

IMPLEMENTATION
ANALYSIS OF CUTTING
TOOL CARBIDE WITH
CAST IRON MATERIAL
S45 C ON UNIVERSAL
LATHE

by

Junaidi , Soni hestukoro , Ahmad yanie ,
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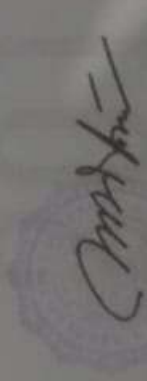
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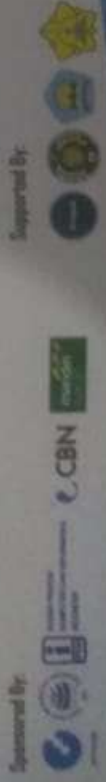


Table of contents

Volume 930

2017

◀ Previous issue Next issue ▶

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Visual Approach of Searching Process using Boyer-Moore Algorithm

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Forecasting Error Calculation with Mean Absolute Deviation and Mean Absolute Percentage Error

Ummul Khair, Hasanul Fahmi, Sarudin Al Hakim and Robbi Rahim

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012003

Analysis of Multiple Data Hiding Combined Coloured Visual Cryptography and LSB

Halim Maulana and Edy Rahman Syahputra

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012004

Measuring the Accuracy of Simple Evolving Connectionist System with Varying Distance Formulas

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Symmetric Stream Cipher using Triple Transposition Key Method and Base64 Algorithm for Security Improvement

Heri Nurdiyanto, Robbi Rahim and Nur Wulan

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012006

Analysis of Accuracy and Epoch on Back-propagation BFGS Quasi-Newton

Herlan Silaban, Muhammad Zarlis and Sawaluddin

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Comparison Searching Process of Linear, Binary and Interpolation Algorithm

Robbi Rahim, Saiful Nurarif, Mukhlis Ramadhan, Siti Aisyah and Windania Purba

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012008

PERFORMANCE ANALYSIS OF COMBINED METHODS OF GENETIC ALGORITHM AND K-MEANS CLUSTERING IN DETERMINING THE VALUE OF CENTROID

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012009

The Combination of RSA And Block Chiper Algorithms To Maintain Message Authentication

Sepri Yanti Tarigan, Dewi Sartika Ginting, Melva Lumban Gaol and Kristin Lorensi Sitompul

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012010

ANALYSIS OF BEARING CAPACITY PILE FOUNDATION WITH USING CAPWAP SOFTWARE FOR TESTING PILE DRIVING ANALYZER (PDA) AT FASFEL DEVELOPMENT PROJECT PARLIMBUNGAN KETEK SIKARA-KARA MANDAILING NATAL DISTRICT (NORTH SUMATERA)

Johan Oberlyn Simanjuntak and Diana Suita

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Automatic Locker Key With Barcode Based Microcontroller Atmega 8535

M. Irfan Fahmi and Jhonson Efendi Hutagalung

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Data Collision Prevention with Overflow Hashing Technique in Closed Hash Searching Process

Robbi Rahim, Nurjamiyah and Arie Rafika Dewi

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Analysis of Intergrade Variables In The Fuzzy C-Means And Improved Algorithm Cat Swarm Optimization(FCM-ISO) In Search Segmentation

Jepronel Saragih, Opim Salim Sitompul and Zakaria Situmorang

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Application of fuzzy C-Means Algorithm for Determining Field of Interest in Information System Study STTH Medan

Edy Rahman Syahputra, Yulia Agustina Dalimunthe and Irvan

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Doni Situngkir, Dikri Arisandi, An Ushada, Yedy Irwan and Robbi Rahim

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Arnes Sembiring, Arif Budiman and Yuyun D Lestari

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The Effect Of Attributes Product's Analysis, Halal Certification, And Product Innovation To The Interest Of Consumer Buying-Back Through The Advantage Competitive Of Micro Small And Medium Business (MSMB) In Medan

Bunga Aditi

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IMPLEMENTATION OF K-MEANS CLUSTERING METHOD FOR ELECTRONIC LEARNING MODEL

Herlina Latipa Sari, Dewi Suranti Mrs. and Leni Natalia Zulita

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012022

The Accuracy Of Fuzzy Sugeno Method With Antropometry On Determination Natural Patient Status

