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Aims and Scope

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Liquid-liquid extraction of Barium(II) using Cyanex 301 in Kerosene

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ABSTRACT

An analytical method has been developed for the extraction and separation of barium (II) using cyanex 301 in potassium oxalate medium. The various parameters such as concentration of potassium oxalate, concentration of cyanex 301, concentration of metal ion and effect of various stripping agents were studied. The advantages of this method over the reported methods are, that the concentration of cyanex 301 required for quantitative separation of barium(II) is very low and clear cut separation of barium(II) from strontium(II), Chromium(VI), lead(II) have been achieved. The method can extend to the analysis of barium(II) in real samples like rock samples. The method is simple, rapid and selective with good reproducibility (approximately±2%).

Keywords: Solvent extraction, Barium(II), cyanex 301, kerosene

Barium(II) present in an environmental samples (like, rocks, minerals, marine organism and bone) as well as the main constituent in the fission process. So barium(II) has versatile applications ingeologically and biochemistry field. Hence researchers focus on their view t o barium extraction. It is essential to precise determination and rapid separation of barium. The environmental samples containingcalcium(II) with other alkaline earth metal as result spectral interference in the determination of barium(II). The exact separations, determination and separation form other metals is very important task.

In precipitation method and solvent extraction method separation were achieved at concentration level of milligram and microgram respectively. Separation of barium(II) by solvent extraction using extractant β–diketones [1] and 8-Quinol in chloroform [2-3] was carried out for quantitativeextraction. The extraction of barium(II) in a case of bis-2-ethylhexyl phosphoric acid [4-6] and benzoylacetone and dibenzoylmethane [7] is also shows poor extraction. Separation of alkaline earth metals by solvent extraction method using various crown ethers, which was reported previously. Benzo-15-crown 5, benzo-18- crown-6 and dibenzo18–crown-6[8-11], dibenzo 24–crown-8 [12] have been used to extract alkaline earths [13]. The extraction of barium(II) in alkaline medium using hexafluroacetylacetone [14]and thenoyltrifluoroacetone [15- 16], has been reported by authors and separations are carried out in amedium of hydrochloric acid [17] and picric acid [18]. The literature survey reveals that there are no anyreport on extraction of barium(II) using cyanex 301 in kerosene as solvent and potassium oxalate as

medium. In present work the method for extraction and separation of barium(II) from its associated metal ion was carried out at micro level using cyanex 301 in kerosene from potassium oxalate as a medium.

II. Experimental

2.1 Apparatus and reagents

Optical absorption measurements were carried out by using a visible spectrophotometer (Chemito 215D), a digital pH meter (Model LI-120, Elico, India) with glass and calomel electrodes were used for pH measurement and digital flame photometer (PI, Model no.041, India) was used for determination of alkali and alkaline earth metals.

A stock solution of barium(II) was prepared by dissolving 11.29 g of barium chloride dehydrate (AR grade Merck Specialties Private Limited, Mumbai, India) in 100 mL distilled deionised water and standardized gravimetrically [19]. A solution containing 100 µg/mL of barium(II) was prepared by appropriate dilution of the standard stocksolution. A stock solution of potassium oxalate (1.0 M) and (5x10-3 M) was prepared by dissolving 18.423 g potassium oxalate extra pure (Molychem Pvt Limited, Mumbai, India) in 100 mL distilled deionised water. Cyanex 301 (American Cyanamide Co) was used without further purification.

2.2 General procedure

To an aliquot of solution containing 100 µg/mL barium(II), potassium oxalate solution was added in the concentration range of 5x10-5to 1.0 M in a total volume of 10 mL. The solution was transferred to a separating funnel and equilibrated with 10 mL of 5x10-3M cyanex 301 in kerosene as the diluent, for 10 minutes on a wrist action flaskshaker. The two phases were allowed to settle and separate. Barium(II) was stripped from the organic phase by shaking with 10 mL of 2.0 M HCl. Barium(II) in the aqueous phase was determined spectrophotometrically with sulfonazo (III) at 640 nm[20] using a calibration graph.

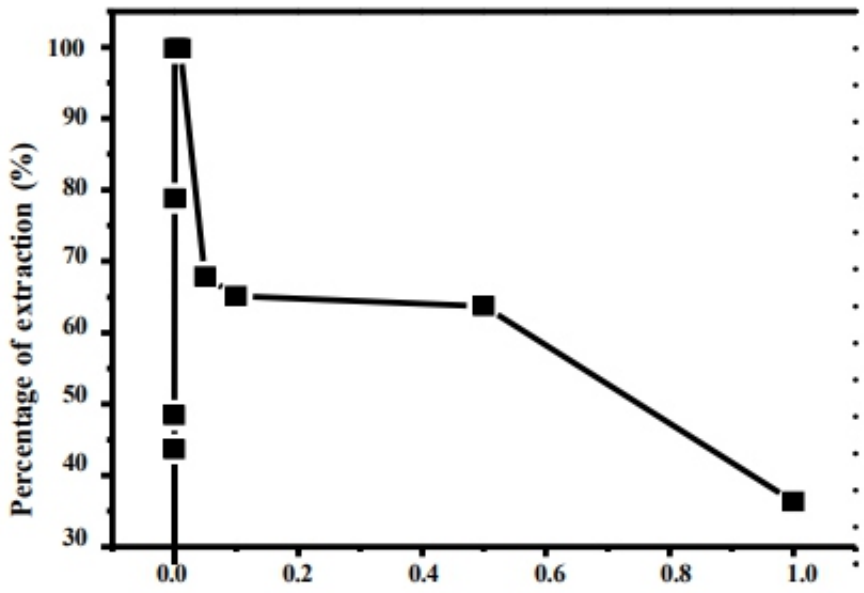
III. Results and discussion

3.1 Extraction of barium(II) as a function of potassium oxalate concentration with cyanex 301.

The optimum concentration for the quantitative extraction of barium(II) was ascertained by extracting barium(II) with 5x10-3 M cyanex 301 in kerosene as a diluent. In these experiments the concentration of cyanex 301 in the organic phase was fixed at 5 x10-3 M and concentration of potassium oxalate was varied from 5x10-5to 1.0 M as shown in (figure 3.1). It was found that there was quantitative extraction of barium(II) from 1x10-3to 1x10-2 M potassium oxalate concentration. For further extraction studies 5x10-3 M of potassium oxalate was selected and used.

Table 3.1 Extraction of barium(II) as a function of potassium oxalate concentration with cyanex 301
Ba (II)=100 µg/mL ,cyanex 301=5x10-3 M, strippant=2.0 M HCl

Concentrations of potassium oxalate [M]	% Extraction	Distribution ratio(D)
$5x10^{-5}$	45.57	0.83
$1x10^{-4}$	50.21	1.0
$5x10^{-4}$	79.64	3.9
$1x10^{-3}$	100	∞
$5x10^{-3}$	100	∞
$1x10^{-2}$	100	∞
$5x10^{-2}$	69.02	2.22
$1x10^{-1}$	66.37	1.97
$5x10^{-1}$	65.04	1.86
1	38.49	0.62



Conc.of potassium oxalate(M)

Figure 3.1 Extraction of barium(II) as a function of potassium oxalate concentration
Ba(II) = 100 µg/mL, cyanex 301= 5x10-3 M, strippant = 2.0M Hcl

3.2 Effect of varying concentration of cyanex 301

In order to ascertain the optimum concentration of cyanex 301 required for the quantitative extraction of barium(II), the concentrations of cyanex 301 were varied in the range of 1x10-3to 1x10-1 M by using

g 5x10-3 M concentration of potassium oxalate as shown in (figure 3.2). It was found that the extraction of barium(II) increases from 84.07 % at 2 x10-3 M, to 94.24 % at 7 x 10-3 M and was quantitative from 4x10-3 M to 6x10-3M. Hence, further extraction studies of barium(II) was carried out using 5x10-3 M cyanex 301.

Table 3.2. Effect of varying concentration of cyanex 301
Ba(II)=10 µg/mL, potassium oxalate=5x10-3 M, strippant=2.0M HCl

Cyanex 301 [M]	% Extraction	Distribution ratio(D)
$1x10^{-3}$	78.31	3.61
$2x10^{-3}$	84.07	5.27
$4x10^{-3}$	100	∞
$5x10^{-3}$	100	∞
$6x10^{-3}$	100	∞
$7x10^{-3}$	94.24	16
$1x10^{-2}$	89.38	8.41
$5x10^{-2}$	86.72	6.53
$1x10^{-1}$	76.10	3.18

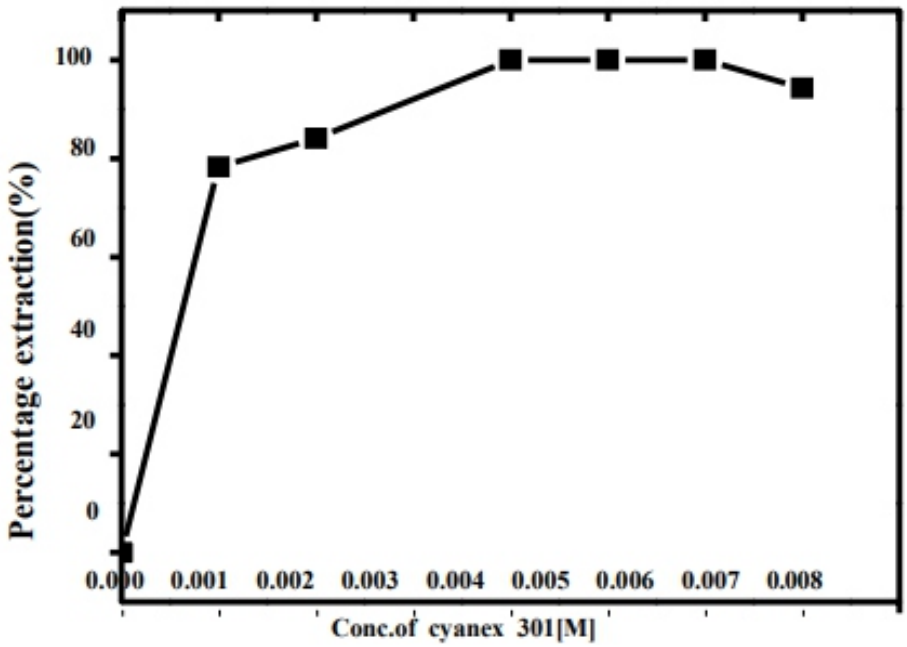


Figure 3.2 Effect of varying concentration of cyanex 301
Ba(II)=100 µg/mL, potassium oxalate=5x10-3 M, strippant=2.0 M HCl

3.3 Time of equilibration and choice of stripping agents

The extraction time was optimized by performing the equilibration for various time periods (1-20 min.). The result shows that with 10 minutes of equilibration there was quantitative extraction of barium(II). So, 10 minutes equilibration time was used. After extraction, back extraction was carried out to remove barium(II) from the organic phase, for which various stripping agents were used. The concentrations of strippant were varied from 0.1-8.0 M. Back extraction of barium(II) was quantitative with 4.0–8.0 M nitric acid, 0.5–8.0M sulphuric acid, 2.0-8.0 M hydrochloric acid, 2.0-8.0 M perchloric acid, 4.0-8.0 M acetic acid, 3.0 -8.0 M hydrobromic acid, where as all strippant are efficient strippants for barium(II) as shown in (figure 3.3). Among all strippants sulphuric acid, hydrochloric acid, perchloric acid are most efficient strippants,, for barium(II) further back extractions were carried out with 2.0 M Hcl.

