Computer Program To Relate Dust Generation to Drum-Type Coal Mining Machines

By Wallace W. Roepke, Bruce D. Hanson, and Robert L. Schmidt
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Roepke, Wallace W

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CONTENTS

Abstract................................................................. 1
Introduction....................................................................... 2
Acknowledgments.......................................................... 2
REDI program description.............................................. 3
Program usage............................................................... 4
Program conversion....................................................... 9
Summary.......................................................................... 9
Appendix A.--Program listing.......................................... 10
Appendix B.--Variable, function, and program descriptions 16
Appendix C.--Example of output....................................... 18

ILLUSTRATIONS

1. Flowchart...................................................................... 5
2. Program output showing listing of input variables and data correction 6
   prompts........................................................................ 6
3. Program output showing data modification procedure.............. 7
4. Program output showing dust value for optimum bit spacing option with maximum production 7
5. Program output showing effect of changing advance rate........... 8

TABLES

1. Input variables.......................................................... 3
2. Program usage example: Operator-controlled variables........... 8
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cfm</td>
<td>cubic foot per minute (airflow)</td>
<td>mg/m³</td>
<td>milligram per cubic meter</td>
</tr>
<tr>
<td>ft</td>
<td>foot</td>
<td>mg/min</td>
<td>milligram per minute</td>
</tr>
<tr>
<td>ft/min</td>
<td>foot per minute</td>
<td>mg/st</td>
<td>milligram per short ton</td>
</tr>
<tr>
<td>ft³/min</td>
<td>cubic foot per minute (solids)</td>
<td>min</td>
<td>minute</td>
</tr>
<tr>
<td>in</td>
<td>inch</td>
<td>μm³</td>
<td>cubic micrometer</td>
</tr>
<tr>
<td>in³</td>
<td>cubic inch</td>
<td>μm³/ft</td>
<td>cubic micrometer per foot</td>
</tr>
<tr>
<td>lb</td>
<td>pound</td>
<td>pct</td>
<td>percent</td>
</tr>
<tr>
<td>lb/ft³</td>
<td>pound per cubic foot</td>
<td>psi</td>
<td>pound per square inch</td>
</tr>
<tr>
<td>Mcfm</td>
<td>thousand cubic feet per minute</td>
<td>rpm</td>
<td>revolution per minute</td>
</tr>
<tr>
<td>mg</td>
<td>milligram</td>
<td>st/min</td>
<td>short ton per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>st per shift</td>
<td>short ton per shift</td>
</tr>
</tbody>
</table>
COMPUTER PROGRAM TO RELATE DUST GENERATION TO DRUM-TYPE COAL MINING MACHINES

By Wallace W. Roepke, ¹ Bruce D. Hanson, ² and Robert L. Schmidt ¹

ABSTRACT

The Bureau of Mines has developed an interactive computer program that enables mine operators and others to identify the effect of cutting system changes on relative dustiness at the face. The program, which simultaneously evaluates machine parameters, coal seam parameters, and operator-controllable parameters, was developed for use on any microcomputer using BASIC programming language. The program allows the user to change one or more of the cutting system parameters at a time to see how these changes affect relative dustiness. A complete program listing and flowchart are included along with operating instructions and sample outputs. An example showing how to use the program is also included.

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INTRODUCTION

Since the enactment of the Federal Coal Mine Health and Safety Act of 1969, the Bureau of Mines has conducted an intensive research program on the control and abatement of respirable coal dust. This research has been channeled into three separate but interrelated approaches: (1) primary control, wherein the coal is fragmented so that either generation of respirable dust is reduced or the dust is not entrained in the airstream, (2) secondary suppression, wherein respirable dust, already entrained, is "knocked down" or diverted with water sprays, dust collectors, or changes in ventilating patterns, and (3) respirable dust instrumentation development, which is essential to the conduct of the other two approaches. This paper deals only with the first approach, i.e., with reducing dust generation during cutting by adjusting cutting system parameters.

Bureau research on reduction of primary dust generation during coal cutting has been conducted over the past 15 years in small-scale laboratory tests, intermediate-sized prototype tests, and full-scale in-mine demonstrations. The main objective of this work has been to determine the effect of controllable machine parameters on respirable dust generation. These controllable parameters include such things as bit geometry, bit mounting configuration, and operator techniques.

The body of data collected during this research provides a broad base of knowledge on coal cutting phenomena. The results are available to the industry in a multitude of Bureau publications. There is so much information in so many places that anyone interested in reducing respirable dust generation in a specific coal mining operation may have difficulty in finding all the available data and extracting the specific information needed. The advent of the microcomputer and its universal availability provide a means of alleviating this problem.

This publication presents a computer program which is a synthesis of research results about the effects of various cutting system parameters on the generation of respirable coal dust. It is the first attempt to provide a means to consider the effects of several parameters simultaneously. It will enable an individual to play "what if" with those cutting system parameters that can be controlled. The program deals in relative rather than absolute values, since the user only needs to know whether the changes will increase or decrease dust generation.

This publication is the first step in a long-term effort to structure available data on machine parameter effects into a mathematical cutting system model (CSM). The CSM input will be measurable or controllable machine, site, and coal parameters, and the output will be the dust generation and energy requirements of the complete cutting system. Until this complete model is a reality, the Relative Dustiness Indicator (REDI) program based on empirical data will be useful to the industry.

ACKNOWLEDGMENTS

The data used to develop this first cutting system model have been acquired over many years by several people at the Bureau's Twin Cities Research Center, each of whom has contributed significantly to the program effort. Initial efforts were started by Kelly Strebig, supervisory physical scientist, and William Zeller, physical scientist, in 1970. Since 1973 Ted Myren, mining engineering technician, has been actively involved with every activity; without his skillful and willing assistance over the years, the work would not have been possible. More recently field data acquisition with the In-Seam Tester has received the active support and guidance of Laxman Sundae, mining engineer. The continuing
efforts of Carl Wingquist, physicist, on instrumentation and Richard C. Olson, mechanical engineer, on test systems design to support the research efforts have also been essential to the results.

REDI PROGRAM DESCRIPTION

This program has been developed to provide operators and machine designers with a mechanism for determining the effects of cutting system changes on dust generation due to cutting action of the drum. This program is meant to be generic rather than site specific. Therefore, no site-specific variable coal dustiness index is incorporated in this model. The dust factor used is an average value which will increase or decrease as the user inputs changes to the program in response to prompting questions asked by the program. This will provide the user with a relative change in dust generated. Determination of the actual dust volume change would require an operator to take dust samples at the actual mine site.

The program is simple and easy to use. It is written in BASIC for an Apple IIe microcomputer and requires approximately 7k of memory. A listing of the program is given in appendix A. A detailed explanation is given in appendix B. The BASIC functions used in the program should be fairly universal with the exception of the HTAB command. The output is formatted for 80 columns. Once REDI is loaded, prompts will appear where necessary to guide the operator on the input needed. While a printer is not a necessity, it is useful since the output more than fills the screen and will, therefore, scroll off the top.

The input variables are listed in table 1. The machine dimensions and swell factor will determine the volume of cut coal that can be held between the drum and face without further crushing. Swell factor is defined as the increase in volume when a given mass of solid coal is fragmented. The program incorporates the number of vane starts and the wrap angle since the volume of the vane(s) must be known to obtain free volume available for fragmented coal. The vane angle component obtained by the program is the information needed to properly design for coal transfer to the panline. Rapid transport to the panline will prevent additional dust generation by secondary fragmentation.

When the program asks the user if optimum bits are desired, a "Y" answer causes the computer to calculate the number of face bits by using the space-to-depth ratio and advance rate. The number of bits

TABLE 1. - Input variables

<table>
<thead>
<tr>
<th>Variable Type</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine dimensions.......</td>
<td>Drum diameter, top vane diameter, inner drum diameter, vane height, vane thickness, vane width, web width, drum vane wrap angle, number of starts, shearer horsepower, drum revolutions per minute.</td>
</tr>
<tr>
<td>Coal properties..........</td>
<td>Compressive strength, grindability index, swell factor, 2 dust parameters.</td>
</tr>
<tr>
<td>Operator controlled......</td>
<td>Bits per vane, number of gage bits, number of gage lines, airflow, production time per shift.</td>
</tr>
</tbody>
</table>
can also be set by the user to any number desired. Gage bits are still considered as an independent variable since insufficient data are available yet to properly design end rings. Primary dust (dust generated from cutting coal) is determined from the number of bits and the average depth of cut. The calculation is based on the total lineal cutting done by the bits. The dust generated per foot of cut is a function of depth of cut. The coefficients used (two dust parameters for slope and intercept on dust versus depth) were derived from analysis of cutting tests done by the Bureau. An assumption is made that the secondary dust generated from recirculation, grinding, and falling coal is directly proportional to the product of the Hardgrove grindability index and the amount of primary dust generated. Although exact correlation has not been made, laboratory research and field tests support this assumption adequately for purposes of this relative dustiness program. Once the dust generation rate of the cutting system has been established, a relative shift average dust concentration is calculated based on the airflow and production time per shift.

