

## Contact Applicator Head Materials for Corrugated Manufacturer's Joint Gluing

*D. Riehle, Mechanical Engineering Manager  
D. Swedes, Director of Engineering and Manufacturing  
Valco Cincinnati, Inc.*

### Abstract

Since the inception of contact extrusion for gluing manufacturer's joints in corrugated cases, Valco has offered a number of materials for applicator heads that claim different wear properties and therefore life expectancies. Each applicator head material has a different price point. With the advent of *imitation competitive applicator heads*, making the selection of head material can be difficult and confusing. This paper will present wear data for Valco heads and show that the carbide head provides the best price/performance ratio, followed closely by the tool steel heads. Stainless steel heads, however, have demonstrably shorter lives and are, therefore, poor investments for customers. The paper will also show that hardness is not an appropriate substitute for wear in various materials. Only experimental evidence can determine how well a given material will wear.

### Description of the Experiment

The following method was used to test and compare the wear rate of applicator heads, so that a comparison can be made from one material to another, and hence a wear rate per price can be established. The test fixture uses a 320 grit aluminum oxide belt running at 800 fpm on which the applicator head, floating on frictionless bearings makes contact with the sanding belt at the standard 35 degree angle (fig. 1). For the first 20 minutes, the heads are measured for wear every minute. If a severe wear rate is observed, the head is re-measured every minute; otherwise checks are reduced to every half hour.

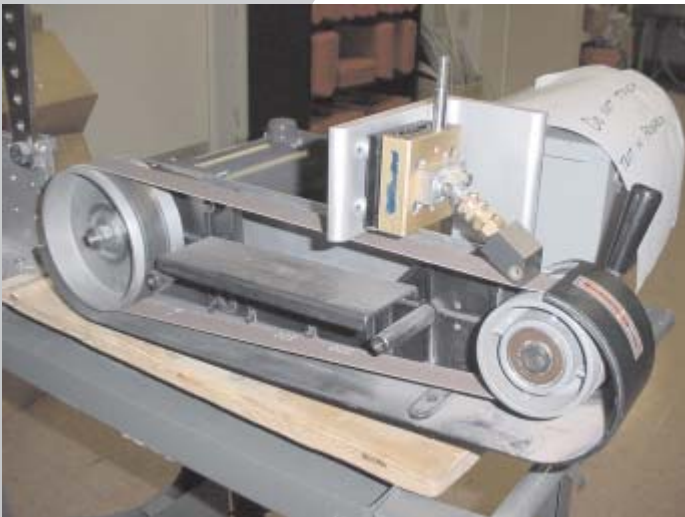


Fig. 1 – Experimental test fixture showing frictionless bearing and applicator head

The heads are measured using a special fixture equipped with a dial indicator that sweeps across the head profile (fig. 2). The sanding belts are changed every hour to maintain a consistent wear surface against the applicator head.



Fig. 2 – Measuring fixture for establishing the degree of wear on each applicator head

This test was performed on two versions of stainless heads as well as ceramic, carbide and tool steel heads. All applicator heads tested were 3 vein with ¼ inch (5mm) spacing between the holes. The applicator head veins were all 0.060 inch (1.5mm).

### Results

Both stainless steel heads had the highest wear rate of 0.011 inch (0.28mm) in 19 minutes, or  $579.0 \times 10^{-6}$  per minute. Stainless steel was followed by the tool steel head that had a wear rate of 0.00875 inch (0.22mm) in 830 minutes or  $10.5 \times 10^{-6}$  per min. This means that the tool steel head should yield 55 times more life than the stainless head. The ceramic head wore 0.00875 inches (0.22mm) in 1200 minutes, or  $7.3 \times 10^{-6}$  per minute, which is 1 ½ times better than the tool steel.

The carbide head performed the best. Its wear rate was .00025 inches (0.006mm) in 1200 minutes or  $.2 \times 10^{-6}$  per minute. This rate is 52 times better than the tool steel head and 2895 times better than a stainless head. Table 1 shows the wear rates for all heads.

