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Enhancement of PQ parameters in Distribution System by DGs with Load Model using Exhaustive Search Value Method

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ABSTRACT

This paper presents the enhancements of PQ parameters such as voltage profile (voltage swell, voltage sag, harmonics, etc.) in Distribution power system by Distributed Generation (DGs) using exhaustive search method. This article is very much useful for researchers, scientific engineers and industrial persons in conjunction with improvements of PQ parameters in distribution systems by DGs exhaustive search method. The investigation of proposed methodology tested on IEEE37 bus distribution power systems.

Key words: Voltage profile, Distribution power systems, Distributed generation, Exhaustive search method.

INTRODUCTION

The new technology seeking attention is distribution generation system, the distributed generation system are much demanded because there are several advantages like reduced the operation cost, lower losses and lower transmission losses, eco-friendly, it reduces green gas house effects, reduced the active and reactive power losses in the distributed generation system. There has been found a wide range of modular size from 5 KW to 500 MW. In recent years the integration of distributed generation system units in power distribution network has increased. To reduce the electrical distribution network operation to provide the best appropriate location and size of the distributed generation, installation of multiple DGs, objective the total power, designs the variables and size are some of the same characteristics of optimal distributed generation plant [1].

DG uses a wide range of technologies to generate power like combined heat and power plant, PV system, small scale wind turbine and other renewable resources. The main feature of DG is that it can be used as an isolated way or in an integrated way supplying energy to the remaining of the electric system. DG system improves power quality and system reliability [1]. DG system reduces transmission loss. There are many environmental benefits of using DG like it reduces carbon emission. Micro-grid integrates small scale distributed energy resources. It integrates distributed power generator and local renewable energy which include wind, hydro, solar power, fuel cell and bio energy. Micro-grid utilizes waste heat produced from electricity generation so that transmission efficiency improves [2]. It reduces greenhouse gas emission by avoiding unnecessary transmission loss. Apart from several advantages, there are some complications involved in generating power from DG sources for example there is instability and unpredictability in power generation from solar and wind power cause of its dependability on weather condition [3].

The important factors to be considered in power quality measurement are the active power, reactive power, variation of voltage and current, flicker, harmonics, and electrical behaviour of switching operation [4]. According to definition of power quality given in IEEE standard, ‘Power quality is the concept of powering and grounding sensitive equipment in a matter that is suitable to the operation of that equipment.’ Serious problems in electrical systems is the increasing number of electronic components of devices that are used by industry as well as residences and increasing use of nonlinear loads is the main cause for increased voltage, current and harmonics issues[5-6].

In recent years, the development of power electronics devices has been led for the implementation of electronic equipment which is suitable for electrical power systems [7]. These types of devices allow great flexibility in: a) controlling the power flow in transmission systems using Flexible AC Transmission System (FACTS) devices, b) enhancing the power quality in distribution systems employing Custom Power devices [8-9]. Harmonic current components create several problems like as follows :1) Increase in power system losses, 2) Overheating and insulator failures in transformers, rotating machinery, conductor, and cables, 3) Reactive power burden, 4) Low system efficiency, 5) Poor power factor, 6) System unbalances and causes excessive neutral currents, 7) Malfunctioning of the protective relays and untimely tripping. It is the only versatile device which can easily mitigate many power quality problems related with voltage and current simultaneously. It also compensates almost all power quality problems like voltage harmonics, voltage unbalance, voltage flickers, voltage sags & swells, current harmonics, reactive current, current unbalance, and can also be used to prevent harmonic load current from entering into the power system [10].

Electric PQ is a term which has captured increasing attention in distribution system. The measure of PQ depends upon the needs of the equipment that is being supplied. Usually the term PQ refers to maintaining a sinusoidal waveform of bus voltages at rated voltage and frequency. There are two approaches to the mitigation of PQ problems [10-11]. The first approach is called load conditioning, which ensures that the equipment is less sensitive to power disturbances, allowing the operation even under significant voltage distortion. The other solution is to install line conditioning systems that suppress or counteracts the power system disturbances.

The quality of the power is affected if there is any deviation in the voltage and frequency values at which the power is being supplied. This affects the performance and life time of the end user equipment. Whereas, the continuity of the power supplied is affected by the faults which occur in the power system. So to maintain the continuity of the power being supplied, the faults should be cleared at a faster rate and for this the power system switchgear should be designed to operate without any time lag. The power quality is affected many problems which occur in transmission system and distribution system. Some of them are like- harmonics, transients, sudden switching operations, voltage fluctuations, frequency variations etc. These problems are also responsible in deteriorating the consumer appliances. In order to enhance the behaviour of the power system, these all problems should be eliminated. With the recent advancements in power electronic devices, there are many possibilities to reduce these problems in the power system. One of them is the use of Flexible AC Transmission System (FACTS) devices. The connection of these devices in the power system helps in improving the power quality and reliability [11-14].

This paper organized as follows: Section two introductions to Power Quality problems, key issues, opportunities and challenges are discussed. In preceding section the taxonomical review of enhancement of PQ parameters with conventional devices, DGs, FACTS controllers or custom power devices is presented. In final conclusion of paper is presented.

POWER QUALITY RELATED ISSUES IN DISTRIBUTION GENERATION

The electric power network has undergone several modifications from the time of its invention. The modern electric power network has many challenges that should be met in order to deliver qualitative power in a reliable manner. There are many factors both internal and external that affect the quality and quantity of power that is being delivered. [11]

Power Quality

Power quality is a term that means different things to different people. Institute of Electrical and Electronic Engineers (IEEE) Standard IEEE1100 defines power quality as ‘the concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment.’

Power Quality Issues

There are many reasons by which the power quality is affected. Power quality is a simple term, yet it describes a multitude of issues that are found in any electrical power system and is a subjective term. The concept of good and bad power depends on the end user. Here an overview of different power quality issues with their causes and consequences is presented in Fig. 1.

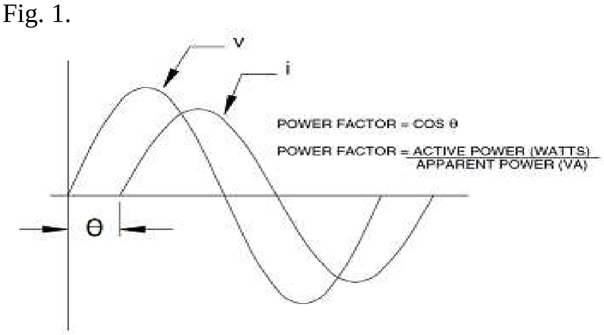

Fig.1 Power Quality Issues

Interruptions
It is the failure in the continuity of supply for a period of time. Here the supply signal (voltage or current) may be close to zero. This is defined by *IEC* (International Electro technical Committee) as 'lower than 1% of the declared value' and by the *IEEE* (IEEE Std. 1159:1995) as 'lower than 10%'.Based on the time period of the interruption; these are classified into two types [12]. The various power quality issues are presented in Fig. 2-5.

