Phase stable Optical Cable

Optical devices and equipment have been gradually replacing electric parts or equipment in various fields in recent years due to the advantages of low cost, high security and confidentiality. However, in practical applications, the high stability requirement of optical transmission signals required by these devices or equipment limits the development progress. For example, in the fields of phased array radar, signal simulation and other, after a certain distance transmission, phase coherence of the multiple signals is the key factor of these application. For conventional optical fibres and cables, in process of a certain distance transmission, the signal transmission distance (optical path difference) will have a certain drift (generally 40ps/Km/k) due to the temperature changes of transmission path, which affects the phase stability of the signals. This path difference restricts the development of phased array radar, information simulation and other fields. In order to solve the problems above, Yangtze Optical Fibre and Cable Joint Stock Limited Company (hereinafter referred to as YOFC) has developed a phase stable optical products with **a temperature drift coefficient in the range of 5-10ps/km/K**, which can greatly improve the stability of the system.

The propagation time of light in the phase stable optical cable fluctuates little with temperature, and even the propagation time of light at the same transmission distance does not change with temperature. The most important index is temperature drift coefficient, which is the optical path difference caused by temperature changes when a light of a certain wavelength is transmitted in optical cable, which is defined as:

$$Kf=d\tau/(L\,dT)$$

Where dT is the amount of temperature changes (K), dτ is the change amount of optical cable transmission delay (ps) caused by changes of temperature, and L is the length of optical cable (km). Temperature drift coefficient is determined by three factors: length change caused by thermal expansion, group index of refraction change caused by thermo-optical effect and group index change caused by elasto-optical effect. At present, there are two major solutions: one is to use negative thermal expansion coefficient material to reduce the length change, and the other is to use hollow-core plastic photonic crystal fibres to reduce the thermo-optical effect.

At present, the temperature drift coefficient of common communication optical fibre is 40ps/km/K. However, the temperature drift coefficient of the tight buffered fibre is 40-130ps/km/K due to the external protective layer with a relatively large expansion coefficient. Currently, in various military and civil product systems which have a relative higher requirement on the optical path difference, normally the active compensated phase stabilization system will be added to satisfy the requirement of phase stabilized transmission. However, the compensation scope of this controlling method is limited and the system is relative complex.

