Nozzles And Spray Systems


Before delving into the nozzle varieties available and their usage, there are some physical attributes that ought to be considered. Just how accurate should one expect a nozzle to be at the time of purchase, and how long should this accuracy remain?

We feel that if we can manufacture an orifice with a tolerance of plus zero, minus 0.00" to 0.002" we will be able to deliver to the customer a nozzle that will meet his specifications as to gallonage, spray angle, distribution of liquid throughout the spray angle, proper particle size and particle size distribution, and from a good to a long performance life depending upon the conditions under which the nozzle is used. The reason for slightly undersizing the orifice is to give an extended wear life to it. However, if it is made too small, then the desired spray characteristics will be altered.

In order to have a rough gauge of comparison, here are results of accelerated erosion tests. The conditions of the test were: 1) finely ground quartz suspended in water under continuous agitation; 2) different materials; 3) all orifices mounted on the same header; 4) the header fed from more than one location if necessary; 5) pressure held to a constant reading; 6) all orifices tested the identical length of time under the identical conditions.

Unless such conditions are used and met, results will be incorrectly interpreted and reported. Repeated tests of orifices and nozzles showed the following relationships to be consistent: Using brass as a base and giving it a life of one (1), whether it be minute, hour, day, week, etc. we have:

<table>
<thead>
<tr>
<th>Material</th>
<th>Life</th>
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<tbody>
<tr>
<td>Plastic</td>
<td>½ to 1</td>
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<tr>
<td>Aluminum or brass</td>
<td>1</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>3.5</td>
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<tr>
<td>Hardened Stainless Steel</td>
<td>10 to 15</td>
</tr>
<tr>
<td>Ceramic</td>
<td>90 to 180</td>
</tr>
<tr>
<td>Tungsten Carbide</td>
<td>180 to 250</td>
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While one plastic orifice did give an extended life, it was due to a small skin burr around the orifice that tended to flap back and forth without wearing off, thus interfering not increasing the wear life. Upon removing this flap from other identical orifices, we found that it did not withstand erosion any better than orifices made from other plastics. Flow rates were inconsistent with those marked on the orifice.

There are a multitude of grades of ceramic. Some are good, all are extremely brittle, and all have been inaccurate so far. Most are placed in a brass holder that does not stand up under certain chemicals, and if cemented into stainless steel holders, some chemicals attack the cement and the tip falls out. So far it has been the brittleness and inaccuracy that has defeated these tips.

PLASTIC orifices, depending upon the material from which they are made, can vary due to absorption of liquid or loss of moisture. They are made by molding over a pin. Shrinkage must be considered in this molding process, because these pieces are literally knocked out of the molds and ejected from the orifice core pins by the thousands. Orifice sizes will vary due to the mold, tically matched orifices, except in
mold temperature, mold pressure, molding time, the plastic used, the plastic temperature, the skill of the operator or the skill of the set-up man. Accuracy is not one of the strong points of this type of orifice in a production run due to the aforementioned variables. Machining plastic would improve the accuracy, but results in fibers and burrs in the orifice that would require hand deburring at a great expense and possible distortion of the spray.

**BRASS AND ALUMINUM** are easily machined, can be made to almost any tolerance desired if the proper equipment is available, will withstand most of the ordinary agricultural chemicals used in weed and pest control, and are readily available. Aluminum does have the tendency to gall and to wire draw if hurried through the machining process. If threaded and joined aluminum to aluminum, then a lubricant, such as molybdenum disulfide is suggested so that the parts ring with the spray pattern, but may be disassembled at a future time.

**STAINLESS STEEL** orifices are punched, drilled or machined, depending upon the type being produced. If punched, then one must expect dulled or broken punches which will produce irregular or oversized orifices, resulting in greater capacities than those indicated on the nozzle. In addition, ridges and burrs can be found within the orifice as well as on either side of it that will interfere with the flow characteristics of the liquid and the nozzle capacity. If machined to tolerances, then the only care to be taken concerns the fibrous nature of stainless steel itself. Minute burrs or fibers can be pulled into the orifice by the dragging action caused by the drill, or cutter in forming the orifice. This occurs when the machine is pushed for time on each tip and cannot properly do the work it should, or the tools are too dull.

**HARDENED STAINLESS STEEL** has the same problems as stainless steel, but a much tougher grade of stainless is used and it has a tendency to chip or break off pieces as it is machined. Furthermore, the stainless qualities can be lost or greatly reduced if the heat-treating process that hardens it is done incorrectly.

**CERAMIC** orifices are sensitive to chipping or crumbling when made, which will result in distorted spray patterns and flow rates due to the orifice irregularities. Among new orifices, whether molded or machined, a wide variation of flow rates is found among those orifices supposed to be of the same size. The normal orifice configuration requires an extreme control of dimensions and positions that ceramic fabrication methods cannot meet. Experimental tests with ceramics, as with plastics, have resulted in great variations in the orifices of a single batch, and even wider variations in batch to batch runs. Orifices can be individually tested, selected and matched, but that would defeat the low cost supposedly possible through their use. Ceramic technology is certainly well advanced for many items, but it has not gone far enough nor adequately enough for spray nozzle orifices.

**TUNGSTEN CARBIDE** orifices can be manufactured with great accuracy. The corrosion resistance to various chemicals is an unknown, and even greater variation can be expected when these chemicals are mixed with local water supplies. However, one could expect a long
life from these orifices due to ero-
sive conditions that might be present,
such as high pressure or en-
trained solids or both. Orifices of tungsten carbide are quite expen-
sive when compared to brass or stain-
less steel, but if there is no violent corrosive condition present,
and the erosive condition is not ex-
cessive, then one could expect the orifice to outlast the machine and
still be accurate.

