ON THE PHYSIOLOGICAL INFLUENCE OF ELECTROMAGNETIC WAVES CONSIDERING AN ELECTRICAL MODEL OF PULMONARY VENTILATION

PhD. Student **Cătălina LUCA** , Prof. Dr. Eng. **Alexandru SĂLCEANU**

University „Gh. Asachi " from Iasi
Faculty of Electrical Engineering , Computer Science and Applied Energy
Electrical Engineering Department

REZUMAT. Am dezvoltat un model electric al ventilatiei pulmonare in Simulink-Matlab , si am studiat influenta radiatiei electromagnetice asupra functionarii fiziologice a plamanului. In cadrul modelului nostru simulat , am observat ca radiatiile electromagnetice de frecvata joasa (7.83-50 Hz) influenteaza intr-o mare masura functionarea fiziologica a plamanului. La expunerea organismului uman intr-un mediu cu radiatii electromagnetice se produc modificari la nivelul ventilatiei pulmonare , scazand volumul si crescand fluxul aerului ce intra in plaman , oadata cu cresterea frecventei radiatiei la care este expus organismul uman. Acest lucru duce la cresterea numarului de respiratii pe minut , a numarului de batai ale cordului si a tensiunii arteriale.

Cuvinte cheie: radiatii electromagnetice , modelul electric al ventilatiei pulmonare, radiatii daunatoare corpului uman .

ABSTRACT. We have developed an electrical model of pulmonary ventilation in Simulink-Matlab , and we have studied the influence of electromagnetic waves on physiological lung function. In our simulated model, we observe that low frequency electromagnetic radiation (7.83-50 Hz) greatly influences the physiological functioning of the lungs. At the exposure of the organism in an environment with electromagnetic radiation, volume of air in the lungs decreases and flow increases with increasing frequency radiation they are exposed. This increases the number of breaths per minute, increased heart rate and blood pressure.

Keywords: electromagnetic waves, electrical model of lung ventilation, human body harmful radiation.

1. INTRODUCTION

Models designed using classical Simulink networks provide a clear graphic visualization of individual mathematical relationships. Starting fron a specific input signal , we obtaine miscelanious outputs , taking into the consideration the alterations provided by the transfer functions of the inserted blocks. This is the so called causal modelling. By interconnecting individual components, the systems of equations become connected with each other. Interconnection of the components does not define the calculation but the reality modeled.

2.MECHANICAL LUNG VENTILATION

The lungs receive a flow of air that starts from the mouth, going on through the airways: trachea, main bronchi, smaller bronchi branch, up to the bronchioles, and finally the alveolar ducts and alveoli. Alveoli are tiny air sacs where oxygen and carbon dioxide can be exchanged with adjacent blood capillaries[1]. Lung size may vary by distension and retraction in two ways:

1.by rise and fall movements of the diaphragm, which elongate and shorten the chest cavity.

2.by raising and lowering the ribs, which increase respectively decrease antero-posterior diameter of the chest cavity[1].

During inspiration, contraction of the diaphragm pulls down to basal lung. Then , during exhalation quiet, the diaphragm relaxes and elastic retraction of the chest wall and abdominal structures compresses the lungs[2].

The pleural pressure is developed inside the space determined between the pleura and the parietal part of the lungs. Normally, there is a constant suction of fluid in this space, which leads to a lower pressure compare with the atmospheric value. Pleural pressure varies with respiration phases[3].

Alveolar pressure is the pressure inside the lung alveoli. While resting quite, the glottis is open, air circulates between the lungs and the atmosphere and at this point, the pressure in any part of the respiratory tree is equal to atmospheric pressure, 0 cm H2O. To allow air into the lungs during inspiration, the pressure in the alveoli must drop below atmospheric pressure, during a normal inspiration it becomes lower. This value is quite enough that 500 ml of air enter the lung during the two seconds of an normal inspiration[3].

The reverse complementary process of exhalation lasts for 2-3 seconds , time enough for the previous mentioned volume of air to be expelled , by using the increased alveolar pressure.