Short Interruptions
If the duration for which the interruption occurs is of few mille seconds then it is called as short interruption.

Long Interruptions
If the duration for which the interruption occur is large ranging from few mille seconds to several seconds then it is noticed as long interruption.

Waveform Distortion
The power system network tries to generate and transmit sinusoidal voltage and current signals. But the sinusoidal nature is not maintained and distortions occur in the signal. The cause of waveform distortions are discussed in reference [14].

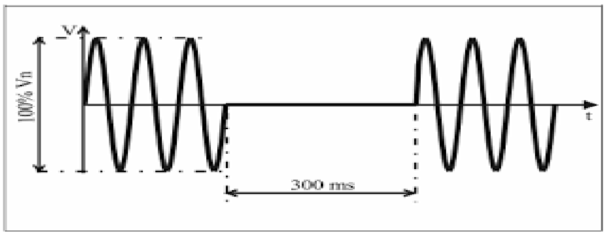

Fig. 2 Short interruptions

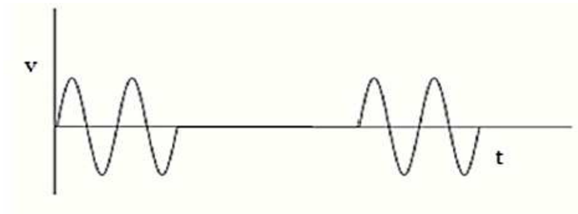

Fig. 3 Long interruptions

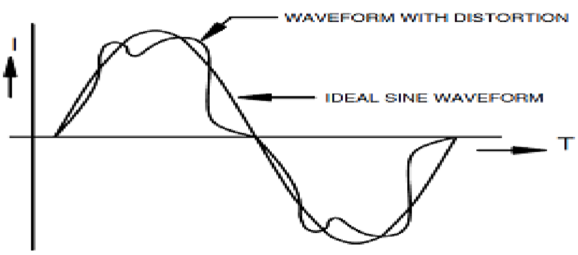

Fig. 4 Voltage transients

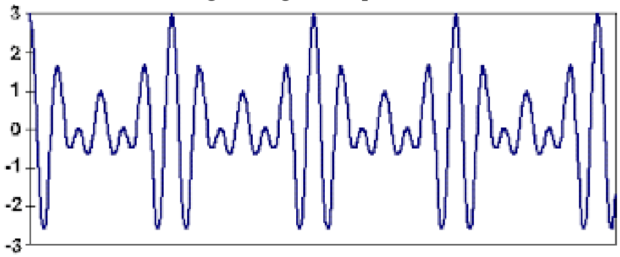

Fig. 5 Waveform distortion

DC Offset
The DC voltage which is present in the signal is known as DC offset. Due to the presence of DC offset, the signal shifts by certain level from its actual reference level.

Harmonics
These are voltage and current signals at frequencies which are integral multiples of the fundamental frequency. These are caused due to the presence of non-linear loads in the power system network.

Inter Harmonics
These are the harmonics at frequencies which are not the integral multiples of fundamental frequency.

Notching
This is a periodic disturbance caused by the transfer of current from one phase to another during the commutation of a power electronic device.

Noise
This is caused by the presence of unwanted signals. Noise is caused due to interference with communication networks.

Frequency Variations
The electric power network is designed to operate at a specified value (50 Hz) of frequency. The frequency of the framework is identified with the rotational rate of the generators in the system. The frequency variations are caused if there is any imbalance in the supply and demand. Large variations in the frequency are caused due to the failure of a generator or sudden switching of loads. The Fig.s 6 and 7 show the impulse transients and transient respectively.

Transients
The transients are the momentary changes in voltage and current signals in the power system over a short period of time. These transients are categorized into two types- impulsive, oscillatory. The impulsive transients are unidirectional whereas the oscillatory transients have swings with rapid change of polarity.

