Robust modeling applied to energy production and use

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Workshop Digital Science and Energy – December 19th, 2023

- Personal Information

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Areas of interest:

1. Advanced Process Control (Model Predictive Control);
2. Artificial Intelligence Models in Process Engineering;
3. Digital Transformation (Digital Twins).

PUC RIO

IMES
Instituto de Mobilidade e Energias Sustentáveis

Who are we?

5.000m²

Multidisciplinary team
with D.Sc., M.Sc., engineers and technicians

Chassis and engines dynamometers
with consumption and emissions measurement

Rapid compression machine
for the study of combustion

RESEARCH LINES

Value chain of sustainable energies

Decarbonization and energy efficiency

Industry 4.0

TYPES OF DELIVERABLES

Experimental studies and/or **numerical simulations**

Multidisciplinary assessment: technical, environmental and economical aspects

Development of new products

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Robust empirical prediction of the washed and unwashed gums formation in mixtures of Brazilian gasoline and ethanol

Campaign of tests
- Use design of experiments approach
- Second order mathematic model with interaction of order 2

Neural Computing and Applications (2023) 35:16267–16284
https://doi.org/10.1007/s00521-023-08396-1

ORIGINAL ARTICLE

Polynomial and ANN models applied to the formation of gums in Brazilian ethanol–gasoline blends—impact of gasoline composition, ethanol concentration, storage temperature, and aging duration

José Eduardo S. P. Carvalho[1] · Brunno F. Santos[2] · Ana Rosa F. A. Martins[2] · Sergio L. Braga[1] · Renata N. C. Pradelle[3] · Franck Turkovics[3] · Béatrice Perrier[3] · François Maire[3] · Florian Pradelle[1]

ANN models
- 601 data for washed gums
- 571 data for unwashed gums

Knowledge aquisition / Uncertainty reduction

Phase 1
Doehlert design

Regular gasoline with or without additive
% ∈ [21;94.2] $vol\%$
D ∈ [0;161] $days$
T ∈ [18;42]°C

Properties: Washed gum; Induction period; Water content; Kinematic viscosity; Density

Phase 2
Doehlert design

Regular gasoline with or without additive
% ∈ [0;50] $vol\%$
D ∈ [0;161] $days$
T ∈ [23;47]°C

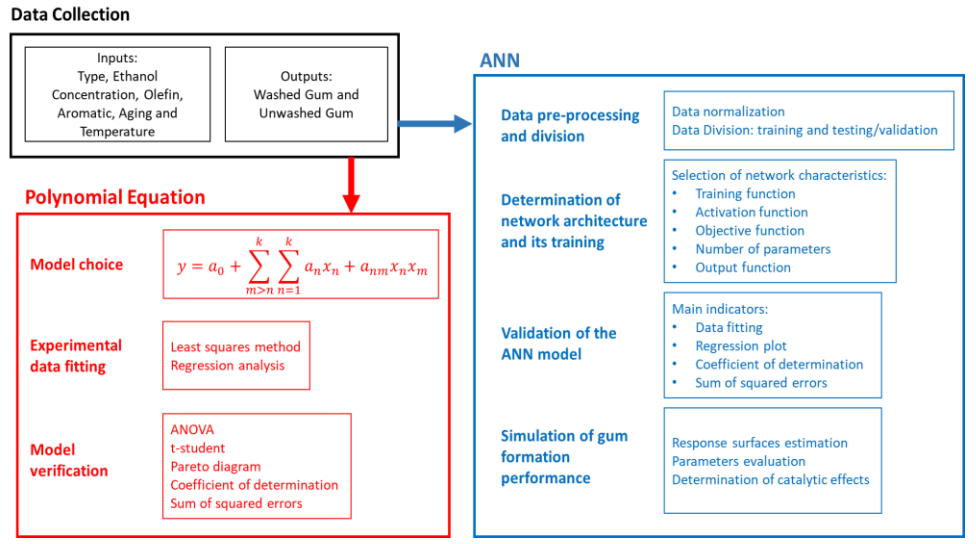
Properties:
Unwashed gum
Washed gum

Phase 3
Central composite design com α=1 (3^k)

