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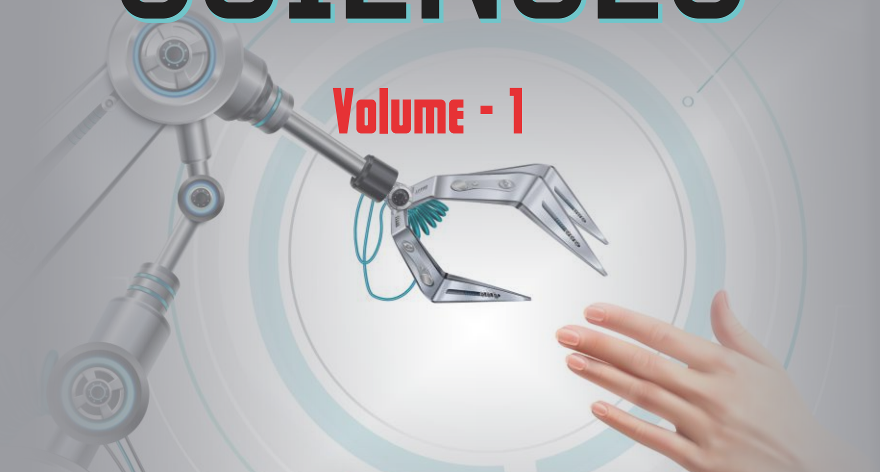

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Chapter - 2
Application of Genetic Algorithm in Short Term Hydrothermal Scheduling for Cost and Emission

Authors

M Laxmidevi Ramanaiah
Associate Professor, EEE Department, Institute of Aeronautical Engineering, Hyderabad, Telangana, India

Raja Reddy. Duvvuru
Associate Professor, EEE Department, Malla Reddy Engineering College, Hyderabad, Telangana, India

M.V.S. Sudheer Babu
Assistant Professor, ECE Department, Narayana Engineering College, Gudur, Telangana, India

Chapter - 2

Application of Genetic Algorithm in Short Term Hydrothermal Scheduling for Cost and Emission

M Laxmidevi Ramanaiah, Raja Reddy.Duvvuru and M.V.S. Sudheer Babu

Abstract

The Hydrothermal Generation Scheduling Problem is a nonlinear optimization problem with high dimensionality, continuous and discrete variables, a no explicit objective function, with equality and inequality constraints. Beside this, it is a large multi modal and non-convex problem. Most of the conventional optimization techniques such as lagrangian, firefly, modified firefly (Taher Niknam 2012) and flower pollination algorithm (Rodriguez et, al., 2016) are unable to produce near optimal solutions for this kind of problem. In order to deal with the Hydrothermal Generation Scheduling Problem in a more efficient and robust way, this work proposes an optimization model using a Multi-Objective Genetic Algorithm based Hydro Thermal Scheduling (MOGAHTS) to solve it.

Hydrothermal Generation Scheduling Problem is usually decomposed into smaller problems in order to solve it. In this way, the hydrothermal generation scheduling problem involves three main decision stages, usually separated using a time hierarchical decomposition such as Hydrothermal power generation demand Problem, total power generation cost for demands and the emission rate for the particular power demands.

Keywords: HTS, GA, Cost Analysis.

1. Introduction

Long range problem includes the yearly cyclic nature of reservoir water inflows and seasonal load demand and correspondingly a scheduling period of one year is used. The solution of the long range problem considers the dynamics of head variations through the water flow continuity equation. The coordination of the operation of hydroelectric plants involves, of course, the scheduling of water releases. The long-range hydro-scheduling problem involves the long-range forecasting of water availability and the scheduling of reservoir water releases (i.e., “drawdown”) for an interval of time that depends on the reservoir capacities. Typical long-range scheduling goes anywhere from 1 week to 1 year or several years. For hydro schemes with a capacity of impounding water over several seasons, the long-range problem involves meteorological and statistical analysis. Nearer-term water inflow forecasts might be based on snow melt expectations and near-term weather forecasts. For the long-term drawdown schedule, a basic policy selection must be made. Should the water be used under the assumption that it will be replaced at a rate based on the statistically expected (i.e., mean value) rate, or should the water be released using a "worst-case" prediction. In the first instance, it may well be possible to save a great deal of electric energy production expense by displacing thermal generation with hydro-generation (Eiben A.E & Smith J.E 2003). If, on the other hand, a worst-case policy was selected, the hydro plants would be run so as to minimize the risk of violating any of the hydrological constraints (e.g., running reservoirs too low, not having enough water to navigate a river). Conceivably, such a schedule would hold back water until it became quite likely that even worst-case rainfall (runoff, etc.) would still give ample water to meet the constraints

