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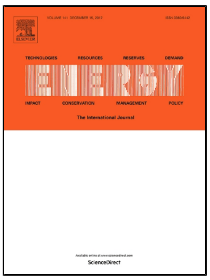

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Optimizing Combustion of Coal Fired Boilers for Reducing NOx Emission using Gaussian Process

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Abstract: Since the mechanism of boiler combustion is extremely complicated and difficult to apply to model and optimize the combustion process directly, data-driven models attract increasingly attention from industry. This paper focuses on the application of Gaussian Process (GP) in optimizing combustion process for reducing NOx emission of a 330MW boiler. GP is used to model the relationship between the NOx emission characteristic and boiler operation parameters. The hyperparameters of the GP model are optimized via Genetic Algorithm (GA). Based on 670 sets of production data from the 330MW tangentially fired boiler, two GP models with 13 and 21-inputs are developed, respectively. The experimental result shows that the 21-inputs model provides better prediction performance than 13-inputs model does. The comparison between Support Vector Machines (SVM) and GP is also given under the 21-inputs circumstance. The influences of some inputs are investigated separately. Then, the predicted NOx emission is used as the objective of searching the optimal parameters for the boiler combustion. Under a given production combustion condition, the NOx decreases from 345 ppm to 238 ppm via optimizing the boiler operational parameters using the 21-inputs GP model , which is a reasonable achievement for the coal fired combustion process.

Keyword: Gaussian process, NOx emission, boiler combustion, optimization.

Nomenclature

sets	indices
GP	Gaussian Process
GA	Genetic Algorithm
NOx	Nitrogen Oxide
IEA	International Energy Agency
CFD	Computational Fluid Dynamics
SVM	Support Vector Machine
ANN	Artificial Neural Networks
SVR	Support Vector Regression
BPNN	Back Propagation Neural Networks
GRNN	Generalized Regression Neural Networks
CFB	Circulating Fluidized Bed
SOM	Self-Organizing Maps
SCR	Selective Catalytic Reduction
LSSVM	Least Squares Support Vector Machines
OFA	Over Fire Air
DCS	Distributed Control System
SECF	Squared Exponential Covariance Function
RBF	Radial Basis Function

1 Introduction

Currently, coal is still a primary power generation energy resource for modern society. This role will remain until 2030 because of the cheap price and abundant [1]. International Energy Agency (IEA) reported that the total coal production all over the world was 7861 million tons in 2015[2]. Thereinto, the quantity of coal production was 3750 million tons[3] and the consumption of coal was 3965 million tons[4] in China.