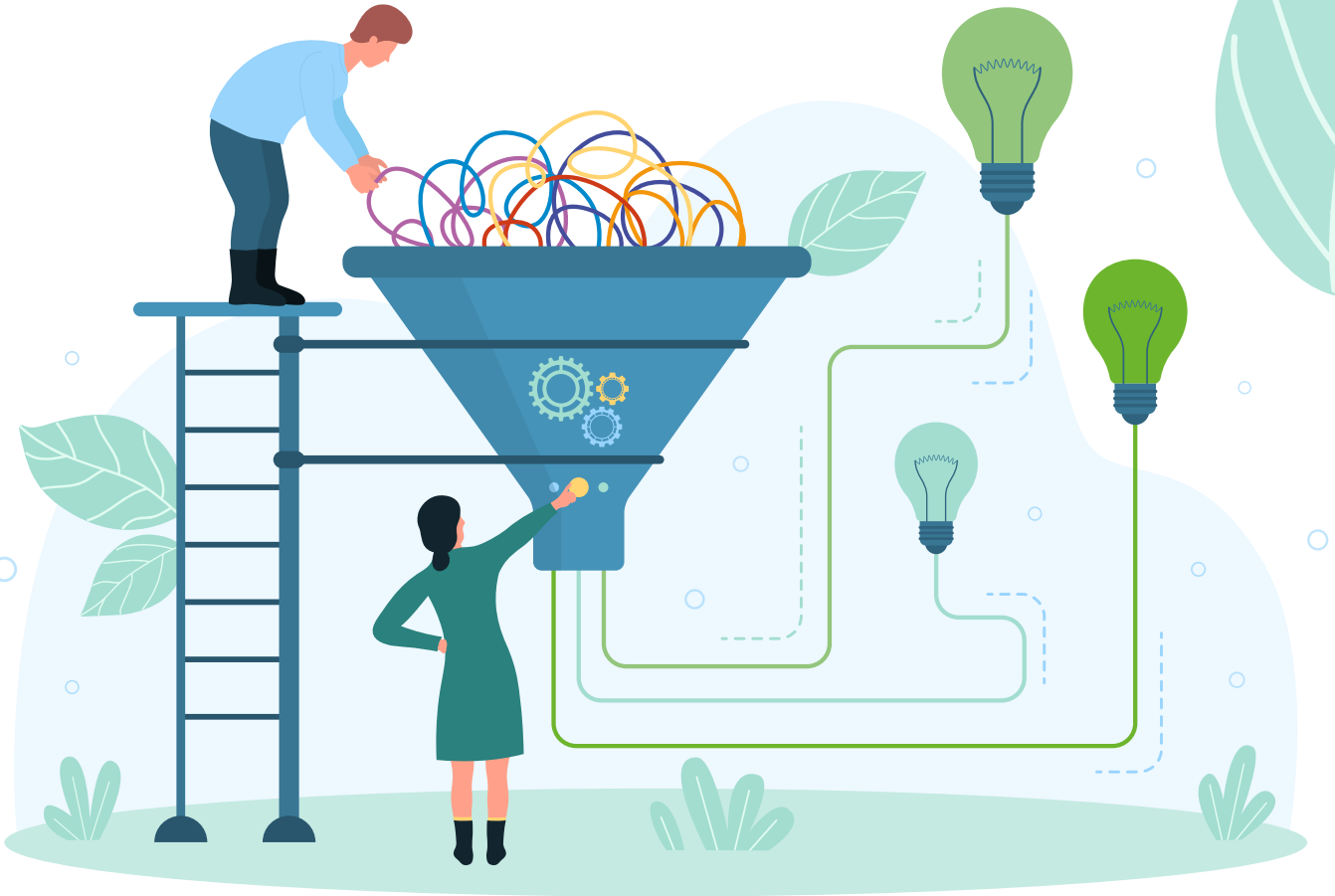
The cleaner the better

Neil Richards, PS Filter, Canada, considers the importance of effective filtration and separation techniques within the downstream oil and gas industry, in order to produce cleaner fuels.

Separation technology is a critical part of the downstream oil and gas industry, as it is used to separate the various components of crude oil and natural gas into different products. Some of the key areas where separation technology is utilised within the industry include:

- Refining: separation technology is used in the refining process to separate crude oil into its various components such as gasoline, diesel, jet fuel, and other fuels. This is achieved by way of distillation, whereby the crude oil is heated and the different components are separated based on their boiling points.



- Petrochemicals: used to separate the various chemicals and compounds that are derived from crude oil and natural gas. This is accomplished through processes such as fractionation and distillation, which allow for the separation of chemicals based on their physical and chemical properties.
- Gas processing: used to separate the natural gas from other gases and impurities, such as sulfur and carbon dioxide (CO_2). This is achieved with absorption and adsorption, which allow for the removal of impurities and the separation of different gases.
- Environmental protection: lastly, separation technology is also used to protect the environment by removing pollutants and contaminants from industrial wastewater and other waste streams. This is carried out through processes such as sedimentation, filtration and adsorption, which allow for the removal of solids, oils, and other contaminants from water and other waste streams.

Figure 1. Spent amine cartridges, completely filled with solid contaminants.

Figure 2. A PS-Filter activated carbon adsorber (separation) amine system.

Both filtration and separation are important processes, but they differ in their approach and in the level of efficiency that they provide.