While the program was developed to provide the user with a tool for determining relative changes in dust concentration due to changes in drum parameters or operating conditions, it may be possible to use the program to obtain site-specific dust concentrations. To do this, the user can compare the program results for a set of conditions for which actual dust concentration values are available. If the first and second dust parameters are then multiplied by the ratio of actual dust level and the program-computed dust level, the program will produce a dust level equal to the actual value. There is no assurance that modifying the dust parameters to the actual dust levels for a given set of conditions will give program results and actual dust levels showing exact correlation for changes in operating conditions, since the slope and intercept may not be correct over the full range of conditions. On a relative basis and order of magnitude basis, however, the program should then be representative of actual in situ conditions.

PROGRAM USAGE

The flowchart for this program is shown in figure 1. The complete program listing is contained in appendix A. Appendix B contains a complete functional description and list of variables. Data input is accomplished either by use of DATA statements (lines 520 and 530) or by entering the data from the keyboard in response to program prompts (lines 550 to 590). When using the DATA statements method, the order of the input variables is the same as that of the variable names contained in the array NAM$ (lines 270 to 470). It will be to the user's advantage to use the DATA statements method (lines 520 and 530) of inserting machine parameters and seam conditions for his or her own operation and then SAVE(ing) the revised program for later reuse. If this is not done, each time the computer is turned off the site-specific changes inserted will be lost. After the data have been entered, they will be listed and the user will be given the opportunity to make changes or corrections (fig. 2). If there are changes, the entire data list will be printed again so change(s) may be made in response to prompts shown in figure 3. After necessary changes have been made, or if no changes are necessary, the user next has the option of having the program calculate the optimum bit spacing. For compressive coal strength less than 4,000 psi, bit spacing will be two times the maximum depth of cut. For a compressive strength greater than 4,000 psi, bit spacing will be 4/3 times the maximum depth of cut. The program then prints a table containing bit information, maximum cutting force available per bit, production information, and dust levels (fig. 4). The calculations are always maximums based on full utilization of the free volume of the drum. The user does not have the option of increasing the original maximum volume shown. If the user attempts to increase the maximum, the program will automatically print
FIGURE 1. Flowchart.

1. Read input data
2. Calculate dust and production values
3. Display results
4. Optimize bit spacing?
   - Yes, correct data?
   - No, change advance rate
5. Modify variables?
   - Yes, modify variables
   - No, change advance rate
6. End

Flowchart:
- Read data into system
- Calculate dust and production values
- Display results
- Optimize bit spacing for optimum spacing
- Correct data if necessary
- Modify variables if necessary
- Change advance rate if necessary
- End the process
I
I
L

II

6

1RUN

RELATIVE DUSTINESS INDICATOR

by Wallace W. Roepke and Bruce D. Hanson
US Department of the Interior, Bureau of Mines

For technical assistance contact the authors at the Twin Cities Research Center, 5629 Minnehaha Avenue So., Minneapolis, MN 55417 or phone (612) 725-3466 or 725-3232

THIS PROGRAM CALCULATES RELATIVE RESPIRABLE DUST GENERATED BY A ROTARY DRUM BASED ON THE DRUM DIMENSIONS, COAL PARAMETERS AND OPERATING CONDITIONS OF THE MINER. SECONDARY DUST, THAT IS, DUST GENERATED BY THE GRINDING ACTION OF THE DRUM AND FALLING COAL, IS INCLUDED IN THE CALCULATIONS. THE EFFECTS OF SUPPRESSION AND/OR COLLECTION SYSTEMS ARE NOT INCORPORATED. THE USER CAN MODIFY ALL OF THE DRUM DIMENSIONS, COAL PARAMETERS AND OPERATING CONDITIONS EITHER COLLECTIVELY OR INDIVIDUALLY TO DETERMINE THE EFFECT ON DUST GENERATION.

.....HIT ANY KEY TO CONTINUE.....

<table>
<thead>
<tr>
<th>DRUM DIAMETER (IN)</th>
<th>51</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOP VANE DIAMETER (IN)</td>
<td>45</td>
</tr>
<tr>
<td>VANE WIDTH (IN)</td>
<td>27.5</td>
</tr>
<tr>
<td>VANE LENGTH (IN)</td>
<td>65.01</td>
</tr>
<tr>
<td>VANE THICKNESS (IN)</td>
<td>3</td>
</tr>
<tr>
<td>NUMBER OF STARTS</td>
<td>3</td>
</tr>
<tr>
<td>SHEARER H.P.</td>
<td>250</td>
</tr>
<tr>
<td>COMpressive STRENGTH (PSI)</td>
<td>3400</td>
</tr>
<tr>
<td>FIRST DUST PARAMETER</td>
<td>1000000</td>
</tr>
<tr>
<td>AIRFLOW (CFM)</td>
<td>5000</td>
</tr>
<tr>
<td>INNER DRUM DIAMETER (IN)</td>
<td>30.625</td>
</tr>
<tr>
<td>DRUM VANE WRAP (DEG)</td>
<td>150</td>
</tr>
<tr>
<td>WEB WIDTH (IN)</td>
<td>30</td>
</tr>
<tr>
<td>VANE ANGLE (DEG)</td>
<td>64.97</td>
</tr>
<tr>
<td>VANE HEIGHT (IN)</td>
<td>6</td>
</tr>
<tr>
<td>DRUM REVOLUTIONS (RPM)</td>
<td>41</td>
</tr>
<tr>
<td>SWELL FACTOR</td>
<td>1.4</td>
</tr>
<tr>
<td>GRINDABILITY INDEX</td>
<td>100</td>
</tr>
<tr>
<td>SECOND DUST PARAMETER</td>
<td>500000</td>
</tr>
<tr>
<td>PRODUCTION TIME PER SHIFT (%)</td>
<td>20</td>
</tr>
</tbody>
</table>

PLEASE CHECK THESE VALUES, DO YOU WISH TO MAKE ANY CHANGES (Y/N) ? Y

FIGURE 2. - Program output showing listing of input variables and data correction prompts.

THE FREE VOLUME OF THE DRUM HAS BEEN EXCEEDED. EXCESSIVE RESPIRABLE DUST IS BEING CREATED BY RECIRCULATION AND CRUSHING OF THE CUT COAL.

The assumption is made in the program that coal beyond the maximum free volume always produces respirable dust in excess of the legal limit.

The user has the option of modifying the maximums by reducing the advance rate to match a particular situation. When this option is selected, the user inputs the new advance in either feet per minute, short tons per minute, or cubic feet per minute. Once the new advance rate is entered, the program asks if the optimum bit spacing is to be calculated for the reduced advance rate. The program output will proceed as described in figure 5. It should be noted that if the user subsequently modifies any of the parameters, the program will revert to using maximum free volume in the calculations. If the user does not use the reduced advance option, the program prompt asks if there are any changes in drum dimensions, bit parameters, or operating conditions. If the user responds in the affirmative, the program will go back to the data modification procedure (fig. 3). A "NO" (N) response terminates the program. Note in
figure 5 that the dust increased even though the production was reduced by one-third from 12 st/min to 8 st/min. This occurs because the depth of cut was decreased, causing two more bits per vane to be inserted when optimum bit spacing was used.

An example of program use is summarized in table 2. The program printouts for this example are shown in appendix C.

For the sake of brevity, only the portion of the printout necessary for the reader to follow the example is included in appendix C. In this particular example, six operator-controlled variables were changed to reduce the dust level.

The last two lines of table 2 show how the program can be used to examine means of increasing production levels and determine the effect on relative dust levels. The data incorporated into the program are for a specific shearer system. All of the examples presented in the text use the program as written so that readers may follow it easily. It is anticipated that each user will insert specific system conditions in the manner described above.

Do you wish to recalculate optimum bits per vane (current value is 6) (Y/N) Y

Max. cut depth, vane bit (in) 3.03
Vane bit spacing (in) 5.5
Bits per vane 4
Avail. cutting force (lb) 2511.77
Advance (ft/min) 31.04
Tons per shift 1160.87
Dust (mg) per minute 3937.23
Vane contribution (%) 47.91

Max. cut depth, gage bit (in) .5
Number of gage lines 4
Number of gage bits per line 6
Cubic feet per minute 302.31
Tons per minute 12.09
Dust (mg) per ton 325.59
Gage contribution (%) 52.09

* Dust concentration (mg/m^3) 3.71 *

Figure 4. - Program output showing dust value for optimum bit spacing option with maximum production.
ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N)? Y

ENTER NEW VALUE IF YOU WISH TO CHANGE ADVANCE, OTHERWISE ENTER ZERO (0) - 0

ENTER NEW VALUE IF YOU WISH TO CHANGE TONS PER MINUTE, OTHERWISE ENTER ZERO (0) - 8

DO YOU WISH TO RECALCULATE OPTIMUM BITS PER VANE (CURRENT VALUE IS 4) (Y/N)? Y

MAX. CUT DEPTH, VANE BIT (IN) 2
VANE BIT SPACING (IN) 3.93
BITS PER VANE 6
AVAIL. CUTTING FORCE (LB) 1674.51

ADVANCE (FT/MIN) 20.53
TONS PER SHIFT 768

MAX. CUT DEPTH, GAGE BIT (IN) .33
NUMBER OF GAGE LINES 4
NUMBER OF GAGE BITS PER LINE 6
CUBIC FEET PER MINUTE 200
TONS PER MINUTE 8
DUST (MG) PER TON 529.91

