POWER FLOW ANALYSIS OF DOUBLY FED INDUCTION GENERATOR BASED 220/132KV POWER GRID

Arsalan Muhammad Soomar¹, Abdul Hakeem Shaikh¹, Muhammad Hanif Lashari²

¹Department of Electrical Engineering, Mehran University of Engineering and Technology, Jamshoro, Pakistan

²Department of Electrical Engineering, Quaid-e-Awam University of Engineering, Science and Technology, Pakistan

ABSTRACT

This paper proposes the analysis and review of different factors of wind farm connected grid station. the ideal situation is rarely mate by wind farm due to this similar condition for difference reasons. In this study the model is of wind farm connected grid is developed with maximum capacity. A data of for months in real time was collected, simulated results were analyzed and the same was reviewed carefully by increasing the capacity from 750MW to 1250MW. The validity of results was found satisfactory by comparing the simulated results with the real data.

Key words: Power Flow analysis, Electrical Transient Analysis Program, Single line diagram, Wind Turbine Generator, Doubly-Fed induction generator

Cite this Article: Arsalan Muhammad Soomar, Abdul Hakeem Shaikh and Muhammad Hanif Lashari. Power Flow Analysis of Doubly Fed Induction Generator Based 220/132KV Power Grid. *International Journal of Electrical Engineering and Technology (IJEET)*. 12(9), 2021, pp. 107-120.

<https://iaeme.com/Home/issue/IJEET?Volume=12&Issue=9>

1. INTRODUCTION

In our power system renewable energy sources like solar, wind are increasing rapidly as electricity generation source, with inclusion of these sources in existing system the load flow (also known as power flow analysis) which is backbone and has great importance in the systems planning and operation as we know the need for electric power is exceeding and expanding day by day, load flow studies can play indispensable parts. Load flow analysis is more accurate which takes less time to calculate with highly reliable results by user friendly software ETAP Electrical Transient Analyzer Program to carry out the load flow analysis of the grid. This Jhimpir grid is located in the Sindh, interconnected to NTDC (National transmission and dispatch company). The major cause of all the leading disturbances caused in the power system is under voltages, reactive power is never be conveyed identical faraway, exclusively beneath

substantial consignment situations so it obligation be In our power system load flow (also known as power flow analysis) which is backbone and have great importance in the systems planning and operation as we know the need for electric power is exceeding and expanding day by day, load flow studies can play indispensable parts. Load flow is considered as obligatory for system planning, operation, economical operations, development with exchanging of power among utility sections. Load flow investigation is further used in stability under transients, optimal flow of power and continuity or exigency studies Therefore, this increasing demand not only to overcome by building more generating stations but also to redesign and restructure the current power grids with advance techniques, furthermore the data of analysis of load flow which is useful to discovery out the degree , and angle in phase between voltages at every bus with the reactive and real power graceful and consumptions in separately transmission lines through the implementation of the software electrical transient and analysis program (ETAP) these all things are much more easier to find with accuracy more than human calculations by hand.

(Albadi, M., 2019) Analyzed the power flow by considering the simple power system and made the equation. Since these equations are nonlinear, that's why he used iterative techniques which used to solve these equations like Newton Raphson, gauss-seidel and the fast-decoupled methods, when he come through the solutions and he concluded in the results that he found fast decoupled method is faster and simplified form of newton Raphson method which is much reliable and faster method to solve the equations of power flow.

The power flow analysis of a 138/69kV grid station and examined different operating setups using ETAP and result obtained from the load flow analysis to improve the system performance by different approaches of power factor rectification with fixed and switched techniques which originates with plentiful technical and financial profits [1]. These techniques aids contain improvement in voltage stability and loss in power, with minimum equipment's loading, and reorganizing costly network advancements.

By constructing the one line diagram in software named Electrical transient analysis program, and with various cases he did the analysis of substation such as by doing loss of generators, a transmission line, a transformer and a load , and to determine the load analysis at various cases and self-made conditions and he also regulate the optimal size and area in which capacitor bank is to overcome the problem of under voltage [2].

