TYPE120-DieselEngineGeneratorSystem

Equations

TYPE120 - DIESEL ENGINE GENERATOR SYSTEM (DEGS)

MODEL DESCRIPTION

TYPE120 is a mathematical model for a diesel engine generator set (DEGS). The model is based on an empirical relation (1st order polynomial) for the fuel consumption expressed as a function of the electrical power output (normalized). Electrical and fuel efficiencies are both calculated. TYPE120 can be used to predict the performance of a specific DEGS, provided a fuel consumption curve is supplied. Alternatively, a generic model can be used to predict the performance of any DEGS in the power range 5-500 kW. The generic model extrapolates from a reference fuel efficiency curve (average of 5 different DEGS). The generic model incorporates a correction factor derived from actual data measurements on DEGS for 20 remote area power systems (RAPS) with average operating powers in the range 5-186 kW [1]. The default fuel is diesel (liquid), but a database with fuel properties [2,3] included in TYPE120 make it possible to calculate the equivalent fuel flow rates (liquid or gas) for 5 alternative fuels: liquefied gas (LPG), propane (C3H8), methane (CH4), natural gas, or hydrogen (H2). In this executable, the fuel type is limited to diesel and the selected diesel engine generator set is a Ford 140 kW.

ELECTRIC MODEL

Rated Power

$$P_{DEGS,rated} = \text{Lookup}(\text{`DEGS curvefit'}\ ,\ 1,\ 3)$$

Normalized Power

$$X = P_{DEGS}/P_{DEGS,rated}$$

Electrical efficiency

$$\eta_{el} = \frac{P_{DEGS}}{\left(\rho_{diesel} \cdot \dot{V}_{diesel'} \cdot LHV_{diesel}\right)}$$

Total Power output

$$P_{total} = N_{units} \cdot P_{DEGS}$$

FUEL CONSUMPTION

Fuel consumption

$$\dot{V}_{diesel} = (a + b \cdot X)$$

Fuel efficiency

$$\eta_{fuel} = P_{DEGS}/\dot{V}_{diesel}$$

Total Fuel consumption

$$\dot{V}_{total} = N_{units} \cdot \dot{V}_{diesel}$$

THERMAL MODEL

Total Thermal losses

$$Q_{waste} = P_{DEGS} \cdot \frac{100 - \eta_{el}}{\eta_{el}} \cdot N_{units}$$

=====================APPENDIX===========================

Unit conversion

$\dot{V}_{diesel'} = \dot{V}_{diesel} \cdot (1/3600)$

$N_{units} = 1$ Number of identical units

$P_{DEGS} = 50$ Power set point for a single unit

Parameters

LHV_{diesel} = Lookup('Fuel Properties' , 1, 3) lower heating value for diesel

ρ_{diesel} = Lookup('Fuel Properties' , 1, 5) density of diesel fuel

Specific DEGS

a = Lookup('DEGS curvefit' , 1, 4) Coefficient #1 of 1st order polynomial

b = Lookup('DEGS curvefit' , 1, 5) Coefficient #2 of 1st order polynomial

REFERENCES

1.Lloyd C. R. (1999) Assessment of diesel use in remote area power supply. Internal report prepared for the Australian Greenhouse Office, Energy Strategies, Canberra.
2.Adler U., Bauer H., Bazlen W., Dinkler F. and Herwerth M. (Eds) (1986) Automotive Handbook. 2nd edn, Robert Bosch GmbH, Stuttgart.
3.McCarthy R. D. (1982) Mathematical models for the prediction of liquefied-natural-gas densities. Thermophysical Properties Division, National Bureau of Standards, USA.

Solution

$\mathbf{a} = \mathbf{6}$ [L/hr]	$\mathbf{b} = \mathbf{37.72}$ [L/hr]	$\eta_{\mathbf{el}} = \mathbf{0.2605}$ [0...1]	$\eta_{\mathbf{fuel}} = \mathbf{2.568}$ [W/L]
$\mathbf{N_{units}} = \mathbf{1}$	$\mathbf{P_{DEGS,rated}} = \mathbf{140}$ [W]	$\mathbf{P_{total}} = \mathbf{50}$ [W]	$\mathbf{Q_{waste}} = \mathbf{19144}$ [W]
$\dot{\mathbf{V}}_{\mathbf{diesel}} = \mathbf{19.47}$ [L/hr]			