

Effects of Wireless Electricity on Human Bodies

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Abstract— In the near future we will live in a world with no power cables. The innovation of wireless electricity started way back in 2007 at MIT. The CEO of MIT-inspired WiTricity, Eric Giler has a plan to beam electric power through the air to wirelessly power your laptop or recharge your car. But what are effects of this wireless electricity on human beings? How safe are wireless electric waves?

Keywords— Wireless, WiTricity, human bodies, electromagnetic radiations, electricity

I. INTRODUCTION

WiTricity's technology of wireless electricity approach is called magnetic coupled resonance, which can provoke an energetic response at a distance between two coils, one powered, and the other not. If the two coils are correctly tuned to one another, energy flows from the connected one (installed, say, on the ceiling of a room) into the other (inside, say, your laptop). Giler presented a demo of it at TED Global 2009 -- and several companies are already planning to add it to their phones, cameras, TVs and other devices. Though there is lot of research going on wireless electricity and we are almost near to see it everywhere shortly, what really matters is does wireless electricity really effect human bodies? Are there any limitations in transmission of amount of electricity or currents? Does is it only applicable for low power devices like laptops and mobile phones? Are there any dangers if high power devices are powered wirelessly? This needs deeper study of various effects on human body.

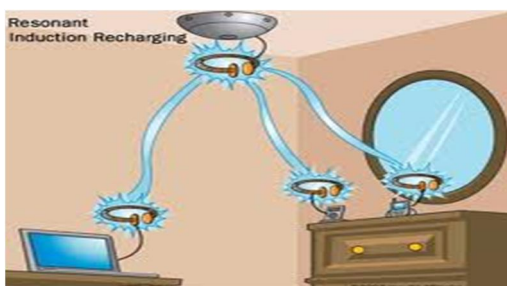


Figure 1

II. HUMAN BODY RESISTANCE:

Every person will not have same electrical resistance and it has lot of factors associated to it. In general Men tend to have lower resistance than Women.

Like the resistors that are used in electronics circuits the resistance of a person's arm will depend on the length of the arm and its diameter. If length is more the resistance goes up and will down with the diameter. Men usually have thicker arms and legs that means more muscle and that usually tend to have lower resistance. It is estimated that a rough value of human internal resistance of the human body is 300 -1000 ohms depending on various factors. The path of current flow also determines the value of resistance which implies to human bodies also if the current flows from left hand to right foot will have more resistance that compared to flow of current in two adjacent fingers.

TISSUE	RESISTIVITY
Blood	1.5 ohm-meters
Fat	12.75 ohm-meters
Bone	166 ohm-meters
Arm Longitudinal	2.4 ohm-meters
Arm Transverse	6.75 ohm-meters
Body	<10 ohm-meters

Table I

In the human body the bone and fat have greater resistance than nerves and muscle. The majority of the body resistance is in its skin. Varying from person to person the resistance of dry skin is usually between 1000 to 100000 ohms. In wet conditions the body resistance drops. It means that a person in real life gets electrocuted the body resistance drops as the skin is burned.

Now interestingly to determine any person's total resistance, just add together the resistance of each part of the body and note that the electricity must pass through the skin twice (on

the way in and on the way out), so the total resistance is:

$$R_{\text{total}} = R_{\text{skin(in)}} + R_{\text{internal}} + R_{\text{skin(out)}}$$

one more point to consider is that in addition to acting like a resistor, the epidermis now acts like a capacitor if placed in contact with a piece of metal. In cases of electrocution by a DC voltage source, this capacitive property has little importance. But if the electrocution is by an AC source, the epidermis's natural resistance is "shorted out", allowing the current to bypass that part of the body's resistance and making the body's total resistance much lower. On the contrary the interesting fact is : it generally takes about 8 to 10 amps to kill a male but only 7 to 9 amps to kill a female. The important thing here is that when electric current flows through a person's body, it will mostly travel through the muscle tissue. Since Men tend to have more muscle than Women, the current is naturally more spread out. And if the current is more spread out, it will take a higher total current to damage any particular area or spot. There is quite a bit of variation in the body structures in large groups of both men and women, and so these numbers probably represent either averages or medians. Certainly there are lightweight men with little muscle, and also very muscular women. This is how the human body behaves.

BODY EFFECT	GENDER	DC	60HZ AC	10kHz AC
Slightly sensation at point(s) of contact	Men	1 mA	0.4 mA	7 mA
	Women	0.6 mA	0.3 mA	5 mA
Threshold of bodily perception	Men	5.2 mA	1.1 mA	12 mA
	Women	3.5 mA	0.7 mA	8 mA
Pain, with voluntary muscle control maintained	Men	62 mA	9 mA	55 mA
	Women	41 mA	6 mA	37 mA
Pain with loss of voluntary muscle control	Men	76 mA	16 mA	75 mA
	Women	51 mA	10.5 mA	50 mA
Severe pain difficulty breathing	Men	90 mA	23 mA	94 mA
	Women	60 mA	15 mA	63 mA
Possible heart fibrillation after three seconds	Men	500 mA	100 mA	–
	Women	500 mA	100 mA	–

Table II

III. DOES REALLY WIRELESS ELECTRICITY HAS ANY EFFECTS ON HUMAN BODIES:

First of all we should understand that the human nervous system works through the transfer of electrons and such transfer is only a chemical process and not electrical. Neuro-transmitters released from one nerve will cause the release of electrons inside the cell when hitting receptors in another producing very low measurable charge and can be influenced using very high and strong charges. Human beings are far more chemical than electrical.