3.MECHANICS OF BREATHING AND PRESSURE CHANGES

The normal breathing process means changes in lung volume, air flow, intrapleural pressure and alveolar pressure. The diagram below shows the lung and a spirometer measuring its changes:

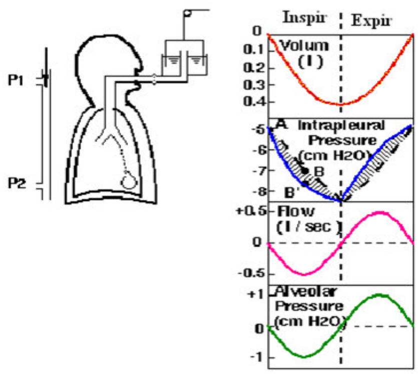


Fig.1. Main parameters of breathing measured with a spirometer

According to these graphs normal values are:

- **The volume V = ± 0.4 l (inhale / exhale)**
- **Intrapleural pressure Ppl = ± 8 cm H2O**

  (inhale / exhale) [6,7].

4.THE MECHANICS OF PULMONARY VENTILATION MODEL

The difference between the pressure inside the mouth and the chest, driving air flow can be simulated by a voltage V. Conseqvently air flow can be modeled as a current intensity I and the resistance to airflow through the airways can be represented as an electrical resistance, R. The Ohm's law:

V=RI

Let us consider a simple model of pulmonary mechanics schematically shown in Fig. 2. By applying significant simplification, the lungs can be viewed as three bags connected through two tubes.

The lungs are connected to the ventilator of artificial pulmonary ventilation, which blows air into the lungs periodically under the pressure **PAO**. **P0** is the pressure of ambient atmosphere[7]. The air flow **Q** circulates through upper respiratory tract having the resistance ***RC***. From the upper respiratory tract, air struggles through the lower respiratory tract into alveoli. The resistance of the lower respiratory tract is ***RP***, the pressure in central parts of the respiratory tract (at the borderline of the upper and lower respiratory tract) is ***PAW*** while pressure in alveoli is ***PA***.

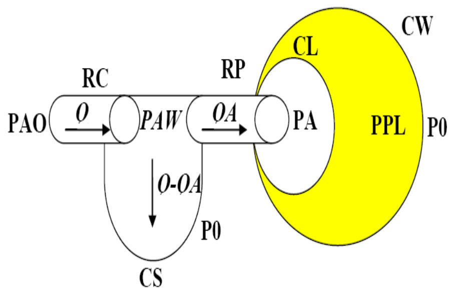


Fig.2. Lung Hydraulic model

Consequently , an electrical model of the lung could be the following presented in Fig.3:

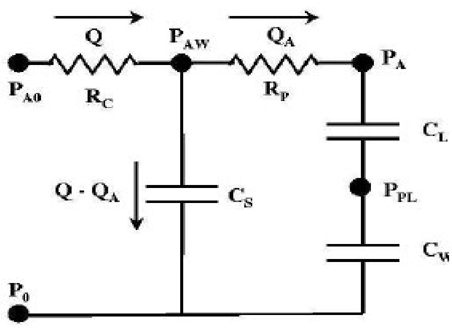


Fig.3. Lung Electrical model

Considering Ohm's law in elasticity equations we obtain:

$$RPQA + \left(\frac{1}{CL}+\frac{1}{CW}\right)\int QAdt \; \frac{1}{CS}\int (Q-QA)dt = 0 \quad (1)$$

First Kirchoff law on loop 2

$$QRC + \frac{1}{CS}\int (Q-QA)dt + (P0-PAO) = 0 \quad (2)$$

First Kirchoff law on loop 1

5.ON THE INFLUENCE OF ELECTROMAGNETIC RADIATIONS ON HUMAN BODY

Although at present little is known about the danger posed by artificial electromagnetic fields (or in other words created by man) , there are increasingly more researchers and scientists who warn of real threats posed by so-called "electromagnetic pollution"[4].

