Coking/Delayed Coking – Filtration of Heavy Coker Gas Oil Product

The delayed coking process is one of the most important conversion techniques being used to convert today's heavy residue oils to transportation fuels. Petroleum residues are used as a feedstock for coking. One of the main products of Delayed Coking is Heavy Coker Gas Oil (HCGO), often processed in a downstream catalytic unit (such as a HCU). HCGO product consists of heavy polyaromatic hydrocarbons, predominantly in the range of C13 to C60. The heavier ones are so called asphaltenes, in the shape of long, un-cracked (cyclic) hydrocarbon chains. Asphaltenes can form larger hydrocarbon structures which can precipitate on the surface of filtering media. HCGO product also often contains fine coke particles which, on penetrating filter media, might cause plugging and poses a big threat for reliable operation. In this respect, a robust and reliable filtration system is required. Not only to prevent fouling of the filtration system itself, but also to prevent any of your downstream equipment and catalyst beds. Contrary to the common backwash filters available in the market, Royal Dahlman distinguishes itself with filters that are cleaned using a gas as the driving force. The advantage is that a much more effective way of cleaning is achieved, allowing even the most heavy oils to be filtered on these filters. Through a special developed back flush valve and filter element, efficient cleaning is ensured and as such a reliable filter design is provided.

Fluidized Catalytic Cracking – Filtration of FCC Slurry Oil

Developed in the late 1930's, Fluid Catalytic Cracking is still the primary conversion process in modern refineries. The Cat Cracker unit is the key to profitability for most refiners; efficient and successful operation determines whether a refiner can be competitive in today's market or not.

The FCC reactor contains a fluidized bed of catalyst with an equilibrium particle distribution range between 20 and 150 microns. In the reactor, coke forms on the catalyst as a result of condensation reactions and deactivates the catalyst. In order to prevent the formation of coke and to continuously keep providing energy to drive the endothermic cracking reaction, the catalyst is circulated between the reactor and the regenerator to burn off coke.

Reaction products leave the reactor in a gaseous state after passing through cyclones that remove the majority of entrained equilibrium sized catalyst particles and smaller catalyst fines. The latter have great chance of escaping capture in the reactor cyclones, since the removal efficiency of cyclones reduces with decreasing particle size. As such, these fines are carried over along with the reactor pro-ducts to the main fractionator of the FCCU and leave the fractionator with its bottom product, also referred to as slurry oil. By removing these catalyst fines from the slurry oil, product fuel oils can be upgraded, or feedstock can be provided for production of carbon black or other products. Royal Dahlman designs, fabricates and assembles fully dressed FCC Slurry Oil Filtration packages, based on proven filtration technology with a continuous solids content reduction to < 50 ppm wt. For many refineries operating an FCCU, filtration of main fractionator bottoms (MCB), or so-called slurry oil, offers very attractive benefits. By reducing the amount of catalyst fines in the slurry oil, the product is upgraded to a more valuable commodity and can be used for various applications instead of disposing it as a waste product. As a result, additional revenues up to $40/barrel have been seen and short return on investments are achieved. Since 2004 Royal Dahlman has supplied complete FCC Slurry Oil filtration systems. All filter systems are still up and running according to their design and duty requirements.

Fluidized Catalytic Cracking – Reduction of FCC Flue Gas Emission (Catalyst Fines)

Filtration of catalyst fines has always been an important issue in refineries. Not only to protect downstream equipment, but also to meet local environmental and governmental legislations. Worldwide refiners need to revamp their FCCU regenerator off-gas systems and grassroots refineries need to implement the latest filtration technology due to the required reduction of stack emissions. While in most countries the maximum particulate emission level is 50 mg/Nm^3, some targets have already been reduced to 40 mg/Nm^3 or to limitations on particulate matter (*i.e.* PM10 or PM2.5). In many cases, conventional separation technology is not sufficient anymore to meet these guidelines.