Table 3.3 Choice of stripping agents

Ba(II)=100 µg/mL, potassium oxalate=5x10-3 M, cyanex 301=5x10-3 M,

Concentration [M]	% Stripping					
	HCl	H_2SO_4	HNO_3	$HClO_4$	CH_3COOH	HBr
0.1	90.29	92.53	82.46	90.76	80.22	88.46
0.5	95.89	100	87.68	95.38	89.55	89.23
1	97.01	100	89.55	100	91.04	93.84
2	100	100	94.40	100	93.28	98.84
3	100	100	98.88	100	99.62	100
4	100	100	100	100	100	100
5	100	100	100	100	100	100
6	100	100	100	100	100	100
7	100	100	100	100	100	100
8	100	100	100	100	100	100

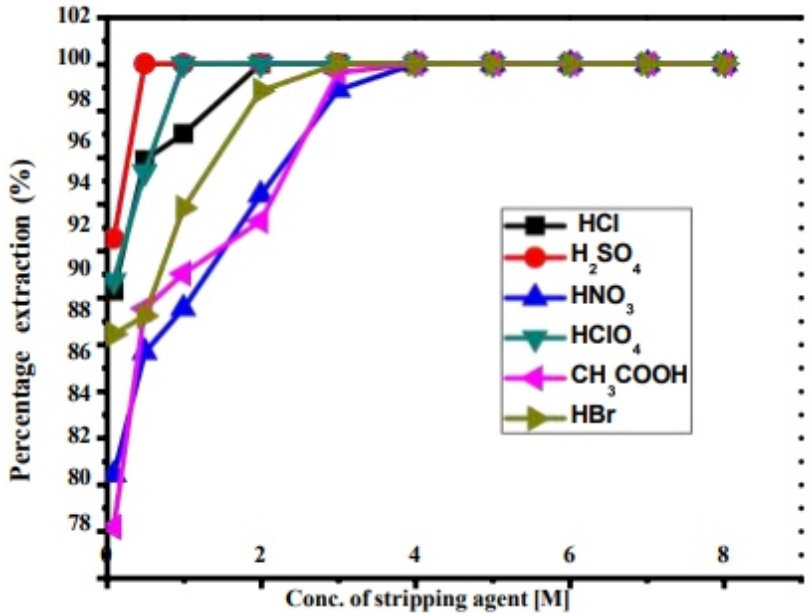


Figure 3.3 Choice of stripping agents

Ba(II)=100 µg/mL, potassium oxalate=5x10-3 M, cyanex 301=5x10-3 M

3.4 Effect of diluents on the extraction of barium(II)

In the extraction of barium(II) the influence of solvent is very important. The polarity of solvent seems to be the most decisive factor. Barium(II) extraction was carried out from 5x10-3 M potassium oxalate using 5x10-3 M cyanex 301 with various solvents, such as carbon tetrachloride, xylene, toluene, chloroform, kerosene, tetrachloroethane, dichloroethane, n-dodecane as shown in (Table 3.4). The phase volume ratio was maintained at unity from the organic phase barium(II) was stripped with 2.0M HCl. It was observed that there was quantitative extraction with kerosene while carbon tetrachloride, xylene, toluene, chloroform, tetrachloroethane, dichloroethane and n-dodecane were found to be inefficient diluents. Kerosene was the cheapest and best diluent among tested and clear cut separation was achieved. Hence, kerosene was selected as diluent for further study.

Table 3.4 Effect of diluents on the extraction of barium(II)

Ba(II)=100 µg/mL, cyanex 301=5x10-3 M, potassium oxalate=5x10-3 M, strippant=2.0M HCl

Diluents	Dielectric constant	% Extraction	Distribution ratio(D)
Chloroform	4.80	10	0.1
Carbon tetrachloride	2.24	10	0.1
Toluene	2.38	10	0.1
Kerosene	**2.02**	**100**	∞
Xylene	2.30	45	0.8
n-Dodecane	2.00	36	0.56
Dichloroethane	10.50	28	0.3
Tetrachloroethane	8.20	36	0.56

3.5 Effect of varying concentration of barium(II)

Barium(II) was extracted with 10mL of 5 x10-3 M cyanex 301 from 5x10-3 M potassium oxalate medium using kerosene as a diluent. The concentration of barium(II) was varied from 10-500 µg/mL. It was found that 10 mL of 5x10-3 M cyanex 301 solutions was adequate to extract barium(II) quantitatively up to 300 µg/mL of sample solution.

Table 3.5 Effect of varying concentration of barium(II)

Cyanex 301 =5x10-3 M, potassium oxalate =5x10-3 M, strippant=2.0M HCl

Barium (II) µg/mL	% Extraction	Distribution ratio(D)
10	100	∞
20	100	∞
30	100	∞
60	100	∞
80	100	∞
90	100	∞
100	100	∞
200	100	∞
300	100	∞
400	96.80	24.2
500	85.26	5.78

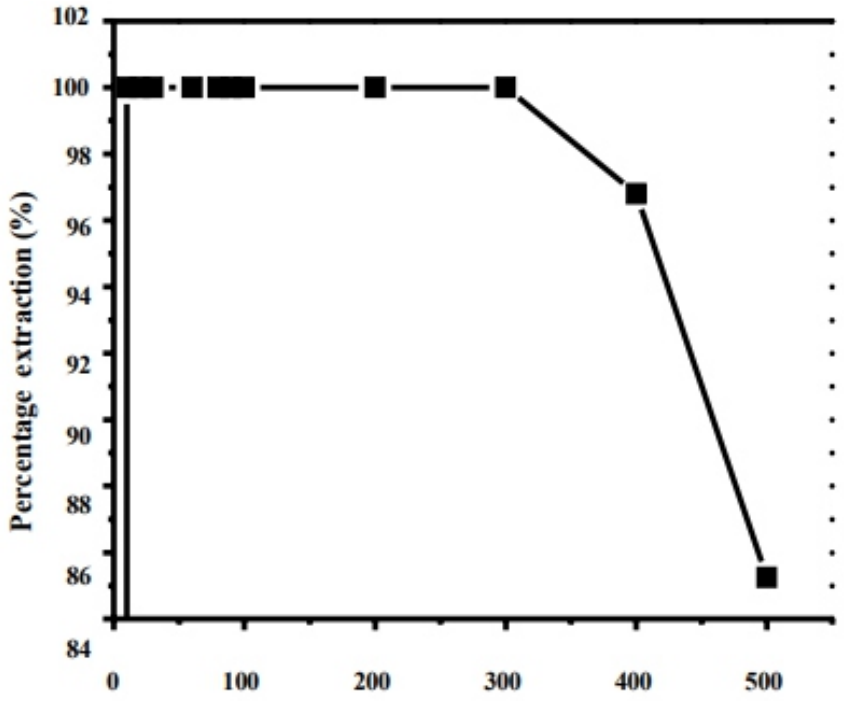


Figure 3.5 Effect of varying concentration of barium(II)
Cyanex 301=5x10-3 M, potassium oxalate= 5x10-3 M, strippant=2.0 M Hcl

3.6 Study of diverse ion effect on extraction of barium(II)

The barium(II) was extracted in the presence of wide range of foreign ions. The tolerance limit was set such that the amount of foreign ions required causing ±2% error in the recovery of barium(II), strontium(II), cesium(I) was co extracted along with barium(II). Some of d-block cations showed low tolerance limit except cadmium(II) andmanganese (II). But most of p-block and f-block cations showed low tolerance limit. Most of the s-block and anions of organic and inorganic acids showed very high tolerance limit except rubidium(I) and anion higher tolerance limitexpect No3-2.. The tolerance limit of various cations and anions are listed in (Table 3.6)

Table 3.6 Study of diverse ion effect on extraction of barium(II) Ba(II)=100µg/mL, cyanex 301=5x10-3
M, potassium oxalate=5x10-3 M, strippant=2.0 M HCl

Ion	Added as	Tolerance limit(mg)	Ion	Added as	Tolerance limit(mg)
Li^{+}	LiCl	20	Tl^{3+}	$Tl(NO_3)_3H_2O$	0.1
Na^{+}	NaCl	10	V^{5+}	$VOSO_4.4H_2O$	0.1
K^{+}	KCl	1	Mo^{6+}	$(NH_4)_6Mo_7O_{24}.4H_2O$	0.08
Cs^{+}	CsCl	3	U^{6+}	$UO_2(NO_3)_2.6H_2O$	3.5
Be^{2+}	$BeSO_4$	0.1	Th^{4+}	$Th(NO_3)_4.6H_2O$	5
Mg^{2+}	$MgCl_2.6H_2O$	5	La^{3+}	$La(NO_3)_3.6H_2O$	2.5
Ca^{2+}	$CaSO_4.6H_2O$	5	Cl^{-}	HCl	15
Sr^{2+}	$Sr(NO_3)_2$	Co-extract	Br^{-}	HBr	10
Cu^{2+}	$CuSO_4.6H_2O$	2.5	SCN^{-}	NaSCN	3
Co^{2+}	$CoCl_2.6H_2O$	2.5	ClO_4^{-}	$HClO_4$	11
Ni^{2+}	$NiCl_2.6H_2O$	3	CH_3COO^{-}	CH_3COOH	10
Mn^{2+}	$MnCl_2.4H_2O$	8	$SO4^{2-}$	H_2SO_4	3
Zn^{2+}	$ZnCl_2$	2.5	Tartarate	Tartaric acid	2.5
Cd^{2+}	$(CH_3COO)_2CdH_2O$	10	EDTA	EDTA	0.01
Pb^{2+}	$Pb(NO_3)_2$	0.1	Ascorbate	Ascorbic acid	5
Fe^{3+}	$FeCl_3.6H_2O$	0.1	Citrate	Citric acid	2
In^{3+}	$InCl_3.3H_2O$	2.5	BO_3^{3-}	$H_3BO_3^{-}$	10
Cr^{6+}	$K_2Cr_2O_7$	10	NO_3^{-}	HNO_3	0.5
Al^{3+}	$AlCl_3.16H_2O$	<0.01	PO_4^{3-}	H_3PO_4	5
Ce^{3+}	$CeCl_3.6H_2O$	5	NH_4^{+}	NH_4OH	1

3.7 Separation of barium(II) from multicomponent mixtures

The mixture containing barium(II), strontium(II) and chromium(VI) in 5x10-3 M potassium oxalate was extracted with 5x10-3 M cyanex 301 in kerosene. Under this set conditions barium(II) and strontium(II) were extracted leaving behind chromium(VI) in the aqueous phase. From the organic phase strontium(II) was first stripped with 1.0MNa2CO3 while barium(II) remained in the organic phase. Finally, barium(II) was stripped with 2.0 M HCl. Under set condition the mixture containing barium(II), strontium(II) and lead(II) in 5x10-3 M potassium oxalate was extracted with 5x10-3 M cyanex 301 in kerosene. Under this set condition barium(II) and strontium(II) were extracted leaving behind lead(II) in the aqueous phase. From the organic phase strontium(II) was first stripped with 1.0 M Na2CO3 whilebarium(II) remained in the organic phase. Finally, barium(II) was stripped with 2.0 M HCl. The result shows that goodseparation is achieved by using this method and recovery is often greater than 98 % as shown in (Table 3.7).

Table 3.7 Separation of barium(II) from multicomponent mixtures

Sr. No.	Mixture	Taken µg	Found µg	*Recovery Percentage	Extractant	Strippant
1	Ba(II) Sr(II) Cr(VI)	50 50 50	48.9 49.5 49.9	97.8 99.0 99.8	CX-301+ PO CX 301+PO Aq. Phase	2.0 M HCl 1.0 M Na_2CO_3 -
2	Ba(II) Sr(II) Pb(II)	50 50 50	48.9 49.5 49.7	97.8 99.0 99.7	CX-301+ PO CX-301+ PO Aq. Phase	2.0 M HCl 1.0 M Na_2CO_3 -

CX-301+ PO =Cyanex 301 + 5x10-3 M potassium oxalate
*Average of triplicate analysis

3.8 Determination of barium (II) in real sample

Barium metal determination in different certified rock samples like barite and witherite and a plastic stabilizer [Obtained from IIT Pawai, Bombay, India]. The standard rock samples included KC-11, KC-12 (King's College London), USGS-G2 (US Geological Survey), Basaltic-BR (France) and Syenite-Sy-2 (Canada).

The samples were decomposed and brought into solution as in the procedure described elsewhere [21] evaporated, the residue was extracted with water and the barium content of the extract was determined by spectrophotometry with Sulfonazo (III). The results of triplicate analyses have shown (Table 3.8 A and 3.8 B).

Table 3.8 A Determination of barium in real samples

Name of rock sample	Barium (ppm)	
	Present	Found
KC-11	49	48.50
KC-12	1600	1590
Syenite-SY-2	460	455
Basaltic-BR	1050	1046

Table 3.8 B) Determination of barium in real samples

Name of rock sample	Percentage of barium (%)	
	Present	Found
Barite	58.80	58.69
Witherite	69.60	69.57
Plastic stabilizer	11.48	11.45

IV. Conclusions

From investigation it is concluded that cyanex 301 is a potential extractant for the extraction of barium(II) from potassium oxalate medium. The proposed method has advantages such as easy phase separation, less equilibration time and single extraction is sufficient for quantitative extraction of barium(II). Cyanex 301 extracts barium(II) very rapidly; equilibrium was reached within 10 minutes. The method permits the separation of barium(II) from other elements. The method is also useful for the extraction and separation of barium(II) from number of certified rock samples like KC11, KC-12 (King College London),USGC-G2 (US geological survey) Basaltic BR (France) and Syenite SY-2 and plastic stabilizer. This method is simple, rapid and selective with good reproducibility (approximately±2%).

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A Study on Rural Technology and Innovation: Rural Development

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ABSTRACT

The article „Rural Technology and Innovation" mentions that for a developing country like India, the role that science and Technology can play in bettering the lives of its citizens. India is traditionally an agrarian economy. Nearly, 70 per cent of its population still resides in the villages. The penetration level of the new technologies and ICT platforms is continuously increasing in rural areas, thus enhancing the rural connectivity. Access to digital as well as physical infrastructure i.e., roads, railways, airports, hospitals, can be transformative, helpingcitizens to improve their livelihoods and enabling business to flourish. The government is taking numerous steps to connect the rural areas with rest of country to achieve the vision of "Aatma Nirbhar Bharat". The governments thrust on new digital technologies, innovations and focus on research and development in the agricultural sector, has helped not only boost farmers income but also ensure that the country remains self-sufficient in most of the agriculture value system, and farmers are increasingly becoming more informed, as various measures are taken to provided them ready access to technology and information. Policies and programmes of the government not only outline the blueprint for economy development of the country but also ensure that the fruits of economic development reach the weaker sections of the population.

