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CONTENTS

ACQUISITION AND PROCESSING DATA FROM THE RESISTIVE DISPLACEMENT SENSORS

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Abstract: In this paper a solutions for data acquisition and processing from the displacement resistive sensors is proposed. For these displacement sensors, is used a DC potentiometric bridge whose output signal is a voltage that has the amplitude dependent of resistance variation namely displacement value and polarity dependent of displacement direction.

Key words: resistive sensor, displacement, data acquisition, LabVIEW.

1. INTRODUCTION

Displacement is defined as a physical size that provides information on changing the mechanical position of a material point or a body to a reference system. Other sizes derived from it can be considered: position, distance, proximity. Position is spatial location of a point or body in relation to the reference system; distance is a measure of the relative position between two points or between a point and reference system, and the proximity is the location at very short distance of a point or a body to a fixed reference [1]. In most applications, it is necessary to consider these sizes as vectors, so it is necessary to determine both the module and their sense. The displacement, as vector, may be linear when this is determined by a linear trajectory of movement or angular when this is determined by a circular trajectory. A specific problem for the displacement transducer is how they are coupled to measure the size that can be both linear and (especially) rotating [1], [2] ,[3].

Determination of a displacement, either linear or angular, can be used to measure several sizes whose primary effect is materialized by changing the position of a point, surface or body in relation to a reference such as e.g.: pressure, force, level, temperature.

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2. PRINCIPLES OF DISPLACEMENT IN THE VOLTAGE CONVERSION

Resistive sensor can be made by winding with uniform step, turn near a turn, a conductor wire on support insulation (ceramic) or by depositing a continuously resistive film on an insulating support so that the resistance per unit length is constant (the usual case). The resistance is proportional to the distance d travelled by the wiper between point B and point A in a case of linear movement (Fig.1.a) or to the angle θ_d in a case of angular movement (Fig.1.b), on the sensor surface.
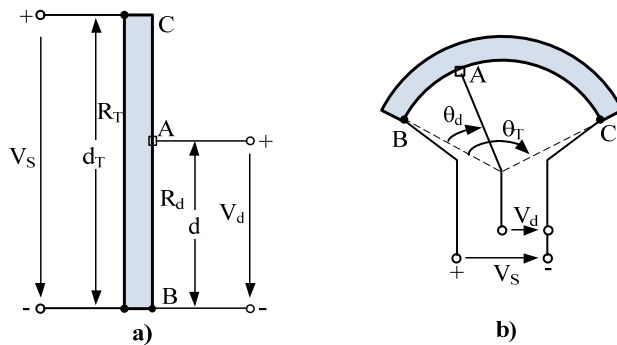
Fig.1. The constructive principle of resistive sensors

The movement is converted into a variation of the length of the conductor so that is obtained a linear relationship between the displacement d and resistance R_d of the sensor.

$$R_d = \frac{R_T}{d_T} \cdot d \tag{2}$$

To retrieve information about displacement with a data acquisition system is necessary to convert the resistance R in current or voltage and this conversion can be made with a rheostat (dimmer) type circuit or most often simplest potentiometer type circuit.
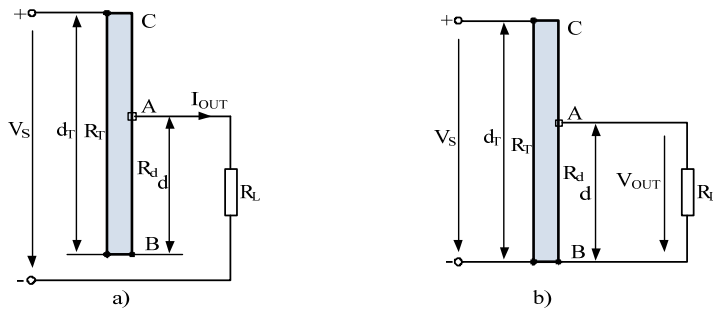
Fig.2. The basics connections of the resistive sensors

If the rheostat connection is used, (Fig.2.a), the displacement d is converted into a current variation, I_{OUT}, according to the relation:

$$I_{OUT} = \frac{V_S}{R_T - R_d + R_L} = \frac{V_S}{R_L} \cdot \frac{1}{1 + \frac{R_T}{R_L}\left(1 - \frac{d}{d_T}\right)} \tag{3}$$

If the potentiometric connection is used, (Fig.2.b), the displacement d is converted into a voltage variation, V_{OUT}, according to the relation:

$$V_{OUT} = \frac{V_S \cdot \dfrac{d}{d_T}}{1 + \dfrac{R_T}{R_L} \cdot \dfrac{d}{d_T}\left(1 - \dfrac{d}{d_T}\right)} \tag{4}$$

As shown in Eq.3 and Eq.4, in both cases, the outputs I_{OUT} and V_{OUT} are not linearly related to the displacement d. In addition, from these outputs cannot retrieve the information regarding to the sense of the displacement [3], [4].
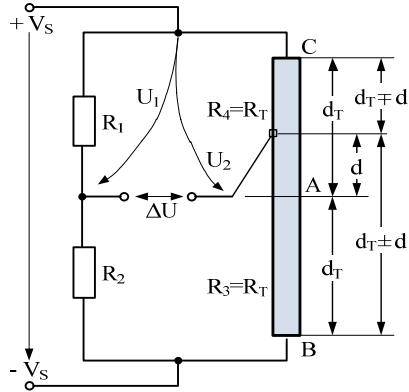
Fig.3. The potentiometric bridge connection

If the sensor is connected into a resistive bridge so that this represent two arms of the bridge, like as shown in Fig.3, the output will become more acceptable, as we see below.

In this case, the full displacement d_t is half the total length of the sensor and can be to one side or another towards to the middle of the sensor, to the limits of this B or C.

It is assumed that the two arms of the bridge are formed by two parts of the displacement sensor with total resistance $2 \cdot R_T$ and for the median position of the cursor, bridge with maximum sensitivity are balanced which means that $R_1 = R_2 = R_3 = R_4 = R$.

As the result of moving of the cursor with distance d, the values of the resistors R_3 and R_4 changes with quantity:

$$r_d = \frac{R_T}{d_T} \cdot d \tag{5}$$

where R_T / d_T is the resistance per unit, so that their values are:

$$R_3 = R_T \pm r_d \quad and \quad R_4 = R_T \mp r_d \tag{6}$$

If the voltage unbalance ΔU output is considered, by applying Kirchhoff's second law is obtained, successively:

$$\begin{aligned} U_1 + \Delta U - U_2 &= 0 \\ \Delta U &= U_2 - U_1 \end{aligned} \tag{7}$$

Voltages U_1 and U_2 are determined based on the voltage divider expression, i.e.|:

$$U_1 = \frac{R_1}{R_1 + R_2} \cdot V_S = \frac{R}{R + R} \cdot V_S = \frac{1}{2} \cdot V_S$$

$$U_2 = \frac{R_3}{R_3 + R_4} \cdot V_S = \frac{R_T \pm r}{R_T \pm r + R_T \mp r} \cdot V_S = \frac{R_T \pm r}{2 \cdot R_T} \cdot V_S$$

(8)

and, based on Eq.7 result:

$$\Delta U = U_2 - U_1 = \pm \frac{r_d}{2 \cdot R_T} \cdot V_S$$

(9)

Taking into account the expression (2) of the resistance per unit, we obtain:

$$\Delta U = \pm \frac{V_S}{2 \cdot d_T} \cdot d = \pm k \cdot d_T$$

(10)

where $k = V_S / 2 \cdot d_T$ is a constant determined by the fact that the supply voltage V_S and total displacement d_T are constant.

Therefore, is obtained an output voltage ΔU that is the displacement d_T linearly dependent, and in addition, its polarity provides information about the displacement sense [4].

3. DESIGNING OF THE VIRTUAL INSTRUMENT FOR DATA ACQUISITION AND PROCESSING

In order to the acquisition, the output voltage ΔU from the potentiometric bridge having connected the resistive sensor is used the National Instruments data acquisition module NI USB – 6008. The National Instruments USB-6008 provides basic data acquisition functionality for applications such as simple data logging or portable measurements [7]. The NI USB-6008 is ideal for academic lab experiments because this allow create the own measurement application by programming using *LabVIEW* and *NI-DAQmx* driver software for Windows [6].

Because the unbalanced voltage of the bridge is a differential signal that depends on the displacement, one of the signal poles is connected to the AI+ (pin 3) data acquisition module terminal, and the other pole is connected to the terminal AI- (pin 2), shown as in Fig.4. Supply voltage V_S for the bridge is also ensured through data acquisition module.

In according with Eq.9., because de supply voltage is $V_S = 5V$ result that the maximum unbalance voltage ΔU is obtained if the displacement d = 0 that corresponding to a proper resistance $r_d = 0$. Thus, the maximum unbalance voltage is $\Delta U = \pm V_S/2 = \pm 2.5V$. This value is in the input range (±1V to ±20V) for the data acquisition module voltage, so is assured the measurement dynamic range and the necessary measurement accuracy.
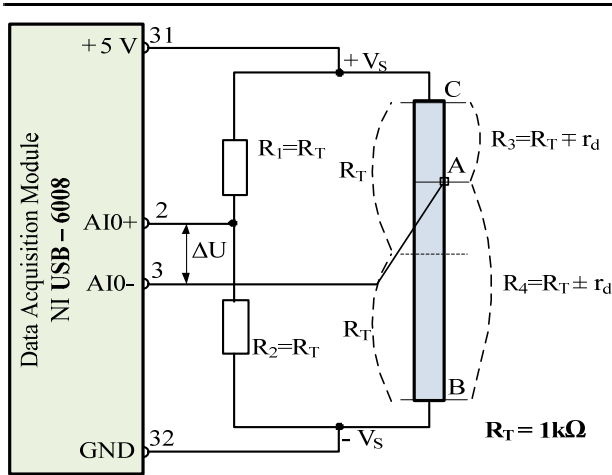
Fig.4. Bridge connection to data acquisition module

For the application presented further, is used a multiturn type resistive sensor with maximum angular displacement of 3600 degrees (10 full rotations) having a 2kΩ total resistance. Displacement is considered null for the position corresponding of the middle of the maximum angular displacement for 1800 degrees (5 full rotations). This position ensures the balance of the potentiometric bridge used as a measurement circuit.

The virtual instrument (VI) is a program written in LabVIEW environment and has the three specific components: Front Panel, Block Diagram, Icon/Connector. The
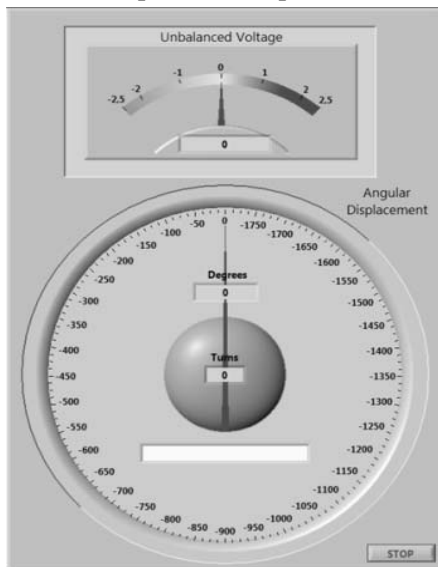
Fig. 5. Front panel of the virtual instrument

front panel is the user interface and contains elements of type controls used for data input or parameter setting values and elements of type indicators used for reading the values of variables resulting from running programs [5].

In Fig.5. the front panel of the virtual instrument is presented, corresponding to a null displacement, represent the balance of the potentiometric bridge.

In this case, the front panel of the virtual instrument realized for data acquisition and processing of resistive sensor signal is represented by a single control button, STOP, used to stop running of the application.

The other elements on the front panel are indicators, and they are:

• **Unbalanced Voltage**; indicator that displays the value of unbalanced voltages of the potentiometric bridge used to convert the variation of resistance, and thus the

displacement, in voltage. This indicator is represented both as Meter form and as Digital form.

- **Angular Displacement**; indicator that display the value in degrees of angular displacement measured with resistive sensor, value which can be up to 1800 degrees. This indicator is represented both as Gauge form and as Digital form.
- **Turns**; Numeric indicator that displays the entire number of revolutions, number which can be up to five.
- String indicator that display one of the messages: EQUILIBRIUM, RIGHT or LEFT according as the displacement is null or the displacement is in right or left direction.

The unbalanced voltage and the angle of displacement will be with negative or positive values as the displacement occurs in one sense or the other relative to the position of equilibrium.

In Fig.6, the screenshots of the front panel are shown, corresponding to the three cases, namely for three different values of the displacement, in right or in left sense.
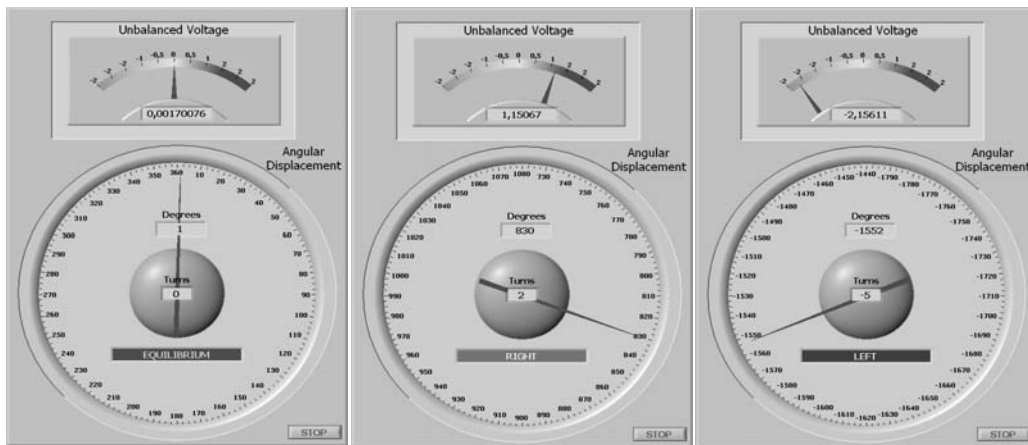
Fig.6. Screenshots of the front panel of the virtual instrument

Block diagram that represents the program itself contains structures, functions and operations required program accomplishments. For this application, the algorithm shown in Fig.7 realizes the acquisition and data processing program.

The acquisition process begins with acquisition settings, which means the choice of the output signal from the sensor (Analog Input →Voltage), its variation range (-5 … +5 V), the proper input of the acquisition module (a0, Terminal Configuration → Differential), the number of samples (100) and sampling rate (1kHz). All of these settings can be made through DAQ Assistant function (National Instruments 2009) [6].

Based on data acquisition and processing algorithm, is built the corresponding program that is represented by the diagram block, shown in Fig.8.
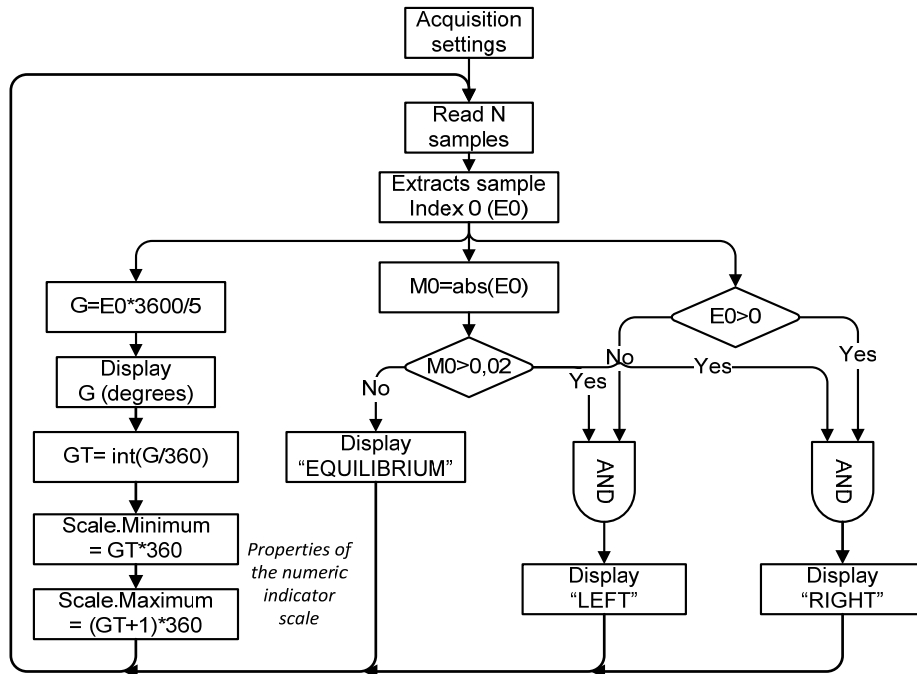
Fig.7. The data acquisition and processing algorithm
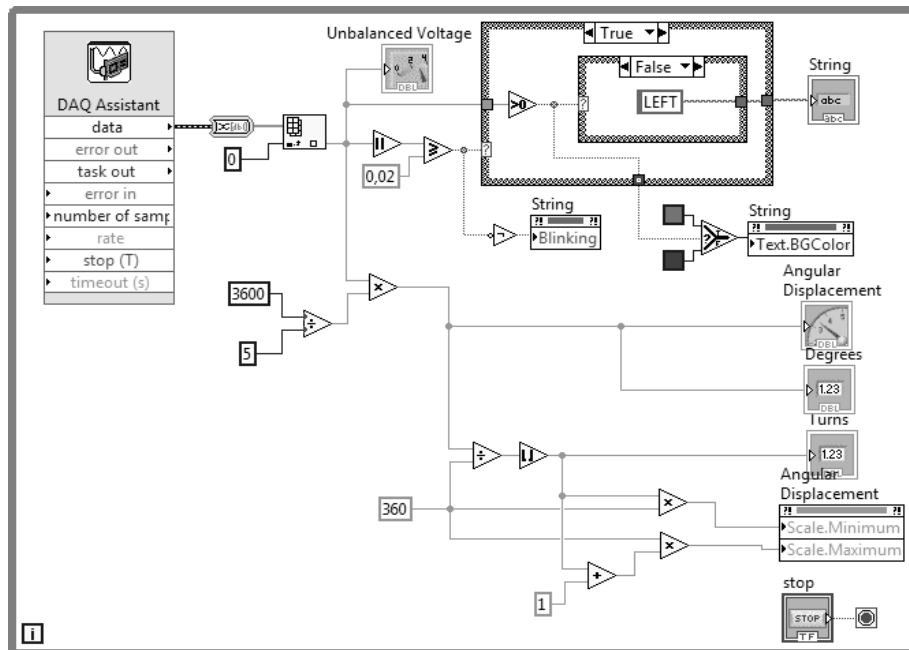
Fig.8. The diagram block of the virtual instrument

After the acquisition of each package of samples is extracted the sample with index 0, which is displayed as a voltage imbalance, is used in calculating the angular displacement by multiplying it by the constant 3,600/5 (range of displacement over the range of bridge output voltage). In addition, its absolute value is used to identify the equilibrium state of the bridge, which supposedly corresponds to a null angular displacement. Angular displacement is expressed also by the number of complete turns (GT), the number that is calculated by dividing the total angular displacement with 360 degrees (complete turn).

