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SENSORS TO IMPROVE TIMBER BARKING – ROBOT INTELLIGENT BEHAVIOUR

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Abstract - Having been realized the Timber Barking Model Device with the Operational Dimensions, which used the new untraditional timber barking way – by means of the Electric Current Effects Passing through the Subcortical Layers, the number of Sensors have to be used, to be set the adaptive intelligent barking device on the robotized level. To be reached the successful timber barking - the key problem is the electric power controller's setting with respect - first – to the subcortical layers quality (being changed in time); - second – with respect to the log's cone; - third – with respect to the input (output) log's diameter to (out) of the device. The other problem is timber – barking surface quality processing.

Key words: timber, barking, electrode.

1. INTRODUCTION – NEW TIMBER BARKING PRINCIPLE

To this time, the mechanical way is preferred by industry timber barking, being accompanied with the wood loss. To be eliminated this disadvantage any new ways are tested as e.g. : the high-frequency currents using; the intense heating of the frozen timber; the overheating vapour stream using; the vacuum degassing of the hermetic closed spaces with timber; „the ball burnishing" - that is the small particles stream strike; only rarely the chemical or biological way is used. No wood loss is realised by using of the original timber barking way by means of the Electric Current Effects. The principle consists in the fact, that the subcortical layers (no completely dried) being passed with an electric current for a certain time causes theirs evaporation, so that the coherence of bark compact with the wood is destroyed. Then, the bark either goes away, or such a one can be put down with the very low forces only.

2. TIMBER BARKING MODEL WITH OPERATIONAL DIMENSIONS – MAIN PARAMETERS

The great number timber barking experiments had been done on only scale-down static model, before the Dynamic Model with the Operational Dimensions has been realized – see "Fig. 1". The main part is the "electric head" /4 / what is the cylinder from 18 chain electrodes, active length of each

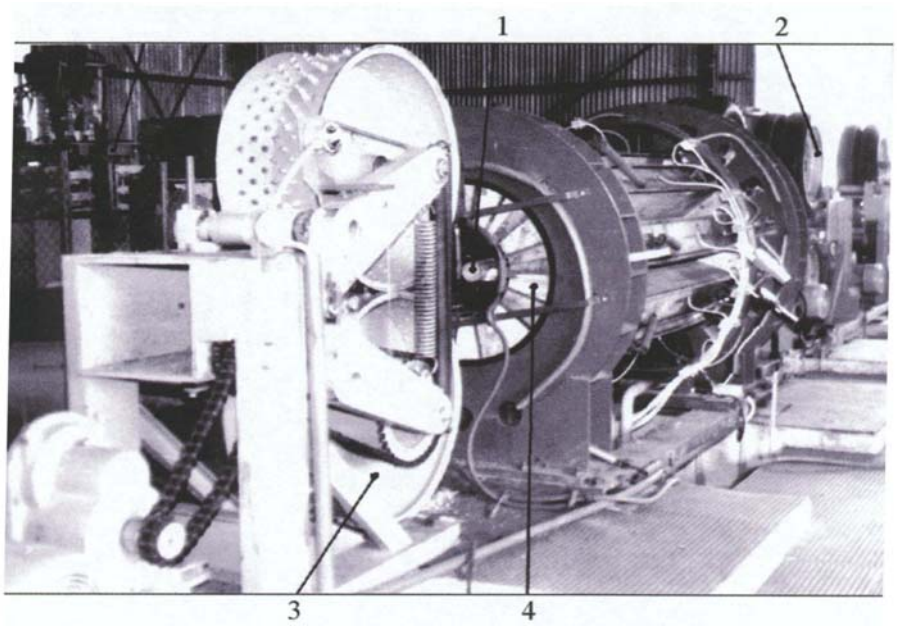

Fig.1. Timber Barking Device

one is 1,5 m and these ones are situated round the log's circumference /1/. Through this "head", the spruce logs (with diameter 0,06 – 0,24 m; length up to 16 m) can be drawn with the speed 0,23 ms^{-1} (input /2/ - output /3/ feeding devices). The distance between two electrodes has to be automatically adapted from 0,02 to 0,04 m with respect to the log's cone. Between two electrodes, the max. line to line voltage level can be set up to 1730 V, 50 Hz, IT ~ 3 line system. The voltage can be automatically controlled by means the power unit (AC – chopper).

