Compressed Air – Too Expensive to Waste

Leading Energy Expert Helps Industry Identify Missed Efficiency Opportunities

Professor Peter Radgen, Chair of Energy Efficiency at University of Stuttgart, Germany and Director of the Graduate and Research School Energy Efficiency Stuttgart (GREES), was the guest speaker at a seminar organised by compressed air specialists O'Neill Industrial in Cork last month.

During his presentation, Professor Radgen looked at the key requirements to improve compressed air systems and shared his insights based on years of research and hands-on experience in helping German industry to achieve increased energy efficiencies.

Explaining the rationale behind the seminar and bringing Professor Radgen to Ireland, Austin O'Neill, O'Neill Industrial, said, "Whether the burning platform is to achieve energy savings or to play an active role in the transition to a low carbon economy, the industrial and manufacturing sectors are seeking smarter ways to achieve energy efficiencies and savings. As a result, plants and production facilities are placing greater attention on the energy efficient use of compressed air and for very good reason. On average, compressed air systems use 10% of the energy consumed by a production facility. Plus, energy costs, over the 10 yr life cycle of an air compressor, represent 80% of the cost of ownership. With statistics like that we know that even small improvements to a compressed air system can help maximise overall plant energy efficiency."

In this article we look at some of his recommendations.

In a study dating back to 2000, the Energy Efficiency Institute at the University of Stuttgart identified several energy saving measures that could reduce the annual energy consumption of Compressed Air Systems (CAS) and produced a book with its findings and recommendations. At the time, on average, companies could reduce their energy costs by 33% with 16% achieved through the reduction of air leaks.

Radgen is almost intrigued that 18 years on, and despite advances in technology and growing pressure on industry to reduce energy costs, there are still significant energy savings to be achieved.

Air Leakages

Interestingly, one of the biggest savings measures continues to be air leakage prevention. Many companies place a great emphasis on generating compressed air efficiently while at the same time ignoring the fact that a large volume of compressed air is being wasted through leakage. The majority of companies have a leakage rate of more than 20%. It is estimated that a hole 1mm in diameter with pressure of 6 bar would typically cost 268 per annum. So why is industry failing to address this?

There are many reasons; (i) leakage management efforts in many plants can be ad hoc and lack a long term strategy which is necessary to achieve results, (ii) inconsistency in the time intervals between surveys make it difficult to achieve long term reductions in leakage rates, and (iii)the failure to complete the leakage repair work is another major reason why companies fail to make a

significant impact on leakage levels. Furthermore, many fail to recognise that most leakages occur in the last 1/3 of the distribution network. Their survey starts in the compressor room but fails to look at the pistons and couplings. A compressed air generation plant and the pipe distribution network are all part of the same system however, while the Compressor plant is routinely serviced and maintained, the pipe distribution network is often neglected.

To overcome these road blocks to achieving low leakage rates, many companies are now contracting leakage detection and repair management to specialists in the same way as the maintenance of the compressor plant.

In a study conducted by the Energy Efficiency Institute at the University of Stuttgart, it was estimated 400 TWh/a electricity is required to power compressed air worldwide.

Professor Radgen noted, "When we talk about a compressed air system we are not necessarily just talking about the compressor – we are speaking about so much more; the controls, receiver, air treatment (dryers, filters or condensate technology), the distribution network, right down to the ultimate end use devices, which all have a factor to play in terms of the overall efficiency of the system. And when you look at the system in its entirety, the improvement potential is quite significant."

Lifetime Costs

Another common mistake is the tendency to focus on the initial investment instead of the lifetime costs of the CAS.

More than two thirds of all costs related to compressed air are related to energy consumption over the lifetime of the compressor so it makes sense to look at the energy efficiency of the system. There are three compressed air system requirements in particular that need to be considered (i) reliability – nothing is more expensive than production downtime, (ii) air quality – highest quality is required to avoid damage to machines and ensure product quality and (iii) cost – low cost vs cost of producing compressed air.

According to Radgen, many companies don't even know how much compressed air they are consuming and recommended they analyse their compressed air demand immediately. An initial assessment can be done quite simply by gathering data over two weeks and analysing consumption during a work-free weekend – this will give an indication of the leakage rate and consumption demand.

Audits

Ideally, a more comprehensive audit of the CAS should take place annually.

