INTRODUCING A NEW TECHNIQUE FOR 3-D SURFACE TEXTURE ASSESSMENT BASED ON VOLUMETRIC METAL PERCENTAGE (VMP)

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ABSTRACT

Industry toady is faced with the need to operate sliding systems under condition that are vacuuming more unconvententional. Beside that, the technology of mechanical surface interaction new demands better understanding of surface texture measurement and assessment. perhaps the most outstanding need in the development of surface measurement today is to know more about the surface texture parameters that will reflect most significantly the behavior of the surface for specific functions. No surface texture parameter is known which deal with the whole feature of irregularities that exists on the measured surface. beside, no instrument exemplifying any one method has been devised to deal with the whole feature of the surface texture. In the presented paper a new Technique is presented based on a weighing procedure, to introduce a new surface texture parameter namely Volumetric-Metal-Percentage (VMP). This parameter can reflect some surface characteritices such as load carring capacity and tribological properties. A cluster of specimens with different processes and machining conditions were tested by the new technique and it was concluded that there exist significant relation between the variations in VMP with the variation of surface texture. This lead to the recommendation that introducing this parameter to be included in the standard specificationes for surface. Furthur work could be extended for more investigation of the correlation between the VMP value and the tribological behavior of sliding surface in order to establish better understanding of the tribological theory.

INTRODUCTION

Measurement of the topographic features of surfaces as practiced today may provide data in which when combined with experience gives useful guidance. The objective of topographic measurement is to reveal the nature and indicate the magnitude of the irregularities in whatever degree of detail considerations of manufacture of function may be required.

A great variety of methods and instruments has been devised which was summarized by Piper and Pacllis [1] and by Drews [2].

Due to the need for better measurement and analysis of surfaces and with the introduction of microcomputers, many digital devices has been developed based on different technique some based on previous methods such as stylus equipment [3] and others based on optical systems [4,5].

Because of the impossibility of representing every irregularity within the whole area of the measured part, some researchers [6,7,8] introduce different technique for the three-dimensional surface topography in order to solve this problem.

In each case extensive software has been developed to measure 3-D geometrical parameters of the surface. The representative surface parameters cover only a limited area of the surface in which more work should be carried out in order to cover the whole surface produced.

The technique presented in this work is based on weighing technique and suitable optical equipment depending on the range of surface texture to be measured.

The results from the weighing system and the optical instrument are fed into a microcomputer and a new parameter namely "Volumetric Metal Percentage" [VMP] is calculated and displayed on the CRT.

The new parameter VMP can be added to the design standard parameters as it described the ratio of the volumetric amount of the surface irregularities between actual produced and nominally designed surfaces.

A knowledge based system of surface texture parameter could be developed including the new parameter VMP value, other surface topography parameters and tribological behavior of the surfaces such as wear resistance and lubrications.

PRINCIPLE OF VMP TECHNIQUE

The newly surface texture parameters namely VMP can be defined as the percentage ratio between volume actual irregularities of metal on the surface of the part to be measured V1 to the nominal volume V2 which can be computed as the difference between the theoretical volume that will cover the highest peaks (Vp) and the other theoretical volume that will touch the lowest valleys (Vv), this can be presented by formula (1).

$$VMP = \frac{V1}{V2} \% \qquad (1)$$

This is different of surface from the fullness factor obtained from the ordinary 2-D bearing area curve.

First dimensional measurement are to be carried out in order to obtain the outer over all dimensions of the workpiece Rmax.

According to the shape of the workpiece and metal type (density), the dimensions are fed into the microcomputer and the first theoretical (nominal) peak weight of the part is computed as Wl (Wp), also the theoretical (nominal) valley weight of the part is computed as W2 (Wv), the actual weight W3 is then obtained by actually weighing the part on a weighing scale. By feeding the true W3 to the computer, calculation is carried out as follows in order to obtain VMP:

$$= \frac{W3 - W2}{W1 - W2} \% \qquad (2)$$

MEASUREMENT ARRANGEMENT

A block diagram of the measurement arrangement of the system is shown in Figure (1) with additional optional arrangement in order to establish an integrating knowledge based system of the surface texture irregularities.

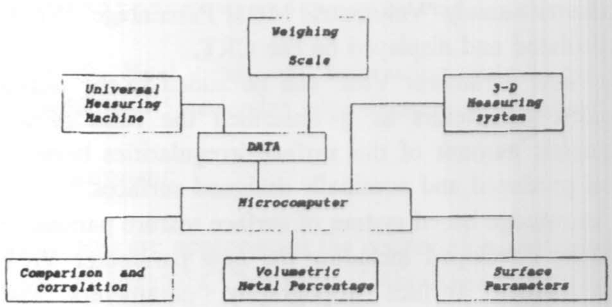

Figure 1. Block diagram of the measuring arrangement.

