

FILTRATION & SEPARATION EQUIPMENT



REFINERY – HYDROTREATING UNIT

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PROCESS UNIT	PROCESS DESCRIPTION	FEED TO THE UNIT	KEY ISSUES	FILTRATION SOLUTIONS
<ul style="list-style-type: none">Hydrotreating Unit (HTU)Hydro Desulfurization (HDS)Naphtha Hydrotreater (NHT)Distillate Hydrotreater (DHT)Black Oil or Heavy Oil Hydrotreater (HDT)	Commonly used as Feed Preparation Units for downstream Catalytic Processes, Hydrotreating Processes remove impurities such as sulfur and nitrogen from distillate fuels (naphtha, kerosene and diesel) by treating the feed with hydrogen at an elevated temperature and pressure in the presence of a catalyst. Hydrotreating has been extended in recent years to atmospheric residuals to reduce the sulfur and metal content of residuals for producing low sulfur fuel oils. The principal impurities removed by this unit are sulfur, nitrogen, oxygen, olefins, aromatics, halogens, and metals.	<ul style="list-style-type: none">Naphtha (Straight Run Naphtha, FCC Naphtha, HC Naphtha, Coker Naphtha) – acts as an Isom and Reformer feed pretreatKerosene, Jet Fuel, Diesel, Heater OilVacuum Gas Oils (VGO)Atmospheric Gas Oils (AGO)Residual	Feed Contaminated feed stocks foul heat exchangers, clog reactor nozzles, cause corrosion, reduce reactor efficiency and results in catalyst deactivation. Feed such as VGO, HCGO, AGO, diesel, and middle heavy distillate need to be water washed to take out the salts. Otherwise nitrogen, which gets converted to NH ₃ in the reactor, reacts with the salts to form NH ₄ Cl. This can cause downstream catalyst issues and exchanger fouling. The washed feed needs to be free of water as water fouls critical downstream equipment. Hydrogen The HDS reaction needs hydrogen. The hydrogen is either added as fresh make-up hydrogen or hydrogen produced as a byproduct in the CCR unit is used. The hydrogen, which is recycled, contains particulates, trace liquids and aerosols. If not treated, this creates issues with compressor performance and also causes reactor catalyst bed and tower fouling.	FEED FILTRATION ① Liquid Filter PECO, XtreamPure®, Series 55X filter with 6” diameter XP cartridges <ul style="list-style-type: none">Removes corrosion products and particulatesAssists in maintaining reactor pressure dropPrevents clogged reactor nozzlesPrevents particulate deposits in reactor bedProlongs catalyst life and yield ② Liquid-Liquid Phase Coalescer PECO, XtreamPhase®, Series 110H coalescer with TLPC or PLPC cartridges <ul style="list-style-type: none">Protects reactor catalyst fouling by removing water down to 8-10 ppm in the feed stream FUEL GAS FILTRATION ③ Gas Filter-Coalescer PECO, PEACH Gemini PuraSep® 2, Series GEM2 horizontal coalescer with PGC cartridges <ul style="list-style-type: none">High efficiency 0.3 micron coalescerRemoves solid and liquid contaminantsProtects burner tips HYDROGEN FILTRATION ④ Gas Filter-Coalescer PECO, PEACH Gemini PuraSep® 2, Series GEM2 horizontal coalescer with PGC cartridges <ul style="list-style-type: none">High efficiency 0.3 micron coalescerProtects compressor to minimize downtime and maintenance costsRemoves particulates, trace hydrocarbon liquids and aerosols ⑤ Gas Coalescer PECO, Spartan PuraSep®, Series 77V vertical coalescer with NGGC cartridges <ul style="list-style-type: none">High efficiency 0.3 micron liquid coalescingPrevents lube oil carryover in the compressed hydrogen to the reactorProlongs catalyst life and yield ACID GAS TO AMINE UNIT ⑥ Gas Filter-Coalescer PECO, PEACH Gemini PuraSep® 2, Series GEM2 horizontal coalescer with PGC cartridges <ul style="list-style-type: none">High efficiency 0.3 micron coalescerRemoves particulate and liquid carryover from the acid gasHelps protect amine absorber/contactorReduces amine foaming and contamination
CONTAMINANTS	<ul style="list-style-type: none">MetalsSulfur CompoundsNitrogen CompoundsOxygen Compounds	RELIABILTY ISSUES <ul style="list-style-type: none">Furnace and Exchanger FoulingFeed Quality – high contaminationReactor Pressure DropCatalyst DeactivationEffluent Exchanger Fouling and Corrosion (NH₄Cl, NH₄HS)Tower Stripper Operation – fouling and corrosion		STRIPPER FEED FILTRATION ⑦ Liquid-Liquid Phase Coalescer PECO, XtreamPhase®, Series 110H coalescer with TLPC or PLPC cartridges <ul style="list-style-type: none">Protects stripper fouling by removing water carryover down to 8-10 ppmHelps to maintain stripper efficiency SOUR WATER FILTRATION ⑧ Liquid-Liquid Phase Coalescer PECO, XtreamPhase®, Series 110HR coalescer with TLPC or PLPC cartridges <ul style="list-style-type: none">Removes particulates in the sour water streamRemoves hydrocarbon (oil) carryover down to 8-10 ppm in the sour water streamPrevents fouling in downstream equipment such as Sour Water Stripper and ReboilersHelps maintain good water quality and steam balanceReduces loss of water or requirement of fresh water make-up Typically all sour water is taken to a Sour Water Treatment System which includes a Liquid Filter and Liquid-Liquid Phase Coalescer. A Liquid-Liquid Phase Coalescer is shown in the diagram for reference. For particulate removal it is recommended to include a PECO, XtreamPure®, Series 55X filter with 6” diameter XP cartridges (not shown) before the Liquid-Liquid Phase Coalescer.