In [3], ETAP software is used to support his research for the analysis of 220/132kV substation in which he carried out load flow analysis and found the problem of under voltages at the substation buses , and he found this software useful and excellent tool while doing the study ,and system planning also to determine the optimum size and location of capacitor to triumph the underneath voltage problem and this software was originated this to be useful while connecting or disconnecting the loads to identify the system voltages under various cases to find out the system equipment's ratings.

In [4] author did the analysis of CIGRE Micro-grid Model which he simulated in ETAP software to analyze the load flow to determine its voltage Stability, the power flow both real and reactive among all the buses. The results stated that the power flows between the buses and loads then he also explained the system voltage at buses which he concludes that these results will be helpful during system physical implementation and planning. Further research work incorporates the load transients and transient's stability study.

In [5], the author did the Power flow analysis of power station 220/132 kV in ETAP. To carry out the study for future planning and expansion of the substation in addition to determine the best process for the present system which exist, after analysis he found the problem of under voltages, then he provide the solution of under voltage by adding a capacitor to overcome this issue to maintain the voltage levels under safe operating values of equipment.

In [6], the author carried out power flow analysis for reasonable process of the power system. In this analysis he adopted the results by using simulation software Power World. In this software he also analyzes the effect of adding and removing of transmission line from the power system component, simulator results gives information for what amount of power the system works with maximum efficiency and he also found the software is user friendly which provides visual results.

In [7], the analysis of the 132kV grid voltages of two month then he observed the problem of under voltages by using the software ETAP, then he also provide the solution of that problem of under voltages by inserting the capacitor bank of 8MVAR in shunt with the feeders, then he compare the result and analyze the problem of under voltages and losses is reduced and voltages are not in critical situation.[8] Load flow analysis on 220/132kV transmission system of Maharashtra state ETCL, one-line diagram in MATLAB, then he recognized the overload bus and he anticipated appropriate procedures for decreasing the overload and advised. The advancement in the substation change in tapping of transformers, capacitive banks for power compensation, shifting techniques of capacitors, and substituting single lines circuits by double lines circuits were initiated to be operative in improving the issue of under voltages. In [9], the researcher did the Load flow analysis and verified the data of 220kV MSETCL substation by equating the results with three methods that is by hand calculations, the data collected by ABT metering installed at substation and ETAP, then results were found to be technically correct and time required is very less. The difference in the results is less than 1% for all bus voltages and 2 % for all power flows, and he found the ETAP software was useful for this operation.

2. POWER FLOW ANALYSIS

The Immensity and phase angle of voltage, real and reactive power are the foremost extents that are accompanying with the bus in power system. Based on four extents, buses are confidential hooked on three classes two of which are quantified and the enduring two cannister be originate out by the resolution of the comparison.

2.1. Load Bus

Active and reactive power of load bus can be quantified nevertheless phase angle and greatness of the bus voltage is determined. The load bus that can be allowed to vary the voltage buy permissible value such as 5% would only to specify the active and reactive although the voltage phase angle is not that abundant significant.

2.2. Generator Bus

The rated real power and rated magnitude of voltage is quantified for bus. The outstanding two measures that are voltage phase angle and the reactive power cohort of the bus is strongminded. Generator bus is considered at generation stations or wherever power generation devices are installed.

2.3. Swing Bus

In this bus greatness and phase angle of the voltage is identified whereas the real power and reactive power is strongminded by the load flow resolution. This is the category of the generator bus that underwrites to the transmission losses to make additional real and reactive power supply. For this bus is acknowledged as swing bus.