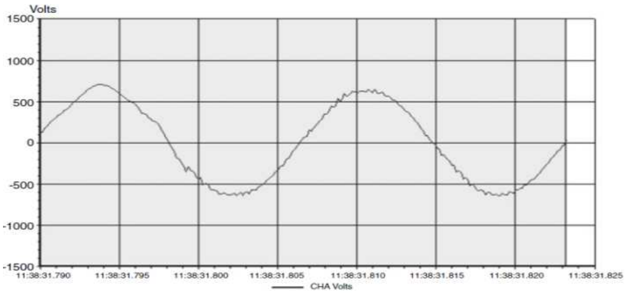

Fig. 6 Impulse transients

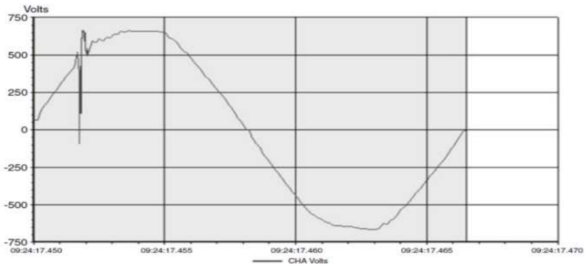

Fig. 7 Transients

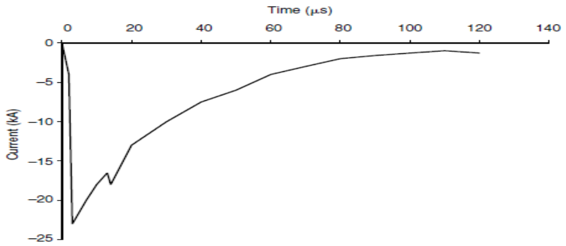

Fig. 8 Oscillations transients

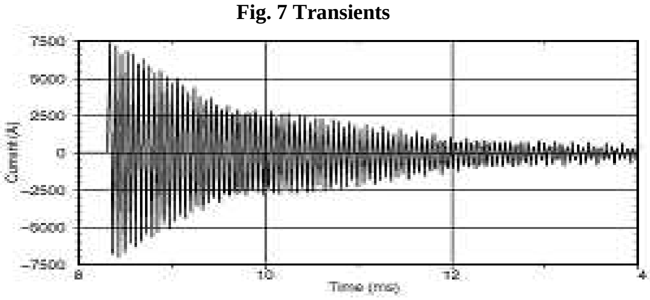

Fig. 9 Voltage unbalance

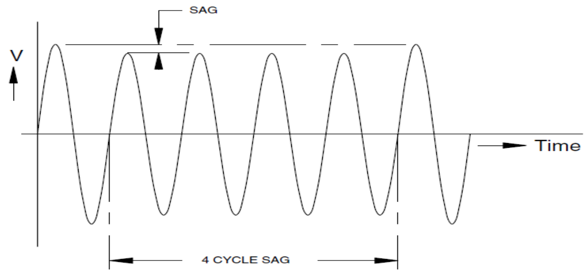

Fig. 10 Voltage sag

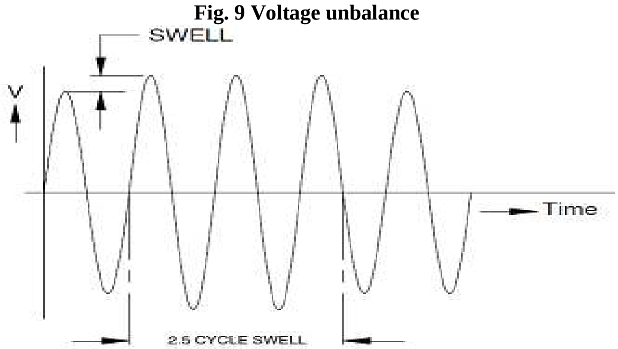

Fig. 11 Voltage swell

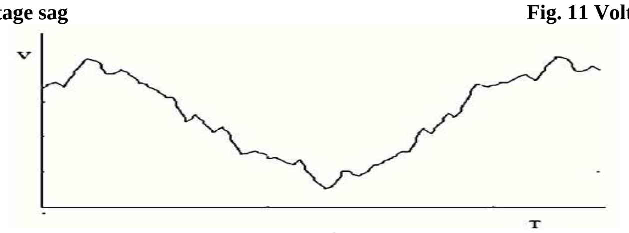

Fig. 12 Voltage fluctuations

Impulsive Transients

An impulsive transient is a sudden; non–power frequency change in the steady-state condition of voltage, current, or both that is unidirectional in polarity (primarily either positive or negative). The Figs 8 and 9 shows the oscillations transients and voltage unbalance wave forms.

Oscillation Transient

An oscillatory transient is a sudden, non–power frequency change in the steady-state condition of voltage, current, or both, that includes both positive and negative polarity values.

Voltage Sag

RMS reduction in the AC voltage at power frequency from half of a cycle to a few seconds' duration. The Fig. 10 and 11 shows the voltage sag and swell wave forms respectively.

Voltage Swell

RMS increase in AC voltage at power frequency from half of a cycle to a few seconds' duration.

Voltage Unbalance

The unbalance in the voltage is defined as the situation where the magnitudes and phase angles between the voltage signals of different phases are not equal.

Voltage Fluctuation

These are a series of a random voltage changes that exist within the specified voltage ranges. Among the different power quality problems discussed, the under voltage or voltage sag is the prominent one as it occurs often and affects the power system network largely. Fig. 12 show the voltage fluctuations wave forms.

MATHEMATIC MODELLING OF THREE PHASE INDUCTION MOTOR (TAKEN AS A DYNAMIC OR REALISTIC LOAD MODEL IN DISTRIBUTION SYSTEM)

Three IM taken as realistic load model in this paper. Three phase IM is basically known as dynamic load in distribution system. The powers drawn from 3 phase supply are real and reactive power as per loading of machine, so that real and reactive power index calculated in this section for incorporation of three phases IM as a dynamic load in IEEE 37 bus system. The three phase induction motor as shown in Fig. consists of the fixed stator or frame, a three-phase winding supplied from the three-phase mains and a turning rotor. There is no electrical connection between the stator and the rotor. The currents in the rotor are induced via the air gap from the stator side. Stator and rotor are made of highly magnetisable core sheet providing low eddy current and hysteresis losses.

This motor is commonly used for industrial drives because it is cheap, robust, efficient and reliable. This motor has high starting torque and good speed regulation. In the three phase induction motor stator is built up high grade alloy steel laminations cores to reduced eddy current losses. In three induction motor laminations are supported in a stator frame of cast iron. In the IM insulated stator conductors are placed these slots. Stator conductors are conductors are connected to form a three phase winding in the induction motor. Induction motors is the simplest form of ac motors. The induction motor is used in 95% of industrial applications. The induction motor like a synchronous machine, consist of a stationary part and a rotating part. The equivalent circuit diagram of three phases IM shown in Fig. 13.

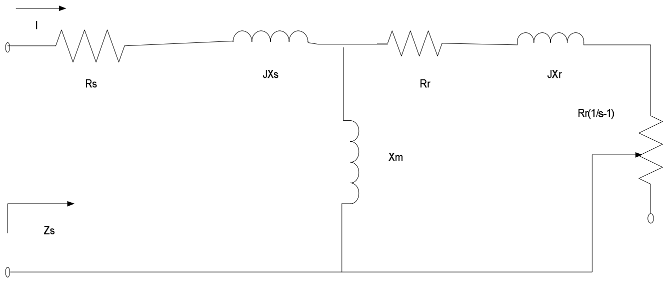

Fig.13 Circuit model of three phase induction motor

Total source impedance seen by source of three phase IM given as equation (1-2).

$$Z' = \left(\frac{R_2}{s} + jX_2\right) \| \, jX_m \tag{1}$$

$$Z_s = (R_1 + jX_1) + Z' \tag{2}$$

Where R_1 = Stator resistance of three phase IM, X_1 = Stator reactance of three phase IM, R_2 = rotor Resistance of three phase IM, X_2 = rotor reactance of three phase IM and Xm = magnetizing reactance of core of three phase IM
Total input current drawn by motor from supply given as equation (3)

$$I_s = \frac{V_1\angle 0^\circ}{Z_s} \tag{3}$$

Total apparent power drawn by motor from supply given as equation (4)

$$S = V_1 I_s^* = P + jQ \tag{4}$$

The real and reactive power index of motor given as equation (5-6)

$$P = P_0\left(\frac{V}{V_0}\right)^a \tag{5}$$

$$Q = Q_0\left(\frac{V}{V_0}\right)^b \tag{6}$$

Where P & Q are real and reactive power demand of three phase induction motor from supply; P_0 and Q_0 are real and reactive power nominal values of three phase IM; V is applied voltage across three phase IM; V_0 is nominal voltage of three phase IM.

The real and reactive power index of three phase IM taken as a realistic load model given in table 1. The specification of 3ϕ induction motor given in table 2.the equivalent circuit parameters of 3ϕ induction motor such as R1=6.63 ohms, R2=3.35 ohms, Xm=81.95ohms and X1=X2=9.675 ohms are taken experimental values from electrical machine lab of electrical engineering department KNIT Sultanpur, India. Table 2 shows the specifications of three phase IMs.

Table -1 Real and reactive power index of 3ϕ induction motor

S No	Real Power Index (A)	Reactive Power Index (B)
1	8.9471	2.9575
2	7.8185	2.9942
3	7.2542	3.0309
4	6.6555	3.1228
5	6.1320	3.2146
6	5.7740	3.3008

Table -2 Specifications of 3ϕ induction motor

Parameters	Ratings
Volts	440
Amps	7.5
Output	5 HP
PH	3
CYS	50
Speed	980
Rating	CMR
Poles	6

RESULTS AND DISCUSSION

The values of bus voltage profile without and with DGs and realistic load model such as three phase IM at different speed such as N=993, 991, 989, 987, 985,and 984 rpm from min PLOSS, min QLOSS and min MVA point of view are given in table 3.