OBJECTIVES OF HYDROTREATING	<ul style="list-style-type: none">Removal of contaminant with minimal effect on boiling range of fuelHelps in the saturation of olefins and some aromaticsUsed to meet product quality, performance and environmental product regulationsImproves and/or protects downstream processing and catalystsPlays a key role in improving downstream process and catalyst performanceCan increase cetane rating of diesel	RELIABILTY ISSUES EXPLAINED Feed Quality: High contamination in the feed leads to catalyst deactivation. The feed contains substances which induce corrosion and need to be removed. A good feed quality, free of contamination, results in better catalyst yield and activity. Furnace and Exchanger Fouling: Furnaces and exchangers can get fouled if the hydrocarbon stream is contaminated with scale, silica and rust particles. Furnace tube fouling leads to lower heat transfer in the convection zone and radiation zone. This then leads to lower feed temperature in the reactor, which affects the catalyst activity. In a furnace with fouled/choked tubes, to maintain high catalyst activity and optimum inlet feed temperature, higher temperature will be required which leads to high energy consumption. Higher temperature can also induce cracking and coking which is not desirable. Exchanger fouling which is caused by scale, silica, and rust leads to poor heat exchange which in turn leads to improper feed temperature. Exchanger fouling causes frequent shutdowns for tube bundle repairs and change outs, causing production losses and increased OPEX.	Acid Gas/Sour Gas The acid gas, which is mainly sour gas, contains hydrocarbon liquid as carryover. This can create foaming issues in the downstream amine unit.	
HYDROTREATING CATALYST	KEY REACTIONS Desulfurization (HDS): Conversion of organic sulfur compounds to hydrogen sulfide (H ₂ S) which can be easily removed in downstream amine units. Denitrification (HDN): Conversion of organic nitrogen compounds to ammonia (NH ₃) proceeds through aromatic saturation, then extraction. Other Hydrotreating Reactions: <ul style="list-style-type: none">Removal of organo metallic compounds. Metals are irreversible catalyst poison.Saturation of olefins and aromatics.Conversion of organic oxygen compounds to water. Water and oxygen can strip chloride off reforming catalyst and deactivate it, so it needs to be removed from the product stream.Conversion of organic halides to hydrogen halide. Halide ions can form NH₄Cl salt with NH₃ resulting in fouling/corrosion.	RELIABILITY ISSUES EXPLAINED Feed Quality: High contamination in the feed leads to catalyst deactivation. The feed contains substances which induce corrosion and need to be removed. A good feed quality, free of contamination, results in better catalyst yield and activity. Furnace and Exchanger Fouling: Furnaces and exchangers can get fouled if the hydrocarbon stream is contaminated with scale, silica and rust particles. Furnace tube fouling leads to lower heat transfer in the convection zone and radiation zone. This then leads to lower feed temperature in the reactor, which affects the catalyst activity. In a furnace with fouled/choked tubes, to maintain high catalyst activity and optimum inlet feed temperature, higher temperature will be required which leads to high energy consumption. Higher temperature can also induce cracking and coking which is not desirable. Exchanger fouling which is caused by scale, silica, and rust leads to poor heat exchange which in turn leads to improper feed temperature. Exchanger fouling causes frequent shutdowns for tube bundle repairs and change outs, causing production losses and increased OPEX.	Tower Stripper Fouling The stripping column separates the light gases from the hydrotreater products. Contaminated inlet feed to the stripping column impacts the separation and hence leads to poor quality of hydrotreated product. The effluent exchanger or reboiler fouling not only creates limited heat transfer but in order to maintain the same reboiler temperature, more energy is consumed. Fouling causes shutdowns and maintenance leading to production losses.	⑨ Liquid-Liquid Phase Coalescer PECO, XtreamPure®, Series 55X filter with 6” diameter XP cartridges ⑩ Liquid-Liquid Phase Coalescer PECO, XtreamPhase®, Series 110H coalescer with TLPC or PLPC cartridges <ul style="list-style-type: none">Removes particulates in product streamRemoves sour water carryover down to 8-10 ppm from the product stream The product from the hydrotreater becomes a feed for various downstream processes which have catalyst that is highly sensitive to water. Removal of water helps in protecting the downstream catalyst from getting poisoned. For example, in an Isom unit, 1.6 lbs of water can kill 100 lbs of catalyst. Hydrotreater product such as diesel also needs removal of water, as water in diesel decreases the product quality (considered off-spec) and prevents the refinery from selling it.
Catalyst Supports (Provides acid function) <ul style="list-style-type: none">AmorphousZeolite (Porous Aluminium – oxide) Base Metal (Metal Sulfide is the Active form) <ul style="list-style-type: none">Ni-Mo (Nickel – Molybdenum)Co-Mo (Cobalt – Molybdenum) Noble Metals (Strong Hydrogenation Function) <ul style="list-style-type: none">Pd (Palladium)Pt (Platinum)				