Before the flue gas leaves the stack, many FCC plants have a flue gas expander to recover energy from reducing flue gas pressure. Typically, regenerators are designed with multi-stage cyclones to capture and return entrained catalyst back to the fluidized bed. However, the flue gas still contains high contents of catalyst fines that can do harm to the expander. A so-called Third Stage Separator (TSS) is installed upstream of the expander to protect the expander blades from undue erosion by abrasive catalyst. The TSS contains cyclonic separation technology, reducing the high amount of cat fines in the regenerator off-gas significantly. The required emission levels cannot always be reached using a single TSS. The Royal Dahlman Fourth Stage Separator (FSS) increases the separation of the total TSS package efficiency to the required values in combination with the underflow of the TSS. Our FSS features a 'downflow' arrangement and special gas distribution inlet section, developed based on extensive CFD analyses and tailored for the filtration of FCC flue gas. Our FSS utilizes high quality, sintered porous metal filter elements, which have proved to perform excellent under the severe FCC flue gas conditions.

Gas Treatment – Filtration of Amines

Gas treating units using amines, also known as gas sweetening, refers to a group of processes that use aqueous solutions of various alkyl amines (commonly referred to as amines) to remove hydrogen sulfide (H_2S) and carbon dioxide (CO_2) from gases. The process runs in a common unit used in refineries named GTU (Gas Treating Unit), and is also used in petrochemical plants, natural gas processing plants and other industries. Processes within oil refineries or gas processing plants that remove hydrogen sulfide and/or mercaptans are commonly referred to as sweetening processes because they result in products which no longer have the sour, foul odors of mercaptans and hydrogen sulfide. A typical amine gas treating process includes an absorber unit and a regenerator unit as well as accessory equipment. The construction material commonly used is carbon steel. The sulphur components, present in the amine after being absorbed, react with the piping and vessels and forms FeS (iron sulphide). The formation of iron sulphide (H_2S + Fe --> FeS + H_2) is unavoidable and causes operational problems. In combination with injected anti-foaming agents into the gas treating systems, the FeS particles form oleophilic encapsulated FeS particles which show a "filming" tendency on filter materials. As such, amine filters tend to plug quickly. At Royal Dahlman, we have tested, designed and installed field proven filter designs since the early nineties and as a result we provide reliable and proven filter technology to many refineries and gas plants. One of these technologies is the Royal Dahlman Terraced Filter (T-filter). The T-filter is suitable for amine filtration applications, with the unique benefit of having no resin binder and a higher filtration surface compared to the conventional cartridge filters of the same dimensions. The T-Filter derives its name from the construction of the filter media. By applying a radially pleated construction instead of the axially pleated construction or string wound cartridges, a significant increase in filtration area is achieved. The filtration direction is from inside to the outside. Between each terrace, a layer of drainage material is provided. This ensures a proper flow distribution and makes a high DHC possible. The latest development of this type of element is doubling the length of the element. Typically this double length element is used for excessively high dirt loadings. The filter housings are available with 1, 3, 5, and 7 elements installed with single or double length elements. The Industries where Royal Dahlman has successful references are, amongst others, the LNG production and GTL production but also in GTU's in refineries. Many references are available related to the filtration of amines for Iron Sulphide (FeS) removal, CO_2 removal applications and glycols for gas dehydration.

Cooling Water/Produced Water – Filtration with Pressurized (Dual) Media Filters

This technology using pressurized sand filters is applied to industrial open circulating cooling water systems, but also for the fine filtration of produced or fresh sea water for the injection into oil or gas fields. Royal Dahlman has been supplying high-end pressurized sand filters to the Oil & Gas Industries since the early nineties for a variety of applications. Typical applications involving media filtration are the filtration of cooling water; produced water for well injection, side stream filtration for cooling towers, etc. Today, an impressive number of filter systems has been installed in various plants all over the world and at major Oil & Gas companies our technology is preferred. All of the delivered and installed filter packages are still up and running and performing excellent within the required process performance parameters.