Natural frequency of electromagnetic radiation emitted by our planet is on average 7.83 Hz and is called electromagnetic resonance Schumann, named for the memory of the physicist Otto Schumann who mathematically demonstrated the global phenomenon of electromagnetic resonance existence in 1952 [5].

All the eletromagnetic artificial devices, from mundane plugs, cables, lamps, televisions, computers, wireless devices, microwaves, mobile phones and satellite dishes to, electrical and telecommunications electromagnetic energy losses over 50 Hz in the environment, which some researchers call "electricity polluted" [6].

Extended scientific studies conclude that there is a proportional corespondence between the frequency of the polluting electromagnetic radiation and the number of breaths per minute , the heart rate and the blood pressure.

6.MODEL IMPLEMENTATION IN SIMULINK

The Simulink model can also be expressed in a simpler form. From the begining we will derive the differential equation considerent the elasticity equation :

$$\frac{d^2PAO}{dt^2} + \frac{1}{RP\,CT} * \frac{dPAO}{dt} = RC\frac{d^2Q}{dt^2} +$$

$$+\left(\frac{1}{CS}+\frac{RC}{RP\,CT}\right)\frac{dQ}{dt} + \frac{1}{(RP\,CT)\left(\frac{1}{CL}+\frac{1}{CW}\right)} \quad (3)$$

While entering the following numerical parameters of resistances (in the units: cm H2O/L/sec) and elasticities (in the units: L/cmH2O) : RC=1 ; RP=0.5; CL=0.2; CW=0.2 ; CS=0.005 equation (3) becomes:

$$\frac{d^2PAO}{dt^2} + 420\frac{dPAO}{dt} = \frac{d^2Q}{dt^2} + 620\frac{dQ}{dt} + 4000Q \quad (4)$$

Upon Laplace transform of Equation (5) we obtain:

$$\frac{Q(s)}{PAO(s)} = \frac{s^2+420s}{s^2+620s+4000} \quad (5)$$

This gives us the possibility to simplify the Simulink model.

We have to consider that connection blocks in Simulink reflect the calculation procedure and no real structure modeling.

For simulation we use three oscilloscopes:

1. **Q vs time** oscilloscope which displays the airflow values during yhe inspiration.

2. **V vs. time** oscilloscope wich displays the amount of air entering in lung alveoli during an inspiration and expiration

3. **PA0 vs. time** oscilloscope displays the pressure values at the airway opening.

To implement the model of lung volumes in Simulink , we need the already discussed equation (5) .

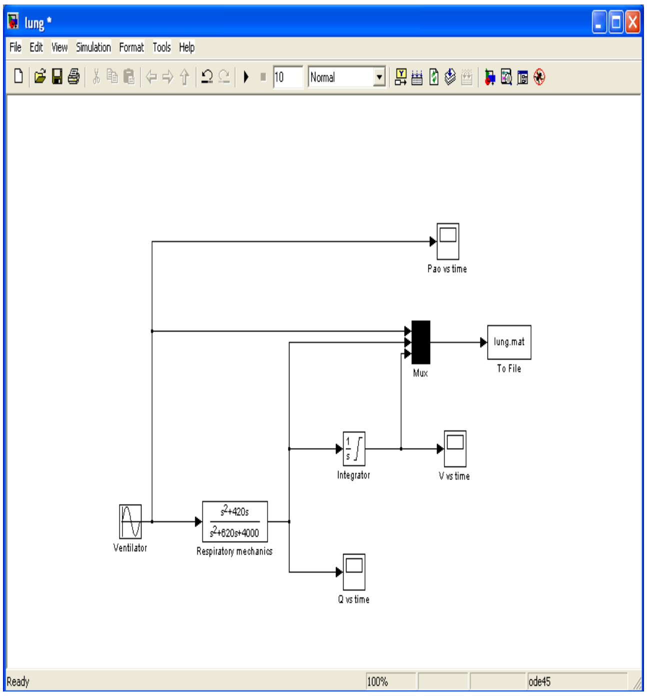
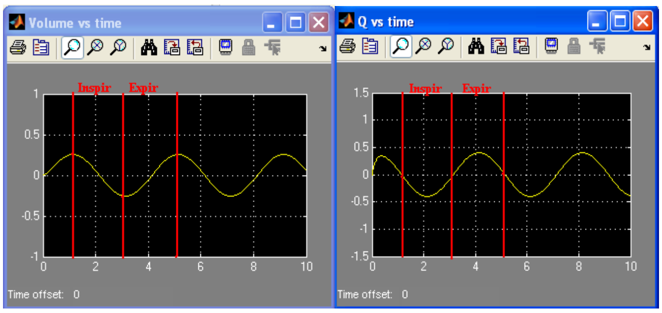