Keywords: Rural Development, Innovation, Technology, Economic Growth

Introduction

India lives in more than 6.5 lakh villages where 69 per cent of her population in rural areas. The country"s 650 plus rural districts have 14.5 crore farmer households. The prime occupations of the rural population are – cultivation, agricultural labour, rural artisanry, retail business or small business and services, ect. The large size and share of the rural population, their prevalent socio-economic situations and the desired levels of quality of life demands an all round improvement in the rural infrastructure. Improved infrastructure is the key to achieve the objectives of an equitable and inclusive growth with social justice. Scientific inputs in agriculture are of direct importance to the rural sector. So are the expansions efforts in telecommunications and roads, though much remains yet to be done.

Technology for rural areas must be aimed at creating gainful employment, recycling wastes to create value added products, human welfare through better housing, drinking, promotion of non-conventional

energy, climate change and decentralized techno-economic systems, particularly for remote areas in fact, science and technology can develop in rural communities, a learning and innovation capacity that increases the effectiveness of their efforts to solve problems and improve their lives.

The technological advancements empower these communities and increase the effectiveness of their development efforts through informed decision making to achieve the objectives of poverty eradication, food security and sustainable development in rural areas.Agriculture is the mainstay of India‟s rural population.

Objectives of the study:

The objectives of the study are.

To study the various Rural Development in India.

To study the technologies and innovations in rural regions.

To study understand Agriculture Infrastructure Fund.

To give conclusion revival strategy of Technologies and Innovations.

Methodology:

The observed base of the study rests on the data collected from secondary sources. The secondary data was collected from published sources; the data was gathered by the researcher from the records, reports of Covid-19, NABARD, news papers, journals, teams and government publications and websites.

Review of Literature:

The Technology and Innovations has emerged over the last decade. Heaps of researches have been conducted in India. Schemes and programs associated with science and technology. The effective, scientific and optimal evaluation, conservation, exploitation and distribution of rural resources determine Rural Development. Center for Monitoring Indian Economy (CMIE), 2020-21, the data from the consumer pyramid household survey shows the share of agriculture in total employment has gone up from 38 per cent in 2019-20 to 41.49 per cent in 2020-21. So it has become highly apposite to work shoulder to –should to implement specific schemes and technological advancements in agriculture. Economic Survey (2021-22), the survey stated that the agriculture sector in the country has experience buoyant growth in the past two years. The sector which is the largest employer of workforce, accounted for a sizable 18.8 per cent in Gross Value Added of the country registering a growth of 3.7 per cent in technology and innovations. Jayade, K.Getal (2014) published an article entitled as “Study of Information Communication Technology in Agriculture in Vidargha Region of Maharashtra state of India.” And concluded that ICT has improved the economical condition of the farmers in Vidarbha Regtion of Maharashtra state; ICT is advanced tools to disseminate the modern agricultural knowledge to the farmer and it plays an important role for the development of economy by enhancing the effectiveness of agricultural market, productivity and competitiveness in Vidarhba region of Maharashtra state. According to FAO (2011), disseminating is essential for players in the agriculture value chain to minimize knowledge and communication asymmetries, as well as to break the poverty cycle. In addition, the importance of ICTs in gaining access to more information to improve food security and promote rural livelihoods has been more acknowledged and formally approved at the world summit on the information society.Greenridge and Lightfoot, (2003) Farmers and residents of rural communities are increasingly recognizing the value of knowledge, information and proper learning techniques in moving toward growth.

Technology in Agriculture:

The agriculture sector plays a critical role in rural livelihood, employment and national food security. The sector provides the largest source of livelihoods in the country. Proportion of the Indian population depending directly or indirectly on agriculture for employment opportunities is more than of any other sectors. It is estimated that around 58 per cent of its rural households depend primarily on agriculture census. The committee on doubling farmers‟ income in its reports 2018 has noted the role of digital technology, which can play a transformational role in modernizing and organizing how rural India performs its agricultural activities. Digital technologies are finding increasing use in the agricultural value system, and farmers are increasingly becoming more informed. The e-NAM intended to promote trade and marketing of agricultural produce wherein farmers will be facilitated to sell the produce outside their state borders. Under the PM KISAN scheme Rs. 6000 annually in three installments is directly transferred into the bank accounts of the eligible farmers under direct benefits mode.

Integrated scheme for agricultural marketing schemes to promote creation of agricultural marketing infrastructure by providing backend subsidy support to state, cooperative and private sector investments services are provided through AGMARKNET portal which is a G2C egovernance portal that caters to the needs of various stakeholders such as farmers, industry, policy makers and academic institutions by providing agricultural marketing related information from a single window.

Usage of Drones in Agriculture:

To promote the use of drones in agriculture, the department of agriculture and farmers welfare has released the standard operating procedures for use of drones in pesticide and nutrient application, which provide concise instructions for effective and safe operations of drones. Rural areas producer‟s organizations are provided grants of 75 per cent for purchase of drones for its demonstration on the farmer‟s fields.

Infrastructure Fund: Agriculture

To mobilize a medium long term debt finance facility for investment in viable projects for post-harvest management infrastructure and community farming assets through incentives and financial support in order to improve agriculture infrastructure in the country. Financial assistance is provided digitally in the form of interest subvention and credit guarantee for setting up post-harvest management infrastructure to beneficiaries such as farmers, primary agricultural credit societies, farmer producer‟s organization, self help groups, state agencies. The fund also allows convergence with other schemes so that benefits from other centre/state government schemes can also be availed along with AIF. The total size of the fund is Rs. 1 lakh crore. All loans up to Rs.2 crore per project under this financing facility have interest subvention of 3 per cent per annum.

AGMARKNET portal:

Integrated scheme for agricultural marketing schemes to promote creation of agricultural marketing infrastructure by providing backend subsidy support to state, cooperative and private sector investments services are provided through AGMARKNET portal which is a G2C egovernance portal that caters to the needs of various stakeholders such as farmers, industry, policy makers and academic institutions by providing agricultural marketing related information from a single window.

Digital Technologies': Rural Economy The digital revolution has enormous potential to improve social and economic outcomes, increase productivity worldwide, among other things. While several major research programmes, interventions and policies have been implemented to advance rural development as part of this revolution. Digital services are proving to be less complex and more effective along with ensuring transparency in the governance and services delivery. Digital technology cases our lives at every step. It is used by the government and the public sector to ensure transparency accountability of governance, meet the increased demand for digital services among citizens and to provide more simplified and high-quality service.

Digitalization will go a long way in reducing traditional bottlenecks such as shrinking markets and low density that have been roadblocks in building long-term and sustainable rural economies. Often, issues like these can lead to economies of scale, wherein skilled individuals from rural areas cannot find the right employment opportunities and small businesses lose out on opportunities to grow. Digitalization, undoubtedly, can provide new growth opportunities and opportunities for better and more diverse occupations in rural areas.

In rural economies, new technology can also help to improve the entrepreneurial business environment. Cross-border e-commerce or commerce through digital platforms has critical in lowering entry barriers for enterprises and SMEs looking to sell in worldwide markets. Similarly, new technologies such as additive manufacturing, for example, 3D printers, have the potential to lessen the need for economies of scale by making small-scale production more cost effective. Small business can use 3D printers to create items and standard parts according to local demand without importing or storing vast quantities of materials from elsewhere, reducing their dependency on imports.

Agri-tech and Financial Literacy:

The government of India has rolled out schemes from education to financial literacy and agri-tech to skill development that cater to nearly 506 million people living in rural regions. It is admirable to see that the central and state governments are united with a vision for the betterment of rural India. Digital literacy and connectivity have strengthened the labour market and provided a platform to educate and become financially independent. Enhanced innovation has helped the rural areas improve their growth prospects and the policy makers support reforms beyond subsidies and sector-specific approaches.

Innovation:

To effectively realize the positive impact of the fourth industrial revolution, a fusion of advances in artificial intelligence, robotics, the internet of things, genetic engineering, quantum computing and more. It is essential to use technology to bridge the gap between skille3d and unskilled labour. As more and more men from rural areas start migrating to urban areas in search of employment opportunities, the brunt of agriculture is being born by women who now have to perform highly labour intensive jobs on their own, resulting in lower productivity levels. They further face a lack of access to land, irrigation, credit, inputs, and markets. Technological advancements can lower trade expenses, allowing rural areas to tap into new markets. Rural goods and services are likely to reach more distant markets at a lesser cost and at faster pace than they are now, innovation to new technologies. Over the last few years, especially, on account of the persisting COVID-19 pandemic, the financial inclusivity in the country has gained pace. Modern Information and Communication Technologies has acted as a catalyst in establishing a platform that extends financial goods and services, even to remote and marginalized regions and individuals, several efforts of the government of India, aims at initiating a direct transfer of benefits

across the country. One of the innovations for Technology enabled Rural Development is Technological Advancement for Rural Areas. This scheme under the sill enhancement education and development program is critical in providing long-term core support to science based voluntary organizations and field institutions in rural and other disadvantaged areas to promote and nurture them as "S & T Incubators" and "Active Field Laboratories" to work and provide technological solutions and effective delivery of technologies for livelihood generation and societal benefits.

Similarly, e-Shram is a platform designed by Ministry of Labour and Employment to benefit unorganized workers who are not member of employee‟s state insurance. Signing up for the shramik yojana and acquiring an e-shram card entitles them too many benefits. The country‟s 177250 gram panchayats have already been linked to national optical fiber net work (NOFN) by June 2022 using existing public sector undertaking fibers and laying new fiber to connect all 250000 panchayats in the near future, thus filling the connectivity gap between gram panchayats and blocks.

Conclusion:

It is the universal assumption that support for the latest technology and innovation for entrepreneurship development is the sine-qua-non for accelerating the overall development of Rural India. Rural India is becoming digitally savvy, with smart phone and internet usage increasing 30 per cent above in the last four to five years. Online classes during the pandemic were a major catalyst for digital adoption amongst rural population because they forced many new users to explore advanced functionalities. There has been a significant decline in the cost of technology access as well. Technologies is streamlining access to FPOs and enabling information sharing and greater transparency. Leveraging local languages and voice messages for two-way communication proved to be major facilitators for increasing engagement. Innovation in digital payments has enabled faster and easier access to cash, particularly in rural areas that have been cash-strapped due to lower penetration of ATMs and banking products. Finally, the most important is the building of trust with farmers so that they can readily adopt new and innovative practices, For this, an effective collaboration among progressive Rural Development, government extension agencies, traditional large and trusted players.

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The Application of Semantic Machine Learning to Cybersecurity Monitoring

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ABSTRACT

Security precautions have been taken in order to preserve both the accessibility and the authenticity of the information included within digital communities. In most cases, information protection methods will restrict persons from accessing, revealing, manipulating, or even erasing facts on both software and hardware technologies. These steps can be used to secure information. According to an assessment that was carried out by industry specialists in the field of information security, new forms of cyberattack continue to surface in all business operations. After all of the data had been analysed, an assessment of the level of risk revealed that although it is not extremely dangerous in the majority of instances, it is extremely dangerous for valuable data, and the severity of those attacks is prolonged. This was discovered despite the fact that the data had been analysed. In order to identify and protect against a wide variety of cyber-threats, several levels of protection have already been put into place. These layers of security primarily make use of a processed data feed or alert in order to disclose both predictable and stochastic behaviour. Cyber assaults have been shown to follow deterministic patterns, which indicate that they are neither random nor unbiased over time. Attacks that have been carried out in the past can be used to estimate the likelihood of attacks in the future. In a general sense, the deterministic approaches can be utilised to provide monitoring that is just somewhat correct.

Keywords : Cyber Security, Network Monitoring, Machine Learning, Cyber Attacks

INTRODUCTION

To raise awareness of growing cyber-threats and new attacks, systems that offer real-time assessment were created. While explaining the concept of a risk system, we introduce a define of software systems that provide real-time visibility into global cyber-attacks risk systems, which provide animated maps that are created from real-time data about attacks on the location. Real-time traffic data is designed to identify the different types of traffic that could be indicative of malicious intent. When it comes to finance, social development, and even our every-day lives, it has become increasingly difficult to deal with communication networks and facts systems. However, the rapid development of the internet offerings and digital communication networks, along with increasing use of records structures, make them vulnerable to one or more kinds of cyber-attacks.

A. Cyber Security

In this context, "cyber protection" is synonymous with "asset protection," which is made up of a variety of tools and strategies designed to defend assets (computers, networks, applications, and statistics) from assault, unauthorised access, change, or destruction. Community safety systems include PC (host) protection systems while PC (host) protection systems include community safety systems.

No firewall, antivirus software, and intrusion detection device is completely essential, but these items have each, at a minimum, a firewall, antivirus software programme, and an intrusion detection gadget (IDS). Increasingly, computing generation engineering statistics, such as security and privacy, are important issues for computer scientists.

