Synthesis and Research of Neuro-Fuzzy Model of Ecopyrogenesis Multi-circuit Circulatory System

Yuriy P. Kondratenko[1,2], Oleksiy V. Kozlov[2],
Leonid P. Klymenko[1], and Galyna V. Kondratenko[1,2]

[1] Intelligent Information Systems Department, Ecology Department
Petro Mohyla Black Sea State University, 68-th Desantnykiv str. 10,
54003 Mykolaiv, Ukraine
y_kondrat2002@yahoo.com, rector@chdu.edu.ua,
galvlad09@rambler.ru
[2] Computerized Control Systems Department
Admiral Makarov National University of Shipbuilding, Geroiv Stalingrada ave. 9,
54025 Mykolaiv, Ukraine
oleksiy.kozlov@nuos.edu.ua

Abstract. This paper presents the development of the neuro-fuzzy mathematical model of the ecopyrogenesis (EPG) complex multiloop circulatory system (MCS). The synthesis procedure of the neuro-fuzzy model, including its adaptive-network-based fuzzy inference system for temperature calculating (ANFISTC) training particularities with input variables membership functions of different types is presented. The analysis of computer simulation results in the form of static and dynamic characteristics graphs of the MCS as a temperature control object confirms the high adequacy of the developed model to the real processes. The developed neuro-fuzzy mathematical model gives the opportunity to investigate the behavior of the temperature control object in steady and transient modes, in particular, to synthesize and adjust the temperature controller of the MCS temperature automatic control system (ACS).

Keywords: ecopyrogenesis complex, multiloop circulatory system, neuro-fuzzy mathematical model, adaptive-network-based fuzzy inference system, membership functions.

1 Introduction

The problem of industrial and domestic organic waste recycling is one of the main environmental problems caused by the development and growth of urbanization in many countries of the world. Quite a prospective method of this problem solution is the use of ecopyrogenesis technology, which allows complete utilization of the whole scope of the organic part of solid waste and low-grade coal in the environmentally-friendly and energy-saving modes [1]. EPG technology provides a simplified sorting of organic solid waste into two categories: the first category - dried organic waste, which includes all of the polymer waste, including polyvinylchloride (PVC) but not

M. Jamshidi et al. (eds.), *Advance Trends in Soft Computing WCSC 2013*,
Studies in Fuzziness and Soft Computing 312,
DOI: 10.1007/978-3-319-03674-8_1,

more than 2%, worn tires, rubber, oil sludge, paper, etc.; the second category - waste with high humidity, which include food waste, shredded wood, paper, cardboard, etc.. The first category of waste is disposed by a multi-loop circulatory pyrolysis (MCP) to obtain from the mass of raw materials up to 60-85% of the liquid fuel of light fractions with characteristics comparable to diesel fuel. The second category of waste is utilized by the method of multi-loop bizonal circulatory gasification (MCG) with obtaining generator gas, which has a calorific value 1100-1250 kcal/m^3 [1]. For realization of the EPG technology specific technological complexes are used, which are, in turn, complicated multi-component technical objects. Automation of such technological complexes allows to significantly increase the operation efficiency and economic parameters.

Stabilization of the set temperature value on the outlet of the MCS is one of the important tasks of automatic control of the EPG process [1]. The possibility of temperature control with high quality indicators allows controlling of the thermal destruction process in terms of various depth of hydrocarbon decay starting with petrol and up to diesel fuel. This allows obtaining of high-quality liquid fractions of alternative fuel on the outlet with the set molecular mass and, in turn, requires a special temperature ACS.

To study the ACS effectiveness at the stage of its design it is reasonable to use the mathematical and computer modeling methods that are quite effective and low-cost, comparing with experimental and other approaches, especially while studying the behavior of thermal power objects and their control systems [2-5]. In particular, development and adjustment of MCS ACS temperature controller requires an availability of an adequate mathematical model. Also MCS temperature ACS quality indicators significantly depend on the accuracy of the synthesized model and its adequacy to the real processes.

Therefore, the aim of this work is development and research of the mathematical model of the EPG complex MCS as a temperature control object.

2 MCS Temperature Control System and Neuro-Fuzzy Mathematical Model Structure

The principle diagram of the output (control) point of the temperature control system of the of the EPG MCS is shown in Fig. 1 [1], where the following indications are used: CB – control block; TS – temperature sensor; LFR – linear flow regulator; OC – output condenser; AF – air fan; SD – servodrive; V – valve; CA – cooling air; CW – cooling water; 1C, 2C, 3C – first, second and third MCS cooling circuits; OW – organic waste; GB – gas burner which heats the reactor; GT – gas tank with liquefied gas.

The MCS task is to cool the gas-vapor mixture, obtained in the process of waste decay in the reactor, to the set temperature in its output point. The MCS system includes three sequentially connected circuits with various cooling types: the 1st – with non-regulated air cooling; the 2nd – with regulated air cooling; the 3rd – with non-regulated water cooling. Thus, the temperature control in the output point on the MCS outlet can be performed due to the flow change of cooling air of the 2nd MCS circuit.