For each of the five complete turns, corresponding to either direction of the angular displacement, the scale of the indicator "Angular displacement" is corresponding adjusted by setting minimum and maximum values of this scale though Property Node function. The minimum value is calculated by multiplying with 360 degrees the current number GT of complete turns made, and the maximum value is calculated by also multiplying with 360 degrees but the number GT+1 that represent the next turn. For example, assuming that two complete turns are made and the movement is ongoing within the three turn, the minimum scale value is set to *3·360 = 1080* degrees and the maximum scale are set at *(3 +1)·360 = 1440* degrees.

4. CONCLUSIONS

The solution presented can be applied to any resistive sensors connected to any data acquisition boards or data acquisition module.

The solution presented allows both determination of the amount of displacement and its direction against a reference position.

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MOTION CONTROL OF ELECTRIC VEHICLE

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Abstract: In this paper we present a new cinematic structure of an electric vehicle driven by three induction motors with short-circuited rotors. Motion control is done by the means of three DFOC type position vector regulating systems that contain Gopinath type rotor flux estimators in their loops.

Key words: Motion control simulation model electric vehicle.

1. INTRODUCTION

The proposed cinematic structure for the electric vehicle is presented in Figure 1. The wheels are placed perpendicularly on the main axes situated 120 degrees from each other.

Each wheel consists of two circles of roll modules that allow the wheel to slide in the direction of the arm (Figure 2).

The main advantage of this kind of electric vehicle with respect to the classical configuration, that includes two fixed parallel active wheels and a mobile one, is that the omni directional one can move in any direction in the plane at any given moment, without being influenced by the current position of the electric vehicle.

Fig. 1. The electric vehicle configuration
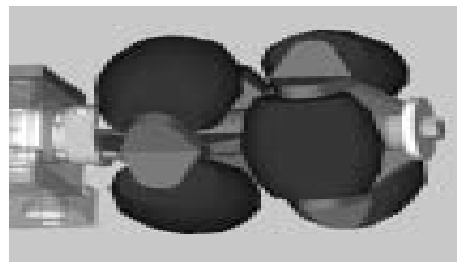
Fig. 2. The structure of the wheel

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The classical configuration doesn't allow the electric vehicle to move in any direction, in most cases a rotation being necessary before the desired movement could be performed. The only disadvantage of the omni directional model would be the structure that is a bit more complex, and that can result in a higher production cost.

2. KINEMATIC STUDY

The kinematic model of the electric vehicle will compute the rotation speed of each wheel in order for the center of the vehicle to move straight from one point to another, at a given velocity and with an added rotation of the entire vehicle around its axis with a given angle. In order to perform the kinematic study, four orthogonal coordinates: three of them attached to the motor arm (X_aY_a for the QA arm; X_bY_b for the QB arm; X_cY_c for the QC arm) and a general one, that is XY, are used. All these systems originate in the intersection point of the three arms of the vehicle, the Q point in the figure 3.
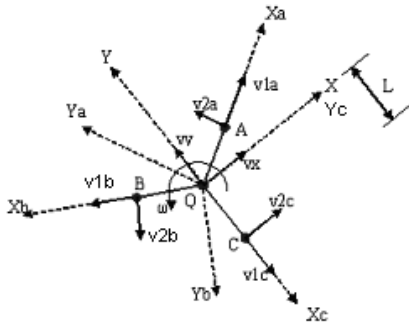
Fig. 3. The graphical layout for determing the kinematic model of the electric vehicle
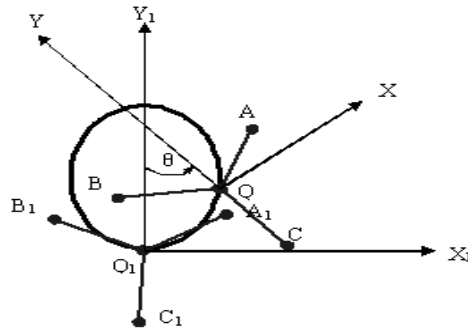
Fig. 4. Graphical help for calculating the kinematic model

For to calculate the kinematic model, were made the following presumpsions :
a) in the $X_1Q_1Y_1$ system the coordinates of the (x_1, y_1) points are known; (the parametrical equations of point Q trajectory) the length L of the arms QA, QB, QC; the radius r of the wheels and the rotation angle θ (figure 4).
b) the following variants are unknown
    –   the angular velocity ωa, ωb, ωc of the three wheels;
    –   the v1a, v1b, v1c velocities;
    –   the v2a, v2b, v2c velocities.
In order to perform the kinematic study, the following steps have to be made:
Step 1: The XQY system is rotated with 30⁰ counterclockwise, until it becomes the new X_aQY_a system. The kinematics equation (1) is projected on the X_a axis and respectively on Y_a axis, thus obtaining (2)

$$\overline{va} = \overline{v1a} + \overline{v2a} = \overline{v_Q} + \overline{\omega} \times \overline{QA} \tag{1}$$

$$\begin{cases} v1a = vx \cdot \cos(30) + vy \cdot \sin(30) \\ v2a = \omega a \cdot r = -vx \cdot \sin(30) + vy \cdot \cos(30) + \omega \cdot L \end{cases} \tag{2}$$

System (2) becomes

$$\begin{cases} v1a = vx \cdot \sqrt{3}/2 + vy \cdot 1/2 \\ v2a = \omega a \cdot r = -vx \cdot 1/2 + vy \cdot \sqrt{3}/2 + \omega \cdot L \end{cases} \tag{3}$$

Step 2: The XQY system is rotated with $150^{\mathbf{0}}$ counterclockwise, until it transforms into the new X_bQY_b system. The kinematics equation (4) is projected on the X_b and respectively on Y_b axis, thus obtaining (5)

$$\overline{vb} = \overline{v1b} + \overline{v2b} = \overline{v_Q} + \overline{\omega} \times \overline{QB} \tag{4}$$

$$\begin{cases} v1b = vx \cdot \cos(150) + vy \cdot \sin(150) \\ v2b = \omega b \cdot r = -vx \cdot \sin(150) + vy \cdot \cos(150) + \omega \cdot L \end{cases} \tag{5}$$

System (5) becomes

$$\begin{cases} v1b = -vx \cdot \sqrt{3}/2 + vy \cdot 1/2 \\ v2b = \omega b \cdot r = -vx \cdot 1/2 - vy \cdot \sqrt{3}/2 + \omega \cdot L \end{cases} \tag{6}$$

Step 3: The XQY system is then rotated with $270^{\mathbf{0}}$ counterclockwise, until it transforms into the new X_cQY_c system. The kinematics equation (7) is projected on the X_c and respectively on Y_c axis, thus obtaining (8)

$$\overline{vc} = \overline{v1c} + \overline{v2c} = \overline{v_Q} + \overline{\omega} \times \overline{QC} \tag{7}$$

$$\begin{cases} v1c = vx \cdot \cos(270) + vy \cdot \sin(270) \\ v2c = \omega c \cdot r = -vx \cdot \sin(270) + vy \cdot \cos(270) + \omega \cdot L \end{cases} \tag{8}$$

System (8) becomes

$$\begin{cases} v1c = -vy \\ v2c = \omega c \cdot r = vx + \omega \cdot L \end{cases} \tag{9}$$

Now the following variables have to be determined

$$v_{Qx} = dx_1/dt; \quad v_{Qy} = dy_1/dt; \quad \omega = d\theta/dt$$

and then

$$\begin{cases} vx = v_{Qx} \cdot \cos\theta + v_{Qy} \cdot \sin\theta \\ vy = -v_{Qx} \cdot \sin\theta + v_{Qy} \cdot \cos\theta \end{cases}$$

Equations (3), (6), (9) put together make up a system, which gives the unknown variables:

$$\begin{bmatrix} \omega a \\ \omega b \\ \omega c \end{bmatrix} = \begin{bmatrix} -1/(2 \cdot r) & \sqrt{3}/(2 \cdot r) & L/r \\ -1/(2 \cdot r) & -\sqrt{3}/(2 \cdot r) & L/r \\ 1/r & 0 & L/r \end{bmatrix} \cdot \begin{bmatrix} vx \\ vy \\ \omega \end{bmatrix} \tag{10}$$

$$\begin{bmatrix} v1a \\ v1b \\ v1c \end{bmatrix} = \begin{bmatrix} \sqrt{3}/2 & 1/2 \\ -\sqrt{3}/2 & 1/2 \\ 0 & -1 \end{bmatrix} \cdot \begin{bmatrix} vx \\ vy \end{bmatrix} \tag{11}$$

$$\begin{bmatrix} v2a \\ v2b \\ v2c \end{bmatrix} = r \cdot \begin{bmatrix} \omega a \\ \omega b \\ \omega c \end{bmatrix} \tag{12}$$

In the above equations the Euler rotation matrix was used. A short graphical presentation and the corresponding Euler rotation matrix can be seen as follows

$$\begin{bmatrix} pX \\ pY \end{bmatrix} = \begin{bmatrix} \cos(\theta a) & \sin(\theta a) \\ -\sin(\theta a) & \cos(\theta a) \end{bmatrix} \cdot \begin{bmatrix} px \\ py \end{bmatrix} \tag{13}$$

If the following notation is made

$$A = \begin{bmatrix} -1/(2 \cdot r) & \sqrt{3}/(2 \cdot r) & L/r \\ -1/(2 \cdot r) & -\sqrt{3}/(2 \cdot r) & L/r \\ 1/r & 0 & L/r \end{bmatrix} \tag{14}$$

$$A^{-1} = \begin{bmatrix} -r/3 & -r/3 & 2 \cdot r/3 \\ r \cdot \sqrt{3}/3 & -r \cdot \sqrt{3}/3 & 0 \\ r/(3 \cdot L) & r/(3 \cdot L) & r/(3 \cdot L) \end{bmatrix} \tag{15}$$

One can write

$$\begin{bmatrix} vx & vy & \omega \end{bmatrix}^T = \begin{bmatrix} A \end{bmatrix}^{-1} \cdot \begin{bmatrix} \omega a & \omega b & \omega c \end{bmatrix} \tag{16}$$

Equations (10) and (16) were used to write two short programs, which can be seen as follows:

```
function[sys,x0]=mmm(t,x,u,flag,Lu,ra)
if flag ==3
sys=[-
(1/(2ra))*u(1)+(sqrt(3)/(2ra))u(2)+(Lu/ra)*u(3);
-(1/(2*ra))*u(1)-(sqrt(3)/(2*ra))*u(2)+(Lu/ra)*u(3);
(1/ra)*u(1)+(Lu/ra)*u(3)];
elseif flag ==0
sys=[0,0,3,3,0,1];
else
```

```
sys=[ ];
end
function[sys,x0]=mmm1(t,x,u,flag,Lu,ra)
if flag ==3
sys=[-(ra/3)*u(1)-(ra/3)*u(2)+((2*ra)/3)*u(3);
((ra*sqrt(3))/3)*u(1)-(ra*sqrt(3))/3)*u(2);
(ra/(3*Lu))*u(1)+(ra/(3*Lu))*u(2)+(ra/(3*Lu))*u(3)]
elseif flag ==0
sys=[0,0,3,3,0,1];
else
sys=[ ];
end
```

These two programs were included in the S_Function blocks "BC_MP" and "Robot", as can be seen in figure 5. These blocks were obtained in Matlab-Simulink.

3. MOTION CONTROL OF THE ELECTRIC VEHICLE

In order to analyze the model that was implemented in the BC_MP, a reverse problem has been solved. On one hand, the rotation velocities of the three wheels were first considered to be:

$$\omega a = \omega b = 0 \quad \omega c \neq 0 \tag{17}$$

After making the necessary changes in (16), system (18) is obtained

$$\begin{cases} vx = (2 \cdot r/3) \cdot \omega c \\ vy = 0 \\ \omega = (r/3 \cdot L) \cdot \omega c \end{cases} \quad \text{or} \quad \begin{cases} vx = 2 \cdot L \cdot \omega \\ vy = 0 \\ \omega = (r/3 \cdot L) \cdot \omega c \end{cases} \tag{18}$$

in which the value of ωc was used from the last equation for expressing vx. On the other hand, from the following system of equations

$$\begin{bmatrix} vx \\ vy \end{bmatrix} = \begin{bmatrix} \cos(\theta) & \sin(\theta) \\ -\sin(\theta) & \cos(\theta) \end{bmatrix} \cdot \begin{bmatrix} v_{Q1x} \\ v_{Q1y} \end{bmatrix} \tag{19}$$

one can obtain

$$\begin{bmatrix} v_{Q1x} \\ v_{Q1y} \end{bmatrix} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} \cdot \begin{bmatrix} vx \\ vy \end{bmatrix} \tag{20}$$

Considering that $vx = 2 \cdot L \cdot \omega$ and $vy = 0$ from (20), we obtain

$$v_{Q1x} = 2 \cdot L \cdot \omega \cdot \cos(\theta) \quad v_{Q1y} = 2 \cdot L \cdot \omega \cdot \sin(\theta) \tag{21}$$
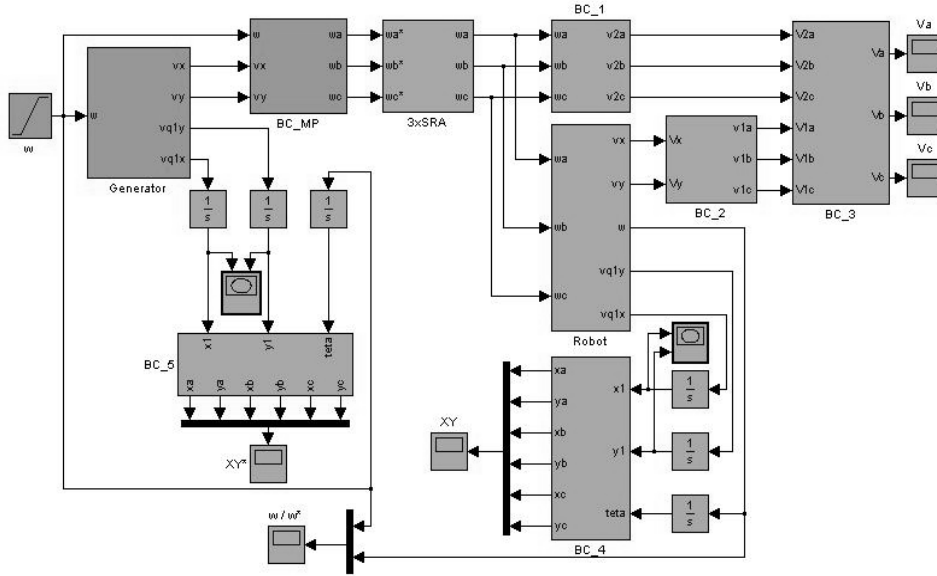
Fig. 5. Simulation diagram of the kinematic model of the electric vehicle

By integrating (21) with respect to time and considering that $\theta(t) = \omega \cdot t$

$$x1 = 2 \cdot L \cdot \sin(\theta) + c1 \qquad y1 = -2 \cdot L \cdot \cos(\theta) + c2 \qquad (22)$$

If the initial conditions are taken into consideration in (22) $\theta = 0; x1 = 0; y1 = 0$ the constants from (22) become

$$c1 = 0; \quad c2 = 2 \cdot L \qquad (23)$$

In these conditions:

$$x1 = 2 \cdot L \cdot \sin(\theta) \qquad y1 = -2 \cdot L \cdot \cos(\theta) + 2 \cdot L \qquad (24)$$

which are the parametrical expressions of a circle having the following coordinates of its center: (0,2L) and the value of its radius 2L

$$x1^2 + (y1 - 2 \cdot L)^2 = (2 \cdot L)^2 \qquad (25)$$

The expressions from (21) were used as entry data for the simulation, these being implemented in blocks Generator as shown in figure 5. The values of v2a, v2b, v2c velocities are calculated in blocks BC_1 and BC_2 as shown in figure 5, using (12), and respectively v1a, v1b, v1c using (11). The value of va, vb, vc velocities can be obtained using the following relations:

$$va = \sqrt{v2a^2 + v1a^2}; \quad vb = \sqrt{v2b^2 + v1b^2}; \quad vc = \sqrt{v2c^2 + v1c^2} \qquad (26)$$

which are implemented in block BC_3. In block BC_4 in figure 5, the coordinates of A (xa,ya), B(xb,yb), C(xc,yc) are calculated using the following relations:

$$\begin{cases} xa = L \cdot \dfrac{\sqrt{3}}{2} \cdot \cos(\theta) - L \cdot \dfrac{1}{2} \cdot \sin(\theta) + x1 \\[2mm] ya = L \cdot \dfrac{\sqrt{3}}{2} \cdot \sin(\theta) + L \cdot \dfrac{1}{2} \cdot \cos(\theta) + y1 \end{cases} \tag{27}$$

$$\begin{cases} xb = -L \cdot \dfrac{\sqrt{3}}{2} \cdot \cos(\theta) - L \cdot \dfrac{1}{2} \cdot \sin(\theta) + x1 \\[2mm] yb = -L \cdot \dfrac{\sqrt{3}}{2} \cdot \sin(\theta) + L \cdot \dfrac{1}{2} \cdot \cos(\theta) + y1 \end{cases} \tag{28}$$

$$xc = L \cdot \sin(\theta) + x1 \qquad yc = -L \cdot \cos(\theta) + y1 \tag{29}$$

The simulation diagram, which tests the above calculations, was designed in Simulink (fig. 5).

