Spray gun needles for finishing

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A continuation of the articles on the fundamentals of spray equipment, which targets experienced finishers who need a gentle reminder of the details of spray machine components. Figure 1 shows the cross-section of a high-pressure spray gun that is fitted to a transverse, rotary, or oval path spray machine. Several immediate component details need to be noted for the purposes of this article.

Firstly, note the grey rod-shaped needle valve that is a vertical position in the spray gun. The side-to-side motion of the needle is controlled by good machining of the internal structure. Poor precision of that internal sleeve will mean lateral movement of the needle, and problems that will be experienced consequently and will be explained later.

The needle is lifted upwards by a piston mechanism. Figure 1 shows how air comes into the assembly underneath the lower edge of the piston, drives the piston up under pressure taking the needle up with it. A needle that is raised no longer seals the fluid nozzle, and liquid under pressure will exit the nozzle. Correct setting of the gun is vital. Atomising air must leave the annular ring before the needle is lifted – failure to do so will result in no atomisation of the liquid leaving the nozzle, and the gun will drip finish onto the leather.

For the needle to return to its nozzle seating, it has a counter spring that will push the piston back into position if the upward pressure is stopped. The strength of the spring is important. A stiff spring will cause the needle to slap back, which can cause metal fatigue. The thread adjustment of the needle will raise the needle allowing a greater height, a greater lift of the needle and less fluid to exit the nozzle. Tightening the screw decreases the fluid emanation.

Needle importance

It is useful to remember the checklist from the finishing article published in ILM (Flowers, Mar-Apr 2018) to set the scene for finishing parameters:

1. Type of liquid is going to be sprayed – specific gravity, viscosity (differing types), temperature and surface tension.
2. Spray pattern required – full cone, hollow cone, flat spray.
3. Flow rate/application rate.
4. Spray angle and spray coverage required.
5. Drop size.
6. Liquid quality/level of contaminants.
7. Velocity and impact required.
8. Pressure drop through spray system.
9. Spray system operation – continuous or intermittent.
10. Cost of the finish application.
11. Spray machine type/drying tunnel type.

The needle type and adjustment are linked to the flow rate/application rate given in #3. Of course, the first parameter will influence the nozzle type and changing the nozzle will normally mean the finisher has to change the needle valve. Some finishers are tempted to purchase nylon needles, normally for cost reasons. There are pros and cons, for all component choices, but remember what the needle must do. It must rapidly move up and down and, of all things, it must make a tight seal in the fluid nozzle. A material that has compressibility can wear quickly and will not be able to achieve either of these primary aims.

A needle of any material will wear at the point where the needle contacts the fluid nozzle. This contact point should be the focus of the finisher's scrutiny. If rapid wear is seen at the contact point, then the needle material malleability is too high (deformation will cause malfunction). Hardness can also be a negative. If the needle is too hard, it may cause a failure in the nozzle.

Needle types

In Figure 2, the two main types of needle tips are illustrated, and the way the needle seats in the fluid nozzle. The round tip has a very flush contact with the nozzle. Ensure that the correct needle is matched up with the fluid nozzle or a failure of the system will occur.

For high pressure applications, the round tip needle is generally preferred. The fluid under pressure can leak around a tapered needle that has brief contact with the fluid nozzle internal walls. Round tip needles tend to come into multiple contacts with the internal walls and provide a better guarantee against dripping. Be cautious, however, lateral movement of the