VANE CONTRIBUTION (%) 45.62
GAGE CONTRIBUTION (%) 54.38

**DUST LEVEL, mg/m³**

19.12
16.32
10.2
7.49
6.26
3.13
2.5
2.01
1.88
1.97
1.81

**TIME, cutting, pct**

40
40
40
40
40
40
20
20
20
20

**PRODUCTION, st per shift**

2,321
1,536
1,536
1,536
1,536
768
768
768
768
864
991

**ADVANCE rate, st/min**

12.09
8
8
8
8
8
8
8
8
10.32

**Airflow, Mcfm**

5
5
5
5
10
10
10
10
10
10

**TABLE 2. - Program usage example: Operator-controlled variables**

<table>
<thead>
<tr>
<th>Bits</th>
<th>Lines</th>
<th>Number of gage--- Bits</th>
<th>Number of vane--- Vanes</th>
<th>Speed, rpm</th>
<th>Advance rate, st/min</th>
<th>Airflow, Mcfm</th>
<th>Time cutting, pct</th>
<th>Production, st per shift</th>
<th>Dust level, mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>41</td>
<td>12.09</td>
<td>5</td>
<td>40</td>
<td>2,321</td>
<td>19.12</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>41</td>
<td>8</td>
<td>5</td>
<td>40</td>
<td>1,536</td>
<td>16.32</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>41</td>
<td>8</td>
<td>5</td>
<td>40</td>
<td>1,536</td>
<td>10.2</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>18</td>
<td>3</td>
<td>41</td>
<td>8</td>
<td>8</td>
<td>40</td>
<td>1,536</td>
<td>7.49</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>18</td>
<td>3</td>
<td>41</td>
<td>8</td>
<td>8</td>
<td>40</td>
<td>1,536</td>
<td>6.26</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>18</td>
<td>3</td>
<td>41</td>
<td>8</td>
<td>8</td>
<td>20</td>
<td>768</td>
<td>3.13</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>15</td>
<td>3</td>
<td>41</td>
<td>8</td>
<td>10</td>
<td>20</td>
<td>768</td>
<td>2.5</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>15</td>
<td>3</td>
<td>35</td>
<td>8</td>
<td>10</td>
<td>20</td>
<td>768</td>
<td>2.23</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>15</td>
<td>3</td>
<td>35</td>
<td>8</td>
<td>10</td>
<td>20</td>
<td>768</td>
<td>1.88</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>15</td>
<td>3</td>
<td>35</td>
<td>9</td>
<td>10</td>
<td>20</td>
<td>864</td>
<td>1.97</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>12</td>
<td>3</td>
<td>35</td>
<td>10.32</td>
<td>10</td>
<td>20</td>
<td>991</td>
<td>1.81</td>
</tr>
</tbody>
</table>
PROGRAM CONVERSION

To convert the Apple IIe program for use with another microcomputer, the output statements must be modified. The Apple IIe version assumes a screen 80 columns wide with 24 vertical lines. Conversion to a 40-column screen is accomplished by abbreviating the text portion of the output. If the text scrolls off the screen, elimination of print statements that print blank lines will close the text. If the data modification section (fig. 2) scrolls off the screen, printing the data list in two columns should alleviate the problem.

Using the HTAB function is necessary with the Apple IIe because the TAB function acts as a SPC (space) function when the IIe is in the 80-column mode. The HTAB statements must be deleted or replaced with an equivalent function, such as LOCATE (IBM PC BASIC.) Deleting the HTAB statements will have no effect on the output except an occasional shifting of the left column.

Modification of the subroutine, starting at line 2180 and lines 1530-1580 in the main program, will be necessary if the optional hard copy feature is to be retained. The BASIC manual for the particular system being used should be consulted.

The GET A$ statement (line 230) is used to stop the program to allow the user to read the preamble. The GET function should be replaced with an equivalent function. An alternative is to use an INPUT A$, in which case the program can only be continued by hitting the RETURN key.

SUMMARY

An interactive computer program written in BASIC has been developed to allow operators and others to determine relative dustiness at the face. The program lets the user make one or more changes in the cutting system to determine the effect of these changes without the time or expense of making the changes on the equipment at the face.

The program is a precursor to a more sophisticated cutting system model. The complete cutting system model will more rigorously calculate average and peak forces and will incorporate engineering factors such as torque, thrust, and motor size requirements.
APPENDIX A.—PROGRAM LISTING

