What a Nozzle Can Do Better Than a Wheel

by Ken I'Anson, Progressive Technologies

There are applications where wheel blasting is the best solution. I will leave it to wheel machine manufacturers to state their case. In this issue of **The Shot Peener**, I'll highlight the benefits of the compressed air counter-part of the wheel peener—the nozzle peener. I'll also share with you some of the latest developments in nozzle peening at Progressive Technologies and why we provide the complete air solution for our customers.

First, a little background on Progressive Technologies. We've been at the forefront in developing reliable and repeatable nozzle peening systems for 35 years. If fact, Progressive Technologies was the first to build a robotic peening system and has provided nearly 500 systems to the aerospace, automotive and IGT (Industrial Gas Turbine Power) industries in the United States, Europe and Asia. The following are a few of the reasons for our success.

The flexibility of the nozzle

Above all, nozzle peening systems allow the flexibility to peen very complex components without compromise. By this I mean that a robotic shot peener will follow the complex geometry of a part and automatically adjust speed and angles to maintain a near-constant coverage rate, stand-off, and most importantly, the angle of impingement. A wheel peener can easily over-peen an area of the part while trying to reach difficult areas. A nozzle system can be fitted with a large variety of nozzles to customize the peening program. For example, a wheel system cannot shot peen areas of a part that have non-line-of-sight features such as deep bores, slots and crevices. A nozzle peening machine can be fitted with a different nozzle in a matter of minutes and peen these difficult features.

When repeatability is crucial

As the internal components of a wheel unit wear, the media spray pattern is shifted. Likewise, when the RPM of a wheel unit is increased or decreased to adjust the speed of the media, the pattern changes directions. Wheel peening suppliers are now addressing electro-mechanical methods of compensating the projected media pattern. Nozzle peeners, however, have always enjoyed a high level of repeatability since the shot stream is straight and fans out at a 12-degree angle as the media pattern is measured farther from the nozzle. And the direction of the media does not move as the air pressure is increased/decreased or the nozzle wears. Today's robotic peener is outfitted with high accuracy encoders to control the speed and position of the nozzle, providing accuracies of +/- 0.020" (.51mm) and repeatability of +/- 0.010" (.25mm). Compressed air pressure and media flow control are also tightly controlled.

Why a nozzle is so reliable

Now that you've read about the high level of control and accuracy of the nozzle system, it's time to understand how this makes a nozzle peener more reliable. There is far less—and this is worth repeating—far less damage to the part fixtures, the masking, and the internal surfaces and cabinet liners of a nozzle peener machine than in a wheel peener. The simple fact is that the nozzle-to-work position is controlled and the shot pattern is focused so that media damage is minimized, downtime is minimized and therefore, operational costs are minimized.

Less damage + less wear = greater reliability!

More media choices

Nozzle peeners have always enjoyed the option of using many different types of peening media. Although wheel units are now capable of throwing ceramic and glass bead medias, the applications are in the blast cleaning field and not in the peening industry. Media consumption and directional control have still hampered wheel systems. Nozzle systems can operate with all the conventional granular peening materials, plus they have the advantage of using water to wet-peen when required.

We've upped the production rate

Most peening practitioners would say that a wheel peening system out-performs a nozzle peening system by sheer volume of media thrown. In the last five to seven years, the tables have been turning. Progressive Technologies has produced several nozzle peeners that propel volumes of shot up to 400 lbs/min using four nozzles. These machines are replacing the traditional wheel machines in a variety of peening applications. Sure these high-production nozzle peeners require a large volume of compressed air to operate, but the balance is that these machines provide unparalleled accuracy and repeatability when peening and they minimize the operating costs due to fewer consumable parts such as liners, blades and fixtures.

Managing the cost of air

As a leading manufacturer of compressed air systems says, "Air is free... but compressed air isn't!" The cost of compressed air puts nozzle peening at a disadvantage compared to wheel peening for applications where accuracy and repeatability aren't crucial—the cost of media and replacement components are less than the cost of air. Plus, a poorly-designed or poorly-functioning compressed air system will add considerable expense to a peening process. And if the system fails, the shot peening process stops.