B. Cyber Attacks

Intentional use of laptop structures, generation-dependent businesses, and networks are utilised in cyber-attacks. The rise of documents, attachments, and malicious configurations on servers causes websites and applications to be attacked every day. Malicious code is used in an attack as both the attack and the malware are being completed at the same time. Information and identification robbery could jeopardise essential statistics because of it. Precise records about the attacks and beliefs are critical in order to avoid finding the poor results and taking preventative measures. [2] Computer-based attacks, such as denial-of service (DoS) attacks, botnets, man-in-the-middle attacks, phishing, spear phishing attacks, password attacks, malware attacks, brute force attacks, etc, can be detected by a few unique purpose websites like Denial-of-Service (DoS) Attack, Botnets, Man-In-The-Middle Attack, Phishing, Spear Phishing Attacks, Password Attack, Malware Attack, Brute Force Attack.

C. Machine Learning in Cyber Security

Cyber Machine Learning takes on an important role in next-generation cyber security. As the next cyber security products develop, increasingly they incorporate AI and ML technologies. According to educational AI software on huge stores of data from the cyber security, community, or maybe physical facts, the cyber security is intended to get an organization's goal to reveal and avert average behaviour, however, without including a “signature” or sample. Cyber security experts predict that, over time, agencies will integrate learning into all levels of cyber security products. This latest development in deep learning and one-of-a-kind, promising technology has an undeniable impact on the overall network community. Current efforts have included numerous large advancements in numerous networking sub disciplines. In the future, a number of issues will be solved. To begin, the strength of the equipment's relationship to algorithms is a crucial undertaking for software. [3]

II. RELATED WORK

The project entitled “EMBER” presents the open dataset with labelled factors in order to enable successful training of predictive analytics and learning gadget models. Since the dataset contains specific penetration levels for the training of fashions and predictions, the dataset will serve as a fertile environment for malware.

Banin S, Dehghantanha A, Shalaginov A, and Franke K. Highlights the separate survey for malware detection that may include techniques and procedures. To arrive at higher degrees accuracy and predictions, the methods and algorithms described in this work use highly powerful and advanced methods and algorithms. Sixteen - two students, doyen Sahoo, Chenghao Liu, and Steven C.H. Hoi, and Categorize and overview the components of research that attempt to counter various angles of Malicious URL Detection, such as design of functions and collection of policies.

N. Whitton, Crockett, A. Latham, & Proposed Predicting learning patterns in conversational creative tutoring systems by using a fuzziness rating system on a random sample of previousstudents' choices is possible. The publication is available online: B. Sun, S. Chen, J. Wang, H. Chen Described a method called noise-detection that is based on AdaBoost called AdaBoost Boosting through which one can

decorate AdaBoost's robustness (2016).

E. M. El-Alfy, M.M. Awais, and M. Baig. Covered a new method of studying a feed-before ANN with a single hidden layer and a single output neuron. X, Pan, and Y. Luo are renowned performers. a structural dual vector machine proposing to implement K-nearest neighbour installations with a singular vector machine (KNNSTSVM). Instead of calculating the samples based on their beauty scores, the intra-beauty KNN approach ensures that certain weights are given to the samples so that they may help to embellish the structural facts. To speed up the education system, wasteful constraints are eliminated using the inter-eligance KNN technique. [10]

B. Ottersten, D. Aouada, and A. C. Bahnsen, they introduced a fee-sensitive selection tree which includes rules that rely on one of kind examples. Later, people began to use it (Adler et al., 2002; Mayhew et al., 2001; Cleveland et al., 2002; Atighetchi et al., 2002; and Greenstadt et al., 2002.) When using every okay-manner clustering and manual SVM, take advantage of every overlap between skills with the skills you have selected and tested in the MBM machine and studied in the relevant literature. [12]

The flora of F. U., P. Palmieri, A. Castiglione, and A. Santis When both randomness and burstiness of traffic behaviour are present; the classifier's general overall performance is affected. As long as ICS networks remain unaffected, these issues will have no impact on them. The subject of this study is Restricted Boltzmann Machines (RBM), or more specifically, Discriminative RBM (DRBM). The findings unveiled a novel method. This use of a non-labelled approach is comparable to the method applied with MBM, as there are no previous records on the records of individuals who have visited an anomalous site. [13]

III.OBJECTIVE OF THE PRESENT WORK

The ultimate goal of this work is to discover a gadget that detects network anomalies and cyber-attacks with no more infrastructures on the network, which is capable of locating those issues in a very short period of time by utilising data-mining tools without compromising the overall network. Here, the goal of the study is to look into work.

A new set of rules for keeping the Network Security under watch will be suggested by the researcher

Researcher will compare a new set of rules with the existing set of rules to determine how well they perform together.

The next steps are to be completed in order to achieve objectivity

Study activities and alerts in order to establish if they are connected/linked to assaults that are ongoing

Buildings, networks, and applications should be covered.

Discriminate between possible threats that may exploit, acquire, or take advantage of the vulnerabilities for unauthorised entry

Examine the company's information technology to catch actual-time or nearly-real time cyber-attacks, security violations, or breaches, as well as symptoms of anomalous or symptomatic sports.

Provide records and documents.

IV.WORK PLAN AND METHODOLOGY

a) Approach

To perform this task, first UCI machine repository data will be gathered to create the training, validation,

and test sets after which processing will be done. To obtain the matrix of collected data, it will be processed to the various input formats from the different algorithms, and this will result in a dataset where each instance is a row and each feature column is a feature. In order to avoid biased results, the values in the entire matrix will be standardized so that no feature can have greatly exaggerated values relative to other features. In this case, standardization consists of determining each feature's mean and standard deviation, and then subtracting the former from the latter. Additionally, feature selection is implemented in this step, which is aimed at determining the features of relevance for this problem.After this, a machine learning algorithm is used to build a model, which is tested and validated using the training, validation, and test sets. This model can be used in the future to find out what network conditions exist.

b) Methodology

In this system architecture, several modules have been constructed to help fulfill objectives. Data Collection, Data Pre-processing, Model Creation, and, Network State Identification are the modules of the system. In the Data Collection Module, the user decides whether or not the network is normal, anomalous, or unknown. The user can also choose how long they want to collect data and on which device, and they can do this by specifying the IP address of the device to be monitored. The training, validation, and testing sets in the second module, Data Preprocessing, are prepared beforehand. Since in a multi-class algorithm both anomalous and non-anomalous data are used in all sets, the user must specify if the data is to be used with a one-class or multi-class classification algorithm. In addition to providing multiple data files, the user can also give the resulting data set a name.The Model Creation and Performance Measurement module includes a machine learning algorithm for training, saving, and testing a model that is built using the data that is acquired. The user only has to specify which data set matrix (previously created in the Data Pre-processing module) and the desired machine learning algorithm are required, except for the specific machine learning algorithm that been selected

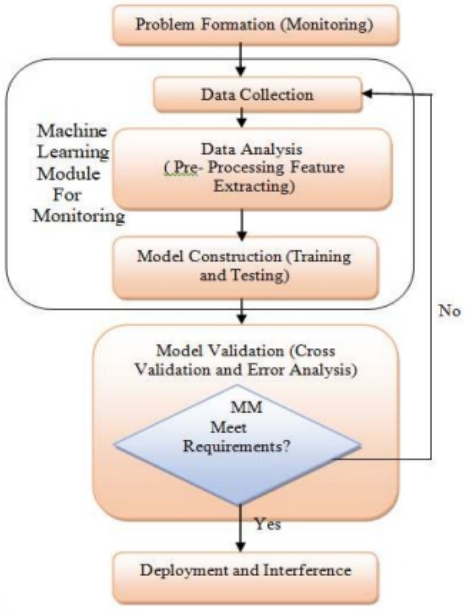

Fig. 1 – Flow Chart

V. TOOLS FOR IMPLEMENTATION

a) Anaconda

Anaconda is commonly used for computational sciences, data science, statistical analysis, and system evaluation. Anaconda 5.0.1 is released on October 1, 2017, in the ultra-modern model. A recently released model 5.0.1 contains a few minor bugs fixes, and includes features such as up-to-date R programming assistance. As with previous versions, all of those capabilities were not included in the authentic 5.0.0 launch. This supervisor includes a Python distribution, a collection of open supply packages, and an environment supervisor. This package deal supervisor also incorporates more than 1,000 R and Python packages.

b) Spyder

An open source Python project known as Spyder provides a powerful medical environment for scientists, engineers, and records analysts. it is a bit of a departure a combination of the development device's advancement optimizing, investigation, development, and monitoring expertise with the programming package's exploration, self-procedural execution, deep look, and brilliant visual results. Additionally, many famous clinical applications are integrated into Spyder, with the option to integrate in more of these via Python integration.

c) SIEM Tool

Additionally, managing the hectic volume of facts gained from pastimes on systems is a significant demanding situation in cyber security. In order to make sense of it, one must derive warning signs of attacks, understand the nature of faults, or supply proof for decision makers. the 'security facts event management' concept was first put forward by Gartner in 2005 (SIEM). Conventional safety tracking machines meet audit and compliance needs, which is why they used it to describe such a machine. On the other hand, as record security has advanced, the needs of the SIEM have also increased.

VI. CONCLUSION AND FUTURE SCOPE

A great number of security monitoring systems are available for use in a system. In actuality, machine learning and network security advancements have benefited one another. A records evaluation process in which a decision feature is based on the network's protection level has a history of issues. Dynamic protection monitoring is an important component of system studying. It is essential to have the latest development trends in mind, in order to ensure the maximum level of system mastery. Truly useful systems are very fruitful when it comes to accumulating masses of facts, and as a result there is a pressing need for screening tools to help find possible threats in the community. Together with supervised classification and clustering, the device learning methods have also proven to be useful for network security. On the other hand, cybersecurity specialists know that community safety monitoring is critical, and they can deduce what initiatives humans, procedures, and mindsets are needed to meet those objectives. Network security monitoring is rapidly increasing in both quantity and difficulty.

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Grid Integration of PV system with Trans-ZSI based AC Load by using Fuzzy Logic Controller

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ABSTRACT

Now-a-days the power generation using renewable energy sources has gained attention. Here the power generation is done by using solar energy. Solar based microgrid can be operated in isolated mode (DC grid) and can be integrated with AC grid. Due to the solar irradiation power cannot be obtained maximum all the time so Maximum Power Point Technique (MPPT) is used for obtaining maximum power from PV array. Here Perturb and Observation MPPT is used. Generally, PI controller is used to control boost converter at DC side and at Inverter at AC grid side. But due to the manual tuning problems in PI controller, here fuzzy controller is proposed. To integrate the PV system to AC grid, Trans-ZSI is usedinstead of boost converter and inverter. It reduces the circuit complexity by eliminating both boost converter and inverter at grid. The system is simulated for fuzzy controller for both cases 1) Boost converter at DC grid side and 2) Trans ZSI at AC grid.

Keywords: Photovoltaic (PV) power system, DC grid, Boost Converter, Fuzzy logic controller (FLC), Trans-ZSI.

INTRODUCTION

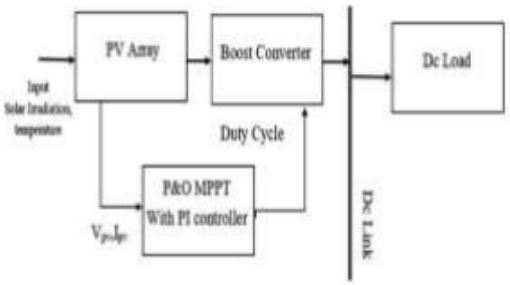
The PV standalone system can be operated as a DC grid or can be integrated to an AC grid using the Inverter circuit. The DC grids are used for the HVDC transmission and AC grids are used for integrating various renewable energy sources.

Due to the partial shading of the PV array MPPT technique is used to obtain the maximum power from the PV array and to give the duty cycle to the boost converter. Generally, Perturb and Observation (P&O) with a PI controller is used. And to integrate the DC grid to the AC grid Inverter operation is done. Tolga Ozer at.el [1] have presented the implementation of the PWM technique to control dc-dc converter. The main drawback of PWM is voltage spikes and electromagnetic interference.

Marif Daula Siddique at.el [16] have proposed new multilevel inverters with less number of switches to obtain a balanced AC output.

Huan-Liang Tsai has developed a generalised photovoltaic model. In this work discussed the modelling of PV arrays and their simulation Bin at. el [14] has developed cyclo converters topologies for industrial applications having medium voltage driversGenerally, a PI controller is used, but tuning of the controller is difficult and takes more time. The proper gains are calculated by using mathematical calculations and the error obtained is also not accurate. And it is not suitable for dynamic systems as the irradiance and loads are variable.

Besides this to integrate PV standalone system into the AC grid a Boost converter and inverter circuit are needed and for both converters controlling techniques are required to provide switching of the circuits. So, to eliminate this complex circuitry, here it is proposed with the trans-ZSI circuit which provides both boost converter and inverter circuit operation.to obtain the efficient operation of the system the PI controller is replaced with a Fuzzy Logic Controller. As the fuzzy logic controller produces the accurate error by using the fuzzy rules and depending upon the fuzzy rules output the desired output can be obtained.Perturb and Observation (P&O) MPPT with a traditional proportional-integral (PI) controller and a suggested non-traditional Fuzzy Logic Controller (FLC) for a PV standalone system operating in DC grid mode are shown in Figs. 1 and 2, respectively.



