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ADAPTIVE CONTROLLING OF POWER BOILER

This paper presents research on adaptive control (AC) of combastion process in industry. Results were obtained from research conducted in laboratory combustion chamber with usage of Fiber Optical Measurement System (FOMS) with electronic block. Simulation proved that implementing AC and FOMS to burning process improves flue gasses parameters -direct measure of power boiler ecologic and economical quality of work.

1. Advanced control

Contemporary industrial process control systems in the power industry mainly on PID-based controllers, though the hardware used to implement control algorithms has improved significantly in recent years. The improvements that can be obtained with PID based controllers are limited. For this reason the modern advanced control techniques based approach is gaining acceptance.

The most important methods are systems based either on genetic algorithms or artificial neural networks. Both these methods can successfully cope with non-linear or poorly defined problems.

Genetic algorithm give us the possibility to incorporate the linguistic or rule-based knowledge into classical control scheme. It can be achieved in many ways, mainly by: Genetic Controllers, Evolutionary Models, and Genetic Expert Systems [6].

2. Adaptive control

In most real world control problems, any considered plant is partly known and partly unknown. The primary purpose of an adaptive scheme, is to manipulate the controller to cope with unknown or changing dynamics in plant and environment. Beyond that, however, adaptive controllers have also been advocated as an alternative to prior analysis: "automatic adaptation" is then seen as a mean to discharge the user from modeling uncertainty. We can enumerate three basic adaptive control structures:

- gain scheduling - nowadays this approach can be met in new version, if we consider fuzzy Takagi-Sugeno based multiregional controllers,
- Model Reference Adaptive Control (MRAC) algorithm based on controlled plant model in the form of ARMAX structure,
- Self-Tuning Regulator (STR) algorithm is quite similar to the MRAC, but we do not use ARMAX model explicitly to compare with the plant,

Joining advanced controlling (NN and AG usage) together with adaptive control allows us to obtain very promising results in situations where traditional methods do not turn out to be useful [6].

3. Genetic control

Recently a number of articles concerning GA have appeared. Heaving considered them we can draw a conclusion, that optimisation algorithm play a significant role in all kinds of control methods nowadays. Classical optimum searching methods (direct and indirect) based on simple seeking of results space have a principal drawback – when dealing with function of many extremes it is very probable that we miss out global extreme. GA implementation makes possible to overcome this obstacle by simultaneous parallel searching of many points in data space and exchanging information between the points. This improves both speed and quality of the search.

4. Genetic algorithm in neural networks

In order to design a robust observer we can make use of a combination of two methods: genetic algorithm and neural networks. Such combination can be either supporting or cooperating. Supporting neural networks by GA is based on using one method for preparing data which are consequently transferred to be processed by the other method. Cooperation of GA and neural network means using both methods simultaneously.

4.1. GA supporting neural networks GA used for trainning neural network

In majority of cases such an algorithm optimises neural network weights with previously designed topology. Each chromosome is characterized by a set of network weights end evaluated by fitness function. This function is defined as a difference between desired value and an output value. It is essential in two cases: first it allows global searching in weights space (which helps avoiding too fast convergence) and second if the gradient is not available.

GA for defining network topology

This type of GA is used during simulation. Optimal design of neural network architecture means seeking for a network which will operate best for a given example. Such an assumption leads to searching the architecture space composed of all possible architectures and selecting the most appropriate one (respecting given optimality criterion) [4].

In the issue a GA was used to optimalise neural network weights. It allows to create appropriately robust observer.

5. Burner row control system approach.

The diagram of burners' unit control operation is presented below. It consists of two basic components: an observer and burners' operation optimisation system. The observer consists of burner's model in the form of neural network and GA supporting the NN operation. Burners' operation optimisation system is based on GA that operation parameters were matched on the basis of experience.

