Instrumentation & Control of Impact Finishing Processes

R.J. Deloughry,* S.T.S. Al-Hassani,** M.A. Browne,** R.G. Green**

*Bolton Institute of Higher Education, U.K.

**U.M.I.S.T. U.K.

Abstract.

This paper describes a microcomputer controlled nozzle peening system which regulates the mass flow rate and velocity of the shot and enables a continuous recording of the peening cycle to be produced. A series of tests have been made on Almen strips with different shot flow rates. Results of arc height measurements are presented. Surface analysis results are presented which compare the finish produced by computer control to that of manual control.

Key Words.

Microcomputer, controlled, nozzle peening.

1. Introduction.

This paper describes a microcomputer controlled shot peening system designed to produce a desired Almen height. This research is a continuation of the work initiated by Neelakantan(Neelakantan et al 1981).

The required Almen height, shot size, type of shot, nozzle distance and angle are entered into the computer, which adjusts the mass flow rate and the average velocity of the shot in the blast hose. The computer also calculates the exposure time necessary to produce the Almen height under these flow conditions.

A complete data record is produced during the peening operation. The record consists of samples of mass flow rate, solids velocity, air inlet pressure and feed valve position. At the termination of the blasting phase the computer calculates the average values and standard deviations of the measurands and produces a hard copy record of them. Prior to this work, control of the shot stream had been an intuitive function of the skilled operator.

2. System Description.

The control system has been developed on a Vacublast single nozzle machine (Figure 1). The measurement section consists of two capacitance transducers (Tealgate 1980) and a pressure transducer positioned on the blast hose as close as practicable to the blast nozzle. The output from one transducer is proportional to the shot concentration (Green 1976). The output signals from both transducers are processed by a cross-correlator (Beck 1981) which gives the transit time of the shot between the two transducers. These signals are interfaced to a microcomputer for which a specific algorithm has been developed. The algorithm relates the measured signals to stored reference signals and actuates the control devices.

There are two primary controllers. Shot velocity is controlled primarily by the air pressure setting and by the feedrate of the shot into the system. The air pressure is regulated by a Norgen air control valve which is driven by a d.c. motor through a 50:1 ratio gearbox. The shot feedrate is controlled by a linear actuator which operates on the shot feed valve.

In practice the operator enters the required Almen height into the microcomputer and switches on the air flow. When the required flow parameters are established (approximately 5 seconds) the computer informs the operator that peening may proceed.

3. Test Procedure.

(i) Almen Arc Height.

In the tests, type N, Almen strips were moved at a controlled rate backwards and forwards beneath a fixed flow nozzle by a pneumatic ram. Each test was repeated several times so that an estimate of the average arc height and its standard deviation could be obtained. Three different feedrates were used and at each of these settings three different arc heights were demanded. The results are shown in table I.

(ii) Surface Analysis.

Two samples each of 15 strips were subjected to surface analysis to determine if other factors besides residual stress could be differentiated between them. One sample consisted of strips peened under microcomputer control, the other sample under manual control.

4. Discussion of Results.

(i) The tolerance on desired Almen height after peening is improved from 15 - 25% for manually controlled systems to 5 - 10% for the microcomputer controlled system. Computer control also reduces the setting up time to 5 seconds.

(ii) Roughness parameters of the Almen strips, measured on a Talysurf system, peened under computer control were compared with those peened under manual control using feature space graphs. There were two significant results. The first relates to the root mean square (RMS) surface slope which is an important parameter in relating the surface finish to wear and tear. The computer controlled strips had significantly lower RMS surface slope values which indicates a smoother surface finish and subsequently lower wear and tear rates. The second result of this analysis showed a higher repeatability for the computer controlled strips.

5. Conclusions.

A computer system has been designed to control the velocity and mass flow rates of shot from a nozzle type peening machine. The control system has a present day cost of approximately £2000. The system should prove very reliable because it uses components which have proven maintenance free when used in service.