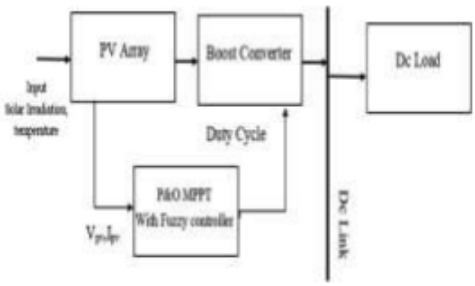


Fig.1: DC Grid with PI Controller Fig. 2: DC Grid with Fuzzy Controller

When the PV standalone system is integrated into the AC grid along with the boost converter and inverter circuit is shown in Fig.3.

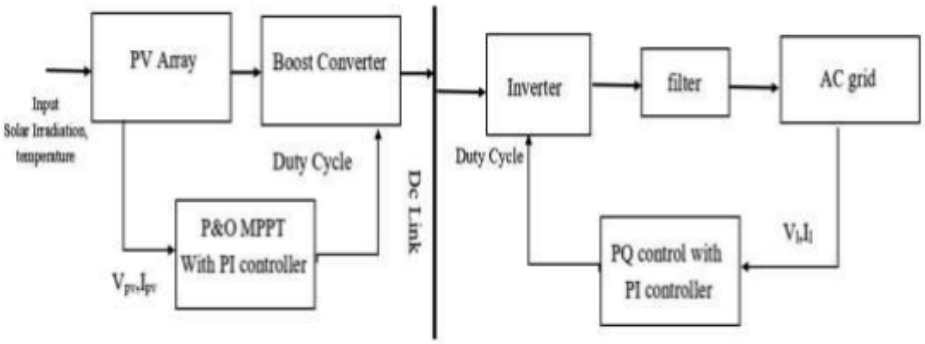


Fig.3: PV System with Boost converter and inverter connected to AC grid

In Fig.3 boost converter is used to step up the voltage to the required voltage and then given to the inverter to convert DC voltage to AC voltage. Because of using the multilevel converter, the switching operations are more and difficult to reduce switching operation and to get smooth operation Trans-ZSI is proposed which is used to operate either as a converter or inverter by providing a suitable control gate signal obtained from the controller. The block diagram of trans-ZSI is shown in Fig.4.

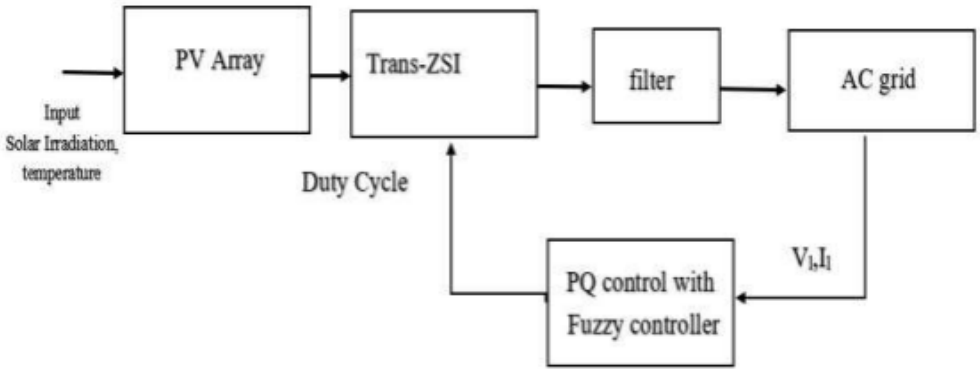


Fig.4: PV System with Trans-ZSI connected to AC grid

2. METHODOLOGY

Here in solar-based renewable energy, a maximum power tracking point is used to obtain the maximum power from the PV array and also to give a gate signal to the Boost converter, to step up the voltage, as the voltage from the PV system is not sufficient to supply the loads. In this method, Perturb and Observation (P&O) MPPT with a fuzzy controller is used. To connect the PV system with the AC grid Trans-ZSI converter is proposed here.

2.1 Z-Source Inverters

When it comes to voltage, ZSI is the buck-boost inverter of choice because of its wide range. When the input DC voltage is not sufficient, the voltage may be increased to the necessary amount by gating two switches on the same leg during the shoot-through By blocking the circuit's return current, diode D is an essential component.When the duty cycle of the circuit's switches is adjusted, as it is with pulse width modulation of Z-source inverters, an increase in the output AC voltage is achieved. The block diagram of trans ZSI is shown in Fig.5.

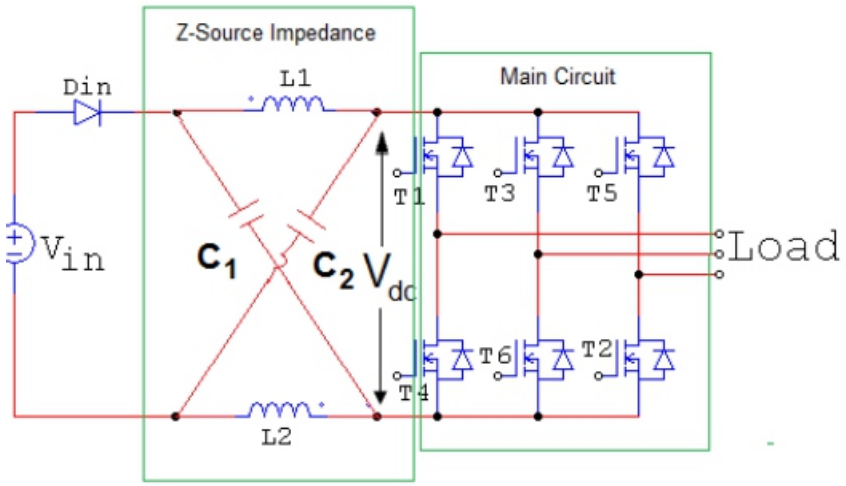


Fig. 5: Z source network

By varying the on-time of the circuit's switches in a sinusoidal pattern, pulse width modulation of Z-source inverters generates the AC voltage boost. The modulation index of the PWM used determines the level of dc voltage boost. Shoot-through is achieved by simultaneously gating the switches,

which creates the condition for the inverter. The voltage may be raised to the necessary level without the need for any extra switches. By utilising the correct gating signals, the shoot-through situation may also be utilised to buck the voltage supplied to the load side, allowing the ZSI to serve as a dual buck/boost device.

2.2 Fuzzy Logic System:

A block diagram fuzzy logic controller is shown in Fig. 6. It contains the inputs, fuzzification, rule base, defuzzification and output are all known to the knowledge-based module. The two inputs to the system are error and change in error. The output is a controlled action depending upon the fuzzy rules. The shape of two inputs is a triangular type of membership and the output is the triangular type with a range of membership functions [NB,NS, Z, PS, PB].

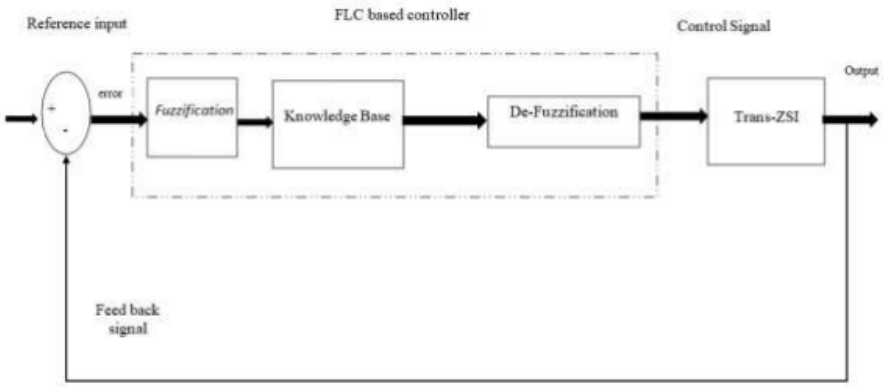


Fig.6: Simple Fuzzy Logic System

3. RESULTS & DISCUSSION

Here the PV system is simulated for the DC loads and also the PV system is connected to the AC grid using the Trans-ZSI. Perturb and Observation(P&O) MPPT Fuzzy controller is used for providing gate signals. The below Simulink diagram represents a PVsystem with a DC grid as shown in Fig.7.

Here the input to the PV array is solar irradiation and temperature. In this work solar irradiation is given as 1000W/m2, and temperature 250C. The performance of the system is analysed with P&O MPPT using a PI controller and Fuzzy Logic Controller (FLC)

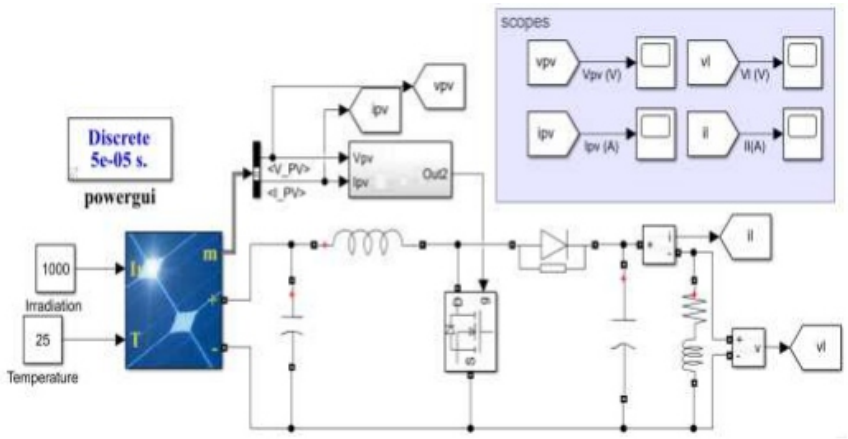


Fig. 7: Simulation and modelling of MPPT-based PV system without Trans-ZSI The obtained output voltage of the PV system for PI & Fuzzy controller are shown in Fig.8,9 respectively DC load voltages are shown in Fig.10,11.

