GAS NITRIDING A4601 – Issue 1
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Introduction of the nitriding factor, K_N as the driving force for gas nitriding, provides for precise, continuous control. The traditional measurement of % dissociation now provides a convenient parameter for checking the accuracy of the calculated K_N and in some cases, as the primary control parameter. 关于渗氮成分的介绍，K_N
作为渗氮气体的驱动力提供了一个精确，持久的动力，传统的分裂百分比的测量标准现在提供了一个方便的参数来检查其计算出的K_N的精确性，并且在某些情况下它是做为一个初级控制参数存在的。

INTRODUCTION
简 介

The metallurgical processes of carburizing and nitriding have followed similar patterns as the technology advanced, and in a process of continuous evolution both procedures have progressed through similar developmental stages.

渗碳和渗氮冶金工艺都遵循相似的先进科技模式，在持续的演化过程中两个程序都经历了两个相同的发展阶段

Carburizing, early on, was conducted by packing the work pieces in a thick layer of carbon powder and raising them to temperatures conducive to diffusion of carbon into the work.
在初期，渗碳是将碳素渗透到工件的深层，并将温度上升到有意于碳粉扩散到工件中的程度.

While the process was effective, it was excessively slow, and difficult to control, so it progressed into a process utilizing a carbonaceous gas atmosphere.
当工艺运行的时候，它进行的速度是十分缓慢的，并且难以控制，因此它可以进入到利用含碳气体气氛的工艺 .

The only effective way of controlling this process was to establish a relationship between the enriching gas flow, and measurement of the carbon potential, using either periodic shim stock or dew point measurements.
控制这个工艺的唯一的有效方法是用周期性的垫片或露点测量仪器在加强气体流动和对碳式的测量之间确立起相应的关系.

This technique persisted until the early seventies when the zirconia carbon sensor was first introduced. 这一技术会一直持续直到开始的七十件氧化锆碳传感器先行被渗透以后.

This device provided continuous measurement of the carbon potential, rather than the discontinuous measurements from shim stock or dew point.
这一设备提供了持续的碳式测量仪，而不是用周期性的垫片或露点进行的不连续测量。

The measurement has been subsequently refined, by adjusting the sensor calibration using 3-gas (CO, CO_2 and CH_4) IR nalyzers to calculate the true carbon potential.
通过用

3种气体（一氧化碳、二氧化碳、甲烷）调整传感器的刻度，它的测量也会更加精确.
The technique is currently applied to carbon control using continuous non-dispersive infrared analyzers, which measure continuously rather than periodically.
当前应用于碳式控制的是一个连续性的非红外线分仪。它连续性的分析而不是周期性的。
Nitriding has followed a similar path. The process provides several advantages for the alloys treated, such as high surface hardness, wear resistance, antigalling, good fatigue life, corrosion resistance and improved sag resistance at temperatures up to the nitriding temperatures.
渗氮也是采用的相同的方式，这种技术为处理合金提供了几大优点，比如表面硬度高，耐磨性、抗磨性好，抗疲劳强度高，抗腐蚀性能好，提高了在氮化温度下抗凹陷的程度。
Since the early beginnings of gas nitriding, the % dissociated ammonia (PD) was considered the appropriate control parameter.
在渗氮的早期氨气(PD)的分解的百分比被认为是最合适的控制参数.
This parameter is easily (but discontinuously) measured using the ammonia dissociation burette, which is calibrated directly in PD. In the 1990’s, however, a new control parameter, the nitriding potential, was introduced. This parameter is defined by the equation.
用氨气测量计这个参数很容易（非连续性的）就被测量出来。用均衡仪可以精确这种参数。

$$K_N = pNH_3/pH_2^{3/2}$$

It is now the preferred control parameter for many industry material specifications.
<u>现在可以精确工业原料明细表的控制参数</u>

<u>THE TECHNOLOGY</u>

技术参数
When ammonia is introduced into a furnace, it dissociates according to the following reaction;
将氨气应用于热处理设备后，它会根据下面的反映进行分解.

$$2NH_3 => N_2 = 3H_2$$

Although this reaction will ultimately go to completion, it is basically very slow. It has been determined that, if the furnace atmosphere is changed four times every hour, the amount that the ammonia is dissociated is 25% +- 10 %.
虽然这个反映最终会完成，基本上它的进行会十分缓慢，如果熔炉气氛每个小时改变四次，氨气分解量为25% +- 10 %。

An approximate relationship between ammonia flow rate and % dissociation is shown in Fig. 1. The general shape of the curve will vary with the particular nitriding furnace, and will also likely be affected by the size and surface area of the load.
在图1中显示的氨气流动率和分解百分比十分近似，曲线图表的大致形状和特定的渗氮炉是不一样的，并且在熔炉的形状和装载面积等方面也会受到影响。
Fig. 1 also illustrates the basic relationship of ammonia concentration in the furnace atmosphere to the % dissociation, i.e. PD = 100 - %NH_3.