Table 1 Summary of three types of buses

Bus Cataloging	Specified Constraints	Obtained Constraints
Generator Bus	Voltage magnitude, Active power	Voltage angle, Reactive Power
Swing Bus	Voltage magnitude, Voltage Angle	Active Power, Reactive Power
Load Bus	Active Power, Reactive Power	Voltage magnitude, Voltage angle

3. RESEREACH METHODOLOGY

ETAP is the electrical instrument its abbreviation electrical transient analyzer program , its prototypical ambitious construction affords the quicker and factual time data to its users, and it also offers a complete explanation to all the electrical complications such as power flow ,arc flash and short circuit scrutiny, transient stability relay synchronization, cable assortment to estimation the antedating manners, cautionary accomplishment and situational flair [10].Solitary of its untouchable assemblies is that it distributes the atmosphere for the unceasing functionality from deceitful to dispensation. It affords tailored amplification for any encompassing of a unimportant or bulky power arrangement. At this point we are absorbed on an extra high tension (EHT) line involvement valuation of 132kV.

Simulating model of 220/132kV grid under study is developed in ETAP as shown in Fig.1. The model is made to simulate in order to determine the performance of grid Table I: Summary of Data collected from the grid for generating plants. The actual rating of the grid components such as transformers summary of data in Table V, circuit breakers, current transformers, potential transformers, isolators and various buses data summary at Table III, IV the data are taken from grid and modified accordingly in the ETAP.

Table 2 Summary of WTG Capacity and Ratings

Generating Plants	Control Breaker	Capacity	Voltage Rating
ARTISTIC	(E17Q1)	50MW	11/132kV
MASTER	(E13Q1)	49.5MW	11/132kV
Metro	(E5Q1)	60MW	11/132kV
Sachal	(E7Q1)	49.5MW	11/132kV
TBA	(E4Q1)	50MW	11/132kV
TBC	(E3Q1)	50MW	11/132kV
TGS	(E9Q1)	50MW	11/132kV
TGT	(E8Q1)	50MW	11/132kV
UEP	(E18Q1)	99MW	11/132kV
ZEPHYR	(E14Q1)	50MW	11/132kV

Table 3 Summary of 220kV transmission line Capacity

Name of T/line	Control Breaker	Length of line (KM)	Conductor	
			Type	Capacity (Amps)
TMK Road CKT-I	(D3Q1)	83.98	Greely ACCR	1582
TMK Road CKT-II	(D4Q1)	83.98	Greely ACCR	1582

Table 4 Summary of 132kV transmission line Capacity

Name of T/line	Control Breaker	Length of line (KM)	Conductor	
			Type	Capacity (Amps)
TMK City CKT-I	(E16Q1)	75	Greely ACCR	791
TMK City CKT-II	(E17Q1)	75	Greely ACCR	791

Table 5 Summary of 132/220kV Capacity.

Name of T/line	Bus Bar	CT Ratio	Conductor	
			Type	Capacity (Amps)
220 KV Bus Bar-I	2 Bundled flexible	2400/1	Coreopsis	2416
220 KV Bus Bar-II	2 Bundled flexible	2400/1	Coreopsis	2416
132 KV Bus Bar-I	Rigid	1600/1	Coreopsis	4000
132 KV Bus Bar-II	Rigid	1600/1	Coreopsis	4000

Table 6 Summary of Transformers capacity.

Transformer	Make	Rating	Capacity Amps	
			HV	LV
Auto T/F T-1	XIAN XD China	250 MVA, 220/132kV	656.099	1093.498
Auto T/F T-2	XIAN XD China	250 MVA, 220/132kV	656.099	1093.498
Auto T/F T-3	XIAN XD China	250 MVA, 220/132kV	656.099	1093.498
Auto T/F T-4*	XIAN XD China	250 MVA, 220/132kV	656.099	1093.498
Power T/F T-t	PEL	10/13MVA, 132/11kV	56.9	652.7

*future addition

4. RESULTS AND DISCUSSION

4.1. Wind Farm Running at Maximum Capacity

In this case WTG are running at maximum installed capacity and power injected to 132kV bus with 2 incoming grid circuits of TMK and power is taken from 220KV two kV circuits as shown in Fig.1, Results of various equipment's and buses are shown in (Table VII-IX) respectively.