Table- 3 the values of bus voltage profile without and with DGs and realistic load model such as three phase IM at different speed such as N=993, 991, 989, 987, 985,and 984 rpm from min P_{LOSS}, min Q_{LOSS} and min MVA point of view

Sr. no.	Voltage w/o DG	Minimum P_{LOSS}						Minimum Q_{LOSS}						Minimum MVA					
		N=993 rpm	N=991 Rpm	N=989 Rpm	N=987 rpm	N=985 rpm	N=984 rpm	N=993 rpm	N=991 rpm	N=989 rpm	N=987 rpm	N=985 rpm	N=984 rpm	N=993 rpm	N=991 rpm	N=989 rpm	N=987 rpm	N=985 rpm	N=984 rpm
1	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300	1.0300
2	1.0272	1.0274	1.0275	1.0275	1.0275	1.0275	1.0274	1.0274	1.0275	1.0275	1.0275	1.0274	1.0274	1.0279	1.0277	1.0276	1.0276	1.0279	1.0276
3	1.0142	1.0155	1.0161	1.0160	1.0162	1.0157	1.0155	1.0156	1.0156	1.0159	1.0159	1.0155	1.0155	1.0148	1.0174	1.0163	1.0165	1.0148	1.0164
4	1.0074	1.0096	1.0104	1.0104	1.0107	1.0099	1.0096	1.0096	1.0098	1.0102	1.0102	1.0096	1.0096	1.0081	1.0126	1.0095	1.0097	1.0081	1.0096
5	1.0008	1.0039	1.0050	1.0050	1.0054	1.0042	1.0037	1.0039	1.0040	1.0047	1.0048	1.0038	1.0038	1.0014	1.0080	1.0028	1.0030	1.0014	1.0030
6	0.9844	0.9887	0.9897	0.9903	0.9909	0.9892	0.9886	0.9887	0.9883	0.9899	0.9900	0.9886	0.9887	0.9851	0.9941	0.9863	0.9866	0.9850	0.9867
7	0.9814	0.9849	0.9850	0.9861	0.9867	0.9853	0.9848	0.9849	0.9839	0.9858	0.9860	0.9848	0.9849	0.9820	0.9908	0.9832	0.9836	0.9820	0.9836
8	0.9770	0.9825	0.9804	0.9845	0.9823	0.9832	0.9823	0.9825	0.9822	0.9840	0.9841	0.9823	0.9825	0.9776	0.9862	0.9788	0.9791	0.9776	0.9792
9	0.9714	0.9788	0.9744	0.9788	0.9767	0.9776	0.9786	0.9789	0.9763	0.9784	0.9785	0.9786	0.9788	0.9720	0.9802	0.9731	0.9735	0.9720	0.9736
10	0.9662	0.9757	0.9688	0.9736	0.9714	0.9724	0.9753	0.9758	0.9707	0.9731	0.9733	0.9755	0.9756	0.9668	0.9747	0.9679	0.9683	0.9668	0.9685
11	0.9655	0.9749	0.9680	0.9728	0.9707	0.9716	0.9751	0.9755	0.9699	0.9723	0.9725	0.9747	0.9754	0.9661	0.9739	0.9671	0.9675	0.9660	0.9677
12	0.9641	0.9736	0.9666	0.9715	0.9693	0.9702	0.9737	0.9742	0.9685	0.9710	0.9711	0.9733	0.9740	0.9647	0.9724	0.9658	0.9661	0.9647	0.9664
13	0.9587	0.9681	0.9607	0.9660	0.9638	0.9648	0.9683	0.9687	0.9626	0.9655	0.9657	0.9679	0.9686	0.9593	0.9666	0.9603	0.9607	0.9593	0.9610
14	0.9567	0.9661	0.9586	0.9640	0.9619	0.9628	0.9663	0.9668	0.9605	0.9635	0.9637	0.9659	0.9666	0.9573	0.9645	0.9583	0.9587	0.9573	0.9590
15	0.9555	0.9649	0.9572	0.9627	0.9606	0.9616	0.9651	0.9655	0.9591	0.9622	0.9624	0.9646	0.9654	0.9561	0.9631	0.9571	0.9575	0.9561	0.9578
16	0.9543	0.9637	0.9559	0.9615	0.9594	0.9604	0.9638	0.9643	0.9578	0.9610	0.9612	0.9634	0.9642	0.9549	0.9618	0.9558	0.9562	0.9548	0.9565
17	0.9525	0.9619	0.9540	0.9597	0.9576	0.9586	0.9621	0.9625	0.9559	0.9592	0.9594	0.9617	0.9624	0.9531	0.9599	0.9541	0.9545	0.9531	0.9548
18	0.9520	0.9614	0.9534	0.9592	0.9576	0.9580	0.9580	0.9620	0.9553	0.9587	0.9589	0.9611	0.9619	0.9526	0.9593	0.9535	0.9540	0.9525	0.95430
19	1.0267	1.0269	1.0270	1.0270	0.9571	1.0269	0.9615	1.0269	1.0270	1.0270	1.0270	1.0269	1.0269	1.0273	1.0272	1.0270	1.0271	1.0273	1.0270
20	1.0231	1.0233	1.0236	1.0234	1.0270	1.0233	1.0269	1.0233	1.0235	1.0234	1.0234	1.02330	1.0233	1.0237	1.0238	1.0234	1.0234	1.0237	1.0234
21	1.0224	1.0226	1.0229	1.0227	1.0234	1.0226	1.0233	1.0226	1.0228	1.0227	1.0226	1.0226	1.0226	1.0230	1.0231	1.0227	1.0227	1.0230	1.0227
22	1.0217	1.0219	1.0223	1.0220	1.0227	1.0219	1.0225	1.0219	1.0222	1.0220	1.0220	1.0219	1.0219	1.0223	1.0225	1.0221	1.0221	1.0223	1.0220
23	1.0107	1.0121	1.0126	1.0125	1.0220	1.0122	1.0219	1.0121	1.0122	1.0124	1.0124	1.0120	1.0120	1.0113	1.0139	1.0142	1.0130	1.0113	1.0143