The program that draws the current position of the robot "grafic.m" has the following code:

```
n=length(xy(:,1));
for i=1:n
xa=xy(i,2);
ya=xy(i,3);
xb=xy(i,4);
yb=xy(i,5);
xc=xy(i,6);
yc=xy(i,7);
xnh=(xa+xb+xc)/3;
ynh=(ya+yb+yc)/3;
a=[xa,xnh,xb,xnh,xc];
b=[ya,ynh,yb,ynh,yc];
hold on
plot(a,b,'r');
grid;
axis('equal');
pause;
end
```

The structure and the projecting of the position regulating system are presented in detail in the book [14] so that in this paper we will not insist on this.

By starting the program, "grafic.m", the following graphics were obtained by simulating the kinematic model using as values for length and respectively radius: L =2 [m], r =0.325 [m].

4. CONCLUSIONS

The graphics presented above agree with the hypotheses that were made when resolving the reverse problem from the application, which proves that the mathematical model of the electric vehicle is valid. This model that was implemented in block BC_MP has a crucial part in developing the control system of the vehicle, to be more precise it can prescribe the angular velocities (if the positions are integrated) for the three velocity (position) control systems for each motor that actuate the arms of the vehicle. The simulation model has also an important role in real time simulation of the position control system (velocity) using the Matlab simulation platform.
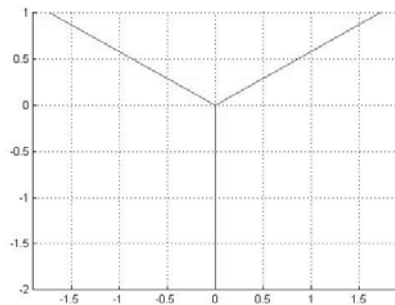
Fig. 6. The initial position of the electric vehicle
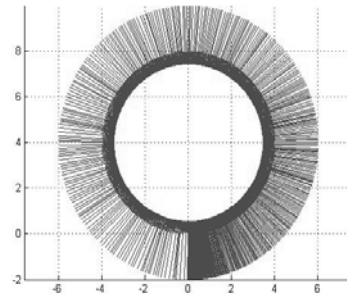
Fig. 7. The position of the electric vehicle for 360 degrees rotation
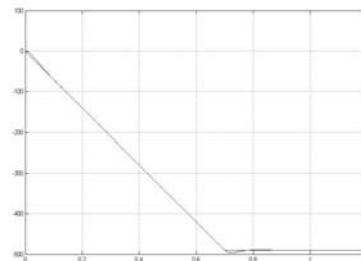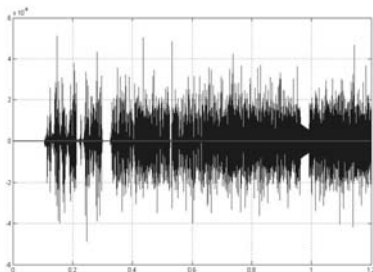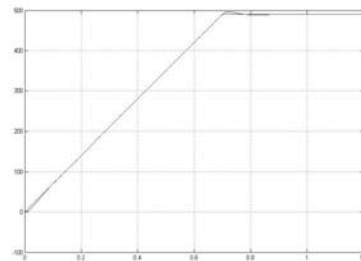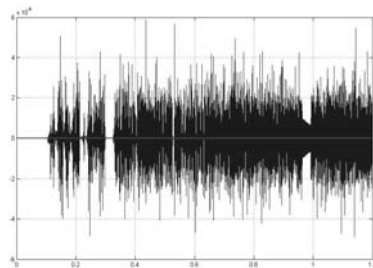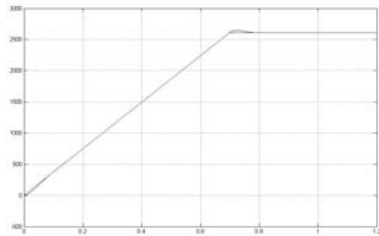
Fig. 8. Angular velocities: wa, wb, wc
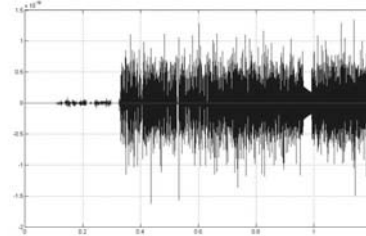
Fig. 9. Velocities: v1a, v1b, v1c
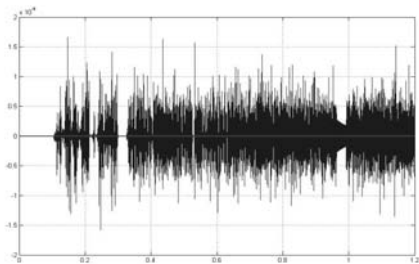
Fig. 10. Velocities: v2a, v2b, v2c
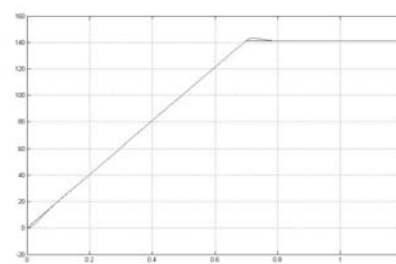
Fig. 11. Velocities: vx, vy, w

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MONITORING SYSTEM OF RENEWABLE ENERGY SYSTEMS

ADRIAN NICOLAE DINOIU [1] IOANA CAMELIA BARBU [2] EMIL POP [3]

Abstract: One aspect not for ignoring in renewable energy is the monitoring of renewable energy systems. We need this measurement to know their characteristics, and their evolution over time. We need to know when they are working properly and when they can produce energy. Thus, we developed a system of regenerative energy system monitoring.

Keywords: renewable, energy, system, monitoring, wind, solar, hydro.

1. ABOUT RENEWABLE ENERGY [1] [2] [4] [5] [6]

It is known that all plants that burn fossil fuels produce CO_2, which is the main cause of global warming, new EU policy focusing on reducing emissions of greenhouse gases by 20% until 2020.

Studies of this are staggering! If we do not start actions that aim to reduce these emissions, in 2030 they will be with 25-90% higher than current levels, and overall will increase in temperature of 0,2 ^{o}C for each of the next three decades, thus reaching 1-6 ^{o}C increase by the year 2100!

Wind energy - both on the ground and at sea, the wind has the power to generate energy. Based on the evaluation and interpretation of data recorded, it follows that in Romania, we can set up wind turbines with a total power of up to 14000 MW, which means a power input of about 23000 GWh / year.

Advantages
- The main advantage of wind energy is zero emission of pollutants and greenhouse gases, because no fuels are combusted;

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- No waste is produced. Production of wind energy production does not involve any kind of a waste;
- Lower cost per unit of energy produced. The cost of electricity in modern wind power decreased substantially in recent years.

    Disadvantages
- A practical disadvantage is the variation in wind speed. Many places on Earth can't produce enough electricity using wind power, and because of this wind is not viable in any location;
- "Visual pollution" - has an unpleasant appearance - and also produces "noise pollution" (too noisy). Others argue that the turbines affect the environment and surrounding ecosystems, killing birds and requiring large vacant land for installation.
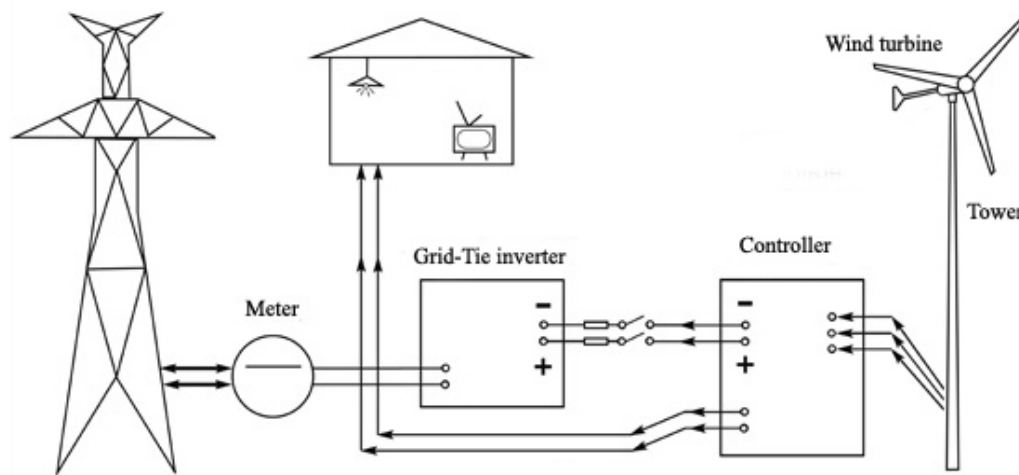
Fig. 1. Wind energy system

Solar power - "The sun is the energy source of the future"! He is an inexhaustible energy and therefore renewable. If we exploit the full potential of solar in our country, we can substitute in this form about 50% of domestic hot water or 15% share of energy for heating.

    Advantages
- Solar energy does not pollute;
- Panels can be operated easily, are subsequent low maintenance and interventions;
- Generate solar energy is a good solution where power lines are missing, such as detached houses, islands, satellites, ships, etc.;
- Solar thermal plants can cover the entire hot water consumption.

    Disadvantages
- Electricity generated from solar sources is often more expensive than electricity produced from other sources;
- At night and cloudy weather, electricity generation can't be achieved, less electricity is made;
- Solar panels produce DC which must be converted to alternating current.

Hydro Energy - Another renewable energy which Romania's hydropower potential is huge. Water is one of the most precious natural resources. Water is at the same time and the best source for green energy. At present, Romania's hydropower potential is exploited at a rate of 48%.

Advantages

- Economic: The main advantage of hydroelectricity is elimination of the cost of fuel. Labor costs are low since plants are automated and have few personnel for normal operation;

- Greenhouse gas emissions: Since hydro turbines not burn fossil fuels, they do not directly produce carbon dioxide.

Disadvantages

- Environmental impact: Some Hydraulic river diversion channels are used to fill tanks in some cases this deviation leads to depletion of some whites.

2. THE MONITORING SYSTEM FOR RENEWABLE ENERGY SYSTEMS [1] [3]

2.1. The principle of operation

The system consists of a hardware part and a software part, with the purpose to retrieve data and display them in a user-friendly interface. Electronic assembly is to take the output voltage transducers and send them through the serial port software interface. It consists of a serial coupling, input voltage representing a PIC 16F877, which makes analog-to-digital conversion and sends it on to the MAX 232 chip that converts the RS-232 format for transmission over the serial port of the computer . The monitoring system records the amount of energy produced by regenerative energy system implemented. Also, you can pick up and transfer characteristics for both wind turbine, and solar panels based on recorded data.

The input data are the voltage and current output measured both regenerative changes, system.

Output data are represented by electric power and energy for each energy system components (wind turbine, solar panels, hydroturbine).

System operation is done using the following algorithm: input pass through mounting hardware are represented by current and voltage transducers, they pass on maximum voltage 5V, which are taken as input by electronic editing, namely the PIC-16F877. Its role is to convert anolog - digital and send data through the serial port MAX232 integrated circuit computer.

Reached the computer data are read from the serial port interface software and using this software they are processed and displayed by the options available. Some options include: real-time graphic display of energy produced by renewable implemented system, storing data read into a database to be used later, displaying a history of energy. In the future, if the computer has internet access can view the recorded data remotely via the Internet.

2.2. The hardware

As mentioned above, this system requires hardware and software, both essential for the functioning of the monitoring system.

The hardware is divided into 2 parts represented by two assemblies, each consisting of 2 transmitters and 2 power supply, used to read current and voltage at the output of the wind generator, solar panels, hydro and other energy systems. For this we chose transducers LEM type that is based on Hall effect.

The components (Fig. 2.) are:
• Two voltage transducers LEM LV 100-100;
• Two current transducers LEM HX 20-P;
• 2 power supply for transducers ± 15 V;
• Resistant 4 x 125 Ω;
• 10 terminals, of which 2 to 220 V power supply sources transducers, 4 terminals for voltage and current collection on the wind and 4 terminals for voltage and current collection on the sun (or hydroturbine) D9 plug for output measurement.
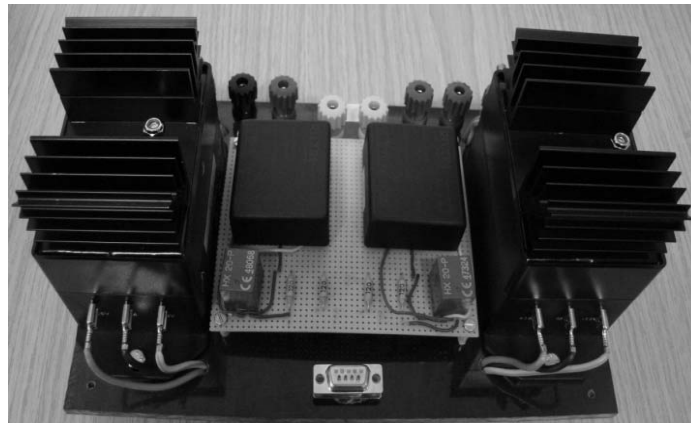
Fig. 2. Hardware interface with current and voltage transducers
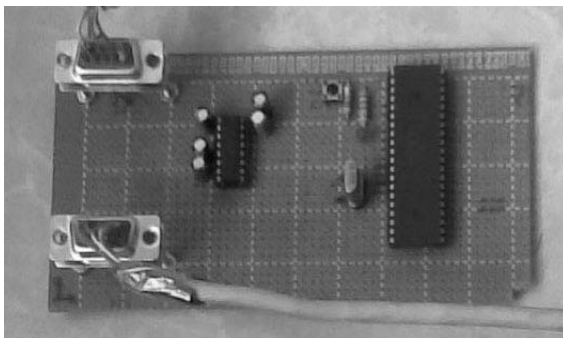
Fig. 3. Hardware interface PIC16F877 and MAX

The second installation is the PIC 16F877 and MAX232 chip. We can say that this assembly has an intermediary role between anterior assembly and computer. Input data, which are now represented by voltages in the range of 0-5V, are taken by the PIC, analog – digital converted and sent to MAX, its role being to pass on your computer's serial port, RS-232 format. Without this hardware interface, no data could be transmitted to the computer.

2.3. The software

The software is represented by the user interface and database where data will be stored input and output.

Software interface role is to give visual information about regenerative system implemented. The most important would be about energy, its graph by time, displayed in real time or historically. Both the data taken and processed are stored in a database and called when needed. A schedule allows us to choose days that we wanted to see history, displaying the graph. Power is displayed in watts, voltage V and the current in A. The monitoring system records the amount of energy produced by regenerative energy system implemented.

The input data are the voltage and current output measured both wind turbine, solar panels or hydroturbine.

Output data are represented by each of the components of electric power energy system (wind turbine, solar panels, hydroturbine).

Monitoring software was developed in Visual C #, programming environment is Visual Studio. GUI interface, where you can see the components, from the chart and the command buttons is shown in Fig. 4.

