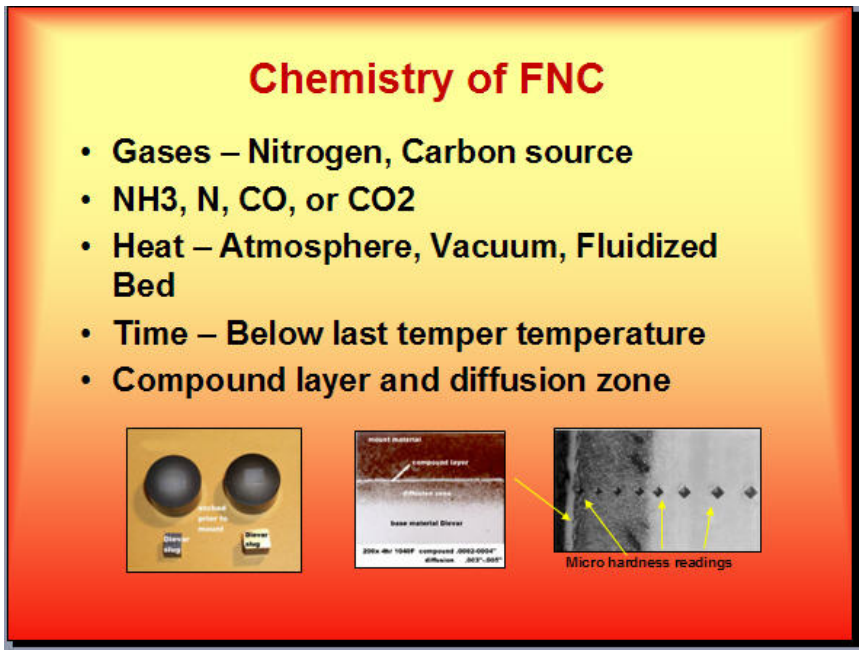
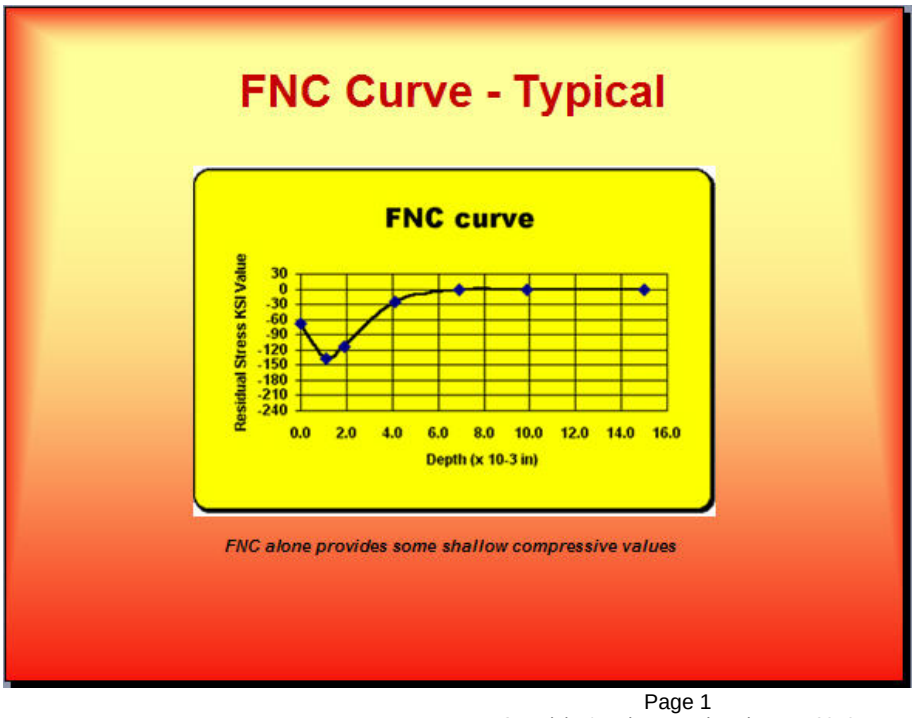
BADGER METAL TECH, INC.

N60 W15088 Bobolink Ave Menomonee Falls, WI 53051 262-252-3804

ThermaLife®

Our diffusion process is a proprietary form of ferritic nitrocarburizing performed in a vacuum assist environment. By a batch process, tool steel is heated to a safe temperature that is well below the final temper of the tool so final hardness is not affected. Once heated, uniformly, a mixture of gases are introduced under pressure with the tooling experiencing the temperature, pressure, and gas environment for a prescribed time. Each type of steel receives a different combination or recipe of these parameters. The gases contain both Nitrogen and Carbon atoms. A thermo-chemical reaction occurs whereby sub-zone and a compound layer are created as nitrogen and carbon atoms are diffused into the steel's surface. The depth of diffusion can be anywhere from .004"-.006" (102 to 203 microns) depending on the recipe used. The compound layer is both hard and much thinner .0002" to .0008" (5 to 20 microns) and somewhat ceramic in nature. This compound layer is about 1200 to 1500 vickers in hardness. If you try to abrade the steel with a 65Rc common file, it will not damage a ThermaLife® processed surface.



