M. Tech Eleventh Batch (2010-2011) Dissertation Abstracts

CONTENTS

A. Mechanical

Analysis of Heat Transfer in a Reheater in a Coal Fired Steam Generator

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There are two popular designs of coal fired steam generators used in NTPC power plants namely, Tower type (single pass) and II shape type (double pass. Double pass steam generators are more in number in the recent past due to cost effectiveness in construction. NTPC Vindyachal Power Plant Stage I consists of 6 nos. of double pass 210 MW units of Russian make. In these steam generator units, reheating of the HPT exhaust steam is done in three stages namely Stage I (Regulating stage), Stage II and Stage III.

Reheater 1st stage is located at the entrance of second pass and operates in relatively low temperature gas flow region, and is of cross flow heater exchanger type in which heat is transferred from hot flue gases to steam by convection. As these reheater tubes are designed for low temperature operation due to cost effectiveness, any marginal increase in local gas temperature leads to overheating of tube and finally tube failure. This is frequently seen at NTPC Vindyachal and caused major outage and generation losses.

Hence an attempt has been made in this project to analyse and find out the causes for this frequent failure of boiler tubes in the Reheater 1st stage and possible solution for the same.

Computational Fluid Dynamics (CFD) is efficient tool for analysing the fluid flow and the heat transfer. In this present study, the commercially available CFD package, FLUENT® is utilized to numerically diagnose gas flow distribution over reheater tubes. Geometric modelling of Gas path in a boiler was developed in GAMBIT® software. Cold air flow and hot air flow simulation has been done in 2-D. All heat exchangers are modelled as porous media and heat sinks. Boiler flue gas flow path has been modified to get desired flue gas flow distribution.

Thus a comprehensive study on the reheater stage I has been done using the available tools and the simulations are carried out for different operating conditions. The results obtained are analysed, possible reasons are discussed and the feasible solutions are recommended.

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Thermodynamic Modeling of Biomass Gasification in Supercritical Water

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Biomass gasification in supercritical water medium is a promising technology for production of Hydrogen from biomass. Hydrogen yield depends upon reactor temperature, pressure and concentration of feed stock. Successful design of reactor requires knowledge of optimum pressure and temperature for maximization of Hydrogen yield. In our present work, we did non-stoichiometric thermodynamic equilibrium modelling to predict equilibrium gas composition. Gibbs free energy minimization has been done using Lagrange constrained optimization method. Fugacity co-efficient has been calculated using Duan Equation of state which gives very accurate results for gases at elevated temperature and pressure. Model compound such as Glucose, real biomass such as corn silage and ethanol has been used to validate our model. Thermodynamic vapor liquid phase equilibrium calculation has been done in separator. For calculation of fugacity coefficient of gases in vapor liquid phase equilibrium has been done using SRK equation of state. Exergy analysis will give direction for further research and scope for optimization. Exergy analysis of entire supercritical water gasification plant has been done in our present work. Results from our modeling have been validated with the experimental results obtained by researcher in "VERENA" test facility at Institute of Technical Chemistry, Karlsruhe, Germany. Parametric study of supercritical water gasification plant has been done with ethanol as model compound. Parametric study gives us the idea of optimize zone of operation.

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Design of Drop Tube Reactor for Solid Fuel Combustion Experiments

Puneet Jain*

In today's world solid fuels like coal and biomass plays an important role to meet the current demand of energy of the society. Design of the combustors to burn these solid fuels requires a very accurate characterisation of the fuel to optimise the performance of the combustor. Various techniques are available to characterise the fuels of which Drop tube reactor (DTR) gives very reliable results as compared to other techniques. DTR reactors provide high volatile yields at heating rates close to those occurring in industrial combustors. A drop tube reactor (DTR) is a relatively simple apparatus to study the fast pyrolysis of coal/biomass fuels. High heating rates (of the order of 104 K/s) and low residence times (0.1–1 s) can be reproduced, while different analyses can be carried out on the solid residues (char properties). Fragmentation behaviour of the solid fuel particles during combustion can also be studied by collecting the residue at different residence time of the particle inside the reactor. In this work, a lab-scale drop tube reactor is characterized and an experimental procedure is developed to test a bituminous coal and a biomass fuel at high heating rate in oxidative conditions. Thermo-gravimetric, size and SEM analyses will be used to determine the conversion degree, the reactivity and the morphological variations (swelling, fragmentation, agglomeration) of solid residues in different operating conditions. Furthermore, a model is developed in order to simulate the momentum balance, the energy balance and the mass transfer during the partial oxidation of fuel particles. The application of this model allows the residence time and the thermal history of the particle inside the drop tube to be estimated.

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B.Electrical

Wind Energy Conversion System Using Squirrel Cage Induction Generator

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Wind energy is gaining increasing importance throughout the world. This fast development of wind energy technology and of the market has large implications for a number of people and institutions. Distributed generation using wind energy has attracted a lot of attention world wide. Distributed generation can be in an isolated way supplying the consumer's local load or integrated in to the grid supplying electrical energy to the power system network. More cost effective and reliable large wind energy conversion systems are becoming increasingly attractive in order to make wind energy to have better competition with other traditional sources of electrical energy. The intermittent energy production must absolutely be optimised to obtain significant system efficiency. Various wind turbine concepts have been rapidly developed during last two decades and this has brought opportunities for increased utilisation of wind energy for electric power generation around the world. The requirement of variable-speed constant frequency operation led to several developments in the generator control of WECS. This project aims mainly on modeling of WECS using different configurations like boost converter fed, PWM converter etc on Squirrel cage generators and comparing their performances. WECS using squirrel cage machines have gained popularity in the few years due to its robustness, reliability and cost, hence SCIG was chosen in this study. This energy can surely transform the whole society in the coming decades by the application of technological innovation.

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C. Control & Instrumentation

Boiler Tube Inspection Using Active Thermography and Related Image Processing

Pinaki Podder*

The combined effects of corrosion, scaling, stress, temperature, erosion and vibration cause the deterioration of boiler tube materials properties and reduction in boiler wall thickness. The poor calorific value of coal which results in high specific coal consumption ,the high ash content in Indian coal erode the boiler metal thickness in an unpredictable pattern and force unit outage. This contributes to the external erosion. Internal corrosion and deposition also takes place due to steam water quality owing inside the boiler tube. Calcium, magnesium, iron, copper and silica predominate in most boiler deposits. These deposits usually form dense layer that impedes heat transfer which cause boiler tube failures. So inspection of the boiler tube is necessary.

In this project, the new technique of active thermography called Frequency modulated Thermal Wave Imaging (FMTWI), has been used for the boiler tube sample inspection. Raw Images of the boiler tube sample is taken and required analysis is carried out for the subsurface defects. After getting raw image, data extraction is done for image processing. Image Processing is carried out using standard GIMP software and relative comparison has been drawn among different image processing algorithm.

In my work, extensive studies are done regarding Scene-Based Non-uniformity Compensation in Focal Plane Arrays. Different Algorithms have been presented and Kalman Filter based Algorithm has been proposed for its success over other methods.

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