Figure 1. One line diagram of System under study in ETAP

Table 7 Summary of WTG Generation and Loading.

Name of WTG	Rating/Limit	MW	Amp	% Generation
ARTISTIC	50 MW	50	218.7	100
MASTER	49.5 MW	49.5	216.5	100
Metro	60 MW	60	262.4	100
Sachal	49.5 MW	49.5	216.5	100
TBA	50 MW	50	218.7	100
TBC	50 MW	50	218.7	100
TGS	50 MW	50	218.7	100
TGT	50 MW	50	218.7	100
UEP	99 MW	99	433	100
ZEPHYR	50 MW	50	218.7	100

Figure 2. Generation at Maximum capacity

Figure 3. Ampere loading at Maximum capacity

Table 8 Power flow from 132/220kV transformer

Transformers	Rating	Allowable	kW Flow	kVAR Flow
Auto T/F T-1 XIAN XD	132 / 220 kV	250000 kVA	215473	-16466.1
Auto T/F T-2 XIAN XD	132 / 220 kV	250000 kVA	215473	-16466.1
Auto T/F T-3 XIAN XD	132 / 220 kV	250000 kVA	215473	-16466.1
Auxiliary load TF	132 / 11 kV	13000 kVA	25.5	15.81

Table 9 Power flow from 132/220kV transmission line

Name of bus	Rated kV	Type	Rating	MW	Amp
TMK CITY CKT-I	132	Power Grid	30 MW	30	132.6
TMK CITY CKT-II	132	Power Grid	60 MW	60	272
TMK Road CKT-I	220	Distribution grid	380 MVA	-323.2	850.7
TMK Road CKT-II	220	Distribution grid	375 MVA	-323.2	850.7

4.2. Wind Farms Running at Different Capacities (As Per Grid Data)

In this case WTG are running at different generation ratings capacity which are collected from the grid data here we will compare four months data i.e. (March, April, May, June) to analyze the power flow injected to 132kV bus with 2 incoming grid circuits of TMK and power fed to 220kV two circuits as shown in Fig.1, Results of various buses, transformers and generator loading are shown in Table X-XVIII respectively.

Table 10 Summary of WTG Generation and Loading.

Name of WTG	Rated Capacity	March		April	
		MW Loading	Amp Loading	MW Loading	Amp Loading
ARTISTIC	50 MW	14	61.23	23	100.6
MASTER	49.5 MW	9	39.36	13	56.86
Metro	60 MW	20	87.48	22	96.23
Sachal	49.5 MW	22	96.23	24	105
TBA	50 MW	20	87.48	30	131.2
TBC	50 MW	20	87.48	29	126.8
TGS	50 MW	23	100.6	31	135.6
TGT	50 MW	24	105	26	113.7
UEP	99 MW	26	113.7	40	175
ZEPHYR	50 MW	26	113.7	47	205.6
Name of WTG	Rated Capacity	May		June	
		MW Loading	Amp Loading	MW Loading	Amp Loading
ARTISTIC	50 MW	33	144.3	30	131.2
MASTER	49.5 MW	22	96.23	22	96.23
Metro	60 MW	38	166.2	32	140
Sachal	49.5 MW	42	183.7	40	175
TBA	50 MW	43	188.1	41	179.3
TBC	50 MW	42	183.7	40	175
TGS	50 MW	47	205.6	48	209.9
TGT	50 MW	46	201.2	47	205.6
UEP	99 MW	58	253.7	55	240.6
ZEPHYR	50 MW	64	279.9	32	140