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Dinur Syahputra, Tulus and Sawaluddin

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Optimization Of Feature Weight The Voting Feature Intervals 5 Algorithm Using Partical Swarm Optimization Algorithm

Eka Hayana Hasibuan, Herman Mawengkang and Syahril Efendi

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Improved Fuzzy K-Nearest Neighbor Using Modified Particle Swarm Optimization

Jamaluddin and Rimbun Siringoringo

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Modification Of Learning Rate With Lvq Model Improvement In Learning Backpropagation

Jaya Tata Hardinata, Muhammad Zarlis, Erna Budhiarti Nababan, Dedy Hartama and Rahmat W Sembiring

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Optimizing Support Vector Machine Parameters with Genetic Algorithm for Credit Risk Assessment

Jonson Manurung, Herman Mawengkang and Elviawaty Zamzami

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The Expansion of Initial Point Algorithm for K-Modes Algorithm

Juliandri, M Zarlis and Z Situmorang

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012028

PERFORMANCE ANALYSIS OF ENTROPY METHODS ON K MEANS IN CLUSTERING PROCESS

Mhd. Dicky Syahputra Lubis, Herman Mawengkang and Saib Suwilo

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012029

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 Rachmat Aulia, Ahmad Zakir, Haida Dafitri, Dodi Siregar and Hasdiana
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THE ANALYSIS PERFORMANCE METHOD NAIVE BAYES ANDSSVM DETERMINE PATTERN GROUPS OF DISEASE
 Rianto Sitanggang, Tulus and Zakarias Situmorang
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Prime Number: an Experiment Rabin-Miller and Fast Exponentiation
 Robbi Rahim, Hendryan Winata, Iskandar Zulkarnain and Hendra Jaya
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 Suhardi, Saib Suwilo and Erna Budhiarti Nababan
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 Tarida Yanti Nasution, Muhammad Zarlis and Mahyuddin K.M Nasution
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Analysis Resilient Algorithm on Artificial Neural Network Backpropagation
 Widodo Saputra, Tulus, Muhammad Zarlis, Rahmat Widia Sembiring and Dedy Hartama
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Performance Measurement Of *Mel Frequency Ceptral Coefficient* (MFCC) Method In Learning System Of Al- Qur'an Based In *Nagham* Pattern Recognition
 Yesy Afrillia, Herman Mawengkang, Marwan Ramli, Fadlisyah and Rizky Putra Fhonna
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Analysis Of Using Firewall And Single Honeypot In Training Attack On Wireless Network

Tengku. Mohd. Diansyah, Ilham Faisal, Adidtya Perdana, Boni Octaviani Sembiring and Tantri Hidayati Sinaga

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Representative Model the Graph Theory in Calculations Kendall Correlation Coefficient

Pasukat Sembiring, Ujian Sinulingga, Marihat Situmorang and Sajadin Sembiring

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Multithreading with separate data to improve the performance of Backpropagation method

Mulia Dhamma, Muhammad Zarlis and Erna Budhiarti Nababan

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Denni Algorithm An Enhanced Of SMS (Scan, Move and Sort) Algorithm

Denni Aprilsyah Lubis, Opim Salim Sitompul, Marwan, Tulus and M. Andri Budiman

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Impact of GDP Information Technology in Developing of Regional Central Business (Case 50 Airports IT City Development in Indonesia)

Joko Suyono, Agus Sukoco, M Ikhsan Setiawan, Suhermin and Robbi Rahim

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012046

Data Reduction Algorithm Using Nonnegative Matrix Factorization with Nonlinear Constraints

Pasukat Sembiring

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012047

MODIFICATION OF RC6 BLOCK CIPHER ALGORITHM ON DIGITAL IMAGE

Mardiana, Fajrillah, Yuyun Dwi Lestari and Ummul Khair

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012048

The Time Window Vehicle Routing Problem Considering Closed Route

Nenna Irsa Syahputri and Herman Mawengkang

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012049

Modeling And Simulation Of Electrical Prevenion System Using Arduino Uno,Gsm Modem, And Acs712 Current Sensor