Fig.4. Lung Simulink model

After simulation , we obtain the following graphs:



a) b)

Fig.5. a) Air volume in time (V = ± 0.4 inspire / expiration)

b) Air Flow that enters the lung (Q = -0.5 l / sec to inspire and +0.5 l / sec in expiration)

Considering the values in these graphs we see that the model perfectly simulates the designed physiological model because the same values were obtained from the flow and volume measured by spirometry, in a normal situation.

The control of blocks that are used in the model is done through a file type lung.mat, in which there is the code that connects these blocks. This file is a function that defines all the blocks (and the necessary settings) of the model and the links between them.

7.PULMONARY VENTILATION AND ELECTROMAGNETIC FIELD INFLUENCE

In order to study the influence of electromagnetic fields on pulmonary ventilation and how electromagnetic radiation affects the flows and the lung volumes, we use a sinusoidal wave generator. With this source we apply different frequency values of the electromagnetic fields on the electric model of the lung.

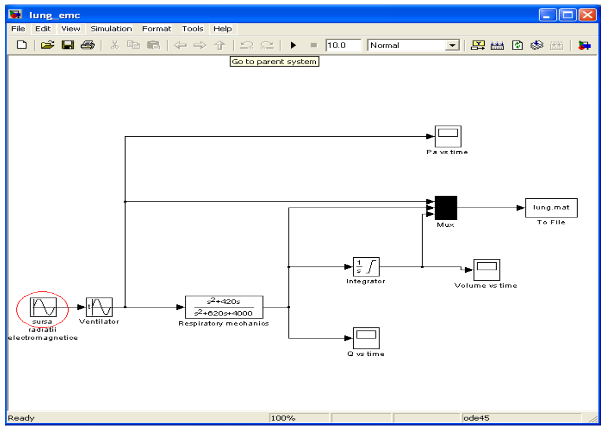
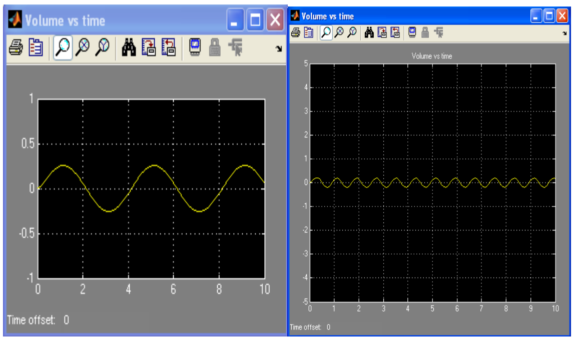


Fig.6. The influence of electromagnetic waves on pulmonary ventilation

The first frequency of induced electromagnetic field has a value of 7.8 Hz (Schumann) , natural frequency emitted by our planet.