Fig. 4. The software interface

Fig. 5. Monitoring system (the hardware) with solar panel

3. REGENERATIVE SYSTEM [3]

3.1. Solar panel

For this system we chose a solar panel 5 W/13.5 V (Fig. 6). Smaller, used for educational purposes. Photovoltaic panels are able to convert light (solar energy) directly into electricity through a complex chemical process. Free electricity! Conversion is clean, which is why this method of power generation is environmentally friendly. Power generation based on solar cells. In short, in contact with sunlight, it produces electricity. To enter into detail, but we would have needed quite advanced knowledge of chemistry: photons of sunlight "bombard" the atoms of the materials is done photovoltaic cell. Under this action, they tend to be free and thus form electricity.

Specifications:
- Type: Amorphous Silicon;
- Output Voltage: 13.5 V;
- Output current: 350mA;
- Output Power: 5W (with charge indicator);
- Dimensions: 352 x 338 x 16mm;
- Waterproof;
- Color: Gray.

3.2. Block diagram of system

Block diagram of the interface between pilot system and a computer system is shown in Fig. 7.

It can be seen in the block diagram of a monitoring system components regenerative system. The solar panel system is regenerative, the second block and the third is hardware interface with current and voltage transducers and electronic assembly with PIC 16F877 and MAX232 chip. The connection between hardware and computer interface, ie the interface between the hardware and the software is done through the serial port of the computer.

Fig. 6. Solar system consists of solar panel, controller, battery and consumer
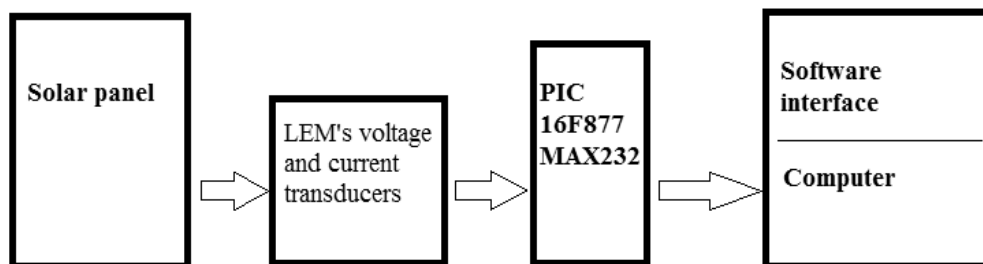
Fig. 7. The monitoring system block diagram of a renewable energy system

3.3. Portability of monitoring systems

Most of monitoring systems would better be portable. This system allows portability, it can be easily installed wherever needed. With minor adjustments, it can be connected to other regenerative systems, hardware interface supporting an input voltage up to 100 V, and software interface can easily be run on a laptop, with a monitoring system regenerative system in minutes.

4. CONCLUSIONS

Although this monitoring system is built with educational purposes, it can be easily adapted to a larger scale and implemented in most location, giving us a visual perspective on affordable energy system implemented.

In the following years, renewable energy will play an important role both in Romania and worldwide, reducing CO_2 emissions, helping to reduce pollution and increase energy independence of the countries that implement this type of energy.

To note that the majority of medium and large companies that implement renewable energy systems, providing at the time of implementation and advanced monitoring systems, custom system configurations and customer requirements, the monitoring system is an important part of the whole energy system implemented.

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DATABASE MANAGEMENT APPLICATION FOR A TIMETABLE SOLUTION

BADEA ALIN[1] BADEA FLORIN[2]

Abstract: The paper presents the design and implementation of a database management application. This application is a WPF application used to manage the database for a Timetable application solution. The database will be accessed using WCF services which will be consumed by the client. The client is implemented using the MVVM pattern[2].

Key words: WPF, MVVM, WCF Services, Database, Timetable

1. DESIGNING THE SOLUTION

The image below presents a high view of the solution structure.
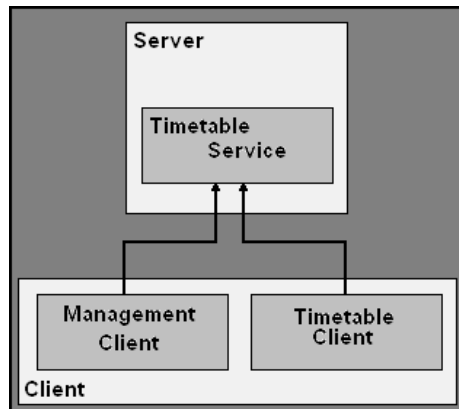
Fig.1 Complete solution structure

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This paper is going to present the second part of the solution, the Management Client. The Management Client is a WPF application that uses MVVM[2]. A high view of the solution can be seen in the image below.
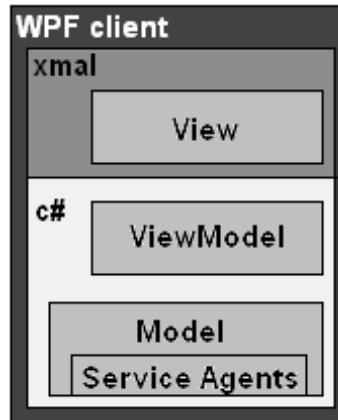
Fig.2 Client structure

As you can see from the image above the application structure is split in 3 parts: the model – represents the data that the application will work with, the view – represents what the user sees on the screen and the view model – represents an abstraction of the view.

From the image above you can see that the service agent pattern is also used. This is a light wrapper around the WCF service proxies to make them easier to use. They localize the service consumption in a single place and make it easier to debug the service consumption code.

The image below presents the solution folder structure.
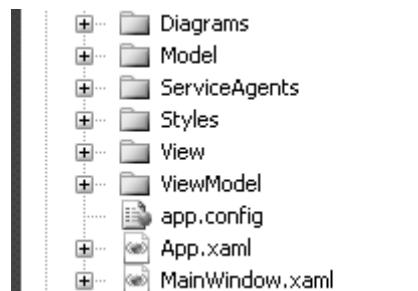
Fig3. The project structure

The solution has a folder to hold the service agent files, one to hold the model, one to hold the view model class hierarchy and one to hold the views. The solution also contains a directory that holds all the resource files. These files will be used to style the application and to bind the view models to the views.

The sections that follow will describe all these parts in detail.

2. THE MVVM PATTERN

Model-View-View Model (MVVM) is a variation of the Model-View-Controller (MVC) pattern that is tailored for modern UI development platforms where the View (developed using declarative techniques like HTML and XAML) is the responsibility (concern) of a designer and the rest (writing the code) is the responsibility of the classic developer[2].

In the MVC the model is the data, the view is the user interface and the controller is the programmatic interface between the view, model and the user input. In the MVP pattern the presenter is responsible for setting and managing the state for the view.

The MVVM pattern is an adaptation of the MVC and MVP patterns in which the view model provides a data model and behavior to the view and allows the view to declaratively bind to the model. The model is especially important because it wraps the data access. The model is separated from the view model so that the view's data (the view model) can be tested in isolation from the actual data the application works with.

The MVVM pattern relies on a couple of things: commands and a general mechanism for data binding[2].

The model is defined as in MVC. It is the data or business logic completely UI independent, that stores the state and does the processing of the problem domain.

The view consists of the visual elements, the buttons, windows, graphics and more complex controls of a GUI. The view is almost always defined declaratively, very often with a tool. At this point data binding comes into play. In simple examples the View is data bound directly to the Model. Parts of the Model are displayed in the View by using one way data binding. Other parts can be edited by using two way data binding. In practice however only small parts of the UI can be bound directly to the Model. This is because there is a high probability that the Model has a structure that cannot be mapped directly to controls. This is where the View Model comes in[2].

The View Model is responsible for preparing the model to be bound to the view. The term means "Model of a View", and can be thought of as an abstraction of the view, but it also provides a specialization of the model that the view can use for data binding. The View Model also contains the commands used by the View to interact with the Model[2].

3. THE CLIENT APPLICATION

The following sections will describe in detail the design and implementation of the management application and the way it uses the MVVM pattern.

3.1 The Model

The model is made up of all the data objects that the application works with. In the particular case of this solution the objects come from WCF services. In order to access the service data more easily the service agent pattern was used to wrap the

service proxies. Using the service agent pattern makes for easy coding and helps debugging by grouping all the service access code in a single place[1].

The service agent pattern is a service oriented architecture (SOA) pattern that promotes service loose coupling and service reusability. As long as the service agent interface does not change the agent can access different services and the client application code does not need to change[1].

The following listing shows the structure of a service agent as implemented in this solution.

```
public class DepartmentServiceAgent:IDisposable
{
    DepartmentServiceClient proxy;
    public DepartmentServiceAgent()...
    public DepartmentModel
        CreateDepartment(string name, string faculty)...
    public bool DeleteDepartment(DepartmentModel dept)...
    public bool DepartmentExists(string department)...
    public bool UpdateDepartment(DepartmentModel dept)...
    public List<DepartmentModel> GetAllDepartments()...
    public List<DepartmentModel>
        GetDepartmentsByFaculty(string faculty)...
    IDisposable Members
}
```

As you can see from the image above the service agent wraps a proxy to the DepartmentService WCF service. The methods it exposes delegate the responsibility of data retrieval to the proxy.

The constructor for the service agent instantiates the proxy and sets some other properties necessary to access the proxy (it sets the client credentials in this case because the service uses message security with a ClientCredentialType of UserName). This can be seen in the listing below.

```
public DepartmentServiceAgent()
{
    proxy = new DepartmentServiceClient();
    LoginModel lm = LoginModel.GetInstance();
    if (lm != null &&
        !string.IsNullOrEmpty(lm.Password) &&
        !string.IsNullOrEmpty(lm.Password))
    {
        proxy.ClientCredentials.UserName.Password
            = lm.Password;
        proxy.ClientCredentials.UserName.UserName
            = lm.Username;
    }
}
```

The rest of the service agent functions delegate to the proxy methods. This can be seen for example in the case of the CreateDepartment() method. The code can be seen in the listing below.

```
public DepartmentModel
    CreateDepartment(string name, string faculty)
{
    try{
        Department d =
            proxy.CreateDepartment(name, faculty);
        if (d != null){
            DepartmentModel dm =
                DepartmentModel.CreateDepartment(
                d.DepartmentId, d.DepartmentName,
                d.FacultyName);
            return dm;
        }
        return null;
    }catch (FaultException<FaultInfo> fex)
    {throw new Exception(fex.Detail.Reason);}
    catch (CommunicationException cex)
    {throw new Exception(cex.Message);}
}
```

As you can see all this method does is to call the proxy CreateDepartment() method. After the response is retrieved a new DepartmentModel object is instantiated and returned. You can also see that service specific exceptions are caught and rethrown. The rest of the service agents are implemented in a similar manner.

The second part of the model story is represented by the model classes. These classes are the entities the application will work with. These are very simple objects. You can see the structure of such an object in the listing below.

```
public class DepartmentModel:
    IDataErrorInfo,ICloneable
{
    public Guid Id { get; private set; }
    public string Name { get; set; }
    public string Faculty { get; set; }
    private DepartmentModel() { }
    public static DepartmentModel
        CreateDepartment()
    { return new DepartmentModel(); }
    public static DepartmentModel
        CreateDepartment(Guid id, string name,
        string faculty)...

    IDataErrorInfo Members

    ICloneable Members

    validation functions
}
```

As you can see from the image above the model objects have a very simple structure made of a few properties. The objects also implement 2 interfaces: IDataErrorInfo – in order to signal field validation errors and iCloneable – in order to make duplicates. The IDataErrorInfo implementation is very useful in this case because it is integrated with the WPF framework and it is used to signal validation errors in the UI. The interface members delegate the validation checking to the validation functions. These functions apply some checks in order to make sure that the fields are in a consistent state (ex: Name and Faculty are not null). The main validation function can be seen in the listing below. This method will be used by the IDataErrorInfo indexer.

```
string GetValidationError(string propertyName)
{
    string error = null;
    switch (propertyName)
    {
        case "Name":
            error = this.ValidateName();
            break;
        case "Faculty":
            error = this.ValidateFaculty();
            break;
        default:
            break;
    }
    return error;
}
```

You can also see that the factory method pattern is also used. This allows for a more controlled object creation process. The rest of the model objects are implemented in a similar manner.

3.2 The View Model

The view model is used to prepare the model in order to be bound to the view. In practice there will be a hierarchy of view models. All of the models will inherit directly or indirectly from a base class. In this solution the base class will be ViewModelBase. This base class will implement the basic functionality each view model should have. In particular this functionality is represented by the capability of a view model to notify listeners when it's properties are changing and by providing a way to dispose of the resources the view model is using.

In order to achieve this, the view model base class will implement 2 interfaces: IDisposable and INotifyPropertyChanged. This can be seen in the listing below.

```
public abstract class ViewModelBase :
    INotifyPropertyChanged, IDisposable{
    Constructor

    DisplayName

    Debugging Aides

    INotifyPropertyChanged Members

    IDisposable Members
}
```

The image above presents the structure of the base class. The constructor is an empty default constructor. The DisplayName is a virtual string property that will hold the name of the view model. This will be used as a label and displayed in the view. The rest of the regions implement the 2 interfaces. The code that implements the IDisposable interface can be seen in the listing below.

```
public void Dispose()
{
    this.OnDispose();
}

protected virtual void OnDispose()
{
}
```

As you can see from the above image the OnDispose() method can be overridden in derived classes in order to provide for a resource release functionality specific to that derived class.

The code that implements the INotifyPropertyChanged interface can be seen in the listing below.

```
protected virtual void OnPropertyChanged(string propertyName)
{
    this.VerifyPropertyName(propertyName);

    PropertyChangedEventHandler handler = this.PropertyChanged;
    if (handler != null)
    {
        var e = new PropertyChangedEventArgs(propertyName);
        handler(this, e);
    }
}
```

As you can see we have a virtual method that triggers the event. The good thing about this implementation is that we can override this method in the derived classes. From this base class derive all the other view model classes. The class hierarchy looks like in the image below.
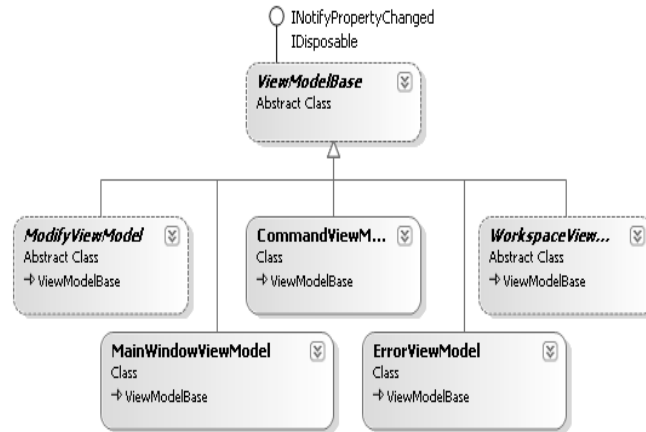
Fig.4 ViewModel class hierarchy

The rest of the View Model classes derive from the modify view model and workspace view model classes.

3.3 The Views

In the solution the views are represented by user controls and by windows although the window views could have been converted to user controls. The user control views will be displayed in the right part of the main window. This part is where the Workspace will be. That's right the view model in the Workspace property will be bound to a view and that view will be shown in the main window[2]. The window views will be used to add new or edit existing model objects. The image below presents the starting view of the application.
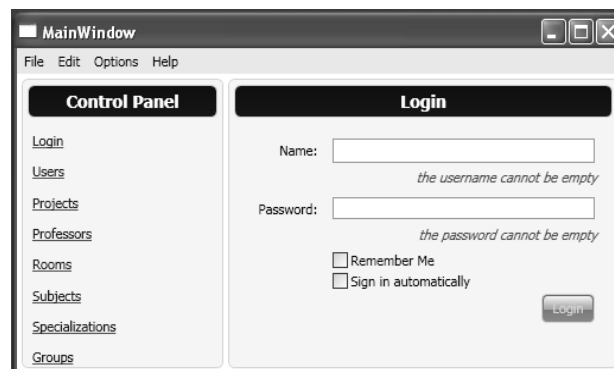
Fig.5 The login view

In the above image the entire application window is the view for the MainWindowViewModel view model. The main area of the window holds the view for any WorkspaceViewModel view model. In this case the Workspace property happens to be a LoginViewModel instance. On the left we can see the control panel. This is the view for the Commands property on the main window view model instance. Other view models could be shown if the menus were opened.

As you can probably guess when the user selects a command from the control panel a new view will be presented in the main area of the window.

