Phoenix™ Tines – *Born in Fire*

Since 1998 when the first practical carbide tipped coring tine was introduced [the *Dillennium* tine[1]], the industry has been looking for a tine that would last as long but *not* have the problems associated with carbide tips. The Phoenix™ tine is the answer.

- The Phoenix™ process is a complex "thermo-chemical" metal treatment. It is *not* a coating but a fundamental reconstitution of the best available steel alloy, 4140. It is not a sprayed-on deposition and therefore cannot crack or chip off as a coating might. The multi-step process creates a much tighter cell structure than is present with the original alloy. Phoenix™ tines are processed in a vacuum under extreme heat and pressure which results in a new and far more durable metal composition.

- All Phoenix™ tines are guaranteed to last as long as comparable carbide tipped coring tines. In tests Phoenix™ tines surpassed carbide in use-life. When compared to non-carbide tipped coring tines one can expect a use-life gain of 300-500%.

Below are some typical examples of Phoenix™ tine usage in comparison tests:

In late September 2011 Buffalo Hill Golf Course in Montana used three sets of CTI 1S-626075 (5/8" X 6") alongside two 5/8" Phoenix™ 1SP-626075 (5/8 X 6") tines over 27 holes. A new set of 1S-626075 (non-Phoenix™) tines was used on each of the three nine holes (marked as A, B, & C). 2 X 2" spacing was used to a 2.5" core depth on a Toro 648 aerifier. The same set of two 5/8" Phoenix™ tines was used on all 27 holes [180,000 sq. ft.], shown above on the right. Two representative examples of each set are shown above with an unused tine on the far right. Due to scheduling the aerification so late in the season carbide tipped tines could not be used according to the superintendent because it would cause 'turf-lifting'. The Phoenix™ tines had an average loss of length due to wear of 0.265" over the entire 27 greens. The 'nose' on each tine was 1.2" long, so 22% of the tine life was lost over the 27 greens with no loss of wall thickness. In the pictures above two non-Phoenix™ tines are shown from each of the sets used on each nine holes; on the far right are two used Phoenix™ tines (gold colored) and an unused 5/8" tine as an example.

Conclusion

Since the nose wall has thinned so much with less than half the original 0.0650" it is likely that had the tines been left on the machine they would have only been able to continue to pull cores for another three or four greens. Therefore, the Phoenix™ tines have a 'use-life' ratio advantage of 4:1 as compared to non-Phoenix™ tines.

The Superintendent, Jon Heselwood said, "The Phoenix™ tines went the whole distance; they worked great". "They last as long as carbide tines."

Eagle Ranch Golf Course in Eagle, Colorado used both Phoenix™ and non-Phoenix™ 5/8" X 6". Prior to the aerification they 'top-dressed' with a significant sand mix. This led to a situation of significant tine abrasion where the non-Phoenix™ tines wore out and had to be replaced in just 5-6 greens [40,000 sq. ft.]. The Phoenix™ treated tines completed all 18 greens and the putting surface and could have done more.

Phoenix™ tines when compared to carbide tipped tines shortened the 'grow-in' time by 10-30%. How? The 'cut' with a carbide tip is never as sharp and clean and there is a very slight depression around the lip of the hole. This depression prolongs the grow-in by up to 30%. What does this mean for a course? We all know that serious golfers are very aware of when a course is to be aerified. With pay-for-play courses this means lost revenue and with private clubs this means unhappy members. For a course with a $50/round fee, doing 40,000 rounds per year, considering rain days, seasonality, and other factors, this means a loss of more than $7,000/day. Tests have shown that using Phoenix™ tines, instead of carbide, can shorten the grow-in by several days or as much as a week. Phoenix™ tines can actually pay for themselves by increasing revenues due to shortening the grow-in period.

- Carbide tip tines typically wear unevenly. In fact, companies that sell carbide tipped tines have 'side-wear' or 'timing problems' as an exception to their warranty. The little known fact is that *all aerifiers have some side-wear* – it's impossible to have absolutely even wear. As a machine is used, the bushings, cams, bearings, belts and other components wear and become loose causing side-wear. The faster a machine goes the more pronounced the uneven wear is likely to become. If you have used carbide tipped tines in the past, you may have seen a hole appear just above the tip -- often just before the tip falls off! This is because the tine wall is continually thinning and at some point the shaft can no longer support the tip. Some machines have side-wear programmed into their system as a function of how the aerifier works.