Unlike the real lung , in the absence of any disturbance, is unchanged in volume (V) and flow (Q) lung. Volume changes with 0.20 units in both expiration and inspiration and the flow increased from 0.5 to 1.6 units if we apply an electromagnetic signal with frequency = 7.8 Hz.



a) b)

Fig.7 a) Volume = 0.4 units if disturbing signal frequency = 0 Hz

b)Volume = 0.2 units if disturbing signal frequency = 7.83 Hz

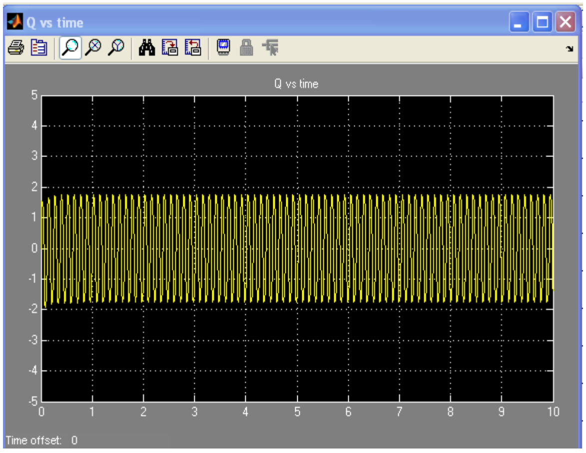
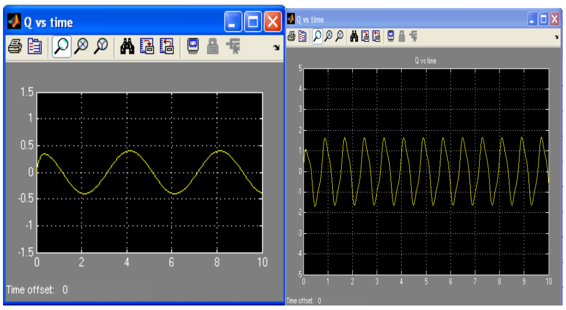


Fig.9. Flow = 2 units if disturbing signal frequency = 50 Hz



a) b)

Fig. 8. a)Flow = 0.5 units if disturbing signal frequency = 0 Hz
b) Flow = 1.6 units if disturbing signal frequency = 7.83 Hz

As disturbing signal frequency increases, we see that more and more volume decreases and flow increases to a value of 2 units. The highest frequency disturbance that we used in this simulation was 50 Hz because we took into account all eletromagnetic artificial devices, from mundane plugs, cables, lamps, tv-sets, computers, wireless devices, microwave ovens, mobile phones electromagnetic energy losses (over 50 Hz) the environment, and that influence the human body. We considered the maximum 50 Hz, because part of the electromagnetic radiation is absorbed by soft tissues before reaching the lungs.

At a frequency of 50 Hz electromagnetic radiation pollution, obtained values were as follows:

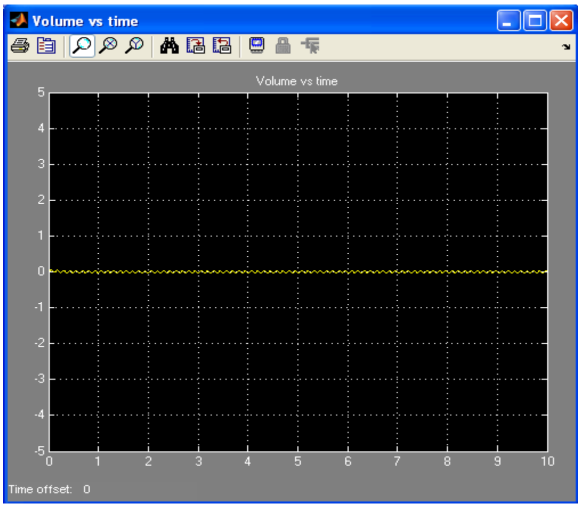
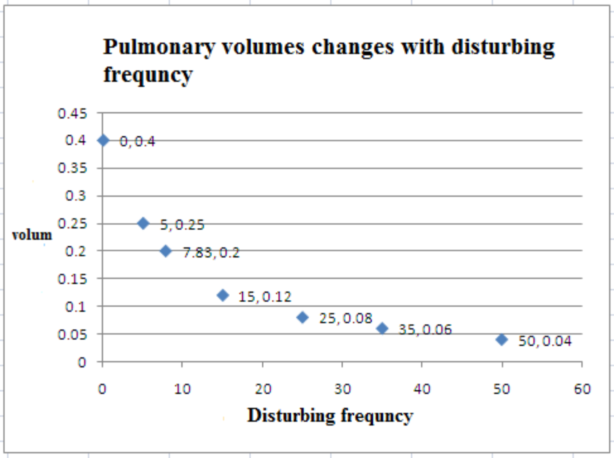
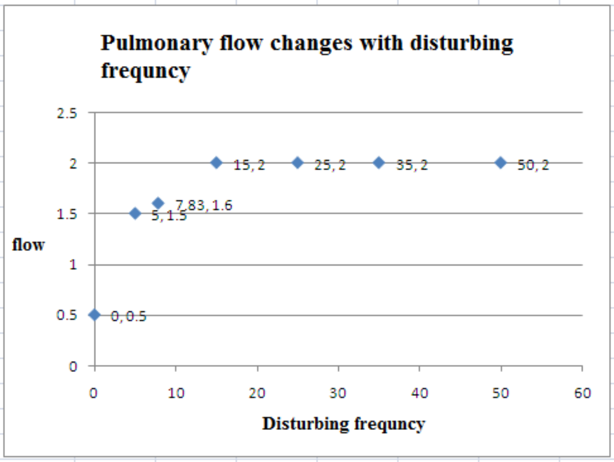


