Theory of "NELVAC (No EMI Low Voltage AC Cables)"

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Abstract - *Electro Magnetic Interference is a serious problem in applications involving field sensor data acquisition. It is also an important cause of system malfunction in oil and gas industry installations. In this paper we have taken a 6sqmm wire and simulated the NELVAC model using Quick Field Software and concluded that there is substantial decrease in EMI compared with normal 6sqmm wire.*

Key Words: Analysis, EMI, Flux Density, Quick Field Software, Insulation.

1.INTRODUCTION

When electromagnetic energy flows from external or internal sources to electrical or electronic equipment, it adversely affects that equipment by creating undesirable responses (degraded performance or malfunctions), the electromagnetic energy is defined as electromagnetic interference or induction (EMI) [2].

Electro Magnetic Interference is a serious problem in applications involving field sensor data acquisition. It is also an important cause of system malfunction in oil and gas industry installations [1]. To solve the problem, we introduce you to No E.M.I Low Voltage AC Cables.

In NELVAC wire there are two EMI's generated, one for the currents flowing into the load and other flowing out of the load and also as they are same in magnitude the net EMI is reduced compared with normal wires.

2. MODEL AND SIMULATION

2.1 Model for NELVAC Cables: For Modelling and Simulation, we have considered Quick field software.

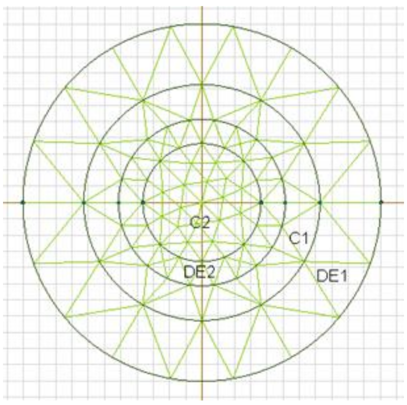

Figure 1: NELVAC wire

Figure 1 is an exact representation of NELVAC cable, NELVAC cables differ from normal cables in their construction, let us consider inner and outer insulation as DE2 and DE1 respectively also consider inner conductor and outer conductor as C2 and C1. In NELVAC cables there is a second conductor which is used as a return path for outer conductor in order to neutralize the magnetic field produced due to current in the outer conductor.

Now let us consider an example of 6sqmm wire, in this wire the outer conductor diameter is 2.91mm and outer insulation diameter from center is 4.41mm which makes insulation thickness as 1.5mm, also inner conductor diameter is 1.45 mm and inner insulation is 2.05mm which makes the inner insulation thickness as 0.6 mm .

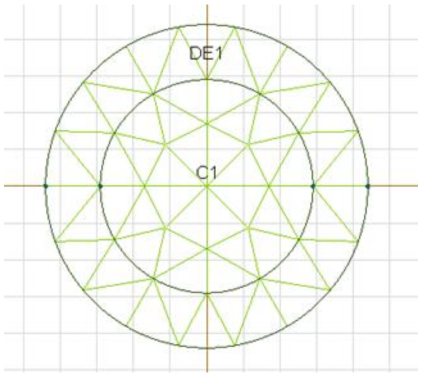

Figure 2: Normal wire

Figure 2 shows normal 6sqmm cable with conductor diameter as 2.91mm and insulation diameter from centre as 4.41mm which makes insulation thickness as 1.5mm.

2.2 Simulation

In the software we have used AC Magnetics problem for this simulation, Figure 3 and Figure 4 show circuit diagram of the modelled wires respectively.