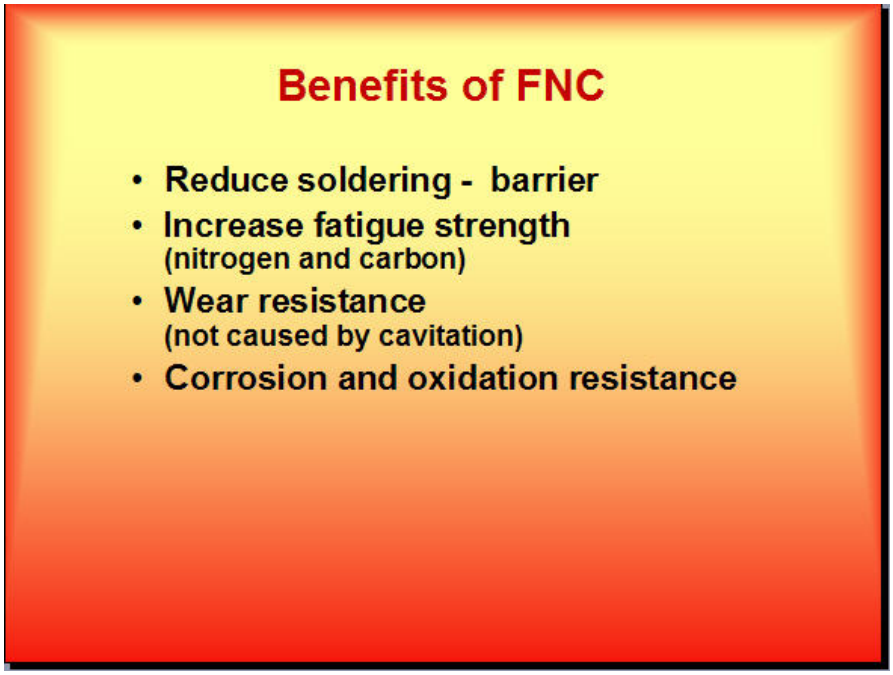


It is this diffusion zone and compound layer that provide protection against soldering of aluminum for die casting & extruding tooling, increased wear resistance, and protection against corrosion, while providing an increase in the fatigue strength of the steel from compression.

It differs significantly from common nitriding in that the cycle time is much shorter, a functional compound layer is created, and both nitrogen and carbon are diffused

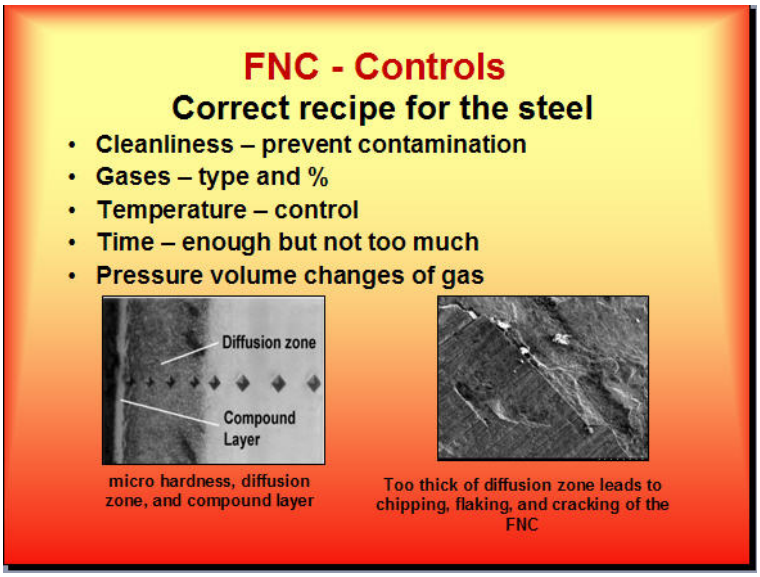
Iron and aluminum, due to their electron imbalance have an affinity to one another. The ceramic barrier of ThermaLife® prevent this interaction from occurring As the

atoms of nitrogen are diffused into the surface of the steel, they have, on a nano level, a stretching affect on the steel. Opposing this is the layer just below the diffusion zone. Hence a compressive layer is created much the same way as impacting the surface is done with MetaLife® to create the high residual strength of tool steels. In the case of TherMaLife® higher hardness is created with no distortion. The core properties of the steel do not change.



Because of the thin compound layer that prevents soldering it is important to protect this layer.

There are two types of soldering effect – mechanical and intermetallic. Only the intermetallic occurs when the barrier for solder prevention breaks down or is removed. Mechanical is simply the adherence to the surface due to loss of die lubricant. It is important not to polish or stone this solder since it could damage the compound layer resulting in the loss of the protective barrier since both the aluminum and some of the die steel are removed. It is best to remove the solder using ultrasonics and/or sodium hydroxide (NaOH) which will dissolve the aluminum without attacking the steel. Other chemicals or methods should not be used.



CONTROLS

Just as protecting the compound layer is important, we also control the thickness of both of the TherMaLife® layers. Too thick of diffusion zone can lead to chipping, flaking, and cracking of the FNC. To thin of zone results in a thin compound layer and loss of the desired benefits. Desired results can be obtained from any method as long as a proper recipe is followed to attain the results and the benefits customers desire.

This separates TherMaLife® from the other nitriding and FNC methods. We have developed through years of research the correct recipe for tool steels that maximize the desired benefits.

Time and temperature are the two most critical factors which may result in a thick diffusion zone and resulting compound layer. Below are 100x photos of two types of steel with different chemical compositions and diffusion characteristics. The one on the left has the correct diffusion zone and compound layer. The one at the right has a crack prone diffusion zone and compound layer even though both received the same recipe**.**

Both **ThermaLife®** and our other process – **MetaLife®** have profit and cost saving benefits for productivity and casting cost. Only Badger Metal Tech, however, knows how to combine the two processes to receive the synergistic benefits.

TooLife

By first applying **MetaLife®** and following it with **ThermaLife®**, you receive not only the compressive benefits of both but also the buffering of cavitation damage to your tooling. Here is what it is all about. Make sure you download our brochure on **TooLife™.**