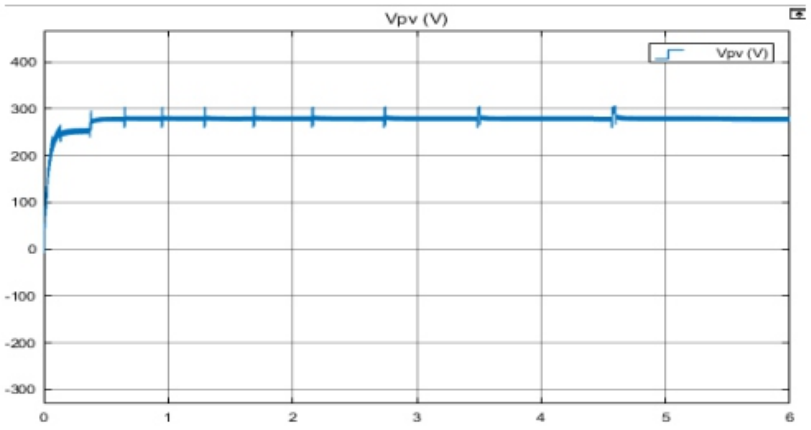


Fig. 8: Output voltage of PV array by using the PI controller

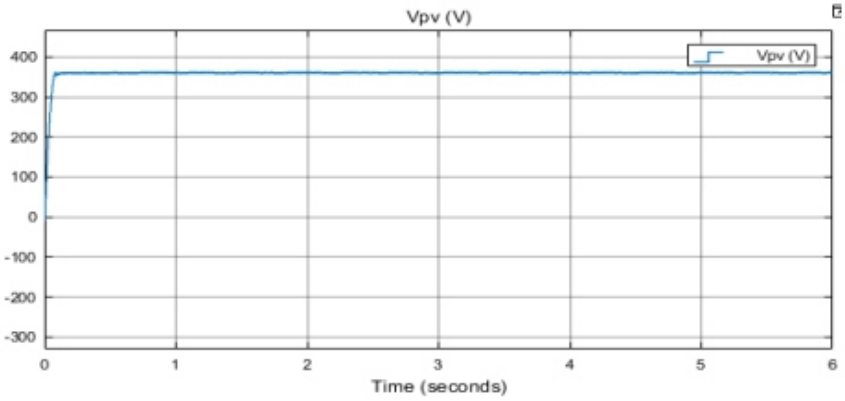


Fig. 9: Output voltage of PV array by using Fuzzy controller

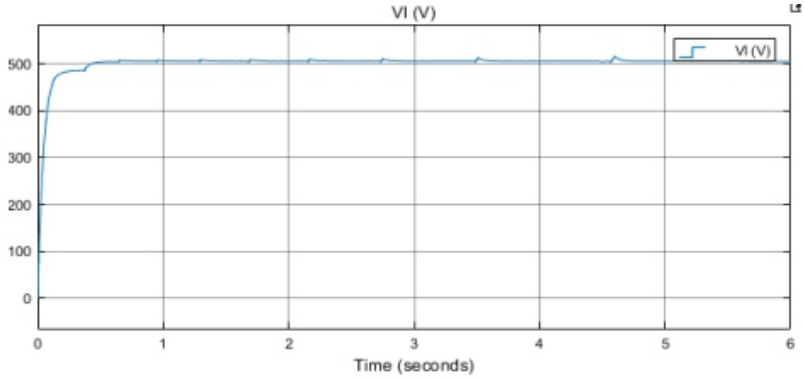


Fig.10: Dc load voltage by using PI Controller

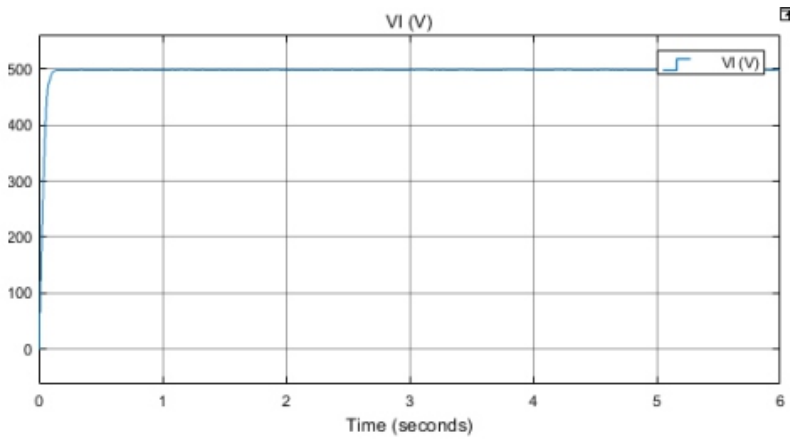


Fig. 11: Dc load voltage by using Fuzzy Controller

By observing fig.8 Output voltage with the PI controller has more ripples and the magnitude of voltage is also less. Which reduces efficiency. And by observing fig.9 Output voltage of the PV system with a Fuzzy Logic Controller is smooth and the ripples are eliminated and the magnitude of voltage is also high compared with the PI controller.The Simulink diagram of the PV system connected to the AC grid using the TransZSI is shown in Fig.12. Here the controlling of gate signals of the trans-ZSI is provided by using a Fuzzy logic controller.

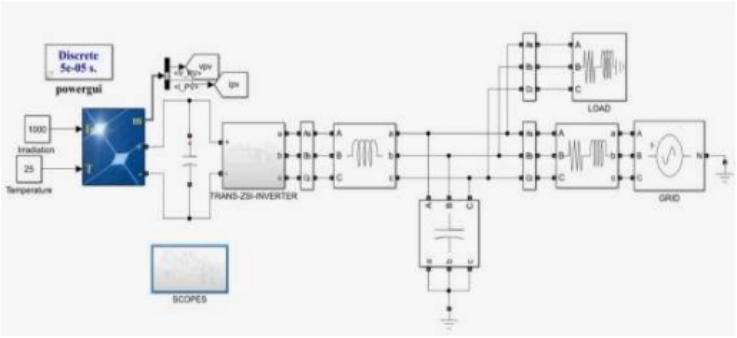


Fig. 12: Simulation and modelling of PV-system to Grid connected to using Trans-ZSI converter with fuzzy controller

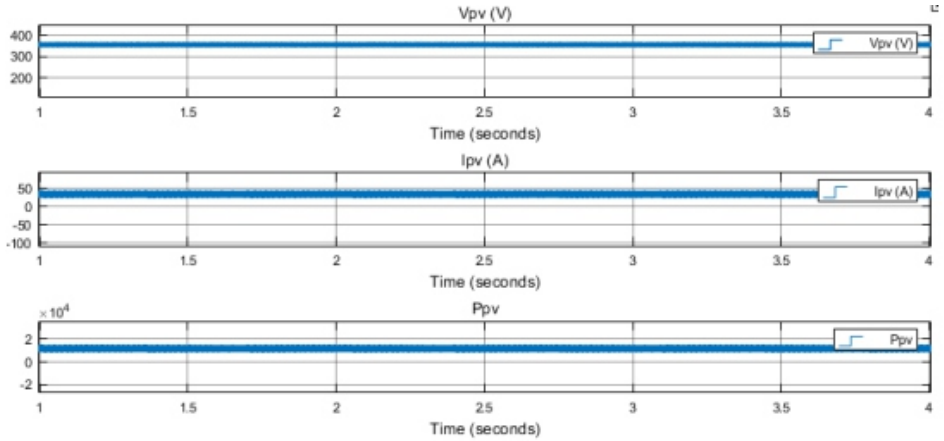


Fig.13 PV side voltage, current & power

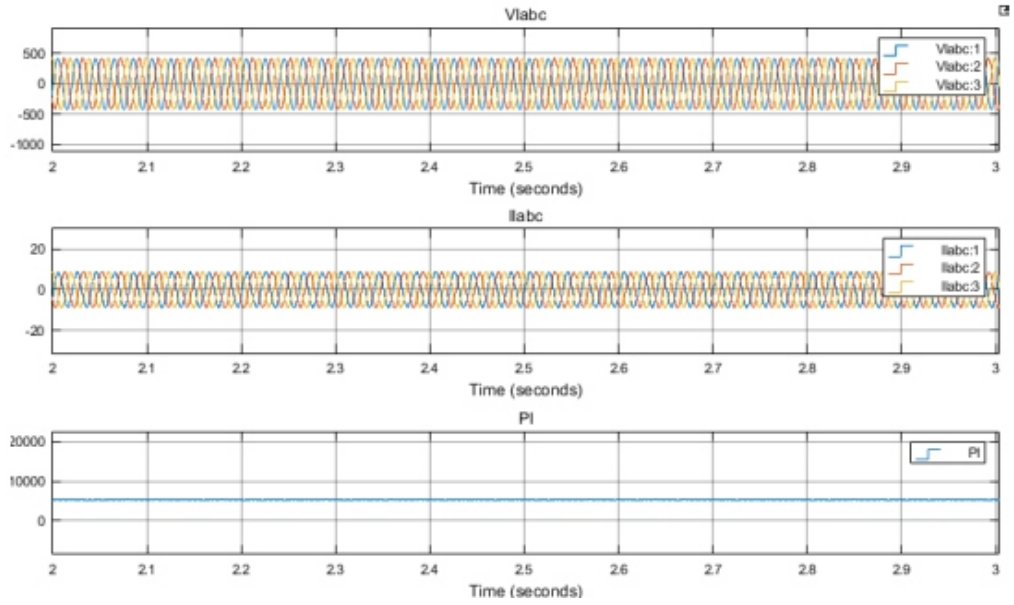


Fig.14 Load side voltage, current & power

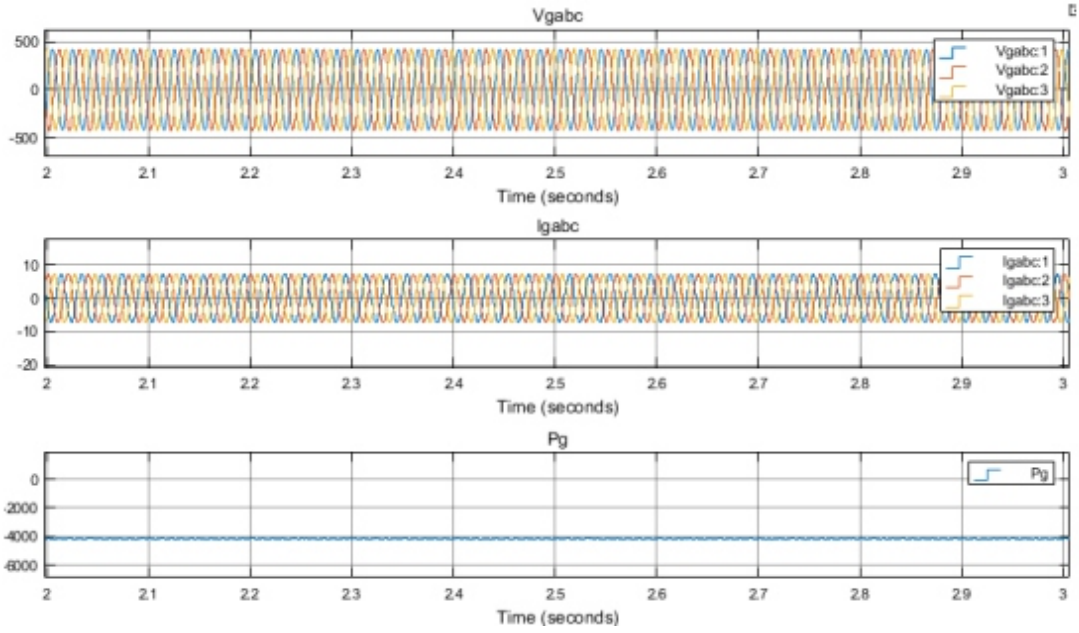


Fig. 15: 3-phase output waveforms at trans-ZSI by using Fuzzy controllers.

The integration of the PV system with the AC grid is done by using Trans- ZSI with fuzzy logic controller (FLC) is implemented. The results obtained are shown in Fig.13 and 14,15.

From Fig.14,15 it is observed that the output obtained from the system is balanced. The output of the PV system is 350V DC and the output voltage of Trans-ZSI is 440V and the grid side voltage is also 440V. By this, it is concluded that irrespective of the PV system output voltage the voltage at the grid and Trans-ZSI is maintained constant.

IV. CONCLUSION

The proposed Trans-ZSI with Fuzzy Logic Controller (FLC) has several advantages, the complexity of the circuit has been reduced by Eliminating the inverter circuit and the boost converter. It has also eliminated the controlling techniques used for switching the circuits, as only a Trans-ZSI converter is used.

The problems of using a PI controller are eliminated such as tuning the controller, and selecting the proper gain values consumes more time and mathematical calculations, the error obtained is also not accurate, so the output is also not accurate. So, to overcome this problem Fuzzy Logic Controller (FLC) is used, it is the auto-tuning controller and gives the accurate error depending upon the fuzzy rules, and so that the desired output is obtained.Thus, using a Fuzzy Logic Controller (FLC) with trans-ZSI makes the circuit a simple, cheaper and efficient operating system.

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VOLTAGE SAG MITIGATION IN ON-GRID HYBRID POWER SYSTEM USING BATTERY AND SMES BASED MULTI-LEVEL DYNAMIC VOLTAGE RESTORER

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ABSTRACT

In recent years, renewable energy sources have increased in popularity and deployment throughout the world. While fossil fuels have long been relied upon, they too will eventually run out and need to be replaced. Here's where the infinite supply of renewable energy (wind, solar, etc.) comes in [1]. When renewable energy sources are integrated into the power grid, their unpredictable availability causes power quality issues. Voltage fluctuations, spikes, and distortion in frequency may all cause headaches for power companies and their clients. Better power quality standards and proper loading per the guidelines [2] are essential for sensitive and costly equipment including computers, relays, sensors, & optical devices. One of the most dependable Distributed Flexible AC Transmission Devices (D-FACTS) for fixing power quality issues is the Dynamic Voltage Restorer (DVR). It regulates the voltage at the load and injects power further into the supply line to ensure the voltage profile is within acceptable limits [2]. This study employs a Multi-Level Dynamic Voltage Restorer (MDVR) to avoid voltage drops under a wide range of situations. For the purpose of evaluating the efficiency of the proposed system, computations were performed in MATLAB/SIMULINK.

Keywords: Dynamic Voltage Restorer (DVR), Super Magnetic Energy Source (SMES), Battery Energy Source (BES), Hybrid Power System.

INTRODUCTION

Electricity is essential for survival and is a ubiquitous commodity in the world. Fossil fuels are mainly used for power generation. But renewable energy sources are the solution due to disadvantages like pollution and extinction problems. With population growth, renewable energy can sustain our energy needs. The Earth constantly cycles and continuously replenishes renewable energy, making renewable energy inexhaustible and promising. Many believe this benefit and due to this electricity generation using renewables has tripled between 2000 and 2022. Power quality issues are exacerbated by the varying availability of renewable energy.

According to IEEE (Institute of Electrical and Electronics Engineers), the definition of power quality: is "Powering and grounding of sensitive electronic equipment in a suitable manner". As a service to the client, it is defined as good, continuous power that does not affect the performance of equipment and

machinery. For the manufacturer, the quality and tolerance of the voltage and current parameters mean that the products are within the limits of the parameters that he has manufactured and tested. It's the restrictions that keep a system functioning as designed yet don't compromise its performance or user expectations.