Ummul Khair, Abdul Jabbar Lubis, Indra Agustha, Dharmawati and M. Zulfin

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012050

Weighted hybrid technique for recommender system

S. Suriati, Meisyarah Dwiastuti and T. Tulus

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Abstract. Cutting tool is the tools lathe .Cutting process tool CARBIDE with Cast Iron Material Universal Lathe which is commonly found at Analysiscutting Process by some aspects namely Cutting force ,Cutting Speed,Cutting Power,Cutting Indication Power ,Temperature Zone 1 and Temperatur Zone 2. Purpose of this Study was to determine how big the cutting Speed ,Cutting Power, electromotor Power, Temperatur Zone 1 and Temperatur Zone 2 that drives the chisel cutting CARBIDE in the Process of turning Cast Iron Material .Cutting force obtained from image analysis relationship between the recommended Component Cuting Force with plane of the cut and Cutting Speed obtained from image analysis of relationships between the recommended Cutting Speed Feed rate.

Keywords: Cutting Force,Cutting Speed,Cutting Power, Electromotor Power ,Temperatur Zone 1,Temperatur Zone 2

1. Introduction

In the process of cutting, cutting tool moves relatively to workpiece and separates part of workpiece material, commonly called by chips. Part of cutting tool feeds into the workpiece material called by cutting element of the cutting tool. Turning process is the machining to produce parts of engine which is generally cylindrical(3). The basic principle of machining process outer and inner surface is cylindrical such as shafts, holes /drill, threaded and tapered. In the machining, the function of axis is to transmit power and circle, based on the function axis is designed to be strong in accepting the load. The axis has shaft strength and hardness so the material used is made of carbon steel S 45 C (2). Generally the process of making the axis is done in the lathe, using cutting tools on a rotating workpiece. Cutting tools is the most critical part of a machining process.

Material, parameter and geometry of cutting tool and cutting style will determine a machining process and affect the power of cutting tools. In a machining process cutting tool always changes. Cutting tool is a production component which can be wear and the price is relatively expensive. Cutting tool will be wear after being used for cutting. More wear, the cutting tool will be in critical condition. If it uses continuously the cutting tool wear will be faster, and someday cutting edge will be broken at all. The broken should be avoided to cutting tool, machine tool, workpiece because it can endanger to the operator, and also affect on the geometric and quality of production(3). Basically the wear will determine the limits of cutting cut power. The selection inappropriate type of cutting tool, workpiece material and cutting conditions can affect strength of the cutting tool. Therefore it is important to know the type of cutting tool, workpiece material and cutting conditions (cutting speed, depth of cut and feeding movement) on the cutting tool wear. Cutting speed can't be chosen randomly, if the cutting speed is low, it will take time a long to do it. If the speed is too high cutting tool will lose hardness it is one the heating effect soferates in fast time ,it will if the cutting tool operates in fast time,it will take the short life time.

Based on the background and the problems above, the formulations of the problems in this study are:

1. How do we know the cutting tool and the material used which relates to the counting formulation?
2. How do we choose a counting formulation for cutting tool and material?This paper presents the type of cutting tool and material that related the counting formulate to finish the cutting process corecttly and accurattly.



The deviation factors in cutting metal process is setting of machine tools, measurement methods, the movement of machine tools, the wear of cutting tool, temperature, and cutting styles. Rochim (2003) states that the wear of cutting tool is affected by the geometry of cutting tool, beside that it is influenced by all factors related to all machining processes, such as the types of workpiece material and cutting tool, cutting conditions (cutting speed, cutting depth and feeding movement), liquid cooling, and type of machining process. When cutting takes place, high temperature will occur in the cutting edge. This heat will flow in part to growl, workpiece and cutting tool. The heat caused by friction in transmission power system from machine tools (gears) will flow to the components so it will occur the difference temperature between the parts of the machine which are not the same size, the result from this is deformation. May be the spindle of the lathe is not the same level with the table or there is changing heath. Although the deformation is small but we should consider if we want to create the ideal product. Therefore to reduce geometric errors as the result of deformation from this temperature, it is usually warmed up the engine before production starts.