Table 11 Power flow from 132/220kV transformer

Transformer Name	Rated kV	Allowable	kW Flow	kVAR Flow	Amp Flow
Auto T/F T-1 XIAN XD	132 / 220 kV	250000 kVA	104774	416.8	458.3
Auto T/F T-2 XIAN XD	132 / 220 kV	250000 kVA	104774	416.8	458.3
Auto T/F T-3 XIAN XD	132 / 220 kV	250000 kVA	104774	416.8	458.3
Auxiliary load TF	132 / 11 kV	13000 kVA	4221.7	2807.8	22.18

Table 12 Power flow from 132/220kV transmission line

Name of bus	Rated kV	Type	Rating	MW	Amp
TMK CITY CKT-I	132	Power Grid	30 MW	77	337.3
TMK CITY CKT-II	132	Power Grid	60 MW	38	166.2
TMK Road CKT-I	220	Distribution grid	380 MVA	-156.98	412.4
TMK Road CKT-II	220	Distribution grid	375 MVA	-156.98	412.4

Table 13 Power flow from 132/220kV transformer

Transformer Name	Rated kV	Allowable	kW Flow	kVAR Flow	Amp Flow
Auto T/F T-1 XIAN XD	132 / 220 kV	250000 kVA	104774	416.8	458.3
Auto T/F T-2 XIAN XD	132 / 220 kV	250000 kVA	104774	416.8	458.3
Auto T/F T-3 XIAN XD	132 / 220 kV	250000 kVA	104774	416.8	458.3
Auxiliary load TF	132 / 11 kV	13000 kVA	4221.7	2807.8	22.18

Generation Comparison of Plants

Figure 4 Generation at Different capacities

Amp Loading of the Wind Turbine generators & buses

Figure 5 Ampere loading at Different capacities

Table 14 Power flow of 132/220kV transmission line

Name of bus	Rated kV	Type	Rating	MW	Amp
TMK CITY CKT-I	132	Power Grid	30 MW	77.1	343.7
TMK CITY CKT-II	132	Power Grid	60 MW	77	336.8
TMK Road CKT-I	220	Distribution grid	380 MVA	-267.69	704.1
TMK Road CKT-II	220	Distribution grid	375 MVA	-267.69	704.1

Table 15 Power flow from 132/220kV transformer

Transformer Name	Rated kV	Allowable	kW Flow	kVAR Flow	Amp Flow
Auto T/F T-1 XIAN XD	132 / 220 kV	250000 kVA	191365	-13455	503.4
Auto T/F T-2 XIAN XD	132 / 220 kV	250000 kVA	191365	-13455	503.4
Auto T/F T-3 XIAN XD	132 / 220 kV	250000 kVA	191365	-13455	503.4
Auxiliary load TF	132 / 11 kV	13000 kVA	4221.7	2807.8	22.18

Table 15 Power flow from 132/220kV transmission line

Name of bus	Rated kV	Type	Rating	MW	Amp
TMK CITY CKT-I	132	Power Grid	30 MW	73	328.8
TMK CITY CKT-II	132	Power Grid	60 MW	72	314.9
TMK Road CKT-I	220	Distribution grid	380 MVA	-287.048	755.2
TMK Road CKT-II	220	Distribution grid	375 MVA	-287.048	755.2

Table 16 Power flow from 132/220kV transmission line

Transformer Name	Rated kV	Allowable	kW Flow	kVAR Flow	Amp Flow
Auto T/F T-1 XIAN XD	132 / 220 kV	250000 kVA	178452	-11964.7	469.4
Auto T/F T-2 XIAN XD	132 / 220 kV	250000 kVA	178452	-11964.7	469.4
Auto T/F T-3 XIAN XD	132 / 220 kV	250000 kVA	178452	-11964.7	469.4
Auxiliary load TF	132 / 11 kV	13000 kVA	4221.7	2807.8	22.18

Table 17 Power flow from 132/220kV transmission line

Name of bus	Rated kV	Type	Rating	MW	Amp
TMK CITY CKT-I	132	Power Grid	30 MW	77.1	343.7
TMK CITY CKT-II	132	Power Grid	60 MW	77	336.8
TMK Road CKT-I	220	Distribution grid	380 MVA	-267.68	704.1
TMK Road CKT-II	220	Distribution grid	375 MVA	-267.68	704.1

