|| Volume 5 || Issue 5 || May 2020 || ISSN (Online) 2456-0774

INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH AND ENGINEERING TRENDS

ANALYSIS OF R-EDFA AND REVIEW FOR OPTICAL FIBER COMMUNICATION SYSTEM

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Abstract: This paper presents a simple and efficient design process of a remotely pumped optimized Erbium doped fiber amplifier (R-EDFA) for repeater less long haul optical fiber communication system (OFCS) by the numerical analysis of EDFA rate equation model. The length of Erbium doped fiber (EDF) is optimized using very low remote pump power. Optical fiber communication is the best transmitting data may be capable of Terabit per second data rate. No existing single communication system can make complete use of this speed. Many types of Optical amplifiers have been developed to amplify optical signal. EDFA is one of the examples of optical fiber amplifier to amplify optical signal. To design optical amplifier gain and NF are most significant points. Gain and NF are more significant points.

Keywords: *Erbium-doped fiber amplifier, EDFA, WDM*

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I. INTRODUCTION

Optical fiber communication is the most reliable telecommunication technologies to achieve customer needs for present and future applications. System capacity can be increased by 1) deploying new optical fiber,2) increasing transmission bit rate 3) multiplexing more channels on to the existing fiber. Optical transmission systems are based on the principle that light can carry more information in a glass medium over longer distances. Optical fiber is a waveguide doped with Neodymium Nd3+ used in a single mode fiber was demonstrated in 1960(James,1991).The DFA are achieved with elements such as praseodymium (Pr3+) through doping fluoride based fibers (kunihiko,1998),Europium (Eu3+) with 613nm windows(Lihue 2004) and Neodymium (Nd3+) with 730 nm windows (Jouin,2002).DFA has less attenuation is operating in the 1550nm window by doping silica fiber core with Erbium(Er3+).EDFA could provide gains as 40dB associated with less noise with pump power range 50 to 100MW (Mears,1987).A highly efficient gain clamped can be achieved by simply adding c-band fiber brag grating in double pass system-band EDFA with improved characteristics (Suleiman al,2004a;Naji et al.,2007a).Numerical analysis of EDFA rate equation model is needed to design a C-band R-EDFA for the long haul OFCS and design of R-EDFA their numerical lays an important effect on the C-band EDFA design (Nadir et el,2007a).In order to achieve less NF and gain enhancement DCF module and gain equalization filter (GEF) are commonly located within the stages (Zhi et al.,2003).The L-band EDFA have higher gain from 1574nm to1604 nm at gain variation and NF variation from 5.6 to 7.6 dB(Suleiman et al.,2004c).Many researchers carried out extensive investigation for EDFA (Desuvire,1987;Bjrklev et al.,1989). R-EDFA Configuration

The basic configuration of single pass (SP) R-EDFA is depicted in figure-1. In order to focus on the optimized design procedure, a simple SP configuration is considered in this present work. Forward pumping scheme with respect to the direction of the input signal has been used to design the amplifier.

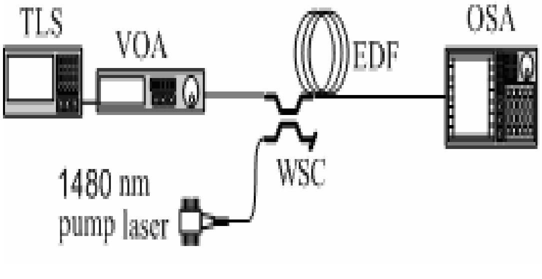

Figure 1: SP R-EDFA configuration.

II RESULTS AND DISCUSSION

In case of remotely pumped repeaterless long haul OFCS, location of the R-EDFA is far away from the remote pump source and for this reason the necessity of very low pump power is essential. Initially the designers need to determine the available pump power at the input of the R-EDFA. A very low remote pump power of 10 mW is considered at the input of the R- EDFA in this work. Now the length of the EDF is needed to be optimized with respect to the input pump power to achieve maximum gain and low NF. Upper (N2) and ground (N1) state population can be calculated with respect to the various EDF lengths from the numerical simulation. Figure -2 shows the population density in per cubic meter in the upper state and ground state as a function of position along a 20 m long EDF using 10 mW pump power.

