COMPARISON OF SMF, DCF, NZDF, NZDSF FIBRES CONSIDERING SRS INDUCED CROSSTALK IN SUBCARRIER MULTIPLEXED WDM TRANSMISSION SYSTEM

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ABSTRACT: In this paper the analysis of Stimulated Raman Scattering induced crosstalk in Subcarrier Multiplexed WDM system has been discussed. The expression for SRS induced crosstalk have been observed for different fiber types such as single mode fiber, dispersion compensation fiber, non-zero dispersion shifted fiber and non-zero dispersion fiber. Comparison of different fibers is done at varying transmission length keeping the modulation frequency constant at 5 GHz. In general, it has been observed that that the SMF and DCF show the better results over span of the transmission length. The present work shows that out of four different types of fiber SMF and DCF have the minimum crosstalk range as (-82dB to -75dB) and (-70dB to -75dB) but DCF shows the fluctuation over the span of transmission length.
Keywords: DCF, NZDF, NZDSF, Transmission Length, SRS

I. INTRODUCTION

A communication system transmits information from one place to another, whether separated by a few kilometres or by transoceanic distances. Information is often carried by an electromagnetic carrier wave whose frequency can vary from a few megahertz to several hundred terahertz. Due to explosion in information technology application, the demand for bandwidth has increased enormously. Therefore second window having capacity of more than 100Tb/s is used. The initial development of optical fiber was for long haul or submarine transmission systems but now in telecommunications, telephony, cable TV (CATV) and even for the shorter distances within the buildings optical fibers are used. Direct fiber connection has always been viewed as the long awaited solution due to the large bandwidth and low maintenance. However, in order to remain competitive for FTTH, a passive optical network is required. SCM is a potential solution for transmission in OPNs. The combination of SCM and WDM is a viable method to further increase the transmission capacity in OPNs. SCM-WDM systems, however suffer from non-linear effects in fiber. These non-linearity cause crosstalk between subscribers on different wavelengths. In a dispersive fiber, the dominant fiber nonlinearity that causes crosstalk is cross-phase modulation (XPM). Fiber nonlinearities such as stimulated Raman scattering (SRS) and cross phase modulation (XPM) may generate significant amounts of nonlinear crosstalk between adjacent SCM channels because they are very closely spaced. SRS and SBS transfer energy from pump pulse to generate stoke pulses which co-propagates along with the pump signal in the same or opposite direction if the peak power of the incident waves is more than the threshold level, and these two pulses interact with each other through the Raman gain and XPM[9]. The SRS effect is more dominant for the frequencies which are adjoining to the transmitted ones. Crosstalk mainly due to SRS, SBS and XPM occurs due to nonlinearities of the fiber. Effect of SRS and XPM in an SCM-WDM system has been studied previously in some literatures. In crosstalk has been evaluated using fibres Single Mode Fiber (SMF), dispersion compensation fiber (DCF), True Wave fiber (TW), True Wave-Reduced Slope fiber (TW-RS) and Large Effective Area Fiber (LEAF). As dispersion coefficient and effective area was decreased, crosstalk remains high and then decrease with the increase in frequency. TW had the maximum crosstalk and SMF had the minimum crosstalk. In SRS and XPM induced crosstalk in SCM-WDM system have been analyzed and combined effect of this crosstalk on the system performance had been investigated. In crosstalk between wavelengths in the SCM-WDM optical communication system was investigated experimentally and theoretically. It has been shown that by reducing optical power through carrier suppression, crosstalk can be reduced. In crosstalk in two wavelength of 1550 nm standard fibre system has been measured and analyzed at subcarrier frequency of 50-800 MHz

II. SRS INDUCED CROSSTALK

Analysis had been done for two optical waves with different modulation index in the crosstalk suffered by the subcarrier in the probe channel due to SRS is (5)

$$\text{Crosstalk, (SRS)} = \left|gS_o \frac{\sqrt{1+e^{-2\alpha z}-2e^{-\alpha z}\cos(\omega d_{12} z)}}{A_{eff}\sqrt{\alpha^2+(\omega d_{12})^2}}\right|^2 \qquad (5)$$

where, g is the standard Raman Gain coefficient divided by the fiber effective area (g_R/A_{eff}),

S_o is average optical power

α is the fibre loss coefficient,

d is walk-off parameter and it is related to dispersion coefficient D as $d_{12} = D(\lambda_1 - \lambda_2)$,

ω is modulation frequency,

z is transmission length.

