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Corina Daniela I. Cunţan, Ioan I. Baciu

Fuzzy Algorithm Used to Water Debit Control to the Secondary Cooling in Continuous Casting Proces.

The relised research, reffering to human expert behaviar, show that this have a strong nonlinear behaviar, accompanied by prediction, integration, anticipation and delayed effects and even in adaptation of the real functioning process.The prominencing of languages caracterisation of process and also the interpretation based of experience in commands generation process represent the parameters which can modify the controll properties.The projected Fuzzy algorithms lead to nonlinear controllers. To determine the controlling characteristics was used: Fuzzy Controller PIC 16C74, the appropriate software and ADA 3100 data acquisition board.To obtain a best controlling precision, the process was divided in two parts: start-stop and continuous casting process. For each part was establised the base rules and the membership functions which lead to obtain the controll surfaces and statical characteristics.

1. Introduction

In casting of small section semifinished products should exist a very accurate correlation between the drawing speed and the steel level in the mould. Non-repecting of this desiderate leads to non-uniformity of the cas product's cross-section, thus to rejected product. Modification of the casting speed should lead to the modification of the material's cooling regime. Currently is not taken into account the material's temperature decreasing slope. Improving of the presented situation can be achieved by using an expert system. Its need is imposed by the fact that the process can not be accurately modelled mathematicaly and a lot of parameters (steel fluidity, its chemical properties, heat transfer coefficients, etc.) are modifying in time in a way which can not be previously known.

2. Expert system for secondary cooling control, based on Fuzzy logic

The structure of the proposed system is presented in fig. 1.

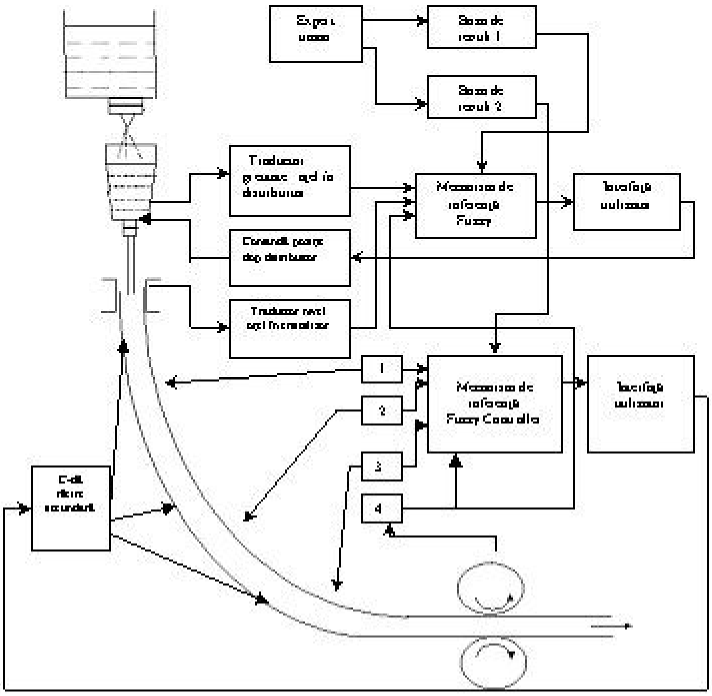


Figure 1. 1,2,3 – temperature transducers (pyrometers); 4 – casting speed transducer;

For expert system's implementation, it is formed a base of specific knowledges, introduced by the human expert. They are materialized as sets of rules, which consists of the judgement based on which the system acts, analyzing the variables' real values. Based on human expert's experience, the system elaborates the values prescribed for the classic adjustment loops for the aimed measures, using adequate interference mechanisms.

In the practical case presented in this work, have been proposed the following measures considered as important for adjusting the water flow in the secondary cooling:

Input variables: drawing speed, material temperature zone 1, material temperature zone 2, material temperature zone 3.

Output variables: cooling water flow zone 1, cooling water flow zone 2, cooling water flow zone 3.