3. MAIN PROBLEMS X BRIEFLY SENSORS INTRODUCTION

To be improved Timber Barking Robot Intelligent Behaviour, it's supposed to collect the data results (quality of the timber barking surface; used voltage - for the subcortical layers quality) and adapted or correct these ones in the future with respect to be reached either the successful timber barking, and either to optimize the el. energy consumption. The problems analyses:

- the timber barking surface quality processing x TV-camera, A/D-converter, 2D-half-tone- view (e.g.: 95% - "white–barked" log's surface against 5% - "dark–unbarked rests", what means the well barked surface; the other scale 98% … etc.);
- to determine the subcortical layers quality (to be preset the power unit either for the log's input into the "el. head" and either to be controlled the voltage level during the log's stay in active zone; in case "low" applied voltage – no timber barking is realized, in case "very high" voltage – the sparksovers or breakdowns possibilities are generated) x the Qualitative parameter *dI/dt* can be set by the electronic way - what means the current growth in defined conditions as e.g.: by the "1 second test" with 700 V as average for 3 couples of electrodes (length 0,1 m; distance 0,02 m);
- further will be given only the others main problems x using standard sensors (as – inductive, optical, proximity etc.) would be only briefly appointed later :
- to set the right voltage levels for the log's input and output, when only a small part of the log is situated in the el. head, with respect to the log's diameter and the subcortical layers quality;
- to control the voltage level with respect to the tree-cone;
- to prevent the el. sparksovers and breakdowns due to the vapours and gasses concentration in the interelectrodes spaces;
- to ensure the reliable log's movement speed through the "el. head";
- to ensure the reliable el. energy transmission to the subcortical layers;
- to solve the "crash situations", as broken electrodes, short connections, sticking or log's stop in electric head;
- to realise the safety rules precautions.

4. TIMBER BARKING TECHNOLOGY

The ideal voltage control can be introduced in agreement with "Fig. 2" – so called "The Constant Current Control I_a = const."– passing between two electrodes. With respect to the log´s cone the log´s diameter D is increasing and the electrodes distance, too. For the first time, the narrow log´s part being supposed always entering to the electric head, then the voltage control necessity can be simply expressed as follows:

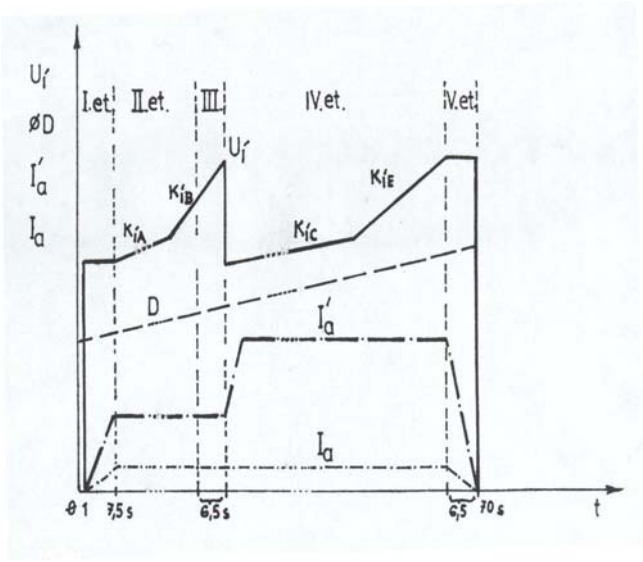

Fig. 2 - Voltage control

$$U_{i} = K_{ix}(D - D_{ox}) + U_{oi} \quad , \tag{1}$$

where:
K_{ix} – increasing voltage factor with respect the log´s cone (V/m), for the subcortical layers quality – *í = H; M; L* (note – three quality groups have been set , to this time), and either for the interelectrodes distance (characterised with the log´s diameter *x = A; B; C; E*);
D_{ox} – the minimal log´s diameter for given interelectrodes distance (m);
U_{oi} – the minimal starting voltage value with respect the quality *í*.
This type of the voltage control is used during the II-nd and III-rd stage (when the first electrodes set (9 pcs) is in activity; and during the IV. stage, too (when the both electrodes sets (18 pcs) are in activity. The total current $I^{\vee}_{a} = const.$ can be expected. No voltage control U_i is supposed during the I-st and V-th stage, when only the small part of the log is situated among the electrodes, and the risk of the breakdowns and sparksovers is generated. Therefore, no voltage is used for an entering narrow part of the log – in the length about 0,3 m, during the I-st stage. Similarly, during the III-rd stage, being used no voltage by the second electrodes set installing among these first ones (which stay in activity). The stages limits are controlled, either with the mechanical switches, and either with the proximity sensors. From the above mentioned, it´s quite clear – having been preset the right input parameters values ($í; D_{ox}; K_{íx}; U_{oi}$) – the successful Timber Barking can be expected. Therefore, the task for the stand – by workplace – to be caught these ones parameters:
- *í* … the subcortical layers quality. As the sensor is used the current transducer – being supplied from the couple of

electrodes (length 0,1 m; distance 2 cm) during "1 second test" by U = 700 V, 50 Hz. By the electronic way is determined dI/dt (for 1s – simplified as I_7 (A) – the Qualitative Subcortical Layers Parameter, only). The I_7 – level is determining for the one of three (to this time) Qualitative Groups (*H; M; L*) setting. Each of them is characterised with the minimal voltage level – U_{oi};