The strength and rigidity of the machine tool and workpiece are very important to reduce deformation caused by forces when cutting occurs. Bending occurs in the workpiece or other engine parts will reduce the accuracy of product. In the turning process, there is a cutting force such as radial force (the force on the depth of cut), tangensial force (force in cutting speed), and the longitudinal force (force funerals). Many factors affects the cutting forces like depth of cut, feed rate and the cutting speed, working forces can also be determined by empirical formulation such as specific cutting force. Specific cutting force (K_s) is a numbers of force or energy required to move a unit volume of metal called specific cutting force or specific cutting energy. The relationship specific cutting energy with a workpiece material and tensile strength can be shown in table 1(1)

Table 1. Specific Cutting Force (1)

Material of workpiece	σ_b (Kg/mm ²)	K_s	Material of workpiece	BHN	K_s
Steel	30-40	132	Cast Iron	140-160	81
	40-50	145		160-180	86
	50-60	157		180-200	92
	60-70	170		200-220	98
	70-80	191		220-240	104
	80-90	200		240-260	108
	90-100	225			
	100-110	240			
	110-120	260			

From Table 1 above we can show the correlation between workpiece material, the tensile strength (σ_b) and specific cutting force (K_s). Tensile strength (σ_b) is close relation to carbon steel. Carbon steel is given every symbol which relate directly to the standard, heating performance and tensile strength as shown in Table 2 carbon steel for machine construction and steel rod is cold difinis to the shaft.(2)

Table 2. Carbon Steel For machine Conctruction and difinis Steel rod to the exis.(2)

Standar and type	symbol	Treatment Hot	Tensile strength (Kg/mm ²)	Information
Carbon steel construction machinery (JIS G 4501)	S30C	Penormalan	48	
	S35C	”	52	
	S40C	”	55	
	S45C	”	58	
	S50C	”	62	
	S55C	”	66	

Stainless steel rods	S 35 C-D		55	Pulled cold, digrinding, in-lathe, or connect between these things
	S 45 C-D		60	
	S 55 C-D		72	

The shape and size of the cutting cross affect the specific cutting force (ks), as well as the main cutting force Fz. A Specific cutting g style will decrease by increasing in cutting cross (see chart 10.1). The price of Ks will also be affected by the comparison of depth of cut, a, to feeding S.

Cutting speed affects little cutting forces. In cutting speeds below 75 m/ minutes, the cutting forces will come down with increasing rise and then a constant cutting speed if the speed is above 75 m/ minutes. It is the reason why the carbide tool has a constant cutting force unaffected by the cutting speed. The correlation between cutting speed and feeding S for tool life of 60 minutes, 240 minutes and 480 minutes as shown in .

The varieties of cutting tools determine tool life and final result from workpiece surface. The cutting edge angle in cutting tool edge is called cutting edge angle and the composition is also called cutting geometry. The composition of cutting edge angle and fingers of cutting edge are called by tool signature. Tool signature of a single point tool usually consists of seven elements, they are:

1. Back rake angle
2. The side rake angle
3. The end relief angle
4. The side relief angle
5. The end cutting edge angle
6. The side cutting edge angle
7. Nose radius

2. Research Methods

The implementation of this research will be conducted to purchase cast iron material and cutting tool HSS in selling place in Medan. And the implementation will be carried out in production process laboratory at STT Harapan Medan. It will be done in December 2016 until the end of February 2017.

The process of making object test Cast iron which is larger than 3 x 140 mm and 20 mm diameter, cut into 3 parts. Then making process object test by using machine tools (milling, shaping, and drilling machine) to get shape and size object test is done by cold work, so it can be considered no changes in microstructure, deformation, plastic or residual stress (residual stress cause by the manufacturing process). Then 3 part of cutting tool is also geared up with grinder machine one by one. The next the biased of cutting tool is cut in turning machine.

Then it is installed by using a wrench, after that workpiece is installed by using dial indicator. Then turning machine is turned on by cutting the workpiece, try to move automatically and turn on for 1 hour or 60 seconds. In turning process we observe automatically how the condition of workpiece in turning process, whether cutting tool still have function or not, if it is not, we replace with the new sharpened cutting tool. Then we analyze several times to change cutting tool for 1 hour and how the condition of the axis whether it is smooth or rough, next we do the second test materials such as the first job by rotation and the same speed as the first job but different time that is 4 hours or 240 minutes. And the third job as the first job with different time that is of 8 hours or 480 minutes.

