NAVIGATING GREEN PATHWAYS

Craig Martin, Paul Modern and Juan Moreno, Cook Compression, explore two potential pathways to decarbonisation for energy companies.

In response to climate concerns, most countries around the world have goals to reach net zero by 2050. This means that all greenhouse gas (GHG) emissions produced are balanced by an equal amount of emissions that are eliminated. As a result, governments are establishing more stringent regulations to encourage companies to accelerate their decarbonisation efforts. For example, the US Environmental Protection Agency (EPA) announced forthcoming regulations that will usher a path for companies to increase the urgency to reduce their carbon footprints – primarily GHG emissions.

So, how can energy companies bring new and existing equipment into compliance? What impact will green technology and alternative fuels have? Energy companies will have to address these and other difficult questions in order to determine their best pathway to decarbonisation. This article will explore two potential paths – emission reduction and hydrogen fuel – and how new technologies are being developed to support energy companies as they navigate these decisions.

Emission reduction

In the natural gas sector, piston rod packing on reciprocating compressors is a major source of methane emissions. In 2019, the Pipeline Research Council International (PRCI) determined that, on average, compressors in storage and transmission emit 2458 and 3012 ft^3/d of methane gas per unit, respectively.

Methane emissions at the rod packing tend to come from one of three sources. The first and most conspicuous is leakage that occurs along the piston rod past the seal rings. Some gas loss here is expected, as packing rings shuttle back and forth with the reciprocating action, but this can increase greatly as the packing wears over time, or possibly due to process upsets that damage the wear components.

Second, leakage can occur between cups in a rod packing case. Damage to cup faces over time, poor repair procedures, or insufficient clamping force can result in a loss of cup-to-cup contact. Though less attention is paid here, research has shown that emissions between cups can equal or exceed those past the rod rings. Finally, the nose gasket seal can be a significant leak source if there is damage or a loss of clamping force.

In addition to emission sources during operation, rod packing can leak significantly when in standby mode. This can be addressed with standby seals, which activate a positive seal upon shutdown of a compressor. One natural gas distributor recently recorded a reduction in standby emissions of 86% by employing a standby seal on multiple units. However, these standby seals are optional packing case features that are utilised on only a small fraction of units in the field.

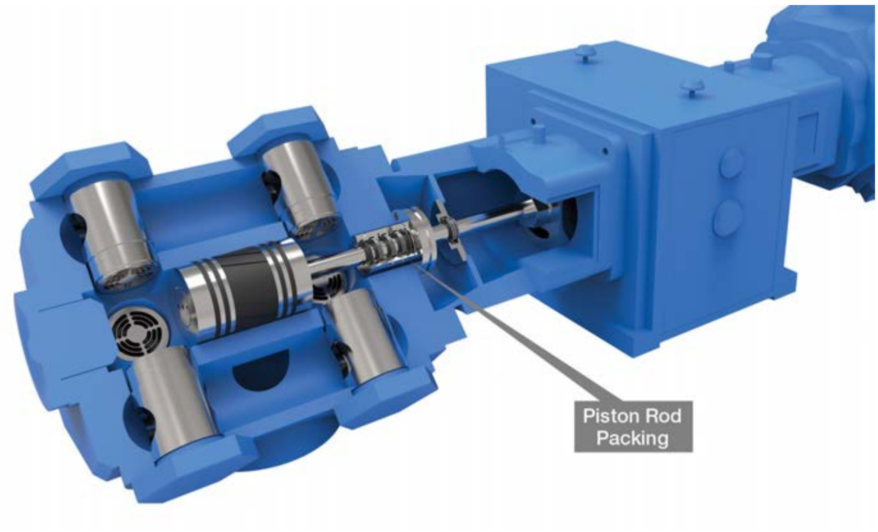

Figure 1. Piston rod packing on reciprocating compressors is a major source of methane emissions.

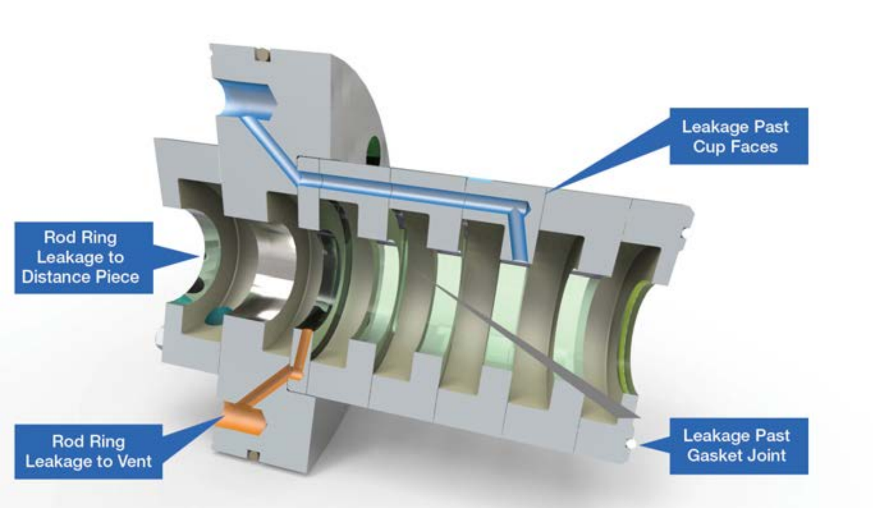

Figure 2. Sources of leakage within the piston rod packing.