2. Plant Requirement for Base Load and Peak Load Operation

The suitability of a plant for supplying the base load or peak load depends on its characteristics. For base load operation a plant should have following features:

1. The operating costs of the plant should be low.
2. The plant should be capable of working continuously long period.
3. Few operating personnel should be required for plant operation
4. It should be possible to repair the plant speedily and economically

For peak load operation, a plant should have following features:

1. It should be possible to start, synchronize and load the plant quickly.
2. The plant should have quick response to load variations.

The hydro plants are well suited for both base load and peak load operation. Since their capital cost is high, they should be, as far as possible, used for base load operation. However during the periods of lean river flow, a hydro plant may be used as a peak load plant. A thermal plant gives minimum cost per unit of energy generated when used as a based load plant. A steam plant needs considerable time for being started from clod conditions. However to conserve fuel it can be used as a peak load plant.

Nuclear plants are suitable for operation only as base load plants. Diesel and gas turbine plants are very suitable for peak load operation. However due to the increasing oil cost these plants are playing only a small role in bulk power generation by utilities.

2.1 Hydroelectric Power Plant Models

Hydroelectric power plants harness water power of generation of electric energy. The potential energy of water is converted to kinetic energy. When water drops through a height, the energy is able to rotate turbines which are coupled to alternators. These plants have the advantage of very low operating cost. Moreover they can be started and loaded quickly. However they take long time for installation and entail huge investment. Moreover, their firm capacity is low and need to be backed by steam plants.

2.2 Neural Network

Classification

a) Run off river plants: They use water as it comes. No storage is required. Evidently there is no control on flow of water.

b) Reservoir plants: Water is stored in a big reservoir behind dam. Water flows through penstock and enter the turbine.

Types of Turbines

a) Pelton turbine: it is characterized by high head and low quantity of water.

b) Francis turbine: it is a reaction turbine suitable for medium heads and medium water, Flow.

c) Kaplan turbine: it is also a reaction turbine suitable for low head and large quantity of water.

Pumped Storage Plants It is a special type of plant suitable for supplying peak load. During peak load, it generates electrical energy. During off-peak period the same water is pumped back from trail water pond so that the same water is used again to generate electrical energy.

3. Combined Working of Run-off River Plant and Steam Plant

A run off river hydro plant uses water as it is available. These plants have a small pond age which makes it possible to cope with hour to hour fluctuation of load. The run offs of rivers vary widely during the year. The ratio of run off during rainy season to that during dry season may be as a large as 100. As such the run off river have very little firm capacity. The usefulness of these plants can be considerably increased if such a plant is used in combination with a steam plant. When such a combination exists, the hydro plant may carry the base load (up to its installed capacity) during the periods of high stream flows and the stream plant may carry the peak load. During the period of lean flow the steam plant supplies the base load and hydro plant supplies the peak load. Thus the amount of load carried by the steam plant can be adjusted to conform with the available river flow. Such a plan of operation results in a greater utilization factor (ratio of amount of energy developed to the amount of energy available in the stream) of the river flow and a saving in the amount of fuel consumed in the steam plant.

The determination of the sizes of runoff river plant and steam plant for supplying a given area requires the knowledge of the load curve of the area, the efficiency of the hydro plant, transmission loss and the stream flow. The stream flow available for 97%of the time during the year is used for calculating the capacity of the hydro plant. Since the loads on week days are higher than the loads during weekends, the capacity is determined in the basis of week day load curve. It is assumed that the run off river plant has a small pond age to take into account the hour to hour fluctuations of the load during the day.

4. Testing Analysis

Dynamic programming algorithm and Genetic algorithm are used to solve the short term hydrothermal scheduling problem. Short-Term Hydro Thermal Scheduling (STHTS) is a very complicated optimization problem. Many successful and powerful optimization methods and algorithms have been employed to solve this problem. It is a dynamic non-linear problem and requires solving unit commitment and economic power load dispatch problems. The main purpose of hydrothermal coordination is to minimize the cost of operation subject to attainment of a certain level of security and reliability. Also, owing to environmental considerations, operation at absolute minimum cost cannot be the only objective of optimal thermal unit commitment in the recent year. The environmental effect of thermal power generation is also becoming a major concern in most countries.

