Shot Intensity Monitoring with Impact Sensor
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ABSTRACT

Experiments with impact sensors exposed to shotpeening, identical an actual shotpeening process, have been performed and systems are described in order to monitor process intensities at intervals. Combined with other monitoring technics, such a combination can give a maximum of online information in common shotpeening applications and especially when peening critical parts.

KEYWORDS

Almen substitute, impact sensor, intensity gauge, shot peening.
INTRODUCTION

For many years the standard strain gauge in many configurations gave good services to solve a lot of measuring problems. But in recent years, additional technologies have been developed and today a wide range of all sorts of sensors and transducers are available: Piezo systems, sputtered strain gauges and lately the SOS (silicone on sapphire) technology. Individually selected, a suitable sensor can be found at least for all common industrial applications. So this fact makes it possible to start thinking of monitoring devices for shot-peening wheel systems and especially for air driven equipment. Also utilization could be extended to ordinary blasting when treating comparably critical parts.

BASICAL IDEA

It is common knowledge that any obstacle brought into a linear flowing mass (gases, liquids pure, or such propellants mixed with solids) will create a reaction to such a piece, and also it is obvious, that the force induced will increase with increased speed and also with increased mass. To measure this reaction and to combine it with data from other essential parameters is the base of this study.

EXPERIMENTAL HISTORY

In first instance it was the idea to find out more about the kinetic behaviours of particles on a theoretical base. But authors have not been able to trace necessary fundamentals from scientific literature. Also no exact speed-pressure diagram which covers the entire range from inside the nozzle and the surrounding peening area was available. Only particle-speed evaluations by laser technic are known or can be done but at comparably high costs.

Also it was not possible to find out the path of a single projectile (shot-particle) either under 90 degrees or other angles or even with an eventual rotation. The practical process with numerous projectiles at individual speeds with all rebounding and collision events inside a shot stream is extremely complex and not known (?). Under such facts, authors have disregarded from thinking of e.g. mathematical models or computer assistance on fundamental theory.

First experiments in order to measure effects from shot streams have been carried out with various sensors all under prestress application, this technic can be superior under certain circumstances. But sincere temperature effects could not have been compensated. Fact is, that when approaching the outer section of an airstream, the temperature drops towards freezing due to the expanding air. But in the center of the shot stream, the temperature rises to at least 50 degrees C (orig.test conditions) on the surface depending on parameters involved.

![Diagram](image-url)
PRINCIPLE OF IMPACT SENSOR UTILIZATION

A sensor is moved radially through the air-shot-stream. The surface is hit by the shotstream resulting in force "FS" (Fig.1) and additionally by force "FA" which is induced by the airstream itself. FS and FA are highly simplified resultants from the physical effect but for an industrial application quite sufficient due to the definition in peening intensity investigations.

DESIGN OF AN IMPACT SENSOR

The exposition of a sensor to the hazardous influence of a shot stream makes it necessary to design a device that withstands such attacks. So the best thing will be a combination of the electronical device with an inexpensive and easily replacable protector. Fig.2 gives an idea of such an arrangement. Depending on intensities applied, a lifetime of more then 2000 measuring cycles can be expected.

VARITIES OF PRACTICAL APPLICATIONS

1. Intensity verifications at long intervals

The most simple procedure with little technical effort is sampling e.g. between process stops when changing workpieces. (Fig.3) For this application a CNC controlled machine is most useful. A subroutine will be programmed in such a way that the nozzle or nozzles will pass the sensor unit in a defined distance, depending on computing facilities of the sensoric system, the travelling speed is of little importance and can be in the range of common peening speeds of e.g. 200 to 600 mm/ min or more.

Fig.3 Remote Sampling  
Fig.4 Integrated Sampling
2. **Intensity verifications at short intervals**

With an additional technical device sampling can be performed in between short peening breaks e.g. at the end of a stroke in reciprocating processes. The sensor will swing through the shotstream in a pendular motion in less then 3 seconds. (Fig.4)

3. **Internal peening intensity verification**

In this case, not a protector plate is used but a ring with protective function. With a simple 1-sensor device, intensity results can be gained only over a 90 degree range of a full bore. Better information will require a more complicated system with 3 pieces sensors spread over a full circle.

**INTENSITY TEST EXPERIMENTAL RESULTS**

Fig.5 shows a typical diagram with the necessary informations:

![Diagram](image)

**Parameters:**
- **Nozzle dia:** 10 mm
- **Nozzle Shape:** common
- **Nozzle Distance:** 80 mm
- **N. Expos. Angle:** 90°
- **Blast Pressure:** 2,4 (2,0)*bar
- **Media Specs:** S 110
- **Media Flow:** 0,0 Curve a
  - 2,5 Curve b
  - [kgs/min]
- **Mode:** Experimental

* Pressure drop inside length of hose when vessel pressure is hold constant, here 2.5 bar. Pressure is measured near nozzle.

**INDUSTRIAL APPLICATION**

Tests performed show significant results and a good repeatability under shop conditions. The development of a system is in progress for an automatic computing and compensation of the influence of the air by sampling the actual air pressure.

**CONCLUSION**

The impact sensor technic could help to achieve a very extensive shot peening parameter control as required mainly when processing critical parts. But it could also be helpfull for general machine testing, calibration, performance survey or research.

**OUTLOOK**

Research and development is going on to create an Almen-strip substitute. Patents are already pending. It will be possible to set machine parameters and individual nozzles within minutes. Intensities will be automatically sampled and curves will be displayed on the monitor and can be printed.