Journal Menu

- Journal Home
- Editorial Board
- Guidelines for Authors
- Subscribe
- Content
- Publication Ethics and Publication Malpractice Statement
- Journal Metrics / Impact Factor

Content

- Volume 21 (2020)
- Special Issue (2020)
- Special Issue (2020)
- Volume 20 (2020)
- Volume 19 (2020)
- Volume 18 (2019)
- Special Issue (2019)
- Volume 17 (2019)
- Volume 16 (2019)
- Special Volume (2018)
- Special Volume (2018)
- Special Volume (2018)
- Volume 15 (2018)
  - Volume 15, Issue 4 Pg 791 - 1001 (November 2018)
  - Volume 15, Issue 3 Pg 483 - 790 (August 2018)
  - Volume 15, Issue 2 Pg 157 - 481 (May 2018)
  - Volume 15, Issue 1 Pg 1 - 156 (February 2018)
- Volume 14 (2017)
- Volume 13 (2016)
- Volume 12 (2015)
- Volume 11 (2015)
- Volume 10 (2014)
- Volume 9 (2014)
- Volume 8 (2013)
- Volume 7 (2013)
- Volume 6 (2012)
- Volume 5 (2011)

JP Journal of Heat and Mass Transfer

Volume 15, Issue 4, Pages 791 - 1001 (November 2018)

Articles 1 - 12 of 12 [1]

NUMERICAL STUDY OF THERMAL PERFORMANCE IN A CIRCULAR PIPE USING ANGLE PLATE INSERTS DIRECTED IN HORIZONTAL AND VERTICAL DIRECTIONS
by: R. Thejaraju, Raman Bedi, Sonal P. Joseph and Eldho Paul
Page: 791 - 811
Abstract | Add to my cart

THE EFFECT OF INITIAL PRESSURE ON CLATHRATE HYDRATE FORMATION OF PROPANE-BUTANE MIXTURES
by: Widya Wijayanti, Mega Nur Sasongko and Purnami
Page: 813 - 828
Abstract | Add to my cart

A COMPARATIVE STUDY OF HYDRODYNAMIC AND THERMAL PERFORMANCE OF DIFFERENT AIR JETS IMPINGEMENT SOLAR AIR COLLECTOR
by: Nitin Kumar, Anil Kumar, Robin Thakur, Ankit Thakur and Raj Kumar
Page: 829 - 845
Abstract | Add to my cart

FLOW AND HEAT TRANSFER IN A MAXWELL LIQUID SHEET OVER A STRETCHING SURFACE WITH THERMAL RADIATION AND VISCOUS DISSIPATION
by: Hajar F. Ismael and N. M Arifin
Page: 847 - 866
Abstract | Add to my cart

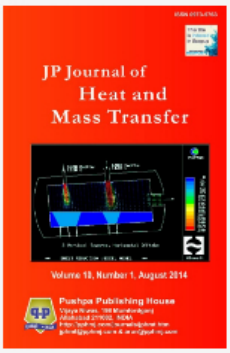
THE THERMAL CONDUCTIVITIES OF HYBRID COMPOSITES AS DEFINED BY A DETERMINISTIC MODE OF FILLER PACKING
by: J. Venetis
Page: 867 - 886
Abstract | Add to my cart

EFFECT OF INCLINATION ANGLE AND RAYLEIGH NUMBER ON DOUBLE NATURAL CONVECTION WITHIN A THREE-DIMENSIONAL CAVITY SUBJECT TO CROSS-DIMENSIONAL GRADIENTS OF TEMPERATURE AND CONCENTRATION
by: Meriem Ouzaouit, Btissam Abourida, Lahoucine Belarche, Hicham Doghmi and Mohamed Sannad
Page: 887 - 905
Abstract | Add to my cart

ANALYSIS OF MICROSCOPIC RESISTANCE ON CONDUCTIVE CLOTHING FOR TRANSLUCENT INTENSITY ELECTRIC FIELD WAVE IN EXTRA HIGH VOLTAGE TRANSMISSION LINE 500 KV
by: Herawati Ys and Aurizan Sahril Shodiq
Page: 907 - 914
Abstract | Add to my cart

BEM SOLUTIONS FOR UNSTEADY TRANSPORT PROBLEMS IN ANISOTROPIC MEDIA
by: Moh. Ivan Azis, Laode Asrul, Khaeruddin and Paharuddin
Page: 915 - 934
Abstract | Add to my cart

ISSN: 0973-5763



LATEST ISSUE
SUBMIT AN ARTICLE
SEARCH WITHIN JOURNALS

PERFORMANCE EVALUATION OF A WET COOLING WATER TOWER USING GRAPHENE NANOFLUIDS
by: Mohammad N. Fares, Mohammad A. Al-Mayyahi and Ali D. Salman
Page: 935 - 951
Abstract | Add to my cart

