The Weil Group is using a new membrane technology to recover high-purity helium from Canada's Great Plains.

The rise of helium

The helium industry is making a comeback – partly due to dwindling reserves, and partly to a new method developed by Linde that is set to make efforts to exclusively recover this noble gas viable. The company's membrane technology completes the gas separation wishlist – there are now no limits to what Linde can offer its customers in this area.

HELIUM SOURCE DEVELOPED BY
THE WEIL GROUP IN NORTH AMERICA

The US government's decision to sell off the nation's helium stockpile has made recovery of this gas financially attractive once again – even from remote locations such as the Great Plains in Canada.

Anyone driving through Saskatchewan in central Canada knows the true meaning of vast. The only points of reference in this flat, treeless expanse are the old wooden grain elevators. However, a new landmark has recently sprung up on the horizon of "big sky country", as the locals also call their province. Shining brightly in the sun, the snow-white tarpaulin of the tent-like construction is located near the village of Mankota. But what makes this beacon in the prairie landscape so interesting is actually what is going on inside. Using a completely new gas separation process from Linde, US company Weil Group Resources, is recovering a long-neglected local treasure from the ground: helium. This might even trigger the next gold rush, as global supplies of this gas are running out.

In demand the world over

Paradoxically, helium is the second-most-abundant element in the universe (after hydrogen). Yet it is a scarce commodity here on earth. The noble gas is extremely volatile and not even gravity can keep it in its grasp. Once released, sooner or later it escapes from the atmosphere into space.

All of which would not be an issue if helium was just the stuff of party balloons. But the fact of the matter is that helium is a billion-dollar business – and reserves of this gas on earth are finite. A few years ago, research and industry were already warning of a global helium crisis. With this in mind, the US government delayed selling off the nation's stockpile several times in recent years. For decades, the US dominated this market, with the world power maintaining a near-monopoly on the gas. In a natural underground cavern near Amarillo, the nation stored up to one billion cubic metres of this valuable element. For a while, these Texan rock formations were thus home to around 30 percent of the world's accessible helium assets. But then storage grew too expensive and in 1995, Congress decided to sell off the stock entirely. This initially resulted in a veritable glut of helium. Meanwhile, though, growing demand has long since outpaced even this surplus supply. Indeed, the price of this noble gas continues to rise each year.

The helium is transported onwards for further processing.

Helium hero: Jeffrey Vogt, Founder and CEO of the Weil Group.

The downstream membrane further increases the efficiency of Linde Engineering's pressure swing adsorption unit.

At least four more projects are planned in North America over the coming years.

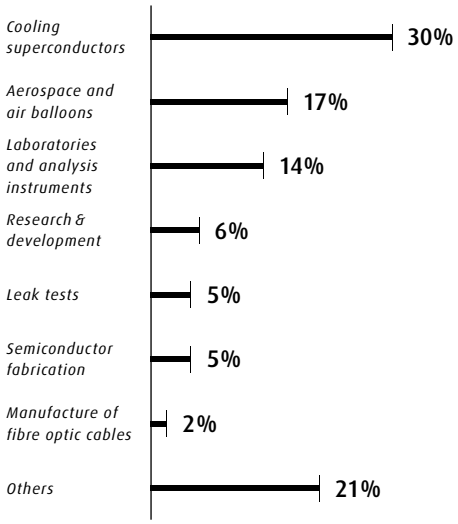
APPLICATIONS

WHAT IS HELIUM USED FOR?

A free spirit among industrial gases, helium was formed within the earth's crust over billions of years through the radioactive decay of uranium and radium, accumulating primarily in natural gas reserves. It is extremely volatile and highly sought-after, since it possesses a number of exceptional properties. Helium has the lowest boiling point of any element (–268.9 degrees Celsius). It thus remains liquid even in the vicinity of absolute zero (–273.15 degrees Celsius), making it the cooling agent of choice – especially for superconducting magnets in research and medicine.

Both the world's most powerful particle accelerator, CERN's Large Hadron Collider, and MEG equipment for imaging brain activity depend on helium as a refrigerant. It also quite literally keeps airship aviation afloat – the Hindenburg disaster of 1937 saw non-flammable helium replace hydrogen in the balloons.

In space travel, too, this gas is injected into rocket tanks to maintain a constant pressure. As an inert gas, helium is also valuable in plasma welding. And in the semiconductor industry, this noble gas is used to detect leaks in the ultra-pure vacuum fabrication chambers. After repeated bottlenecks over the past few years, efforts to recycle this valuable element are now under way in many places.



