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INVESTIGATION SURVEY OF REACTIVE POWER COMPENSATION USING ENUGU ELECTRICITY DISTRIBUTION COMPANY OF NIGERIA (EEDC) SUB-TRANSMISSION STATION ENUGU AS A CASE STUDY

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ABSTRACT

This paper presents the investigation survey for reactive power compensation using EEDC sub-transmission station Enugu as a case study. The investigation under this scope of study is for a 276km transmission line from New Haven Sub-Transmission Station Enugu to Makurdi in Benue State. Using practical values of shunt elements (inductance and capacitance), the end results showed the compensated and uncompensated voltage profiles as displayed in the hard copies.

KEY WORDS: a.c. transmission line, static var compensator (SVC), light load and heavy load conditions, fuzzy controllers.

1.0 INTRODUCTION

This work is devoted to a 276km transmission line with the following distributed line parameters: line inductance L = 0.97mH/km, line capacitance = 0.0115μF/km and line resistance R = 0.016Ω/km. The purpose of this work is to use the practical values of shunt elements under different loading conditions to get both sending and receiving end voltages equal thus, compensating the reactive power. Simple electrical apparatus employed include: an independent voltage source (Vs) or transmitter, digital and analog meters, step-up transformers, millimeters etc.

1.1 METHOD

The apparatus was setup as shown in figure 1.1. A supply voltage (v_s) of about 230KV – 50Hz, having source internal resistance of 1KΩ, was connected to node A via a transmission line onto a receiving end node B. A static load was then connected to node B with the following: practical shunt elements (TCR + FC), Fuzzy Logic Controller (FLC), and a load measurement device (see fig. 1.1). The load insistence was varied in order to obtain the voltage variations at the receiving end V_R.

A shunt branch consisting of inductors and capacitors were added in stages to compensate for the reactive power in the line. The practical values of these shunt elements are as displayed in table 1.1. While the table of result obtained from the investigation survey is shown in table 1.2

Table 1.1: Compensated practical values of Inductance and capacitance

S/Nos	Load Resistance (Ω)	Compensation Inductance (H)	Compensating Capacitance (μF)
1	500	6.4H	8
2	400	7.2H	8
3	300	1.52H	16
4	200	1.44H	40
5	150	1.52H	40
6	100	1.76H	64
7	50	1.12H	68
8	40	1.12H	72
9	30	1.12H	80
10	20	1.12H	96