As you can see the main area is represented by a content control. The content of the control is data bound to the Workspace property of the MainWindowViewModel instance. The control also has a template to better display the data. This template is a resource and is named WorkspaceTemplate. The code for this template can be seen in the listing below.

```
<DataTemplate x:Key="WorkspaceTemplate">
    <HeaderedContentControl Style="{StaticResource MainHCCStyle}"
                            Header="{Binding Path=DisplayName}">
        <ContentControl Content="{Binding}" />
    </HeaderedContentControl>
</DataTemplate>
```

The template is a headered content control. The header is bound to the DisplayName property of the view model. The content is data bound to the entire view model instance. In order to properly display a view model other templates need to be used. These templates are also data templates and they are automatically applied by type. The code in the listing below shows one such template.

```
<DataTemplate DataType="{x:Type vm:LoginViewModel}">
    <vw:LoginView Margin="6,2" DataContext="{Binding}" />
</DataTemplate>
```

The template above is for the LoginViewModel type. This means that whenever a LoginViewModel needs to be displayed this template is used. In particular this means that when the content in the workspace headered content control is a LoginViewModel a LoginView will be shown. In turn, the LoginView will bind its controls to the different parts of the data context which in this case is a LoginViewModel. This can be seen in the listing below.

```
<CheckBox Grid.Row="4" Grid.Column="2" Content="Remember me" Margin="2"
          VerticalAlignment="Center" IsChecked="{Binding Path=RememberMe}"/>
<CheckBox Grid.Row="5" Grid.Column="2" Content="Sign in automatically" Margin="2"
          VerticalAlignment="Center" IsChecked="{Binding Path=AutoLogin}"/>
<StackPanel Grid.Row="6" Grid.ColumnSpan="3" Orientation="Horizontal"
            HorizontalAlignment="Right">
    <Button Content="Login" Command="{Binding Path=LoginCommand}"
            IsDefault="True"/>
</StackPanel>
```

This code shows how the 2 checkboxes and the login button are bound to the RememberMe, AutoLogin and LoginCommand properties on the login view model.

The XAML that shows the control panel is shown in the image below.

```
<Border Grid.Column="0" Style="{StaticResource MainBorderStyle}"
Width="170" >
    <HeaderedContentControl Content="{Binding Path=Commands}"
ContentTemplate="{StaticResource CommandsTemplate}"
Header="Control Panel" Style="{StaticResource MainHCCStyle}" />
</Border>
```

As you can see this is also a headered content control. The difference here is that the header is hard coded. This control binds to the Commands property of the MainWindowViewModel instance. The template for this control can be seen in the listing below.

```
<DataTemplate x:Key="CommandsTemplate">
    <ItemsControl IsTabStop="False" ItemsSource="{Binding}" Margin="6,2">
        <ItemsControl.ItemTemplate>
            <DataTemplate>
                <TextBlock Margin="2,6">
                    <Hyperlink Command="{Binding Path=Command}">
                        <TextBlock Text="{Binding Path=DisplayName}" />
                    </Hyperlink>
                </TextBlock>
            </DataTemplate>
        </ItemsControl.ItemTemplate>
    </ItemsControl>
</DataTemplate>
```

As you can see, this template uses an items control. Each item is than data bound to the 2 properties of a command view model.

The rest of the views are bound in a similar manner.

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MODELING AND SIMULATION OF AN INTEGRATED RENEWABLE ENERGETIC SYSTEM

CAMELIA BARBU[1], EMIL POP[2], PETRE VAMVU[3]

Abstract: In this paper the main renewable energy resources in order to design of an integrated renewable energetic system are first presented. Second, is presented the integrated energetic system concept. The integrated system has following characteristics: microclimate; envinroment integrated; sustainable; renewable; clean energy; software oriented; systemic structure. This principle is used for designing a proposed energetic system to produce renewable energy based on sun, water, wind and biomass in an environmental local microclimate context.

Key words: microclimate, renewable energy, modeling and simulation.

1. INTRODUCTION

The simple definition of sustainability can be that: the quality of a process to be maintained in the same state boundless time. The sustainable development is a collection of methods in order to accomplish a sustained development of environment to protect the natural capital for long-term profits.

Such energetic system keeps a dynamical equilibrium between electrical energy extracted and environment protection. In this balance are taken into account the following types of renewable energy resources: solar energy; solar radiation; wind energy; hydro energy; biomass.

The possibilities to use *hydro energy* depend on the geographical and climate conditions. Several countries have a great potential in hydro electricity production. The Nordic countries have much potential comparing with others.

The hydro-plants depend on the natural water cycle, in which the water evaporated due to solar radiation together with wind and clouds energy transportation falls back on Earth as precipitations.

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On the other hand *wind energy* is very popular in electricity generation, because of very high potential in many countries. In many cases the costs are comparable to conventional energy cost. In European western countries the wind is the main renewable energy resource [1].
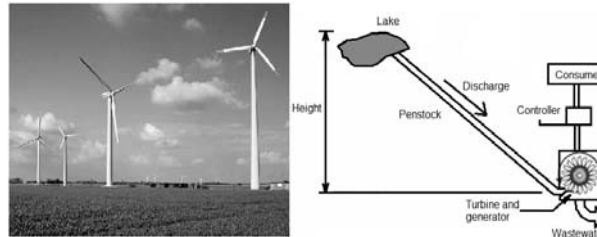
Fig.1. Wind turbine and pico-hydro system

The photovoltaic effect means the direct change of light in electricity by active use of *solar energy*. This is a completely new technology that was possible due to semiconductors technology improvements. Today, the solar energy is used today in many countries.
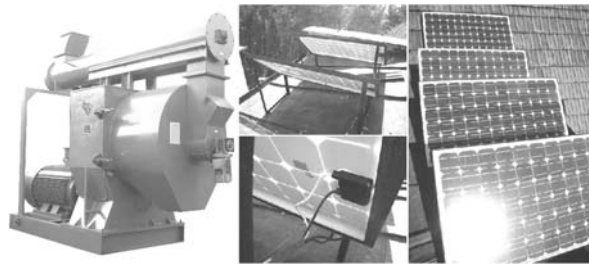
Fig.2. Biomass plant and solar panels

The *biomass* as an organic matter can be used directly (grass, grain, leaves, wood) or indirectly by fermentation (alcohol or the fuel oils). The use of biomass does not represent only a renewable energy source, but also an opportunity for rural places of a sustainable development [4].

So, in fig.3 is presented a renewable sustainable energetic system consisting of the main four energy sources power plants, like pico-hydro, wind turbine, solar cells and biomass.

It is not so easy to combine more different power plants together because of the environment conditions of having sun, water, wind, biomass in the same area. But, it is possible to find some area where all the conditions or three of them can be created with a rational investment.
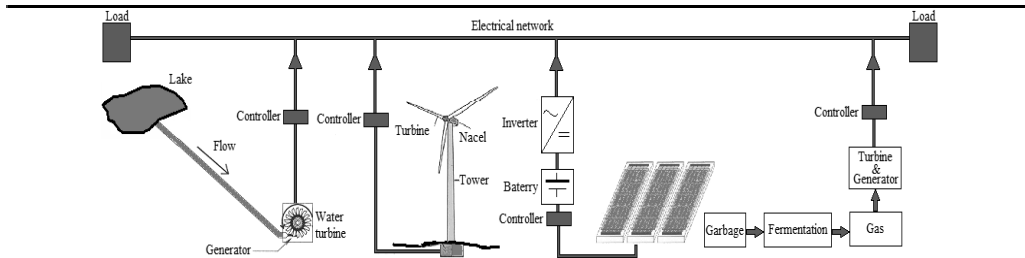
Fig.3. Energetic system: wind turbine, pico-hydro, photovoltaic panels and biomass

2. MODELING AND SIMULATION OF AN INTEGRATED RENEWABLE ENERGETIC SYSTEM

An integrated sustainable renewable energetic system is an energetic system consisting of electromechanical equipments, unitary organized, in order to produce and distribute electric power using primary energetic resources obtained from a well delimited area.

The main elements of an energetic system are: interconnected electric power plants as micro-electric wind turbines, pico-hydro power plants, micro-solar electric power station together with distribution electric networking.

Based on these sources it is designed an integrated renewable sustainable energetic system. The concept consists in designing an energetic system to produce clean energy like: solar, hydro, wind, biomass based environment and local microclimate [2] [3].

For each subsystem (wind turbines, pico-hydro turbine and solar panels) was written a mathematical model and below is presented the model of an renewable integrated sustainable energetic system and simulation results (fig.4). As we can see, the electrical power depends on solar radiation, wind speed and water flow.
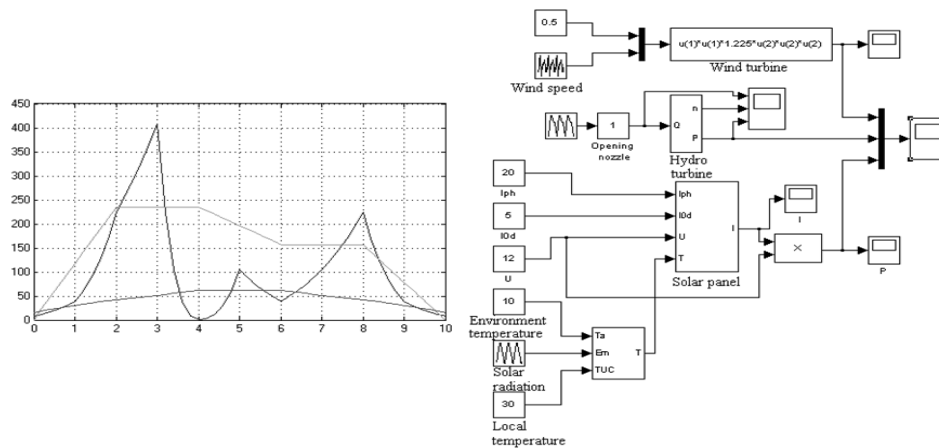
Fig.4. Modeling and simulation of a renewable energetic integrated sustainable system

3. CONCLUSIONS

- The structure of an integrated sustainable renewable energetic system is presented in this paper. The element components of this system are: pico-hydro, wind turbine, solar cells and biomass plant.
- Before designing and implementation of a renewable system is necessary to develop a local climate study and an integration management plan.
- Another important step is the modeling and simulation of entire renewable system before start to implement.
- In most of the cases, the initial investments are recoverable and this solution can be very attractive for the future.
- Based on the principles presented above it is possible to establish a mathematical model to determine the optimum of the environment management in order to extract the maximum electrical energy.

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SOFTWARE APLICATION FOR MODELING, SIMULATION AND CONTROL OF A SUPPORT SECTION

VALI-CHIVUTA SIRB[1], ANGELA EGRI[2]

ABSTRACT: This paper shows how simulation modeling and control of a support section with Petri Nets using Visual Object Net + +. During development of this software, special attention was given to use intuitive, thanks to ease of design, simulation fast and clear documentation of Petri networks. In the current version, events / terms of Petri networks planned with infinite capacity are allowed.

KEY WORDS: Petri Nets, Visual Object Net + +, hybrid dynamical systems, innovative tool CAD / CAE and simulation modeling and control of a support section.

1. INTRODUCTION

Petri networks are sufficiently generic to ensure the possibility of being used in a wide variety of applications, though, because of their asynchronous behavior, are more often used for distributed and other similar processes, however is an ideal way of representation simultaneously both the data stream of system and system state.

To modeling and simulate the support section to use simulation environment VISUAL OBJECT NET + + 2.0A, which is an innovative tool CAD / CAE PC useful network simulation with Petri Petri events supporting mixed continuous and discrete. During development of this software, special attention was given to use intuitive, thanks to ease of design, simulation fast and clear documentation [2] of Petri networks. In the current version, events / terms of Petri networks planned with infinite capacity are allowed.

Key innovation of Visual Object Net + + is support for new network elements further, in addition to traditional discrete Petri networks: continuous transitions and positions. Continuous updates to transitions is that they behave in a continuous execution, execution speed can be attributed to the transition described by differential equations with continuous processes which shape the behavior of continuous dynamic

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becomes accessible. Once further evidence can be combined with the discrete concept allows modeling complex hybrid dynamical systems. Including elements of continuous Petri Nets in Petri traditional networks, until now reserved for describing discrete event systems, bringing the two concepts so far separated. Discrete transition is an active element of the discrete events of Petri networks. Its activity consists in the execution.

Transitions can be executed only if enabled, each transition may be assigned a specific time delay.

Positions are the liabilities of Petri networks and allow state modeling processes. They contain tokens that can be interpreted as states or processes. A special feature of the program is continuous and discrete chips displacement animation (fig.1). Thus it is easier to follow the model and the dynamic behavior of network. Before beginning the simulation should take place in simulation mode by clicking the Start button. After that, the network will be checked and formulas will be compiled and in some cases if necessary, will receive some error messages.
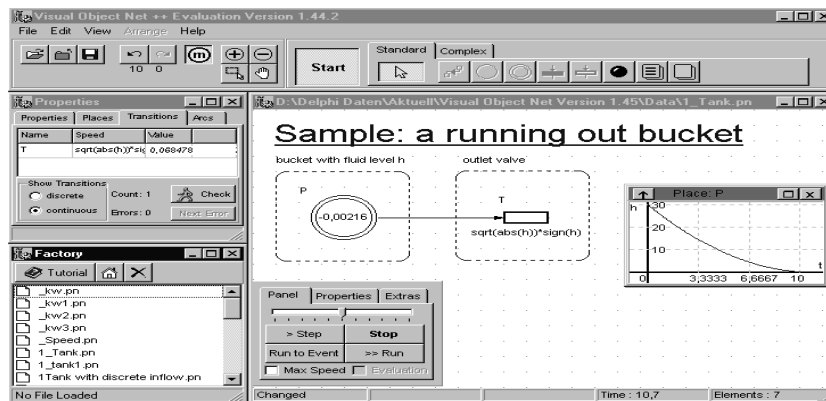
Fig. 1. Visual Object Net + +

2. CONSTRUCTION AND FUNCTION OF THE SUPPORT SECTION

Support sections are arranged on the entire length of slaughter and moving to the front on the extent of coal extraction, a well established sequence (fig.2). A support section (fig.3) consists of the following main elements: the element or shield barriers 1, 2 soles, now foot-shield elements 3, 4 beams, beam-joint shield 5, hydraulic support pillars 6, extensible beams (folding and / or sliding) 7, hydraulic cylinder for operating the extensible beam 8 and 9 hydraulic pusher.Operations that the support sections perform are the same for all: relief (download) columns hydraulic displacement section, strain and displacement hydraulic pillars to the front of the carrier with scraper. The section beam is intended to cover the surface created by extracting coal roof and took over direct pressure is the main element of protection from falls or falling rocks.Sole section is to send the hearth hewing rocks, roof pressure and weight machines. The shield is to protect the slaughter space from the rock fall in the collapse zone. When hydraulic pillars have their higher supports on the shield, it has a bearing

function. To avoid penetration of sterile material in the roof layer and the collapse zone in the work space of the slaughter, shields are provided with extensible side hydraulic or spring.

When driving an automatic [4] support section, needs to know at any time its position towards or against a neighboring sections of slaughter axis and position of each point of the Department depending on the direction of advancement slaughter tilt and relative position between ceiling and fireplace slaughter.

Fig. 2. Support section
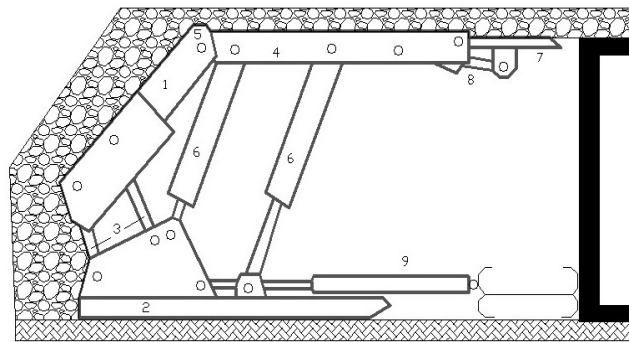
Fig. 3. Structure of support section

For modeling the support section we consider the scheme of such section placed in a cartesian axis system (FIG.4). WE KNOW, OF CONSTRUCTION, SIZE OF AB, AA ', A'B', BB ', AS, BC, CD, DE, BE, EF, FD, EJ, RJ, JJ', FK, KK ', FG, GQ, FL, LL ', FP, MM', NN ', NM, NH, MH, HR', HR, HI, RI and AS. It is thought that pillar sizes varying lengths N, the cylinder of the main beam M, cylinder and cylinder beam I, beam folding sliding J.
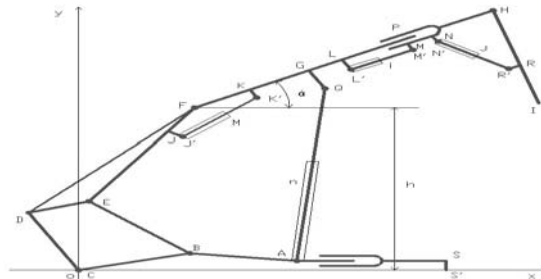
Fig. 4. Support section scheme

3. MODELING, SIMULATION AND CONTROL RESULTS

Simulation of the support section was performed starting from modeling them using Petri networks (fig.5) using the Visual Object Net. The simulated work was done in the window, the simulation started after activating the Start button in the toolbar's main menu and execution simulation environment Run Code of simulation window. Control of the support section begins with storing tokens in a position P1, then combine cutting command gets the first strip to determine and indicate the production of the first event. After execution first transitions token reaches the position P2 which indicate evniment next production, positioning the visor. This algorithm [3] is applied to each of the positions P1-P8 producing corresponding events described in the technological process [1].Transitions are enabled and assigns with a time delay, will indicate the execution of process activities to support the mechanized slaughter. After the last move executed by support section is received the new order of cutting operations by repeating the same algorithm (fig.6).

Slaughter complex management starts with the cutting order of the slaughter combine, indicated by the existence of the token in the second position after the front was prepared, indicated by the existence of the token in the first position. Then the support sections a the carrier that discharges the cut material (fig.7).