Fig.10. Volume = 0.04 units if disturbing signal frequency is 50 Hz

For a better visualization of the effects of electromagnetic disturbance on the electric model of the lung, we made a graphic showing volume and flow changes depending on the disturbing signal. We deserved that there are no changes of pressure in the lungs, regardless of the amount of harmful electromagnetic radiation.





Our researches might be considered as a new arguments for the harmful effects of electromagnetic fields on human health. The less is the distance from the emitting source , the higher are the disturbing effects on human lungs functioning. Electromagnetic radiations are harmful for human lungs , and influences the air flow and blood circulation in to it. It is suggested that the transmission sources whitch radiate electromagnetic radiation should be located far away from the high residential areas.

8.CONCLUSION

Exposure to electromagnetic waves emitted by electronic devices such as computers, electric blankets, cameras, mobile phones, devices and TV-sets leaves serious consequences on health, due to strong electromagnetic fields (EMF). In the last period more refined researches evidences of the harmful influnce of electromagnetic waves on human health. Particularly dangerous are high voltage magnetic fields IT, between 50-60 Hz, low voltage systems, radar, and a frequency communication systems.

Electromagnetic radiation waves in the cells of living organisms, causes changes in membrane potential, so they polarize and depolarization. Chronic exposure of organisms to such radiation can cause serious disorders.

In our simulated model, we observe that electromagnetic radiation (7.83-50 Hz) greatly influences the physiological functioning of the lungs. At the exposure of the organism in an environment with electromagnetic radiation, volume of air in the lungs decreases and flow increases due to the increasing frequency of radiation they are exposed to. This increases the number of breaths per minute, heart rate and blood pressure.

BIBLIOGRAPHY

[1].*http://www.fiziologie.ro/curs04/2R&EAB.pdf (curs Dr. Anca Bubuianu)*

[2]*http://www.authorstream.com/Presentation/aSGuest11846-144692-mecanica-respiratiei-entertainment-ppt-powerpoint/*

[3] *http://www.ymed.ro/volume-si-capacitati-pulmonare/*

[4] **Mihai Spiridon :”***POLUAREA ELECTROMAGNETICA” , Revista “ Lohanul” , anul V , nr.5(20) , dec.2011*

[5]**Tim Williams , Keith Armstrong** :”*EMC for systems and Installations”- Great Britain , 2000 , Cap.1 (pag.3-5)*

[6]**Tim Williams , Keith Armstrong** :”*EMC for systems and Installations”- Great Britain , 2000 , Cap.4 (pag.68-76)*

[7]**Jakub Rafl** *:“ Artificial Ventilation Simulator” , Czech tehnical university in Prague , Faculty of Electrical Engineering , department of Cybernetics , may 2008.*