Homologation gasoline
% ∈ [0;80] $vol\%$
D ∈ [0;150] $days$
T ∈ [20;40]°C

Properties:
Unwashed gum
Washed gum

Phase 4
Artificial Neural Network (ANN)

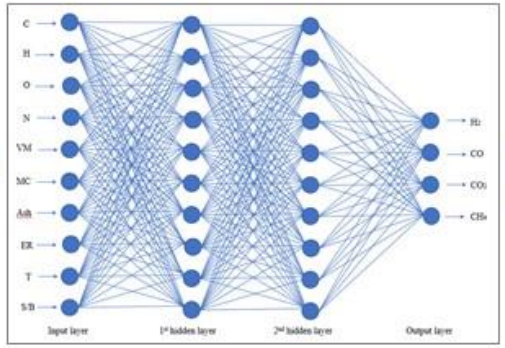


Development of predictive models for biomass gasification using artificial neural networks and comparison with a thermodynamic equilibrium model

Data collection

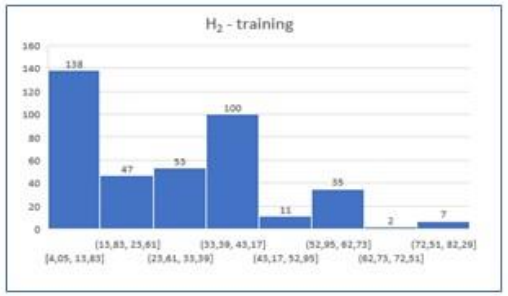
First version of the database comprised 718 data, collected from 19 references.

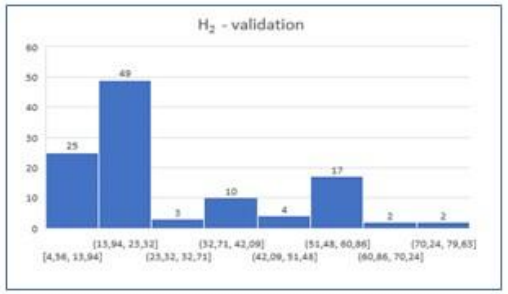
ANN models screening



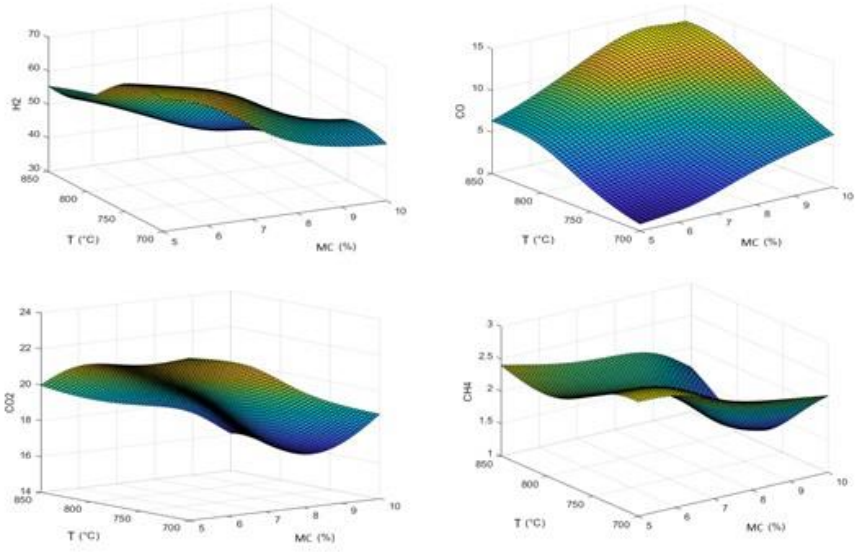
The best topology presented R^2 values greater than 0.88 and 0.70 for training and test, respectively, for each output gas.