10 DIM NAM$(21),IV(21)
20 PRINT
30 PRINT TAB(26);"RELATIVE DUSTINESS INDICATOR"
40 PRINT
50 PRINT TAB(20);"by Wallace W. Roepke and Bruce D. Hanson"
60 PRINT TAB(17);"US Department of the Interior, Bureau of Mines"
70 PRINT "For technical assistance contact the authors at the Twin Cities"
80 PRINT "Research Center, 5629 Minnehaha Avenue So., Minneapolis, MN 55417"
90 PRINT TAB(20);"or phone(612) 725-3466 or 725-3232"
100 PRINT "This program calculates relative respirable dust generated by a rotary drum"
110 PRINT "Based on the drum dimensions, coal parameters and operating conditions of the"
120 PRINT "miner. Secondary dust, that is, dust generated by the grinding action of the"
130 PRINT "drum and falling coal, is included in the calculations. The effects of"
140 PRINT "suppression and/or collection systems are not incorporated. The user can"
150 PRINT "modify all of the drum dimensions, coal parameters and operating conditions"
160 PRINT "either collectively or individually to determine the effect on dust generation."
170 PRINT ".....Hit any key to continue....."
180 GET A$:
190 CI = LOG(10)
200 DEF FN RO(X) = INT(100 * X + .5) / 100
210 DEF FN OP(Y) = INT(LOG(Y) / CI)
220 NAM$(1) = "DRUM DIAMETER (IN)"
230 NAM$(2) = "TOP VANE DIAMETER (IN)"
240 NAM$(3) = "INNER DRUM DIAMETER (IN)"
250 NAM$(4) = "DRUM REVOLUTIONS (RPM)"
260 NAM$(5) = "VANE WIDTH (IN)"
270 NAM$(6) = "WEB WIDTH (IN)"
280 NAM$(7) = "DRUM VANE WRAP (DEG)"
290 NAM$(8) = "VANE THICKNESS (IN)"
300 NAM$(9) = "VANE THICKNESS (IN)"
310 NAM$(10) = "NUMBER OF STARTS"
320 NAM$(11) = "BITS PER VANE"
330 NAM$(12) = "NUMBER OF GAGE BITS"
340 NAM$(13) = "NUMBER OF GAGE LINES"
350 NAM$(14) = "SHEARER H.P."
360 NAM$(15) = "COMPRESSIVE STRENGTH (PSI)"
370 NAM$(16) = "GRINDABILITY INDEX"
380 NAM$(17) = "Swell Factor"
390 NAM$(18) = "FIRST DUST PARAMETER"
400 NAM$(19) = "SECOND DUST PARAMETER"
410 NAM$(20) = "PRODUCTION TIME PER SHIFT (%)"
420 NAM$(21) = "AIRFLOW (CFM)"
480  PI = 3.1415926
490  FOR I = 1 TO 21
500   READ IV(I)
510   NEXT I
520   DATA 51,45,30,625,41,27.5,30,150,3,6,3,6,24,4,250,3400,100
530   DATA 1.4,1E7,5E6,20,5000
540   GOTO 600
550  FOR I = 1 TO 19 STEP 3
560   PRINT
570   PRINT "ENTER "; NAM$(I); ", "; NAM$(I + 1); AND "; NAM$(I + 2);"
580   INPUT * "; IV(I),IV(I + 1),IV(I + 2)
590   NEXT I
600  PRINT
610  PRINT
620  FL = 0
630  VL = ((PI * IV(2)) * (IV(7) / 360)) ^ 2 + (IV(5) ^ 2) * (1 / 2)
640  AN = ATN ((PI * IV(2)) * (IV(7) / 360)) / IV(5) * (180 / PI)
650  X = 13 - FN OP(IV(1))
660  PRINT "DRUM DIAMETER (IN)"; SPC(X); IV(1)
670  X = 7 - FN OP(IV(3))
680  HTAB 36
690  PRINT "INNER DRUM DIAMETER (IN)"; SPC(X); IV(3)
700  X = 9 - FN OP(IV(2))
710  PRINT "TOP VANE DIAMETER (IN)"; SPC(X); IV(2)
720  X = 11 - FN OP(IV(7))
730  HTAB 36
740  PRINT "DRUM VANE WRAP (DEG)"; SPC(X); IV(7)
750  X = 16 - FN OP(IV(5))
760  PRINT "VANE WIDTH (IN)"; SPC(X); IV(5)
770  HTAB 36
780  X = 17 - FN OP(IV(6))
790  PRINT "WEB WIDTH (IN)"; SPC(X); IV(6)
800  X = 15 - FN OP(VL)
810  PRINT "VANE LENGTH (IN)"; SPC(X); FN RO(VL)
820  HTAB 36
830  X = 15 - FN OP(AN)
840  PRINT "VANE ANGLE (DEG)"; SPC(X); FN RO(AN)
850  X = 12 - FN OP(IV(8))
860  PRINT "VANE THICKNESS (IN)"; SPC(X); IV(8)
870  HTAB 36
880  X = 15 - FN OP(IV(9))
890  PRINT "VANE HEIGHT (IN)"; SPC(X); IV(9)
900  X = 15 - FN OP(IV(10))
910  PRINT "NUMBER OF STARTS"; SPC(X); IV(10)
920  HTAB 36
930  X = 9 - FN OP(IV(4))
940  PRINT "DRUM REVOLUTIONS (RPM)"; SPC(X); IV(4)
950  X = 19 - FN OP(IV(14))
960  PRINT "SHEARER H.P."; SPC(X); IV(14)
970  HTAB 36
980  X = 19 - FN OP(IV(17))
990  PRINT "SWELL FACTOR"; SPC(X); IV(17)
1000 X = 5 - FN OP(IV(15))
1010 PRINT "COMPRESSIVE STRENGTH (PSI)"; SPC(X); IV(15)
1020 HTAB 36
1030 X = 13 - FN OP(IV(16))
1040 PRINT "GRINDABILITY INDEX"; SPC( X); IV(16)
1050 X = 10 - FN OP(IV(18))
1060 PRINT "FIRST DUST PARAMETER"; SPC( X); IV(18)
1070 HTAB 36
1080 X = 10 - FN OP(IV(19))
1090 PRINT "SECOND DUST PARAMETER"; SPC( X); IV(19)
1100 X = 18 - FN OP(IV(21))
1110 PRINT "AIRFLOW (CFM)"; SPC( X); IV(21)
1120 HTAB 36
1130 X = 2 - FN OP(IV(20))
1140 PRINT "PRODUCTION TIME PER SHIFT (%)"; SPC( X); IV(20)
1150 PRINT
1160 PRINT TAB( 18)"PLEASE CHECK THESE VALUES, DO YOU"
1170 PRINT TAB( 18)"WISH TO MAKE ANY CHANGES ";
1180 INPUT "(Y/N) ?"; A$
1190 IF A$ = "Y" THEN GOSUB 2030
1200 VO = (PI * (IV(1) / 2) ^ 2 - PI * (IV(3) / 2) ^ 2) * IV(6)
1210 VO = VO - VL * IV(9) * IV(8) * IV(10)
1220 CM = VO / IV(17) / 3456 * IV(4)
1230 CF = CM
1240 GOSUB 1940
1250 TP = (CF * 80) / 2000
1260 AD = (CF / (IV(1) / 12)) / (IV(5) / 12)
1270 DC = AD * 12 / IV(10) / IV(4)
1280 PS = TP * 4.8 * IV(20)
1290 GD = DC / (IV(12) / IV(13))
1300 IF IV(11) > 0 THEN 1360
1310 SF = 2
1320 IF IV(15) > 4000 THEN SF = 4 / 3
1330 OS = DC * SF
1340 F = IV(5) / OS - .5
1350 IV(11) = INT (F)
1360 BI = IV(10) * IV(11) + IV(12)
1370 OS = IV(5) / (IV(11) + 1)
1380 PO = IV(12) / IV(13)
1390 T = (IV(14) * 33000) / (2 * PI * IV(4))
1400 TD = IV(1) / 2
1410 FC = (12 * T) / TD
1420 FC = FC / (IV(11) * IV(10) * .5)
1430 DV = (BI - IV(12)) * (IV(18) + .8 * IV(19) * DC) * IV(16) / 10
1440 DG = IV(12) * (IV(18) + .8 * IV(19) * GD) * IV(16) / 10
1450 DU = DV + DG
1460 VC = 100 * DV / DU
1470 GC = 100 - VC
1480 DU = DU * PI * IV(1) / 12
1490 DM = DU * IV(4) / 7.7E8
1500 DT = DM / TP
1510 DS = 35.3145 * DM / IV(21)
1520 DS = DS * IV(20) / 100
1530 Y = 3
1540 GOSUB 2180
1550 PRINT: PRINT TAB(18)"DO YOU WISH A HARD COPY OF THE ABOVE RESULT
S"; INPUT "(Y/N) ? "; A$
1560 IF A$ = "N" THEN 1590
1570 Y = 1: GOSUB 2180
1580 Y = 3: GOSUB 2180
1590 PRINT
1600 PRINT TAB(18);"ANY CHANGE IN ADVANCE(FT/MIN), TONS PER MINUTE,"
1610 PRINT TAB(18);"OR CUBIC FEET PER MINUTE";
1620 INPUT "(Y/N) ? "; A$
1630 IF A$ = "N" THEN 1670
1640 GOSUB 1760
1650 PRINT
1660 GOTO 1250
1670 PRINT
1680 PRINT TAB(18);"ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS,"
1690 PRINT TAB(18);"OR OPERATING CONDITIONS";
1700 INPUT "(Y/N) ? "; A$
1710 PRINT
1720 IF A$ < > "Y" THEN 1750
1730 GOSUB 2030
1740 GOTO 600
1750 END
1760 PRINT
1770 PRINT TAB(18);"ENTER NEW VALUE IF YOU WISH TO CHANGE ADVANCE, "
1780 PRINT TAB(18);"OTHERWISE ENTER ZERO";
1790 INPUT "(0) - "; AD
1800 IF AD = 0 THEN 1830
1810 CF = IV(1) / 12 * IV(5) / 12 * AD
1820 GOTO 1940
1830 PRINT
1840 PRINT TAB(18);"ENTER NEW VALUE IF YOU WISH TO CHANGE TONS PER MINUTE,"
1850 PRINT TAB(18);"OTHERWISE ENTER ZERO";
1860 INPUT "(0) - "; TP
1870 IF TP = 0 THEN 1900
1880 CF = (TP * 2000) / 80
1890 GOTO 1940
1900 PRINT
1910 PRINT TAB(18);"ENTER NEW CUBIC FEET PER ";
1920 INPUT "MINUTE - "; CF
1930 IF CF = 0 THEN 1940
1940 PRINT
1950 PRINT TAB(18);"DO YOU WISH TO RECALCULATE OPTIMUM BITS"
1960 PRINT TAB(18);"PER VANE (CURRENT VALUE IS "; IV(11)"");"
1970 INPUT "(Y/N) ? "; A$
1980 IF A$ = "Y" THEN IV(11) = 0
1990 FL = 0
2000 IF CF > CM THEN FL = 1
2010 PRINT
2020 RETURN
2030 PRINT
2040 PRINT
2050 FOR I = 1 TO 21
2060 X = 35 - LEN (NAM$(I)) - INT (I / 10)
2070 PRINT TAB(18); I;" - "; NAM$(I); TAB(X); IV(I)
2080 NEXT I
2090 PRINT
2100 PRINT TAB(18)"ENTER THE NUMBER OF THE VARIABLE YOU WISH "
2110 PRINT TAB(18)" TO CHANGE, USE ZERO(0) TO TERMINATE "
2120 INPUT " - "; J
2130 IF J = 0 THEN RETURN
2140 PRINT TAB(18)" ENTER NEW "; NAM$(J);
2150 INPUT " - "; IV(J)
2160 GOTO 2090
2170 RETURN
2180 PR# Y
2190 FOR I = 1 TO 6
2200 PRINT
2210 NEXT I
2220 X = 2 - FN OP(DC)
2230 PRINT " MAX. CUT DEPTH, VANE BIT (IN)"; SPC(X); FN RO(DC);
2240 X = 2 - FN OP(GD)
2250 HTAB 36
2260 PRINT " MAX. CUT DEPTH, GAGE BIT (IN)"; SPC(X); FN RO(GD)
2270 X = 10 - FN OP(OS)
2280 PRINT " VANE BIT SPACING (IN)"; SPC(X); FN RO(OS);
2290 HTAB 36
2300 X = 11 - FN OP(IV(13))
2310 PRINT " NUMBER OF GAGE LINES"; SPC(X); IV(13)
2320 X = 18 - FN OP(IV(11))
2330 PRINT " BITS PER VANE"; SPC(X); IV(11);
2340 HTAB 36
2350 X = 3 - FN OP(PO)
2360 PRINT " NUMBER OF GAGE BITS PER LINE"; SPC(X); PO
2370 X = 6 - FN OP(FC)
2380 PRINT " A VAIL. CUTTING FORCE (LB)"; SPC(X); FN RO(FC)
2390 PRINT
2400 X = 15 - FN OP(AD)
2410 PRINT " ADVANCE (FT/Min)"; SPC(X); FN RO(AD);
2420 X = 10 - FN OP(CF)
2430 HTAB 36
2440 PRINT " CUBIC FEET PER MINUTE"; SPC(X); FN RO(CF)
2450 X = 17 - FN OP(PS)
2460 PRINT " TONS PER SHIFT"; SPC(X); FN RO(PS);
2470 HTAB 36
2480 X = 16 - FN OP(TP)
2490 PRINT " TONS PER MINUTE"; SPC(X); FN RO(TP)
2500 PRINT
2510 X = 11 - FN OP(DM)
2520 PRINT " DUST (MG) PER MINUTE"; SPC(X); FN RO(DM);
2530 HTAB 36
2540 X = 14 - FN OP(DT)
2550 PRINT " DUST (MG) PER TON"; SPC(X); FN RO(DT)
2560 X = 10 - FN OP(VC)
2570 PRINT "VANE CONTRIBUTION (\%); SPC( X); FN RD(VC);";
2580 X = 10 - FN OP(GC)
2590 HTAB 36
2600 PRINT " GAGE CONTRIBUTION (\%); SPC( X); FN RO(GC)"
2610 PRINT
2620 PRINT TAB(18);"***********************************************************************************"
2630 X = 6 - FN OP(DS)
2640 IF FL > 0 THEN 2680
2650 PRINT TAB(18);" DUST CONCENTRATION (MG/M^3); SPC( X); FN RO(DS)"
2660 PRINT TAB(18);"***********************************************************************************"
2670 IF FL = 0 THEN 2730
2680 PRINT TAB(18);" THE FREE VOLUME OF THE DRUM HAS BEEN *
2690 PRINT TAB(18);" EXCEEDED, EXCESSIVE RESPIRABLE DUST *
2700 PRINT TAB(18);" IS BEING CREATED BY RECIRCULATION AND *
2710 PRINT TAB(18);" CRUSHING OF THE CUT COAL *
2720 PRINT TAB(18);"***********************************************************************************"
2730 PRINT
2740 RETURN
APPENDIX B.--VARIABLE, FUNCTION, AND PROGRAM DESCRIPTIONS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td>Advance rate, ft/min</td>
</tr>
<tr>
<td>AN</td>
<td>Vane angle, degree</td>
</tr>
<tr>
<td>BI</td>
<td>Total number of bits, vane plus gage</td>
</tr>
<tr>
<td>CF</td>
<td>Production rate, ft$^3$/min of in situ coal</td>
</tr>
<tr>
<td>CM</td>
<td>Same as CF</td>
</tr>
<tr>
<td>DC</td>
<td>Depth of cut for vane bits, in</td>
</tr>
<tr>
<td>DG</td>
<td>Dust from gage bits, $\mu$m$^3$/ft</td>
</tr>
<tr>
<td>DM</td>
<td>Total dust rate, mg/min</td>
</tr>
<tr>
<td>DS</td>
<td>Total dust concentration, mg/m$^3$</td>
</tr>
<tr>
<td>DT</td>
<td>Total dust rate, mg/st coal</td>
</tr>
<tr>
<td>DU</td>
<td>Dust per revolution, $\mu$m$^3$</td>
</tr>
<tr>
<td>DV</td>
<td>Dust from vane bits, $\mu$m$^3$/ft</td>
</tr>
<tr>
<td>FC</td>
<td>Available force per vane bit, lb</td>
</tr>
<tr>
<td>FL</td>
<td>Flag, set to 1 if free volume of drum is exceeded</td>
</tr>
<tr>
<td>GC</td>
<td>Contribution of gage bits to bit dust make, pct</td>
</tr>
<tr>
<td>GD</td>
<td>Depth of cut for gage bits, in</td>
</tr>
<tr>
<td>OS</td>
<td>Bit spacing, in</td>
</tr>
<tr>
<td>PO</td>
<td>Number of bits per gage line</td>
</tr>
<tr>
<td>SF</td>
<td>Spacing factor</td>
</tr>
<tr>
<td>TD</td>
<td>Drum radius, in</td>
</tr>
<tr>
<td>TP</td>
<td>Production rate, st/min</td>
</tr>
<tr>
<td>VC</td>
<td>Contribution of vane bits to dust make, pct</td>
</tr>
<tr>
<td>VL</td>
<td>Vane length, in</td>
</tr>
<tr>
<td>VO</td>
<td>Internal free volume drum, in$^3$</td>
</tr>
</tbody>
</table>
Function Description