That's why Progressive Technologies optimizes the nozzle-to-part relationship. Complex parts are often peened faster when a single nozzle is correctly peening all surfaces vs. multiple nozzles over-peening some areas to achieve correct coverage on difficult areas. Higher shot flows reduce cycle times and compressed air draw. An aircraft wheel manufacturing customer has benefited from this single nozzle, high-flow approach.

When using multiple nozzles, the goal is to define the purpose and aim of each nozzle so that media collisions and overlap don't take away the benefits of each nozzle position. Often... less is more.

Helping customers achieve the complete air solution

Progressive Technologies assists our customers in the decisions about compressed air supply. Does the existing system

Continued in page 6

Continued from page 4

have enough capacity without causing problems elsewhere in the plant? Is the existing system maintained correctly or are several small air leaks stealing valuable air? Should a new air supply be dedicated to the new peener? Is the peening process intermittent with short powerful bursts or long steady cycles? Will an accumulator help?

Additonally, we ask our customers to provide compressed air to the following minimum quality:

Air Dry to less than dew point 45 F or 5C

Oil filtered to less than 5mg/cubic meter

Even the diameter and length of the compressed air supply lines can create a large pressure drop, thereby robbing valuable compressed air from use. For long supply runs, the pipe diameter needs to be larger to reduce the pressure drop. See the following charts—these are typical of the worksheets Progressive Technologies utlizes to determine the usage and costs of compressed air.

For more information on nozzle peening, please contact Ken I'Anson with Progressive Technologies:
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For a complete review of all of Progressive Technologies services, visit their web site: www.ptihome.com

Pressure Blast Nozzle CFM Usage

Nozzle Dia.	50 PSI	60 PSI	70 PSI	80 PSI	90 PSI	100 PSI
1/8"	11.3	13.2	15.1	17.0	18.5	20.3
3/16"	26.0	30.0	33.0	38.0	41.0	45.0
1/4"	47.0	54.0	61.0	68.0	74.0	81.0
5/16"	77.0	89.0	101.0	113.0	126.0	137.0
3/8"	108.0	126.0	143.0	161.0	173.0	196.0
1/2"	195.0	24.0	252.0	280.0	309.0	338.0
5/8"	308.0	256.0	404.0	452.0	504.0	548.0
3/4"	432.0	504.0	572.0	644.0	692.0	784.0

Cost of air leaks to atmosphere in a 100-psig compressed air system

Diameter of Opening (inch)	Air Loss (scf/mo. at continuous operation)	Cost of Air Leakage ($/mo.)*
1/32	69,850	$ 17
1/18	278,700	70
1/8	1,114,800	279
1/4	4,450,000	1,113
3/8	9,980,000	2,495
1/2	17,800,000	4,450

* Based on $0.25/1,000 scf

Estimating Air Flows

Air flow out of the compressor can be related to the horsepower required to drive the compressor. Compressor output varies with the discharger pressure. To estimate air flow in scfm, multiply horsepower by the factors shown below.

Discharge Pressure (PSIG)	Multiplier
75	6
100	6
125	4 1/2
150	4

For example, a 25-hp compressor discharging air at 150 psig will deliver about 4 x 25 or 100 scfm. If the compressor runs intermittently, multiply the calculated air flow by the percentage of operating time. Thus, in the above example, if the compressor runs only 20% of the time, the average air flow will be only about 20 scfm downstream of the receiver. Be sure to check periodically for overloading due to increased demand.

Calculate blowoff nozzle CFM usage with the following formula:

(Qty of nozzles) * (CFM per nozzle) * (Blowoff minutes per hour/60 min) = Blowoff Nozzle CFM

__________ * __________ * __________ minutes/60 min = __________ CFM

Cost of Compressed Air

The compressed air costs are computed by converting the total CFM requirement into compressor horsepower, converting horsepower into kilowatt hours, and finally multiplying by the cost for electricity. Electricity costs will vary from $0.05/kWH to $0.10/kWH depending on the location where the machine will be installed.

An air compressor will deliver approximately 5 CFM per motor HP.

1 HP = 0.75 kilowatt

Use the following formula to determine the cost of compressed air:

(Total CFM) * (1 HP/5 CFM) * (0.75 kW/HP) * (Electricity cost/kWH) = Cost of Compressed Air

(________CFM) * (0.15 kWH/CFM) * (________ /kWH) = $________ /hour