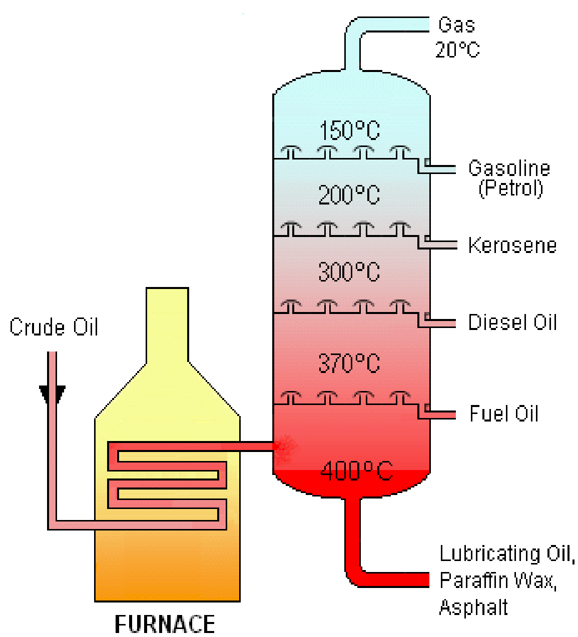
Petroleum Refining

Industry: Refining
Product: GD40 and GD402

Introduction

The U.S. refineries represent approximately 23 percent of the world's petroleum production, and the United States has the largest refining capacity in the world. Petroleum refining is an industry, which is undergoing intense amounts of scrutiny in the United States from regulatory agencies and environmental groups. As a result, releases of pollutants caused by corrosion leaks are becoming a high consequence event. The Clean Air Act of 1990 has forced refiners to implement a number of costly measures to reduce their impact on the environment, both with the types of products they produce and the manner in which they operate their refineries.



An oil refinery is an industrial process plant where crude oil is processed and refined into more useful petroleum products, such as gasoline, diesel fuel, asphalt base, heating oil, kerosene, and liquefied petroleum gas. The measurement of hydrogen purity throughout a system allows for efficient control of the process.

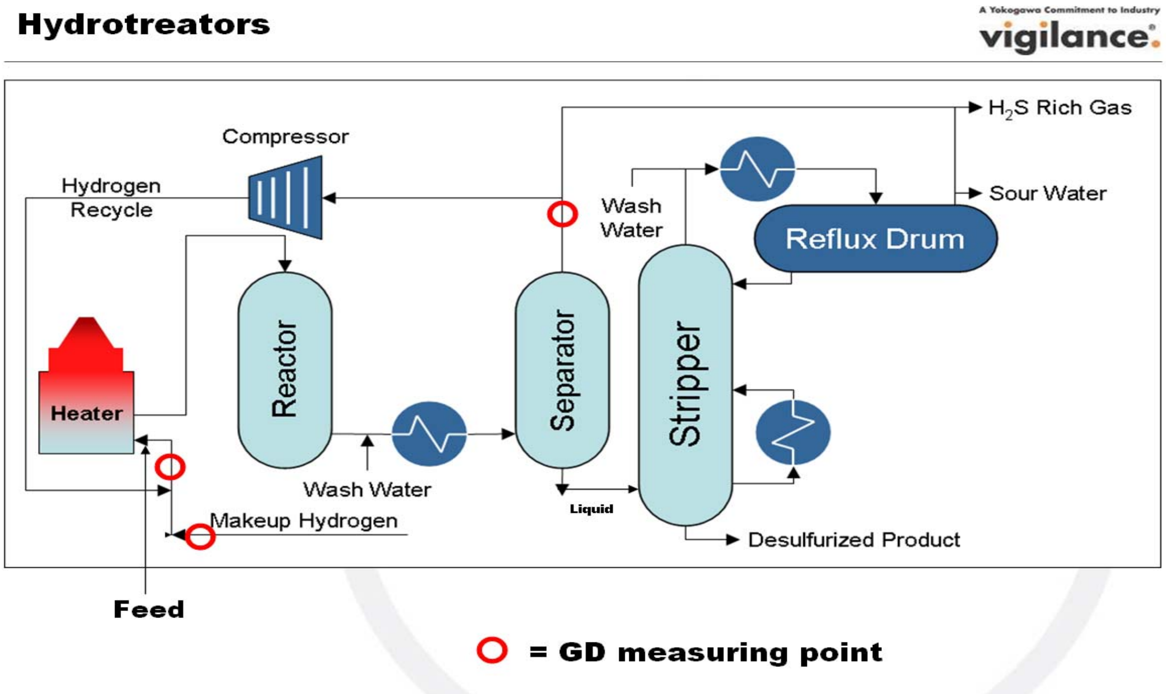
Gas density can be measured in various portions during petroleum refining.

