Multi-Fuel Power Dispatch in an Interconnected Power System using Ant Lion Optimizer:
Multi-Fuel Dispatch Considering Tie-Line Limits

Balachandar P, Annamalai University, Department of Electrical Engineering, Chidambaram, India
Ganesan S, Annamalai University, Department of Electrical Engineering, Chidambaram, India
Jayakumar N, Annamalai University, Department of Electrical Engineering, Chidambaram, India
Subramanian S, Annamalai University, Department of Electrical Engineering, Chidambaram, India

ABSTRACT

The electrical power generation from fossil fuel releases several contaminants into the air and this become excentous if the generating unit is fed by Multiple Fuel Sources (MFS). The ever more stringent environmental regulations have forced the power producers to produce electricity not only at the cheapest price but also at the minimum level of pollutant emissions. Inclusion of this issue in the operational task is a welcome perspective. The cost effective and environmental responsive power system operations in the presence of MFS can be recognized as a multi-objective constrained optimization problem with conflicting operational objectives. The modern meta-heuristic algorithm namely, Ant Lion Optimizer (ALO) has been applied for the first time to obtain the feasible solution. The fuzzy decision-making mechanism has been integrated to determine the Best Compromise Solution (BCS) in the multi-objective framework. The intended algorithm is implemented on the standard test systems considering valve-point effects, CO₂ emission and tie-line limits.

KEYWORDS

Ant Lion Optimizer, Economic Dispatch, Emission Dispatch, Multi-Area Economic Dispatch, Multiple Fuel Sources, Valve-Point Effects

NOMENCLATURE

\( \alpha_i, \beta_i, \gamma_i \) emission coefficients of generating unit \( i \) for fuel type \( j \)
\( a_{ij}, b_{ij}, c_{ij}, f_{ij} \) fuel cost coefficients of generating unit \( i \) for fuel type \( j \)
\( B \) network loss coefficients
\( P_{i}^{\text{min}}, P_{i}^{\text{max}} \) Minimum and maximum real power generation limits of unit \( i \) in MW
\( T_{i}^{\text{max}} \) power flow limit from area \( i \) to area \( p \)
\( T_{p}^{\text{max}} \) power flow limit from area \( p \) to area \( i \)
\( \mu_i \) fuzzy membership function of objective \( i \)
\( \mu_k \) normalized membership function value of candidate \( k \)
\( A_{i,k} \) position of \( i^{th} \) ant at iteration \( k \)
\( A_{j,k} \) position of \( j^{th} \) ant lion at iteration \( k \)

DOI: 10.4018/IJEOE.2017070102

Copyright © 2017, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.
$E(P_i)$ pollutant emission function of generator $i$ with real power output of $P_i$ in kg/h
$F(P_i)$ fuel cost function of generator $i$ with real power output of $P_i$ in $$/h

**iter**$_{max}$ maximum iteration number
$m_i$ maximum of all variables at ant $i$
$m_{i,k}$ maximum of variable $i$ at iteration $k$
$m_k$ maximum of all variables at iteration $k$

$N$ number of generating units
$NA$ number of area
$N_d$ number of decision variables
$P_d$ real power demand in MW
$P_i$ real power output of generator $i$ in MW
$P_j$ real power output of generator $i$ using fuel $j$ in MW
$P_{\ell}$ real power loss in MW
$P_{\ell}$ number of search agents
$q_{i,k}$ minimum of all variables for ant $i$
$q_{i,k}$ minimum of variable $i$ at iteration $k$
$q_i$ minimum of all variables at iteration $k$
$R_{A,k}$ random walk around the ant lion selected by the roulette wheel at iteration $k$
$R_{E,k}$ random walk around the elite at iteration $k$
$r_{i,j}$ maximum and minimum random walks of variable $i$
$T_{i,k}$ tie line real power transfer from area $i$ to area $k$
$X_{i,k}^*$ value of variable $i$ at iteration $k$

**INTRODUCTION: MULTI-FUEL POWER GENERATION DISPATCH**

In practical conditions of power system operations, different Fuel Sources (FS) like coal, natural gas and oil supply certain generating units. The cost function for each fuel type is derived and is segmented as Piecewise Quadratic Cost Function (PQCF) for a generating unit fed by Multiple Fuel Sources (MFS). These generating units face with the dilemma of finding out the most economical fuel to fire. Further, the complexity is increased while considering the valve-point discontinuities. Nowadays, Emission Control (EC) is likewise an important objective, which must be weighed along with fuel price. The emission function can also be approximated like the Fuel Cost (FC). Therefore, the process becomes trickier when the conflicting objectives (total operating cost and pollutant emission) are taken in concert. The solution process is detailed in Figure 1.

**EXISTING SOLUTION METHODS**

The solution approaches addressing this problem can be categorized into mathematical and heuristic methods. Table 1 summarizes the published reports for solving multi-fuel dispatch problem.

The classical optimization methods, including Hierarchical Method (HM) and Hopfield Neural Network (HNN) have been reported to address the economic operation of MFS (Lin & Viviani, 1984; Park et al., 1993). The main drawback of these methods is the exponentially growing time for large scale systems with non-convex constraints.

The meta-heuristic search techniques such as Evolutionary Programming (EP) (Jayabarathi et al., 2005), Particle Swarm Optimization (PSO) (Park et al., 2005), Artificial Immune System (AIS) (Panigrahi et al., 2007), Differential Evolution (DE) (Noman & Iba, 2008), Artificial Bee Colony Algorithm (ABC) (Hemamalini & Simon, 2010) and Biogeography Based Optimization (BBO) (Bhattacharya & Chattopadhyay, 2011) have been reported for solving Economic Dispatch (ED) with PQCF. The modified versions of heuristic search techniques have been reported to solve multi-fuel
The Use of the Data Transformation Techniques in Estimating the Shape Parameter of the Weibull Distribution for the Wind Speed

Transmission Line Theories for the Analysis of Electromagnetic Transients in Coil Windings
[www.igi-global.com/chapter/transmission-line-theories-analysis-electromagnetic/68872?camid=4v1a](www.igi-global.com/chapter/transmission-line-theories-analysis-electromagnetic/68872?camid=4v1a)