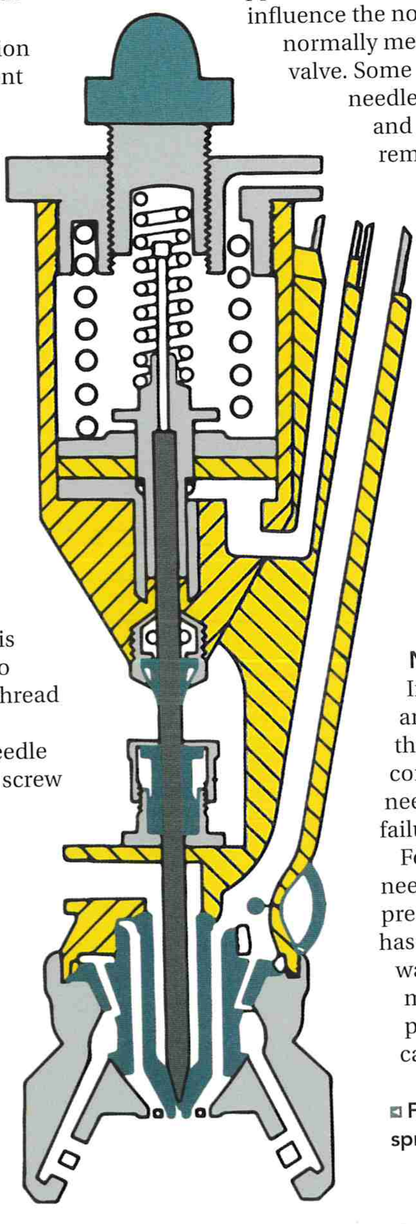

Figure 1. Schematic outline of an automatic spray machine gun

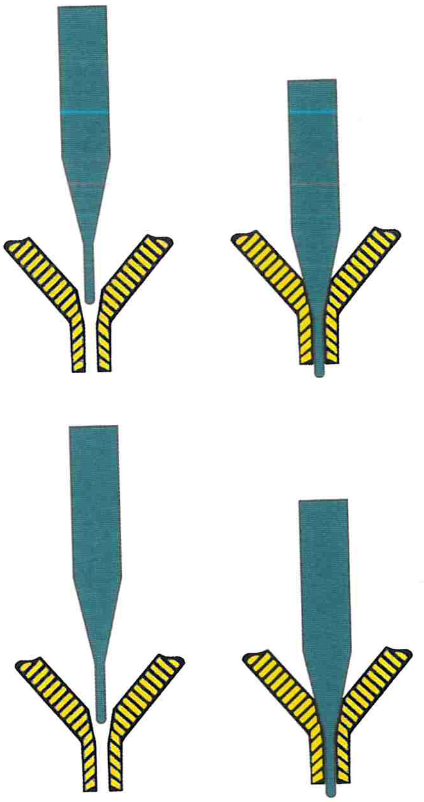

Figure 2. Two types of needles are used: round tip (top two images) and tapered tip (bottom two images – given in the open position (left) and closed position (right).

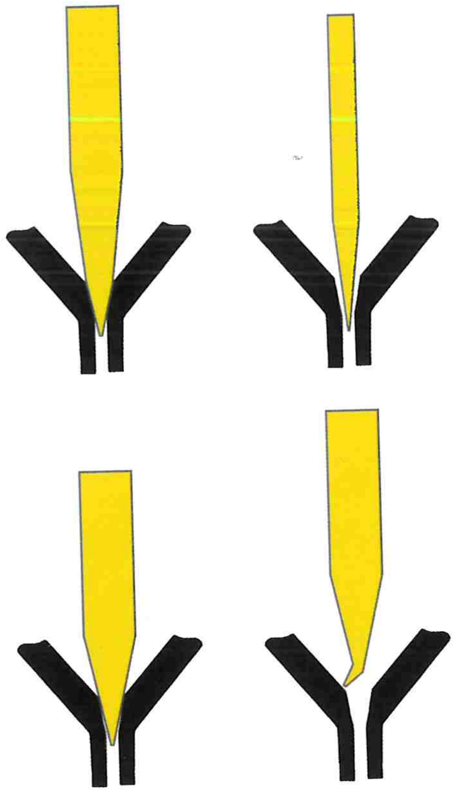

Figure 3. Some of the typical problems associated with needles; ill-fitting and bent.

needle can cause the more fragile round tip meeting the side wall, bending, causing a gun malfunction.

Another important feature to note is that the tapered tip is like a wedge and, like any other wedge, this wedge-like device can slowly make its way into the confined space that it is forced to enter and over time slowly widen the space.

