

## Automatic neontube processing 自动化霓虹灯管处理的经济理论

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In recent years there is an increasing interest in automatic neon-processing equipment, especially in Europe.

There are several reasons for this phenomenon.

近几年来,尤其是在欧洲,业内人士对于自动化霓虹灯处理系统的兴趣日益增加。产生这种现象的原因归纳起来有以下几点:

Firstly, people are getting very quality aware. Customers are turning away from neon because they don't want to see neon failing so frequently.

首先,人们对质量的意识愈来愈深刻,很多顾客正因为霓虹灯的频繁失灵而掉头而去。

The industry is losing customers and is now focusing on how to improve the quality and to raise life expectancy of the tubes and hence warranty periods.

由于顾客不断流失,促使行业现在着眼于如何改善质量和提高灯管的寿命进而延长保用期。

A major step forward was the voltage limitation to 10 kV caused by the implementation of EN50107-1, together with the improved cables and safety distances.

一个主要的改进步骤是实施欧洲EN50107-1安规限制电压不得超过10kV以及改善电缆质量和安全距离。

Improving the quality of the tubes means respecting the guidelines based on many years of combined experience and sharing of knowledge by many companies.

改进灯管的质量意味着遵照指导方针,而这指导方针是建立在众多企业多年经验的结合以及知识共享的基础上。

These guidelines affect temperature, level of vacuum, processing time and filling pressure. Each of these factors are equally important and need to be observed well.

这些方针影响着温度、真空度、处理时间、充气压力,这些因素里面的每一个都同等重要并且需要被严谨监测。

More and more companies adapt to the quality management system ISO9001:2000. A major improvement compared to the old ISO9001 is the built-in obligation of constant improvement of quality. A basic need is to record the procedures and processes in order to trace later why something could go wrong.

愈来愈多的公司适应 ISO9001:2000国际质量管理体系的要求,相比旧的 ISO9001系统,新系统的主要改进之一就是强制性的在一致性质量上的改进。它的另一个基本要求是,所有的工序都必需记录在案,以备日后查找事故原因。

In Europe there is a new requirement to mark neon tubes with their electric characteristics, as they are an electric component under CE. So they need to show running voltages, and hence everybody can compare tubes from different sources.

在欧洲有一个新的规定,要求霓虹灯管必需标签有关的电气特性,因为在CE标准下它是属于电器零件的一种,必须显示运行电流,以便大家对不同公司的产品进行比较。

Next, there is a shortage of skilled workers that really master the processes. We all know that pumping is a critical process that can make or break the tube.

Young people sometimes without adequate training are put on the job, trying to do the job ever faster as they feel the pressure from the boss. But in this work faster is worse. Neon processing needs steady operators that do the job correctly, again and again. Only this consistency can guarantee consistent quality.

再者,就是能掌握制作技术的熟练工人的短缺。众所周知,抽真空是一个非常关键的步骤,若处理不当就会使灯管破裂。许多年青的工人缺乏足够的工作技能训练,同时又因受到雇主的压力而尽快

完成工作，然而这样操之过急的做法所导致的后果非常严重。霓虹灯处理必需依靠稳定的操作员正确地、不断重复地将工作做好。只有这样才能保证产品质量的一致性。

Why is everybody so much in a rush in Europe? Because the wages are very high and the open market faces competition from everywhere; all other places have cheaper wages, without exception. The only way european sign manufacturers can defend their industry is with quality and short lead times.

为什么欧洲的每个人都那么匆忙呢？因为高额的薪金以及市场开放所带来的无处不在的竞争，而这种竞争就算在其它一些相对低薪的国家也不例外。然而欧洲的标牌制造商维护其行业的唯一途径只能是注重质量和交货期。

Automatic neontube processing can help here. It brings the consistent quality, and increases the shop's capacity. Only, some people say it's expensive.  
在这方面，自动化霓虹灯制作可以大显身手，它使产品质量保持一致，同时，它能增强工场的生产能力。只有极少数人会认为它有些昂贵。

Why is automatic processing equipment so expensive?

Because everything must be measured by sensors and controlled by electric signals, not by the eyes and hands of an (unsteady) human operator.

