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RESEARCH ARTICLE OPEN ACCESS

SHORT CIRCUIT ANALYSIS BY USING MI-POWER

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ABSTRACT:
This paper describe the Short Circuit Analysis for finding the maximum fault current for the enhancement of power system by using Mi-Power. In this paper we solve the LLG fault (Line to Line Ground fault) for the undertaking circuit. This circuit has 10 bus, 3 single phase transformer, 3 single phase generator and 4 load is connected to the different buses, this system is used for converting the11KV to 132 KV. During this condition very high current flow through the system which damage the equipment. It also causes the interruption in the supply provided to the customers. Initially load flow analysis is done to obtain the power flow in the complete system which id followed by short circuit studies.[1] In this paper short circuit studies done on the system which gives us the maximum fault current and fault MVA rating which helps in relay setting, co-ordination and setting up the overall protection system.

2) INTODUCTION:

A short circuit is an abnormal connection between two nodes of an electric circuit intended to be at different voltages. This results in an excessive electric current/over current limited only by the Thevenin equivalent resistance of the rest of the network and potentially causes circuit damage, overheating, fire or explosion.[4]
Short circuit studies is done for calculating the withstanding capability of the switchgears like fuse, circuit breaker during the normal operation (load flow) and abnormal operation (fault conditions)
MiPower software is used for performing this study. MiPower is a highly interactive, user-friendly windows based Power system analysis package. Short circuit studies, transient analysis can be done with very high accuracy and tolerance. We will use this software to design the system and then we will simulate LLG fault.[5] We chose the three phase to ground fault for our studies as this fault is the most severe among the faults and provides the worst case for the calculation of the circuit breaker ratings. When a fault occurs in the system very high level of current flows in the system making it very dangerous for the system and if adequate protection is not taken at correct time then the results will severe both for the system and the customers**.** Symmetrical Faults or Three Phase to Ground Fault, refers to those conditions when all the three phases of the system are grounded at the same time.[2]
These types of faults are mainly caused due to insulation failure and lightning stroke. Though symmetrical faults are rare, it leads to most severe fault current to flow in the system and may cause heavy damages to equipment. Therefore, short circuit analysis is performed to protect the system from any damage and limit the flow of current in the system. Short circuit analysis is done to determine the proper choice of protective devices, select efficient interrupting equipment and verify the adequacy of the existing interrupting equipment.[6]

3) Theory:

In double line to ground fault two lines come in contact with the ground. Let us suppose a double line to ground (LLG) fault on phases 'b' and 'c' through an impedance Z_f on an unloaded single phase generator.[5] The terminal conditions at the fault point are:

$$V_b = V_C = Z_f I_f = Z_f(I_b + I_c) \quad \ldots\ldots\ldots 1$$

$$I_a = I_{a1} + I_{a2} + I_{a0} = 0 \quad \ldots\ldots\ldots 2$$

From the above equation and with the help of boundary condition we can determine the value of V_b & V_c

$$V_b = V_{a0} + a^2 V_{a1} + a V_{a2}$$

$$V_c = V_{a0} + a V_{a1} + a^2 V_{a2}$$

Since $V_b = V_c$ Therefore we can write $V_{a1} = V_{a2}$
Substituting this value in equation 1 then we get

$$V_b = Z_f(I_{a0} + a^2 I_{a1} + a I_{a2} + (I_{a0} + a I_{a1} + a^2 I_{a2}) \quad \ldots 3$$

$$V_b = Z_f(2I_{a0} + (a^2 + a)(I_{a1} + I_{a2})) \quad \ldots\ldots\ldots 4$$

$$V_b = Z_f(2I_{a0} - (I_{a1} + I_{a2}) \quad \ldots\ldots\ldots 5$$

We know that $1+a+a^2 = 0$ &

$$I_a = I_{a1}+I_{a2}+I_{a0} = 0$$

Hence $V_b = 3 Z_f I_{a0}$

On further substituting the value of V_b the we get
$3Z_f I_{a0} = V_{a0} + (a^2 + a)V_{a1}$……………………..6
$3Z_f I_{a0} = V_{a0} - V_{a1}$…………………………...….7

Similarly the current is:

$$I_{a0} = -\frac{E_a - Z_1 I_{a1}}{(Z_0 + 3Z_f)}.$$

And the final equation becomes:

$$I_{a1} = \frac{E_a}{Z_1 + \frac{Z_2(Z_0 + 3Z_f)}{(Z_0 + Z_2 + 3Z_f)}}$$

4) CASE STUDY:

The system we considered for our analysis is a 11KV to 132 KV system. This power system has 10 buses whose basic single line diagram is situated below In it we take the base value 100 MVA and all other information is mention below:

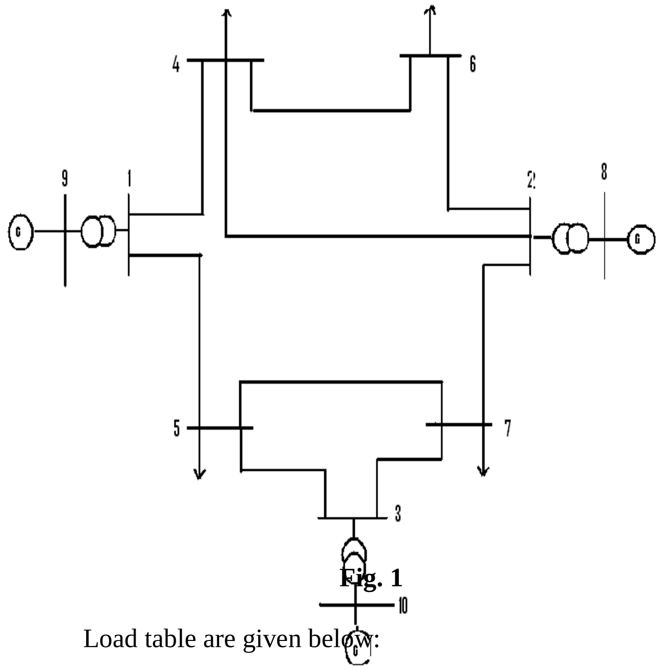

Fig. 1

Load table are given below:

S.No	Bus No.	Load (MW)	Load (M-VAR)
1.	4	25	15
2.	5	20	10
3.	6	45	15
4	7	40	05

S. No	Bus Code	Positive Sequence		Zero Sequence	
		Impedance (R+JX)	Line charging (B/2)	Impedance (R+JX)	Line charging (B/2)
1.	1 - 4	2.45 + 0.001	0.001	1.45 + 0.001	0.002
2.	1 - 5	1.46 + 0.002	0.01	2.4 + 0.01	0.45
3.	4 - 2	1.0 + 0.002	0.010	1.020 + 0.5	0.43
4	4 – 6	1.42+ 0.002	0.10	2.42+ 0.015	0.04
5.	6 - 2	2.45 + 0.001	0.20	2.45 + 0.001	0.5
6	2 - 7	1.46 + 0.001	0.02	0.46 + 0.01	0.34
7	7 – 5	1.42 + 0.002	0.11	2.42 + 0.011	0.43
8	7 – 3	1.002 + 0.02	0.11	1.002 + 0.02	0.82
9	5 - 3	2.45 + 0.001	0.22	0.45 + 0.26	0.73

Table 1.1

Impedance & line charging details are given

Table 1.2

Generator Details:
G1 = G2 = 100 MVA, 11 kV with X'd = 10 %
Transformer details
T1 = T2 = 11/110 kV, 100 MVA, leakage reactance = x = 5 %
** All impedances are on 100 MVA base

5) SIMULATION & RESULT:

The following figure shows the results of simulation when asymmetrical double line to ground fault is applied to the Bus 04 which is connected to a system. The result after simulation is indicated in the form of fault current in Amperes. These fault currents will help us to choose the ratings of the circuit breakers.[5]

Circuit breaker should be chosen such that they satisfy the making current, breaking current and thermal short circuit duty of the system. Making current is the maximum instantaneous fault current magnitude is seen by the circuit breaker during the fault. It is indicated in (KA).Breaking current or asymmetrical break current is the current at the instant of break of circuit breaker. It is generally equal to opening time of the circuit breaker plus the opening time of the relays.[6] The output of single line diagram by MIPOWER is below:

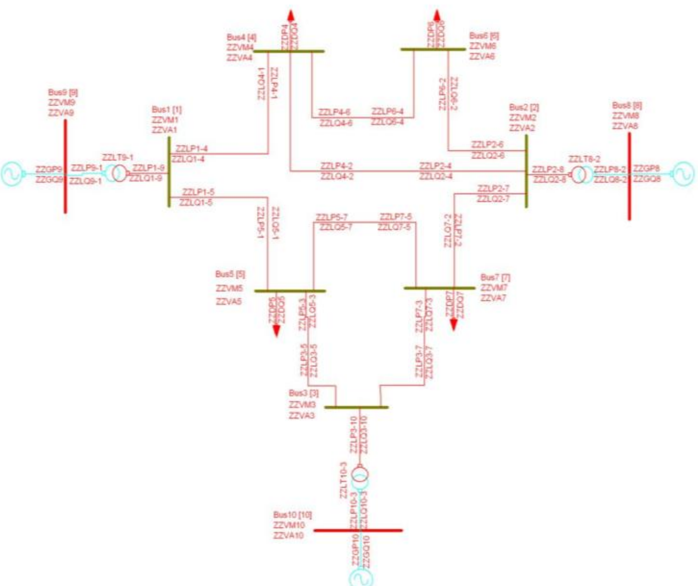

Fig. 2

The generated data sheet is below:

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FAULT AT BUS NUMBER 4 : NAME Bus4

CURRENT (AMPS/DEGREE)				FAULT MVA	
SEQUENCE (1,2,0)		PHASE (A,B,C)		SEQUENCE (1,2,0)	PHASE (A,B,C)
MAGNITUDE	ANGLE	MAGNITUDE	ANGLE	MAGNITUDE	MAGNITUDE
3797	-88.69	0	-90.00	868	0
928	90.07	5972	134.96	212	1365
2869	91.72	5905	47.86	656	1350

POST FAULT BUS VOLTAGES

NUMBER	NAME	SEQUENCE (1,2,0) MAGNITUDE	ANGLE	PHASE (A,B,C) MAGNITUDE	ANGLE	LINE-LINE MAG. PU_ON LN-LN BASE
1	Bus1	0.201	-0.95	0.589	-1.00	0.343
		0.195	-1.01	0.008	-134.76	0.006
		0.193	-1.06	0.007	137.68	0.343
2	Bus2	0.201	-0.95	0.545	-1.19	0.343
		0.195	-1.01	0.049	-172.62	0.006
		0.149	-1.74	0.049	175.30	0.343
3	Bus3	0.207	-0.88	0.513	-1.29	0.347
		0.194	-1.02	0.089	-171.50	0.013
		0.112	-2.52	0.089	173.63	0.347
4	Bus4	0.196	-1.00	0.589	-1.00	0.340
		0.196	-1.00	0.000	-2.33	0.000
		0.196	-1.00	0.000	-1.29	0.340
5	Bus5	0.204	-0.91	0.587	-1.02	0.345
		0.194	-1.01	0.014	-140.08	0.010
		0.189	-1.14	0.014	143.56	0.345
6	Bus6	0.199	-0.96	0.547	-1.18	0.342
		0.196	-1.01	0.046	-174.51	0.004
		0.152	-1.68	0.046	177.20	0.342
7	Bus7	0.202	-0.93	0.538	-1.21	0.344
		0.195	-1.01	0.058	-172.41	0.007
		0.141	-1.89	0.058	175.01	0.344
8	Bus8	0.397	-1.31	0.544	-1.06	0.489
		0.147	-0.39	0.349	-142.95	0.249
		0.000	177.58	0.345	140.22	0.486
9	Bus9	0.397	-1.31	0.544	-1.06	0.489
		0.147	-0.39	0.349	-142.95	0.249
		0.000	178.26	0.345	140.22	0.486
10	Bus10	0.401	-1.27	0.547	-1.04	0.492
		0.146	-0.39	0.354	-142.48	0.255
		0.000	176.80	0.349	139.82	0.489

FAULT CONTRIBUTION

FROM NODE	FROM NAME	TO NODE	TO NAME	CURRENT (AMPS/DEGREE) SEQUENCE (1,2,0) MAGNITUDE	ANGLE	PHASE (A,B,C) MAGNITUDE	ANGLE	MVA PHASE(A,B,C) MAGNITUDE
8	Bus8	2	Bus2	17408	-88.82	13156	-88.42	251
				4253	89.93	19949	161.68	380
				0	-91.74	19808	20.33	377
9	Bus9	1	Bus1	17408	-88.82	13156	-88.42	251
				4253	89.93	19948	161.68	380
				0	-91.06	19808	20.33	377
10	Bus10	3	Bus3	17281	-88.83	13060	-88.42	249
				4222	89.93	19803	161.68	377
				0	-92.52	19664	20.32	375
4	Bus4	1	Bus1	2112	91.26	21	68.40	5
				516	-89.98	3314	-44.76	758
				1577	-88.03	3265	-132.32	747
1	Bus1	5	Bus5	666	91.43	359	91.13	82