CHARACTERIZATION OF EXHAUST GAS EMISSIONS FROM A GENERATOR ENGINE, USING DEGUMMED OIL BLENDS OF JATROPHA WITH DIESEL FUEL
by: Alberto JuliÃ£o Macamo, Carlos Lucas, Shana Michela Machado, Satoshi Kato and Yoshimitsu Kobashi
Page: 953 - 967
Abstract | Add to my cart

COMPARISON BETWEEN 1-D AND 2-D ANALYSES OF A PIN FIN WITH CONSTANT BASE AND TIP TEMPERATURES
by: Hyung Suk Kang
Page: 969 - 982
Abstract | Add to my cart

PERTURBATIVE APPROACH TO WEAKLY COMPRESSIBLE MULTIPHASE FLOW
by: Hyeonseong Jin
Page: 983 - 1001
Abstract | Add to my cart

BACK

JP Journal of Heat and Mass Transfer

http://www.pphmj.com
http://dx.doi.org/10.17654/HM015040907
Volume 15, Number 4, 2018, Pages 907-914 **ISSN: 0973-5763**

ANALYSIS OF MICROSCOPIC RESISTANCE ON CONDUCTIVE CLOTHING FOR TRANSLUCENT INTENSITY ELECTRIC FIELD WAVE IN EXTRA HIGH VOLTAGE TRANSMISSION LINE 500 KV

Herawati Ys and Aurizan Sahril Shodiq

Electrical Engineering
Maranatha Christian University
Indonesia

Electrical Engineering
STT Mandala, Indonesia

Abstract

This paper presents the analysis of microscopic resistance on conductive clothing to electric field from an extra high voltage transmission line of 500 kV. Through microscopic resistance measurements we showed that the use of conductive clothing purchased in 2004 can reduce the intensity of the electric field by 17.69 times and the use of conductive clothing purchased in 2008 can reduce the electric field intensity by 21.44 times. Meanwhile, the use of conductive clothing purchased in 2012 can reduce the electric field intensity by 23.92 times. Hence, this work can provide a clear evidence of the shielding efficiency of the conductive clothing against its life time service through microscopic resistance measurements that is proportional to the magnitude of electric field.

Received: May 19, 2018; Revised: July 24, 2018; Accepted: September 8, 2018
Keywords and phrases: conductive clothing, electric field, microscopic resistance, safety protection.

1. Introduction

High voltage transmissions, communication antennas and other electrical equipment are sources of electromagnetic fields [1]. When a human body is exposed to an electric field for a long period of time, it can cause induced current in the body [2]. This is one reason for electric field to cause biological effect on humans working outdoor [3]. Each country has criteria for exposure to an electric field. These criteria are based on guidelines established by specialized organizations such as the International Commission on the Protection of Non-Ionization (ICNIRP) [4]. Exposure limits of constant electric field 5 kV/m for general frequency of 50 Hz is based on ICNIRP recommendations [5]. Thus, all risks related to the live-line maintenance activities have to be taken into consideration to assure the safety of the worker.

Currently, maintenance on transmission line high voltage has been using the maintenance method of energized condition in network maintenance without cutting the flow of electricity [6]. Conductive clothing is a tool to keep the safety of live-line working on high voltage [7]. However, increased microscopic resistance during its service such as in washing, frequent use and improper maintenance may cause deterioration of the cloth's performance. The ability of conductive clothing to protect the workers during live-line maintenance might be reduced and put the workers at high risk of danger. Therefore, the condition of conductive clothing should be always under high concern.

In this paper, we evaluate the microscopic resistance of the conductive clothing as a function of its life time. The results are expected as the evidence of the shielding efficiency of the conductive clothing when its life time service is considered.

2. Theoretical Review

(1) Exposure limits of electric field and magnetic field

Recommendation of International Radiation Protection Association

(IRPA) and WHO 1990 for the limits of exposure of electric field and magnetic field 50-60 Hz can be seen in Table 1 as follows:

Table 1. Limits of exposure to 50/60 Hz electric and magnetic fields

Classification	Electric Field (kv/m)	Magnetic Field (mT)
Work environment		
- throughout the working day	10	0,5
- short time	30 (s/d 2 hour/day)	5,0 s/d 2 hour/day
- limbs (hands and feet)	-	25
General environment:	5	
- up to 24 hours per day	10	0,1 (outdoor)
- several hours per day **)		1

Source: IRPA Recommendation, INIRC and WHO 1990 [8]

(2) Conductive clothing

Conductive clothing is a most important protective equipment during high voltage live-line maintenance. Conductive clothing is used by bare hand method acting as a Faraday cage [9]. The new classification of conductive clothing is divided as follows [10]:

Class 1: Conductive clothing for use at nominal voltage up to 800 kV AC and ±600 kV DC.