Analyzing from technological viewpoint the measures taken into account, an expert can establish, by the elaborated sets of rules, adequate values for the execution mechanisms. Having in view the great number of variables taken into account for each adjusted parameter, could be obtained an accuracy which is net superior to the actual situation. Obtaining of some performances superior to the actual situation, by the proposed methods, depends essentially on the quality of the rules bases. Drawing-up of these rules bases was made by consulting a great number of technological specialists from practice, in order to be taken into account all the possible situations.

3. Adjusting of water flows in the secondary cooling

In order to obtain a better accuracy of the adjustements, the process was divided in two regimes: start-stop and continuous casting. For each in part were established the rules bases and the appertainance functions, based on which were obtained experimentally the adjustment surfaces and static characteristics. The rules bases include a number of 54 rules, for each regime.

In fig. 2 is presented the block diagram of the Fuzzy regulator.

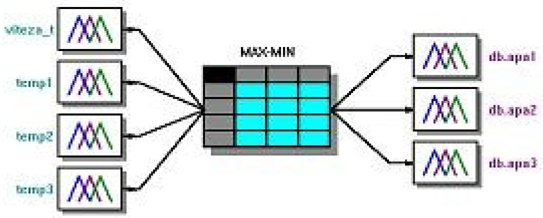


Figure 2. The block diagram of the Fuzzy regulator

Due to the wide variation range of the measures and of the process' complexity, was necessary the achievement of some translation circuits (fig. 3) of the measures taken during the process, for their better analysis by the Fuzzy controller.

Effectively, the translation of the measured values was made by the relation:

$$Y = Y_1 + \frac{Y_2 - Y_1}{X_2 - X_1} \quad (1)$$

Y_1 – minimum limit of the normed field;
Y_2 – maximum limit of the normed field;
X_1 – minimum limit of the real field;
X_2 – maximum limit of the real field;

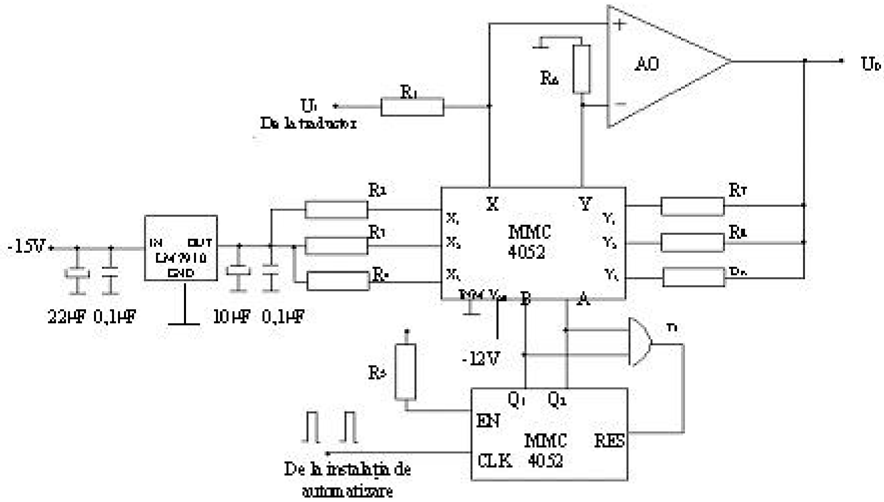
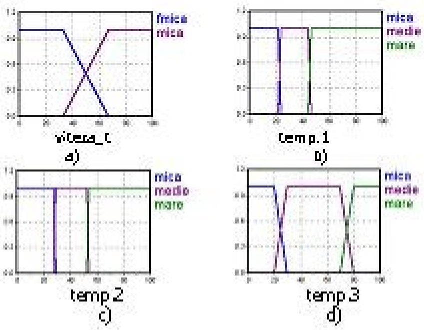


Fig.ure 3. Translation circuit

In fig. 4 are presented the appertainance functions for the input measures, and in fig. 5 are presented the appertainance functions for the output measures.



