



Good for the environment and good for the customers

Dr Rob Grant FRSC, CEO at Gas Recovery and Recycle Limited, dropped in on PES to bring us up to date on their argon recycling process. They have experienced tremendous growth already and more is expected. The ArgonØ™ is good for the environment and through recycling, delivers cost reductions to companies implementing it. No wonder business is good!



Dr Rob Grant

quantities during the crystallisation of silicon into ingots – the first stage in the manufacture of silicon based solar cells.

GR2L entered into partnership with the British based UK Gas Technologies Group based near Gatwick, UK, in 2010 to manufacture GR2L's flagship product, the ArgonØ™ and bring it to market. The UK Gas Technologies Group has a track record in high purity gas installations in the semiconductor and medical markets and is synergistic with GR2L.

PES: You work in several industries, how important is solar to you and in your opinion is it an expanding market or has it reached its peak?

RG: Solar is by far our biggest market, with business in Asia dominating and we continue to expand in the region, which for us has not yet reached its peak. Every solar ingot production facility today uses high purity argon to purge the furnaces, to maintain the purity and performance of the resulting silicon wafers.

The current trend in the industry is away from multi-crystalline to mono-crystalline wafers, with a resultant increase in argon purge gas flow of as much as 50%. This along with the continued growth in the solar PV market itself means demand for high purity argon is increasing, whilst supply remains essentially static. Argon is a by-product of air separation and limited by other industries e.g. steel making.

This increasing demand for high purity argon is fuelling the pull from the industry for argon recycle, to allow the ingot producers to both reduce and, longer term, control their costs where argon contributes 3-5% to the ingot cost of production.

PES: How is this impacting upon your business?

RG: Currently only a small number of silicon ingot producers have argon recycle, but the

cost down demands on the industry mean that this number will only increase. There is a very significant retrofit opportunity on the installed base of 1,000s of mono-crystalline furnaces alongside the demand from new facilities being planned and commissioned.

Argon recycle enables a customer to expand their facilities without having to expand their argon supply and storage facilities. This is particularly good for GR2L, which has seen a 10-fold growth in its business over the last two years and we are predicting healthy, double-digit growth for 2019/20, when we will be shipping our 100th ArgonØ argon recycle system.

PES: ArgonØ™ has been on the market for a while now – what is it for, what does it do, how does it work?

RG: High purity argon is used to purge the environment of a CZ puller or DS furnace to remove contaminants that would result in reduced performance of the resulting solar cells. The exhaust gas is predominantly contaminated with carbon monoxide and hydrogen in the 300 to 3,000ppm range along with lower levels of moisture and carbon dioxide and vacuum pump oil, if oil lubricated vacuum pumps are used. Note that carbon monoxide at levels above 300ppm is considered immediately harmful to life.

The impurity gases originate primarily from reactions of moisture and silicon monoxide with process chamber components such as the heaters and insulation materials. The ArgonØ™ system purifies the contaminated exhaust gas recovered from the vacuum pump, through a two-step process. In the first step the carbon monoxide and hydrogen are combusted in a solid-state combustion reactor to carbon dioxide and moisture respectively.

As the process utilises a unique patented, chemical looping combustive purification technology, no gas phase oxygen is used in the process. This guarantees the recycled gas is oxygen free. In the second step the carbon dioxide and moisture are removed by absorption, into a zeolite-based material, resulting in a high purity exit gas, which is directed back to the process, with a purity of 99.9998% or better. The ArgonØ™ system combines two pairs of reactor/absorber vessels. One pair online and the other being regenerated and in standby allowing 24/7 argon recycling.

No other gases or chemicals are needed for the regeneration of the reactor vessels other than dry compressed air. With few moving parts the system has an uptime of 99.9% and is designed such that most routine service and maintenance can be conducted with no interruption to system operation.