Two functions are used in the program for output purposes. Function RO(X) rounds off to two places to the right of the decimal. Function OP(X) returns the number of digits to the left of the decimal.

Program Description

<table>
<thead>
<tr>
<th>Line Numbers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-470</td>
<td>Prints output heading, sets values for NAM$, PI and defines two functions RO and OP, which are used for output purposes.</td>
</tr>
<tr>
<td>490-530</td>
<td>Reads input data using DATA statements</td>
</tr>
<tr>
<td>550-590</td>
<td>Reads input data from screen</td>
</tr>
<tr>
<td>620</td>
<td>Zeros flag for drum volume being exceeded</td>
</tr>
<tr>
<td>630</td>
<td>Computes vane length (VL) from the formula $VL^2 = (\pi \times TVD \times WA/360)^2 + VW^2$, where TVD = top vane diameter, WA = wrap angle, VW = vane width</td>
</tr>
<tr>
<td>650-1190</td>
<td>Computes vane angle (VA) from the formula $VA = \arctan (\pi \times TVD \times WA/360 \times VW)$, where TVD = top vane diameter, WA = wrap angle, VW = vane width</td>
</tr>
<tr>
<td>1200-1420</td>
<td>Computes free volume of the drum, which is equal to outer drum volume minus the inner drum diameter volume minus the volume of the vanes</td>
</tr>
<tr>
<td>1220</td>
<td>Computes maximum cubic feet (in situ) per minute. The constant 3456 is 1728 (cubic inches in a cubic foot) times 2 (only 1/2 the drum is cutting coal).</td>
</tr>
<tr>
<td>1230-1420</td>
<td>Computes operating parameters for the drum. A coal density of 80 lb/ft³ is used in line 1250. The available force per bit calculation in line 1420 assumes only half the bits are in the coal at any instant of time.</td>
</tr>
<tr>
<td>1430-1520</td>
<td>Computes dust values. Primary dust is assumed to have a linear relationship with depth of cut. The factor of 0.8 in line 1440 is the ratio of average depth of cut to maximum depth of cut. Also in line 1440, the total dust is found by multiplying the primary dust by the grindability index and dividing by 10. In line 1440, the constant $7.7 \times 10^8$ converts cubic micrometers to milligrams. In 1510, the constant 35.3145 converts cubic feet per minute to cubic meters per minute.</td>
</tr>
<tr>
<td>1530-1580</td>
<td>Prints operating parameters and dust values</td>
</tr>
<tr>
<td>1590-1750</td>
<td>Checks if user wishes to change advance rate or drum variables</td>
</tr>
<tr>
<td>1760-2020</td>
<td>Subroutine for changing advance rate</td>
</tr>
<tr>
<td>2030-2170</td>
<td>Subroutine for changing drum variables</td>
</tr>
<tr>
<td>2180-2740</td>
<td>Subroutine for printing operating parameters and dust values</td>
</tr>
</tbody>
</table>
APPENDIX C.--EXAMPLE OF OUTPUT

JRUN

RELATIVE DUSTINESS INDICATOR

by Wallace W. Roepke and Bruce D. Hanson
US Department of the Interior, Bureau of Mines

For technical assistance contact the authors at the Twin Cities
Research Center, 5629 Minnehaha Avenue So., Minneapolis, MN 55417
or phone (612) 725-3466 or 725-3232

THIS PROGRAM CALCULATES RELATIVE RESPIRABLE DUST GENERATED BY A ROTARY DRUM
BASED ON THE DRUM DIMENSIONS, COAL PARAMETERS AND OPERATING CONDITIONS OF THE
MINER. SECONDARY DUST, THAT IS, DUST GENERATED BY THE GRINDING ACTION OF THE
DRUM AND FALLING COAL, IS INCLUDED IN THE CALCULATIONS. THE EFFECTS OF
SUPPRESSION AND/OR COLLECTION SYSTEMS ARE NOT INCORPORATED. THE USER CAN
MODIFY ALL OF THE DRUM DIMENSIONS, COAL PARAMETERS AND OPERATING CONDITIONS
EITHER COLLECTIVELY OR INDIVIDUALLY TO DETERMINE THE EFFECT ON DUST GENERATION.

......HIT ANY KEY TO CONTINUE.....