Class 2: Conductive clothing for use at nominal voltage up to 1000 kV AC and +800 kV DC.

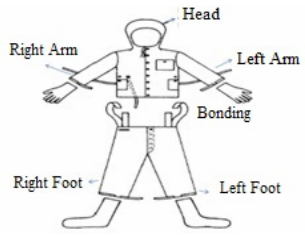


Figure 1. Complete conductive clothing parts.

The screening efficiency of any conductive clothing has to exceed 99% based on the current regulation of International Electrotechnical Commission (IEC 60895). This parameter is obtained from ratio leakage current of the human body [11]. A set of conductive clothing consists of conductive

clothes, conductive pants, conductive gloves, conductive socks and conductive shoes where these are all connected to each other. Parts of conductive clothing are shown in Figure 1.

3. Research Method

1. Measurement of microscopic resistance on conductive clothing

Measurements of microscopic resistance on conductive clothing were done by providing the voltage and current on the clothes in complete accordance with the manual book of measurement of microscopic resistance of conductive clothing. The conductive clothing for the study were selected based on their lifetime. They were conductive clothing purchased in 2004, 2008 and 2012, respectively.

2. Electric field measurement

Electric field measurements were performed at the tower cross arm of 500 kV South Bandung-Ujung Berung T.70 phase T transmission line. The investigations were started from the end part of the cross arm above the isolator to the main body tower with a distance of each measurement as 1 meter. Figure 2 shows electric field measuring instrument. Measuring instrument used is HI-ELF 3604 Survey meter. This meter measuring unit in electric fields is V/m or kV/m meanwhile magnetic field is milli Gauss or Gauss. Figure 3 shows electric field measurement point.

Table 2. Specification HI-3604 ELF Survey Meter [12]

Frequency range:	30-2000 Hz
Frequency Response:	± 0.5 dB (50-1000 Hz) ± 2 db (30-2000 Hz)
Dynamic range:	0.2 mG – 20 G (magnetic field) 1 V/m – 200 kV/m (electric Fields)
Environmental:	10°C-40°C 5%-95% humidity
Detection	Single Axis
Response	True RMS

Figure 2. Electric field measuring instrument [13].

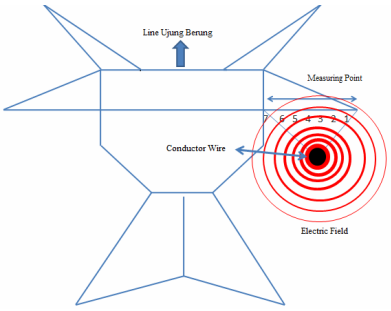


Figure 3. Illustration of electric field.

4. Result of Research

A. Measurement results of microscopic resistance on conductive clothing

The measurement results of microscopic resistance on conductive clothing are provided in the following table.

Table 3. Measurement of microscopic resistance on conductive clothing

2004 Conductive Clothing												
Result Measurement	Point Measurement											
	1	2	3	4	5	6	7	8	9	10	11	12
V (V)	18.57	20.93	21.2	20.38	18.02	17.02	16.78	18.1	19.8	18.63	18.05	19.45
I (mA)	4.01	5.43	6.7	6.68	2.43	2.4	2.68	2.4	4.35	3.4	2.24	2.85
R (Ω)	4630.9	3854.5	3164.1	3050.8	7415.6	7091.6	6261.1	7541.6	4551.7	5479.4	8058	6824.5
2008 Conductive Clothing												
Result Measurement	Point Measurement											
	1	2	3	4	5	6	7	8	9	10	11	12
V (V)	24.44	24.43	24.8	24.69	24.81	24.32	24.78	24.67	24.8	24.67	24.73	24.82
I (mA)	19.6	19.7	17.8	17.5	20	19.6	20	19.2	18.1	17.6	17.6	19.4
R (Ω)	1246.9	1240.1	1393.2	1410.8	1240.5	1240.8	1239	1284.8	1370.1	1401.7	1405.1	1279.3
2012 Conductive Clothing												
Result Measurement	Point Measurement											
	1	2	3	4	5	6	7	8	9	10	11	12
V (volt)	20.6	21.26	21.08	20.44	21	20.33	17.48	16.85	16.55	16.33	16.85	17.23

I (mA)	65	230	187.1	184	171	152.2	330	199.4	178.2	253	163.6	189.5
R(Ω)	316.9	92.4	112.6	111.08	122.8	133.3	52.9	84.5	92.8	64.5	102.9	90

The microscopic resistance of conductive clothing was measured up to 12 points of measurement for each conductive clothing. The results are shown in Table 3.

The microscopic resistivity of conductive clothing was 5660.3 Ω, 1312.7 Ω, and 114.8 Ω for the conductive clothing purchased in 2004, 2008, and 2012, respectively.