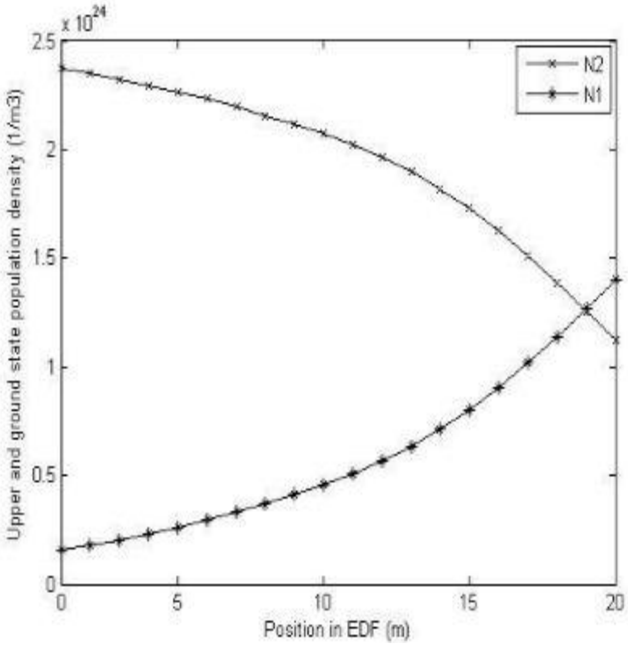

Figure 2: Population in the upper state (N2) and ground state (N1) as a function of position along a 20 m long EDF at 1550 nm using 10 mW of pump power and injected signal power of -35 dBm.

From this figure, after 19 meter length, upper state population is less than the ground state population. For this reason, if we use an EDF of length more than 19 meter then the portion of the EDF that exceeds 19 meter remains unpumped. This unpumped portion of the EDF absorbs the signal and degrades the system performance. Moreover because of the additional length of EDF, backward ASE travels over a longer distance and become much higher at the beginning of the EDF. So an EDF of length more than 19 meter causes higher backward ASE which depletes the inversion and robs gain at the expense of the signal. On the other hand, if an EDF of length less than 19 meter is used for the proposed remotely pumped SP EDFA configuration then a portion of the pump power will remain unused which can causes more population inversion and hence the increment of the gain. For these reasons an EDF length of 19 meter is chosen as an optimized length for the proposed remotely pumped SP EDFA configuration.

Figure -3 shows the signal gain as a function of EDF length at 1550 nm using 10 mW of pump power and injected signal power of -35 dBm. Referring to figure 3, signal gain increases upto the length of 19 meter and after the 19 meter it begins to reduce again which justifies the findings in figure - 2.

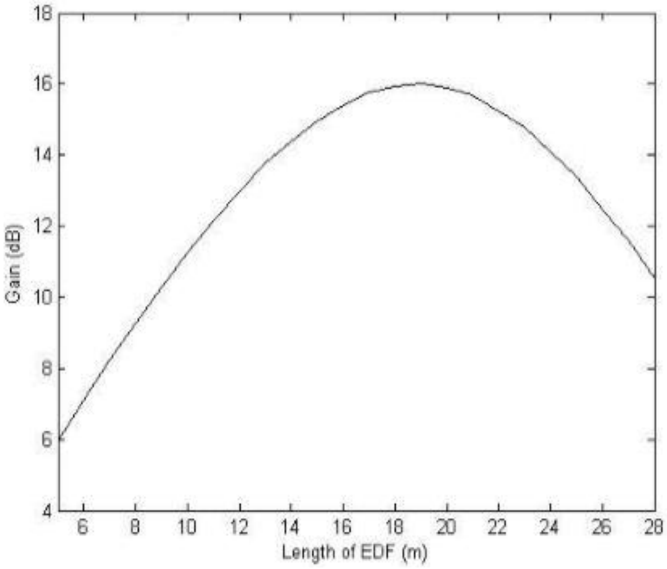

Figure 3: Signal gain as a function of EDF length at 1550 nm using 10 mW of pump power and injected signal power of -35 dBm.