3. Data Analysis

Material Cutting Analysis (10)

$$P_c = \frac{F_c \times V_c}{4500}$$

F_c = Cutting Force (kg)

P_c =CuttingPower(Hp)

V_c = Cutting Speed (m/menit)

$$P_g = \frac{P_c}{\dots} + P_{idd}$$

η_{mk}
 $P_g =$ Elektromotor Power (Hp)
 $\eta_{mk} =$ Mekanis Effesienci (%)
 $P_{idd} =$ Indication Power (Hp)
 $\tan \theta = \frac{rc \times \cos \delta}{1 - rc \times \sin \delta}$
 $rc =$ cutting ratio 0,3
 $\delta =$ in this from tool signatur.
 $\theta + \beta - \delta = 45^0$
 Tangencial Force (Ft)
 $F_t = F_c \tan (\beta - \delta) \dots \dots \dots (Kg)$
 Scisories Force (Fs) $F_s = F_c \cos \theta - F_t \sin \theta \dots \dots \dots (Kg)$
 Normality in Scisorse Force (Fns)
 $F_{ns} = F_c \tan (\beta - \delta + \theta) = F_c \tan 45^0 \dots \dots \dots (Kg)$
 Resultan Force (Fv) $F_v = \frac{F_s}{\cos (\beta - \delta + \theta)} = \frac{F_s}{\cos 45^0}$
 Friction Force (Ff)
 $F_f = F_v \sin \beta \dots \dots \dots (Kg)$
 Normal Force(Fn)
 $F_n = \frac{F_f}{\tan \beta}$
 Friction Factor (η)
 $\eta = \tan \beta$

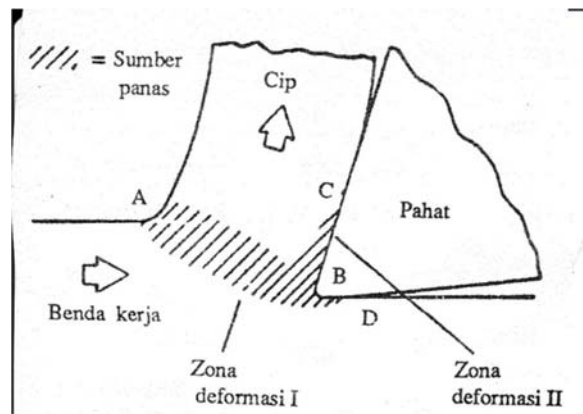


Figure 1. Tool Design
 (**Fundamentals of Tool Design:**Syamsir A.Muin,page.151)

4. Temperatur in first Deformasi Zone 1 (1)

The amountof heat comes from first deformation zone is Q_s and some of this heat is I (read gamma) conducted on the workpiece.The number $(1-I) Q_s$ transformed with chip, so the increasing temperature from material through the first deformation zone are:

$$\Delta t_s = \frac{(1 - \Gamma) Q_s}{\partial \cdot C_p \cdot V \cdot a_c \cdot B}$$

Dimana

B = Plane of the cut. (ft)

a_c = dept of cut (mm)

C_p = Specifik Heat (Joule/kg °C]

Γ = From in Heatreatment

Γ = From Chart with looking for R tan Ø

R = Thermal Number

$$\rho \cdot C_p \cdot V \cdot a_c$$

$$R = \frac{\rho \cdot C_p \cdot V \cdot a_c}{K}$$

K = Konduktivitas panas (Joule/m C)

ρ = Materials Weight (kg/m³)

Wemercan do this equation including to determine some requirements to workpiece, he produces an equation which states (part of Q_s is conditioned on the workpiece) as a unique function of R tan Ø
Ø = shear angle.

The theoretical relationship between I and R tan Ø in comparison with experimental data. it can be seen that a theory I ignore the price of a high R tan Ø is high speed and feed. In theory assumes plane heat source, heat can only flow in the workpiece by conduction; in fact the heat produced covers a large zone, most of it goes into the workpiece. The effects of spreading heat become very important in Maximum Temperature (Ø max)

$$\Delta T_{max} = \Delta T_m + \Delta T_s + \Delta T_0$$

ΔT_m = Temperature high up (°C)

ΔT_m = it can with know l_f/l_o dan W₀

$$L_o = \text{Hotter long source } L_o = l_f / l_o = \frac{l_f \cdot r_c}{a_c} \quad a_o = a_c / r_c$$

W₀ = Konstanta 0,2

$$\Delta T_0 = \text{Home Temperature } (273/d30)^{\circ}C$$

In chart 6.10 shows the effect of large variations in distribution of heat source which isn't uniform. if this curve is used, then L_o can be estimated from the wear on the tool face and wide from the heat source can be estimated from a micrograph photograph of chip.

