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Temperature Change in Skin Tissues due to Mobile Phone Handset Radiations at 3G (2100MHz) Frequency

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Abstract: *This is theoretical study of change in temperature of skin due to 3G mobile phone frequencies. We have done mathematical calculation of temperature change in skin of human body at different depths and different exposure time. Temperature change in skin tissues due to mobile phone radiation at different time exposure 10, 20, 30 40 50, and 60 minutes. The power of mobile phone handset is taken as 1.5 W. The distance inside the skin of 0.1mm to 0.5mm is taken for this study.*

Keywords: *Electromagnetic Waves, Temperature Change, Skin Tissues and Mobile Phone Handset*

1 Introduction

The interaction of electromagnetic wave with the body falls in the field of Bio-electromagnets. During speaking, human being absorbs some electromagnetic energy when it is exposed to it. Electromagnetic fields are all around us as cellular telephones, television signals and radio fields from electrical appliances, power lines and more. The interaction of electromagnetic energy with the body may be thermal or non-thermal. [1]. Depending on the frequency of electromagnetic radiation, the human body interacts with field and thermal effects. heat generated in the medium is proportional to the absorbed power. The thermal interaction may cause tissue heating by deposition of power from the mobile phone [2]. If the organism cannot dissolve heat energy the internal temperature of the body will rise. The Biological effects of radiofrequency energy depend on the rate at which power is absorbed [3]. Tissue damage will occur during exposed to high RF levels generated from mobile phone handset. Exposure to high mobile phone radiations, the power densities increases the human body temperature. At power density levels of 1 to 10 mW/cm^2, the radiofrequency energy can result in heating of body skin and eyes are to mainly known to heating by radio frequency energy. Mobile phone radiation penetrates in tissues is proportional to their power density. Most of the experimental investigations rabbits and mice have been employed for biological effects of radio frequency exposure [4]. That is why it is dangerous to live close to high power mobile phone tower for a long time. Mice and rabbits have been employed for most of the experimental investigations on biological effects of RF exposure [5]. The effect of mobile phone wave is dielectric heating in which the living tissues of human being are heated by the rotations of polar molecules.

2 Method and Calculation

The change in temperature can be calculated by this formula given below

$$\triangle \mathbf{T} = \mathbf{SAR}\,(\triangle \mathbf{t}) / C \qquad \text{.................................. (1)}$$

Where C is specific heat of bio- material and $\triangle \mathbf{t}$ is time in seconds

The Specific Absorption Rate (SAR) can be defined as

$$SAR = \frac{\sigma E_i^2}{\rho} \qquad \text{.................................. (2)}$$

Where ρ is the density of bio material, σ is the conductivity of the biological material and

E_i is the field inside that material,

Standard values [6,7]

At 2100 MHz (3G), σ = 1.283 W K^{-1} m^{-1}

Table 1 Temperature change (degree C/10 minutes) at different depth and 1 cm to 15 cm apart from the mobile phone at frequency of 3G (2100 MHz)

Distance from phone in cm	Temperature change in skin 10 minutes exposure at 3G (2100MHz) frequency				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	1.69079902	1.67910049	1.66748389	1.6559476	1.64449153
2	0.42269967	0.41977537	0.41687105	0.4139869	0.41112288
3	0.18778738	0.18648826	0.18519798	0.1839167	0.18264429
4	0.10569274	0.1049615	0.10423532	0.1035142	0.10279802
5	0.06763196	0.06716405	0.06669937	0.0662379	0.06577965
6	0.04696466	0.04663973	0.04631705	0.0459966	0.04567838
7	0.03450392	0.03426521	0.03402814	0.0337927	0.03355892
8	0.02641873	0.02623596	0.02605443	0.0258742	0.02569517
9	0.02087186	0.02072746	0.02058406	0.0204416	0.02030022
10	0.01690799	0.016791	0.01667484	0.0165595	0.01644492
11	0.01397237	0.0138757	0.0137797	0.0136844	0.01358969
12	0.01173968	0.01165846	0.0115778	0.0114977	0.01141816
13	0.01000283	0.00993363	0.0098649	0.0097967	0.00972887
14	0.00862471	0.00856504	0.00850578	0.0084469	0.00838849
15	0.00751387	0.00746189	0.00741026	0.007359	0.00730808

Table 2 Temperature change (degree C/20 minutes) at different depth and 1 cm to 15 cm apart from the mobile phone at frequency of 3G (2100 MHz)