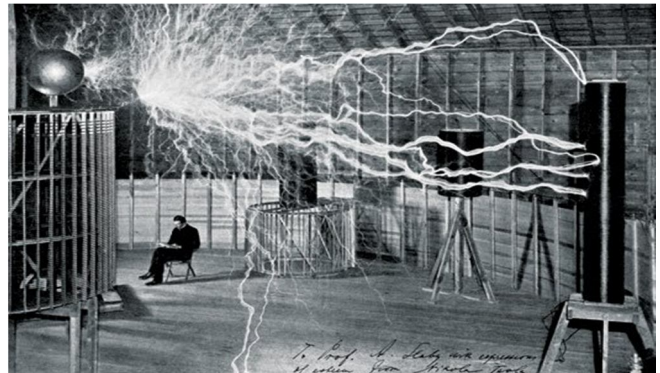


Figure 2

Generally an oscillating Magnetic field contain electric field too. Human body nervous system and muscular system work on electrical impulses. This clearly says that inside our body it does not consider the fact that the resistance of skin is very high even though about a million Ohms. If we consider the frequency is the same as household appliances of 60 to 70 Hz then it is equal to about 1.67 cm wave length and 10^4 times which is too large to penetrate into our human cells. So at this frequency there is no way any harm can be done to our body.

The human body is remarkably adaptable. It can start adapting to any situations. For example: Take the example of today's mobile phones. They emit powerful microwave radiations which are very close of our brains. The cellular technology is very harmful for human beings. Yet the human body has already altered itself and adapted to this technology. This means human brains today actually filter out these frequencies and makes us un-harmed.

The best example which can help us understand about our human brains is say you are in a kitchen of a big hotel. Still you can have normal quite conversation with others in the kitchen. There can be a noisy refrigerator or a grinder etc available in that kitchen room. Now try to record the conversation and listen the record then the noises of fridge and

grinder will dominate the conversation. This shows how our

Brain works and gets adaptable to conditions.

IV. NIKOLA TESLA EXPERIMENT:

History says in 1899 Serbian engineer Nikola Tesla built around 140 foot tall, 12 million volt electric coil in Colorado springs and transmitted electricity wireless across 15 miles which illuminated 100 lamps with the charge. After he switched it on the flashes of lighting leaped the coil and good news was no one was harmed but People walking along the street observed sparks jumping between their feet and the ground . Electricity sprang from taps when turned on. Light bulbs within 100 feet of the lab glowed even when turned off. Horses in a livery stable bolted from their stalls after receiving shocks through their metal shoes

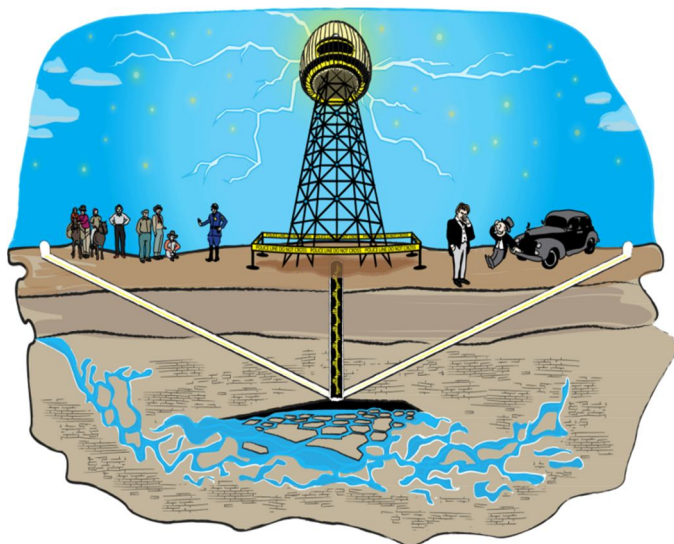


Figure 3

Wireless transmissions of energies at lower levels are not harmful to human bodies. Take Radio or TV transmission from far away broadcasting antennas it does not harm at all. But at very large power levels like very close to powerful antennas there might be problems of excess absorption of energy in human body. Hence it is clearly a matter of magnitude and of principle.

V. CONCLUSION:

Even though it looks safe the effects of electromagnetic radiation on human beings is not fully understood. In reality all electric devices emit radiations. There cannot be complete ban on electromagnetic radiation. The new question that arises now is our human body itself an electromagnetic machinery or device? We need to further study. Yes there is a concern, but we should not underestimate the body's ability to filter out electromagnetic noise! Powering Low power devices with wireless electricity looks safer and does not have any effect on human body. In case of high power devices are powered wirelessly one need to be extremely cautious on the amount of current that is transmitted and if that can affect the human body in any form of leakages or radiations.

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