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Shot Flow Sampling

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Abstract

To test or calibrate shot flow meters in air-operated peening/blasting machinery, a practical standard routine is described herewith.

Introduction

The periodical examination of e.g. pressure gauges on shot peening machines has become a standard routine worldwide. Consequently, shot flow meters should also be attended to in the same way. But it is known to involved engineers, that such tests are time consuming and lots of different methods could be applied. Following, a shop-approved routine is described and can be considered as an example to assure a high quality production standard.

Principle Information

First of all, it has to be understood that the flow-gauge device shall not be separated from the rather complex system arrangement of an e.g. peening machine. It is important to know that the shot flow under influence of various static and dynamic effects can vary. Due to the complexity of the measuring principle, the currently worldwide available flow-gauges have different characteristics. The accuracy can depend and vary caused by shot size, shot quality, shot material, nozzle pressure and actual flow rate in respect of total range of instrument. This practically means, that tests have to be performed in-situ, parallel to a peening process. For technical reasons, no parts can be treated at the same time.

It is also necessary to become familiar with the machines flow control principle. It can be either working with an adjustable, manually remote controlled orifice system or it can have a closed-loop technique, with the set-point adjustment done on the corresponding gauge or via CNC, if equipped with such. There are machines that allow the choice of any of the three different modes. The flow test as herewith described is perfectly reliable with fixed orifice systems only. Closed loop controls of various kinds are much more difficult to measure. This is because of the eventual pulsation caused by the controllers philosophy. But for normal industrial application, this herewith described test with average sampling periods between 30 and 120 seconds can be considered as quite sufficient.

The comparable simple catch-weight sampling does not require really special equipment. It can be performed by any skilled and instructed staff. To work on a scientific background, the shop-approved equipment according Fig. 1 can be recommended. To minimize machine downtime, to care for repeatability and accuracy, to maintain the necessary safety standards and cleanness, improvisation is limited.

Equipment

The following items as shown in Fig. 1 would be arranged for professional flow-gauge testing.

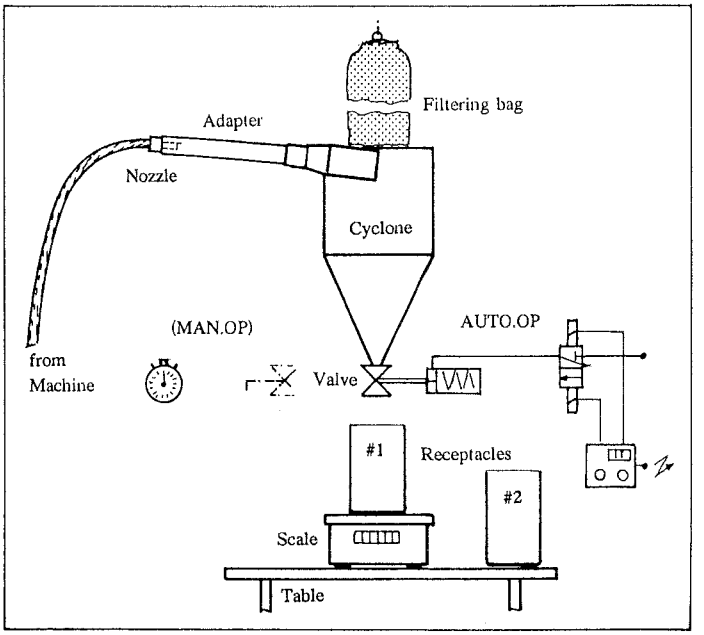

Fig. 1 Flow-test Equipment arrangement

1. Standard nozzle-hose arrangement, but extern from the process cabin.
2. A straight connection adapter, at least two feet long and four times bigger than the nozzle-dia to reduce the intensity harmful to the cyclone.
3. A cyclone (Fig. 2 - see next page) to separate the shot, with preferably a filtering bag on the upper outlet. It can also be connected to the machines' exhaust system, but hardly any pressure difference is allowable.
4. A shut-off valve in the material discharge outlet. Hand operated together with a stop-watch, or preferably automatically timer-controlled. Normally a pneumatic system, if automated, have a button to **Close** the valve and start the timer at the same time. A second button is to **Open** the valve independent from the timer-function. If the set time elapses, the valve must close.
5. An industrial 16 kgs capacity bench scale with a readability and repeatability of ±1 g.
6. 2 pcs 10 dm^3 capacity metallic receptacles of same with ± 2 g. Do not use plastic type, even with ground strip applied as handling is impractical and accuracy may be affected; all caused by electrostatic charging.
7. All equipment should be placed on a table for easy operation.

Procedure

1. Place receptacle #1 underneath cyclone with valve opened. If with automated outfit, set timer according expected total catch-weight, not exceeding e.g. 12 kgs. Advisable are e.g. 120 s for 1 kg/m expected rates, or 30 seconds exceeding 15 kgs/minute. These figures should be observed in order to make handling of receptacles more comfortable at an acceptable accuracy.