DRUM DIAMETER (IN) 51 INNER DRUM DIAMETER (IN) 30.625
TOP VANE DIAMETER (IN) 45 DRUM VANE WRAP (DEG) 150
VANE WIDTH (IN) 27.5 WEB WIDTH (IN) 30
VANE LENGTH (IN) 65.01 VANE ANGLE (DEG) 64.97
VANE THICKNESS (IN) 3 VANE HEIGHT (IN) 6
NUMBER OF STARTS 3 DRUM REVOLUTIONS (RPM) 41
SHEARER H.P. 250 SWELL FACTOR 1.4
COMPRESSIVE STRENGTH (PSI) 3400 GRINDABILITY INDEX 100
FIRST DUST PARAMETER 10000000 SECOND DUST PARAMETER 5000000
AIRFLOW (CFM) 5000 PRODUCTION TIME PER SHIFT (%) 20

PLEASE CHECK THESE VALUES, DO YOU
WISH TO MAKE ANY CHANGES (Y/N) ? Y
1 - DRUM DIAMETER (IN) 51
2 - TOP VANE DIAMETER (IN) 45
3 - INNER DRUM DIAMETER (IN) 30.625
4 - DRUM REVOLUTIONS (RPM) 41
5 - VANE WIDTH (IN) 27.5
6 - WEB WIDTH (IN) 30
7 - DRUM VANE WRAP (DEG) 150
8 - VANE THICKNESS (IN) 3
9 - VANE HEIGHT (IN) 6
10 - NUMBER OF STARTS 3
11 - BITS PER VANE 6
12 - NUMBER OF GAGE BITS 24
13 - NUMBER OF GAGE LINES 4
14 - SHEARER H.P. 250
15 - COMPRESSION STRENGTH (PSI) 3400
16 - GRINDABILITY INDEX 100
17 - SWELL FACTOR 1.4
18 - FIRST DUST PARAMETER 10000000
19 - SECOND DUST PARAMETER 5000000
20 - PRODUCTION TIME PER SHIFT (%) 20
21 - AIRFLOW (CFM) 5000

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO(0) TO TERMINATE - 11
ENTER NEW BITS PER VANE - 10

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO(0) TO TERMINATE - 20
ENTER NEW PRODUCTION TIME PER SHIFT (%) - 40

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO(0) TO TERMINATE - 0

DO YOU WISH TO RECALCULATE OPTIMUM BITS PER VANE (CURRENT VALUE IS 10) (<Y/N>) ? N
MAX. CUT DEPTH, VANE BIT (IN) 3.03 MAX. CUT DEPTH, GAGE BIT (IN) .5
VANE BIT SPACING (IN) 2.5 NUMBER OF GAGE LINES 4
BITS PER VANE 10 NUMBER OF GAGE BITS PER LINE 6
AVAIL. CUTTING FORCE (LB) 1004.71

ADVANCE (FT/MIN) 31.04 CUBIC FEET PER MINUTE 302.31
TONS PER SHIFT 2321.75 TONS PER MINUTE 12.09

DUST (MG) PER MINUTE 6767 DUST (MG) PER TON 559.61
VANE CONTRIBUTION (%) 69.7 GAGE CONTRIBUTION (%) 30.3

****************************
* DUST CONCENTRATION (MG/M^3) 19.12 *
****************************

ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N) ? Y

ENTER NEW VALUE IF YOU WISH TO CHANGE ADVANCE, OTHERWISE ENTER ZERO (0) - 0

ENTER NEW VALUE IF YOU WISH TO CHANGE TONS PER MINUTE, OTHERWISE ENTER ZERO (0) - 8

DO YOU WISH TO RECALCULATE OPTIMUM BITS PER VANE (CURRENT VALUE IS 10) (Y/N) ? N
<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRUM DIAMETER (IN)</td>
<td>51</td>
</tr>
<tr>
<td>TOP VANE DIAMETER (IN)</td>
<td>45</td>
</tr>
<tr>
<td>INNER DRUM DIAMETER (IN)</td>
<td>30.625</td>
</tr>
<tr>
<td>DRUM REVOLUTIONS (RPM)</td>
<td>41</td>
</tr>
<tr>
<td>VANE WIDTH (IN)</td>
<td>27.5</td>
</tr>
<tr>
<td>WEB WIDTH (IN)</td>
<td>30</td>
</tr>
<tr>
<td>DRUM VANE WRAP (DEG)</td>
<td>150</td>
</tr>
<tr>
<td>VANE THICKNESS (IN)</td>
<td>3</td>
</tr>
<tr>
<td>VANE HEIGHT (IN)</td>
<td>6</td>
</tr>
<tr>
<td>NUMBER OF STARTS</td>
<td>3</td>
</tr>
<tr>
<td>BITS PER VANE</td>
<td>10</td>
</tr>
<tr>
<td>NUMBER OF GAGE BITS</td>
<td>24</td>
</tr>
<tr>
<td>NUMBER OF GAGE LINES</td>
<td>4</td>
</tr>
<tr>
<td>SHEARER H.P.</td>
<td>250</td>
</tr>
<tr>
<td>COMPRESSIVE STRENGTH (PSI)</td>
<td>3400</td>
</tr>
<tr>
<td>GRINDABILITY INDEX</td>
<td>100</td>
</tr>
<tr>
<td>SWELL FACTOR</td>
<td>1.4</td>
</tr>
<tr>
<td>FIRST DUST PARAMETER</td>
<td>10000000</td>
</tr>
<tr>
<td>SECOND DUST PARAMETER</td>
<td>5000000</td>
</tr>
<tr>
<td>PRODUCTION TIME PER SHIFT (%)</td>
<td>40</td>
</tr>
<tr>
<td>AIRFLOW (CFM)</td>
<td>5000</td>
</tr>
</tbody>
</table>

Please check these values, do you wish to make any changes (Y/N)? N

Do you wish to recalculate optimum bits per vane (current value is 10) (Y/N)? N
<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX. CUT DEPTH, VANE BIT (IN)</td>
<td>2</td>
</tr>
<tr>
<td>MAX. CUT DEPTH, GAGE BIT (IN)</td>
<td>.33</td>
</tr>
<tr>
<td>VANE BIT SPACING (IN)</td>
<td>2.5</td>
</tr>
<tr>
<td>NUMBER OF GAGE BITs PER LINE</td>
<td>6</td>
</tr>
<tr>
<td>BITS PER VANE</td>
<td>10</td>
</tr>
<tr>
<td>NUMBER OF GAGE LINES</td>
<td>4</td>
</tr>
<tr>
<td>AVAIL. CUTTING FORCE (LB)</td>
<td>1004.71</td>
</tr>
<tr>
<td>ADVANCE (FT/Min)</td>
<td>20.53</td>
</tr>
<tr>
<td>CUBIC FEET PER MINUTE</td>
<td>200</td>
</tr>
<tr>
<td>TONS PER SHIFT</td>
<td>1536</td>
</tr>
<tr>
<td>TONS PER MINUTE</td>
<td>8</td>
</tr>
<tr>
<td>DUST (MG) PER MINUTE</td>
<td>5776.1</td>
</tr>
<tr>
<td>DUST (MG) PER TON</td>
<td>722.01</td>
</tr>
<tr>
<td>VANE CONTRIBUTION (%)</td>
<td>66.51</td>
</tr>
<tr>
<td>GAGE CONTRIBUTION (%)</td>
<td>33.49</td>
</tr>
</tbody>
</table>

**DUST CONCENTRATION (MG/M^3)** 10.2

**ANY CHANGE IN ADVANCE (FT/Min), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N)? N**

**ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS, OR OPERATING CONDITIONS (Y/N)? Y**

1 - DRUM DIAMETER (IN) 51
2 - TOP VANE DIAMETER (IN) 45
3 - INNER DRUM DIAMETER (IN) 30.625
4 - DRUM REVOLUTIONS (RPM) 41
5 - VANE WIDTH (IN) 27.5
6 - WEB WIDTH (IN) 30
7 - DRUM VANE WRAP (DEG) 150
8 - VANE THICKNESS (IN) 3
9 - VANE HEIGHT (IN) 6
10 - NUMBER OF STARTS 3
11 - BITS PER VANE 10
12 - NUMBER OF GAGE BITS 24
13 - NUMBER OF GAGE LINES 4
14 - SHEARER H.P. 250
15 - COMPRESSIVE STRENGTH (PSI) 3400
16 - GRINDABILITY INDEX 100
17 - SWELL FACTOR 1.4
18 - FIRST DUST PARAMETER 10000000
19 - SECOND DUST PARAMETER 5000000
20 - PRODUCTION TIME PER SHIFT (%) 40
21 - AIRFLOW (CFM) 8000

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO(0) TO TERMINATE - 11
ENTER NEW BITS PER VANE - 6

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO(0) TO TERMINATE - 0
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Cut Depth, Vane Bit (in)</td>
<td>2</td>
</tr>
<tr>
<td>Vane Bit Spacing (in)</td>
<td>3.93</td>
</tr>
<tr>
<td>Bits Per Vane</td>
<td>6</td>
</tr>
<tr>
<td>Avail. Cutting Force (lb)</td>
<td>1674.51</td>
</tr>
<tr>
<td>Advance (ft/min)</td>
<td>20.53</td>
</tr>
<tr>
<td>Tons Per Shift</td>
<td>1536</td>
</tr>
<tr>
<td>Dust (mg) Per Minute</td>
<td>4239.31</td>
</tr>
<tr>
<td>Vane Contribution (%)</td>
<td>54.38</td>
</tr>
<tr>
<td>Number of Gage Bits Per Line</td>
<td>4</td>
</tr>
<tr>
<td>Number of Gage Bits Per Line</td>
<td>6</td>
</tr>
<tr>
<td>Dust (mg) Per Tons</td>
<td>529.91</td>
</tr>
<tr>
<td>Gage Contribution (%)</td>
<td>45.62</td>
</tr>
</tbody>
</table>

