Electrical Energy Alternative of Magnetic Field Around Wire of Power Line

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Abstract. The electricity crisis can hamper various community or industrial activities. Meanwhile, the magnetic field with a high field strength around the wire and along the power line wire that is passed through a large electric current can be used as a new source of electricity with considerable power. For this reason, efforts are needed to utilize the magnetic field to offer an energy crisis solution. This research applies the magnet-electric law to the toroid core transformer to become a power plant. The simulation is carried out on a toroid transformer with an outer diameter of 11cm, 2.5cm thick, 9cm long which is mounted on a 27A current; 220V or 380V 3Ø. The result can be to turn on a 5W-160V or 10W-65V incandescent or 7W-200V LHE lamps. The value of 27A on the wire does not change due to the utilization of the magnetic field around the electric wire. From the analysis of a linear approach to power lines with larger currents up to several kA, a power of several kW can be generated at 220V. To get more power at a voltage of 220V required more toroidal transformers placed along the power line.

1. Introduction

Background of the crisis of electrical energy and electrical energy supply increasingly unable to meet consumers' needs. Their electric power transmission system that uses low voltage, medium or extra high voltage with large electric currents cause the magnetic field around the wire channel high power. Electric current in the wire line electric power it is alternating (ac) which will produce a magnetic flux varies with time can generate the induced voltage in accordance with Faraday's law. The emergence of the pros and cons about the dangers of electromagnetic field radiation in the vicinity of high-voltage wires and extra high.[1]. This study intends to utilize magnetic fields that exist on the power line of low voltage or medium voltage as a source of electrical energy, designing a piece of equipment that can tap magnetic flux that surrounds the wire transmission with the goal of making a power plant alternative based magnetic field is in the range of the transmission line that can generate a voltage of 220 V as a power supply for the public electricity supply in these locations, as well as changing views of people about the dangers of electromagnetic field radiation.[4][8]
2. Electromagnetic Fields In Surroundings Wire Channel Power

2.1 Basic Electromagnetic

Based on Maxwell's laws and Flemming around electrical wires that electrified will arise surrounding the magnetic field is along the wire and the wire with a magnetic field pattern as in figure 1. The first law of Maxwell say that; "Integral circumference of the magnetic field strength is proportional to the electric current that is on extents terlingkup the circumference of a circle".[1][2]

\[
\oint_{\Gamma} H \cdot dl = \int_{A} J \cdot dA
\]

(1)

dimana : 
- \( H \) = Magnetic field intensity ( A-t / m )
- \( dl \) = the smallest unit of path length circular
- \( J \) = electric current density ( A/m² )
- \( dA \) = The smallest area of the magnetic field

Another form of equation 1, a direct relationship with a magnetic field intensity \( H \) in a circular path length \( l = 2.\pi.r \), can be written as

\[
2.\pi.r.H = N.i
\]

(2)

In single channel wire or a single wire coil that is \( N = 1 \), then the magnetic field strength at the point \( M \) as far \( r \) from the center point of the wire isr from the center point of the wire is

\[
H = \frac{N.i}{2.\pi.r} = \frac{1}{2.\pi.r}
\]

(3)

If the electricity power lines were installed a toroid is then based on the law of ampere circle where wire line electric current is the primary winding of transformer toroid with the number of winding \( N_1 \) is 1 (one) winding wire through which the current \( i \) of the electricity power lines is considered as a
source of magnetic current or known as forced magnetomoti (mmf) has a direct relationship with a strong magnetic field $H$ in a circular path length $l = 2\pi r$, can be written as $[3][4]$

$$2\pi r H = N_1 i_1 \quad \text{atau}$$

$$H = \frac{N_1 i_1}{2\pi r} = \frac{1}{2\pi r}$$ \hspace{1cm} (4)