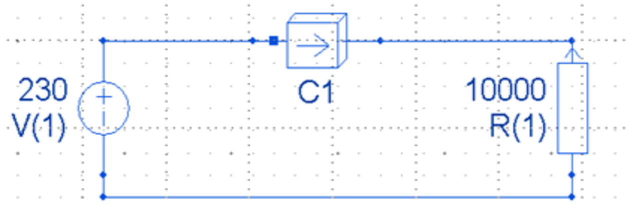

Figure 3: Normal wire circuit

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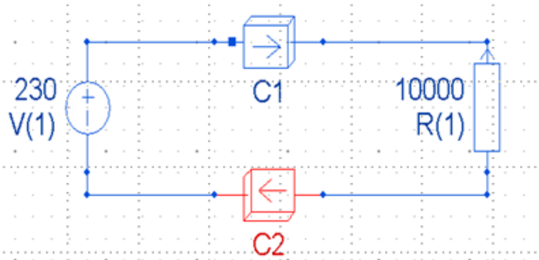

Figure 4: NELVAC wire circuit

3. RESULTS AND ANALYSIS

3.1 Results

The simulation was conducted and EMI fields were observed assuming the wire is in air. Figure 5 shows the Normal wire flux density (B) in T, while Figure 6 shows NELVAC cable flux density (B) in T. For the results, Table 1 shows Normal Wire results and Table 2 shows NELVAC wire with contour taken on horizontal plane passing through the center of the conductor.

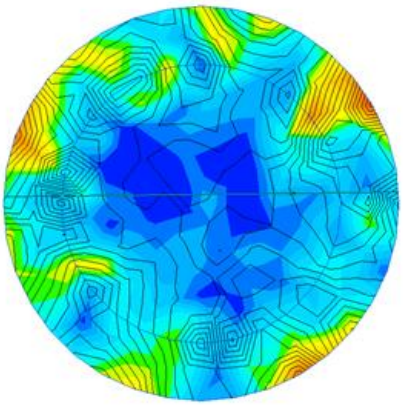

Figure 5: Normal wire "B" in T

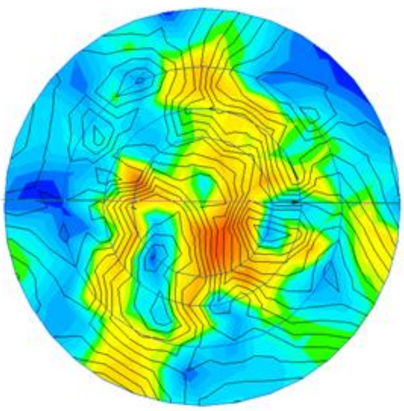

Figure 6: NELVAC wire "B" in T

L (mm)	x (mm)	y (mm)	V (V)	B (T)	H (A/m)	S (W/m^2)
0	-2.04885	0.0703268	0	2.05686e-7	0.16368	28.0328
0.204685	-1.84418	0.0727811	0	8.78455e-8	0.0699053	11.9649
0.409369	-1.63951	0.0752353	0	2.17925e-8	0.0173419	2.97294
0.614054	-1.43484	0.0776896	171.477	1.30038e-7	0.103481	5.34914e-11
0.818739	-1.23017	0.0801439	171.477	1.78647e-7	0.142162	2.06768e-11
1.02342	-1.0255	0.0825982	171.477	9.21458e-8	0.0733273	9.1395e-7
1.22811	-0.820827	0.0850525	171.477	5.68663e-8	0.0452527	4.4351e-11
1.43279	-0.616157	0.0875067	171.477	4.00377e-8	0.031861	3.96761e-7
1.63748	-0.411487	0.089961	171.477	1.2794e-8	0.0101811	2.60375e-11
1.84216	-0.206817	0.0924153	171.477	2.9856e-8	0.0237586	2.40724e-11
2.04685	-0.00214722	0.0948696	171.477	7.90366e-8	0.0628953	1.74538e-11
2.25153	0.202523	0.0973239	171.477	6.82356e-8	0.0543002	1.95126e-11
2.45622	0.407193	0.0997781	171.477	2.91017e-8	0.0231584	1.52842e-11
2.6609	0.611863	0.102232	171.477	3.94792e-8	0.0314166	3.92058e-7
2.86559	0.816533	0.104687	171.477	1.02365e-7	0.0814598	3.29276e-11
3.07027	1.0212	0.107141	171.477	9.43993e-8	0.0751206	1.0112e-10
3.27496	1.22587	0.109595	171.477	8.2207e-8	0.0654183	1.94196e-10
3.47964	1.43054	0.11205	171.477	1.10593e-7	0.0880072	3.14368e-10
3.68432	1.63521	0.114504	0	2.60593e-8	0.0207373	3.15123
3.88901	1.83988	0.116958	0	8.09478e-8	0.0644162	10.9769
4.09369	2.04455	0.119412	0	1.57723e-7	0.125512	21.5184