24	1.0010	1.0056	1.0062	1.0061	1.0127	1.0057	1.0120	1.0056	1.0057	1.0059	1.0060	1.0055	1.0056	1.0049	1.0075	1.0077	1.0065	1.0048	1.0078
25	0.9827	1.0023	1.0030	1.0028	1.0062	1.0025	1.0055	1.0023	1.0025	1.0027	1.0027	1.0023	1.0023	1.0016	1.0043	1.0045	1.0033	1.0016	1.0046
26	0.9805	0.9870	0.9878	0.9885	1.0030	0.9875	1.0023	0.9870	0.9865	0.9882	0.9883	0.9869	0.9870	0.9833	0.9923	0.9846	0.9849	0.9833	0.9850
27	0.9705	0.9847	0.9854	0.9863	0.9892	0.9852	0.9869	0.9848	0.9840	0.9859	0.9860	0.9846	0.9848	0.9811	0.9898	0.9823	0.9826	0.9810	0.9827
28	0.9634	0.9847	0.9745	0.9762	0.9869	0.9752	0.9846	0.9748	0.9731	0.9758	0.9760	0.9746	0.9748	0.9711	0.9789	0.9722	0.9727	0.9711	0.9728
29	0.9603	0.9747	0.9666	0.9689	0.9769	0.9680	0.9747	0.9676	0.9652	0.9686	0.9688	0.9674	0.9677	0.96400	0.9711	0.9650	0.9655	0.9639	0.9657
30	0.9566	0.9676	0.9632	0.9658	0.9697	0.9649	0.9675	0.9644	0.9618	0.9654	0.9657	0.9643	0.9645	0.9609	0.9678	0.9619	0.9624	0.96080	0.9625
31	0.9558	0.9644	0.9593	0.9620	0.9666	0.9612	0.9644	0.9608	0.9579	0.9617	0.9620	0.9606	0.9609	0.9572	0.9638	0.9582	0.9588	0.9571	0.9589
32	0.9556	0.9608	0.9584	0.9612	0.9629	0.9604	0.9608	0.9600	0.9570	0.9608	0.9612	0.9598	0.9601	0.9564	0.9629	0.9574	0.9580	0.9564	0.9581
33	0.9770	0.9600	0.9804	0.9845	0.9823	0.9832	0.9823	0.9597	0.9567	0.9606	0.9610	0.9596	0.9599	0.9562	0.9627	0.9571	0.9577	0.9561	0.9579
34	0.9714	0.9597	0.9744	0.9788	0.9767	0.9776	0.9786	0.9825	0.9822	0.9840	0.9841	0.9823	0.9825	0.9776	0.9862	0.9788	0.9791	0.9776	0.9792
35	0.9641	0.9736	0.9666	0.9715	0.9693	0.9702	0.9737	0.9789	0.9763	0.9784	0.9785	0.9786	0.9788	0.9720	0.9802	0.9731	0.9735	0.9720	0.9736
36	0.9520	0.9614	0.9534	0.9592	0.9571	0.9580	0.9615	0.9742	0.9685	0.971	0.9711	0.9733	0.9740	0.9647	0.9724	0.9658	0.9661	0.9647	0.9664
37	0.9620	0.9745	0.9823	0.9812	0.9654	0.9655	0.9762	0.9620	0.9553	0.9587	0.9589	0.9611	0.9619	0.9526	0.9593	0.9535	0.9540	0.9525	0.9543
38	1.0010	1.0023	1.0030	1.0028	1.0030	1.0025	1.0023	1.0023	1.0025	1.0027	1.0027	1.0023	1.0023	1.0016	1.0043	1.0045	1.0033	1.0016	1.0046

RESULTS FOR MINIMUM P_{LOSS}

From fig. [14] Shows the bus voltage profile without and with DGs and realistic load model such as three phase induction motor at different motor speed such as (a) N=993rpm, (b) N=991rpm, (c) N=989rpm, &(d) N=987rpm respectively. From fig. [14] it is concluded that the bus voltage profile with DGs and with different motor speed such as (a) N=993rpm, (b) N=991rpm, (c) N=989rpm, &(d) N=987rpm respectively is better as compared to without DGs. hence power quality parameters such as voltage drop or voltage deviation (voltage sag) at the different buses with respect to realistic load model such as three phase induction motor in distribution system (IEEE37 bus) .

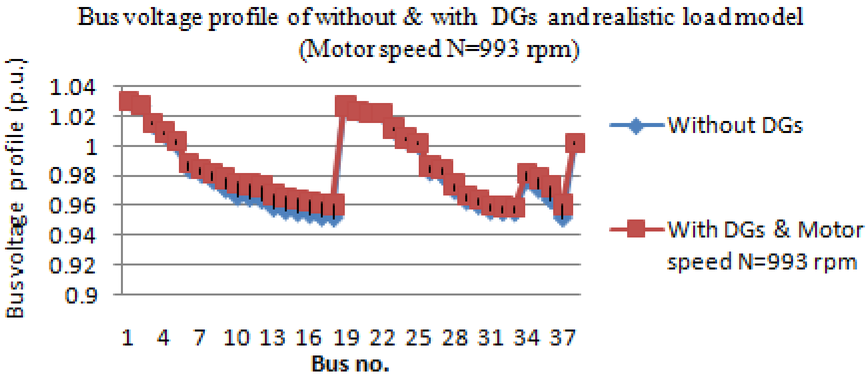

Fig. 14(a)

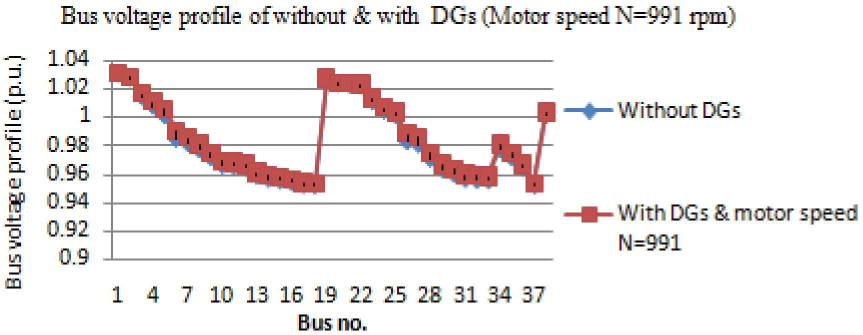

Fig. 14 (b)

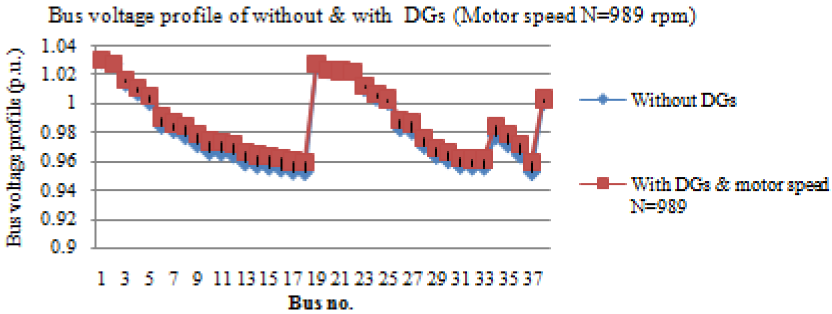

Fig. 14 (c)