- K_{ix} … to be preset this increasing voltage factor, it´s necessary to be determined the log´s cone – what is realised, by means of the couple of inductive sensors (selsyn) – distance 1 m between them; in the same time is being set the real minimal input log´s diameter D. These sensors would be substituted with the optical ones, in the future.

By this way, having been solved the key problem – what voltage value has to be preset for the log´s enter to the el. head. It is important, especially from the view-point of the time constant for the gasses and vapours development. In case, that this one is long – no quite well quality of the timber barking surface can be expected; for the short one – the danger of the sparksovers and breakdowns is generated. Due to this fact, it cannot be so much to relay on the voltage control – to be improved the timber barking quality – during the log´s passing through the el. head, especially what concerns the entering narrow part of the log. The log – having been drawn through the el. head – the constant time of the log´s followed place in active zone is insured. In case, the log´s sticking or slipping in the el. head – the error´s signal is generated from the movement transducer (resolver), to be switch-off the power – supply unit. The others error´s signals (as – overcurrent; overload etc.) are taken in consideration, too.

The timber barking surface quality evaluation is supposed by means of TV-industry camera. The attention can be focused, either on the typical barked area (average quality); or either on worst one. Then, in the definite area – the "Success – Percentage %" of the Timber Barking - having been determined - as ratio:

("white" – "black") / "white" ;

(where: *"white"* – the high barked quality area is compared with the *"black"* one – the unbarked rests) – to be set the Quality Barking Scale : (*1* – excellent 99,5%; *2* – quite well 98%; *3* – well 95%; *4* – bad 70%; *5* – very bad 50%). The result, together with the input parameters would be laid as data in PC-memory. With respect to result – what is the level of the "Success %", the input parameters (K_{ix}; U_{oi}) would be merely or "much more" adapted (fuzzy controller) – to be reach - step by step – the 2-nd Quality Degree (98%), at least. This one is the main philosophy for the learning flow chart (which hasn´t been given in this paper) for the Timber Barking Robot Behaviour. Of course, with respect to the repetition rate, the anomalies could be excluded, too; and for the bad (or very bad) results – to be separated the new Qualitative Group(s) – *í*, if it would be necessary; or to choose the more progressive type of control.

The outlook for the future investigation – beside that, to be improved the "% Quality" of The Timber Barking Surface; to be optimised the energy consumption – what means to test the fresh logs versus these ones with the short x long time storage.

5. RESULTS

The input parameters have been determined for the spruce logs, to this time – as:

í - 3 Qualitative Groups are characterised with the parameter I_7 in the range: L … 0,04 A < I_7 < 0,1 A

M… 0,1 A < I_7 < 0,72 A

H … 0,72 A < I_7 < I_{77}

Note: As the low successful barking limit can be taken - the parameter I_7 = 0,038A, when the barked surface quality has been quite well. The upper limit I_{77} hasn´t been determined to this time – due to the fact, that the oversparks and breakdowns can be expected.

U_{oi} - the minimal voltage for the minimal diameter D_{ox} on the Quality í (e.g.: for D_{oA} = 0,057 m : U_{oH} = 700 V; U_{oM} = 800V; U_{oL} = 1000V - roughly rounded – off).

K_{ix} - the increasing voltage factor (e.g.: K_{HA} = 10300 V/m; K_{MB} = 24100 V/m; K_{LA} = 27600 V/m).

The system of the control equations has been set, in sense of the general "equation (1)", on the base of the first experiments. Being expected, that these input parameters would be modified in the future, either with respect to the used adaptive control; and either to the others experiences – to be reach the quite well timber barking quality, at least – what can be seen in "Fig.4". The total current $I\check{}_a$ - from the first electrodes set (measured in one line) can be seen as Time vs. Current dependence $I = f(t)$, for the log passing through the el. head during the time t = 36,5s ; $\bar{I}\check{}_a$ = 63 A - see "Fig.3".