5.Result

Known example data no.1,known

$$r_c = 0,3, F_f = 674N, \rho = 7800 \text{ kg/m}^3,$$

$$K = 43 \text{ J/m}^{\circ}C, C_p = 0,473 \text{ kJ/kg}^{\circ}C, B = 2,5 \text{ mm}, L_f = 7,5 \text{ mm}, \omega_0 = 0,24, \theta_0 = 28^{\circ}C$$

so ;

Varedire Force

$$F_v = 279,73 \text{ kg} / 0,7071 = 395,6 \text{ kg}$$

Resultan Energi (Pm)

From no1 Vc can = 190 m/menit = 3.16 m/detik.

$$F_c = 350 \text{ kg} = 3430 \text{ Newton}$$

$$P_m = F_c \times V_c = 3430 \times 3,16 \text{ m/detik} = 10838,8 \text{ Nm/detik} = 10838,8 \text{ j/detik}$$

$$P_m = 45161,67 \text{ kal/detik} = 45,16 \text{ kkal/detik.}$$

Hotter in friction force (Pf)

$$P_f = F_f \times V_0 = F_f \times V_c \times r_c = 674 \text{ N} \times 3,16 \text{ m/detik} \times 0,3 = 638,952 \text{ Nm/detik}$$

$$P_f = 638,952 \text{ j/detik} = 2662,11 \text{ kal/detik} = 2,662 \text{ kkal/detik}$$

Hotter in Scisorse force(Ps)

$$P_s = P_m - P_f = 45,16 \text{ kkal/detik} - 2,662 \text{ kkal/detik} = 42,5 \text{ kkal/detik}$$

$$R = \frac{\rho \times C_p \times V \times a}{K}$$

$$= \frac{7800 \text{ kg/m}^3 \times 473 \text{ J/kg}^0\text{C} \times 3,16 \text{ m/det} \times 2,54 \cdot 10^{-3} \text{ m}}{43 \text{ j/m}^0\text{C}}$$

$$R = 688,6$$

$$\tan \Theta = \tan 17,2 = 0,32 \rightarrow R \tan \Theta = 688,6 \times 0,32 = 213,952$$

From grafic 4 ,with R tan 17,72 ,didapat $\Gamma = 0$

So :

$$\theta_s = (1 - \Gamma) \times P_s = (1 - 0) \times 42,5 \text{ kkal/det}$$

$$\rho \times C_p \times a \times V \times B = 7800 \text{ kg/m}^3 \times 473 \text{ j/kg}^0\text{C} \times 2,54 \cdot 10^{-3} \text{ m} \times 3,16 \text{ m/det} \times 2,5 \cdot 10^{-3} \text{ m}$$

$$\theta_s = \frac{178,5 \text{ J/det}}{74 \text{ J/det}^0\text{C}} = 2,41$$

$$74 \text{ J/det}^0\text{C}$$

$$\theta_f = \frac{P_f}{\rho \times C_p \times a \times V \times B} = \frac{2,662 \text{ kkal/det}}{7800 \text{ kg/m}^3 \times 473 \text{ j/kg}^0\text{C} \times 2,54 \cdot 10^{-3} \times 3,16 \text{ m/det} \times 2,5 \cdot 10^{-3} \text{ m}}$$

$$\rho \times C_p \times a \times V \times B = 7800 \text{ kg/m}^3 \times 473 \text{ j/kg}^0\text{C} \times 2,54 \cdot 10^{-3} \times 3,16 \text{ m/det} \times 2,5 \cdot 10^{-3} \text{ m}$$

$$\theta_f = \frac{2,662 \text{ j/det}}{74 \text{ j/det}} = 0,036^0\text{C}$$

Result From Mathematic in calculating T= 1 Hour =60 minute and Cutting Force(Fc) = 350 Kg

Result From Mathematic in calculating live tool T= 1 hour =60 minutewith V= 190 m/minute, T= 4 hour = 240 minutewith V= 190 m/minutet ,T= 8 hour =480 minute withV = 190 m/minute Cutting Force (Fc) = 350 Kg can be show as :

Conclusion

1. Various types of cutting tool research can be applied to obtain the result of calculation analysis according to condition and industry
2. to obtain accurate calculation result analysis, it is necessary ketelitian read the picture on the diagram under study.

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