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Estimating energy requirement in cashew (*Anacardium occidentale* L.) nut processing operations

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Abstract

This work deals with a study on estimation of energy consumption in eight readily defined unit operations of cashew nut processing. Data for analysis were collected from nine cashew nut mills stratified into small, medium and large categories to represent different mechanization levels. Series of equations were developed to easily compute requirements of electricity, fuel and labour for each of the unit operations. The computation of energy use was done using spreadsheet program on Microsoft Excel. The results of application test of the equations show that the total energy intensity in the cashew nut mills varied between 0.21 and 1.161 MJ/kg. Electrical energy intensity varied between 0.0052 and 0.029 MJ/kg, while thermal energy intensity varied from 0.085 to 1.064 MJ/kg. The two identified energy intensive operations in cashew nut processing are cashew nut drying and cashew nut roasting, altogether accounting for over 85% of the total energy consumption in all the three mill categories. Thermal energy, obtained from diesel fuel, represented about 90% of the unit energy cost for cashew nut processing. The developed equations have therefore proven to be a useful tool for carrying out budgeting, forecasting energy requirements and planning plant expansion.

Keywords: Cashew nut; Unit operations; Energy requirement; Empirical equations

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Nomenclature

E_c	energy requirement for cashew nut cleaning (J)
E_{sc}	energy requirement for cashew-nut soaking/conditioning (J)
E_r	energy requirement for roasting (J)
E_s	energy requirement for shelling (J)
E_{sp}	energy requirement for separation (J)
E_d	energy requirement for drying (J)
E_{pg}	energy requirement for peeling and grading (J)
E_p	energy requirement for packing (J)
E_T	total energy requirement for all cashew kernel/nut processing operations (J)
t	time taken for a particular operation(i.e. t_c, t_{sc}, t_r, t_s, t_{sp}, t_d, t_{pg}, t_p) (h)
C	heating value of fuel used for a particular operation (i.e. C_c, C_{sc}, C_r, C_s, C_{sp}, C_d, C_{pg}, C_p) (J/kg or J/l)
W	quantity of fuel used for a particular operation (i.e. W_c, W_{sc}, W_r, W_s, W_{sp}, W_d, W_{pg}, W_p) (l)
P	electrical power consumed for a particular operation (i.e. P_c, P_{sc}, P_r, P_s, P_{sp}, P_d, P_{pg}, P_p) (kW)
N	number of persons involved in a particular operation (i.e. N_c, N_{sc}, N_r, N_s, N_{sp}, N_d, N_{pg}, N_p)
K	efficiency of the electric motor used for a particular operation (i.e. K_c, K_{sc}, K_r, K_s, K_{sp}, K_d, K_{pg}, K_p)

Subscript

c	cleaning
sc	soaking or conditioning
r	roasting
s	shelling
sp	separation
d	drying
pg	peeling and grading
p	packaging

1. Introduction

Energy is an essential facet of human activities. It is indeed the live wire of industrial, food and agricultural production, the fuel for transportation as well as for the generation of electricity in conventional thermal power plants. No action will occur within a system without an enabling energy flow and a system wide entropy increase. According to Sambo [1] and Fluck [2], a high percentage of the world's total energy output is generated from fossil fuels such as oil and coal and it is universally conceded that fossil fuels are finite. It is only a matter of time before fossil fuel reserves will be depleted.

Industrialized agriculture and food production rely on energy to carry out the desired operations and obtain high processing efficiencies in mechanization of crop handling and conveyance and thermal processing, to assure safe storage of agricultural products, and conversion processes that create new forms of food. Electricity and petroleum account for a major portion of energy for food and farm