

ห้องสมุดงานวิจัย สำนักงานคณะกรรมการการวิจัยแห่งชาติ



E42129

**DESIGN PARAMETERS FOR A LAB-SCALE TWO-STAGE RICE HUSK
CASIFICATION SYSTEM**

**MISS KANTAWAN SARASUK
ID: 52810413**

**A THESIS SUBMITTED AS A PART OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ENGINEERING
IN ENERGY TECHNOLOGY AND MANAGEMENT**

**THE JOINT GRADUATE SCHOOL OF ENERGY AND ENVIRONMENT
AT KING MONGKUT'S UNIVERSITY OF TECHNOLOGY THONBURI**

2ND SEMESTER 2010

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Design Parameters for a Lab-Scale Two-Stage Rice Husk Gasification System

Ms. Kantawan Sarasuk

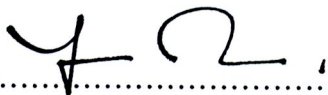
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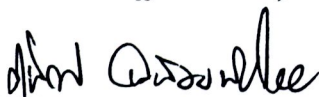
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ABSTRACT

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This research mainly focuses on the design of a lab-scale two-stage gasification system. A commercial two-stage gasification system was constructed in Lopburi province using rice husks as the fuel. It was necessary to perform a further development and study of the optimization conditions to achieve a desired operating of the plant. A design procedure was developed for a 50 kW thermal a two-stage gasification system, and the calculations were made based on the essential parameters of screw conveyor, two-stage gasifier, cyclone, heat exchanger and baghouse filter to find out the dimension parameters of each part. On the basis of the air's supplied rate, the dimensions of the first stage were calculated to provide a sustaining condition of the fluidization. The calculated diameters and heights of the lower part and upper part of the first stage were found to be 0.09, 0.13, 0.50, and 0.50 m, respectively. The height of char reduction chamber in the second stage was 1.4 m, whereas, the height of the char bed was variable. The calculated diameters of throat and reactor were 0.10 m and 0.24 m, respectively. This design facilitated varying parameters such as equivalence ratio, superficial velocity, and temperature. The optimization design was obtained from the experiments and from the theoretical and experimental information available in the literature. Outcomes from this study can be used to prepare a detailed design of a small-scale prototype construction. This lab-scale design was used for the estimation of the varying parameters to find out the optimum conditions, which can be scaled up in the future.

Keywords: Biomass gasification, Two-stage gasification, Bubbling fluidized bed, Tar, Equivalence ratio

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LIST OF ABBREVIATIONS

Abbreviation	Description
Ar	Archimedes number
A	cross-sectional area (m ²)
A _b	amount of fabric required per bag (m ²)
A _c	the total cloth area (m ²)
C, H, N, S, O	Carbon, Hydrogen, Nitrogen, Sulphur, Oxygen
Ca	Calcium
CaO	Calcium oxide
CH ₄	Methane
CO	Carbon monoxide
CO ₂	Carbon dioxide
Cr	Chromium
D	diameter of screw (m)
d	diameter (m)
d _p	diameter of particle (m)
d.a.f	dry ash free basis
d.b	dry basis
ER	Equivalence Ratio (The weight ratio of air to fuel used divided by the weight ratio of air to fuel)
Fe ₂ O ₃	Iron(III) oxide
g	acceleration of gravity, 9.81 m ² /s
H	height of reactor
H ₀	height of feeding point
H ₂	Hydrogen
H ₂ O	water vapor
HCN	Hydrogen cyanide
HHV	Higher Heating Value
ΔH	Heat of reaction
h	the fabric bag height
K	Potassium
K ₂ O	Potassium oxide

K_2CO_3	Potassium carbonate
k	Kilo
k	factor of trough loading
M	Mega
Mg	Magnesium
MgO	Magnesium oxide
m_s	mass flow rate of material
Na	Sodium
Na_2O	Sodium oxide
N	speed of the screw (rpm)
n	mol
O_2	Oxygen
P_2O_5	Phosphorous
p	pitch of screw (m)
ΔP	Pressure drop across bed
Q	volumetric air flow rate (cm^3/sec)
Re	Reynolds number
SiO_2	silicon dioxide
SGR	specific gasification rate
t	residence time
U_{mf}	minimum velocity (m/s)
U_t	terminal velocity (m/s)
U_s	superficial velocity (m/s)
V	air volume flow rate (m^3/s)
v	air velocity (m/s)
v_f	filtration velocity (cm/sec)
W	Watt
ϵ_{mf}	void fraction
μ	fluid viscosity (kg/m-s)
μ	Micron
ρ_f	gas density (kg/m^3)
ρ_s	particle density (kg/m^3)
ϕ_s	sphericity factor