4.3. Wind Farms Response After Adding One More Autotransformer in Grid

In this case WTG are running at optimum ratings capacity and the new transformer of 250MVA is added to the simulation which is going to be installed in future at the present grid to increase its power capacity to accommodate more power ,which will allow to take more power from the 132kV TMK city grid circuits and wind power stations ,so that it can transfer more power to the load side which is 220kV two circuits connecting TMK Road Grid as shown in Fig.3-4, Results of various generators, buses and transformer loading are shown in Table XIX-XXII respectively to examine the load flow so that all bus, transformer are well under limits according to the software calculation.

Load Flow Analysis of Wind Farm Fed 220/132kV grid

Figure 3 One-line diagram after expansion of system in ETAP

Table 18 Summary of generation and loading

Name of WTG	Rated Capacity	Opt Capacity	Amp Loading	% Generation
ARTISTIC	50 MW	50 MW	218.7	100
MASTER	49.5 MW	49.5 MW	216.5	100
Metro	60 MW	60 MW	262.4	100
Sachal	49.5 MW	49.5 MW	216.5	100
TBA	50 MW	50 MW	218.7	100
TBC	50 MW	50 MW	218.7	100
TGS	50 MW	50 MW	218.7	100
TGT	50 MW	50 MW	218.7	100
UEP	99 MW	99 MW	433	100
ZEPHYR	50 MW	50 MW	218.7	100

Table 19 Summary of generation and loading

Transformers	Rating	kW Flow	kVAR Flow	Amp Flow
Auto T/F T-1 XIAN XD	132 / 220 kV	160543	-10037.9	422.1
Auto T/F T-2 XIAN XD	132 / 220 kV	160543	-10037.9	422.1
Auto T/F T-3 XIAN XD	132 / 220 kV	160543	-10037.9	422.1
Auto T/F T-4 XIAN XD	132 / 220 kV	160543	-10037.9	422.1
PEL Auxiliary load TF	132 / 11 kV	4221.7	2807.8	22.18

Table 20 Summary of generation and loading

Bus Name	Type	Rating	MW Loading	Amp
TMK CITY CKT-I	Power Grid	30 MW	30	131.9
TMK CITY CKT-II	Power Grid	60 MW	60	267.3
TMK Road CKT-I	Distribution Grid	380 MVA	-321.086	844.3
TMK Road CKT-II	Distribution Grid	375 MVA	-321.086	844.3

4.4. Response of Grid on Losing Generator

In this case WTG are running at nominal ratings capacity then one of generator is lose after that we will see the results of various equipment's and buses as shown in Table. XXII-XXIV) respectively to examine the load flow on 132kV TMK and load side which is 220kV two circuits connecting TMK Road Grid behavior as shown in Fig.7.

Table 21 Summary of WTG Generation and Loading

Name of WTG	Rated Capacity	Opt. MW	Amp Loading	% Generation
ARTISTIC	50 MW	25	109.3	49
MASTER	49.5 MW	18	78.73	36
Metro	60 MW	32	140	53
Sachal	49.5 MW	35	153.1	71
TBA	50 MW	33	144.3	66
TBC	50 MW	33	144.3	65
TGS	50 MW	38	166.2	78
TGT	50 MW	37	161.8	76
UEP	99 MW	45	196.8	45
ZEPHYR	50 MW	0	-	-

Table 22 Summary of WTG Generation and Loading

Transformers	Rating	kW Flow	kVAR Flow	Amp Flow
Auto T/F T-1 XIAN XD	132 / 220 kV	151850	-9161.5	399.2
Auto T/F T-2 XIAN XD	132 / 220 kV	151850	-9161.5	399.2
Auto T/F T-3 XIAN XD	132 / 220 kV	151850	-9161.5	399.2
PEL Auxiliary load TF	132 / 11 kV	4221.7	2807.8	22.18