The results summarised in this paper show that the system significantly improves the control of the peening process.

The authors wish to thank VacuBlast Ltd (U.K.) for their cooperation and the loan of a machine so that the work could be undertaken.

TABLE I

Mean Values and Standard Deviations of Controlled Almen Peening Results

Shot Concentration kg/min	Almen Height (Type N) Demanded inches $x10^{-3}$	Measured inches $x10^{-3}$	Standard Deviation
2.6	25	26.4	0.55
	28	27.1	1.25
	32	28.3	1.57
3.5	25	24.4	1.19
	28	26.0	1.00
	30	28.3	0.84
3.9	22	21.9	1.14
	24	22.6	1.08
	28	28.5	0.71

References.

Beck M.S., "Correlation in instrumentation:Cross correlation flow meter". J.Phys.E.Sci.Instrum.Vol 14,1981.

Green R.G.,"A frequency modulated transducer for gas/solids flow measurements". A.C.T.A., IMEKO V11,1976.

Neelakantan M.N.,Green R.G., Foo S.H., & John R., "Measurement and control of impact finishing process". Proc. of ICSP - 1,p 147, Sept.1981.

Tealgate Ltd., Unit 2, Monument Industrial Park,Chalgrove,Oxford,U.K.

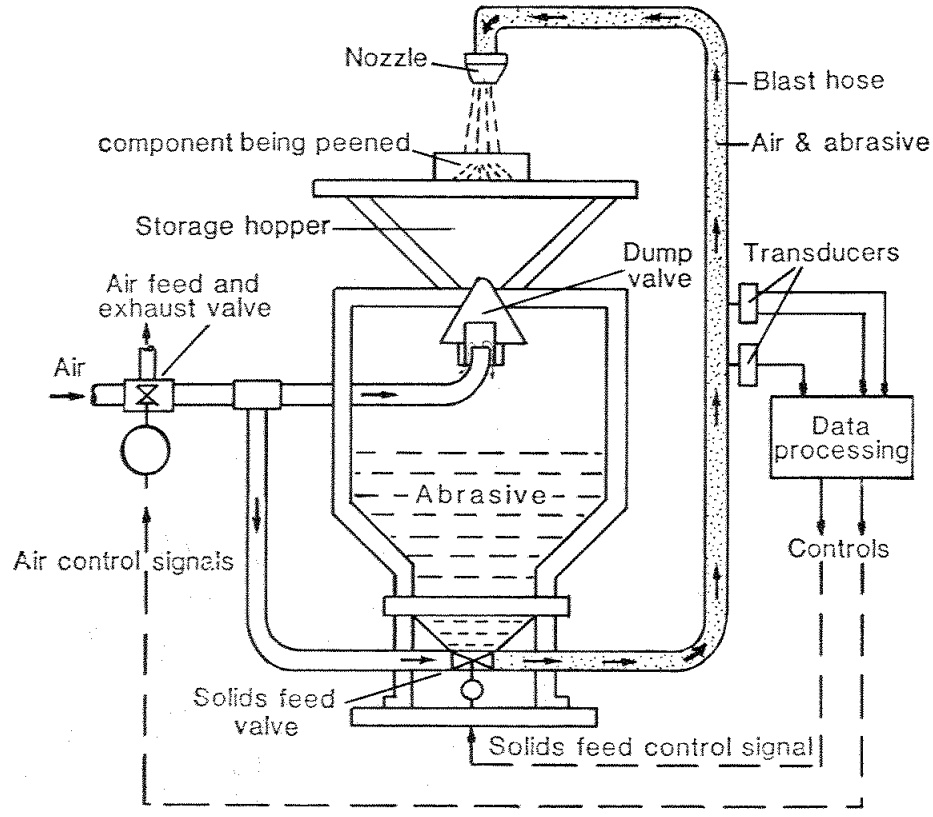

FIGURE 1 COMPRESSED AIR TYPE PEENING MACHINE