A BLADE CUTTER DESIGN FOR AN EFFECTIVE OIL PALM FRONDS CUTING PROCESS

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ABSTRACT

This study aimed to design an improved crosscut blade for fronds cutting in the oil palm industry, considering the cutting vector *X-Y-Z* axis and testing different blade designs based on various Kerf-Sets tooth trigonometrical patterns. The research consisted of two stages; the development of a statistical laboratory test rig platform to analyze the cutting timeline in the Straight-Tooth sections, and a High Accelerated Life Test (HALT) conducted in real field conditions to assess reliability and tooth fracture-wear. The results showed that blade type "F" met the technical design requirements, achieving a Hardness Rockwell of 127HRC per 1mm^2. The N14TP14 Kerf-Sets tooth size provided the fastest fronds cutting, powered by 100V, with a recorded timeline of 00:15.7 seconds per 6.5 kg pressing drag mass cutting against 29 cm^2 fresh fronds specimens. These findings contribute to the development of an improved crosscut blade design, with blade type "F" N14TP14 tooth configuration being the most effective, exhibiting high Hardness Rockwell and no fractured tooth blades. The large Kerf-Set tooth sizing facilitated strong cutting force, and the correct Pitch Pressure Angle design Type B at Cosine 10^0 to 15^0 contributed to prolonged sharpness quality.

Keywords: Oil Palm Industry, X-Y-Z Axis Cutting Vectors, Technical Reliability, Motions and Inertia, Statistical Static-State, (HALT) High Accelerated Life Test, Hardness Rockwell, Kerf-Sets Sizing, N14TP24 Tooths Trigonometry Dimensions, Pitch Pressure Angle Type B.

ABSTRAK

REKABENTUK PEMOTONG BILAH UNTUK PROSES PEMOTONG PELEPAH KELAPA SAWIT YANG BERKESAN

Kajian ini bertujuan untuk mereka bentuk bilah potong silang yang lebih baik untuk pemotongan pelepah dalam industri kelapa sawit, dengan mengambil kira paksi vektor pemotongan paksi X-Y-Z dan menguji reka bentuk bilah yang berbeza berdasarkan pelbagai corak trigonometri gigi Kerf-Sets. Penyelidikan terdiri daripada dua peringkat; pembangunan platform pelantar ujian makmal statistik untuk menganalisis garis masa pemotongan dalam bahagian Gigi Lurus, dan Ujian Hayat Dipercepatkan Tinggi (UHDT) yang dijalankan dalam keadaan lapangan sebenar untuk menilai kebolehpercayaan dan kehausan patah gigi. Keputusan menunjukkan bahawa jenis bilah "F" memenuhi keperluan reka bentuk teknikal, mencapai Kekerasan Rockwell 127HRC setiap 1mm^2. Saiz gigi N14TP14 Kerf-Sets memberikan pemotongan pelepah terpantas, dikuasakan oleh 100V, dengan garis masa yang direkodkan 00:15.7 saat setiap 6.5 kg pemotongan jisim seretan menekan terhadap spesimen pelepah segar 29cm^2. Penemuan ini menyumbang kepada pembangunan reka bentuk bilah potong silang yang lebih baik, dengan konfigurasi gigi jenis bilah "F" N14TP14 adalah yang paling berkesan, mempamerkan Kekerasan Rockwell yang tinggi dan tiada bilah gigi yang patah. Saiz gigi Set Kerf yang besar memudahkan daya pemotongan yang kuat, dan reka bentuk Sudut Tekanan Pitch yang betul jenis B pada Cosine 10^0 hingga 15^0 menyumbang kepada kualiti ketajaman yang berpanjangan.

Kata kunci: Industri Kelapa Sawit, Vektor Pemotong paksi X-Y-Z, Kebolehpercayaan Teknikal, Pergerakan dan Inersia, Keadaan Statik Statistik, Ujian Hayat Dipercepatkan Tinggi (UHDT), Kekerasan Rockwell, Saiz Set Kerf, Dimensi Trigonometri Gigi N14TP24, Sudut Tekanan Pitch Jenis B.

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LIST OF ABBREVIATIONS.

mm	-	Millimeter
Cm	-	Centre meter
m	-	Meters
(ha) m2	-	Hectare
2.47 Acre	-	1 Ha
kg	-	Kilogram
MT	-	Metric Ton
Hp	-	Horse power
kWh	-	Kilowatt hour
V	-	Voltage
m/s2	-	Speed velocity
Newton N	-	Force
N/m2	-	Stress
Nm	-	Energy
hr	-	Hour
‘	-	Degree
‘’	-	Minute
‘”	-	Seconds
HRC	-	Hardness Rockwell Class “C”
BUE	-	Built-Up-Edge
RPM	-	Revolution Per Minute.
RPS	-	Revolution Per Seconds.
Oil Palm	-	Oil Palm.
MPOB	-	Malaysian Oil Palm Board.
S	-	Straight-Tooth.
SC	-	Semi-Circular.
C	-	Curve.
M & I	-	Motion and Inertia.
HAV	-	Health Associated Vibrations.
YAP	-	Year After Planting.
M/T/H/M	-	Man/Tan/Hectares/Months.
SSSTR	-	Statistical Static-State Test Rig.
HRC	-	Hardness Rockwell Class “C”.

HALT	-	High Accelerated Life Test.
UHDT	-	Ujian Hayat Dipercepatkan Tinggi.
STBICP	-	Statistical Tooth Blade Identified Cutting Performance.
DMG	-	Designed Management Guidelines.
DSP	-	Demand Side Platform.
SSP	-	Supply Side Platform.

LIST OF SYMBOLS.

F	-	Force
m	-	Mass of the body
v	-	Velocity of the moving body.
f	-	Acceleration
k	-	Dimensionless constant.
r	-	Radius of curvature
w	-	Angular velocity vector.
w	-	Width of Tooth Blade
t	-	Thickness of tooth blade
g	-	The acceleration due to gravity,
h	-	Height of the tooth body above a reference point of the gullet depth.
B	-	Beta
N-m	-	Newton metre
Cos	-	Cosine
PE (Nm)	-	Potential Energy.
K.E. (Nm)	-	Kinetic Energy.
S	-	Distance traveled in meters
V_o	-	Initial velocity in meters/sec
T	-	Time interval in seconds
F_t	-	Acceleration in meters/sec^2
p	-	pressure in N/m^2
d	-	diameter of the piston in m^2
n	-	ratio of connecting rod to crank radius