EcoProduction.
Environmental Issues in Logistics and Manufacturing

Pawel Zajac

Evaluation Method of Energy Consumption in Logistic Warehouse Systems

Springer

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Environmental Issues in Logistics and Manufacturing

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This book is dedicated to my beloved wife,
Agnes, children Elizabeth and Charles,
who have always supported me
and were forgiving

Acknowledgments

The book “Evaluation Method of Energy Consumption in Logistics Warehouse Systems” was reviewed independently by two investigators Professors: Professor Kazimierz Wojs Phd., D.Sc., Wroclaw University of Technology, Wroclaw, Poland and Professor Jerzy Kwasnikowski Phd., D.Sc., Poznan University of Technology, Poznan, Poland. In this place I would like to thank both for the positive reviews. Professors have wrote, among other things, that topic which is taken into consideration by the author is important and topical. The presented results of the work and the methods used in the book are new and interesting, so that might interest a wide circle of specialists.

Wroclaw, 2015

Contents

Abbreviations and Markings

Q_d	Heat penetrating through walls, ceiling and floor of the cooling chamber
Q_w	Heat dissipated from the refrigerated goods
Q_L	Heat delivered by air, which was introduced into the chamber unintentionally
Q_V	Heat associated with the air cooler fan
Q_{ah}	Any heat while defrosting
Q_{Ma}	Heat generated by lighting, machinery and related equipment in the warehouse
Q_{Me}	Heat generated by people
Q_S	Backup heat due to unforeseen changes of the heat load in the storage
G_i	Load weight (N)
G_k	Weight of carriage and working equipment (N)
G_r	Weight of internal frame (N)
W_t	Work of friction during movement of carriage and mobile frame of the lifting mechanism (N)
l_r, l_k	Distance from the center of gravity from the load with carriage to its gripping and carriage with mobile frame, respectively (l_r, can be assumed equal to l_k)
b_r, b_k	Spacing between retaining rollers of the carriage and mobile frame
d and d_1	Hub diameters of counter-pressure rollers of carriage and frame
D and D_1	Diameters of counter-pressure rollers of carriage and frame
f	Coefficient of friction in hubs
μ	Coefficient of friction of rollers rolling along the tracks
k	Coefficient taking into account other additional resistances (type of wheels and bearings—assumed at 1.1÷1.3)
G_{rg}	Weight of the main frame, including the tilt cylinder

0.75 and 0.25	Coefficients characterizing the approximate position of the frames' center of gravity
$H_{max.}$	Maximum carriage lift height
D_c	Cylinder diameter (cm)
d_t	Piston rod diameter (cm)
p	Pressure (N/cm^2)
I_m	Cylinder capacity (assumed at 0.95)
v_t	Speed of piston movement (cm/min/.)
η_c	Volumetric efficiency of the cylinder, (using rubber and leather seals, approximately equal to 1)
G_I	Cargo weight (N)
v	Carriage lifting speed (platform) (m/s)
η	Coefficient of performance of the device mechanisms
k	Coefficient taking into account the impact of counterweight, equal to 04–06, when none k = 1
ΣW	Driving resistance of stacker crane along the track (N), set as for the track cart
m • a	Forces of inertia
$W_t = f_t \bullet Q$	Movement resistances
f_t	Rolling resistance coefficient
F(V)	Drive force
ξ	Rotating mass factor
L	Conveyor length 70
μ	Rolling friction coefficient
v	Speed of cargo movement
η	Transmission performance
l	Length of the transferred load unit
B_r	Shaft length (m)
K = 1 or K = 2	Factors according to type of rollers (normal, heavy)
W_{edi}	Global ratio characterizing the suitability of EDI in organization (J)
w_i	Weight assigned to the i-th partial indicator
W_j	Value of the i-th partial indicator of EDI suitability

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