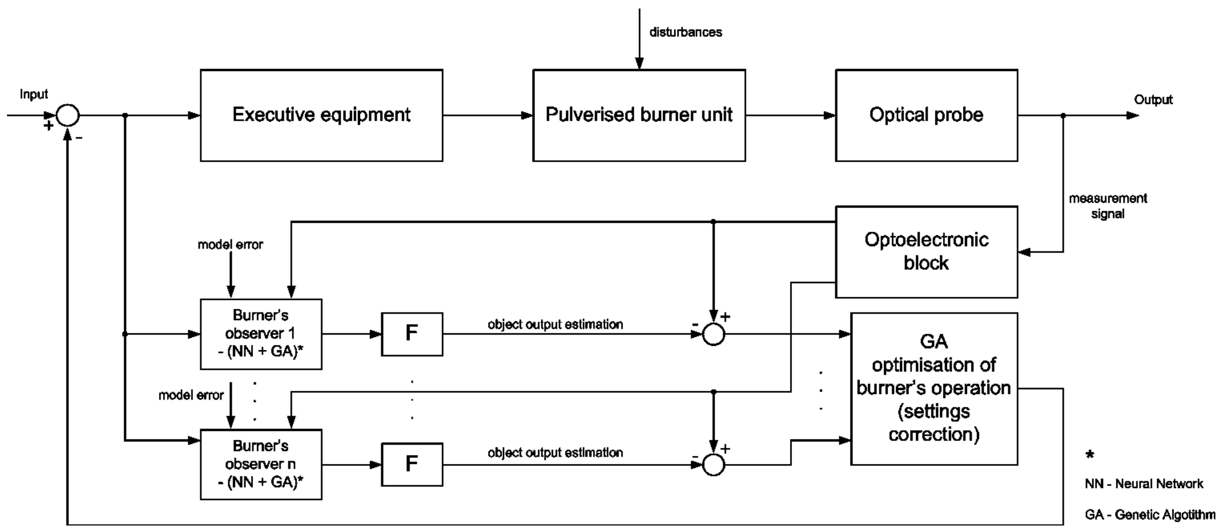
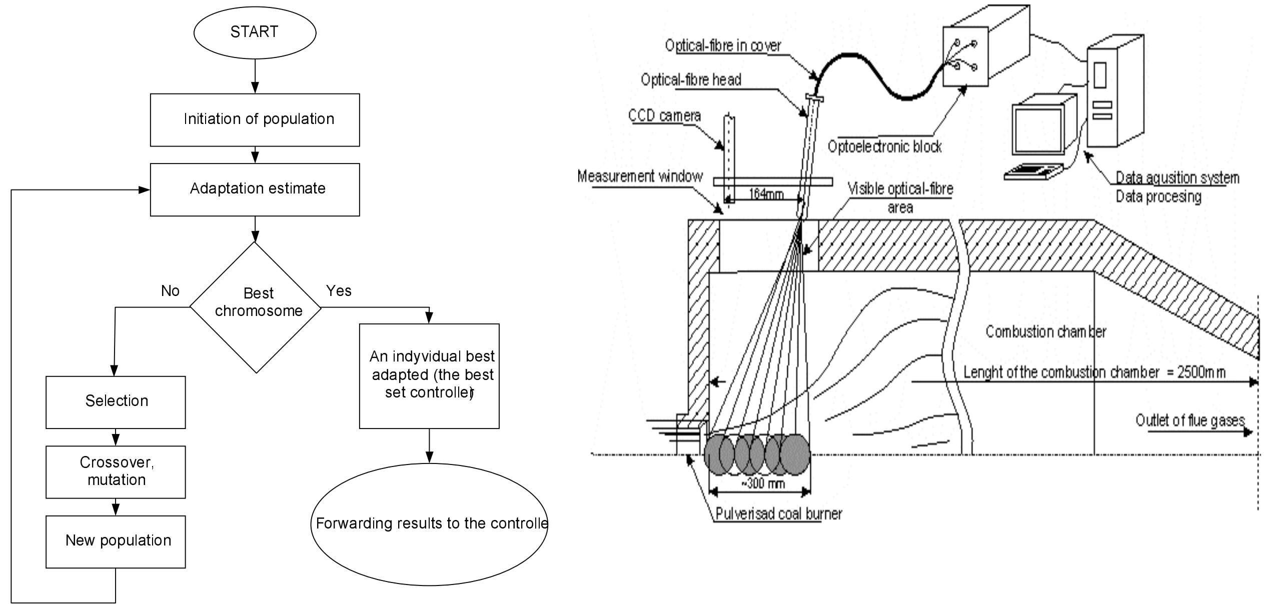


Fig. 1. Burners' unit operation control diagram

The best results were obtained in case of population of 130 individuals, 15 genes chromosome length. It also allowed to define prediction horizon. After generating another population, the best adopted individual is passed as controller setting. The aim of control is minimization of difference between measured NOx concentration and pre-set value. On the diagram below (Fig. 2a) an outline of examined GA is presented.