Table 1: Normal wire contour results

L (mm)	x (mm)	y (mm)	V (V)	B (T)	H (A/m)	S (W/m^2)
0.207039	-1.86681	0.0759585	0	2.81269e-9	0.00223827	0.183467
0.414077	-1.65978	0.074192	0	2.17117e-9	0.00172776	0.141428
0.621115	-1.45275	0.0724255	0	4.00748e-9	0.00318905	0.261292
0.828154	-1.24572	0.070659	81.987	1.10463e-8	0.00879033	1.61829e-13
1.03519	-1.03869	0.0688925	81.987	2.01674e-8	0.0160487	3.01926e-13
1.24223	-0.831657	0.067126	0	2.51149e-8	0.0199858	1.63846
1.44927	-0.624626	0.0653596	81.9871	3.13925e-8	0.0249814	1.55932e-7
1.65631	-0.417595	0.0635931	81.9871	2.66643e-8	0.0212187	1.32448e-7
1.86335	-0.210564	0.0618266	81.9871	2.34555e-8	0.0186653	1.16508e-7
2.07038	-0.00353291	0.0600602	81.9871	1.9626e-8	0.0156178	9.74818e-8
2.27742	0.203498	0.0582937	81.9871	3.00376e-8	0.0239032	1.49198e-7
2.48446	0.410529	0.0565272	81.9871	3.30528e-8	0.0263026	1.64171e-7
2.6915	0.61756	0.0547607	81.9871	1.75144e-8	0.0139375	8.69759e-8
2.89854	0.824591	0.0529943	0	4.48553e-9	0.00356947	0.291646
3.10558	1.03162	0.0512278	81.987	1.48092e-8	0.0117848	7.35466e-8
3.31262	1.23865	0.0494613	81.987	1.64084e-8	0.0130574	5.28883e-13
3.51965	1.44568	0.0476948	81.987	1.93371e-8	0.015388	5.73449e-13
3.72669	1.65271	0.0459284	0	2.16207e-8	0.0172052	1.41047
3.93373	1.85975	0.0441619	0	1.55594e-8	0.0123818	1.01504

Table 2: NELVAC wire contour results

3.2 Analysis

In figures 6 you can clearly observe that the E.M field is concentrated at the center instead of travelling through air in NELVAC wire and In figure 5 the EM filed is traveling through the insulation into the air as magnetic permeability of insulation is 1.

Table 1 and Table 2 are parameters considered for a horizontal contour passing through the center of the conductor. Analyzing the tables gives us the average Flux density of two simulations, let us consider Table 1 average flux density which is of 919 μT and Table 2 average flux density is 171 μT.

4. CONCLUSIONS

By analyzing the results from the simulation, we can conclude that the NELVAC wires are more reliable for applications involving field sensors where you need to get the analog data while sending power to it.

Hence theory of NELVAC cables is proved.

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I want to dedicate this work to my father Late Shri Nidamarthi Venkata Subba Rao.

REFERENCES

[1] M. A. Ayob et al., "Optimal Power and Signal Cables Arrangement for Minimizing Electromagnetic Interference in Oil and Gas Industry," 2018 22nd International Conference Electronics, 2018, pp. 1-5, doi: 10.1109/ELECTRONICS.2018.8443637.M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] "IEEE Guide on Shielding Practice for Low Voltage Cables," in IEEE Std 1143-1994, vol., no., pp.1-88, 13 April 1995, doi: 10.1109/IEEESTD.1995.122624.