Figure 7 Generation at losing one Generator

Figure 8 Ampere loading at losing one Generator

Table 23 Power flow from 132/220kV transmission line

Name of T/L	Type	Rating	Opt limit	Amp
TMK CITY CKT-I	Power Grid	200 MW	80	349.9
TMK CITY CKT-II	Power Grid	200 MW	85	374.5
TMK Road CKT-I	Distribution Grid	500 MVA	-227.78	598.8
TMK Road CKT-II	Distribution Grid	500 MVA	-227.78	598.8

5. CONCLUSION

Load flow analysis for the future expansion of the grid is being successful carried out in this paper we observed , Simulation for the various cases such as optimum load capacity with maximum generation allow us to see the behavior of buses at maximum capacity without any fault system will remain intact., in this second case, the loss of generator we also successfully analyze the loading of other generators are well under capacity and for the future load addition and expansion of the grid adding of new circuits for extension its capacity with the inclusion of one transformer into the grid to increase its capacity from 750 to 1250MW and we have

analyzed from the simulation that all buses are performing well under the specified limits and capacity to continue safe operation to flow maximum power without any hindrance and loading to its maximum possible condition ,

On basis of these cases we can do changes to maintain our systems reliability and safe operation, and future expansion so that more power deliver to the user end, and cheapest power from renewable sources can be injected from this grid. simulation results confirms the effectiveness of the proposed work.

ACKNOWLEDGMENT

Authors are thankful to Mehran University of Engineering and Technology for providing necessary resources and guidance during the Post graduation studies.

REFERENCES

- [1] Albadi, M. (2019) "Power Flow Analysis", Intechopen.83374
- [2] Gomez, A.V (2019), "Load Flow Analysis of 138/69kV Substation Using Electrical Transient & Analysis Program (ETAP)," *Electrical Engineering Undergraduate Honors Theses*. 67.
- [3] Kamble, S.C: Prof. Rajni Rewatkar, (2017) "Load-Flow Analysis of Distribution Systems Using ETAP", *International Journal of Advanced Engineering, Management and Science*, Special Issue-2.
- [4] Kapahi, R. (2013) "Load Flow Analysis of 132 kV Substation Using ETAP" Software, *International Journal of Scientific & Engineering Research* Volume 4, Issue 2
- [5] Mumtaz, M.: Hussain Sarwar Khan, Muhammad Aamir, Muhammad Ali, Ali Rehman, (2018) "Load Flow Analysis of Cigre Benchmark Model Using ETAP", *International Conference on Renewable, Applied and New Energy Technologies Icranet*, 19-22
- [6] Natkar, K, Naveen Kumar, (2015)" Design Analysis of 220/132 kV Substation Using ETAP", *International Research Journal of Engineering and Technology (Irjet)*, Volume: 02 Issue: 03.
- [7] Patel, Y.: Dixit Tandel, Dharti Katti, (2014) "Simulation and Analysis of 220kV Substation", *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, Vol. 3, Issue.
- [8] Rehman, Z: Waqas Hussain, Rizwan Ullah and Zaki-Ud-Din, (2017) "Load Flow Analysis of 132/11kV Substation Using ETAP: A Case Study" *Sarhad University International Journal of Basic and Applied Sciences*, Vol 5.
- [9] Salgar, A.S., Prof. Ch. Mallareddy, (2015)" Load Flow Analysis for A 220kV Line – Case Study", *International Journal of Innovations in Engineering Research and Technology [Ijiert]* Issn: 2394-3696 Volume 2, Issue 5.
- [10] Shinde, K.S: Atul M. Shewale, "Load Flow Analysis of 220 kV MSETCL Substation by Using ETAP", *Elsevier Science & Technology*, Issn No. 978-93-5107-223-2.