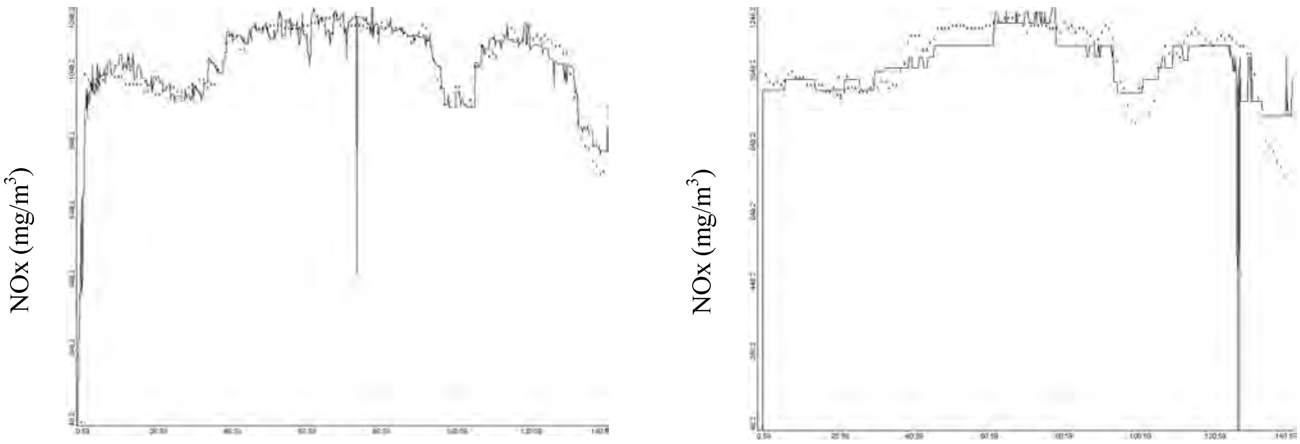
a *b*

Fig. 2. a) GA draft; b) measuring equipment

Initial measurements were carried out in laboratory combustion chamber in Institute of Power Engineering in Warsaw (Fig. 2b).

6. Simulation results

The results of simulation of operation of genetic controller and genetic observer using neural network as controlled object model is shown below. At Fig. 3a simulation is presented, whereas at figure 3b we can see the results of the test simulation for two burners.



sample sample

a *b*

Fig. 4. Result of simulation: a) Fibre Optic Measurement System (solid line) - simulation for single burner with GA system, (dot line) simulation with NN+GA controller; b) Fibre Optic Measurement System (solid line) - test simulation for two burners, (dot line) simulation with NN+GA controller

Generally speaking, system examined during the simulation responded properly to disturbances. However, not all of the circumstances cause the same controller behaviour. Huge changes of NOx did not provoke GA to change controller setting. A lot of amendments in almost every element presented in Fig.1 is still needed. Even though, we can conclude that there is a possibility of implementing GA into process of control of NOx emission from a power burner. Simulations presented in this paper show promising perspectives for development of fibre optic sensors used for burning quality measurements.

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THREE LEVELS OF THE ELECTROMAGNETIC COMPATIBILITY (EMC) IN AUTOMOTIVE ENGINEERING

An important quality factor for vehicles is the compliance of the Electromagnetic Compatibility (EMC). This compliance is given both through legal requirements and by voluntary defaults of the automotive manufacturers and suppliers.

In this paper, some selected EMC measuring methods will be presented, whereas two of these were recently developed at the EMC research laboratory at the University of Applied Sciences Zwickau in close cooperation with Volkswagen and Audi.

1. Introduction

With an increasing number of vehicles, interfering and disturbing systems as well as the increasing protection regulations against electromagnetic fields, the compliance of EMC get more and more important.

In a functional manner the EMC of vehicles can be divided into vehicle level, component level and semiconductor level. The present paper describes a series of test methods in these three levels (Figures 1 to 3). These methods and the appropriate measuring results will be presented in respect of the EMC main research at the Westsächsische Hochschule Zwickau (FH).

Fig. 1. Vehicle level

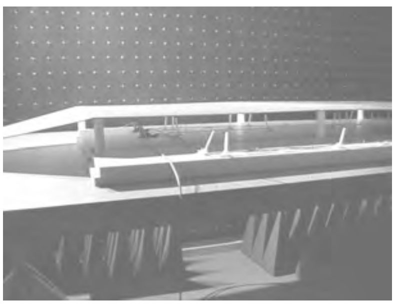

Fig. 2. Component level

Fig. 3. Semiconductor level