Filtration is the process of removing solid particles and contaminants from liquids or gases using a porous medium such as a filter. In the downstream oil and gas industry, filtration is used to remove impurities such as dirt, sand and rust particles from crude oil and refined products such as gasoline, diesel and jet fuel. Filtration is typically used for removing larger particulates in the range of 1 – 100 µm, and it is a cost-effective way of achieving a certain level of cleanliness for the products.

While both filtration and separation are important processes, separation technology is generally more expensive and requires more specialised equipment and expertise than filtration. However, separation technology can provide a much higher level of purity and separation efficiency than filtration, making it essential for many applications in the industry.

Sometimes, filtration and separation terminology are used interchangeably as they can be closely related but, in many cases, they are used in different processes to achieve varying results.

One of the key areas in which PS Filter has utilised effective contamination control (filtration) has been in the amine purification process, to separate solid particulates. When it comes to separation techniques, the company has used carbon adsorption to remove dissolved organics (hydrocarbons) in order to reduce operational and other possible downstream issues.

Amines are designed to remove hydrogen sulfide (H_2S) and carbon dioxide (CO_2) from natural gas. It is a common process that is used in refineries, petrochemical plants, gas processing plants, and other industries.

Effective equipment and media design are two key factors that need to be addressed to ensure that the amine is kept as clean as possible, for optimum performance. PS Filter's scope of design and supply utilises physical filtration and separation (adsorption) in the amine system in conjunction with one another, to ensure optimum and safe performance. Ultimately, a clean amine system is the goal in order to achieve operational excellence.

Some of the immediate benefits that can be realised are as follows:

- Reduced foaming tendencies (reduced solid and liquid contamination).
- Increased gas throughput (clean amine performs effectively to remove H_2S/CO_2).
- Reduced operational labour and the associated costs related to increased contamination, which are avoided with an effective filtration-separation programme.
- Avoidance of excessive mechanical maintenance from corrosion-erosion contamination.

- Reduced disposal costs of spent products (less severe environmental impact).
- Safer operational conditions (reduced operator exposure to hazardous materials).
- Removal of dissolved organics through activated carbon adsorption is of paramount importance in order to reduce the associated costs of chemical addition products such as anti-foam and corrosion inhibitors.

Operating a dirty amine system is never a good idea, and will result in increased costs to the operator. Clean amines should be bright and clear, indicating that the system is in excellent shape. When particulates build up, the amine becomes darker and can get to the point of a translucent black, indicating that processing issues could be on the horizon.

One common problem in gas processing operations is amine foaming. As fine solids build up, the surface tension of the amine changes and foam becomes stabilised, contributing to reduced throughput for the plant, and the possibility of amine losses with carryover and off-specification gas downstream of the contactor.

Figure 3. Amine gas treatment within a refinery.

Table 1. Innovation feasibility: a summary

Innovation feasibility criteria	Applicability to this innovation	Weighting of criteria's importance (%)
Improve operations	Save costs by reducing operational labour costs	5
Reduce filtration costs	Reduce physical number of filters used and total costs reduced based on comparable number of units	5
Reduce mechanical costs	Reduce costs on rotating equipment and other process equipment in the system	5
Improve plant throughput	Increase sales revenue and hence improve the bottom line	20
Extraneous variables	Reduce chemical costs (solvent replacement, etc.)	5
Fewer disposal costs	Reduce the amount of used product to be disposed and hence reduce overall disposal costs	10
Improve safety	Reduce worker exposure time and frequency to hazardous material	50
Total weighting of all criteria		100

Common contaminants in an amine system are iron sulfide particulates, and these can build up from a combination of factors, namely inadequate filtering. A minimum 10% of the amine should be filtered, and this is usually carried out with two filters piped in parallel, so that one filter can be serviced while the other is running, in order to maintain a constant filtering operation.

In addition to effective particulate filtration in the amine system, it is important to have an adequately sized charcoal adsorber system in the loop in order to adsorb dissolved organics such as hydrocarbons that can also contaminate the amine and contribute to the foaming tendency. It is also critical to note that only filtered amine should flow through the charcoal adsorber, and the effluent from this system should be filtered to ensure the capture of any carbon fines that could possibly migrate downstream and also contribute to foaming and other mechanical issues.

Some guidelines to help reduce amine foaming are to ensure that the filter-separation system is designed to meet the process flow rates and is effective to remove the particulates that can contaminate and build up in an amine system, leading to a plethora of problems that multiply over time.

If a filter system is undersized or uses filters that are not sufficient to remove the particle size of contaminants in the 10 µm range, an operator may be unknowingly contributing to amine foaming.

To provide an effective filtration-separation system for the amine process, PS Filter utilises proprietary mechanical and adsorption medias to optimise performance based on the specific process conditions. It is important to work together with clients to understand their goals and expectations.

The energy industry is unique, as the products are ubiquitous and can enhance and enrich the lives for all the inhabitants on the planet.

Former Harvard Professor, Theodore Levitt, summarises the benefit of working together in unison for a common goal: "Sustained growth depends on how broadly you define your business and how carefully you gauge your customer needs". Responsible and operationally-effective downstream energy production with effective filtration-separation is just one example in a complicated industry.

In collaboration with global partners, PS Filter is continuously evolving to utilise innovative and effective filtration and separation medias that are efficient and cost-effective. The goal is to improve operational and safe processes by providing the lowest cost per pound (lb) of contaminant separation. Working with clients, the company utilises various weighted criteria that they deem important for their specific production processes.