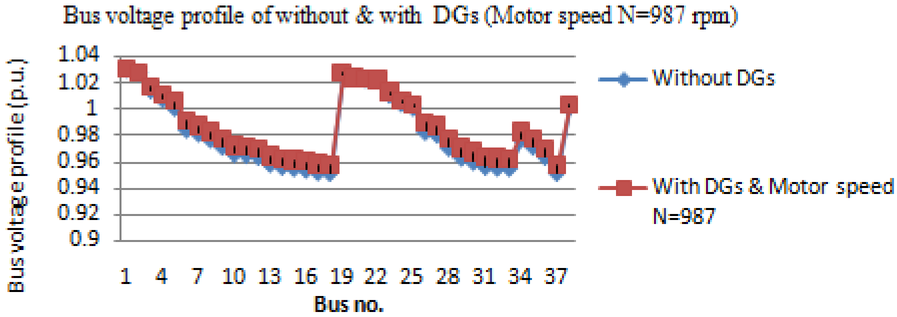

Fig. 14 (d)

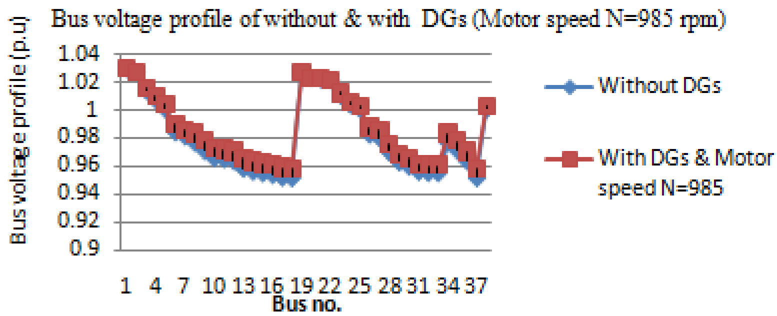

Fig. 15 (e)

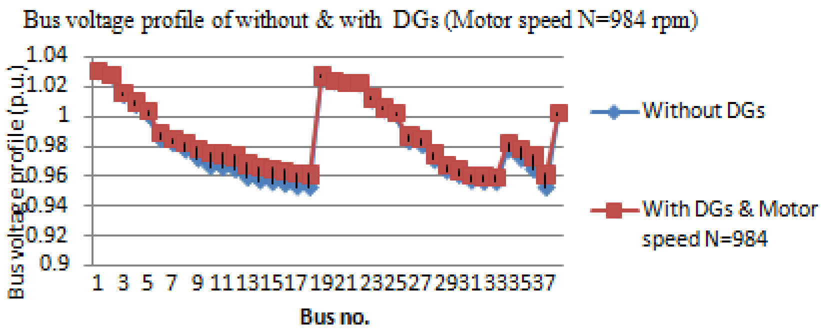

Fig. 15 (f)

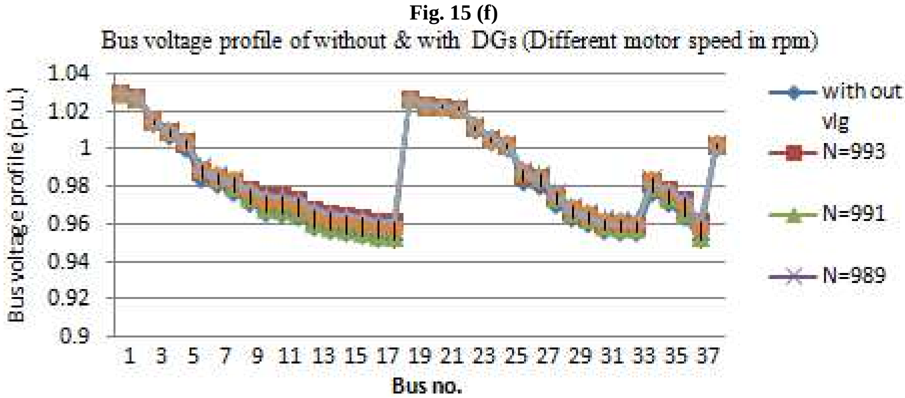

Fig. 15 (g)

From fig. [15] shows the voltage profile without and with DGs and different motor speed such as (e) N=985 rpm, (f) N=984 rpm, (g) comparison of a, b, c ,d, e, f respectively. From fig. [15] it is concluded that the bus voltage profile with DGs and with different motor speed such as (e) N=985 rpm, (f) N=984 rpm, respectively is better as compared to without DGs. hence power quality parameters such as voltage drop or voltage deviation (voltage sag) at the different buses with respect to realistic load model such as three phase induction motor in distribution system (IEEE37 bus) .

RESULTS FOR MINIMUM Q_{LOSS}

From fig. [16] Shows the voltage profile without and with DGs and different motor speed such as (h) N=993rpm, (i) N=991rpm, (j) N=989rpm, & (k) N=987rpm respectively. From fig. [16] it is concluded that the bus voltage profile with DGs and with different motor speed such as (h) N=993rpm, (i) N=991rpm, (j) N=989rpm, & (k) N=987rpm respectively is better as compared to without DGs. hence power quality parameters such as voltage drop or voltage deviation (voltage sag) at the different buses with respect to realistic load model such as three phase induction motor in distribution system (IEEE37bus).

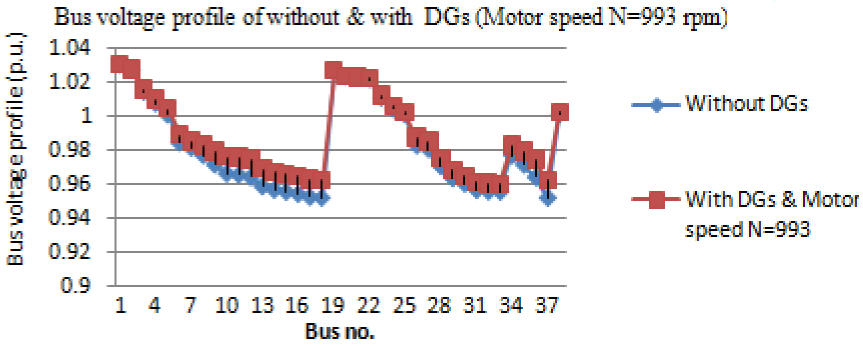

Fig 16 (h)

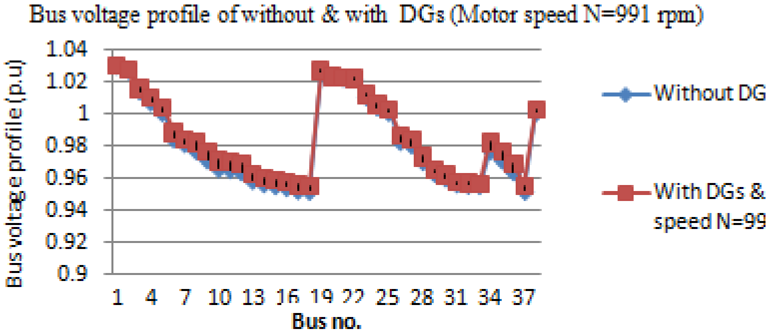

Fig 16 (i)