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Table 1 – Wear rates for various heads and materials

Head	Experimental Wear rate (10 <sup>6</sup> in./min)	Theoretical Comparative life span
Valco Stainless	579	1 week
Imitation Stainless	566	1 week
Valco Tool Steel	10.5	1 year
Valco Ceramic	7.3	1.5 years
Valco Carbide	0.2	50 years

Although the results appear dramatically different for the materials, there are other factors that increase the life of the stainless heads compared to the tool steel, ceramic or carbide. In addition, conversion to actual life spans in a corrugated plant depend on the type of corrugated being run, the number of hours the machine runs, machine speeds, etc.

Although the tests were continued beyond the point where glue patterns would deteriorate, each head, except for the carbide, was taken to roughly the same level of wear. The carbide head never reached a significant amount of measurable wear.

Figure 3 shows the progression of two stainless steel applicator heads, one Valco head and one Haeco head. Although both heads are hardened, there is significant wear after only 5 minutes.

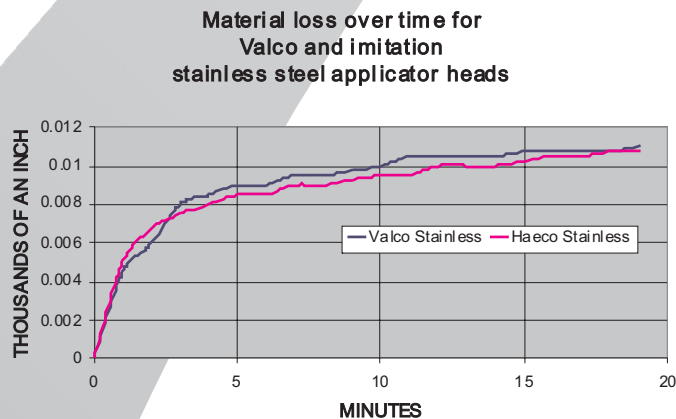


Fig. 3 – Wear rate over time for Valco and imitations stainless steel applicator heads

**Material loss over time for Valco tool steel, ceramic and carbide heads**

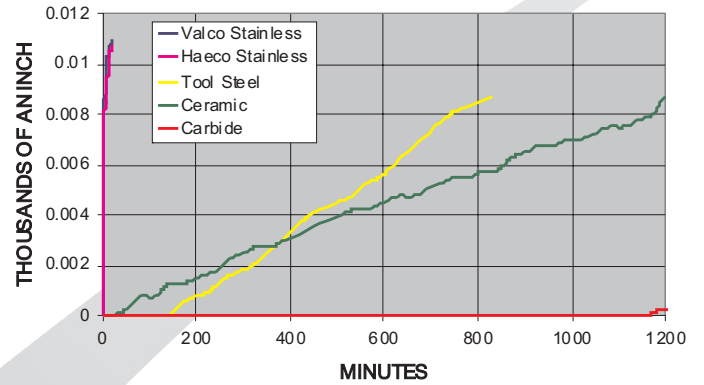


Fig. 4 – Wear rate over time for all applicator heads tested

Figure 4 shows the stainless steel data on the far left of the graph, almost undiscernible. In comparison, the ceramic curve progresses linearly beginning the wear process immediately, but lasting much longer than stainless. The tool steel graph shows no wear for the first 160 minutes and then begins to loose thickness as it wears away. The first 160 minutes showed no wear because the titanium nitrate coating was protecting the tool steel. Finally, the carbide data never really showed any significant wear throughout the test. Only at the 1200 minute mark was there a slight measurable wear.

**Interpreting the Results**

The above tests were conducted with Silicon-Carbide coated 320-grit sand-paper in order to accelerate the results. Material removal rates (the indicator used as a substitute for wear rate) are affected by the hardness of the abrasive as well as the grit size of the abrasive. The hardest abrasives cause other materials to wear faster and last the longest themselves. Larger grit sizes remove material the fastest.