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				162	-89.81	828	-27.57	189
				146	-86.46	812	-149.46	186
4	Bus4	2	Bus2	1056	91.33	795	91.62	182
				257	-89.91	1212	-18.38	277
				5	-70.17	1201	-159.26	275
4	Bus4	6	Bus6	677	91.36	766	-88.90	175
				155	-89.80	1711	-63.71	391
				1288	-88.66	1705	-113.58	390
6	Bus6	2	Bus2	791	91.18	675	-88.81	154
				172	-89.92	1812	-61.25	414
				1294	-88.67	1802	-116.19	412
2	Bus2	7	Bus7	460	91.44	28	99.40	6
				110	-89.78	702	-43.88	160
				322	-88.84	699	-133.53	160
7	Bus7	5	Bus5	447	91.21	564	91.22	129
				97	-89.89	476	5.86	109
				215	90.74	471	176.12	108
7	Bus7	3	Bus3	114	91.07	482	-89.29	110
				16	-89.40	639	-78.98	146
				580	-89.22	640	-99.38	146
5	Bus5	3	Bus3	1241	91.22	893	91.46	204
				280	-89.92	1432	-21.51	327
				68	-87.29	1420	-156.27	325

FAULT CONTRIBUTION FROM SHUNT CONNECTION

FROM NODE	FROM NAME	CURRENT (AMPS/DEGREE) SEQUENCE (1,2,0) MAGNITUDE	ANGLE	PHASE (A,B,C) MAGNITUDE	ANGLE	MVA PHASE(A,B,C) MAGNITUDE
10	Bus10	17281	91.17	13060	91.58	249
		4222	-90.07	19803	-18.32	377
		0	87.48	19664	-159.68	375
9	Bus9	17408	91.18	13156	91.58	251
		4253	-90.07	19948	-18.32	380
		0	88.94	19808	-159.67	377
8	Bus8	17408	91.18	13156	91.58	251
		4253	-90.07	19949	-18.32	380
		0	88.26	19808	-159.67	377
4	Bus4	0	-90.00	0	-90.00	0
		0	-90.00	0	-90.00	0
		0	-90.00	0	-90.00	0
6	Bus6	0	-90.00	0	-90.00	0
		0	-90.00	0	-90.00	0
		0	-90.00	0	-90.00	0
5	Bus5	0	-90.00	0	-90.00	0
		0	-90.00	0	-90.00	0
		0	-90.00	0	-90.00	0
7	Bus7	0	-90.00	0	-90.00	0
		0	-90.00	0	-90.00	0
		0	-90.00	0	-90.00	0

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Waveform for a unsymmetrical fault during double LG fault

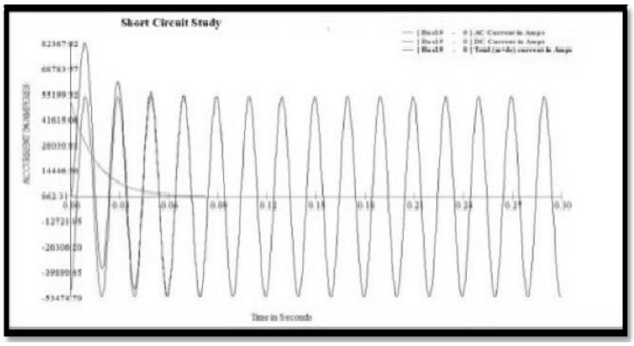

Fig. 3

Conclusion

This paper presents simulation of 132kv single line diagram using MiPower software for double phase to ground fault(unsymmetrical fault). Short circuit analysis is done for calculating the ratings of existing switchgears and settings for protection gear. In this paper short circuit analysis done on the bus 04 gives fault current of 3781A and fault MVA of 1440. Similarly when performed on load bus 7 gives the fault current 1200A and fault MVA of 869.These values indicates that the ratings of switchgear used in the test system are well above the fault limit.[5,6]

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