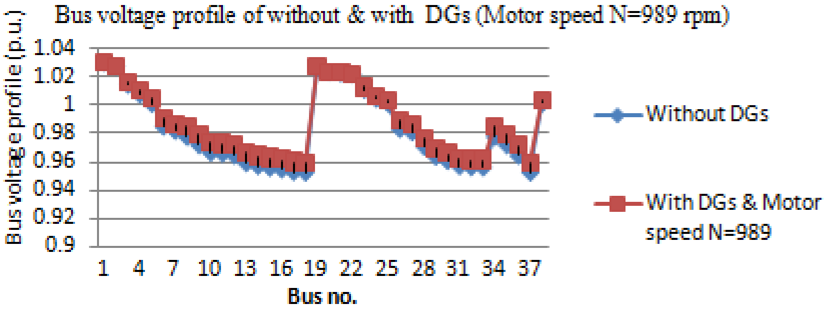

Fig 16 (j)

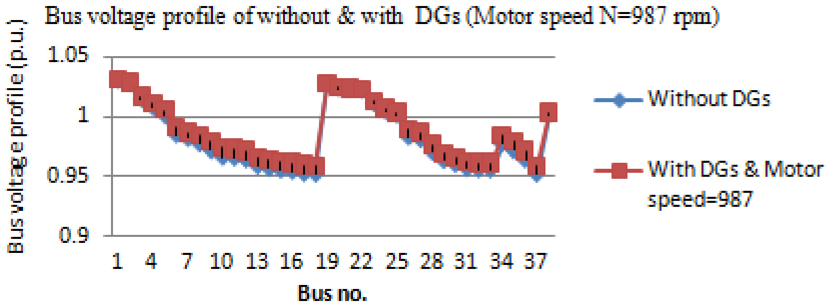

Fig. 16 (k)

From fig. [17] shows the voltage profile without and with DGs and different motor speed such as (l) N=985 rpm, (m) N=984 rpm, (n) Comparison of l, m, n, respectively. From fig. [17] it is concluded that the bus voltage profile with DGs and with different motor speed such as (l) N=984 rpm, (m) N=984 rpm respectively is better as compared to without DGs. hence power quality parameters such as voltage drop or voltage deviation (voltage sag) at the different buses with respect to realistic load model such as three phase induction motor in distribution system (IEEE37 bus) .

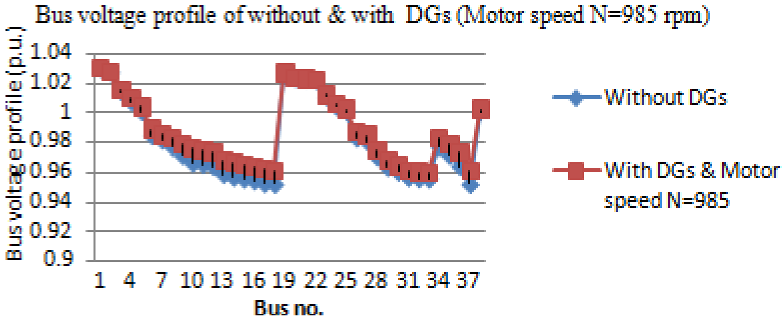

Fig. 17 (l)

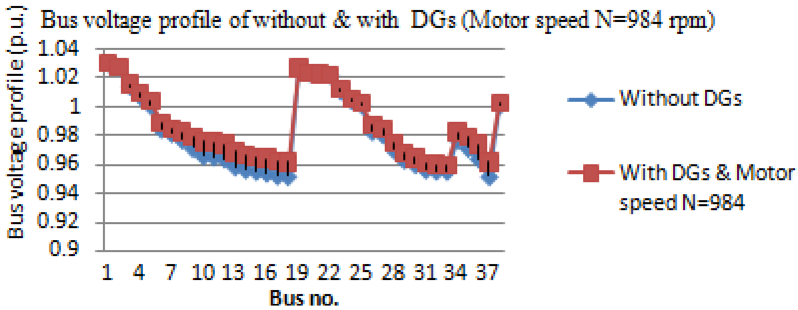

Fig. 17 (m)

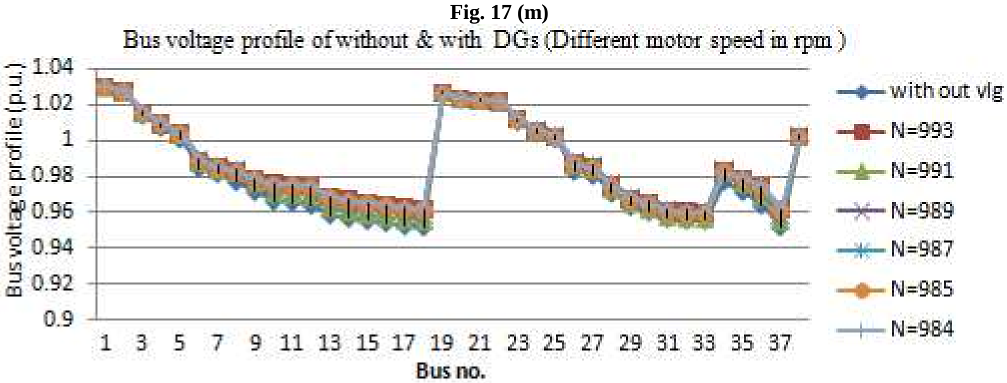

Fig. 17 (n)

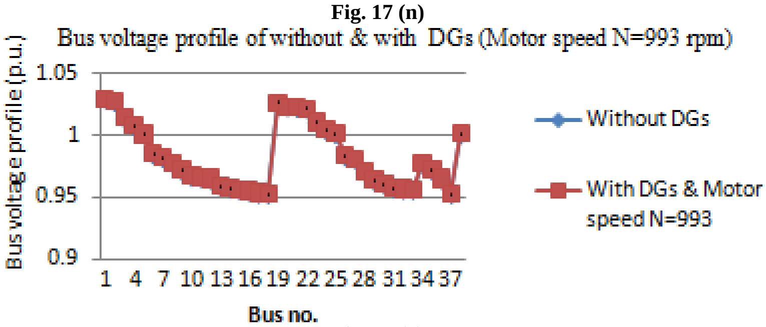

Fig. 18 (o)