Figure -4 shows the signal gain and NF in dB as a function of pump power in mW using a 19 m long EDF at 1550 nm signal wavelength. From this figure, gain values are gradually increased and NF values are gradually decreased with the increment of pump power. This is because the population inversion increases with the increment of pump power.

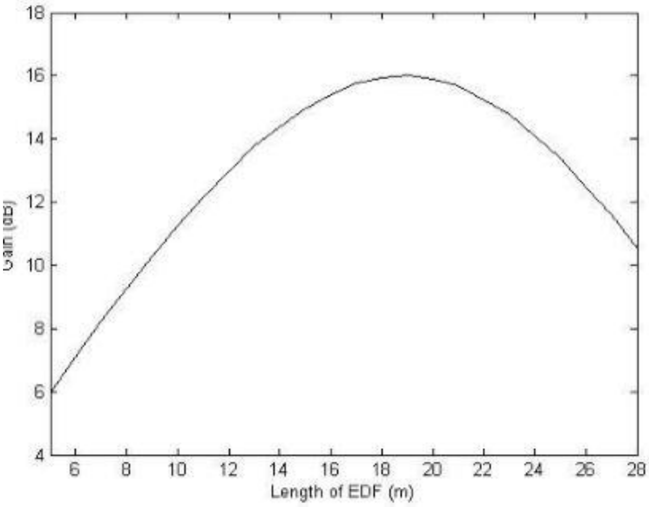

Figure 4: Signal gain and NF in dB as a function of pump power in mW using a 19 m long EDF at 1550 nm signal wavelength and injected signal power of -35 dBm.

After certain pump power, upper state population reaches almost to a constant level and for this reason after a certain pump power gain and NF values become saturated which is noticed in the figure -4. Figure -5 shows that the gain values are gradually decreased and NF values are increased dramatically with the increment of signal power.

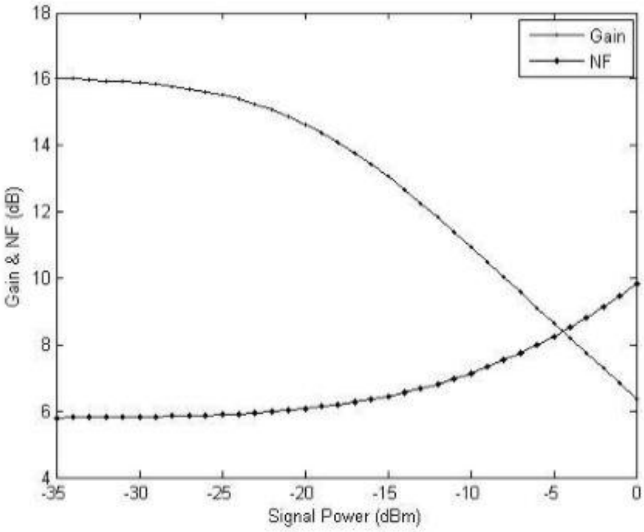

Figure 5: Signal gain and NF in dB as a function of signal power in dBm using a 19 m long EDF at 1550 nm signal wavelength and injected pump power of 10 mW.

At higher input signal power levels, the strong signal significantly depletes the inversion and the pump is not able to replenish it as a result the gain decreases and NF increases rapidly with signal power. Figure -6 shows the signal gain in dB as a function of signal wavelength for the pump powers indicated on the graphs and signal input power -35 dBm using a 19 m long EDF. From this figure, gain for 1530 nm is high due to its higher emission cross section. The spectral shapes of the gain change nonuniformly with the changes in pump power. In particular, as pump powers decrease, signals near 1530 nm will experience a drop in gain much more significant than that for signals near 1550 nm as shown in figure 6.

