. This scattering spreads in all directions, with a portion always entering the numerical aperture angle of the fiber and traveling back along the fiber axis to the input end. The wavelength of the Rayleigh scattered light is the same as that of the incident light, and its power is proportional to the incident light power at the scattering point. Measuring the power of the backscattered Rayleigh scattered light returning along the fiber axis provides information on the transmission loss along the fiber, thus allowing the attenuation of the fiber to be determined [5].

IV. CONCLUSION

Based on production practice, this study identified and proposed recommendations for addressing core production issues in the factory environment. It clarified the interconnected causes of key failures such as bulging and coating adhesion failure. Through solutions including "full-chain moisture control of raw materials, employee operation training, and bird control in the workshop," combined with EN 60794-1-2 mechanical testing and OTDR optical inspection, it effectively controlled product defect rates, ensuring fiber optic attenuation $\leq 0.3\text{dB/km}$.

Future development can focus on three main directions: First, promoting intelligent upgrades by building a "real-

time raw material humidity sensing and OTDR data AI analysis" system to shift fault response from "post-event repair" to "pre-event warning"; second, focusing on special optical fiber processes, developing weather-resistant coating materials and multi-core optical fiber preparation technologies to meet the needs of submarine cables and UAV communication in Southeast Asia; and third, exploring green production by optimizing waste gas recovery and wastewater recycling in the OVD preform process to adapt to regional environmental policies and further improve production capacity stability and market competitiveness.

REFERENCES

- [1] D. M. Cui, C. J. Pan, M. Kong, K. Xie, "Research on green and environmentally friendly manufacturing process of optical fiber preform," Study on Optical Communications, Vol. 49, Iss. 5, 56, 2023.
- [2] S. Liu, Y. Li, H. Hu, B. Sun and Z. Zhang, "Simultaneous Dual-Domain Sensing Based on Forward-Stimulated Brillouin Scattering in Cascaded Optical Fibers," in IEEE Transactions on Instrumentation and Measurement, vol. 74, pp. 1-8, 2025.
- [3] L. Miao, J. Shi, J. Yan, Y. Liu, X. Shu, S. Che, "Experimental study and analysis of high sensitivity interferometric fiber optic gyroscope using multi-core fiber", Optical Fiber Technology, Volume 73, 103052, 2022.
- [4] IEC, "IEC 60794-1-2: International standard", Edition 5.0, 2021. Available at <https://cdn.standards.itech.ai/samples/103031/8c337edadfe546c9bda601037e9345cd/IEC-60794-1-2-2021.pdf>
- [5] J. Scheuner, A. Heidt, S. Pilz, P. Raisin, A. El Sayed, H. Najafi, M. Ryser, T. Feuerer, and V. Romano, "Advances in optical fibers fabricated with granulated silica," in Optical Fiber Communication Conference, OSA Technical Digest (online), Optica Publishing Group, 2017.
- [6] F. Xu, L. Li, P. Jing, Z. Yu, J. Zhang, and S. Liu, "Experimental Study on the Characterization of Aging Resistance Properties of Optical Cables in the Hydrogen-Containing Downhole Environment", Sensors, vol. 24, no. 5, 1655, 2024.



Li Hanyu graduated from Qingchuan University in Wuhan, Hubei, China in 2024. He is currently pursuing a Master's degree in Electrical Engineering (Electronics) at Mahanakorn University of Technology in Bangkok, Thailand. His research interests include the fabrication, maintenance, and overhaul of optoelectronics.



Suchada Sitjongsataporn received her B.Eng. (first-class honors) and D.Eng. degrees in Electronic Engineering from the Mahanakorn University of Technology, Bangkok, Thailand in 2002 and 2009, respectively. She has worked as a lecturer at the department of electronic engineering, Mahanakorn University of Technology since 2002. Currently, she is an Associate Professor in electronic engineering, the Assistant President for Research and Dean of Graduate College in the Mahanakorn University of Technology. Her research interests are in mathematical and statistical models in the area of adaptive signal processing for communications, networking, embedded system, AI & deep learning and image & video processing.



Athikom Roeksabutr received the B.Eng. in Electrical Engineering from King Mongkut's Institute of Technology, Ladkrabang, Thailand, in 1985, the MSEE from Florida Institute of Technology, USA, in 1989, and Ph.D. in Electrical Engineering major in Optical Communication from University of New South Wales, Australia, in 1996.

He has been a lecturer with the Faculty of Engineering at Mahanakorn University of Technology, Bangkok, Thailand since 1990. He is an associate professor in Telecommunication Engineering. He is currently the President of the Electrical Engineering Academic Association (Thailand) of which he is one of the founders. He has been the Chairman of the Technical Committee of Thai Industrial Standards Institute, Ministry of Industry, taking charge in producing the National standards for optical fiber cables and other optical products in telecommunication for more than 20 years. His research interests include optical technology and applications, photonics solutions, and STEM educations.