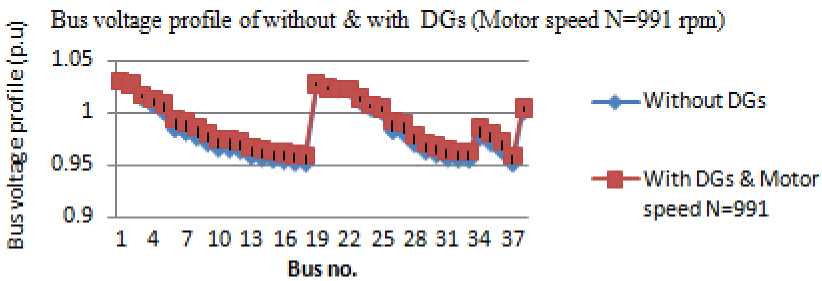

Fig. 18 (p)

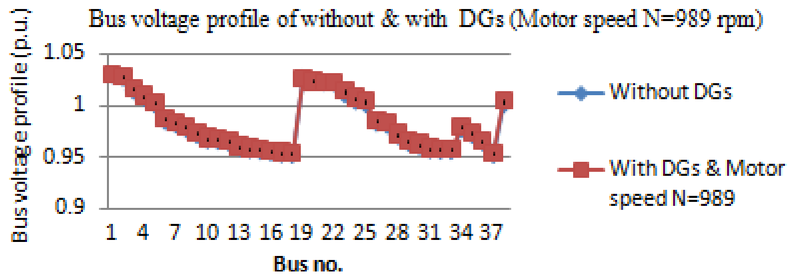

Fig. 18 (q)

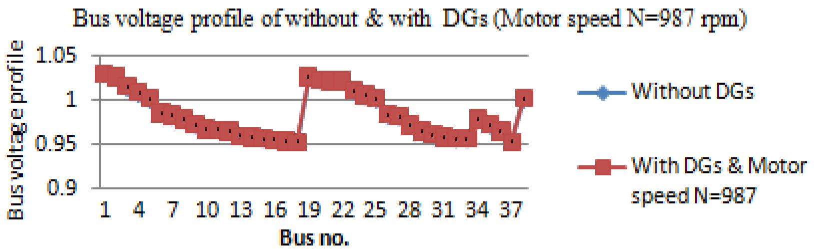

Fig. 18 (r)

From fig. [18] shows the voltage profile without and with DGs and different motor speed such as (o) N=993 rpm, (p) N=991 rpm, (q) N=989 rpm, (r) N=987 rpm respectively. From fig. [18] it is concluded that the bus voltage profile with DGs and with different motor speed such as (o) N=993 rpm, (p) N=991 rpm, (q) N=989 rpm, (r) N=987 rpm respectively is better as compared to without DGs. hence power quality parameters such as voltage drop or voltage deviation (voltage sag) at the different buses with respect to realistic load model such as three phase induction motor in distribution system (IEEE37 bus) .

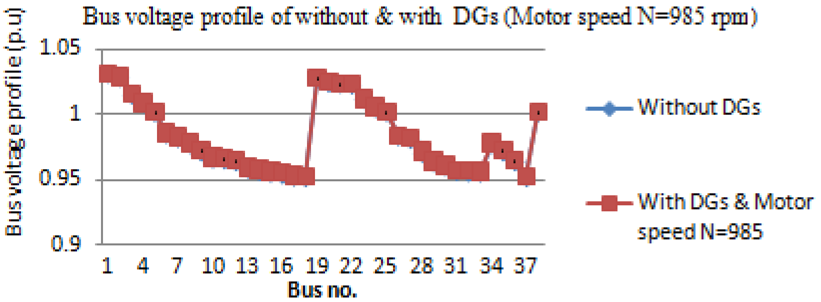

Fig. 19 (s)

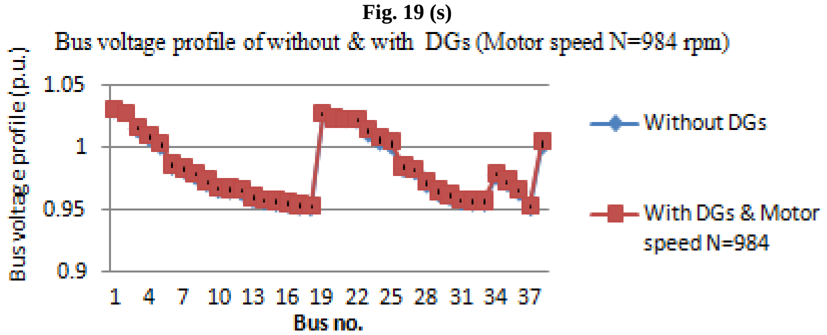

Fig. 19 (t)

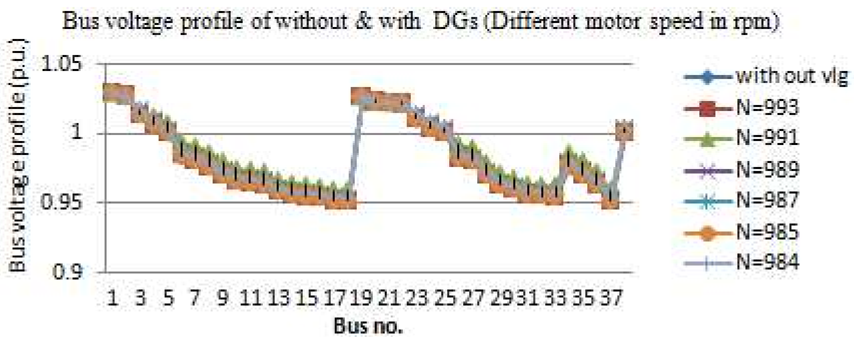

Fig. 19 (u)

From fig. [19] Shows the voltage profile without and with DGs and different motor speed such as (s) N=985 rpm, (t) N=984 rpm, (u) Comparison of s, t, u, respectively. From fig. [19] it is concluded that the bus voltage profile with DGs and with different motor speed such as (s) N=993 rpm, (t) N=991 rpm, (u) N=989 rpm respectively is better as compared to without DGs. hence power quality parameters such as voltage drop or voltage deviation (voltage sag) at the different buses with respect to realistic load model such as three phase induction motor in distribution system (IEEE37 bus).

CONCLUSION

This paper presents the enhancement of PQ parameters by using ES value method. This paper works with different type of loads (three phase induction machine) a realistic load in the IEEE37 bus distributed systems. This paper is useful in analysis of DGs planning based on different types of load models. DGs have significant influence on relevant parameters such as Real and reactive power loss, size reduction of the machine and power intake reduction for the machine.

Future scope regarding with this work as follows:

- Enhancement of PQ parameters by optimal placement and proper coordinated operation of similar and dissimilar type of conventional devices.
- Enhancement of PQ parameters by optimal placement and proper coordinated operation of similar and dissimilar type of DGs.
- Enhancement of PQ parameters by optimal placement and proper coordinated operation of similar and dissimilar type of FACTS controllers.
- Enhancement of PQ parameters by optimal placement and proper coordinated operation of similar and dissimilar type of custom power devices.
- Enhancement of PQ parameters by optimal placement and proper coordinated operation of Hybrid of any two devices or more than two devices.

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