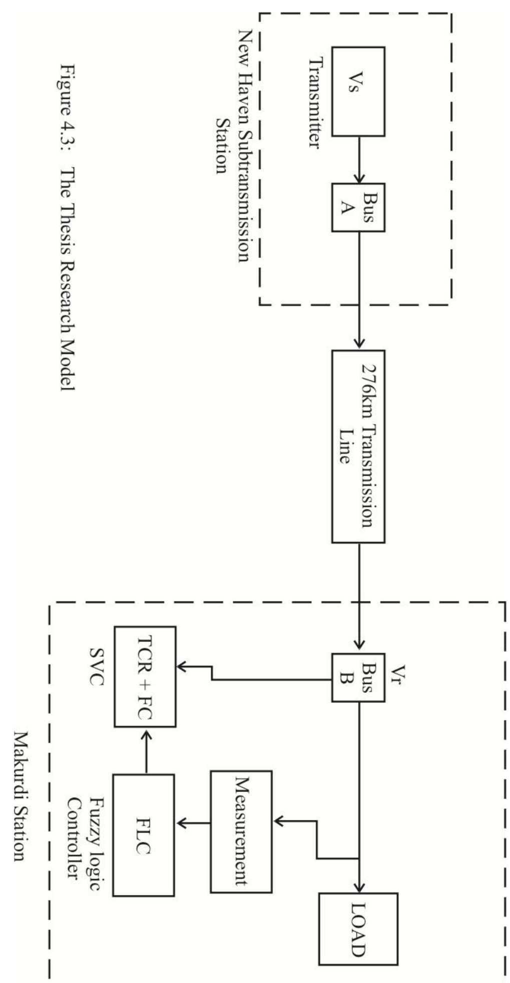

Fig. 1.1: The Research Model

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1.11: TABLE OF RESULTS

Table 1.2: Load voltage before and after compensation

Dsxz\z\Tr. Line parameter Lt = 0.97mH/km Ct = 0.0115μF/km R = 0.016Ω/km		**Before compensation for Vs = 230KV**		**After Compensation for Vs = 230KV**		
R [Ω]	V_S (rms) KV	V_R (rms) KV	I_R (rms) Amp	V_R (rms) KV	I_R (rms) Amp	α (O)
500	135.7	268.75	534.5	135.2	270.4	90
400	135.7	266.90	669.25	135.4	383.5	100
300	135.7	268.00	893.33	135.1	450.33	102
200	135.7	260.20	1300.00	135.5	677.50	103
180	136	258.10	144.44	135.6	753.33	105
160	136	255.50	1596.88	135.3	845.63	106
140	135.7	249.30	1780.71	135.7	969.29	108
120	135.7	243.80	2031.67	135.3	1132.5	109

2.0 THE FUZZY LOGIC CONTROLLER

This fuzzy block senses the load current and accordingly gives the firing pulse delay to achieve the desired voltage at the load terminals (see fig. 1.1). Fuzzy logic facilitates closed-loop control and by using simple set of rules, fuzzy logic decides by itself the firing angle to be given to attain the required voltage [4]. So the fuzzy logic block controls the firing angle circuit designed in MATLAB.
The device TCR + FC is able to achieve flat voltage profile for firing angles greater than 90^O. From Table 1.2 and the waveforms, it can be observed that the TCR + FC provide an effective reactive power control irrespective of load variations.

2.1 SIMULATION RESULTS

Simulation results were obtained using MATLAB software. Figure 2.1 shows the voltage waveforms without compensation for light loads with $V_R > V_S$; that is to say the reactive power generated is greater than absorbed. Again, Figure 2.2 shows the voltage waveforms without compensation for heavy loads with $V_R < V_S$; that is the reactive power absorbed is greater than that generated. However, Figure 2.4 shows compensated r.m.s and instantaneous voltage with and without fuzzy controller.

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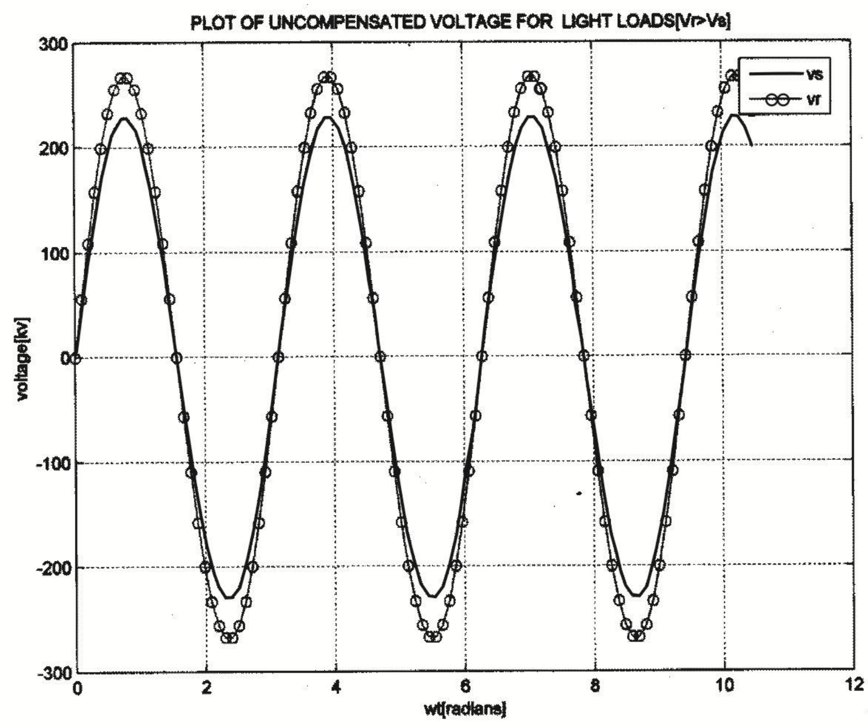