B. Test results and measurement of electric field

The results of the electric field direct measurements are shown in the following Figure 4.

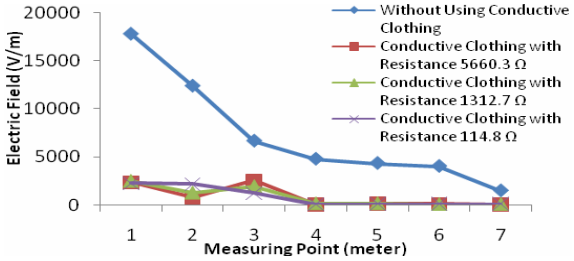


Figure 4. Graph of electric field measurements.

C. Shielding efficiency analysis

The influence of Faraday cage from the conductive clothing were mathematically analyzed by calculating its effectiveness. The results show that the effectiveness of conductive clothing with a microscopic resistance of 5660.3 Ω (purchase in 2004), 1312.7 Ω (purchase in 2008) and 114.8 Ω (purchase in 2012) was 17.69, 21.48 and 23.92, respectively. This means that it can reduce the intensity of the electric field by 17.69 times for 2004 conductive clothing, 21.48 times for 2008 conductive clothing, and 23.92 times for 2012 conductive clothing. Thus, it is clearly seen that the performance reduces with increase in lifetime service. Additionally, the value of microscopic resistance of the conductive clothing has a strong correlation with its performance degradation. Higher the lifetime service of conductive

clothing will result into a higher microscopic resistance value and will degrade its performance.

5. Conclusion

(1) The use of conductive clothing with a resistance value of 5660.3 Ω can reduce the electric field received by the body up to 17.69 times than without using conductive clothing at the same location.

(2) The use of conductive clothing with a resistance value of 1312.7 Ω can reduce the electric field received by the body up to 21.44 times than without using conductive clothing in the same location.

(3) The use of conductive clothing with a resistance value of 114.8 Ω can reduce the electric field received by the body up to 23.92 times than without using conductive clothing at the same location.

(4) The value of microscopic resistance in conductive clothing is directly proportional to the magnitude of the penetrating electric field wave.

Acknowledgement

The authors thank the anonymous referees for their valuable suggestions and comments leading to the improvement of the paper.

References

[1] J. S. S. Samraj and J. Sivadasan, Investigation of electromagnetic interference due to high voltage line, IEEE (2013), 310-314.

[2] C.-J. Lin, H.-R. Chaung and K.-M. Chen, Steady-state and shock currents induced by ELF electric fields in a human body and a nearby vehicle, IEEE Transactions on Electromagnetic Compatibility 32(1) (1990), 59-65.

[3] H. Das, K. Gogoi and S. Chatterjee, Analysis of the effect of electric field due to high voltage transmission lines on humans, IEEE (2015), 1-4.

[4] G. Kulkarni and W. Z. Gandharc, Proximity effects of high voltage transmission lines on humans, ACEEE Int. J. on Electrical and Power Engineering 3(1) (2012), 28-32.

[5] International Commission on Non-Ionizing Radiation Protection (ICONIRP), ICNIRP Guidelines for Limiting Exposure to Time-varying Electric, Magnetic and Electromagnetic, ICNIRP Publication, 1998.

[6] A. I. Carya, A. T. Wibowo, A. Yunianto and Y. Hardiyanto, Panduan Umum Pemeliharaan Transmisi TT/TET Dengan Metode PDKB, Jakarta: PT. PLN (PERSERO) Penyaluran Dan Pusat Pengatur Beban Jawa Bali, 2008.

[7] R. Malgesini, C. Valagussa, A. Villa, R. Carrara, R. Carrara, G. De Dona and C. D. Milanella, Conductive clothing for live line working, IEEE (2014), 21-24.

[8] IRPA/INIRC, Interim Guidelines On limits of exposure to 50/60 Hz Electric and Magnetic Fields. Australia: Australian Radiation Laboratory on behalf of the National Health and Medical Research Council, 1989.

[9] G. Göcsei and D. B. Nemeth, Revision of the way of classification of conductive clothing, IEEE (2017), 1-5.

[10] G. De Donà, C. M. Dante, R. Carraro and R. Carraro, Conductive clothing standard evolution and its connection with the European directive about electromagnetic fields, IEEE (2017), 1-5.

[11] G. Gocsei and D. B. Nemety, Current issues regarding to the inspection of conductive clothing, IEEE (2016), 0-4.

[12] I. Holiday Industries, Specification HI-3604 ELF Survey Meter, p. 700069.

[13] S. A. Ghani, M. S. A. Khiar, I. S. Chairul, M. Y. Lada and N. H. Rahim, Study of magnetic fields produced by transmission line tower using finite element method (FEM), IEEE (2014), 64-68.