So far precision has been men-
tioned and alluded to without any
figures to back it up. One way to
approaching the problem is through
your pocketbook. If you were spray-
ing a chemical that costs $3.20 per
gallon, and you were to mix it at a
rate of 1 pint per 5 gallons of water,
and apply it at a rate of 5 gallons
per acre, then 1 gallon of the chemi-
cal could treat 8 acres at a chemical
cost of 40 cents per acre, or $40.00
per hundred acres.

Some of the more unusual weed
control applications in the central
portion of the country have been:

Airplane or helicopter spraying
under strict control conditions to
prevent leakage and spray drift. An
interesting application has been to
control brush, followed by basal spot
spraying from horseback to com-
plete the kill.

Additional aerial spraying has been
for brush control along power lines,
pipe lines, railroad tracks, streams, etc. These are often fol-
lowed in a few weeks by further
application from ground driven
equipment and handguns to com-
plete the control program.

Spraying rights of way spraying is
done either by the railroads them-
sew or by contracting firms. The
aim is bare ground on the ballast so
that resiliency will be maintained.
Decaying vegetation retains water and
thus fosters compaction of the
ballast. Large volumes of liquid are
sprayed by tank trains moving at
fairly rapid speeds. The desire is to
have large drops and no drift, with
complete coverage of the ballast.

Another way to complete vegetative
control is desired is around, and upon, ammunition stor-
age bunkers in the various arsenals.
This is so that a grass fire will not set
off the explosives. Standard weed
control nozzles are used here, plus
handguns to reach places where
equipment is unable to enter.

We have varied an orifice for spot
treatment of Johnson- or Bermuda-
grass clumps from a knapsack
sprayer that uses gravity flow of the
liquid. Our FloodJet tip could also
be used with one of our trigger
type of handguns.

There are several sectors of agri-
culture that can use a broadcast
method of weed control. We could
expect ground equipment to use the
BoomJet, FloodJet, or FieldJet nozzle
for these purposes along power
lines, for brush control, in pasture-
lands, roadsides, drainage ditches,
streams, ponds and other waterways
to clear out choking vegetation such
as water hyacinths. The process is
also used to break up oil spills in
Sweden and in the Gulf of Mexico.

Another use to to combine herbi-
cides and/or insecticides with fer-
tilizer in solution or suspension, and
to broadcast apply it on fields. How-
ever, there is a problem here, a
plant root will travel to a food
source, whereas a given amount of
herbicide must be deposited upon a
plant to kill it. Therefore, one must
not expect complete weed control
from broadcast applications since
the drops will vary in size and dis-
tribution due to pressure variations,
viscosity of the liquid used across
the field, height and attitude of noz-
zel in relation to the ground sur-
face, plus any of many variables
that always seem to arise at un-
expected moments.

Lastly, there is the possibility of
using Ultra Low Volume sprays to
directly apply technical grade herbi-
cides. The U.S.D.A. defines them as:

1. Ultra-Low Volume
2. Ultra Low Volume
3. Low Volume
4. Conventional

It had been proposed in 1967 that
conventional be considered as all
applications above 4 gallons per
acre, and that low volume be from
50 oz. to 4 gallons per acre.

All of you are aware of the 5 gal-
loons per acre, and larger capacity,
nozzles for weed control. We have
also produced orifices that can apply
less than 1 gallon per acre, but run
into a series of conditions of which
you might be unaware. First of all,
your equipment must be scrupulous-
ly clean to continue to operate; sec-
ond, pressures will have to be in-
creased for the very small capacities
in order to form the spray, and that
means greater speed of the spray
t to hold down the gallonage per
acre; and last, you cannot see
whether the nozzle is operating or
not, and this is the most critical of
all the points. That which is left is
a mist-type of unit using a large fan
to shear and distribute the chemical
over the crop area, and the obvious
problems that entails when using
herbicides, or the helicopter/air-
plane for aerial application, and this
is where the spraying of technical
grade chemicals originated on a
large scale. Lastly, there is a method
of using compressed air to atomize,
impact and project technical grade
chemicals onto a crop at a rate as
low as 4 oz. per acre. However, 16
oz. to 32 oz. appears to be a more
partical rate to use. Fluid rates can
vary with the pressure applied, de-
gree of atomization will vary with
air pressure from 7 psi to 15 psi. Ex-
erience has shown 7-9 psi of air is
sufficient.

**ADVANTAGES**

1. Elimination of water hauling.
2. No mixing required—chemical is
sprayed as supplied by the man-
ufacturer.
3. More effective use of the chemi-
cal—tests indicate that ULV in-
secticide applications can be
made on an extended spray
schedule.
4. Reliable equipment is available
in some areas.
5. More acreage can be covered per
day.
6. More latitude is available to the
chemical formulator.

**DISADVANTAGES**

1. Air assisted atomization creates
such fine particles that wind
drift will be a definite hazard.
2. Conventional equipment cannot
be used. New, and more expen-
sive controls, instruments, air
compressors, pumps, etc. and
other parts must be obtained to
supply the accuracy needed.
3. Operators must be trained.
4. Because it is an herbicide that we
are considering, absolute pre-
cision is necessary through-
out the equipment and appli-
cation procedures.
5. Internal cleanliness of equipment
is a must.
6. If used for herbicides, the equip-
ment cannot be used to apply in-
secticides or fungicides to herbi-
cide susceptible crops. This is
quite an expense to stand idle.

We are now engaged in a study of
particle sizes produced by various
orifices under varying conditions.
So far none of this information
has been published, and it may
never be for its use is highly spe-
cialized. We will listen to the needs
of scientists, and can often give
them the information desired in
short order. However, we cannot do
research work for firms if it has no
bearing on our needs.