Figure 2.1: Shows waveforms without compensation for light loads $V_R > V_s$ achieved by simulation (for R 500Ω)

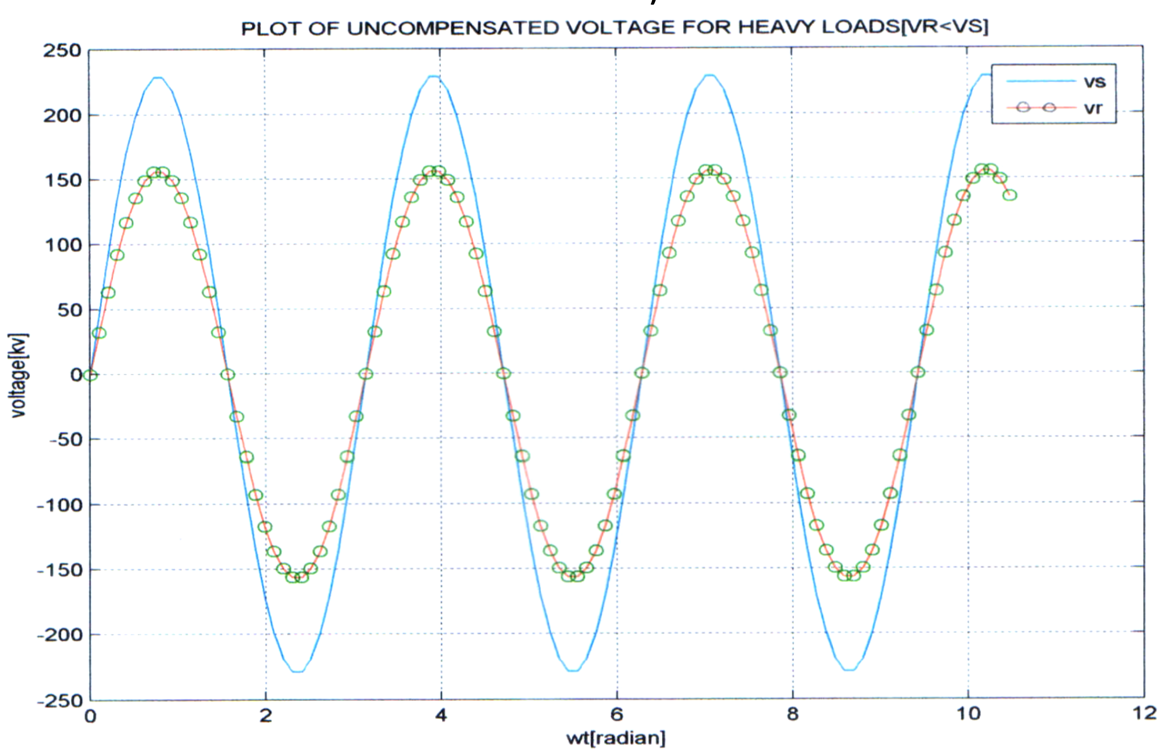

Figure 2.2: Shows waveforms without compensation for heavy loads $V_R < V_s$ (for R 300Ω)