As defined by the IEEE, voltage sag is a momentary dip in electrical voltage. There is a wide range of potential drops from 10% to 90% of the standard 50 Hz Root Mean Square (RMS) voltage. Drop in voltage lasting more than 8 milliseconds but less than 1 min, or longer over half a 50 Hz power cycle. Voltage fluctuations in the RMS value may be caused by interference, growth, or attenuation. An interruption occurs when the voltage on one or even more phases drops to 90% or less of its nominal value. Temporary disruptions may last anywhere from 8 milliseconds to 3 seconds, while those lasting from 3 seconds to 1 minute are considered to be medium-term disruptions and long-term disruptions last more than 1 minute. [3]

Sag is a momentary dip in voltage, while swell occurs when it rises over 110% of nominal. RMS voltage is less than 110% of nominal for less than 1 minute during a voltage surge. A long-term overvoltage condition occurs when the RMS voltage is more than 110% nominal for longer than 1 minute. The voltage propagation noise, voltage, and transistor characteristics are all examples of problems with power quality, phaseto-phase voltage imbalance, and disturbances in the form of voltage swings, harmonics and electrical hum.[4]

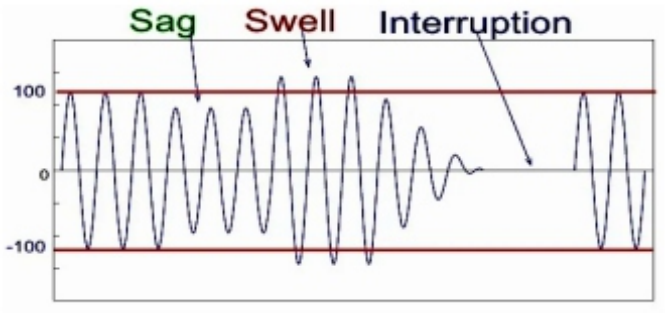


Figure 1. Voltage fluctuations

In this work, Voltage sags are discussed, but other problems with power quality aren't ignored. Power quality issues are interrelated and require a whole plant approach to address power quality issues. Sometimes solving one problem makes another problem worse. When you take in the whole picture, you may begin to address not only the root problem but any contributing factors. In the case of electricity meters, a drop in voltage mostly on the utility side might be caused either by human activity or by natural causes. The switching function is the most often occurring artificial event. Lightning, high winds, falling trees onto power lines, maintenance workers digging up underground wires, squirrels, rodents, failed equipment, and traffic accidents are the most prevalent causes of outages.

In recent years, hybrid solar Photo-Voltaic (PV) and wind-generating systems have emerged as very competitive alternatives, particularly for On-Grid use. Since the shortcomings of one system may be compensated for by the strengths of the other, combining solar and wind can give improved dependability, and their hybrid systems are cheaper to run. Hybrid solar-wind power systems have the

potential to increase the efficiency and dependability of renewable energy production on a large scale. Solar power plants generate electricity from sunlight or concentrated solar power. This study focuses on the photoelectric variety. Numerous books and articles [5-8] provide in-depth explanations of the different PV techniques, physics, and basics. Karthi [9] found that the viability of reproductive cells was only 30% 10 years ago, 40% currently, and 50% probable in the near future. According to reference [10], C cell efficiency is 26%, but multi-junction composite cell efficiency is better than 45% (48.2% in the lab). The quantity of incoming radiation is a primary factor in determining the output of PV modules. Increases in light intensity led to higher photocurrent and lower open-circuit voltage [11]. Any solar cell will lose efficiency as its temperature rises because of the inhomogeneity of the temperature distribution inside the cell [12]. Distributing solar energy over various regions allows for more precise regulation of solar power production [13]. Subsidizing the usage of these technologies by significantly reducing prices or regulations may provide considerable returns due to the high price of electricity generated by solar PV and Concentrated Solar (CSP) plants. [14]

According to the Global Wind Report (2022), yearly market growth of roughly 10% has brought the market size up to 837 GW, with total market growth of about 23% [15]. Both [16] and [17] provide a thorough explanation of wind energy. In the wind power industry, Wind Turbines (WT) may be either Horizontal-Axis Wind Turbines (HAWT) or Vertical-Axis Wind Turbines (VAWT). 59% of the total possible wind power can be extracted with maximum efficiency [18]. Both grid-connected and self-contained hybrid solar-wind systems exist. Many scholars throughout the globe have undertaken literature evaluations for hybrid grid connected and stand-alone solar PV and wind generation, presenting many problems and suggesting some potential solutions. Because of the unique characteristics of solar PV and wind hybrid energy systems, optimization methods play a significant role in maximising their potential.

For the purpose of designing hybrid renewable energy systems that are both technologically and economically viable, several optimization techniques have been developed, including graphical construction methods [19], linear programming [20] [21], and probabilistic approaches [22]. The optimal scaling of renewable hybrid energy systems including energy storage components for both standalone and On-gridconnected systems was examined by Luna-Rubio et al. [23]. The authors briefly explain these indicators and the various quantitative approaches. Both [24], which discusses the best practices for controlling hybrid renewable energy systems, and [25], which focus on optimising such systems with an eye on the wind and solar photovoltaic technologies, provide useful overviews of the field. On-Grid-connected and standalone systems are also discussed in [24] and [25].

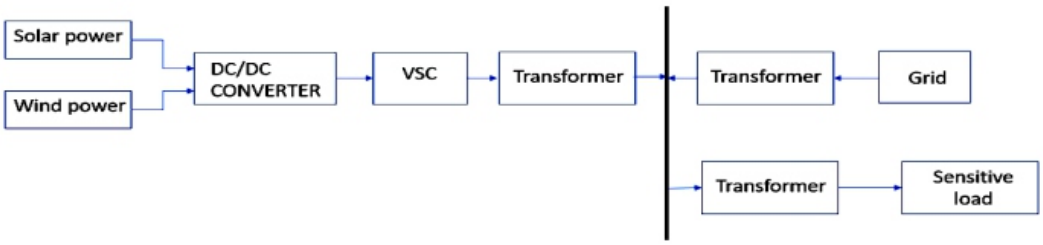


Figure 2.On-Grid Hybrid power system

Due to their intrinsic properties and the constantly lowering investment prices in recent years [26], [27], [28], solar and wind energy sources are the primary sources of hybrid power systems. However, electrical supply from both these sources may be unreliable and unpredictable, so there is a need to have a grid connection and a schematic diagram is shown above. Some of the advantages are Uninterrupted power supply, Increased reliability, Low life-cycle costs, Optimization of the use of renewable energy sources, Correct load management and Environment-friendly.

The main points of this work are summarized below:
(a) To maintain a steady voltage level throughout the load and a suitable voltage profile.
(b) Maintaining a Total Harmonic Distortion (THD) value of less than 5% by reducing power quality problems.
(c) Using MATLAB/SIMULINK under different conditions to apply and analyse the proposed model with and without MDVR with BES and SMES-based energy sources.

LITERATURE REVIEW OF MDVR

DVR is a series-connected solid-state device that injects voltage into the line to maintain a constant load-side voltage. It is usually placed between the supply and critical loads at the Point of Common Coupling(PCC) in the distribution system. Along with voltage sag and swell compensation, DVR is used for line voltage harmonics compensation, transient reduction in voltage, and current fault limits. DVR is one of the power quality control devices. DVR consists of an injection/booster transformer,harmonic filter, Voltage Source Converter (VSC),and energy storage. Transformers are used to voltage and control transistors from primary to secondary.

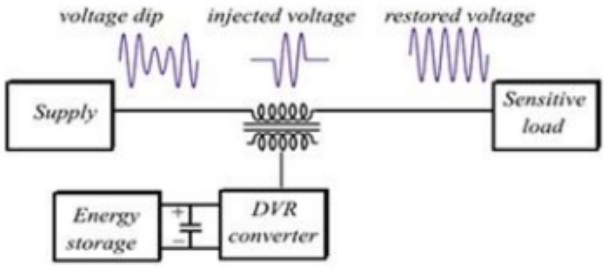


Figure 3. Structure of DVR

The transformer connects the DVR to the PCC. The load-side voltage may be maintained by injecting voltage into the line, as done by DVR. Installing it between the source and major loads, at the PCC, is the norm. Furthermore, a DVR may be used to isolate from the system. The harmonic voltage content generated by the VSC is kept low by using harmonic filters. A VSC is a power electronic system that uses a storage system and switching devices to produce sinusoidal voltages at the desired frequency, amplitude, and phase angle. Temporarily altering the supply voltage or generating a portion of the necessary supply voltage are two uses of VSC in DVR applications. This topology may be used on either a 2-level or 3-level basis, as needed.

Gate Turn-off Thyristors (GTOs) and Insulated Gate Bipolar Transistors (IGBTs) are the two most common types of switching devices. There are advantages and disadvantages to each variety. The IGBT is the most recent compact device with improved performance and reliability, enabling VSC with much higher power ratings to be built. So that the DVR can control a wider range of voltage dips than previous

using conventional equipment because of the advanced converter features with IGBT. There are two primary applications for DC charging circuits. The first application allows the power source to be charged after a sag compensation stage. The second application aids in maintaining the normal DC link voltage. Power is supplied to VSC via a DC link by storage devices for injection voltage generation. Various types of energy storage devices can be implemented such as SMES, BES and Capacitors.

The DVR injects a variable regulated voltage to the load that is created by forced conversion and is converted in series to the load voltage by the injection transformer. To eliminate the negative impacts of line faults, the amplitudes of the three injection level voltages for the Load Voltage (VL) are calculated. Any voltage shift caused by an AC line disturbance is adjusted by the voltage generated by the converter and injected into the medium voltage level by the injection transformer. [2], [3] describe detailed DVR structure, control, and compensation algorithms There are three operation modes of DVR namely Protection mode, Standby mode In this work the mainly focussed on injection mode.

DVR architectures are broken down by inverter type for an in-depth look at all the possibilities. DVR makes use of voltage source inverters with three phases and six switches. The power quality issue cannot be fixed by simply adjusting the voltage drop/rise of the three-phase Sinusoidal Pulse Width Modulation (SPWM) system. A more sophisticated VSC might think about using a split capacitor inverter to minimizevoltage drop. Both of these inverters generate an unbalanced voltage with the aim of lowering sag, but their output is capped at a certain level. H-Bridge Inverter simple DVR is what we need to fix this. The SPWM method or space vector PWM is utilized by this Three-phase Quarter-Inverter. Neither one can mitigate voltage fluctuations that occur for reasons other than balance. Instead, a split capacitor inverter is used. There is a problem with all three-phase six-switch inverters in that the inverter's output voltage is less than the input voltage. An H-bridge inverter, which has two switches with separate output voltages, can be employed where all phases are considered, and switches function autonomously. The following are some of the benefits of using a multi-level converter for DVR instead of a single-level converter:

(a) Quality of Sinusoidal Waveform: There is less dv/dt stress in the system and the voltage produced by multi-level converters is more stable.
(b) Input Current: Input current distortion is minimal in Multi-Level Converters.
(c) Switching frequency: High switching frequency and low switching frequency PWM are both viable options for implementing multi-level converters. Effectiveness is improved by taking measures to reduce switching losses.

ON-GRID HYBRID POWER SYSTEM WITH MDVR

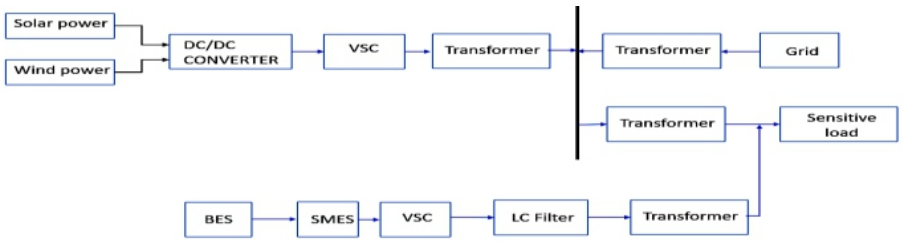


Figure 4. On-Grid Hybrid power system with MDVR

In this work, an On-Grid Hybrid Power System comprised of Wind and Solar energy with an MDVR based on BES and SMES storage system is analysed. The functionality of DVR is discussed above.

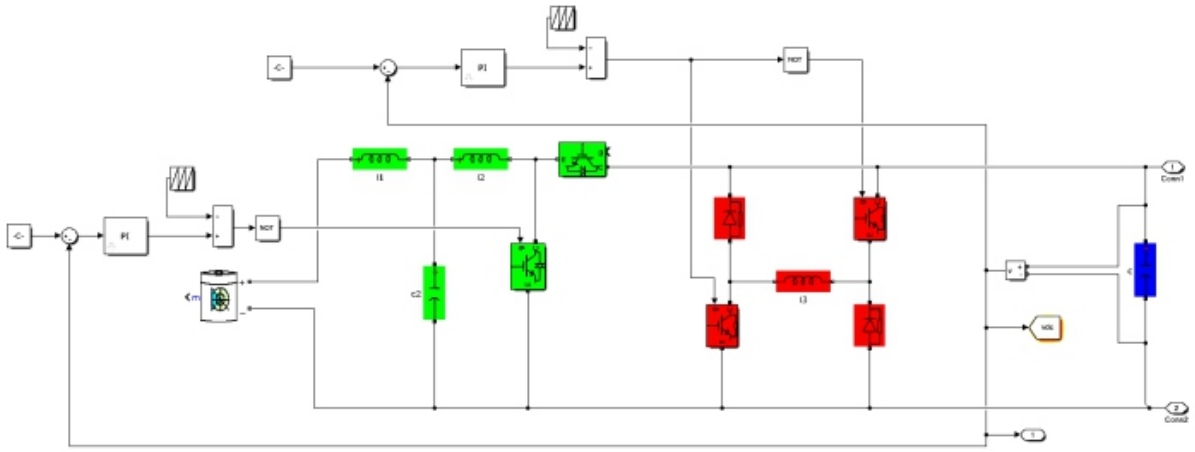


Figure 5. BES and SMES-based Energy Systems

A SMES system uses cryogenics to lower the stored energy far below the superconducting critical temperature. Once a superconducting coil is charged, the current does not leak and the magnetic energy can be retained indefinitely. By discharging the coil, the stored energy is released into the power grid. An inverter/rectifier is a component of power conditioning systems that changes Direct Current (DC) to Alternating Current (AC). The power loss of 3%-5% in both directions is attributable to the inverter/rectifier. When compared to conventional energy storage systems, SMES energy storage suffers from reduced waste. A round-trip efficiency of 95% or more is common for SMES systems. Short-term energy storage is the primary application for SMES at this time due to the high cost of superconducting wire and the high energy cost of cooling it. Depending on the State of Charge (SoC) and budgetary constraints, either a Lithium-Ion or Nickel-Cadmium battery system can be utilized. The system can be effectively utilized due to the ease with which it can be controlled.