但为何自动真空系统这么昂贵呢？因为每项工作都是依靠感应器和电子信号来测量、控制，而不是依靠操作员的肉眼和双手的感觉来判断（这是很不稳定的）。

An operator can watch a dial gauge, throttle a stopcock, monitor the paper that starts getting brown by the heat of the tube (or the meter if he has one), switch a bombardier on or off, pulling the amps up with a handle, yes all of these he can do. If he does it correctly, he can make a reasonably good tube. He can, but will he? Time after time?

操作员可以观看刻度表、调控活门、观察当灯管受热将纸烧黄（若他只有一个表），开/关轰击机、手动推高电流等，当然，他的确能做这些，若他正确操作的话，他是可以做出相当好的灯管。但这不是必然的。试问有谁能够一次又一次持续地做好么？

Automatic equipment can, time after time. But to measure all these variables, to interpret them correctly, to control valves and switches, it takes a whole lot of things.

There is a big difference between a vacuum sensor that you can read and a device that can be safely hooked up to a controller. The price can be more than threefold.

自动化真空设备却恰恰可以重复地工作，它能测量所有这些变量，并正确地译释、控制阀门及按钮等所有程序。比较一个倚靠人工阅读和一个用电脑操控装置的真空感应器，其价格的差距可以超过三倍。

A glass valve, as we all know, is a very simple device. It may cost only a few dollars and if the operator has a sensitive hand he can play it like a music instrument.

众所周知，玻璃阀门是一个很简单的装置，只值几美元，若操作员能熟练地处理，他就能够如演奏一个美妙动人的乐器一样。

But again, not everybody is a 'good musician' and the magic interaction between the operator and the equipment can fail. To build a similar mechanic valve that can be throttled is quite a different story. It can cost up to 300 times more. And we need more than one of these...

但另一个问题是，不是每个人都是‘出色的音乐家’，并且操作员与设备之间的互动可能会失败，就如制作一个类似的机械节流阀便有着很不相同的故事。其价格之差距可达300倍之多，何况所需要的还不只是一个...

The temperature sensor is a vital part in tube processing. No more paper to burn on the tube, but electronic sensors. That can be a contact sensor (like thermocouple or NTC) or a non-contact sensor (infra red). The main problem with the contact sensors is the galvanic coupling between the surface of the tube and the controller, in case of a sudden rise of pressure (e.g. if the tube cracks). That effect causes the high voltage to creep over the surface of the tube... straight through the

controller to earth. Not a pretty view, to see your complete controller being destroyed in one flash... So non-contact sensors are more useful here, but to keep it safe they should have a focus of at least 5:1, for a safe distance of 60 mm against the tube diameter of 12 mm as example. (10:1 would be safer, but the kind of sensor would be more expensive). Then again, the IR sensor must be put exactly in line with the tube and at correct distance, so more equipment is necessary.

温度感应器对于灯管制来说是一个很重要的部分，使用电子感应器则不需要烘烤纸张来测试灯管，这可以是接触式传感器（如热电偶或NTC热敏电阻）或非接触式传感器（红外线）。而接触式传感器有一主要问题是管表面与控制器之间会因压力可能突然上升（若灯管有裂痕）而导致电耦合的产生，这情况将促使高压蔓延至管的表面...直达控制系统至接地。整个控制系统在一瞬间被毁灭，你不想看到这样的情景吧？因此，非接触式传感器在真空系统的应用上会更为适合，但为安全起见，相对焦点距离应是5比1，若管径是12mm,安全距离就是60mm (10比1会比较安全，但所需的感应器相对较昂贵)。此外，红外线感应器必需严格对准灯管，要做到这一点，则必须加装更多的仪器。

The controlling of the bombarder is very critical. You cannot switch on the bombarder before the pressure is down to appr. 2 mbar otherwise you start bad creeping currents. Once the arc in the tube is established, you have to increase the current gradually according to the tube temperature, while throttling the vacuum valve, until the glass reaches a temperature of more than 300°C. That controlling should be a very smooth and timely process, so you need electronic control of the bombarder, linked to the main controller. The controller itself can cost half as much as the bombarder, and you need one bombarder per set of two tubes that you want to process together.

The gas transfer system is also different. Firstly, automatic equipment usually have large capacity gas cylinders, like 200 liters at 1 bar. That is very different from the old 1.5 liter glass bottles at 1 bar that so many shops still use (and change) every day. Next, the filling should happen in a very controlled manner and stop exactly at the required filling pressure. So the equipment must be sensitive and precise, once again a far cry from the old glass stopcocks.