- i.) Hydrotreating
- ii.) Catalytic Reformer
- iii.) Input Hydrogen Purity
- iv.) Catalytic Hydrocracking
- v.) Recycled Hydrogen
- vi.) Fuel Gas Specific Gravity
- vii.) Hydrogen Purification
- viii.) Off Gas Specific Gravity

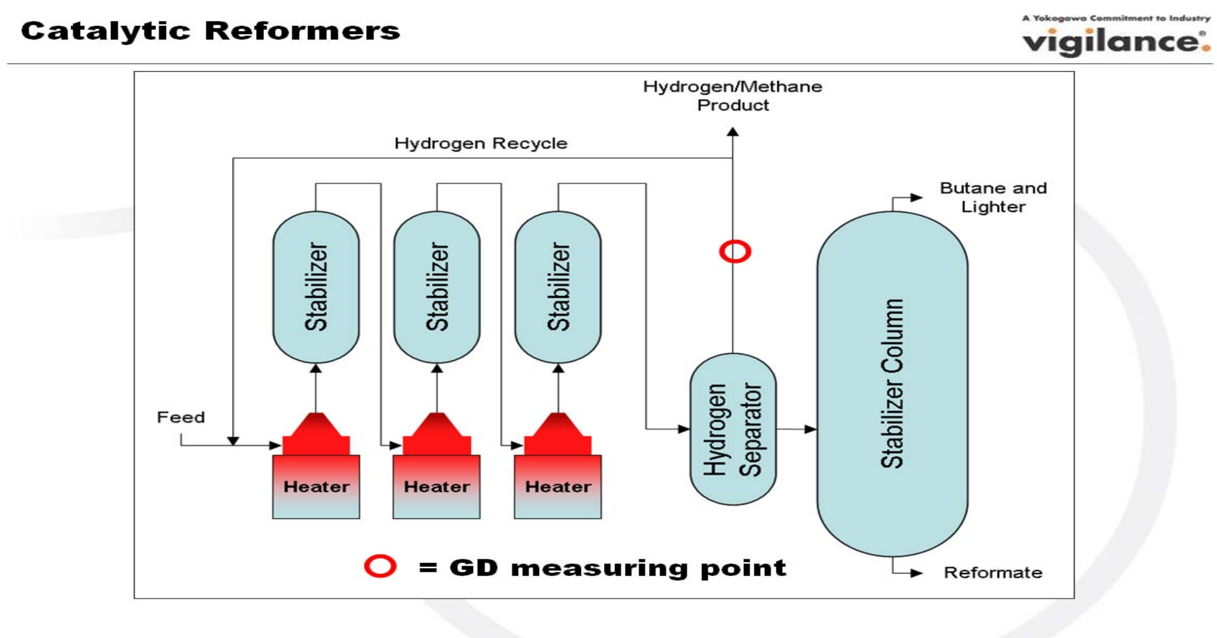
Process

Step One: Hydrotreating is the process where the Hydrotreators or HDS (Hydrodesulfurization) units remove sulfur from products of distillation like Naphtha, Diesel, and Gas Oils before reforming or hydrocracking process. This “sweetening” process reduces SO2 emissions when the product is burned, and protects the catalysts used in down-stream units (Reformers). The hydrotreating process (sweetening) is carried out in the presence of hydrogen to saturate the cleaned hydrocarbons. Hydrogen is consumed during the process, and the purity of the hydrogen present will affect the performance of the reactions. Many of the same parameters exist for the hydrotreater as do for the hydrocracker.

The feed is mixed with Hydrogen, heated to 300-400 degrees Celsius and pressurized up to 1900 psi. This mixture is sent to a reactor containing a fixed bed of catalyst (typically alumina based impregnated with cobalt and molybdenum).



Step Two: Catalytic Reformers convert sweetened Naphtha with low octane ratings into high octane rating Reformate. This is done by "reforming" the straight chain feed molecules into branched and cyclic molecules. The feedstock is mixed with Hydrogen, then pressurized and heated. This mixture is sent to a series of reactors containing a catalyst (usually platinum), where the reforming takes place. The products of this process are high-octane Reformate and Hydrogen-rich gas (due to dehydrogenation of straight-chain molecules).