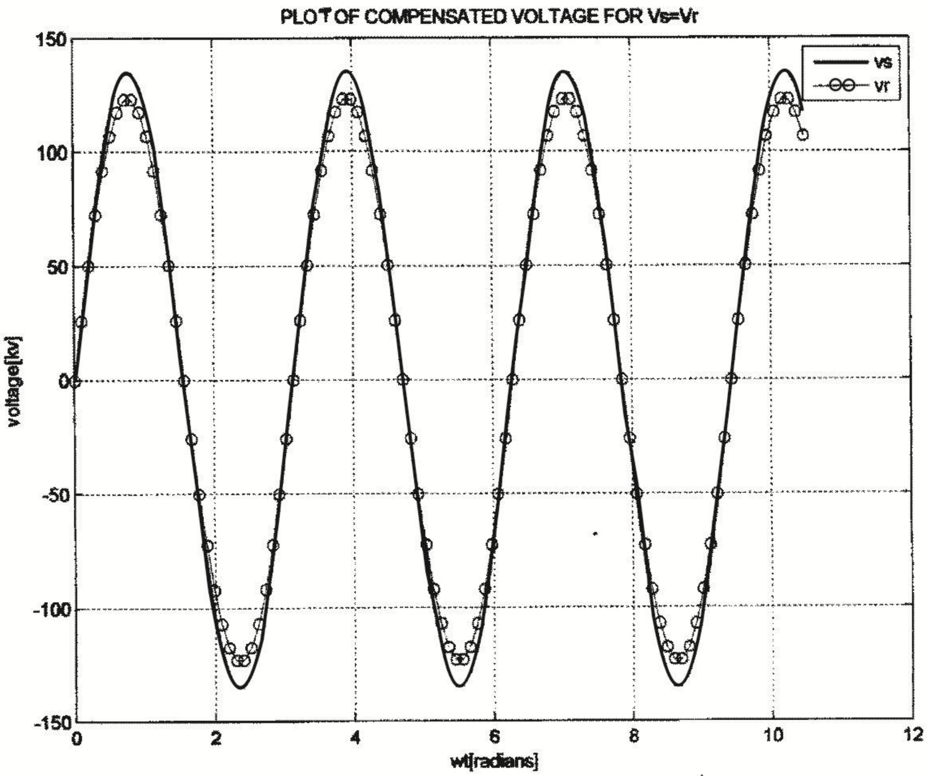

Figure 2.3: Shows waveforms with compensation for V_s = V_R(for R 200Ω)

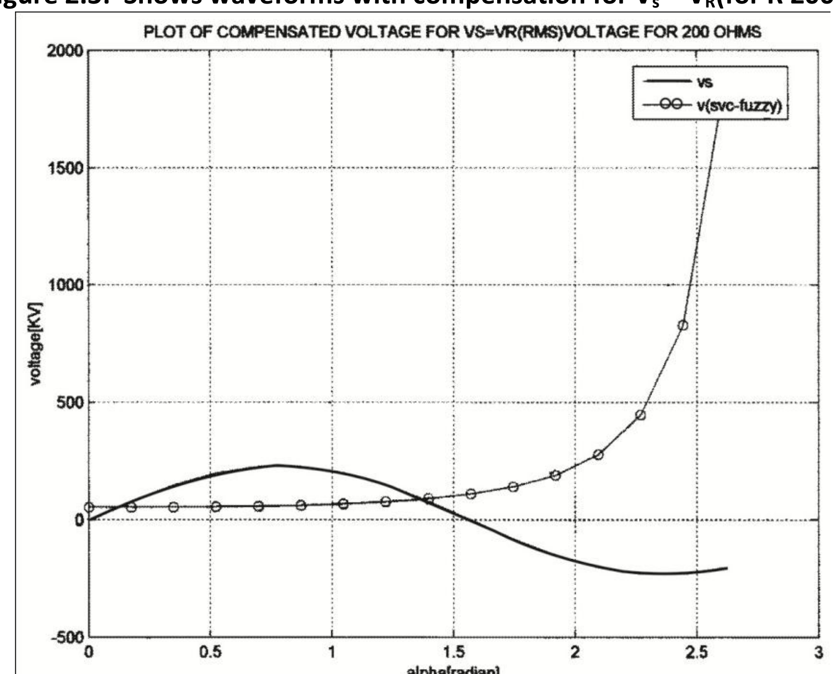

Figure 2.4: Shows voltage waveforms after compensation with and without fuzzy controller

3.0 CONCLUSION

It can be concluded that the use of fuzzy controller static var compensator with the firing angle control is continuous and effective and is the simplest way of controlling reactive power of a transmission line. It was observed that the SVC device was able to compensate both over and under voltages. The network without compensation is not able to satisfy the essential condition of maintaining voltage within reasonable limits [4].

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