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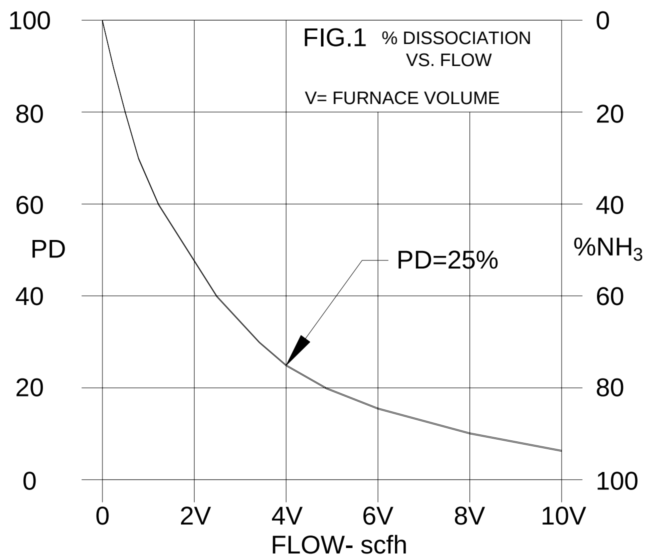
图表1也说明了在熔炉气愤中的氨气浓缩和分解率的基本关系。例如，渗氮历史上是用无水氨通过一个步骤或两个步骤进行的.

Nitriding has historically been conducted as either a single-stage or a double stage process using



anhydrous ammonia. Temperatures in the single stage process range from about 925^{o}F to 975^{o}F, and dissociation from 15% to 30%. The first stage is normally conducted for a period of 4 to 10 hours.
如果只需要用一个步骤温度范围是925^{o}F 到 975^{o}F， 分解范围是从15%
到30%.第一个步骤的渗透通常需要4到10小时.
The process creates an intense layer at the work surface, which is known as the white nitride layer.
在工件表面产生了一个强化层，这就是所谓的白色氮化层。
This layer is rich in dissolved nitrogen and nitrides.
它能有效的分解氮和氮化物。

When the two-stage process, known also as the Floe process (U.S. Patent 2,437,249) is used, it has the advantage of widening and modifying the intensity of the white layer.
如果应用的是两个步骤的工艺，它就是所谓的浮冰工艺(美国专利2,437,249)
，它有加宽和修改白色加强层的优点。
The second stage may proceed at the same temperature as the first stage, or may be raised to from 1025^{o}F to 1050^{o}F.
第二个阶段可能会在和第一阶段相同的温度下继续反应，或者会将温度提高到1025^{o}F 到 1050^{o}F。

The second stage PD is increased to 65% to 80% which allows the further diffusion of white layer components toward the core.
第二阶段的PD 从65% 上升到 80%，他可以使白色加强层向深层扩散.
This PD may be achieved by reducing ammonia the flow rate, or (preferably) by adding a diluent such as nitrogen, dissociated ammonia or hydrogen, in order to ensure adequate positive flow.
通过减轻氨气的流动率可以得到PD参数，为了确保适当的正流，（更适宜）加入稀释后的氮，离解氨或氢。
The nitriding process is carried out by the catalytic generation of nascent (monatomic) nitrogen at the surface of ferrous alloys.
渗氮工艺是通过与表面的铁合金上的初氮（单原子的）发生接触反应.
The nascent nitrogen diffuses into the surface and exists as either dissolved nitrogen or as iron nitrides such as they' phase (Fe_4N) or the ε phase ($Fe_{1-2}N$). There are several alloying elements in alloy steels that contribute to the favorable characteristics provided by nitriding.
初氮在表面扩散后以溶解氮和氮化铁的形式存在，如γ' 元素 (Fe_4N) 或ε 元素 ($Fe_{1-2}N$).在合金铁里含有多种合金元素，这些元素对渗氮形成的良好特征有促进作用。

Notable are aluminum, chromium, molybdenum, tungsten and vanadium, all of which form nitrides that are stable at nitriding temperatures.
值得注意的是铝、铬、钼、钨和钒，所有这些氮化物在渗氮温度中都是很稳定的。

In addition to microscopic cross section evaluation of work samples, effective processes are often evaluated by plotting hardness profiles with depth. Because these profiles are significantly effected by the core hardness, the work must be pre-tempered at the lowest possible temperature, usually 30°F to 50°F above the nitriding temperature.
除了显微的工件样品的横截面的值，有效的工艺的值是由测绘剖面深处的硬度来衡量的。因为这些剖面很容易受到核心硬度的影响，这写工件都必须先经过在尽可能低的温度下的热处理， 通常是在渗碳温度上的30°F到50°F.