**Dust Concentration (mg/m³)**: 7.49

---

**Change Input:**

- Advance (ft/min), Tons per minute, or Cubic feet per minute (y/n)? N
- Change in Drum Dimensions, Bit Parameters, or Operating Conditions (y/n)? y

---

**User Input:**

1 - Drum Diameter (in)
2 - Top Vane Diameter (in)
3 - Inner Drum Diameter (in)
4 - Drum Revolutions (RPM)
5 - Vane Width (in)
6 - Web Width (in)
7 - Drum Vane Wrap (deg)
8 - Vane Thickness (in)
9 - Vane Height (in)
10 - Number of Starts
11 - Bits Per Vane
12 - Number of Gage Bits
13 - Number of Gage Lines
14 - Shearer H.P.
15 - Compressive Strength (psi)
16 - Grindability Index
17 - Swell Factor
18 - First Dust Parameter
19 - Second Dust Parameter
20 - Production Time Per Shift (%)
21 - Airflow (CFM)

**Enter the number of the variable you wish to change, use zero (0) to terminate:**
- Enter new number of Gage Bits - 15
- Enter new number of Gage Lines - 3
- Enter the number of the variable you wish to change, use zero (0) to terminate - 0
MAX. CUT DEPTH, VANE BIT (IN) 2
MAX. CUT DEPTH, GAGE BIT (IN) .4
VANE BIT SPACING (IN) 3.93
NUMBER OF GAGE BITS PER LINE 5
BITS PER VANE 6
NUMBER OF GAGE BITS PER LINE 5
AVAIL. CUTTING FORCE (LB) 1674.51

ADVANCE (FT/MIN) 20.53
CUBIC FEET PER MINUTE 200
TONS PER SHIFT 1536
TONS PER MINUTE 8
DUST (MG) PER MINUTE 3542.5
DUST (MG) PER TON 442.81
GAGE CONTRIBUTION (%) 65.07
VANE CONCENTRATION (%) 34.93

***********
* DUST CONCENTRATION (MG/M³) 6.26 *
***********

ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N) ? N

ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS, OR OPERATING CONDITIONS (Y/N) ? Y

1 - DRUM DIAMETER (IN) 51
2 - TOP VANE DIAMETER (IN) 45
3 - INNER DRUM DIAMETER (IN) 30.625
4 - DRUM REVOLUTIONS (RPM) 41
5 - VANE WIDTH (IN) 27.5
6 - WEB WIDTH (IN) 30
7 - DRUM VANE WRAP (DEG) 150
8 - VANE THICKNESS (IN) 3
9 - VANE HEIGHT (IN) 6
10 - NUMBER OF STARTS 3
11 - BITS PER VANE 6
12 - NUMBER OF GAGE BITS 15
13 - NUMBER OF GAGE LINES 3
14 - SHEARER H.P. 250
15 - COMPRESSIVE STRENGTH (PSI) 3400
16 - GRINDABILITY INDEX 100
17 - SWELL FACTOR 1.4
18 - FIRST DUST PARAMETER 1000000
19 - SECOND DUST PARAMETER 500000
20 - PRODUCTION TIME PER SHIFT (%) 40
21 - AIRFLOW (CFM) 8000

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO (0) TO TERMINATE - 20
ENTER NEW PRODUCTION TIME PER SHIFT (%) - 20

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO (0) TO TERMINATE - 0
<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX. CUT DEPTH, VANE BIT (IN)</td>
<td>2</td>
</tr>
<tr>
<td>MAX. CUT DEPTH, GAGE BIT (IN)</td>
<td>.4</td>
</tr>
<tr>
<td>VANE BIT SPACING (IN)</td>
<td>3.93</td>
</tr>
<tr>
<td>NUMBER OF GAGE LINES</td>
<td>3</td>
</tr>
<tr>
<td>BITS PER VANE</td>
<td>6</td>
</tr>
<tr>
<td>NUMBER OF GAGE BITS PER LINE</td>
<td>5</td>
</tr>
<tr>
<td>AVAIL. CUTTING FORCE (LB)</td>
<td>1674.51</td>
</tr>
<tr>
<td>ADVANCE (FT/MIN)</td>
<td>20.53</td>
</tr>
<tr>
<td>CUBIC FEET PER MINUTE</td>
<td>200</td>
</tr>
<tr>
<td>TONS PER SHIFT</td>
<td>768</td>
</tr>
<tr>
<td>TONS PER MINUTE</td>
<td>8</td>
</tr>
<tr>
<td>DUST (MG) PER MINUTE</td>
<td>3542.5</td>
</tr>
<tr>
<td>DUST (MG) PER TON</td>
<td>442.81</td>
</tr>
<tr>
<td>VANE CONTRIBUTION (%)</td>
<td>65.07</td>
</tr>
<tr>
<td>GAGE CONTRIBUTION (%)</td>
<td>34.93</td>
</tr>
</tbody>
</table>

DUST CONCENTRATION (MG/M³) = 3.13

**Question:**
ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N) ? N

ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS, OR OPERATING CONDITIONS (Y/N) ? Y

1 - DRUM DIAMETER (IN)                        | 51
2 - TOP VANE DIAMETER (IN)                    | 45
3 - INNER DRUM DIAMETER (IN)                  | 30.625
4 - DRUM REVOLUTIONS (RPM)                    | 41
5 - VANE WIDTH (IN)                           | 27.5
6 - WEB WIDTH (IN)                            | 30
7 - DRUM VANE WRAP (DEG)                      | 150
8 - VANE THICKNESS (IN)                       | 3
9 - VANE HEIGHT (IN)                          | 6
10 - NUMBER OF STARTS                          | 3
11 - BITS PER VANE                             | 6
12 - NUMBER OF GAGE BITS                      | 15
13 - NUMBER OF GAGE LINES                     | 3
14 - SHEARER H.P.                              | 250
15 - COMPRRESSIVE STRENGTH (PSI)              | 3400
16 - GRINDABILITY INDEX                       | 100
17 - SWELL FACTOR                              | 1.4
18 - FIRST DUST PARAMETER                     | 10000000
19 - SECOND DUST PARAMETER                    | 5000000
20 - PRODUCTION TIME PER SHIFT (%)            | 20
21 - AIRFLOW (CFM)                            | 8000

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO (0) TO TERMINATE - 21
ENTER NEW AIRFLOW (CFM) - 10000

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO (0) TO TERMINATE - 0
MAX. CUT DEPTH, VANE BIT (IN) 2
VANE BIT SPACING (IN) 3.93
BITS PER VANE 6
AVAIL. CUTTING FORCE (LB) 1674.51
MAX. CUT DEPTH, GAGE BIT (IN) .4
NUMBER OF GAGE LINES 3
NUMBER OF GAGE BITS PER LINE 5
ADVANCE (FT/MIN) 20.53
TONS PER SHIFT 768
CUBIC FEET PER MINUTE 200
TONS PER MINUTE 8
DUST (MG) PER MINUTE 3542.5
DUST (MG) PER TON 442.81
VANE CONTRIBUTION (%) 65.07
GAGE CONTRIBUTION (%) 34.93

DUST CONCENTRATION (MG/M^3) 2.5

ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N) ? N

ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS, OR OPERATING CONDITIONS (Y/N) ? Y

1 - DRUM DIAMETER (IN) 51
2 - TOP VANE DIAMETER (IN) 45
3 - INNER DRUM DIAMETER (IN) 30.625
4 - DRUM REVOLUTIONS (RPM) 41
5 - VANE WIDTH (IN) 27.5
6 - WEB WIDTH (IN) 30
7 - DRUM VANE WRAP (DEG) 150
8 - VANE THICKNESS (IN) 3
9 - VANE HEIGHT (IN) 6
10 - NUMBER OF STARTS 3
11 - BITS PER VANE 6
12 - NUMBER OF GAGE BITS 15
13 - NUMBER OF GAGE LINES 3
14 - SHEARER H.P. 250
15 - COMPRRESSIVE STRENGTH (PSI) 3400
16 - GRINDABILITY INDEX 100
17 - SWELL FACTOR 1.4
18 - FIRST DUST PARAMETER 10000000
19 - SECOND DUST PARAMETER 5000000
20 - PRODUCTION TIME PER SHIFT (%) 20
21 - AIRFLOW (CFM) 10000

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO(0) TO TERMINATE - 11
ENTER NEW BITS PER VANE - 5