The over all dimensions of the workpiece are meas using the Universal Measuring Machine (UMM) i resolution of 1 um and the actual weight W3 is meas using a weighing scale into a resolution of 0.1 mg. data from both equipment is then fed into t microcomputer which is connected to the th dimensional measuring system developed by the author

The theoretical (nominal) peak weight of the part computed as W, also the theoretical (nominal) val weight of the part is computed as W_2 . The VMP val will be displayed ob a CRT.

If a comparison of the volumetric metal percentage a other surface texture parameters are required, differe subroutines can be called depending on the comparis parameters.

RESULTS AND DISCUSSION

In order discuss the feasibility of employing VMP valu to surface texture assessment parameters, a cluster o specimens with different processes and machining conditions were prepared.

Table (1) summarizes the computer output of VMP values for a sample of eight different specimens produced by shaper and milling machines.

A typical talysurf-4 output trace of workpieces numbe 3,5 and 8 are shown in Figure (2).

Table 1. VMP computer output for a sample of 8 specimens.

WP.No.	W1 mg	W2 mg	W3 mg	V1 mg	V2 mg	VMP
1	53826	51747	52033	286	2078	14
2	51413	48981	49491	510	2431	12
3	65927	63571	64456	885	2356	38
4	51018	45502	48424	2922	5517	52
5	41194	39912	40619	706	1281	55
6	41645	38406	40321	1914	3238	59
7	52767	50568	52050	1482	2198	67
8	54808	53767	54528	760	1040	73

From figures and Table (1) it is clear that VMP ga more significant variations for surface texture variatio and clearer actual picture about the different surfa topographies.

A comparison between 2-D surface texture parameters such as R_t value, Fullness Factor (calculated from Bearing Area Curve) and the VMP values are shown in table (2) for the same sample summarized in table (10.

Table 2. Comparison between VMP and other surface roughness parameters.

WP. No.	R_t um	R_a um	F.F. %	VMP
1	92	12.5	30	14
2	104	15.2	32	21
3	68	12.9	45	38
4	80	15.0	40	52
5	66	13.5	45	55
6	120	15.5	50	59
7	100	12.5	54	67
8	52	9.5	60	73

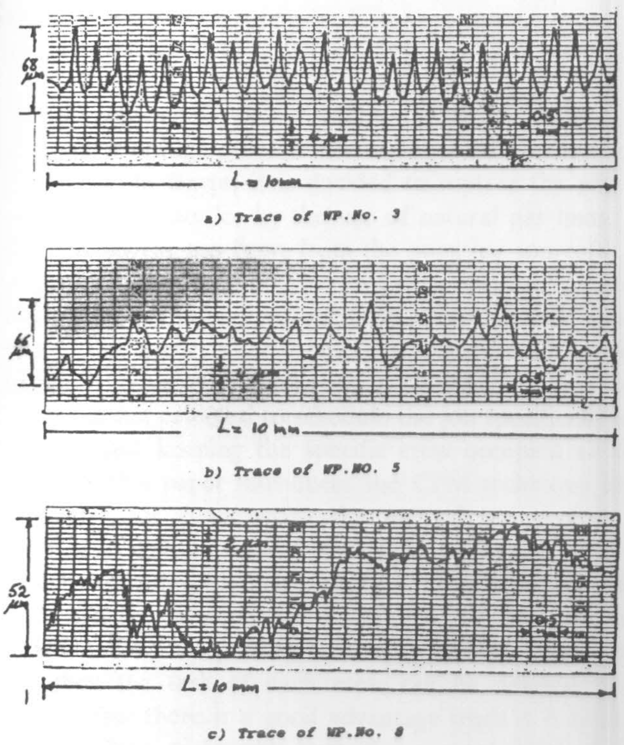

Figure 2. Talysurf 4 output traces for WP. No. 3,5 and 8.

From table (2) it can be seen that VMP showed a good sensitivity of surface variations over F.F. and other parameters. In some cases VMP values were very close to Fullness Factor (F.F) but in other cases VMP values was much different and that is may be due to the scattering nature of the surface texture as found from position-to-position (trace-to-trace) from all the 2-D surface profile tracing instrument, while the presented technique of VMP is actually taking all of the actual surface irregularities in consideration.

CONCLUSIONS

The new parameter VMP was demonstrated, which is based on weighing procedure in order to evaluate the volumetric metal percentage for surfaces.

The VMP parameters gave significant variations with the variation of surface texture.

The new surface texture parameters VMP is recommended to be introduced to the designers to be included in the standard specifications for surfaces. Further work could be extended for a knowledge based system for product quality including VMP value, other surface texture parameters, geometrical error and tribological behavior of the surfaces.

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