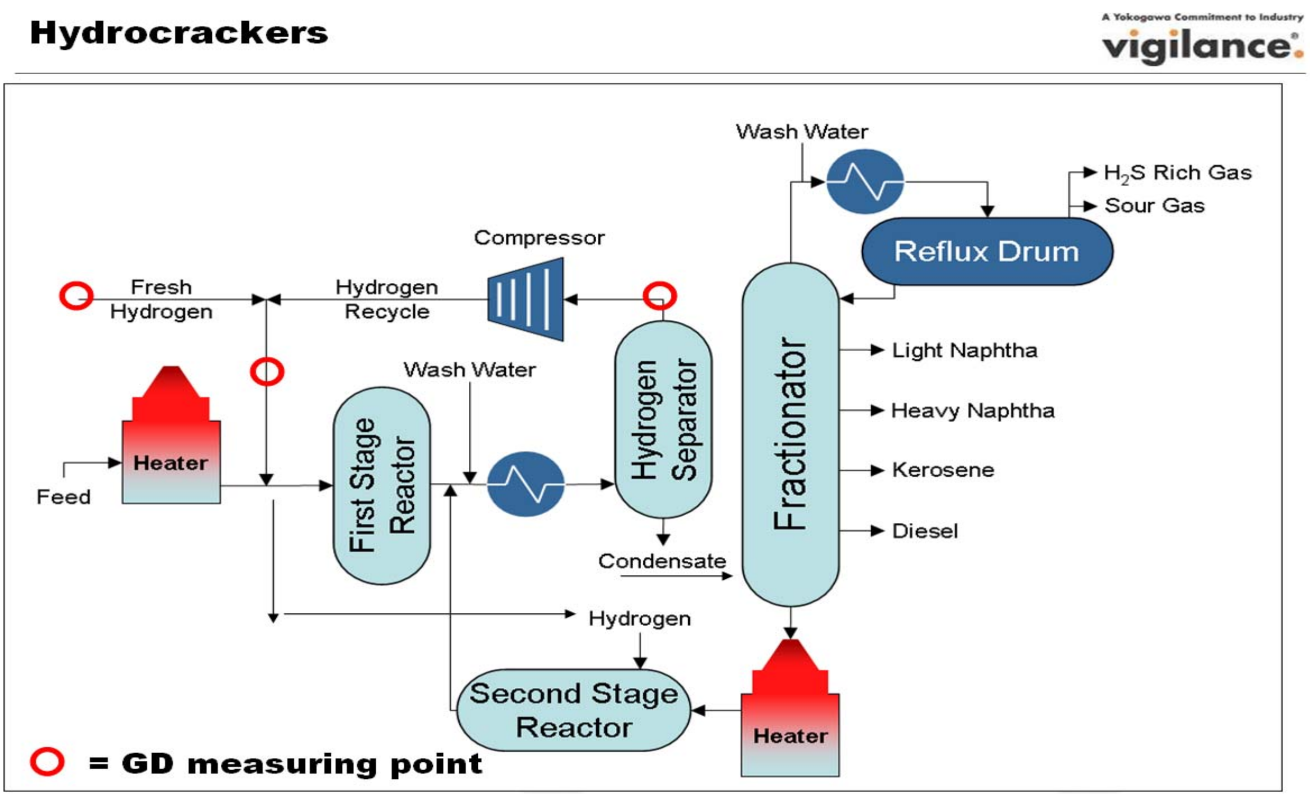
Step Three: Input Hydrogen Purity, in the case of hydrogen production off site the supply of hydrogen is produced by alternate means: steam methane reforming or gasification being the most common. Gasification is a process that converts carbonaceous materials, such as coal, petroleum, or biomass, into carbon monoxide and hydro Gasification is a process that converts carbonaceous materials, such as coal, petroleum, or biomass, into carbon monoxide and hydrogen by reacting the raw material at high temperatures with a controlled amount of oxygen. The resulting gas mixture is called synthesis gas or syngas and is itself a fuel.

From a reformer or hydrocracker perspective there is value in knowing the hydrogen purity from the supplier. Checking for air in leakage or other contaminates could save money and lives.

Step Four: In Catalytic Hydrocracking the hydrocrackers break heavy, long chain gas oil molecules into shorter, lighter, more valuable molecules. This process is called cracking, whereby complex organic molecules such as kerogens or heavy hydrocarbons are broken down into simpler molecules, by breaking of carbon-carbon bonds in the precursors. The broken bond are followed by saturation of hydrogen. The rate of cracking is dependent on temperature and the presence of any catalysts.

Hydrocracker products are sulfur free and saturated. Typical feedstock is Coker gas oil and gas oils from crude oil distillation. Feed stock is mixed with Hydrogen, pressurized (2000 psi), and heated (425 C). This mixture is sent to a reactor containing a catalyst (typically platinum) where the cracking takes place. The hydrogen rich gas is then separated from the cracked product, which is further fractionated.

Hydrocracker units can be configured into single stage or two stage reactor systems that enable a higher conversion of gas oil into lower boiling point material. Distillates from hydrocracking make excellent jet fuel blend stocks. The yield across a hydrocracker may exhibit gains as high as 25% making it a substantial contributor to refinery profitability.