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO(0) TO TERMINATE - 0
<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX. CUT DEPTH, VANE BIT (IN)</td>
<td>2</td>
</tr>
<tr>
<td>VANE BIT SPACING (IN)</td>
<td>4.58</td>
</tr>
<tr>
<td>BITS PER VANE</td>
<td>5</td>
</tr>
<tr>
<td>AVAIL. CUTTING FORCE (LB)</td>
<td>2099.42</td>
</tr>
<tr>
<td>ADVANCE (FT/MIN)</td>
<td>20.53</td>
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<tr>
<td>TONS PER SHIFT</td>
<td>768</td>
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<tr>
<td>DUST (MG) PER MINUTE</td>
<td>3158.3</td>
</tr>
<tr>
<td>VANE CONTRIBUTION (%)</td>
<td>60.82</td>
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<tr>
<td>MAX. CUT DEPTH, GAGE BIT (IN)</td>
<td>0.4</td>
</tr>
<tr>
<td>NUMBER OF GAGE LINES</td>
<td>3</td>
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<tr>
<td>NUMBER OF GAGE BITS PER LINE</td>
<td>5</td>
</tr>
<tr>
<td>CUBIC FEET PER MINUTE</td>
<td>200</td>
</tr>
<tr>
<td>TONS PER MINUTE</td>
<td>8</td>
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<tr>
<td>DUST (MG) PER TON</td>
<td>394.79</td>
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<td>GAGE CONTRIBUTION (%)</td>
<td>39.18</td>
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<td>DUST CONCENTRATION (MG/M³)</td>
<td>2.23</td>
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</tbody>
</table>

ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N)? N

ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS, OR OPERATING CONDITIONS (Y/N)? Y

1 - DRUM DIAMETER (IN) 51
2 - TOP VANE DIAMETER (IN) 45
3 - INNER DRUM DIAMETER (IN) 30.625
4 - DRUM REVOLUTIONS (RPM) 41
5 - VANE WIDTH (IN) 27.5
6 - WEB WIDTH (IN) 30
7 - DRUM VANE WRAP (DEG) 150
8 - VANE THICKNESS (IN) 3
9 - VANE HEIGHT (IN) 6
10 - NUMBER OF STARTS 3
11 - BITS PER VANE 5
12 - NUMBER OF GAGE BITS 15
13 - NUMBER OF GAGE LINES 3
14 - SHEARER H.P. 250
15 - COMPRRESSIVE STRENGTH (PSI) 3400
16 - GRINDABILITY INDEX 100
17 - SWELL FACTOR 1.4
18 - FIRST DUST PARAMETER 10000000
19 - SECOND DUST PARAMETER 5000000
20 - PRODUCTION TIME PER SHIFT (%) 20
21 - AIRFLOW (CFM) 10000

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO (0) TO TERMINATE - 4
ENTER NEW DRUM REVOLUTIONS (RPM) - 35

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO (0) TO TERMINATE - 0
MAX. CUT DEPTH, VANE BIT (IN) 2.35 MAX. CUT DEPTH, GAGE BIT (IN) .47
VANE BIT SPACING (IN) 4.58 NUMBER OF GAGE LINES 3
BITS PER VANE 5 NUMBER OF GAGE BITS PER LINE 5
AVAIL. CUTTING FORCE (LB) 2353.89

AVANCE (FT/MIN) 20.53 CUBIC FEET PER MINUTE 200
TONS PER SHIFT 768 TONS PER MINUTE 8

DUST (MG) PER MINUTE 2846.18 DUST (MG) PER TON 355.77
VANE CONTRIBUTION (%) 62.01 GAGE CONTRIBUTION (%) 37.99

************************************************
* DUST CONCENTRATION (MG/M^3) 2.01 *
************************************************

ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE,
OR CUBIC FEET PER MINUTE (Y/N) ? N

ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS,
OR OPERATING CONDITIONS (Y/N) ? Y

1 - DRUM DIAMETER (IN) 51
2 - TOP VANE DIAMETER (IN) 45
3 - INNER DRUM DIAMETER (IN) 30.625
4 - DRUM REVOLUTIONS (RPM) 35
5 - VANE WIDTH (IN) 27.5
6 - WEB WIDTH (IN) 30
7 - DRUM VANE WRAP (DEG) 150
8 - VANE THICKNESS (IN) 3
9 - VANE HEIGHT (IN) 6
10 - NUMBER OF STARTS 3
11 - BITS PER VANE 5
12 - NUMBER OF GAGE BITS 15
13 - NUMBER OF GAGE LINES 3
14 - SHEARER H.P. 250
15 - COMpressive STRENGTH (PSI) 3400
16 - GRINDABILITY INDEX 100
17 - SWELL FACTOR 1.4
18 - FIRST DUST PARAMETER 10000000
19 - SECOND DUST PARAMETER 5000000
20 - PRODUCTION TIME PER SHIFT (%) 20
21 - AIRFLOW (CFM) 10000

ENTER THE NUMBER OF THE VARIABLE YOU WISH
TO CHANGE, USE ZERO (0) TO TERMINATE - 12
ENTER NEW NUMBER OF GAGE BITS - 12

ENTER THE NUMBER OF THE VARIABLE YOU WISH
TO CHANGE, USE ZERO (0) TO TERMINATE - 0
MAX. CUT DEPTH, VANE BIT (IN) 2.35 MAX. CUT DEPTH, GAGE BIT (IN) .59
VANE BIT SPACING (IN) 4.58 NUMBER OF GAGE LINES 3
BITS PER VANE 5 NUMBER OF GAGE BITS PER LINE 4
AVAIL. CUTTING FORCE (LB) 2353.89

ADVANCE (FT/MIN) 20.53 CUBIC FEET PER MINUTE 200
TONS PER SHIFT 768 TONS PER MINUTE 8
DUST (MG) PER MINUTE 2664.11 DUST (MG) PER TON 333.01
VANE CONTRIBUTION (%) 66.25 GAGE CONTRIBUTION (%) 33.75

* DUST CONCENTRATION (MG/M³) 1.88 *

ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N) ? Y

ENTER NEW VALUE IF YOU WISH TO CHANGE ADVANCE, OTHERWISE ENTER ZERO (0) - 0

ENTER NEW VALUE IF YOU WISH TO CHANGE TONS PER MINUTE, OTHERWISE ENTER ZERO (0) - 9

DO YOU WISH TO RECALCULATE OPTIMUM BITS PER VANE (CURRENT VALUE IS 5) (Y/N) ? N

MAX. CUT DEPTH, VANE BIT (IN) 2.64 MAX. CUT DEPTH, GAGE BIT (IN) .66
VANE BIT SPACING (IN) 4.58 NUMBER OF GAGE LINES 3
BITS PER VANE 5 NUMBER OF GAGE BITS PER LINE 4
AVAIL. CUTTING FORCE (LB) 2353.89

ADVANCE (FT/MIN) 23.1 CUBIC FEET PER MINUTE 225
TONS PER SHIFT 864 TONS PER MINUTE 9
DUST (MG) PER MINUTE 2792.3 DUST (MG) PER TON 310.26
VANE CONTRIBUTION (%) 67.03 GAGE CONTRIBUTION (%) 32.97

* DUST CONCENTRATION (MG/M³) 1.97 *

ANY CHANGE IN ADVANCE (FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N) ? N

ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS, OR OPERATING CONDITIONS (Y/N) ? Y
1 - DRUM DIAMETER (IN)  51
2 - TOP VANE DIAMETER (IN)  45
3 - INNER DRUM DIAMETER (IN)  30.625
4 - DRUM REVOLUTIONS (RPM)  35
5 - VANE WIDTH (IN)  27.5
6 - WEB WIDTH (IN)  30
7 - DRUM VANE WRAP (DEG)  150
8 - VANE THICKNESS (IN)  3
9 - VANE HEIGHT (IN)  6
10 - NUMBER OF STARTS  3
11 - BITS PER VANE  5
12 - NUMBER OF GAGE BITS  12
13 - NUMBER OF GAGE LINES  3
14 - SHEARER H.P.  250
15 - COMPRESSIVE STRENGTH (PSI)  3400
16 - GRINDABILITY INDEX  100
17 - SWELL FACTOR  1.4
18 - FIRST DUST PARAMETER  10000000
19 - SECOND DUST PARAMETER  5000000
20 - PRODUCTION TIME PER SHIFT (%)  20
21 - AIRFLOW (CFM)  10000

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO (0) TO TERMINATE - 11
ENTER NEW BITS PER VANE - 4

ENTER THE NUMBER OF THE VARIABLE YOU WISH TO CHANGE, USE ZERO (0) TO TERMINATE - 0

DO YOU WISH TO RECALCULATE OPTIMUM BITS PER VANE (CURRENT VALUE IS 4) (Y/N) ? N

MAX. CUT DEPTH, VANE BIT (IN)  3.03
VANE BIT SPACING (IN)  5.5
BITS PER VANE  4
AVAIL. CUTTING FORCE (LB)  2942.36
ADVANCE (FT/MIN)  26.5
TONS PER SHIFT  990.99
DUST (MG) PER MINUTE  2559.26
VANE CONTRIBUTION (%)  62.93

******************************************************************************
DUST CONCENTRATION (MG/M^3)  1.81
******************************************************************************

ANY CHANGE IN ADVANCE(FT/MIN), TONS PER MINUTE, OR CUBIC FEET PER MINUTE (Y/N) ? N

ANY CHANGE IN DRUM DIMENSIONS, BIT PARAMETERS, OR OPERATING CONDITIONS (Y/N) ? N