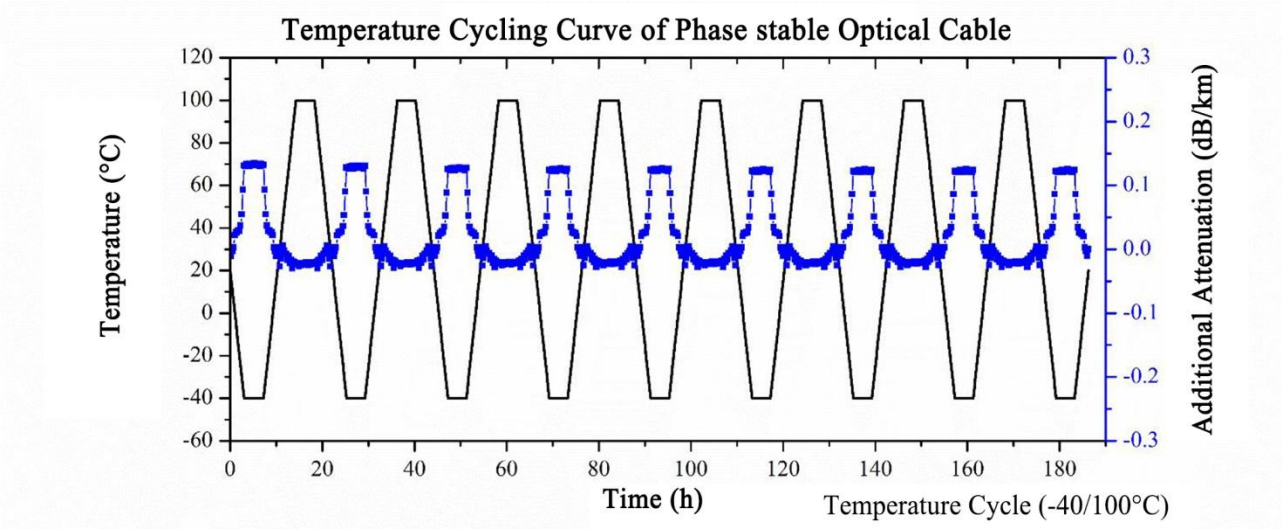

Figure 1 Temperature Cycling Curve of Phase stable Optical Cable

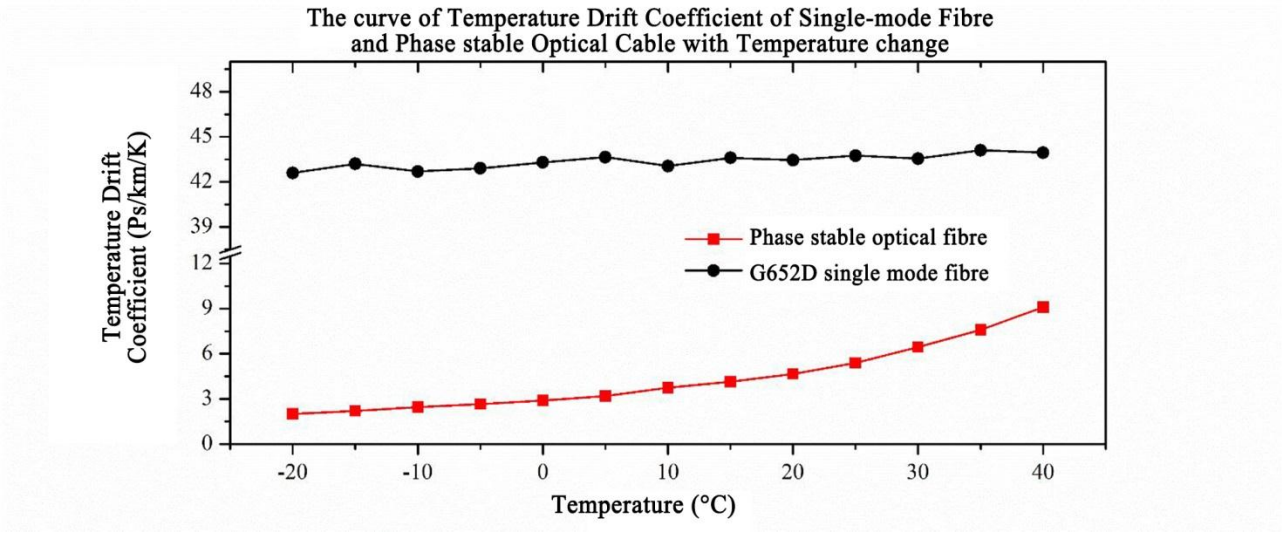

Figure 2 The curve of Temperature Drift Coefficient of Single-mode Fibre and Phase stable Optical Cable with Temperature change

The phase stable optical cable with negative thermal expansion coefficient buffer material developed by YOFC is characterized by low temperature drift coefficient and high temperature stability. The temperature drift coefficient of the cable is 8.5ps/km/k (-40-40℃,Typically) before and after the temperature cycling test (-40/100℃, 10 times), high temperature and low temperature storage test (-40℃/250h，100℃/250h). The decay curve of the cable during the temperature cycling test referred to Fig.1. The maximum additional loss of the product in this temperature range is 0.12dB/km and the additional loss is less than 0.1dB/km at the range temperature of -35/100℃. In addition, compared with the temperature drift coefficient of conventional single-mode fibre, the test value of this product`s temperature drift coefficient is about 20% of the conventional single-mode fibre (the test value of conventional single-mode fibre is 40ps/km/K, 0-40℃).

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The phase stable optical cable developed by YOFC has the characteristics of long band, low product attenuation and stable temperature performance, and so on. The temperature drift coefficient of product is still stable after several times of testing, such as high temperature storage, low temperature storage and temperature cycling test. **Besides, it can be customized according to customer`s requirements, the external diameter and optical fibre types are optional.**

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