Distance from phone in cm	Temperature change in skin 20 minutes exposure at 3G (2100MHz) frequency				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	3.38159803	3.35820098	3.33496778	3.31189514	3.28898307
2	0.84539934	0.83955074	0.83374211	0.82797378	0.82224577
3	0.37557477	0.37297652	0.37039596	0.36783342	0.36528859
4	0.21138547	0.20992299	0.20847064	0.20702835	0.20559605
5	0.13526392	0.1343281	0.13339874	0.13247584	0.13155929
6	0.09392933	0.09327945	0.0926341	0.09199324	0.09135677
7	0.06900783	0.06853042	0.06805629	0.06758543	0.06711785
8	0.05283745	0.05247192	0.05210887	0.05174838	0.05139034
9	0.04174371	0.04145492	0.04116813	0.0408833	0.04060044
10	0.03381598	0.03358201	0.03334968	0.03311895	0.03288983
11	0.02794474	0.0277514	0.0275594	0.02736874	0.02717938
12	0.02347936	0.02331692	0.02315561	0.0229954	0.02283631
13	0.02000566	0.01986726	0.0197298	0.0195933	0.01945775
14	0.01724942	0.01713008	0.01701156	0.01689387	0.01677699
15	0.01502774	0.01492377	0.01482052	0.01471799	0.01461616

Table 3 Temperature change (degree C/30 minutes) at different depth and 1 cm to 15 cm apart from the mobile phone at frequency of 3G (2100 MHz)

Distance from phone in cm	Temperature change in skin 30 minutes exposure at 3G (2100MHz) frequency				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	5.07239705	5.03730147	5.00245167	4.96784271	4.9334746
2	1.26809902	1.25932611	1.25061316	1.24196068	1.23336865
3	0.56336215	0.55946477	0.55559394	0.55175014	0.54793288
4	0.31707821	0.31488449	0.31270596	0.31054252	0.30839407
5	0.20289588	0.20149216	0.20009812	0.19871376	0.19733894
6	0.14089399	0.13991918	0.13895115	0.13798986	0.13703515
7	0.10351175	0.10279563	0.10208443	0.10137814	0.10067677
8	0.07925618	0.07870788	0.0781633	0.07762257	0.07708552
9	0.06261557	0.06218238	0.06175219	0.06132495	0.06090066
10	0.05072397	0.05037301	0.05002452	0.04967843	0.04933475
11	0.0419171	0.0416271	0.0413391	0.0410531	0.04076908
12	0.03521904	0.03497538	0.03473341	0.0344931	0.03425447
13	0.0300085	0.02980088	0.0295947	0.02938995	0.02918662
14	0.02587413	0.02569512	0.02551734	0.02534081	0.02516548
15	0.02254161	0.02238566	0.02223079	0.02207698	0.02192424

Table 4 Temperature change (degree C/40 minutes) at different depth and 1 cm to 15 cm apart from the mobile phone at frequency of 3G (2100 MHz)

Distance from phone in cm	Temperature change in skin 40 minutes exposure at 3G (2100MHz) frequency				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	6.76319607	6.71640197	6.66993555	6.62379028	6.57796614
2	1.69079869	1.67910147	1.66748422	1.65594757	1.64449153
3	0.75114954	0.74595303	0.74079192	0.73566685	0.73057717
4	0.42277094	0.41984599	0.41694128	0.41405669	0.41119209
5	0.27052784	0.26865621	0.26679749	0.26495168	0.26311858
6	0.18785866	0.18655891	0.1852682	0.18398648	0.18271353
7	0.13801566	0.13706084	0.13611257	0.13517086	0.1342357
8	0.10567491	0.10494383	0.10421774	0.10349676	0.10278069
9	0.08348743	0.08290984	0.08233625	0.0817666	0.08120087
10	0.06763196	0.06716402	0.06669936	0.0662379	0.06577966
11	0.05588947	0.0555028	0.05511881	0.05473747	0.05435877
12	0.04695873	0.04663384	0.04631121	0.0459908	0.04567262

13	0.04001133	0.03973451	0.0394596	0.03918661	0.0389155
14	0.03449883	0.03426016	0.03402313	0.03378774	0.03355398
15	0.03005548	0.02984755	0.02964105	0.02943597	0.02923232

Table 5 Temperature change (degree C/50 minutes) at different depth and 1 cm to 15 cm apart from the mobile phone at frequency of 3G (2100 MHz)

