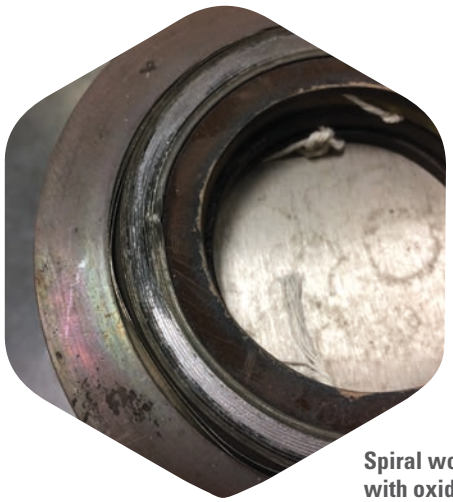
Flexitallic®

GASKETS FOR ETHYLENE PRODUCTION:
3 key considerations to maximise safety and reduce downtime

CHEMICAL PROCESSING



Spiral wound gasket with oxidised graphite

Making the most of the ethylene boom

Following a decade of uncertainty, the ethylene industry is experiencing significant growth. Driven by strong consumer demand for plastic and lower oil prices, which in turn means cheaper feedstocks, growth is projected at 3.4% per year[1], with ethylene demand set to exceed 60 million metric tons between 2018 and 2022.[2]

Following a successful first 'building wave' of new ethylene plants, plans for the second wave are being finalised globally. Choosing the right sealing solution is essential to ensure that new installations are optimised for maximum safety and efficiency, as the harsh operational conditions of ethylene production can cause the deterioration of plant equipment, especially seals, leading to the risk of leaks, fires and costly downtime.

In this paper, we describe the typical challenges of ethylene production and discuss three key considerations to help you choose the best sealing solution.

1. Tackle the safety risks of oxidation

Ethylene production involves steam cracking of hydrocarbon feedstocks at very high temperatures. Amongst the furnace's radiant section, crossover piping, Transfer Line Exchangers (TLE) and quench cooler, temperatures range from approximately 650°C to 1000°C (1200°F to 1830°F) – well above the auto-ignition temperature of the media. Consequently, leakage arising from the use of inappropriate gaskets in these areas will result in spontaneous fires upon contact with the atmosphere.

Besides the high temperatures, the oxidising environment of ethylene production represents a big challenge for sealing materials. Despite the cracking reaction producing hydrogen as a by-product, conditions both within the radiant section of the furnace and the external environment around gasketed joints are oxidising rather than reducing in nature. Superheated steam and external air, in combination with the high temperatures, create oxidising conditions even for high specification, oxidation inhibited, grades of graphite.

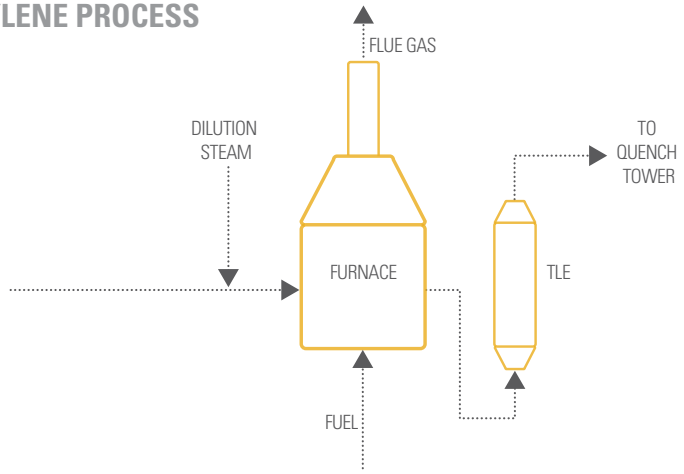
Traditional sealing materials have been shown to fail under these conditions, creating significant safety risks. It is paramount to use a sealing material that can both resist oxidation and remain gas tight over its lifetime as graphite, a commonly used gasket material, is susceptible to degradation. Being a form of carbon, graphite reacts with oxygen present in the external atmosphere or internal process media to form carbon dioxide, which results in mass loss in the gasket and leads to leakage.

An ethylene plant in France, for example, was experiencing weekly fires and tried several types of gasket material in their exchangers, including ceramic and mica, before deciding upon Thermiculite® as it was the only solution that offered effective sealing performance.

Insight

Switching to Thermiculite® gaskets has been shown to be beneficial in modern and older plants alike as it offers key safety and efficiency benefits through oxidation resistant technology.

ETHYLENE PROCESS



2. Prevent decoking-related leaks and avoid unplanned shutdowns

Regardless of feedstock, formation of coke is an undesirable, yet unavoidable, side reaction of steam cracking. Although effective process control and feedstock selection can reduce coke build up (and enhance olefin yield), the build up of these hard carbon deposits on the inner walls of the furnace coils and TLEs is inevitable. The periodic removal of coke deposits known as 'decoking', is essential to maintain acceptable heat transfer, reduce hot spots, and control pressure drop, ensuring maximum plant efficiency and equipment life.

