

Lead free brazing with on-site generated nitrogen

Due to the publication of European Directives 2002/96/EC on waste of electrical and electronic equipment (WEEE) and 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHs), the due date is set, as from 1st July, 2006 elements such as lead, cadmium, hexavalent chromium, PBB, mercury and PBDE shall be prohibited and therefore may no longer be used from midyear 2006 as part of electronic devices or assemblies.

For the electronic manufacturing industry this represents a significant reorganisation. It is now time to leave behind the well tried solder based on tin and lead. As replacement for tin / lead solders are mostly available alternative solders applying consistently higher melting temperatures. As a result of higher brazing temperatures assemblies or components need to be adapted to the higher requirements.

Nitrogen at brazing process:

Nitrogen is an exceedingly advantageous, technical industry gas. As nitrogen is colourless, absolutely nontoxic and nonreactive, nitrogen is successfully used in multiple industry sectors, such as pharmaceutical, foodstuffs, packaging etc.

The application of nitrogen at the brazing process, whether wave soldering, reflow- or selective soldering, improves very often the soldering result, because nitrogen is a better heat conductor compared to air. This fact offers the great advantage that lower process temperatures may be applied and therefore the impact on assemblies and components is reduced. Furthermore, due to the shielding gas atmosphere, a significant reduction of oxidation at wave soldering is achieved, along with a decrease of dross creation.

Furthermore, due to the feed of nitrogen, the surface tension is altered and improves the flow characteristic of the solder. As a result the bridging is reduced and the soldering quality is rectified.

Summary of advantages when using nitrogen N₂:

- Reduction of
 - impact on electronic devices and assemblies
 - oxide film
 - dross creation
 - bridging
- Higher process safety
- Improved flow characteristic of the solder
- Enhancement of moistening

Provisioning of nitrogen:

Often business companies are provided with nitrogen supplied from tank installations, bundles or single steel cylinders. These supplies go along with a very high logistical effort. It is necessary to verify perpetually the nitrogen stocks and to ensure new deliveries in time.

During winter season the situation may become particularly critical. By reason of regulations applicable on hazardous goods it is prohibited to transport gas steel cylinders when roads are under hard-packed snow or glaze. It is also prohibited to move tank vehicles. For this reason, the nitrogen supply is put at risk and a loss of production might be threatening.

Nitrogen provisioning on-site:

In order to avoid the before mentioned risk situation and with a view to benefit from further advantages, more and more business companies switch to „on-site“ nitrogen supply. Under this procedure nitrogen is generated from compressed air which is already available most of the time.

Requirements under varying specific application processes fluctuate from a few litres per day up to very high volumetric flow rates per hour. The nitrogen generators supply between 200 and 800.000 litres nitrogen per hour at purity grades of 95 % up to 99,999 %. By use of the “in-house air fractionation plant”, nitrogen is permanently available at steady high quality.

The nitrogen generators are easy to operate, with only small space requirements and negligible running costs. Both wall- and floor mounting is possible. The nitrogen generator needs just to be connected to the purified compressed air supply and by opening the generator valve the in-house air fractionation plant starts to produce nitrogen at purity of up to 99,999 %. Additional filters mounted up-stream ensure the continuous high quality of incoming compressed air.

Summary of advantages of on-site provisioning compared to gas cylinders, bundles or tank installation supply:

- constant high quality of nitrogen
- no dependency by longtime supply contracts
- permanently assured availability
- low installation costs
- negligible running costs
- safe and easy operation
- no handling costs as for gas cylinders or bundles
- no safety hazard as for gas cylinders.

Cost savings of up to 80 % are feasible for nitrogen produced by generator, by comparison to the conventional gas cylinder supply.

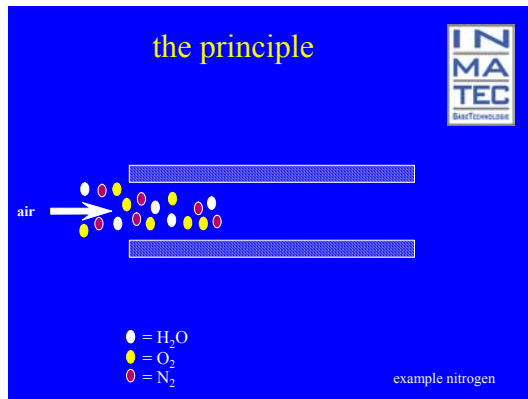
According to requirements for purity of nitrogen, two different systems are in application.
The membrane or PSA technology.