4. CONCLUSIONS

For the simulation of the sustentation section it has been used the simulation environment VISUAL OBJECT NET[++] 2.0A, that is an innovative CAD/CAE instrument for PC's useful in simulation with Petri networks that support Petri mixt, continuous and discrete events.
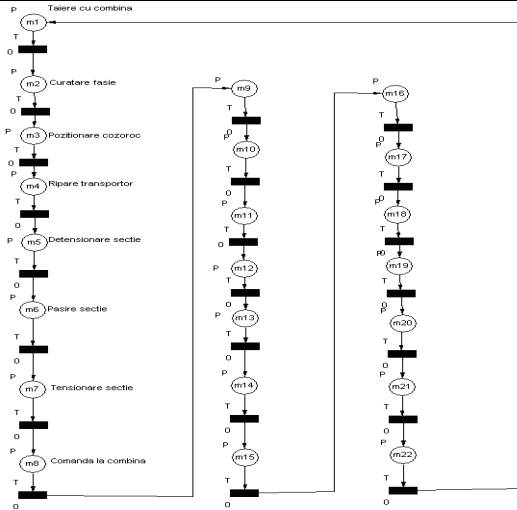
Fig. 5. The Petri Nets model for support section
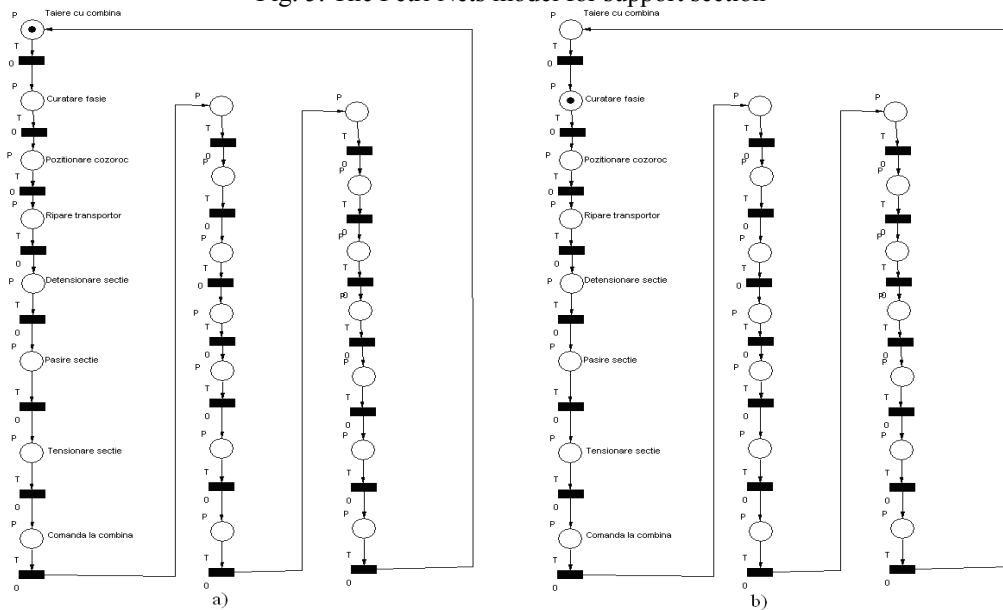
Fig. 6. Simulation with Petri Nets: a) combine cutting step; b) cleaning strip step

During this software development, a great deal of attention was given to intuitive use, because of the ease in designing, quick simulation and clear documentation of Petri networks. In the current version, Petri networks events/conditions planed with infinite capacity are accepted.

The paper present the functioning principles of a mechanized complex, the structure and mechanized sustentation working part of the mechanized complex, the sustentation command section modeling realization and the mechanized complex with

Petri networks and, also, present the sustentation command section simulation realization and the mechanized complex with Petri networks using Visual Object Net simulation environment.
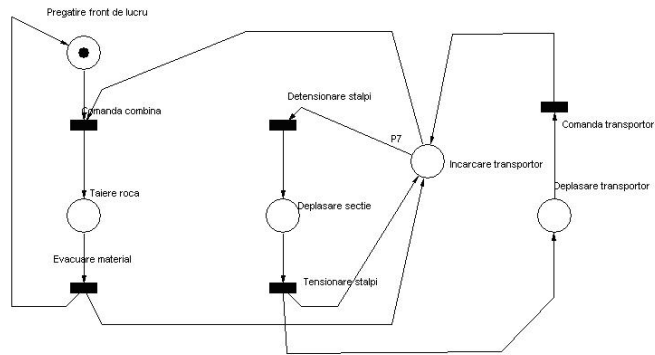
a)
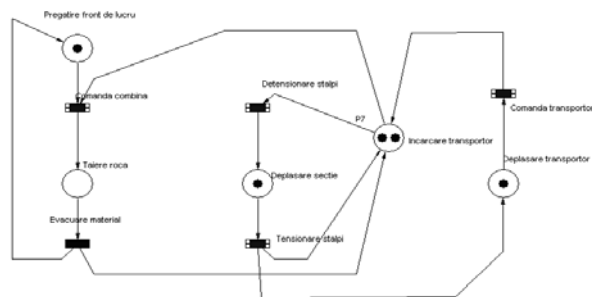
b)

Fig. 7. Simulation with Petri Nets: a) front training step; b) carrier load step

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ICT IN ENVIROMENTAL AND EDUCATIONS - COMPETITIVE ADVANTAGE IN NEW ECONOMY

Zvonko DAMNJANOVIĆ[1], Dragan MANČIĆ[2], Dragana RANĐELOVIĆ[3], Predraf DAŠIĆ[4], Veis ŠERIFI[4]

Abstract: This paper presents concept, aim and significance of innovative training on teachers for implementation of information and communications technologies in environmental education in the processing of significant environmental dates. Special attention has been given to identification of local needs and potentials in terms of selection of significant environmental dates, as well as promotion of these activities on international level through appropriate information and communications technologies.

Key words: knowledge management, intellectual capital, significant environmental dates, information and communications technologies, teachers training, local community.

1. INTRODUCTION

In recent years, United Nations agencies and other international organizations have developed a number of informational, educational, promotional, scientific and other materials, programs and projects based on modern information and communications technologies (ICT) within the process of promotion of important environmental dates. Only few schools and individual teachers, cooperating with partners in the wider community, managed to take advantage of these opportunities by linking them with the needs of their environment and thus to improve school programs, especially by improving the fields of environmental education and the application of information technology in teaching process.

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In the frame of current Decade of Education for Sustainable Development (1) and the environmental education as its pervasive component, it is very important to train as many teachers as possible (especially those whose teaching subjects are possessing a strong environmental component) to be able to find the common available educational materials, refine them and use them in the teaching process, connecting them with the situation and needs of local communities, therefore motivating the pupils and engage them in innovative training methods that are available.

A need to present the results of educational and training activities of schools in Serbia on international web sites that follow the promotion and celebration of important environmental dates, as well as on the school web sites, is not of the less importance, increasing the visibility and impact of such events outside the local community. Therefore, the educational institutions are getting the opportunity to join the international network of organizations whose activities promote and support the current trends in environmental information dissemination, environmental education and upbringing activities.

2. CONCEPT OF PROMOTING THE SIGNIFICANT ENVIRONMENTAL DATES WITHIN THE ENVIRONMENTAL EDUCATION PROCESS

Significant environmental dates are promoted and celebrated around the world in order to highlight the vulnerability of the environment and nature on the Planet and the importance of its preservation for current and future generations to the general world public (2). Diversity of environmental issues that are covered by the significant environmental dates is enlarging day by day (World Water Day, Forest Day, Earth Day, World Biodiversity Day, International Day of Climate Action, Earth Hour, International Mountains Day, Clean Up the World Day, World Habitat Day, etc.) which enables that the inclusion of significant environmental dates in the environmental education covers its most important contents.

The requirement for inclusion of significant environmental dates in environmental education process is to stress it's educational, rather then manifestation component, and to ensure that these dates are not supported by sporadic but by continuous educational activities. The processing of educational content within the celebration of significant environmental dates should be varied or multimedia, should involved different scientific and educational disciplines and methods, and be adapted to pupils of different ages. It should also provide links to schools across the local and social environment, with a wide range of other institutions and partners involved in environmental education and development of environmental awareness (environmental NGO's, local authorities, media etc.) (7).

These conditions can be provided in the best terms if the significant environmental dates in local community are processed by the complex program, which combines a number of the most important environmental dates and environmental issues, and is a part of a wider process of solving local environmental problems, such as is the Local Environmental Action Plan (LEAP) and Local Strategy for Sustainable Development.

Structured program of promoting selected significant environmental dates named "Ecological days of Bor" was developed in 2003. as a part of LEAP process in Bor and was developed on basis of annual environmental events of non-governmental organization Young Researchers of Bor, who began with the promotion of significant international environmental dates in order to raise environmental awareness among youth and other citizens of Bor. Based on this previous experiences, a complex program has been design that initially included 15 significant environmental dates whose contents are estimated as tightly associated with the LEAP process and are responding to the need for improvement of knowledge and awareness of the citizens of Bor on their environment.

During coming years this program has expanded with new dates and environmental issues so that now it encompasses over twenty significant environmental dates. Implementation of specified programs regarding targeted environmental dates nowadays involves a number of institutions - educational and cultural institutions, public and state enterprises, media organizations, NGOs, local authorities and local administration (3, 4).

3. SIGNIFICANCE AND OBJECTIVES OF TEACHERS TRAINING FOR THE APPLICATION OF ICT IN ENVIRONMENTAL EDUCATION

Connection of local environmental needs and issues with global environmental issues, includes the complex of informational, educational and promotional activities, based on available information and educational materials that have been developed by the appropriate agencies of United Nations to mark and promote thematic dates related to nature, water, health, biodiversity, environmental protection, wildlife animals, food, mountains etc. The most important participants on this topic are actually educational institutions, because they are able to effectively and creatively implement ecological and environmental principle in teaching through this program.

Main problem for school's larger participation in these programs during the past was mostly the lack of IT equipment, lack of teacher's knowledge on IT topic, as well as a reduction of environmental education to only a few teaching subjects and forms of extracurricular activities. Project "Digital schools", whose primary aim is to provide computer equipment in Serbian schools, as well as the expanding of environmental education principles application to all school facilities and types of extracurricular activities is giving the preconditions to start with the implementation of environmental dates concept, but the problem of teacher's and collaborator's skills for using modern ICT for environmental education improvement in their schools remains.

In order to solve this problem a specific program for professional training named 'Application of information and communication technologies in the implementation of environmental education through the processing of significant environmental dates' (6) has been developed an accredited, being founded on previous experiences and cooperation of Computer Center Bor and Association of Young Researchers of Bor. Implementation of this training program enables the processing of

significant environmental dates through integrated use of ICT, as well as other ideas and techniques, in order for this to become the common practice in schools and local communities in Serbia.

The overall objective of this program is to gain trained teachers and professors who are able to implement innovative methods of ICT in environmental education.

Specific objectives of this program are:

- acquisition of appropriate knowledge and skills in ICT, especially the use of Internet and specified programs for electronic communication and presentation;
- identification of reliable Internet resources about key environmental issues that are processed on the occasion of significant environmental dates;
- download, customize and implement the educational and informational materials produced by the relevant UN agencies;
- motivation of students, parents and local communities for environmental education through the use of modern ICT;
- promotion and propagation of key environmental issues and opportunities for applying ICT in environmental education;
- promotion of school's environmental education activities on their web sites, web sites of local communities, national web sites and especially the official portal of the UN organizations that are conducting the celebration of significant environmental dates.

Effects of program that is designed to improve the quality of teaching are predominantly new competencies for the implementation of ICT in environmental education, enriched content and methods of environmental education in schools and local communities, greater motivation of pupils and parents to actively participate in environmental education, as well as the promotion and propagation of key environmental issues and opportunities of ICT in environmental education.

Development of ICT sector, applied knowledge and science enabled these fields to become a dominant factor in modern economy and education almost all over the world. The special role of the ICT application in environmental education is development of skills for searching, analyzing and transmitting information, with their usage in raising environmental awareness, protection and preservation of nature and environment, and environmental ethics. Role of ICT in environmental education and following environmental issues has been also stressed in Strategy of Information Society of Serbia (11).

For the implementation of environmental education through processing the significant environmental issues IT knowledge is essential, and it primarily includes knowledge of Internet communications, the most important search engines and web services, portals and other Internet resources, communication via social networks, electronic publishing, setting up web sites, blogs etc (5).

Sustainability of this program is provided by experiences of individual communities in the implementation of long-term processing of key environmental issues through the application of ICT, expressed interest and motivation of teachers and pupils to use modern ICT tools in environmental education, project of providing computer equipment for schools organized as IT classrooms and other ICT resources,

more extensive Internet resources and new computer programs specialized for environmental education.

4. EXPERIENCES FROM PRACTICE

Educational training for teachers and collaborators named "*Application of information and communication technologies in the implementation of environmental education through the processing of significant environmental dates*" was carried out during 2010 and 2011 through seminars in elementary schools in Bor, Dragash and Priboj Spa. This program is accredited as training for professional development in education again for period of the year 2011 and 2012.

Through practical exercises the participants of this program have defined specific activities for environmental education through processing of certain significant environmental dates.

Selected topics have been connected to a local environmental problems and needs and preferably linked to existing strategic documents relating to the environment at the local level (such as Local Strategy for Sustainable Development, Local Environmental Action Plan, etc.) , which enabled a school activities to be associated with a specific situation in each local community. This has resulted with creation of

Fig. 1. Example blog post EKOGORA

Fig. 2. Example Facebook and Youtube video post GORA SEMINAR

several project ideas for promotion of environmental dates such as: World Green Consumer Day (9), International Mountain Day (8,9), World Day for Physical Activity

(9,10), World Environment Day, World Environment Day (9,10) etc., which were then published on hosted free internet blog service (8,9,10). Advantage of blog as one of ICT components is it`s interactive format and the ability to be maintained by an individual with regular entries of commentary, descriptions of events, or other material (Figure 1). A typical blog combines text, images, and links to other blogs, web pages, and other media related to its topic.

5.CONCLUSION

Connection of recent trends in ICT in education and existence of new stakeholders in environmental education at the international level (UN agencies and other international organizations who organize and promote significant environmental dates) provides schools with necessary tools for improving the quality of environmental education. At the same time, by linking the contents of environmental education with key local and global environmental issues, the school also associates with environment issues and contributes on raising awareness and solving environmental problems in a broader context.

Important role in this process is those of teachers and school collaborators that can be more successfully achieved if they are in continuous vocational training. Professional development programs based on the experiences of individual communities and modern principles can contribute immensely to advanced role of teachers and their education quality as a whole.

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REDUCING THE DURATION OF STEEL MELTING IN THE ELECTRIC ARC FURNACE BY INCREASING THE APPARENT POWER OBTAINED AFTER REPLACING THE TRANSFORMER

ADRIAN IOAN TOMA[1], FLORIN GABRIEL POPESCU [2], ALINA DANIELA HANDRA[3]

Abstract: This paper presents a study of electric arc furnace with an new powerful electric transformer. Electric arc furnaces type UHP requires large electrical power so they are modified from conventional ovens. In this case melting and refining are done with a single oxidant slag. Deoxidizing and alloying are done outside the electric arc furnace in the ladle furnace.

This technology greatly increases productivity and lowers furnace specific materials and energy consumption. Increasing power transformer requires many changes. With increasing electric arc furnace productivity increased and extreme fluctuation of voltage, flicker, harmonics and imbalance between phases.

1. INTRODUCTION

The Eccentric Bottom Tapping is a ultra high power electric furnace in which the electric arc is primed between the electrodes and charge (direct action). EBT furnaces have intake of oxygen during preparation, and specific fuel consumption is 450 ... 530 kWh / t of steel, smaller than other types of electric furnaces [2], [6].

Electricity savings are realized from this type of furnace by reducing the period of preparation, reducing heat loss during preparation and cast during the break.

The main disadvantages of EBT furnaces are:
- faster aging the masonry;
- higher electrodes consumption per ton steel.

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Electric Steelwork No 2 belonging to ArcelorMital Hunedoara S.A. was equipped with an electric furnace EBT type that was designed to melting 100t of steel in 70 minutes to 1,600 °C, of which 10 minutes are necessary to prepare furnace and to load the metal scrap [9].

Improvement of the energetic performances of an electric arc furnace imposes a careful technical and economical analysis.