By the first tests, on the Timber Barking Model with the Operational Dimensions, the number of experiences and difficulties has been gained as e.g.: - the worse timber barking quality has been usually situated into the entering narrow part of the log; - by the voltage increasing especially in this part of the log, or generally beyond "certain limits" – the sparksovers and breakdowns hazard has been appeared (due to the high gasses and vapors density - note: no vapors sensors have been tested, to this time).

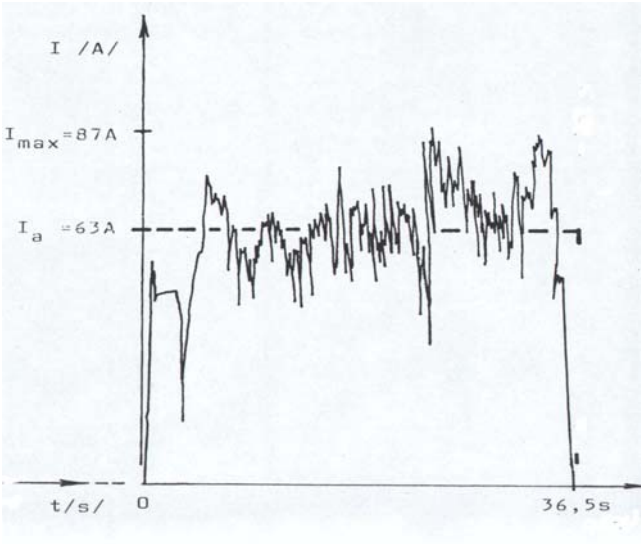

Fig.3 . Time vs. Total line current dependence

6. CONCLUSION

The qualitatively new Timber Barking Principle has been introduced , the main advantage is in the fact – practically no wood losses are realized (compared with these mechanical ways, being mostly prefer, at present). To be reach the high timber barking quality – the adaptive control way is roughly introduced; and the voltage control from the view-point of log´s cone, too. The future experiments show, if it would be necessary to use the more effective control way as: - to control the speed of the feeding devices (to be prolonged the log´s stay in active zone); - or to increase the voltage by the insurance of the short – circuit strength of the timber barking device; - to realize the more effective blowing – out the vapors and gasses from the el. head spaces, etc.
The sensor´s question cannot be considered as definitive – solved; especially what concerns the subcortical layers quality determination; and the vapors and gasses concentration in interelectrodes spaces, too. Being supposed, that the thermocamera would be help so much, but this one hasn´t been tested to this time. The choose and testing the others sensors to verify theirs reliability for the above mentioned purposes would be subject for the other investigation.

First experiences and results have been gained on the functional timber barking model with the operational dimensions – see "Fig.1", to confirm the possibility to use the qualitatively new Timber Barking Method. The conditions and influences variety has to be caught with number of sensors, to be created the intelligent robotized workplace..

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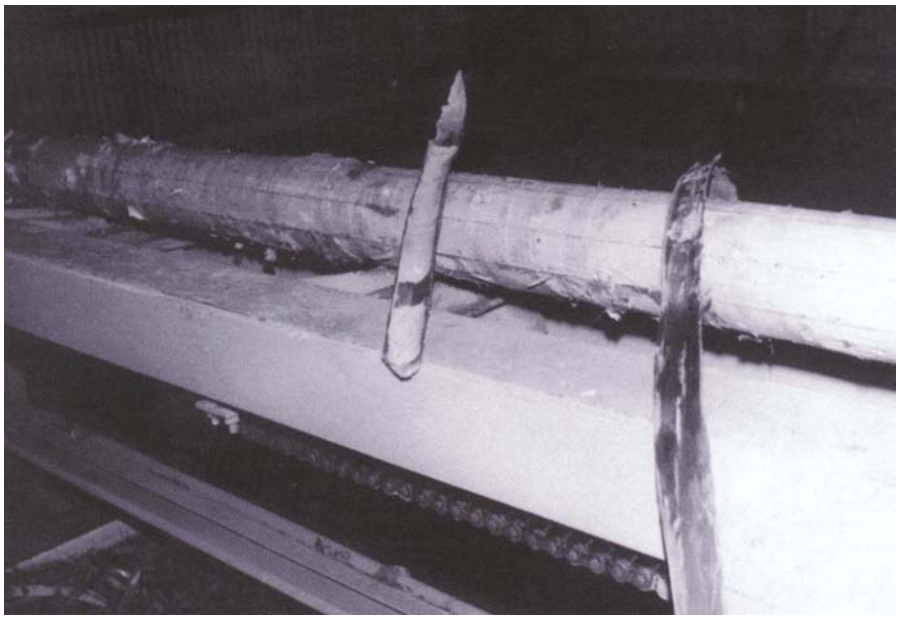

Fig.4. The Timber Barking Log´s Surface