Distance from phone in cm	Temperature change in skin 50 minutes exposure at 3G (2100MHz) frequency				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	8.45399508	8.39550246	8.33741944	8.27973785	8.22245767
2	2.11349836	2.09887684	2.08435527	2.06993446	2.05561442
3	0.93893692	0.93244129	0.9259899	0.91958356	0.91322146
4	0.52846368	0.52480748	0.5211766	0.51757086	0.51399011
5	0.3381598	0.33582026	0.33349686	0.3311896	0.32889823
6	0.23482332	0.23319863	0.23158525	0.2299831	0.22839192
7	0.17251958	0.17132605	0.17014072	0.16896357	0.16779462
8	0.13209364	0.13117979	0.13027217	0.12937094	0.12847586
9	0.10435928	0.1036373	0.10292032	0.10220825	0.10150109
10	0.08453995	0.08395502	0.08337419	0.08279738	0.08222458
11	0.06986184	0.0693785	0.06889851	0.06842184	0.06794846
12	0.05869841	0.0582923	0.05788901	0.0574885	0.05709078
13	0.05001416	0.04966814	0.04932451	0.04898326	0.04864437
14	0.04312354	0.0428252	0.04252891	0.04223468	0.04194247
15	0.03756936	0.03730943	0.03705131	0.03679497	0.0365404

Table 6 Temperature change (degree C/1hour) at different depth and 1 cm to 15 cm apart from the mobile phone at frequency of 3G (2100 MHz)

Distance from phone in cm	Temperature change in skin 1 hour exposure at 3G (2100MHz) frequency				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	10.144794	10.0746029	10.0049033	9.93568542	9.86694921
2	2.536198	2.51865221	2.50122632	2.48392135	2.4667373
3	1.1267243	1.11892955	1.11118788	1.10350027	1.09586576
4	0.6341564	0.62976898	0.62541192	0.62108504	0.61678814
5	0.4057918	0.40298431	0.40019623	0.39742752	0.39467787
6	0.281788	0.27983836	0.2779023	0.27597972	0.2740703
7	0.2070235	0.20559126	0.20416886	0.20275629	0.20135354
8	0.1585124	0.15741575	0.15632661	0.15524513	0.15417103

9	0.1252311	0.12436476	0.12350438	0.1226499	0.12180131
10	0.1014479	0.10074603	0.10004903	0.09935685	0.09866949
11	0.0838342	0.0832542	0.08267821	0.08210621	0.08153815
12	0.0704381	0.06995076	0.06946682	0.0689862	0.06850893
13	0.060017	0.05960177	0.05918941	0.05877991	0.05837324
14	0.0517483	0.05139024	0.05103469	0.05068161	0.05033097
15	0.0450832	0.04477132	0.04446157	0.04415396	0.04384848

3 Results and Discussion

In this paper, we discuss about only one frequency namely 3G of mobile phone waves. Calculation of change in temperature for skin, at different distances and different depth are made. In table 1 when we bring mobile phone from 15 cm towards our body at 10 minutes exposure then temperature of skin increases. When a mobile phone handset move from 15 cm to 1 cm distance towards person, then the temperature of skin tissue increases up to 99.55%. Table 2 represents variation of temperature in skin tissues for exposure time at 20 minutes. The temperature of skin increases from 15 cm to 1cm. The table 3, 4, 5 and 6 represents change in temperature in skin tissues at different time exposure i.e. at 30 minutes, 40 minutes, 50 minutes and 1 hour.

4 Conclusions

From above calculation it occludes that at 3G frequency of mobile phone waves namely 2100 MHz change in temperature for skin, different distances and at different depth are made. For different exposure time temperature is different. It varies for different distances at 10 minutes exposure the highest temperature is 1.690 $C^{0\,at}$ depth of 0.1 mm and lowest at 0.5 mm is 0.007 $C^{0.}$ In table 2 the temperature increases from 0.014 C^0 to 3.381C^0 at distance varies from 1cm to 15 cm at depths from 0.5 mm to 0.1 mm. This highest increase in temperature at 60 minutes talking time for a distance of 1cm apart and at depth of 0.1mm inside the skin. It means that when a person using mobile phone about 1 hour at distance of 1cm and 0.1 mm depth the temperature reaches 10.144 C^0. Such type of increase in temperature is harmful for human being. This increase in temperature can cause blood cancer, brain tumor, skin diseases and various other diseases in human beings. So always use mobile phone at some certain distance and less talk time.

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