2. OE2 220/30 kV THE ELECTRICAL POWER STATION FOR EAF AND LF (LADLE FURNACE)

The electric energy necessary to the melting in the electric arc furnace EBT No.2 from ArcelorMittal Hunedoara is taken from National Energy System through the OE2 Electrical Power Station [9]. The single line diagram of the OE2 220/33kV Electrical Station is represented in the figure nr. 1.
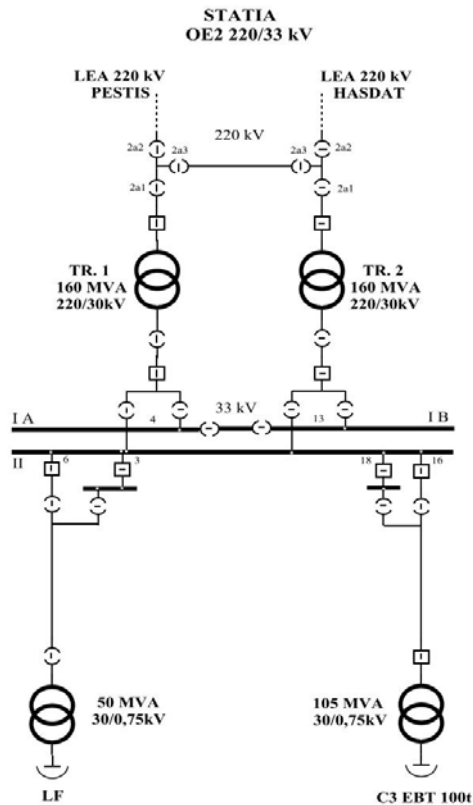
Fig.1. The Electrical Station OE2 220/33kV

The electrical station has the following equipment:
- two transformers (Tr 1 and Tr 2) 160 MW - 220 / 30 kV;
- one transformer of 50 MVA - 30 / 0,75 kV for LF;

- one transformer of 105 MVA - 30 / 0,75 kV for C3 EBT 100t;
- a system with two bars (BI and BII) 30 kV;
- switching elements (switches);
- elements of separation (separators);
- measuring and control devices;
- protection and internal services.

The OE2 electric power station has two separate power sources from National Energetic System, Electric Station Hasdat and Electric Station Pestis that are interconnected through a 220kV line.

3. ANALYSIS OF ELECTRICAL POWER TRANSFORMER REPLACEMENT

3.1. Structural dimensions of the hearth furnace, EBT type

The schematic diagram of the electric arc furnace, EBT type is represented in the figure nr. 2 [6], [7].
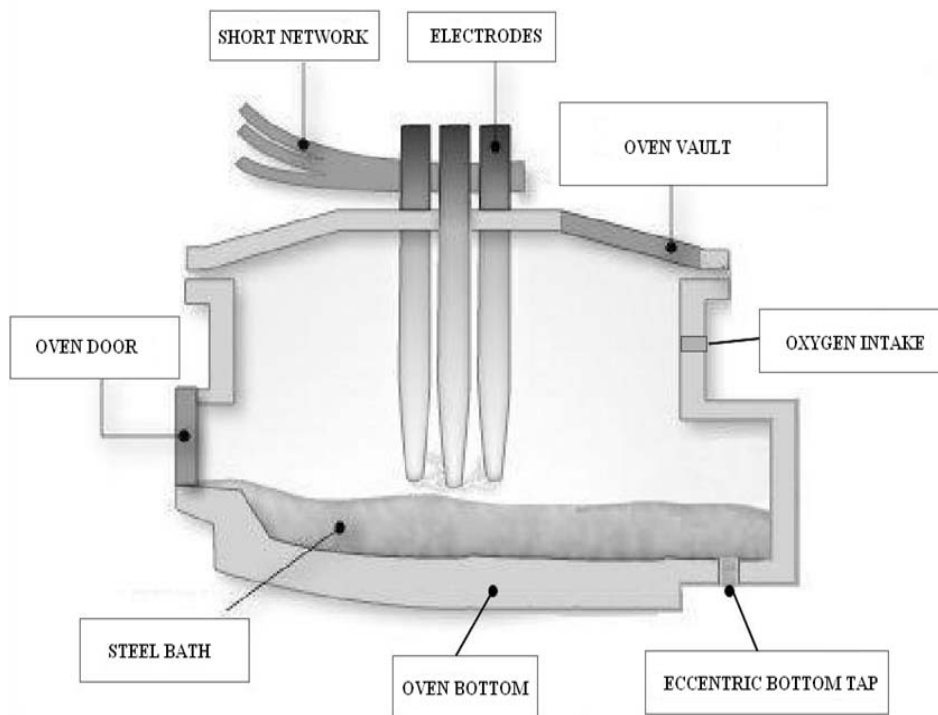
Fig.2. Schematic diagram of the electric arc furnace, EBT type

The electric arc furnace has the following equipment:
- oven vault;
- electrodes;
- short network;
- oven door;
- steel bath;
- oven bottom;
- eccentric bottom tap;
- oxygen intake.

The steel melting process in electric arc furnace is run by computer.

The volume of molten metal:

$$V = \frac{m}{\rho} = \frac{100*10^3}{7,200} = 13.86 m^3 \tag{1}$$

The diameter of liquid steel molten mirror was calculated by the following formula:

$$D_{liquid} = C\sqrt[3]{V} = 2.254\sqrt[3]{13.86} = 5.42 m \tag{2}$$

where:

$$C = 1.75 + 0.084\frac{D}{H} = 2.254 \tag{3}$$

The height of molten metal bath is:

$$H = \frac{D}{6} = 1.2 m \tag{4}$$

where: D=7.216m.

The geometric dimensions of the furnace, EBT type is represented in the figure nr. 3.

Fig.3. Geometric dimensions of the furnace EBT

The spherical portion of the furnace was calculated using the formula:

$$H_S = 0.2 * H = 0.24m \qquad (5)$$

The melting space height was calculated using the formula:

$$H_t = 0.5 * D = 2.71m \qquad (6)$$

3.2. Study of electric arc furnace heat, EBT type

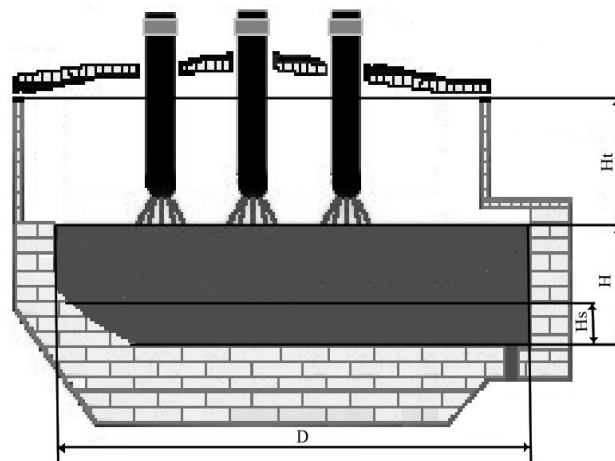Thermal study is performed for the period of heating load from ambient temperature up to melting temperature. The calculation of losses to the side walls and roof counted as 75% of their thickness, 50% of the thickness burns as the result of intense arc radiation and the development time is 80 min, of which 10 min are required for breaks specific technological process [1], [3], [4].

The amount of useful heat is:

$$Qu = m * i \qquad (7)$$

, where the specific energy is: i = 500 KWh/kg and m= 100t.

$$Qu = 50MWh \qquad 8)$$

The amount of heat lost during melting:

$$Qpt = Ppt * t_t \qquad (9)$$

,where Ppt=3.500 kW is heat loss during the melting time t_t:

$$Qpt = 4,095kWh \qquad (10)$$

The amount of heat lost during the break:

$$Qpp = Ppp * tp \qquad (11)$$

,where Ppp=1.5*Ppt is heat loss during the breaks time t_p :

$$Qpp = 892.5kWh \qquad (12)$$

The amount of heat consumed during the elaboration:

$$Q = Qu + Qpt + Qpp = 54.88MWh \qquad (13)$$

Thermal efficiency was determined with the relationship:

$$\eta_t = \frac{Q_U}{Q} 100 = \frac{50.00}{54.88} = 0.91 \tag{14}$$

The total efficiency during melting is:

$$\eta = \eta_{t,} \eta_e = 0.82 \tag{15}$$

3.3. The needing of replacing the electrical furnace transformer for Electric Arc Furnace no 3 - 100t, EBT type from ArcelorMittal Hunedoara S.A.

Verification of the dimensioning of the transformer is made taking into account the total consumption of heat necessary to develop a batch, melting time, power factor and electrical efficiency [5],[8]:

$$S = \frac{P}{\cos\varphi} = \frac{Pu}{\eta_e \cos\varphi} = \frac{Q}{t_t \eta_e \cos\varphi} = 69.626 MVA \tag{16}$$

where: $\cos\varphi = 0,75$ şi $\eta_e = 0,9$.
The $I2_N$ - rated current for the secondary is determined by the formula:

$$I_{2N} = \frac{S}{U\sqrt{3}} = 53.598 kA \tag{17}$$

The $I1_N$ – rated current for the primary is determined by the formula:

$$I_{1N} = \frac{I_{2N}}{N} = 1.339 kA \tag{18}$$

When the load 110t in the oven, the apparent power that is required is greater:

$$S = \frac{P}{\cos\varphi} = \frac{Pu}{\eta_e \cos\varphi} = \frac{Q}{t_t \eta_e \cos\varphi} = 75.957 MVA \tag{19}$$

where: $\cos\varphi = 0,75$ şi $\eta_e = 0.9$.
In this case the secondary current $I2_N$ will be:

$$I_{2N} = \frac{S}{U\sqrt{3}} = 58.472 kA \tag{20}$$

In this case the primary current $I1_N$ will be:

$$I_{1N} = \frac{I_{2N}}{N} = 1.462 kA \tag{21}$$

The power transformer used for Electric Arc Furnace No 3 - 100t, EBT has the next parameters:
- Apparent Power S=75 MVA;
- Primary Voltage U1n=30 kV;
- Secondary Voltage U2n=750 V;
- Primary Rated Current I1n=1.443kA;
- Secondary Rated Current I2n=57.743 kA.

In the particular case of electric arc furnace 3, EBT type, belonging S.C. ArcelorMittal Hunedoara, was found after about six years of operation that the apparent power of 75 MVA was insufficient, even if is used an large time for melting (80 min). If is load over 110t of metallic scrap in the electric arc furnace, the values of absorbed current needed exceed the nominal current of the transformer.

4. CONCLUSIONS

The power transformer showed frequent instances of oil overheating in the normal operation of the electric arc furnace, culminating in the gas Buchholtz outage protection. Since regeneration and change from oil have not achieved significant results, emphasizing the phenomenon of overheating, the transformer was open. At opening has been found an early aging for electrical isolation, so it was decided to replace it with another higher power transformer.

For the economic reasons and organizational reasons, justified by the scale of such operations, the transformer was not replaced in due time, reason to continue to work with the transformer. This fact led to short circuits between windings and it was damage. The damaged transformer was replaced with another higher transformer that has the following parameters:
- Apparent Power S=105 MVA;
- Primary Voltage U1n=30 kV;
- Secondary Voltage U2n=808 V;
- Primary Rated Current I1n=1.966 kA;
- Secondary Rated Current I2n=73.038 Ka.

After the power transformer was replaced, the time for melting was reduced from 80 min to 70 min and also the theoretical specific consumption was reduced 549.88 kW/t to 539.99 kW/t.

To extend the service life of current transformer, it must mitigate harmonics of order 3, 5 and 7 (predominant), because in some cases their weight may increase much above the permissible limits. Modern technical solutions proposing in addition to mitigating the distorting system, a reduction of reactive power and imbalance between phases.

Reduce equipment life can be very costly. For equipment such as transformers, where normal life is 30 or 40 years, replacing them at 7 to 10 years can have great financial consequences. The cost of avoiding this situation is relatively low, requiring only a good experience and an appropriate choice of operating electrical equipment.

The frequency question is: "How much money should be invested in preventive measures to offset the risk of an incident?" The answer can be given only by taking into account all possible risks and the cost of the proposed technical solutions.

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GASIFICATION BOILER CONTROL SYSTEM

BRANA LILIANA SAMOILA[1], MARIUS DANIEL MARCU[2]

Abstract: This paper deals with identifying and solving the problems that occur in gasification heating stations work. Using the device we designed turned out to be convenient both from economic and safety point of view. The control equipment represents a simple, reliable solution for controlling a solid fuel gasification boiler which allowed increasing the level of heating and the heating station efficiency.

Key words: control, gasification boiler, heating, solid fuel.

1. ISSUES RELATED TO HEATING WITH SOLID FUEL GASIFICATION BOILERS

Choosing the heating equipment we want to use has to take into account the housing unit location, its solitude coefficient, climate and the available power sources.

One of the most often used kinds of fuel, especially in villages, is wood (even industrial wooden leavings). Wood is the oldest fuel that mankind has used for heating homes, as it has always been available [2].

In Romania, the use of the wood remaining is an attractive solution for heating. There is a lot of it, at a convenient price, but it needs large and dry depositing spaces. When the combustion process starts, the heat is much higher than later on because the empty spaces inside the lettings mass are larger and the flame gets more oxygen.

A gasification boiler operates with wood fuel based on the gasification principle. This new technology uses the condensation technique. That means that the steam in the furnace gases is condensed and for the same quantity of burned wood fuel it results a higher heating level. It is standard equipped with its own control system consisting of an electronic block that controls the two fans (the variable speed one and the warm air flow one, for automate ignition).

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The condensation latent heat has a precise value for a certain gas and specific temperature and pressure level. That's why we need to control the temperature to increase the gasification boiler efficiency.

We noticed that, for a common boiler, a large amount of the efficiency decrement is caused by the heat lost in the furnace gases [3]. The higher is the temperature, the waste of heat is higher and the efficiency is lower.

For increasing the efficiency of such a boiler, it is necessary to find solutions to increase the return temperature. That can be accomplished by using a by-pass pump or an equipment meant to keep the thermal agent temperature within normal functioning limits (50 – 60 ºC), with minimum fuel consumption.

A gasification boiler is standard equipped with its own control system consisting of an electronic block that controls the two fans (the variable speed one and the warm air flow one, for automate ignition) [6], [8]. Beside this inbuilt control system, it is necessary to achieve another one to command the recirculation and the by-pass pumps depending on the fuel temperature and the heating need of the house [2], [4], [8].

2. THE GASIFICATION HEATING STATION CONTROL SYSTEM

After we identified the main problems in the solid fuel heating boilers work, we designed and manufactured an equipment (figure 1) meant to decrease the inconveniences. The device is made of components with very low power consumption, as we intend to use it for thermal power plants heating out-of-the-way houses, where electric energy supply is often broken, sometimes for a long time, especially in winter [8]. Meanwhile all equipment must keep functioning with electric energy provided by an independent non-interruptible power source. For this purpose, we used a self-manufactured orientation controlled photovoltaic panel which charges two batteries of 12 V, 14.4 Ah.

The equipment is normally supplied from the electric power network. When this supply source breaks down, by means of a timed contact of a voltage surveying relay, a contactor switches to the independent source. This is capable to supply energy for about 8 hours.

The automation electric circuit includes gauges, indicators, contactors, controllers, indication lights, time relay, sensors and an alarm horn.

When designing the heating station control equipment, we took into account the building and functioning characteristics of the station and failure possible causes which we tried to prevent. Also, we had to design a circuit as simple and reliable as possible, with an optimum rate quality – reliability – price.

The alarm values can be set within the equipment measuring range, depending on the input type.

Operating mode most used in the extraction plant (on which we will focus in the study of the harmonics) with drives rectifier-DC motor is the recovery, which is why we refer particularly to it.

Harmonic amplitude spectrum and they place these converters can be calculated by Fourier analysis. In general, the Fourier series expansion i_s input rectifier current is:

In gauging, we have to consider the kind of input: standard, coming from a thermally sensitive resistance or coming from a thermocouple [1].

Figure 1 Gasification boiler control system

Once the fire is on in the boiler, the heating medium temperature starts increasing and the thermally sensitive resistance, mounted on the turn pipe, delivers information to RS485 [9] which processes it and displays the temperature value.

When the temperature reaches $T_1 = 45.1$ °C, the relay d_1 is energized and it commands the C_1 contactor which turns on the by-pass pump. So, the temperature gets increasing faster, as the by-pass pump circulates the water into the boiler.

At a temperature of $T_2 = 65.1$ °C, by energizing the d_2 relay, the circulation pump is turned on. From this moment on the temperature keeps increasing a few tenths of degree and next, it starts decreasing, as the cold water from the radiators flows into the boiler.

When the temperature gets to 44.9 °C, the circulation pump shuts down and cold agent doesn't enter the boiler any more. Still, the temperature goes down a couple of degrees, until the fire succeeds to increase the temperature again. About now, the temperature in the burning place is maximum, as all wood burns. From now on, the temperature keeps increasing, the pumps turning on cycle is restarted and the temperature stabilizes at about 73-75 °C. The difference between the water temperature in turn and return is of about 15°.

3. CONCLUSIONS

When studying a gasification boiler behavior, we noticed that its efficiency decreases especially due to the heat lost in the furnace gases. The higher is the temperature, the waste of heat is higher and the efficiency is lower.

We searched for a solution to increase the return temperature by using a by-pass pump meant to keep the thermal agent temperature within normal functioning limits (50 – 60 ºC), with minimum fuel consumption.

We designed this control equipment and run tests to check whether it works properly. The results were more than satisfactory.

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THE IMPORTANCE AND SOME ASPECTS OF INTRINSICALLY SAFE ``I``

MARIA DANIELA STOCHIŢOIU[1], ILIE UŢU [2]

Abstract. The principle behind intrinsic safety is to ensure that the available electrical and thermal energy in the system is always low enough that ignition of the hazardous atmosphere cannot occur. This is achieved by ensuring that only low voltages and currents enter the hazardous area, and that no significant energy storage is possible.