Control mechanisms used to provide appropriate firing signals for the MDVR include park transformations and PI controllers. In this system, the load voltage is taken as the reference of the control system. The voltage level to be injected by the MDVR can be the frame voltage of the reference voltage. The abc-frame is converted to αβ-frame by connecting the load voltage to the transformation block. The reference voltage generates the gate pulse controlled by calculating the voltage deviations between the load voltage and the dq-axis by equalizing the load voltage and the reference voltage, which injects the required voltage across the PCC, which can be ramped or ramped down using PWM.

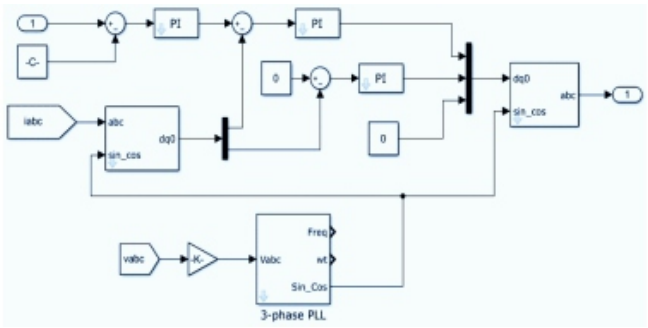


Figure 6. Control system

SIMULATION BLOCK DIAGRAM AND RESULTS

To test the performance of the proposed On-Grid Hybrid Power System using BES and SMES-based MDVR as shown in the above figure is exhibited in MATLAB/SIMULINK for a time period of 0.12 sec under 3 cases as below.

(a) Normal condition
(b) LG fault condition
(c) LLLG fault condition

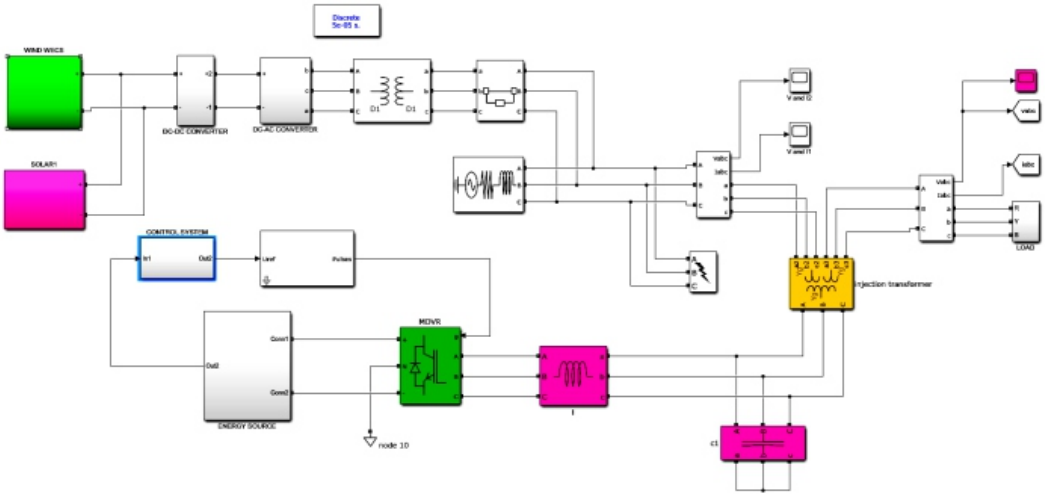


Figure 7. Simulation diagram for the proposed system

(a). Normal condition:

Every power system will experience the starting distortion for very few cycles and we can observe distortions up to 0.08sec. We can observe the THD values for each phase varies like R- 8.15%, Y-12.34%,and B- 4.62%. Using MDVR, we observe constant load voltage and THD values for each phase will be like R- 3.30%, Y-1.51%, and B- 3.47%

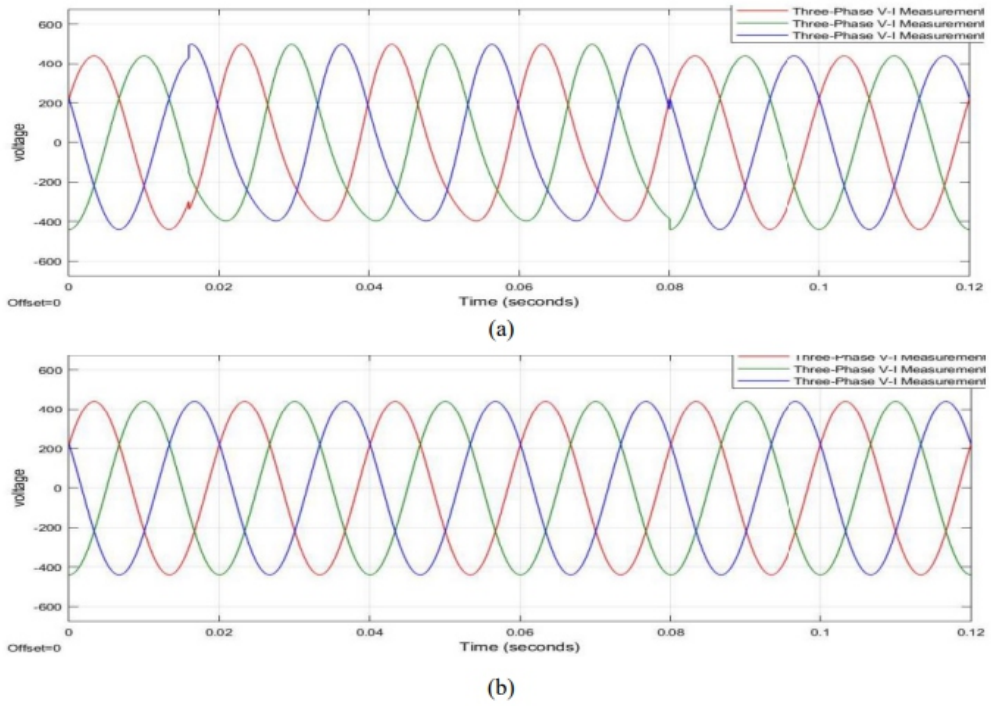
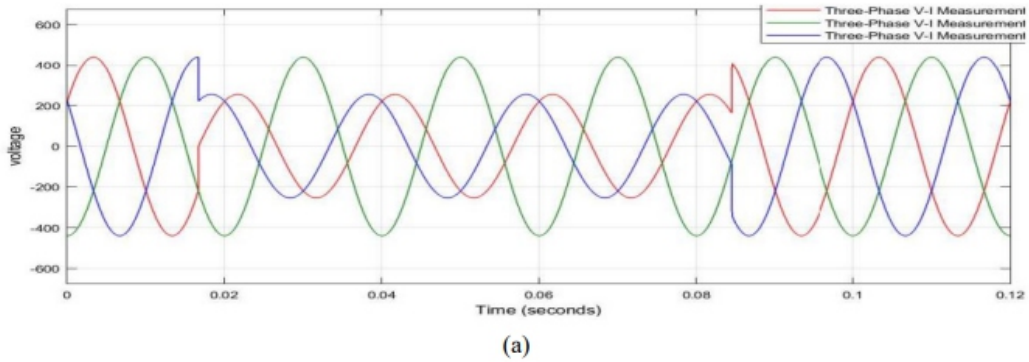
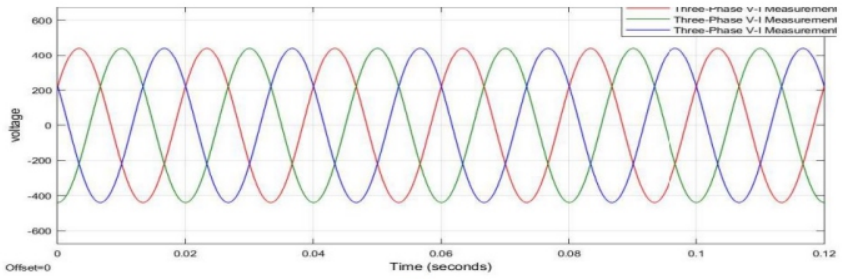


Figure 8. Simulation results under Normal conditions (a) without MDVR (b) with MDVR

(b). LG fault condition

LG faults are the most common, and almost 60-70% of faults are this type. It makes the conductor make a contact with the earth or ground. These faults are called unbalanced faults since the impedance values of each phase will be different and the current flow in each phase will be different. An LG fault is inserted in the system from 0.016sec to 0.0833sec and we can observe the distortions in the sinusoidal waveforms. We can observe the THD values for each phase varies like R- 14.57%, Y- 0.86%, and B- 14.23%. Using MDVR, we can observe constant load voltage and THD values for each phase will be like R- 3.85%, Y- 3.51%, and B- 1.57%.



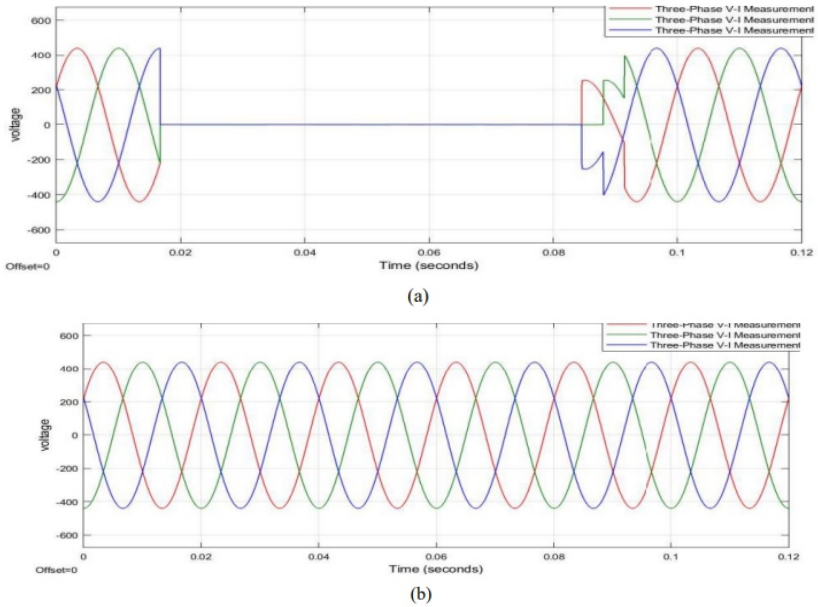


(b)

Figure 9. Simulation results under LG fault conditions (a) without MDVR (b) with MDVR

©. LLLG fault condition:

If an LLLG fault occurs in a system, then the whole system gets disturbed and the complete voltage level almost becomes zero. An LLLG fault is inserted in the system from 0.016sec to 0.0833sec and we can observe the distortions in the sinusoidal waveforms. We can observe the THD values for each phase varies like R- 91.33%, Y- 115.62%, and B- 102.69%, and with MDVR we got good results. Using MDVR, we can observe constant load voltage and THD values for each phase will be like R- 3.58%, Y- 3.15% and B- 1.57%.



(a)

(b)

Figure 10. Simulation results under LLLG fault conditions (a) without MDVR (b) with MDVR

COMPARISON OF THD VALUES WITHOUT AND WITH MDVR

S.NO	CONDITION	THD AT SOURCE VOLTAGE% (WITHOUT MDVR) In each phase	THD AT LOAD VOLTAGE% (WITH MDVR) In each phase
1	NORMAL CONDITON	R: 8.15	R: 3.30
		Y:12.34	Y: 1.51
		B: 4.62	B: 3.47
2	LG FAULT CONDITION	R: 14.57	R: 3.85
		Y: 0.86	Y: 3.15
		B: 14.23	B: 1.57
3	LLLG FAULT CONDITION	R: 91.33	R: 3.58
		Y: 115.62	Y: 3.15
		B: 102.59	B: 1.57

CONCLUSION

This work analysed the voltage sag mitigation for sensitive loads for an On-Grid Hybrid Power System consisting of Solar and Wind power using BES and SMES-based MDVR. This methodology maintained a stable voltage profile and THD values below 5% against normal and fault conditions. Control and operation of BES and SMES equipment are implemented by evaluating voltage values at the PCC and SoC levels. The effectiveness of this methodology system was evaluated by using MATLAB/SIMULINK and good results were observed.

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