Sustainable drop-in fuel design with alternative aviation fuel

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Fuel compositions confine property specifications including volatility, fluidity, combustion, thermal stability, and lubricity characteristics. As jet fuels are composed of hundreds to thousands of different molecules including paraffins, cycloparaffins, aromatics, jet fuel compositions cannot carry out drop-in fuel design. Although the relationship between the chemical compositions of fuels and their properties are complex and interactive influence, artificial neural network (ANN) approaches were developed for drop-in fuel design. Moreover, drop-in jet fuel should comply with the reduction of GHGs emission in whole life cycle with economic competitiveness. The gap from alternative aviation fuel to sustainable drop-in fuel has been bridged by ANN system design and LCA.

From the insight of GHGs reduction, Beihang-AF3E model [1], an integrated computerized model, was develped for aviation fuel assessment on energy, environment, and economy. The system boundary, a whole life cycle of jet fuel integrates three main stages including feedstock, refining fuel, and combustion in engine of aircraft. Energy consumption and GHGs emission are calculated on per unit load and per unit flight range on the assumption of the maximum load and the maximum range[2,3]. The infrastructure construction in feedstock and refining fuel are involved in this assessment but without considering the manufacture and service life of engine and aircraft. The inputs and outputs related with the materials have been calculated by mass allocation method while the electricity utilization shares the emissions and energy consumption by energy allocation on jet fuels and by-products. Accordingly, an example of refining jet biofuel was modified coupling the requirement of GHGs reduction in life cycle.

From the insight of drop-in fuel design, the critical parameters in fuel compositions have been extracted as carbon distribution and classification, which can conduct directly for feedstock choice and refining process modification [4]. The relationships between the critical parameters with properties were established by ANN. The optimization methodologies of ANN design could be benefit to produce sustainable alternative jet fuel.

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