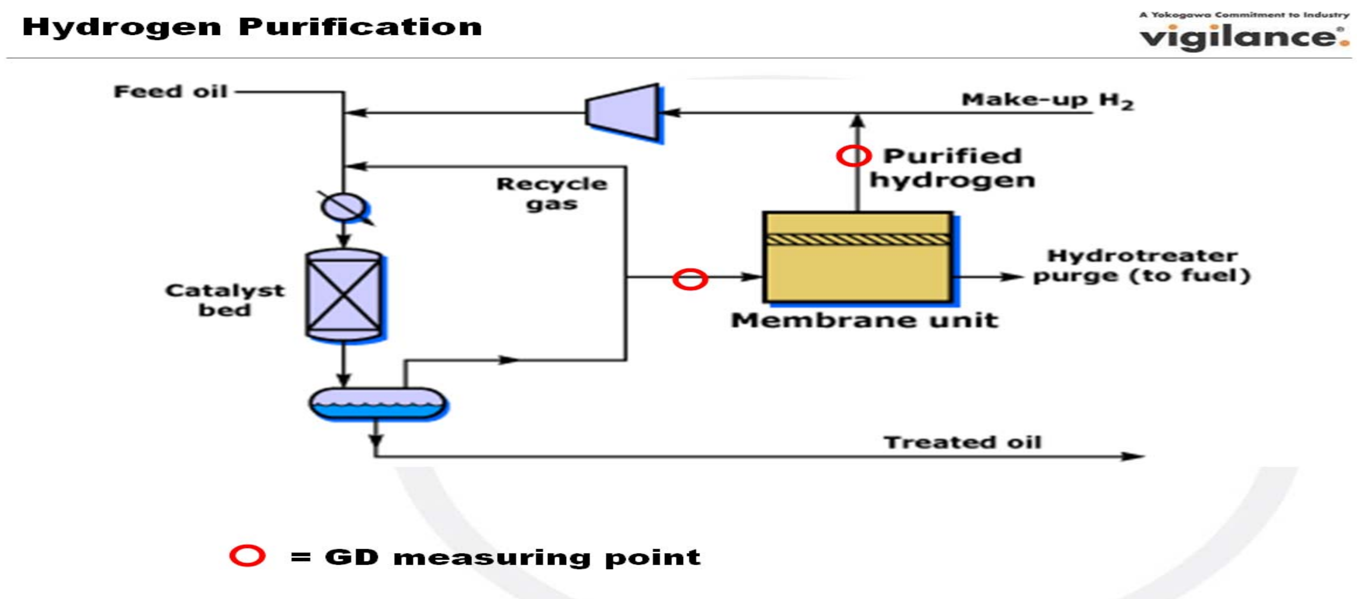
Step Five: Recycled hydrogen is the exit gas produced by a reformer or left after hydrocracking contains condensable hydrocarbons and ~75-90% hydrogen. Some of this mixture is recycled into the process to minimize the use of virgin, pure hydrogen and to reduce cost. The purity of the exit hydrogen also represents the efficacy of production as the hydrogen purity will change as process conditions change, reaction catalysts are contaminated or gas/liquid separators are filled. Measurement of the recycled hydrogen purity allows a more efficient control of pure/recycled hydrogen and a low cost, low maintenance means to monitor real-time hydrogen production performance in the process.

Step Six: Fuel gas and some excess hydrogen is used for burner fuel to heat the process heaters and onsite power boilers. The specific gravity of the fuel gas is used to calculate burner rate. Knowledge of the specific gravity of the fuel allows a more efficient mixing of fuel gases and a better burner efficiency which saves money.

Step Seven: Many refinery units require or produce Hydrogen, and the purity of this hydrogen is essential to the efficiency of the plant. A gas purity measurement before and after the cleaning (absorption) or separation stage of hydrogen recycling can allow accurate determination of the efficiency of the cleaning stage. Recycled gas containing mostly Hydrogen can be purified to supplement the recycled gas “loop”. Many methods are employed including membrane and PSA technologies.

Contaminates in the post cleaning process stream indicate a deterioration of the process parameters (i.e. the separator is full, the membrane or catalysts is contaminated). This information is valuable in preventative maintenance schedules or in trouble shooting batch problems.

Step Eight: The specific gravity of the off gas is monitored to determine hydrogen content. The specific gravity value on the off gas shows hydrogen slip in the process.



Product Recommendations

Analyzer: GD402 Gas Density Meter
Sensor: GD40 Gas Density Detector

* If you need any further assistance please contact the Yokogawa Analytical Marketing Department