如何控制轰击器是非常关键的，在压力还未到达2毫巴（mbar）之前你不可启动它，否则便会产生不良的爬行电流。当管的电弧形成的时候，你需要因应管的温度并透过压制真空阀来逐渐增强电流直到玻璃管的温度超过300°C，由于这样的控制过程相当耗时并需确保流畅，因此有需要使用电子操控轰击器的必要来连接主控制系统。控制系统本身的价值已相等于半个轰击器，而每个轰击器只能同时制作两根管。至于气体输送系统也不相同：首先自动化设备通常使用很大容量的气瓶，例如压力1 bar（巴）200公升，相比今天仍然普遍使用的（需经常更换的）旧式1 bar（巴）1.5公升玻璃瓶的差别很大。其次，充气不能随意，必须在很准确的充气压力下停止，这个同样需要很敏感和精密的仪器，这样再一次把玻璃栓比下去。

If someone wants to invest in a high quality system he expects it to be better than non-automated systems. That usually results in a better vacuum, faster and cleaner pumps with little maintenance. Those pumping speeds are between 7 l/s up to 30 l/s and an ultimate vacuum (in chamber condition) of  $10^{-5}$  or better. These super pumps cost money, but they make it possible to produce excellent cold cathode tubes, even in larger diameters.

如果有人希望投资一套高质量的系统，他必然会期望它比非自动化系统好，自动化系统应该有更好的真空度，更快、更干净以及极少的维护。其抽真空的速度会在7至30秒/公升（l/s）之间和理想真空度是 $10^{-5}$ 或更好的，虽然这些超级泵的价格很高，但是绝对物超所值，因为它能制作优质的冷阴极管或更粗管径的管。

An alternative for the bombarding pumping is oven pumping. The principle is a bit different: up to 20 or even 30 tubes are put in an oven chamber and connected through the walls to a long manifold that has similar function as the system described above. The main difference is speed on the one hand (30 tubes in a two hour cycle) and quality on the other hand. The main reason for the improved quality is the long period that all tubes are kept at 300°C while the vacuum pump can continue pumping down.

除了轰击真空机之外还有烤箱真空机，不同的原理在于它能通过连接一条很长的跟以上所提及系统

相类似的排气管一次性将20根甚至30根管同时放进烤箱内。它的主要分别有二：一是速度（每二小时能处理30根管）二是质量，其主因在于它能保持长时间在300°C状态下不停地抽真空。

We all know that the tube quality will be better if the tube temperature can be kept around 300°C for as long as possible, as the impurities become separate from the glass wall and the coating. And from experience we also know that a vacuum in a vessel gets better if the vacuum pumping was continued for a longer time.

Unfortunately, oven pumping is not so widespread because of the cost and the lack of tradition in this field.

我们都知道只有保持温度300°C左右及尽可能长时间来处理灯管才能做出质量好的管，因为管壁及涂层上的杂质在这样的高温下才能被分离。同时，经验也告诉我们，越持久的抽真空，管的真空度越好。可惜的是烤箱系统因为价格高昂及在这个市场上缺乏使用的传统而未被普遍使用。

So, if automated equipment is expensive, how can it be economical? Those who did invest in such a system don't want to think back to the days they did it all manually.

They fully rely on the system and made quality their trademark when comparing with their competitors. They have more time available for other things and they don't need so many staff. Some traditional companies claim their cost for a worker is not so high, but they forget how much 'bad work' would cost in the end.

这样看来，自动化真空设备非常昂贵，可怎样使之经济化呢？投资者请勿再回想起昔日人手制作的日子，他们必需完全倚靠新的系统和营造比其竞争对手质量更好的商标，他们将有更充裕的时间来处理其他的事情和无需太多的员工，虽然一些传统的公司声称员工的薪金不是很高，但他们却忽略了“问题货品”所做成的最终损失。

So this is where economy comes into place: making quality work again and again, even with less trained workers. And this is exactly what our industry needs: better products that customers are willing to buy because they keep looking good and they hardly ever fail.

所以它真正的经济涵义在于能不断重复制作质量的产品，就算不是很熟练的工人也可以，这也是我们行业所需的，因为顾客只想购买质量好的和不怎么损坏的产品。

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