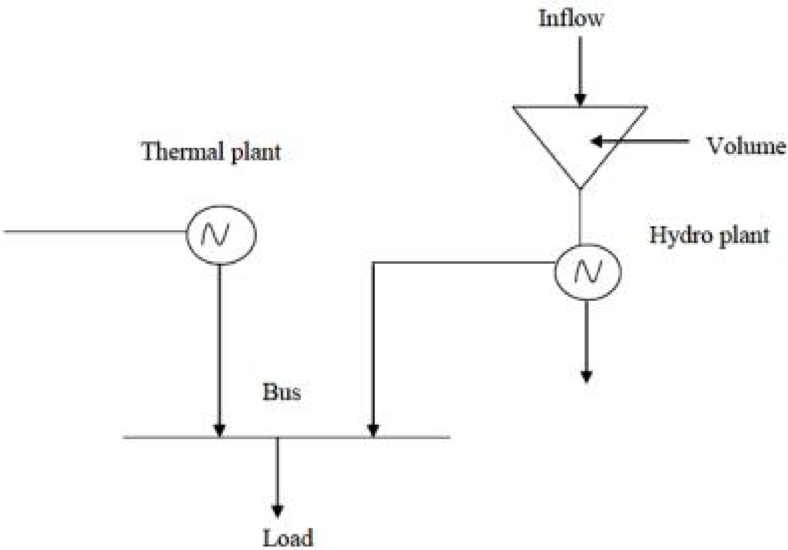

Fig 1: Test System

In Short-term hydrothermal scheduling, Fuel cost calculation vital important role. So to find fuel cost, Genetic Algorithm and Dynamic Programming based method is proposed. Figure 1 show the test system, which is consists of one thermal and one hydro generating station connected to load as shown in. Table 1 shows the Cost coefficient.

Table 1: Load and Natural Inflow

Period J	$P_{Load\ j}$	Inflow Rate r(j) (arce-ft/h)
1	600	1000
2	1000	1000
3	900	1000
4	500	1000
5	400	1000
6	300	1000

The Table gives the summarizes calculation for initial stage j=1 and j=2 respectively. The tabulation for second and succeeding interval is more complex since there are a number of initial volume states to consider.

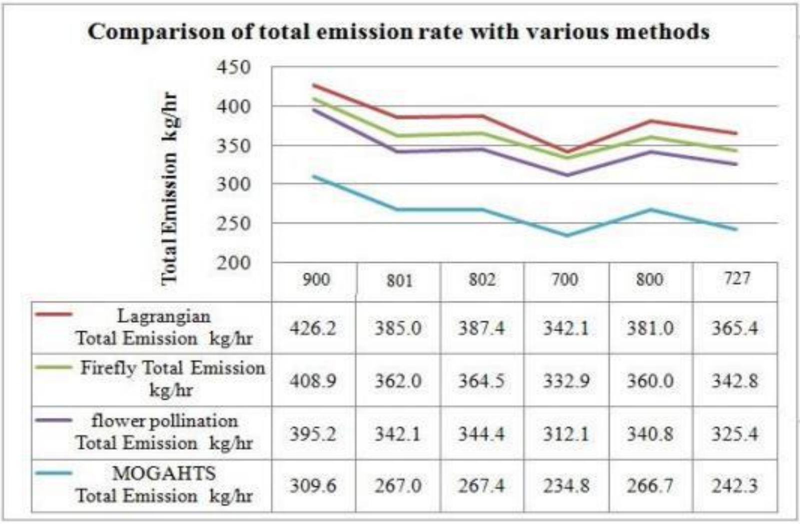

Fig 2: Comparison of Emission Rate

From the observation of the simulation results, the multi objective genetic algorithm method is efficient than the other conventional algorithm for short term hydrothermal scheduling.

Conclusion

The simulated results of the total generation cost and emission rate, obtained from both the proposed techniques and conventional techniques are hereby organized in a proper way for easy comparison and analyzing purpose. Among the above results, the proposed multi objective genetic algorithm shows feasibility and effectiveness in determining the total generation cost and the emission rate than the conventional methods.

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