Helium recovery is thus viable once again – even from smaller wells such as those beneath the Mankota grasslands. However, finding it in the first place is difficult and time-consuming. Up to now, it has often been discovered by chance, primarily in the course of natural gas exploration. But chance was something Jeffrey Vogt, founder and CEO of the Weil Group, was no longer content to rely on – particularly since the main producers, US and Qatar, could scarcely keep up with demand. At the same time, further deposits – for instance in the East African Rift – were unconfirmed. Rarely had there been such a favourable climate to try out something new. "We were specifically aiming for helium – so we went to places where we know this gas resides," explains Vogt. The entrepreneur and commodities expert, whose past activities include successfully drilling for nickel in the Philippines, was determined to go the extra mile. His teams spent months conducting meticulous underground investigations of Canada's Great Plains, delving deep into the earth. The presence of this noble gas in the area was first established in the 1960s but the reserves were not considered to be of further economic interest until the US released its grip on the helium market.

Operations began at the Weil Group's helium facility in June 2016. Since then, around 250,000 cubic metres of raw gas is extracted from the ground and processed each day. "This is not an enormous project – it certainly doesn't put us in the same playing field as the Exxons of this world – but the way we are obtaining the helium is a game-changer for the entire industry," declares Vogt. In fact, his message to the wider world beyond the endless expanses of Saskatchewan can be distilled down to a single figure: 99.999 percent. That is the degree of purity ultimately produced from the nitrogen stream, which initially yields a 1–2 percent helium concentration. The result is a high-purity, industrial-grade product.

Winning combination

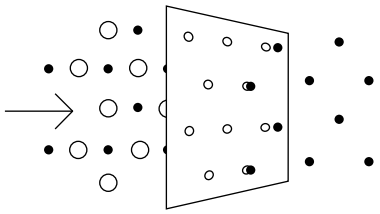
The key to this success lies in the process technology. Previously, large natural gas treatment plants generally distilled helium from the cryogenic nitrogen recovery stream. Now, though, Vogt and his team have a solution that bypasses this type of complex and, above all, expensive technology – thanks to an innovation by Linde Engineering that is set to revolutionise helium production. "Essentially

PARTNERSHIP

FORGING NEW PATHS TOGETHER

To succeed over time in business, you need to have the courage to venture into new territory. Fortunately, this is something the managers and staff of the Fibres, Membranes & Specialities product line at Evonik Industries have in abundance – as do managers at Linde's Engineering Division.

Evonik's core competence lies in innovative specialty chemicals, which are used to enhance the performance of countless consumer and industrial products. To date, however, Evonik has rarely worked with a partner to create a finished product. It is equally unusual for Linde Engineering to cooperate with other companies in its core areas of expertise – in this case,



gas separation. By forming an alliance, both companies are thus embarking on a promising new endeavour.

This partnership centres on Evonik's polymer-based membrane technology, which is used in gas separation and treatment systems from Linde Engineering. The membrane enables gases such as methane, nitrogen, helium and hydrogen to be extremely efficiently separated in pure form from gas mixtures.

For Dr Axel Kobus, Head of Evonik's Fibres, Membranes & Specialities product line, the synergies arising from this collaboration are clear: "Creating a high-performance membrane product portfolio that unites Linde's plant engineering and gas separation expertise with our polymer and technology know-how establishes the best possible springboard for us to develop new markets together."

this is a hybrid process, which we are pioneering in Mankota in partnership with the Weil Group," is how Tobias Keller describes this world first. Keller is Head of the Adsorption and Membrane Plants Product Line at Linde's Engineering Division. His title says it all – this is a combination of two technologies, uniting two companies and leveraging their technology strengths. At its core is a highly selective membrane supplied by Evonik Industries. This is the new component that now makes helium recovery worthwhile even on a smaller scale. It is located upstream of the adsorption step, which means that the helium is first concentrated from the gas stream prior to the conventional gas separation and purification process. The membrane solution is thus a concentration technology. It pre-treats the gas so that all downstream technologies not only work (even) more cost-effectively, but can also be engineered on a smaller scale. This significantly reduces investment – and ultimately also operating – costs.

Summarising the benefits of this synergistic alliance for Linde's strategic path forward, Keller reports: "Evonik's high-selectivity membrane in combination with our other established gas separation technologies, such as our world-class adsorption technology, allows us an extraordinary flexibility in the development and application of new and more efficient purification processes." Essentially, adding Evonik's membrane technology to the mix allows Linde to bundle all the relevant processes as a one-stop provider, strengthening its leadership in gas separation technologies. The move also opens up new opportunities in gas separation. The process to recover helium in Mankota could also be applied to other sources of gases such as methane, nitrogen or hydrogen in the future.

While Jeffrey Vogt already has his eye on further helium projects in North America, the next chapter in the unfolding membrane story is about to begin in South Africa. In partnership with alternative and renewable energy specialist Renergen, Linde is planning to recover another cache of helium from 2018 onwards. The natural gas field in the central province of Free State boasts an unusually high helium content of up to 4 percent. In the end, even if these discoveries in Mankota and South Africa cannot stop helium escaping the earth at some point, they are certainly playing a key role in securing supplies of one of the rarest and most essential industrial gases of our time.

99.999%

is the purity level of helium recovered in Mankota.

250,000

cubic metres of raw gas is extracted from the ground and processed every day.