Which purity grades are required for the soldering process depends on various factors, such as

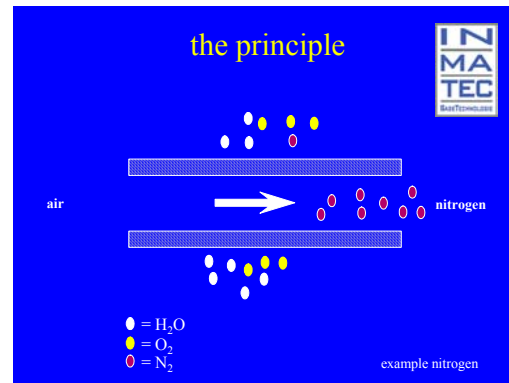
- the type of soldering process
 - wave soldering
 - reflow soldering
 - selective soldering
- the composition of lead free solder
- the component density
- etc.

The membrane technology is mostly used for purity grades of up to 99 %.

The sophisticated and patented gas separation membrane divides compressed air into two different gas flow streams, the nitrogen flow and the oxygen flow. The chemical composition of the nitrogen membrane is unique. It is a combination ensuring the sustainment of quality, performance and a long service life.



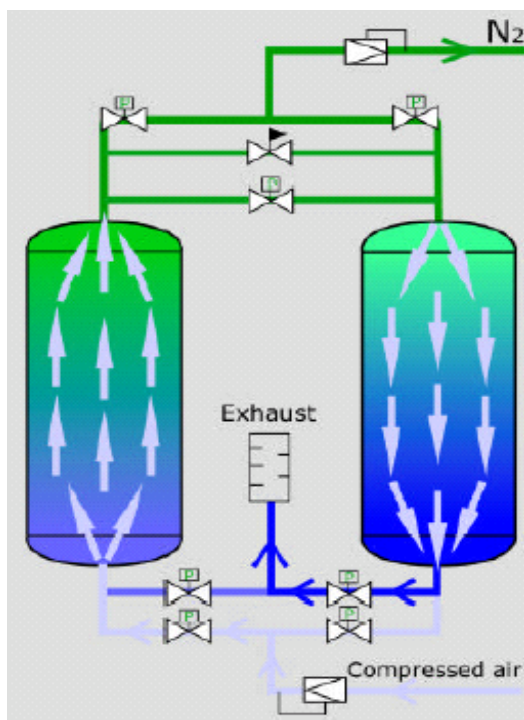
purified compressed air penetrates the membrane



nitrogen molecules pass through the membrane, the oxygen molecules diffuse through the membrane's outside plating

However, for most types of soldering process purity grades of more than 99 % are required. For this purpose, the advantages of **PSA technology** are significant, because for high purity grades smaller quantities of compressed air are required, compared to the membrane technology.

„PSA“ means „**P**ressure **S**wing **A**dsorption“. This operation is working by use of two molecular sieves filled with specific activated carbon (CMS) which filtrate oxygen and carbon dioxide molecules from the compressed air. Both sieves are switched alternately from filter mode to regeneration mode. Thereby a continuous nitrogen flow is warranted.



Production costs of self produced nitrogen with generator per Nm³

(at energy costs for compressor of 0,10 € / kWh)

% purity	costs €uro
99,5	0,03
99,9 (3.0)	0,04
99,99 (4.0)	0,08
99,999 (5.0)	0,10

Comparison of costs between generator und tank

example of costs N2 generator (20Nm³/h)	example of costs N2 tank (20Nm³/h)
one-time costs: - PSA-Generator 24.000 € <hr/> total one-time costs: 24.000 €	one-time costs: - foundation: 4.000 € - fence: 1.500 € - pipework: 2.000 € <hr/> total one-time costs: 7.500 €
running costs per month: - current for compressor at 99,5% [calculation 0,10 € / kWh] (0,03€ / Nm ³ x 20 Nm ³ /h x 8 h x 20 days) <hr/> total running costs per month: 101 €	running costs per month: - lease tank installation: 250 € - hazard goods markup per del.: 70 € - toll per delivery: 40 € - nitrogen N2 700 € (0,20€ / Nm ³ x 20 Nm ³ /h x 8h x 20 days) <hr/> total running costs per month: 1.060 €
Filter replacement / year: 390 € <hr/> ➔ total costs N2 per year: 1.602 €	<hr/> ➔ total costs N2 per year : 12.720 €

Amortisation of generator:

	PSA Generator	Tank
running costs / year	1.602 €	12.720 €
one-time costs	24.000 €	7.500 €
Total:	25.602 €	20.220 €
Amortisation of N2 Generator within 1,5 years !		

Conclusion:

for many soldering techniques nitrogen is essential. The on-site nitrogen generation is by now not only just an alternative. Indeed the in-plant production offers great potentialities of cost savings and flexibility.

With regard to nitrogen purity grades there are still various opinions. One thing is for sure: 99,999 % (5.0 quality) is not required for many applications. The INMATEC nitrogen generators offer the possibility to select the purity by easy reset of an adjustment valve to the purity grade required for your application.

If purity grades of < 99 % are sufficient, the membrane technology is appropriate, for purity grades of > 99 % the preference goes to the PSA technology.

As INMATEC is manufacturer of both technologies, we are in position to meet precisely our customer's requirements.

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