Keywords: intrinsically safe ``i``, electrical equipment, spark.

1. INTRODUCTION

In normal use, electrical equipment contains both intrinsically safe circuits and non-intrinsically safe circuits and is constructed so that non intrinsically safe circuits cannot affect the intrinsically safe circuit, often creates internal tiny sparks in switches, motor brushes, connectors, and in other places. Such sparks can ignite flammable substances present in air.

2. LEVEL OF PROTECTION AND IGNITION COMPLIANCE REQUIREMENTS OF ELECTRICAL APPARATUS

Intrinsically safe equipment or safe apparatus and intrinsically safe parts of associated equipment shall be placed in levels of protection *ia, ib* or *ic.* The maximum intrinsically safe characteristics for the intrinsically safe apparatus and associated apparatus are determined taking into account the requirements for spark ignition.

Level of protection *ia* means to not be capable of causing ignition in each of the following circumstances:

- in normal operation and with the application of those non-countable faults which give the most onerous condition;

- in normal operation and with the application of one countable fault plus those non-countable faults which give the most onerous condition;
- in normal operation and with the application of two countable fault plus those non-countable faults which give the most onerous condition.

      Level of protection *ib* means to not be capable of causing ignition in each of the following circumstances:

- in normal operation and with the application of those non-countable faults which give the most onerous condition;
- in normal operation and with the application of one countable fault plus the application of those non-countable faults which give the most onerous condition.

   Level of protection *ic* means to not be capable of causing ignition in normal operation.

   The maximum permissible current corresponding to the maximum wire temperature due to self heating for copper wires can be calculated from the following equation:

$$I = I_f \sqrt{\left[\frac{t(1+aT)}{T(1+at)}\right]}$$, a- is the temperature coefficient of resistance of the

wire material; I – is the r.m.s current(A); If-is the current at which the wire melts at the maximum specified ambient temperature (A); T- is the melting temperature of the wire ($^{\circ}C$);t- is the threshold temperature ($^{\circ}C$)

   An intrinsically safe circuit has to satisfy three criteria:

- the circuit shall be adequately separated from the other circuit;
- the temperature of intrinsically safe equipment as to ensure that the ignition is not caused by hot surfaces;
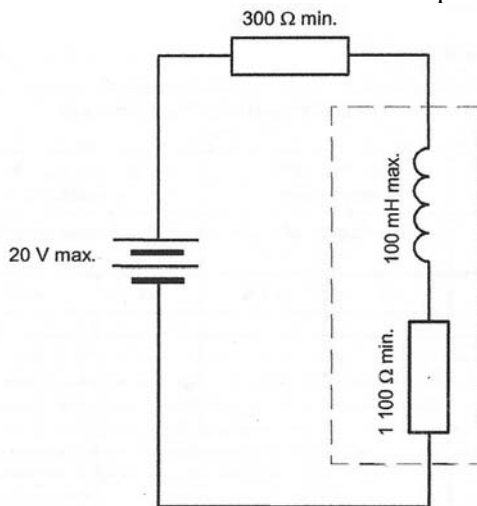- when the circuit is tested no spark ignition shall result.

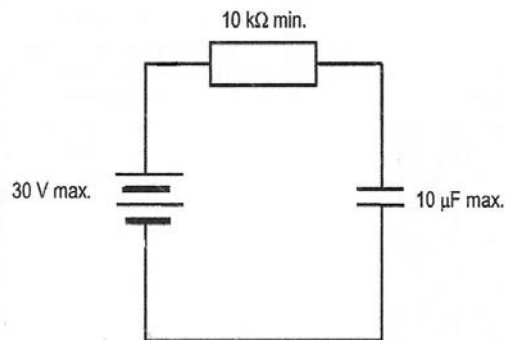**Fig.1** Simple inductive circuit   **Fig. 2** Simple capacitive circuit
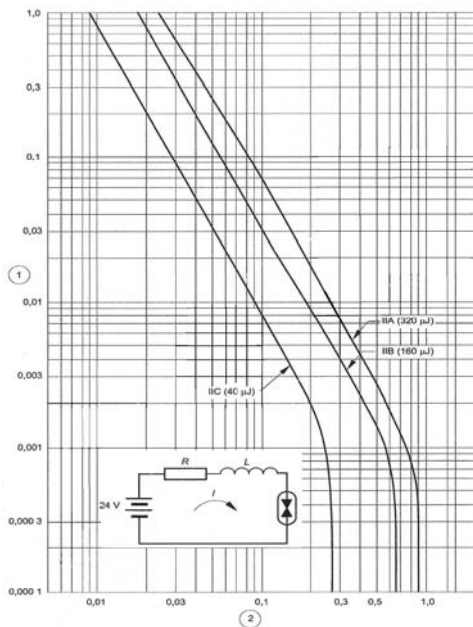
Consider a simple inductive circuit consisting of a power supply comprising a 20V battery with a suitably mounted infallible 300 Ω resistor feeding into a 1100 Ω, 100 mH, inductor like in fig.1. The inductor is air-cored.

The 300 Ω and 1100 Ω values are minimum values and 100 mH is a maximum value. Two assessments are made:
- to ensure that the power supply itself is intrinsically safe;
- to take account of the effect of connected load.

The value of the current limiting resistor is quoted as 300 Ω minimum and represents the worst situation as far as the resistor is concerned. If the resistor does not conform to the requirements for infallibility, application of a single fault would produce a modified circuit in which the resistor would be assumed to be short-circuited. With such a fault, the power supply would not be intrinsically safe. It is also necessary to determine a maximum value for the battery voltage as 22V. The maximum short-circuit is 22/300 = 73,3 mA, but the speciallity literature shows the minimum igniting current for a resistive circuit at 22V is 337mA, so the power supply can therefore be assessed as intrinsically safe in regard to spark ignition.

Connecting a load, the maximum battery voltage is 22V, since 300 Ω and 1100V are minimum values, the maximum possible current in the load22/(300 + 1100) = 15,7 mA. No faults need to be applied since the 300 Ω resistor is infallible and short-circuit failure of the inductor leads to the circuit considered. Reference to the fig.3, for a 100mH inductor, the minimum igniting current for a source of 24 V is 28mA. The circuit can therefore the assessed as intrinsically safe in regard to spark ignition.

1- inductance L (H);
2- minimum igniting current (A)
Fig.3
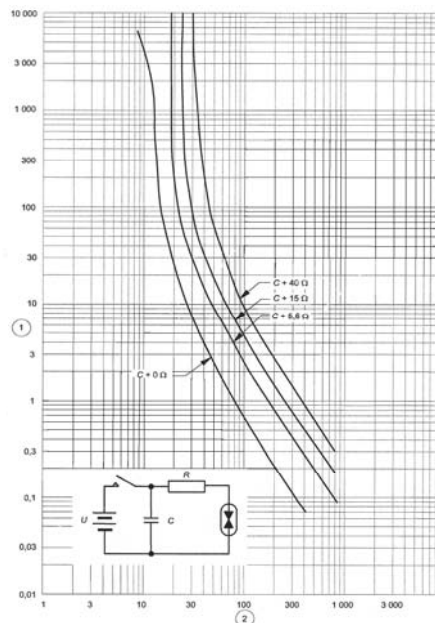
1- Capacitance C (μ F)
2- minimum igniting voltage U (V)
Fig.4

Consider a simple capacitive circuit as shown in the fig.2, using a 30V battery connected to a 10 μ F capacitor through a suitably mounted infallible 10kΩ resistor. For the purpose of this example, the values of 30V and 10 μ F are taken as maximum values and 10kΩ as a minimum value.

Two assessments are made:
- to ensure that the power supply itself is intrinsically safe:
- to take account of the presence of the capacitor.

Since the procedure is almost exactly that described above, the power supply circuit alone can be readily assessed as being intrinsically safe in regard to spark ignition. The circuit voltage or capacitance values could be reduced or an infallible resistor could be inserted in series with the 10 μF capacitor. The fig.4 shows that the minimum igniting voltage for 10 μF is 26V, so that the battery voltage would have to be reduced to 17,3V.

The power supply alone has a minimum safety factor, interconnecting it with a capacitor can lead to a situation where the circuit is not intrinsically safe.

3. CONCLUSIONS

The paper emphasis the importance of intrinsic safety ``i`` as type of protection based on the restriction of electrical energy within equipment and interconnecting wiring exposed to the potentially explosive atmosphere to a level below that which can cause ignition either sparking or heating effects.

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MONITORING THE VOLTAGE AND CURRENT HARMONICS IN MINING ELECTRICAL INSTALLATIONS

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Abstract: This paper makes a theoretical study of the harmonics in the electrical network mining introduced by electrical rectifier drives - power from existing extraction facilities in the Jiu Valley. Based on this study we used a computer program which is determined by the values of voltage and current harmonics which characterize deforming regime.

1. INTRODUCTION

The scale development of power electronics and electrical drives adjustable particular made of static converter-motor system was a new source of customers deformed, resulting in decreased quality of electricity supply by injecting network of current and voltage harmonics.

Electrical networks in the Jiu Valley mining are the main consumers deformed converter-motor drives the high power equipment such as extraction plants, mainly, but general ventilation plants, compressor stations, etc.

Presence of harmonic current and voltage in electric networks mining causes: increased power losses, poor power factor, low yield, improper operation command and control systems, interference with frequencies telemetric stations, etc.

2. PRODUCT DEFORMING REGIME OF STATIC CONVERTERS

Higher harmonics, especially power, as forced switching current at one point asked the average power to be transmitted pregnancy, there are a number of effects assessed through a series of indices, called index of performance or quality.

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Operating mode most used in the extraction plant (on which we will focus in the study of the harmonics) with drives rectifier-DC motor is the recovery, which is why we refer particularly to it.

Harmonic amplitude spectrum and they place these converters can be calculated by Fourier analysis. In general, the Fourier series expansion i_s input rectifier current is:

$$i_s = I_{ds} + \sum_{k=1}^{\infty} (a_k \cos k\omega t + b_k \sin k\omega t) \tag{1}$$

where:

$$I_{ds} = \frac{1}{2\pi} \int_0^{2\pi} i_s \, d(\omega t) \tag{2}$$

is the mean value;

$$a_k = \frac{1}{\pi} \int_0^{2\pi} i_s \cos k\omega t \, d(\omega t) \tag{3}$$

is the amplitude of the cosine component:

$$b_k = \frac{1}{\pi} \int_0^{2\pi} i_s \sin k\omega t \, d(\omega t) \tag{4}$$

is the amplitude of the sine component.

Typically, the current is symmetrical about the abscissa and therefore its average value is zero,

$$i_s = \sum_{k=1}^{\infty} \sqrt{2} \, I_{sk} \sin(k\omega t + \Phi_k) \tag{5}$$

Where the effective value of harmonic order k is

$$I_{sk} = \sqrt{\frac{a_k^2 + b_k^2}{2}} \tag{6}$$

Depending on the actual values of harmonics, RMS current input rectifier is:

$$I_s = \sqrt{\frac{1}{2\pi} \int_0^{2\pi} i_s^2 \, d(\omega t)} = \sqrt{I_s 1^2 + I_s 2^2 + I_s 3^2 + \dots} \tag{7}$$

The Quality indices that characterize the performance rectifiers are:

1. The total harmonic distortion (FTD)

A better measure of the degree of distortion component is obtained by dividing the actual value of the total harmonic distortion obtaining fundamental:

$$FTD = \frac{\sqrt{I_s^2 - I_s I^2}}{I_s} I = \sqrt{\left(\frac{I_s}{I_s} I\right)^2 - 1}$$ 8)

It is obvious that a rectifier is even better the FTD approaches zero. If three-phase rectifier bridge fully controlled FDT = 0.3.

2. Form factor FF

Is defined as the ratio of actual and average values of a quantity and refers usually rectified voltage:

$$FF = \frac{U_{def}}{U_d}$$ (9)

Form factor of the voltage dependence of the number of pulses rectifiers and control angle shows that it has much higher values as p is smaller, and the angle control is closer to $\pi / 2$ (see Figure 1.a and 1.b).
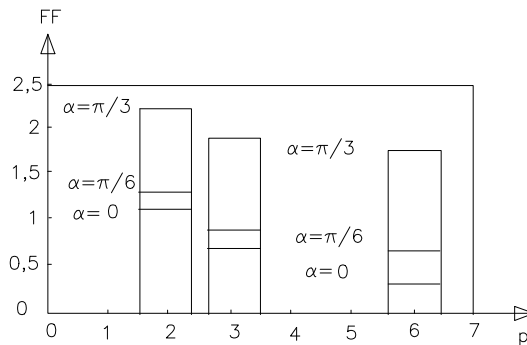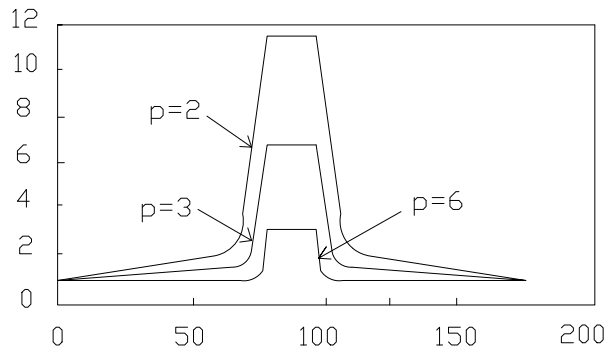

Fig.1.a

Fig.1.b

3. FO ripple factor

Output voltage is pulsed, can be considered as the sum of the DC component (average value) and an alternative component, the actual value $\tilde{U}_d$. Thus, the actual value of the rectified voltage is:

$$U_{def} = \sqrt{U_d^2 + U_{d\_}^2} \tag{10}$$

This shows the magnitude of the alternatives:

$$U_{d\_} = \sqrt{U_{def}^2 - U_d^2} \tag{11}$$

Ripple factor will be:

$$FO = \frac{U_{d\_}}{U_d} = \sqrt{\left(\frac{U_{def}}{U_d}\right)^2 - 1} \tag{12}$$

and is the ideal zero.

4. Input power factor – PF and power factor on the fundamental - FPF

Power factor rectifier assembly - task entry is:

$$FP = \frac{P_d}{S_t} \tag{13}$$

Fundamental power factor is the cosine of the angle of phase shift between current and voltage fundamentals - Φ_1:

$$FPF = \cos \Phi_1 \tag{14}$$

It can be shown that:

$$FPF = \cos \Phi_1 = \cos \alpha \tag{15}$$

That the phase shifts between current and voltage is right fundamentals angle control. This is the main disadvantage of controlled rectifiers, or operation at a power factor much smaller control the angle is closer to $\pi/2$.

By default, the network is required, the fundamental reactive power and power is generated while distorting:

$$D = \sqrt{S_t^2 - P_d^2 - Q^2} \tag{16}$$

which can be written in the form:

$$D = P_{d0}\sqrt{\frac{1}{FU^2} - 1} \qquad (17)$$

That does not depend on the angle distorting power control, load only.

Analyzing the results obtained by means of theoretical harmonics can see that pollution is reduced through the use of converters with a higher number of pulses, the amplitudes of these harmonics decreasing in periods of change in speed (when referring to electric drive) so when the control angle is zero semiconductor.

Given the above considerations has produced a computer program with which we can determine the values of voltage and current harmonics which were measured at the Jiu Valley mining facilities.

Measurements were performed with a PC using a specialized data acquisition board.

3. DISADVANTAGES OF THE HARMONICS

Current harmonics cause additional losses by increasing skin effect due to higher values of higher order harmonic frequencies. Similar losses occur in transmission systems of telecommunications networks are located near industrial recovery facilities.

Harmonic voltages - generally harmonic voltage supply networks - are a consequence of harmonic currents and circulation are proportional system impedance at the corresponding frequencies.

Harmonic voltages are dangerous, especially at the point furthest from the feed point (where the harmonic current source link to installation), where they can find different companies automation systems, remote.

4. CONCLUSIONS

From studies over the years concluded that the best extraction facilities are equipped with DC drives, even if the initial investment is higher.

Following these conclusions were switched to using DC motors extraction facilities commissioned to new installations and replacing drives with obsolete motors from old wells.

DC electric drives were used in the old mines, but the generator-motor system. This type of operation is obsolete, requiring a large number of rotating electrical machines.

Modern solution is the electric drive rectifier-DC motor. The only major drawback of this type of operation is the deforming regime introduced by the rectifier system to be reduced or eliminated whenever possible.

Larger scale use of static converters made with semiconductor electronics has led inevitably to the emergence of inconvenience due to the worsening power quality parameters in the vicinity converters supplied to consumers, consumers connected to the same bush bar.

Because of this significant power losses occur in mines using static converter drives the motor. These losses charged unreasonably selling price of coal delivered to beneficiaries.

The question is to eliminate these drawbacks through a systematic approach to the problems posed deforming regime. To tackle deforming effect is necessary theoretical knowledge parameter characterizing this system: distortion factors, form factor, ripple factor, the harmonics, etc.

The most appropriate theoretical study of the harmonics is the Fourier series expansion of harmonic magnitudes, a method that is used most in Electrical.

Knowing theoretical indicators of the harmonics can be compared with experimental results obtained from a series of measurements at existing plants in operation and can be found on the most appropriate methods to compensate harmonic voltage and current.

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