Green Energy and Technology

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Exploitation of Models Hierarchy for Industrial Design of Control and Diagnosis Strategies

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Nomenclature

Acronyms

AC	Alternating Current
AI	Artificial Intelligence
APU	Auxiliary Power Unit
AS	Anode-Supported
BoP	Balance of Plant
CHP	Combined Heat and Power
CPO	Catalytic Partial Oxidation
CPU	Central Processing Unit
CS	Cold-Start
CS2WU	Cold-Start to Warmed-Up
DC	Direct Current
DIR	Direct Internal Reforming
DOD	Depth of Discharge
DoE	Design of Experiment
EIS	Electrochemical Impedance Spectroscopy
ES	Electrolyte-Supported
EU	European Union
FC	Fuel Cell
FCH-JU	Fuel Cells and Hydrogen Joint Undertaking
FCS	Fuel Cell System
FDI	Fault Detection and Isolation
FSM	Fault Signature Matrix
FTA	Fault Tree Analysis
GT	Gas Turbine
ICE	Internal Combustion Engine
IEA	International Energy Agency
ISM	Integrated Stack Module
LS	Least Squares

LSM	Strontium-Doped Lanthanum Manganite
MIMO	Multi-Input Multi-Output
MLPFF	Multi Layer Perceptron Feed Forward
MLR	Multi Linear Regression
MSE	Mean Squared Error
NN	Neural Network
ODE	Ordinary Differential Equation
PEM	Proton Exchange Membrane
PI	Proportional Integral
PID	Proportional Integral Derivative
PSO	Particle Swarm Optimization
RBF	Radial Basis Function
RC	Resistor-Capacitor
REF	Prereformer Conversion Factor
RNN	Recurrent Neural Network
RUL	Remaining Useful Life
SI	Splitting Index
SOC	State of Charge
SOFC	Solid Oxide Fuel Cell
SVM	Support Vector Machine
TES	Thermal Storage System
WU	Warmed-Up
YSZ	Yttria Stabilized Zirconia

Roman Symbols

A	Area (m^2)
A_s	Heat Transfer Area (m^2)
ASR	Area Specific Resistance (A cm^2)
AU	Air Utilization (–)
c	Specific Heat Capacity (J kg^{-1} K^{-1})
C	Heat Capacity (J K^{-1})
C_c	Heat Capacity of Cold Fluid (J K^{-1})
$\dot{C}_c$	Thermal Mass Flow of Cold Fluid (W K^{-1})
$\dot{C}_f$	Thermal Mass Flow of Hot Fluid (W K^{-1})
C_h	Heat Capacity of Hot Fluid (J K^{-1})
c_p	Specific Heat Capacity at Constant Pressure (J kg^{-1} K^{-1})
D_h	Equivalent Diameter (m)
$\dot{E}$	Enthalpic Power Flow (W)
$\dot{E}_{el}$	Electrical Power Flow (W)
E_{Nernst}	Nernst Ideal Potential (V)
F	Faraday Constant (C mol^{-1})

G	Gibbs Free Energy (J mol^{-1})
h	Specific Enthalpy (J mol^{-1})
$\bar{h}$	Convective Heat Transfer Coefficient (W m^{-2} K^{-1})
H	Heat Convective Coefficient (W m^{-2} K^{-1})
h_{ch}	Channel High (m)
$\bar{h}_f^0$	Specific Enthalpy of Formation (J mol^{-1})
HHV	Higher Heating Value (J kg^{-1})
I	Current (A)
J	Current Density (A cm^{-2})
$\bar{J}$	Average Current Density (A cm^{-2})
J_0	Exchange Current Density (A cm^{-2})
J_{as}	Anode Limit Current Density (A cm^{-2})
J_{cs}	Cathode Limit Current Density (A cm^{-2})
k	Thermal Conductivity (W m^{-1} K^{-1})
l	Length (m)
LHV	Lower Heating Value (J kg^{-1})
m	Mass (kg)
$\dot{m}$	Mass Flow (kg s^{-1})
$\dot{n}$	Molar Flow (mol s^{-1})
N	Computational Elements (–)
n_e	Number of electrons (–)
N_u	Nusselt Number (–)
p	Pressure (Pa)
P	Power (W)
P_{batt}	Battery Power (W)
P_{cp}	Compressor Power (W)
P_{gross}	Gross Power (W)
P_{heat}	Heat Power (W)
$\bar{P}_{heat,dwell}$	Average Heat Power Demand (W)
P_{load}	Power Demand (W)
P_{net}	Net Power (W)
$\dot{Q}$	Heat Flow (W)
$\dot{r}$	Reaction Rate (mol s^{-1})
R	Universal Gas Constant (J m^{-1} K^{-1})
R_{in}	Battery Internal Resistance (Ω)
t	Time (s)
T	Temperature (K)
U_f	Fuel Utilization (–)
V	Voltage (V)
V_0	Battery Open Circuit Voltage (V)
w_{ch}	Channel Width (m)
$\dot{W}$	Mechanical Power (W)
x	Molar Fraction (%)

Greek Symbols

α	Charge Transfer Coefficients (–)
β	Compressor Ratio (–)
Δ	Change
η	Efficiency (–)
λ	Excess of Air (–)
μ	Micro
ξ	Fault Magnitude Coefficient
ρ	Mass Density (kg m^{-3})
σ	Ionic/Electronic Conductivity (S cm^{-1})
τ	Relaxation Time (s)
Ω	Control Volume (m^3)

Footers

a	Air
Act	Activation
an	Anode
aph	Air Preheater
ca	Cathode
cer	Ceramic
ch	Channel
cm	Compressor Motor
Conc	Concentration
cond	Conductive
conv	Convective
cp	Compressor
eff	Effective
el	Electrolyte
eq	Equivalent
ext	External
f	Fuel
front	Frontal
furnace	Furnace
HE	Heat Exchanger
in	Inlet
int	Interconnect
max	Maximum
min	Minimum
Ohm	Ohmic
out	Outlet
ox	Oxidation reaction
Pb	Postburner

pre	Prereformer
pre	Preheater
prod	Product
react	Reactant
ref	Reforming reaction
s	Solid
shift	Water-gas shift reaction
stack	Stack

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