Several factors skewed the results somewhat in favor of the tool steel, ceramic and carbide materials:

- Because sanding belts were only changed once per hour, fresh abrasive was available for much longer in the faster wearing stainless steel heads than the harder heads. This would tend to understate the wear rates of tool steel, ceramic and carbide because they weren't exposed to fresh abrasive as much during the tests.
- There are differential rates of work-hardening that made the tool steel appear to be more wear resistant. Work-hardening happens when the temperature of the metal increases and creates a layer of harder material in contact with the abrasive. These factors were less significant in the stainless because the temperatures reached during the testing were not sufficient to work-harden. Clearly, ceramics do not work-harden.

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### Other Factors

Although a 50-fold difference between wear of hardened stainless and titanium nitrate coated D-2 tool steel would appear implausible, volume loss tests indicate approximately a 60-fold difference between D-2 (an ideal tool steel for wear applications when hardened and coated) vs. other, more conventional steels.

The further 50-fold difference in wear between carbide and tool steel is also feasible. As carbide components are added to an alloy, its hardness increases very mildly, but its wear resistance increases dramatically. However, carbide materials are more subject to pitting and erosion than tool steels. Erosion occurs at the glue orifice outlets and can cause pattern deterioration prior to the contact surface wearing out. However, none of the factors above is significant enough to skew the results by more than a factor of 2.

Ceramic materials can be selected for different levels of performance. The ceramic used in Valco applicator heads is a material that is less hard than some ceramics, but also much less brittle. Valco ceramic heads, therefore, sacrifice some wear resistance in order to be practical to use.

### What is the Best Buy?

Although carbide heads appear to offer the best wear resistance, what is the best overall value among the choices available?

So what is the best buy based on our present pricing structure? In order to determine value a, "wear index" has been assigned to each of the applicator head materials. The index number for stainless steel, which wears the fastest is, 1. Similarly, a "cost index" has been assigned to each head based on its selling price. A stainless steel head, which is the least expensive, will again have an index number of 1.

A "wear/cost" index is then determined by dividing the wear index number by the cost index number. The higher the number, the more wear for the investment. Table 2 shows the results of the wear/cost indexes.

Table 2 – Wear and cost indexes for various heads and materials

Head	Wear Index	Cost Index	Wear/Cost Index
Valco Stainless	1	1	1
Imitation Stainless	1	1	1
Valco Tool Steel	55	1.4	39
Valco Ceramic	79	2.4	33
Valco Carbide	2895	2.4	1206

Clearly, carbide heads appear to be the best buy based on their extreme longevity. However, their brittleness requires very careful handling (they cannot be dropped on concrete floors without fracturing) and they are subject to erosion at the orifice outlets.

Tool steel is the clear value winner over stainless. Although the heads cost 40% more than imitation stainless heads, their added longevity easily justifies the investment, even if a few are lost or destroyed. Further, a stainless head will exhibit deteriorating patterns much more quickly which will require the vigilance of operators or an inspection system. A tool steel head can be run for months without a change in the pattern quality due to the head.

### Summary

Testing the wear characteristics of several glue applicator heads dispels many of the myths surrounding the applicator heads' longevity and value.

- Hardness is not a good predictor of wear performance as noted by the differences in wear among the tested heads, all of which share similar hardness values.
- Carbide applicator heads provide unparalleled wear resistance among the materials tested.
- Tool steel heads offer good value while being easy to handle
- Valco's unique coatings make tool steel heads even more wear resistant.

Clearly, plants buying stainless steel heads based on price are not receiving good value. The heads may put down patterns that are adequate, but, even considering some shrinkage from heads being lost or destroyed, the durability of a tool steel head far exceeds that of a stainless steel head. For plants focused only on longevity, best performing head for price and longevity is carbide. Considering handling factors as well, the overall best performer is Valco's Titanium-coated tool steel head.