Data analysis





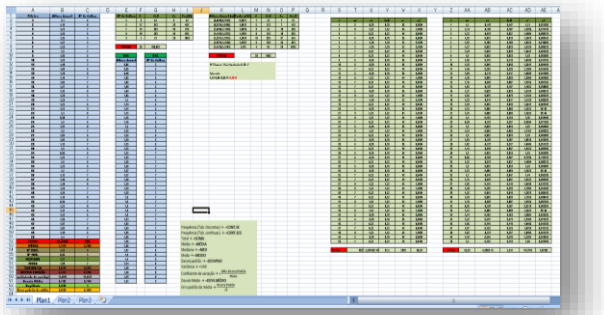
Application and comparison with thermodynamics approach



DEVELOPMENT OF ARTIFICIAL NEURAL NETWORKS (ANN) MODELS TO PREDICT THE PRODUCTION OF CUMULATED BIOGAS FROM FOOD WASTE (FW), FRUITS AND VEGETABLE WASTE (FVW) AND THEIR CODIGESTION (CD)

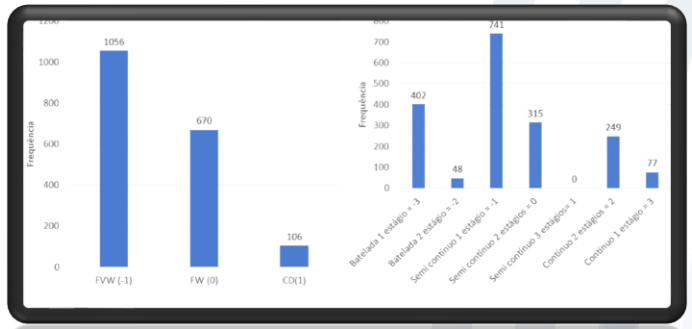
Database

An extensive literature search was conducted to gather scientific articles containing data on key variables in the AD process for biogas production. 47 previously published scientific papers, composing 2098 samples.



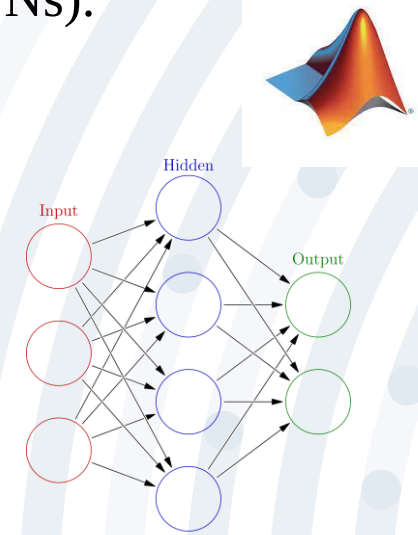
Statistical Analysis of Variables

Data analysis involved constructing histograms using Excel software to identify and address potential outliers.



Model prediction

The modelling of biogas production was carried out using various topologies of artificial neural networks (ANNs).



Detection and Diagnosis of Faults in Diesel Engines via Lubricating Oil Analysis

Database

Lubricating oil from internal combustion engines to diesel Mercedes Benz OM-366 family.

Variables

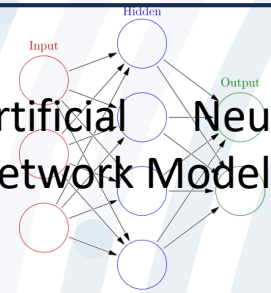
Chemical compounds found in the lubricant (Mileage at the test date, Mileage since the last oil change, Fe, Cr, Pb, Cu, Sn, Al, Ni,Si, Na, Mg, Ca, Ba, P, Zn, Mo, Ti, Ag, B, V, K, oxidation, nitration, sulfation, soot, % of water % of fuel, % of glycol).

Classification

Each sample presents a diagnosis for three different problems: corrosion, contamination and combustion.

Data wrangling

Statistical Analysis of Variables



Artificial Neural Network Models