- Phoenix™ tines do not rust like other tines. All coring tines are shipped with an 'anti-rust' coating. If a coring tine rusts it will often not pull a core -- plug. Why? Severe rust causes 'pitting' of the metal on the inside of the tube. Pitting changes the coefficient of friction making it more difficult for the core to transition up the tube. This limitation means that once a set of coring tines is used steps must be taken to 'store' the tines to prevent rusting. This is a time consuming process and is often omitted. Tines can rust overnight so that they will not pull a core in the morning – and if left unprotected for a week, few tines will work properly. This is not a problem with the Phoenix™ tines, why? During the Phoenix™ treatment almost all of the iron (Fe) is displaced for a new, much harder element. The fractional iron that is left on the Phoenix™ does turn a golden color with no pitting.

- Phoenix™ tines typically have a larger ID (core size) than an equivalent carbide tine. This is because carbide is so brittle that it is limited in how thin it can be designed resulting in a typically large bulbous tip with a resulting reduction in the ID. The agronomic benefit to the Phoenix™ is that it will remove more material for the same size tine (OD).

- With Phoenix™ coring tines, there is less 'trauma' for an equivalent volume of material removed resulting in a faster recovery. Phoenix™ tines typically have a thinner wall than an equivalent carbide tine. By design, either the carbide tine must have a larger OD or a smaller ID. For example, a ½" Phoenix™ coring tine would frequently remove the same amount of material as a 5/8" carbide tipped tine. Phoenix™ tines do not need the additional wall thickness for increased longevity and strength and as the platform to weld on a carbide tip.

- How do Phoenix™ tines wear? As carbide tipped tines wears little change is visable. The tip gets 'rounded' but rarely wears out completely. The wall's thin out until there is a catastrophic failure. Phoenix™ tine walls do not 'thin out' – at least not measurably. The tine does 'wear' from the tip up. Tests have shown that a standard Phoenix™ coring tine might lose 0.250-0.375" over 18 holes; or shorten by 6-8% for a 6" tine with a 5" core. However, the amount of material removed increases by more than 7% during that time since the ID is increasing as the 'nose' is worn. The purpose of the carbide is to 'protect the shaft' but even the best tip cannot prevent the walls from thinning on both the inside and outside. The Phoenix™ treatment is so durable that the only measurable loss is to the length.

- How hard is a Phoenix™ tine? Most alloy steels (4140 or 4130) used for tines are heat treated to a Rockwell C hardness of 46-48RC. Since the Rockwell C scale is a 'logarithmic' measurement and not a straight line linear scale any single digit increase is significant. To try to raise the hardness to a higher, more durable, hardness would result in the tine becoming too brittle. The Rockwell C scale only goes up to a hardness measurement of 72RC. Standard measurement equipment cannot measure hardness above a 72RC level. The reason for this is that the standard technique is to imprint a diamond into a flat surface with a known force and measure the depth of the imprint. This technique cannot take a measurement above about 72RC. Our Phoenix™ treatment is able to raise a theoretical hardness above 85. In short, a Phoenix™ treated tine can safely be called *diamond hardness*. Phoenix™ tines will not chip, scratch, or splinter.

- Turf 'tufting' can be a significant problem with carbide tipped tines, especially as they near the end of their 'life span'. Why? The carbide wears at a much slower rate than does the metal shaft above the tip. This causes an 'interface' junction which has a noticeable 'lip'. This rough place becomes increasingly problematic as the tine shaft wears. This lip causes the sidewalls of the hole to have less integrity and under certain soil conditions will cause the walls to partially collapse. In all cases, as the lip gets larger there is additional material pulled up and 'tufting' around the top of the hole. Phoenix™ tines have no such issues.

- Phoenix™ technology's benefit for *solid* tines is very special. Carbide tips have never been successfully married to solid tines. There have been attempts but it has never worked well at all. So the industry has been left with little recourse but to accept the limited life of standard, heat treated steel. The Phoenix™ technology is ideal for solid tines and will increase the use-life by 300-500% . Ω

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[1] *Dillennium* is a registered trademark of JRM, Inc., Winston-Salem, NC