Whilst the ArgonØ has an inherent recycle rate better than 98% the operational factory recycle rate is slightly less, due to argon

PES: Hi Rob, it's a pleasure good to talk with you. As you know we have been following GR2L for some years now and you are regular participants in PES Solar/PV. To start with please could you give us a brief overview of your company?

Dr Rob Grant: GR2L was founded in 2008 to commercialise chemical looping combustive purification technology developed in collaboration with Cambridge University, UK. This addresses the 10-10,000ppm impurity level gap not addressed by current conventional gas purification technologies as seen, for example, in the microelectronics industry.

GR2L specialises in the recovery, purification and recycling of inert purge gases used in high value manufacturing industries such as Solar PV, microelectronics and 3D metal powder additive manufacturing. Today GR2L's primary focus is on the photovoltaic industry, for the recycle of argon, which is used in very large



losses from the process, such as during recharge steps, or the opening and reloading of the furnaces, when argon escapes into the atmosphere rather than being delivered to the ArgonØ™ for recycling.

PES: What makes it unique?

RG: The chemical looping combustive purifier at the heart of the ArgonØ™ is unique to GR2L and patent protected. This enables GR2L to offer a compact, point of use, argon recycle system distributed across a facility that is easy to install, requires no additional process gases, is inherently multiply redundant and offers a factory recycle rate of better than 95%.

The equipment is easy to use requiring only minimal user intervention and ideal to retrofit to the 1,000s of furnaces already installed and producing ingots, as well as for new installations. Being a point of use system that connects to 3-6 furnaces allows customers to 'try before they buy' and verify the argon recycle rates in their own facilities before a wider factory roll-out.

Competitor argon recycle systems tend to be large, single, centralised systems that also utilise additional process gases, such as oxygen and hydrogen, and represent an 'all or nothing' approach to the client who is unable to test them out before they commit to a factory wide installation.

PES: Please can you explain how it is controlled and monitored?

RG: The ArgonØ™ has an on-board PLC and

they are collectively monitored from a central SCADA computer where top level recycle volumes and rates are collated from the individual ArgonØ™ units located around the ingot production facility.

The SCADA system is linked back to GR2L, both in the UK and in the region, over the internet thus providing the customer with 24/7 support. Data from the ArgonØ™ is also uploaded to the Cloud where regular performance, management and maintenance reports can be generated through the WonderWare Insight software package and can be provided to customers on a regular basis.

PES: We would like to know about the benefits to the end customer, in terms cost savings and to the environment, taking in to account the cost of the initial purchase price.

RG: Our customers see factory recycle rates of about 95 to 98% giving the systems a simple payback of between 18 and 30 months depending on the regional price of virgin argon. As an example, we have one installation, comprising 15 ArgonØs, recycling the argon purge gas from 60 CZ pullers with a facility recycle rate of between 96 and 98%. This means the whole facility can be run with an average flow of only 125slm of fresh, top-up, argon!

In addition to the obvious cash benefit the ArgonØ™ system removes the toxic carbon monoxide gas, which is routinely just vented to the atmosphere without any concern for

the potential environmental impact this may have. Also, by virtue of the significantly reduced argon deliveries, there is a commensurate reduction in diesel cyro-tanker mileage and emissions. Without argon recycle a facility may have as many as 4-6 liquid tanker deliveries a day!

PES: Why should prospective clients choose your solutions, what makes GR2L stand out from the competition?

RG: We now have a number of installations within Asia and Europe, connected to hundreds of vacuum furnaces and operating at the 95-98% recycle rate level. We believe we have the only proven technology to operate reliably at these very high recycle rates and to deliver to the customers a payback of 18 to 30 months.

PES: Moving into the last half of 2019, what are your predictions for the solar/PV industry in general and your company in particular this year?

RG: We forecast that H2 will be up on H1 with the top tier players bringing new facilities online and further consolidating their position within the industry. With this consolidation will come increased demand for argon purge gas that will drive argon prices up and make the business case for argon recycle even stronger. So, for GR2L the second half of 2019/20 will be positive and we see this continuing into 2020/21.

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