Based on law induction voltage of Faraday’s, the voltage induction generated at the primary side of the transformer toroid in the general form is $[1][6][9]$

$$e_1 = N_1 \frac{d\phi}{dt}$$ \hspace{1cm} (5)

or

$$e_1 = \mu_n \mu_r H_1 A N_1 \cos \omega t$$ \hspace{1cm} (6)

by ignoring the loss factor and the other, then in the same may as on the primary side, the induced voltage is generated in the secondary side of the transformer toroid in the general form is $[6][9]$

$$e_2 = N_2 \frac{d\phi}{dt}$$ \hspace{1cm} (7)

or

$$e_2 = \mu_n \mu_r H_2 A N_2 \cos \omega t$$ \hspace{1cm} (8)

When loads such as incandescent lamps, with a rated power $P_2^*$, and the voltage $V_2^*$, lamp resistance is

$$R_B = \frac{(V_2^*)^2}{P_2^*}$$ \hspace{1cm} (9)

The load current on the secondary side of the transformer is

$$I_2 = \frac{V_2}{R_B} = \frac{V_2 P_2^*}{(V_2^*)^2}$$ \hspace{1cm} (10)

If the ratio of toroid winding and primary power line is

$$N_2 \frac{V_2 P_2^*}{(V_2^*)^2} k = N_1 I_1$$ \hspace{1cm} (11)

where: $V_2$ is the voltage that occurs at the secondary side in a state burdened $I_1$ is current on the primary in a state burdened

Then, if we want to determine how much power the load (lights) can be supplied with a voltage $V_2$ equal to the rated voltage of 220 volt lights, then the equation is

$$P_2^* = \frac{N_1 I_1 (V_2^*)^2}{N_2 V_2 k} = \frac{N_1 I_1 220}{N_2 k}$$ \hspace{1cm} (12)

It means that to supply the load with power $P_2^*$ at a voltage of 220 volts required primary current (current on power line) that is equal to $I_1$, $V_2 = \frac{N_1 I_1 (V_2^*)^2}{N_2 P_2^* k}$ \hspace{1cm} (13)
3. Simulations Experiment

In this research used two kinds of toroidal sizes are: Type 1 with a core size of the outside diameter (D) 11 cm, thickness (T) of 2.54 cm, length (L) 9 cm, the maximum output voltage of 240 V, the number of windings (N<sub>2</sub>) 250, and type 2 with size D = 9 cm, T = 2.5 cm, L = 8cm, the number of windings (N<sub>2</sub>) 250 for comparison. See figure 3. Load the secondary form varies the 5W incandescent lamp, 10 W, 25W, 40 W, 60 W and Electronic TL 7W and 15W. [4][7]. Experiment circuits are shown in figures 2 and 3.

![Figure 2: Photo of circuit of Toroid system, in lab](image)

![Figure 3: The Circuits of experiments 2](image)

3.1 Experiment 1

Experiment 1, is intended to determine the magnitude and ability of the magnetic field energy produced by electric current I<sub>1</sub> on the cable to turn on lamps with different power sizes and voltage values generated in the lamp. Technically it is: wire lines as the main power source with a constant load in the form of 17 kW 3-phase electric motors. Using toroid type 1 and type 2 which are installed alternately on a single phase wire, that is in Figure 2. (results see tables 1 and 2).

3.2 Experiment 2

Variable of line current , is intended only to determine how much current I<sub>1</sub> to be flowing in the wire line electric power (on primary side) so that each lamp can light normally at a voltage of 220 V on the secondary side of the toroid.