From the above formula it is seen that the SRS induced crosstalk is directly proportional to the transmission length and optical power. Using the formula given by equation (5), variation of crosstalk with the variation of modulation frequency had been investigated by [9]. The fibres used in

[9] were SSMF, DCF, LEAF, TW, TWR. Modulation frequency was varied in the range 0 to 2 GHz keeping the transmission length constant at 30-km. The optical power at the input of the fiber is assumed to be fixed. The present work is investigating the crosstalk with the variation in transmission length for the fibres SMF, DCF, NZDF, and NZDSF. Modulation frequency has been kept constant at 5 GHz. Here in this paper we are comparing the different fiber types with varying transmission length from 1 to 50 Km at constant power.

III. RESULT ANALYSIS

A. Comparison of Fibers with Varying Transmission Length

Here the result have mention for SRS induced crosstalk using different fiber parameters and variation in transmission length keeping optical power constant. Fig 3.1 shows the graph between SRS induced crosstalk with transmission length with varied fiber parameters. The modulation frequency is constant at 5 GHz and different fibers are taken as SMF, DCF, NZDF and NZDSF. It has been observed that as the transmission length increases the SRS induced crosstalk increases. Moreover the increase in crosstalk depends on the fiber type used.

Table 1. PARAMETRIC CHARACTERISTICS OF DIFFERENT TYPES OF OPTICAL FIBRES

Fiber type	Aeff (µm2)	Dc(ps/nm -km)	α (dB/Km)
SMF	80	17	0.2
DCF	20	-80	0.29
NZDF	72	-3	0.23
NZDSF	50	4.5	0.25

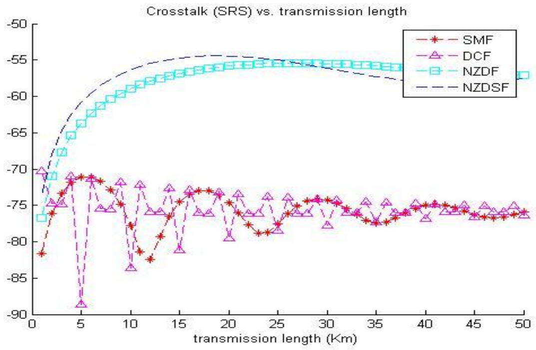

Fig. 1 Crosstalk versus transmission length for SMF, DCF, NZDF, NZDSF

The graph in fig. 1 shows the comparison of different optical fibers at varying transmission length and constant modulation frequency of 5 GHz and at constant power. The stimulated Raman scattering crosstalk range for SMF is (-82dB to -75dB), DCF is (-70dB to -75dB), NZDF is (-74dB to -60dB), and NZDSF is (-76dB to -60dB) with the length increasing from 1 to 50 km. For SMF the initial crosstalk is also less as compared to other fibers and the crosstalk at span of 50 km is also better. In DCF there are more fluctuations in the crosstalk with the increasing transmission length.

IV. CONCLUSION

In this paper comparison of different fiber types SMF, DCF, NZDF and NZDSF have been studied with varying transmission length. In general, it is observed from the results that the SMF and DCF show the better results over span of the transmission length. From the above results, it can be concluded that the optical fiber communication transmission system can be optimized to select the fiber with minimum value of crosstalk for given range of transmission length at constant modulation frequency. For SMF the initial crosstalk is also less as compared to other fibers and the crosstalk at span of 50 km is also better. In DCF there are more fluctuations in the crosstalk with the increasing transmission length hence this fiber is not suitable. So in order to achieve better results SMF should be preferred.

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