# Analisis Keseragaman Distribusi Aliran Udara dan Tekanan pada *Inlet Manifold Furnace* PLTBm 10kW berbasis Komputasi Dinamika Fluida

Haidar Alghazian Abrar

19/439629/TK/48359

Diajukan kepada Departemen Teknik Nuklir dan Teknik Fisika Fakultas Teknik
Universitas Gadjah Mada pada tanggal 2 April 2024
untuk memenuhi sebagian persyaratan untuk memperoleh derajat
Sarjana Program Studi Teknik Fisika

## INTISARI

PLTBm 10kW untuk daerah 3T menjadi salah satu upaya penyelesaian tantangan krisis energi di Indonesia. Namun, prototipe PLTBm 10kW masih belum mencapai kestabilan proses akibat suhu pembakaran pada *furnace* yang belum mencapai target dan produksi uap yang tidak seimbang. Analisis desain *inlet manifold* dilakukan untuk mendapatkan nilai dan visualisasi tingkat keseragaman distribusi aliran udara serta tekanan guna meningkatkan efektivitas pembakaran melalui suplai udara.

Analisis keseragaman distribusi aliran udara dan tekanan dilakukan menggunakan CFD. Parameter analisis yang digunakan adalah *extent of non-uniformity* global ($\overline{ENU}$) dan *coefficient of variation* (CV) yang mewakili keseragaman distribusi aliran dan *pressure drop* ($\Delta P$) yang mewakili distribusi tekanan. Parameter desain optimasi adalah AR, sudut lengkung, dan jumlah lubang dengan kombinasi 18 variasi desain optimasi. Analisis CFD dilakukan menggunakan Ansys Fluent 2023 R1. Validasi model dan *grid independence test* (GIT) dilakukan untuk menentukan dasar model simulasi. Model turbulen yang digunakan adalah *k-ω SST* dengan *solver* COUPLED.

Hasil analisis menunjukkan bahwa distribusi aliran udara pada desain *inlet manifold* terpasang belum seragam dengan $\overline{ENU}$ sebesar 9,20 dan CV sebesar 27,59%. Perbedaan tekanan yang dimiliki juga tinggi, yaitu 5,68 kPa. Desain optimasi 1 direkomendasikan sebagai opsi optimasi dengan penurunan $\overline{ENU}$ sebesar 82,4, penurunan CV sebesar 83,4%. dan penurunan $\Delta P$ sebesar 60,1%.

***Kata kunci***: *Inlet manifold, extent of non-uniformity, coefficient of variation, pressure drop, Computational Fluid Dynamics, k-ω SST.*

| | | |
|---|---|---|
| Pembimbing Utama | : | Dr. Ir. Andang Widi Harto, MT., IPU., ASEAN Eng. |
| Pembimbing Pendamping | : | Ir. Kutut Suryapratomo, M.T., M.Sc. |

# Air Flow Uniformity Distribution and Pressure Analysis on Furnace Inlet Manifold of 10kW Biomass Power Plant with Computational Fluid Dynamics

Haidar Alghazian Abrar

19/439629/TK/48359

Submitted to the Departement of Nuclear Engineering and Engineering Physics
Faculty of Engineering Universitas Gadjah Mada on April 2nd, 2024
in partial fulfillment of the requirement for the Degree of
Bachelor of Engineering in Engineering Physics

## ABSTRACT

10kW PLTBm for 3T areas is one of the manifestation to resolve the energy crisis challenge in Indonesia. However, the 10kW PLTBm prototype still has not achieved process stability due to the combustion temperature in the furnace not reaching the target and unbalanced steam production. Analysis of the inlet manifold design was performed to obtain values and visualization of the level of uniformity of air flow and pressure distribution in order to increase the effectiveness of combustion through the air supply.

Analysis of the uniformity of air flow and pressure distribution was carried out using CFD. The analysis parameters used are the level of global non-uniformity ($\overline{ENU}$) and the coefficient of variation (CV) which represents the uniformity of the flow distribution and the pressure drop (ΔP) which represents the pressure distribution. The design optimization parameters are AR, curved angle, and number of *outlet* with a combination of 18 design optimization variations. CFD analysis was carried out using Ansys Fluent 2023 R1. Model validation and grid independence test (GIT) were also performed to determine the basis of the simulation model. The turbulent model used is k-ω SST with the COUPLED solver.

The analysis results show that the air flow distribution in the installed inlet manifold design is not uniform with ($\overline{ENU}$) of 9.20 and CV of 27.59%. The pressure difference is also high, namely 5.68 kPa. Optimization design 1 is recommended as an optimization option with a reduction in ($\overline{ENU}$) of 82.4%, a reduction in CV of 83.4%. and a decrease in ΔP of 60.1%.

***Keywords***: Inlet manifold, extent of non-uniformity, coefficient of variation, pressure drop, Computational Fluid Dynamics, k-ω SST

Supervisor : Dr. Ir. Andang Widi Harto, MT., IPU., ASEAN Eng.

Co-supevisor : Ir. Kutut Suryapratomo, M.T., M.Sc.