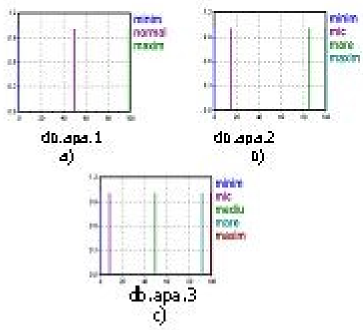


Fig. 4 The appertainance functions for the input measures

Fig.5 The appertainance functions for the output measures

The adjustment surfaces and the static characteristics were obtained experimentally according to the scheme from fig. 6.

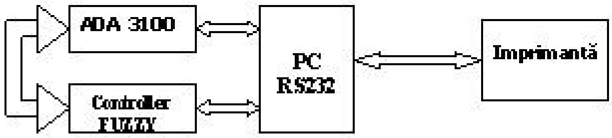


Figure 6

The static characteristics obtained experimentally according to the scheme from fig. 6 are presented in fig. 7 , 8 ,9 and 10.

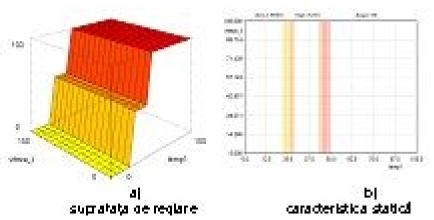


Fig. 7
Water flow 1=f (speed_t, temp. 1)
temp. 2 – average, temp. 3 – average

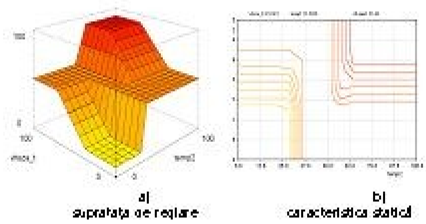


Fig. 8
Water flow 3=f (speed _t, temp. 2)
temp. 1 – average, temp. 3 – average

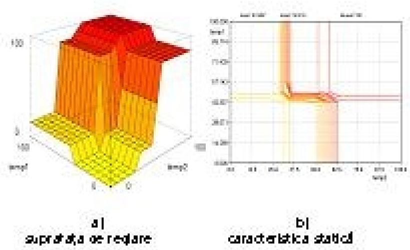


Fig. 9
Water flow 2=f (temp.1, temp. 2)
speed_t – very low, temp. 3 – average

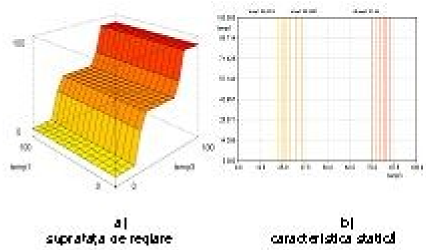


Fig. 10
Water flow 3=f (temp.1, temp. 3)
speed_t – very low, temp. 2 – average

From the surfaces' analysis it can be noticed that there are no discontinuities and that they correspond to all the possible situations included in the rules bases.

4. Conclusion

In this work has been suggested the structure of a management system of continuous casting process and have been conceived the related Fuzzy algorithms for adjusting the water flows in the secondary cooling. These algorithms were verified experimentally in the laboratory, using the Fuzzy controller, a performant PC and an ADA 3100 data acquisition board. In this way, were obtained adjusting surfaces and static characteristics. Theyr analysis by technological specialists lead to the conclusion that they are correct and can ensure an adequate adjustment of the proposed measures.

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Addresses:

- Works Leader Ph. D. Eng. Corina Daniela Cuntan , University Politehnica Timişoara, Faculty of Engineering of Hunedoara, corina_c@fih.utt.ro
- Works Leader dipl. eng. Ioan Baciu, University Politehnica Timişoara, Faculty of Engineering of Hunedoara baciu@fih.utt.ro