Continued on next page

2. Start machine with nozzle installed and set desired flow rate and pressure level.
3. Wait for uniform shot flow, normally 6 to 15 seconds. Keep record of all variable datas and actual shot definition.
4. Close valve at time zero and have timer starting simultaneously.
5. Remove receptacle #1 and instead place empty #2 on scale.
6. Open valve to drain cyclone, keep valve opened. Read gauge of flow-meter and keep recorded. In the meantime also dump receptacle #1 into storage bin or straight back to the machine.

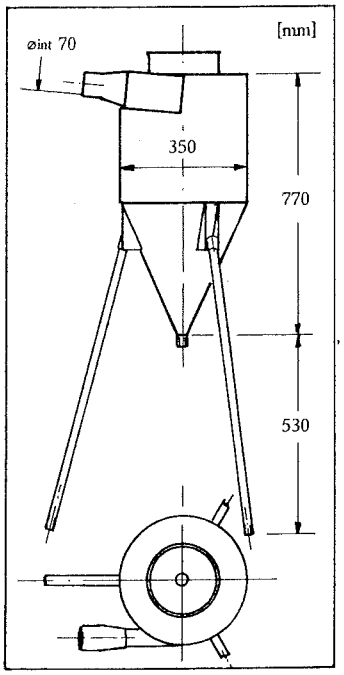

Fig. 2

These jobs must be completed before the test-time ends.
7. Valve will close after set time elapses, or has to be closed when working manually.
8. Now read the sample weight of receptacle #2 and keep recorded. Receptacle #2 may remain.
9. Go back to Step 4. (mind that numbers of receptacles then have changed) for a second run with unchanged parameters. Depending on accuracy of results, decide to run two only or more samplings with the same machine parameters. If results are acceptable, proceed with Step 10.
10. Change to next machine parameter setting without process interruption. Follow Tab. 1 or according to own needs. Proceed with Step 3.
11. Continue nonstop if action allows so.

Parameter Variation

To get full information about one flow-gauge unit, e.g. for factory acceptance tests, a device may require a test-routine as suggested in Tab. 1. The example represents datas for a 1.0 to 10.0 kgs/minute range unit working together with a 10-mm nozzle and S-170 shot.

The shot size/material/quality used can be very important for some of the flow-gauges available. So results obtained with one shot type are only true for one and the same shot. For other shot, mainly other sizes, results may be different. Therefore for all test or calibration work, it has to be referred to the original shot primarily used. This depends of course on the tolerable differences evaluated.

Flow-gauge Characteristics

The measuring principle and interface layout are different according the various suppliers, also costs may be taken into consideration if compared with accuracy and principle design. Often together with control gear equipment it results in a complex system that can stand alone or combined with PLC/CNC organization. Therefore, the various combinations have different characteristics. But for all of them the base datas will be the **Media Definition**, the **Range** and the **Accuracy** guaranteed. Of additional importance may be the temperature range, response time, ect.

Flow Rate Setting [kgs/minute]	1.00	2.00	4.00	8.00
Pressure Setting [bar]	1.20	1.20	-	-
	2.40	2.40	2.40	-
	4.80	4.80	4.80	4.80

Tab. 1 Test routine example

Media type: Dry Only. Various types of steel shot, ceramic beads, glass, abrasives, etc., depending on sensor technique, some can only work with ferrous material.

Media size: 0,1 to 2,5 mm (S 70 to S550) or even up to the 9-mm (3/8") range (peenforming!)

Range: The min/max-flow ratio is normally limited for physical reasons to max 1:20, e.g. 050 to 999 g/m or 0.80 to 16.0 kgs/minute.

Accuracy: The supplier must clearly state what kind of accuracy. In connection with this instruction and field application in general, **operating accuracy** could be specified as follows: (example only)

Resolution: 00.01
Range: 00.70 to 12.00 kgs/minute
Accuracy: ± 4% of actual reading within 01.50 to 12.00 kgs/min ± 1 digit
± 6% of actual reading within 00.70 to 01.49 kgs/m ±1 digit
Repeatability: ± 1%, ± 1 digit
Requirements: Part of machine:
Conveyor screw feed
Direct controlled
Shot specification: S110/S170 (MIL)
Pot pressure range: 1,5 to 5,2 bar

Costs

This given test-procedure instructions aim for high accuracy and moderate testing-time consumption. However, it is obvious that such testing is not a "few-minutes-job". Following recommendations according to Tab. 1, already 18 runs will be necessary and with added one hour to set-up the full installation, the job will hardly be done within less than two hours by trained staff, and this is for one-piece nozzle only.

Conclusion

The described method is intended for routine shop application, both factory acceptance tests and periodical certification of gauges. With this procedure, the shot-flow instrumentation can be brought up to the same level as common in the field of any other industrial-used measuring equipment. ❍