Free compressed air audits were offered to companies in Germany during a four year campaign to increase the efficiency of compressed air. Typical observations of the audits found:

- Size or type of company doesn't necessarily mean no savings potential. Companies with over 1,000 employees could still reduce energy consumption

- Compressor idle time ranged from 20% to 50%
- Significant leakage rates, often in the range of 25% to 50% of average production
- Compressor room ventilation was poor and therefore this impacted on productivity
- Diameter of distribution network often too small
- No plan of the distribution network was available

While encouraging companies to conduct their own audits of their CAS, Professor Radgen believes there are number of steps that must be followed to ensure its success. Not having clarity around these points could lead to a misleading audit:

- Don't focus on the compressor alone, look at the distribution system for instance
- Look at existing faults (e.g. is the cyclone Water Separator after the Particle / Oil Removal filter?)
- Clarify how energy consumption calculations are made, best practice is to use the power based on ISO 1217 Annex C
- Be clear on whether measuring normal or standard cubic meters
- Seek independent advice

Waste Heat Recovery

Heat Recovery by Air - Cooling air back into your building can work in the winter but not necessarily in the summer. Nevertheless, benefits can be realised and it can be done fairly easily with a small installation but only if building size compares to CAS size.

Heat Recovery from Fluid – Here up to 94% of the electrical energy is converted into compression heat. Without energy recovery, this heat is lost into the atmosphere via the cooling system and radiation.

You can use hot water recovered from the compressed air system for sanitary purposes and space heating., but it is particularly suitable for process applications. Using the hot water as boiler pre-feed or directly in processes requiring 70 to 90°C can save you costly energy sources such as natural heating oil. You can also turn waste heat into hot water for showers for employees or if you need water for cleaning during the production process.

Air Treatment

Professor Radgen focused a section of his talk on air drying because at the same event organised by O'Neill Industrial, the new sub-freezing air dryer from Ingersoll Rand was on demonstration. The SF dryer is the only regenerative refrigerant dryer available in the compressed air market today. It is the world's first dryer Refrigerant Type Air Dryer to provide -20 degrees Celsius (-4 degrees Fahrenheit) pressure dew point at 70 percent lower energy costs and 40 percent smaller footprint than that of traditional desiccant type dryers.

Compressed air drying is important if you want to keep water out of your distribution system, avoid corrosion, minimize impact on your product, avoid freezing in winter and avoid clogging in material

transport. However, you need to decide on the dew point settings which might differ between summer and winter, which drying technology is most appropriate and whether you have a centralised treatment for full flow or decentralised add-on treatment for dedicated applications - these can all cause indirect energy costs. The higher the quality of air you demand the higher the cost of producing it.

There is no universal solution for every requirement, but these should be avoided;

- Dryer too small
- Air inlet temperature to dryer too hot – should not be higher than 35°C or it won't do its job properly
- Faulty condensate traps – the best are electronic level controlled traps. Time control, mechanical floating traps and manual traps will not give the same efficiency.
- Wrong dew point settings
- Refrigeration dryer located beside air compressor where the dyer is subjected to exhaust heat from the compressor

In summary, not every company can realise the same savings but, regardless of size or industry, compressed air needs a system approach.

Organisations need to monitor compressed air demand along with electricity demand for compressed air and air quality. The easiest and quickest savings measure is to start reducing demand by leakage repair.

Consider installing a compressor control system where there are two or more compressors installed. These systems will also allow collection of data (e.g. Flow / Pressure) to allow ongoing analysis of usage, efficiency, leakage rate etc.

It may seem obvious, but switch off the system when not required. Identify required air quality and adapt your air treatment accordingly. Analyse and optimise the operation regime of your compressors. Replace outdated components.

Consider heat recovery for heating water or space heating. And whether in doubt or not, it always makes sense to get independent advice

Austin O'Neill, O'Neill Industrial concluded, "The biggest savings can be achieved through leakage reduction and heat recovery. Leakage prevention measures are easy and can be done annually. Heat Recovery is more complicated and requires an investment decision. Other smaller interventions like flow meters can also improve the overall efficiency of your CAS. People may query the cost of flow meters when there appears to be no initial benefit in relation to system reliability or efficiency. But remember, as Professor Radgen iterated at the seminar, to achieve real energy savings in a compressed air system you need to be able to collect and analyse data."

For more information on energy savings measures for Compressed Air Systems, please contact Austin@oni.ie

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About O'Neill Industrial

O'Neill Industrial is a leading supplier of compressed air and pneumatic equipment to Irish industry, employing 30 people across four divisions. http://oneillcompressedair.com/

About the Speaker:
Dr. Peter Radgen is the Chair for Energy Efficiency at University of Stuttgart, Germany and director of the Graduate and Research School Energy Efficiency Stuttgart (GREES). He has a long record of accomplishment in energy efficiency with a focus on motor driven systems and waste heat recovery.

Radgen is the author of numerous national and international publications on energy efficiency and authored the book "Compressed Air Systems in the European Union" in 2001. He has lead awareness campaigns for compressed air in Germany and Switzerland. Together with his team at the university, he helps industrial customers analyse and improve their compressed air systems.