The process of decoking is carried out by periodically stopping production (roughly every 30-60 days) and purging the system at elevated temperature, typically in excess of 800°C, with high pressure steam and/or air. The steam/air mixture acts as a powerful oxidiser converting the solid coke deposits into gas (CO_2) and thus cleaning the system.

Insight

Transfer Line Exchangers (TLE's) can be a difficult application to seal as they are exposed to high operating temperatures and frequent thermal cycling. Older designs can be particularly susceptible to reliability problems due to an absence of refractory lining.

The decoking procedure, combined with the high process temperatures, can lead to oxidation of graphite gaskets, shortening their life span considerably. This damage can go unnoticed after every decoking cycle, posing a significant safety threat and risk of leaks which can result in fires and unplanned maintenance events.

Choosing the right gasket technology can make a huge difference in protecting an ethylene plant from decoking-related damage.

The specification and use of a gas tight, oxidation resistant sealing material should be standard practice under these conditions.

In a US plant for instance, there was frequent occurrences of graphite spiral gaskets oxidising in less than six months, causing flash fires and regular maintenance shutdowns. The issue was resolved after installing Thermiculite®, a sealing solution with superior resistance to oxidation.

3. Improve exchanger and joint reliability during thermal cycling

As with any petrochemical manufacturing process, optimising product yield is paramount to maximising plant efficiency. Conversion rates at such high process temperatures are extremely fast, this means reaction times must be tightly controlled to prevent under or over conversion into unwanted by-products. Termination of the conversion reaction at the correct time is achieved by rapid cooling or quenching of the cracked gas in a TLE. Immediately after cooling, the media stream consists of an ethylene rich gaseous mixture containing ethane, methane, propane and butane. Further processing, including additional cooling, compression and fractionation results in the desired purified ethylene as a compressed gas or cryogenic liquid.

Additional cooling is carried out in the cold section of the process train in a specially designed heat exchanger fabricated from braised aluminium (BAHX), commonly referred to as the cold box. This necessitates the use of a dissimilar metal, aluminium to steel, flanged connection. Differences in thermal expansion between the aluminium and steel flanges can result in a reduction in load on a gasket leading to premature failure. Change™ gasket technology has been employed in both hot and cold cycling services to maintain sealing during thermal changes including differential thermal expansion and contraction seen in heat exchangers.

1. Sinclair, V (2018) 4 *Threats to the Global Ethylene Boom*. Wood Mackenzie [online]. Available at: https://www.woodmac.com/news/opinion/4-threats-to-the-global-ethylene-boom/
2. EIA Energy Conference (2018) US Petrochemicals. *The growing importance of export markets. IHS Markit*

Conclusion

The operational challenges present in ethylene production cannot be underestimated. The high risk of safety complications, calls for serious considerations when choosing sealing materials.

At Flexitallic, we understand that selecting the right sealing material is the first step to eliminating leaks and eventual unplanned outages due to joint failure. Choosing the right gasket material will minimise downtime, ensure safety and maximise efficiency, helping you identify the best available gasket technology for your equipment.

We have therefore developed a range of products that keeps your needs in mind and helps you meet stringent safety and environmental regulations as well as performance requirements.

Thermiculite®

Our tested and proven gasket material is made from chemically and thermally exfoliated vermiculite, with a similar structure to exfoliated graphite, Thermiculite® offers one clear advantage – it can endure a wide range of temperatures without compromising integrity as it's intrinsically resistant to oxidation.

Thermiculite® products are developed for use in high temperature processes in services up to 1000°C (1832°F) working in highly oxidising environments.

Key features

- **Total freedom from oxidation**
- **Wide chemical compatibility**
- **Can be used in temperatures up to 1000° C (1832° F)**
- **TA Luft compliant**
- **Fire safe**
- **Proven track record**
- **Wide range of formats to suit all applications**

Change™ Gasket

Manufactured with proprietary equipment and a unique laser welding process, Change™ is able to perform longer than any other gasket with a dynamic seal used within critical equipment. For applications where leaks are caused by thermal cycling, Change™ with Thermiculite® offers an ideal solution.

For more information about Thermiculite® gasket materials and Change™ gaskets get in touch.

About The Flexitallic Group

The Flexitallic Group is a global leader in specialised sealing solutions and products serving the oil and gas, power generation, chemical and petrochemical industries in emerging and developed markets.

Focused on the refining, petrochemical, chemical, power generation and upstream sectors, it has operations in the United States, Canada, Mexico, the United Kingdom, France, Belgium, Germany, Italy, the United Arab Emirates, Thailand, and China plus a network of worldwide licensing partners and distributors.