Methane emissions from reciprocating compressors have been subject to increasing levels of regulation in recent years. Following a joint resolution by the US Congress in June 2021, the EPA has proposed revisions to the new source performance standards under the Clean Air Act for the oil and natural gas sector, aimed at more comprehensive emissions reductions. The existing OOOO and OOOOa standards established in 2016 require rod packing to be replaced on or before three years, or 26000 run hours. The new rules will shift to a performance-based standard of 2 ft^3/min. The new subparts, OOOOb and OOOOc, would require monitoring on an annual basis (8760 run hours), with replacement and/or repair of the packing in order to maintain the required emission rate. Alternatively, a vapour recovery system can be implemented to capture and re-route these emissions.

Meeting these new regulations can be challenging for natural gas utilities. At present, the regulations do not prescribe a standard system or test method for monitoring, and these systems can be costly to implement and maintain. Changing regulations and uncertainty can be major hurdles to selecting a path to decarbonisation. In order to support those companies working to reduce emissions either as their chosen pathway to decarbonisation or to meet regulations, Cook Compression has developed the COOK CLEAN™ sealing system to reduce fugitive emissions in reciprocating compressors. By incorporating proprietary design elements, this sealing system has documented leakage rates of below 0.75 ft^3/min per throw – well below the defined EPA limits.

Hydrogen

Many experts see hydrogen as the best pathway to decarbonising energy. It makes sense to use a storage and energy vector medium with no GHG impact if released, and that only produces small amounts of nitrogen oxides (NO_x) emissions if used as a direct combustion fuel source. The technology readiness level is also high. Considering fuel cell applications, conversion to ammonia, use in biofuels, and other historic industrial use cases, these are easily achievable right now from a technical standpoint.

So, how does this hydrogen transition play out over time? What needs to happen to accelerate change? Where are the current technical hurdles?

The first and most important factor for many is cost. Industries are challenged to drive down the cost of green or blue hydrogen vs traditional grey hydrogen from natural gas sources. This will require changes to policy, taxation, and tariffs, coupled with a ramp-up of renewable electricity production from wind/solar.

The market must also develop a structure to support global supply and demand transactions. Geographical constraints will affect how this plays out. For example, the current natural gas price in Europe may restrain the transition to blue hydrogen production and force a green hydrogen pathway, whereas the US has natural gas in abundance which might make carbon capture and blue hydrogen production a better option. Asia has ambitious targets regarding infrastructure that will change the shape of the region's transition.

Any energy transition should target the biggest GHG emitters first. For example, steel production facilities are huge global GHG emitters that could potentially change production methods and integrate hydrogen into their processes. Power generation would reap huge benefits by simply swapping from coal-fired to natural gas-fired power production, without the additional step of transitioning an entire infrastructure to hydrogen. Indeed, hydrogen as a pure fuel for this type of application is a poor substitute in terms of calorific value when simply burned. Natural gas in its many forms (CNG, LNG, etc.) must therefore continue to play a huge role during this transition and beyond.

Currently, there is a push to reduce vehicle tailpipe emissions for local air quality reasons. However, it should be noted that modern petrol/diesel-fuelled engines for road use are already quite efficient in this respect. The shipping industry, with its reliance on cheap, low-grade fuel oils, is potentially a much better target to achieve a reduction globally, but this is more difficult to implement. Using biofuels or even ammonia as fuel stock has been suggested, but this demands a huge effort to produce the required quantities at a reasonable cost point and to retrofit or convert fleets.

Technically, there are challenges with materials for pure hydrogen, especially at elevated pressures. Standards development is ongoing but needs to keep pace with the desire to implement quickly. Marrying up renewable, intermittent capacity and sourced production methods with existing equipment that relies on a constant rate feed source is also a challenge. Transportation from locations with good resources for renewable production to demand centres will require new storage and transportation technologies, along with the infrastructure to support them.

So, how will this all play out in the next 5 – 10 years? The current industries that use hydrogen – petrochemical, refining, fertilizer – will not go away. In fact, these users are likely to be the first adopters in this transition, moving from grey production to carbon-captured blue or green hydrogen where available. Many projects are already in motion. Beyond that, policy by region needs to drive change in other sectors. The cost of cleaner hydrogen must be driven down, but there will eventually be a crossover point where it makes economic sense to choose the greener path for industries such as power generation and steel manufacturing. This will take time. The same can be said for hydrogen use in vehicles. Without a large hydrogen refuelling infrastructure investment, battery electric vehicles will continue to dominate in the near-term. Fleet vehicle applications with a single point of origin for hydrogen fuelling will be the most logical path to using hydrogen as a direct fuel source, whether that means a fuel cell or an internal combustion engine.

Cook Compression has prepared for the coming hydrogen transition by investing in research capabilities and expanding the portfolio of TruTech® advanced materials to include formulas engineered to withstand high-pressure hydrogen environments.

Looking ahead

As government regulations continue to evolve, the future is going to be an exciting and challenging mix, with some winners and some losers. Although the future is difficult to predict, energy demand is not going away. Whether an energy company chooses to focus on emission reduction or the introduction of new technologies via hydrogen, it will have to partner with suppliers who are committed to innovation and thinking creatively to meet the decarbonisation challenges.

To tackle the operational and transformational obstacles associated with decarbonisation, Cook Compression is investing in the research and development of new technologies, such as COOK CLEAN products, that help meet current and pending regulatory requirements.