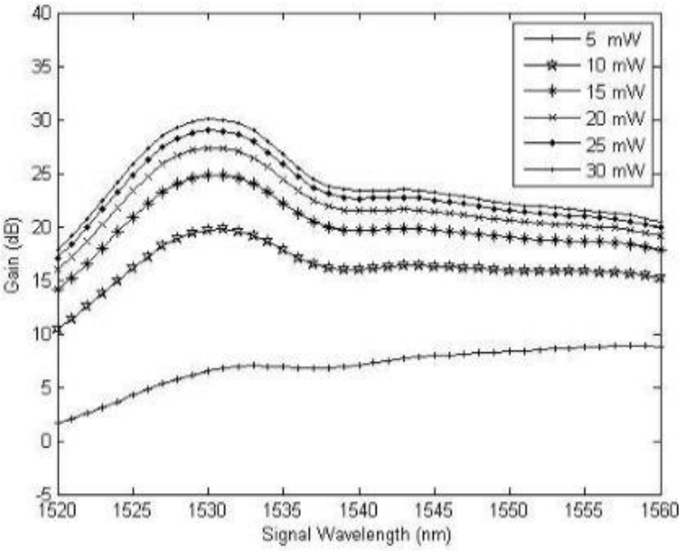

Figure 6: Signal gain in dB as a function of signal wavelength (signal power input -35 dBm), for the pump powers indicated on the graphs using a 19 m long EDF.

III CONCLUSION

The use of OFCS generally allows for the transmission of large amounts of data at high speeds for long distance transmission. A detailed investigation of EDFA was given in three principal levels; first is the EDFA with WDM and DWDM technique in order to achieve higher bit rates. Second level is the Theoretical analysis of EDFA, where it is necessary to understand the physical meaning behind the amplification. The third level is the presentation of various configurations and their performance parameters related to different structures. These parameters need to be controlled to get higher gain and lowest NF.By increasing the total pump power, the transmission distance can be increased. On the other hand increasing the total injected pump power increases the non-linear effects of the transmission fiber, which degrades the system performance. Finally researches are expected to focus on reducing the noise figure at high pump powers.

REFERENCES

[1] Paul Urguhart, “Theory of Erbium-doped Fiber Amplifiers”(BT Laboratories, Mortlesham Health.IP5 7RE).
[2] Emmanuel Desurvire, “Erbium-doped Fiber Amplifiers principles and applications”, A Wiley Interscience Publication.
[3] John A. Buck, “Fundamentals of Optical Fibers” (Wiley 1995).
[4] N.S.Bergano, Y.Yoshida, T.Kawazawa....etal, “9000km, 5Gbs/s NRZ transmission experiment using 274 EDFA” Paper PD 11,1992.
[5] S.Wen&S.chi,“Distributed Erbium-Doped Fiber Amplifiers with stimulated Raman Scattering” IEEE PTL,v.4(2),p 189-192.
[6] Donathan R. Armitage,“ Three-level Finber laser amplifier a Theoritical model” (Applied optics Vol. 27 No:23 December,1998).
[7] E Desurvire,“Recent advances in erbium doped fiber amplifiers at 1.5µm”OFC’90,fai,1990.
[8] A.A.M Saleh, R. M. Jopson …et al. “Modeling of gain in EDFAs”. IEEE PTL,v.2(10),p714-717.1990.
[9] S. T. Davey D. L Williums & B. J. Ainslie, “Distributed Erbium Doped Fiber for lossless link application”,OFC’91,FA 8,P 200,1991.
[10]K. Rottwitt, J. H Povlsen, T. Rasmussen, Optimum signal wavelength for a Distributed Erbium Doped Fiber Amplifier”, IEEE PTL,v.4(7),p 714-717,1992.