PROCESSING
工艺

Metallurgists have developed proprietary recipes for a large variety of products, tailored to suit their requirements for these products. An extensive list of these recipes is provided in the ASM Handbook, Vol. 4, Heat Treating, March 2001. Single stage processes vary in time from 8 hrs to 48 hrs. Two stage processes vary in time between 42 and 127 hours, with the second stage time being between 2 and 5 times the first stage time.
冶金学者研究出出一种适用于大部分产品的
独特的方法，使用于这些产品的各种要求，并在2001年3月出了4卷关于热处理的ASM手册，里面提供了大量的菜单，
单个步骤的工艺在8小时和48小时之间是不同的，而两个步骤的工艺是在47小时到127小时之间是不同的，它是单个步骤的2到5倍.

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An aerospace industry standard was published in 1999, SAE Aerospace Material Standard AMS2759/10, which stipulates control with the K_N nitriding potential as the control parameter. This standard specifies three classes of processes resulting in Class 0- No white layer, Class 1- 0.0005" maximum white layer and Class 2- 0.001" maximum white layer. Nitriding potentials for all classes range from 4 to 15 for the first stage and from 0.2 to 0.8 for the second stage of Class 0, from 0.4 to 2.6 for the second stage of Class 1 and 1.2 to 5.5 for the second stage of Class 2. Treatment times are not stipulated.
1999年出版了关于航天和航空业标准，SAE航空材料标准AMS2759/10，它保证了对作为控制参数的氮式K_N的控制，这个标准表明了3级工艺导致了从0级-白色锘层，1级-0.0005"极限白色层和2级-
0.0001"极限白色层，在0级的第一阶段所有级别的氮式范围是从4级到15级，
第二阶段是从0.2 到 0.8，在1级的第二个阶段是从0.4到 2.6，在2级的第二个阶段是从1.2到 5.5，处理时间是没有做规定的.

This specification provides a brief description of essential controls for nitriding processes:
这一规格提供了一个简单的对渗氮工艺的基本控制的描述.

1) Pressure controls to assure that a positive retort pressure be maintained
压力控制确保维持正向曲颈
2) Nitriding atmosphere to control composition of the feed gasses and the nitriding potential K_{N}-.
渗氮气氛控制流入气体的成分和氮式K_N
3) Atmosphere flow rate controls to maintain the nitriding potential and
气氛流动率控制保持氮式
4) Shutdown and alarm controls for safety shutdown in the event of system malfunctions.
为安全关闭设定的关闭和警报控制，以免出现系统故障

Super Systems nitriding systems meet this specification and exceed it in providing cascade temperature controls and sufficient memory for 300 twelve-step programs.
SSI的渗氮系统满足了这一要求，并且在温度控制方面的性能大大的超过其要求，提供了满足300系列的十二步程序的足够内存。

SUMMARY
摘 要

Nitriding control by % dissociation will continue to be a significant portion of the nitriding market place. The introduction of the nitriding potential, K_N presents a viable alternative, but there is insufficient data on effectiveness of the two parameters to make a judgment about which is preferable. Super Systems addresses this paradox by providing both parameters as a feature of

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all systems. As with carbon control, where %C is calculated from the measurement of oxygen, the nitriding control parameters (PD and K_N) are precisely calculated by an SSi proprietary analytical technique.
通过分解程度来控制渗氮将仍然是渗氮市场的一个重要部分，对氮式K_N的介绍提供了两个可行的选则，但在两个参数的有效性上要证明哪一个参数更优越其数据还很不充分，SSI通过提供做为所有系统的特征的这两个参数来解决这一矛盾，作为碳控制，碳当量是通过对氧气的测量来计算的，渗氮控制参数(PD and
K_N)是由SSI的所有的分析技术来精确测量的。

The importance of superior temperature control has been demonstrated, and is related to the fact that a change of 1^{o}F causes a change of about 1 % PD. This is addressed by the provision of advanced cascade temperature controls in SSi nitriding systems.
高温控制的重要性已经被充分证明，它涉及到一个事实就是改变1^{o}F的温度就会产生1 % PD的变化，这通过SSI的渗氮系统中先进的温控系统已经得到解决。