Also note how the needle lifts out of the fluid nozzle orifice. The round tip needle does not fully leave the internal space of the nozzle. The impact of this is vibration caused by fluid flow around the needle tip. Any vibration in an engineering system is rarely helpful. The fluid flow around the needle tip will become turbulent, what can provide additional stress to the need tip. Laminar flow is helpful for fast fluid exit and for non-Newtonian liquids. Remember that non-Newtonian liquids can change their viscosity (shear thickening or shear thinning) and the viscosity exiting the gun will not be what is measured by the Ford Cup 4.

Tapered points provide less resistance and non-Newtonian fluids will only be affected if the pressure affects seen at the nozzle orifice are significant.

Needle problems

The first image in Figure 3 shows the perfect seating of a tapered needle valve. Note good contact between the needle walls and the fluid nozzle internal walls. A good seal will result from the contact and upon the needle slapping back contact stress will be distributed evenly.

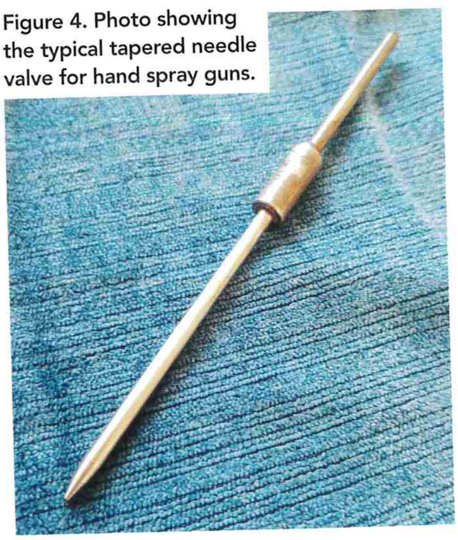

Figure 4. Photo showing the typical tapered needle valve for hand spray guns.

The image to the right of the perfect fit shows a thin taper. The needle is also not positioned low enough and no seal is possible. The spray gun with this needle/nozzle match-up is not able to close off and the gun will not be able to stop fluid from emerging. The problem will be easily detected and solved. The tannery will get this kind of problem when the engineer has no idea of which needles belong to which nozzle. The typical scenario is an operator that selects any nozzle and puts it in and does not change the needle.

The bottom left image (Figure 3) shows the impulse force problem. An impulse force is a very violent contact between objects that have very focussed contact, and a short contact time. A cricket ball, connecting with the cricket bat is an impulse force; small surface contact for a fraction of a second. The resulting exit of the ball is with great force (and speed!). The bottom left (Figure 3) demonstrates slight contact between needle and nozzle. The wedge effect, mentioned earlier, takes effect. The impulse force slowly cracks the nozzle open and, with a split nozzle tip, the fluid exits into the air travelling at great speed down the annular ring, giving a D-shaped spray fan.

The bottom right image (Figure 3) shows the typical problem seen when someone drops the needle, bends it and then places it into the gun un-straightened. The contact will never be enough and the gun will drip finish. More commonly, the operator can cause this defect through incorrect nozzle insertion. It is important, whether changing a nozzle on hand spray or into an automatic spray machine, that the operator backs the needle off. A nozzle in the fully extended position (forced there by the spring) will try and seat with the fluid nozzle. If the fluid nozzle is removed, for maintenance reasons, and the new nozzle is re-inserted in a incorrect position to begin, it may bend the needle in the manner shown. If the nozzle is then screwed in correctly, the damage that has already occurred will remain as seen in Figure 3 (bottom left).

Hand spray needles

The final image (Figure 4) shows the tapered tip needle valve that is commonly seen in the hand spray gun. It differs from the automatic spray machine needle as it is not piston operated. The hand spray gun needle valve is simply pulled back by the gun trigger. A spring still pushes the needle valve forward.

The most common problem with needle settings in hand spraying is normally linked to the operator not pulling the needle valve back far enough, only half triggering the fluid exit. It is better to turn the needle valve in.

The needle valve may be a simple part of the spray gun, but it is the ultimate component that controls the flow of finish. Its importance should not be underestimated. ■

References: Flowers, K. Getting the most out of spray finishing. 2018. International Leather Maker Mar/Apr. p. 94-98.