3.3. Experiment Results

For the first experiment are shown in Table 1 and 2. And to experiment 2 are shown in Table 3. The experimental results that the primary burden in the form of three phase motors in a normal running state shown in tabel1, Toroid type 1. Load of toroida is (a) incandescent lamp as a and (b) Electronic TL as b

3.3.1. The results of the experiments 1a , with current I<sub>1</sub> are the value of the 3-phase motor current as a load of the primary power line, and using toroid type 2 are shown ini table 1

| Lamp (W) | Volt.of Lamp (V) | I<sub>1</sub> (A) | Description |
|----------|------------------|-----------------|-------------|
| 5 W<sup>a</sup> | 160 | 27 | dim |
| 10W<sup>a</sup> | 60 | 27 | dim |
| 7W<sup>b</sup> | 200 | 27 | bright |
3.3.2. The results of the experiments 1b, with current $I_1$ are the value of the motor starting current as a load of the primary power line, dan using toroid type 1 are shown in table 2

| Load | Lamp (W) | $I_1$ (A) | $V_{1,1}$ (V) | Description |
|------|---------|----------|-------------|-------------|
| 10W  |         | 80       | 230         | bright      |
| 40W  |         | 80       | 225         | bright      |
| 60W  |         | 80       | 165         | dim         |

3.3.3. The results of the experiments 2, Variable of line current, is intended only to determine how much current $I_1$ to be flowing in the wire line electric power (on primary side) so that each lamp can light normally at a voltage of 220 V on the secondary side of the toroid. The secondary (low voltage) short circuited with a long wire as the primary line current $I_1$, by using slide regulator to obtain the amount of current that can be set, see figure 3 and the results can be seen in table 3.

| Load | Lamp (W) | $I_1$ (A) | Lamp voltage (V) | Description |
|------|---------|----------|-----------------|-------------|
| 40W  |         | 70       | 220             | bright      |
| 60W  |         | 105      | 220             | bright      |
| 100W |         | 175      | 220             | bright      |

Table 2. Results of the experiments, with current $I_1$ are the value of the motor current

Table 3. The results of the experiment 2, with variable line current, using the toroid type 1

The value of the current in table 3 above is the large excitation current is required to flow on the wires of electricity to power the lights burden toroid size or type 1 at the price of normal voltage of 220 volts. It can be analyzed through the characteristic curve current wires primer $I_1$ and toroid load voltage $V_L$ for some great nominal wattage of incandescent bulbs following

![Figure 4. Curve $I_1 - V_L$ on the value of different loads](image)

The dashed line is the possible voltage that can occur and curved lines caused by saturation of the toroid core. Results of experiments using toroidal type 1 ($T_1$), type 2 ($T_2$) and type 3 ($T_3$), using a set of images and slide regulator fig.3 single phase system as a variable voltage source, shown in table 3

4 Discussion

From table 1 with a load of secondary that incandescent lamps 5W, the light is dimmed with a voltage of 160 V, the current ($I_1$) 27 A, an incandescent bulb 10 W, the light is dimmed by the voltage 65 V, is still on the current ($I_1$) 27 A, whereas with Electronic TL 7W bulbs, lights brightly with a voltage of 200 V, and the current ($I_1$) is still at the same value at 27 A; meaning there is no change in the current.
flow in primer power line due to the load change of the toroid transformer secondaries. In table 2 with incandescent light load on the flow channel 80 A, 10 W lamps can be lit up very bright and 40 W lamps also brightly, while the 60 W lamp dimly. In table 3 with toroid transformer type 1, shows that to light a 40W incandescent lamp at a voltage of 220 V necessary flow channel 70 A, 60 W lamps need current 105 A, and 100W lamps need current 175 A.

5. Conclusion
Alternative energy can be obtained through the use of magnetic field energy that is along the power lines using toroids. From the analysis through a linear approach that in power lines with larger currents up to hundreds of amperes can be obtained power up to several kilowatts at 220V. And the more toroids installed along the power line, the more new electrical energy will be obtained. The greater the electric current flowing in the wire, the greater the energy produced by the magnetic field around the wire with the highest magnetic field intensity located at the nearest radius of the electric power line.[2]

6. Suggestion
Further study on power lines with larger electric currents, it is necessary to design toroidal core transformers with larger sizes. The use of more transformers to be installed in rows on long electric cables in a three-phase system, to ensure there is no influence of the use of the magnetic field along the wire line on current, voltage and power in this main power line.

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