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VDU Technical Description

ATB is charged to the VDU from the ADU. The design pumping rate is 7,500 bpd. The ATB level control valve controls the flow rate from the ADU to the VDU. The ATB heater is a direct-fired heater.

The hot ATB enters the flash zone of the vacuum tower at approximately 705° F and a pressure of approximately 10 millimeters of mercury (torr). A temperature controller maintains the heater outlet temperature setpoint by adjusting the flow of fuel to the burners thereby increasing or decreasing the firing rate of the heater.

The vapors flow upward through the packed zones of the vacuum tower and the unvaporized liquid collects in the bottom section of the tower. The unvaporized liquid (vacuum tower bottoms or VTB) is pumped from the tower using the VTB pumps as regulated by level control. The hot vapors flow up the vacuum tower and the heavier compounds are condensed by liquid reflux. The tower consists of a heavy vacuum gas oil (HVGO) draw, and a light vacuum gas oil (LVGO) draw with vapors exiting the tower via the overhead vacuum system.

Overhead vapors exit the vacuum tower and flow through the first stage condenser. The cooled fluid and any remaining vapor exit and flow to the first overhead accumulator where it separates into liquid and vapor. The accumulator operates at approximately five torr absolute pressure. Any uncondensed light hydrocarbon vapors and inert gases are drawn from the top of the accumulator under vacuum by the vacuum system.

Each vacuum system is a three stage system consisting of two (2) booster blowers, two (2) interstage coolers and a vacuum pump. The system is designed to use variable frequency drives (VFDs) so that the boosters and vacuum pump can operate at 3,450 to 3,600 rpm with an inlet pressure of five to ten torr and deliver a capacity of 3,000 to 3,500 acfm per train.

The vacuum pump is first started and will always run at 3,600 rpm. The secondary booster is started based on feedback from the temperature transmitter and system pressure requirement and is brought up to 3,500 to 3,550 rpm. Finally the primary booster is started based also on feedback from the temperature transmitter and system pressure requirement and is brought up to 3,100 rpm to achieve 3,000 acfm. The train can achieve up to 3,500 acfm at 3,450 to 3,550 rpm.

The pressure of the system is controlled by adjusting the speed of the primary booster within its operating range.

Vapors between the two booster pumps and the vacuum pump require cooling for proper operation of the system. The vapors exit the primary booster and pass through the first Gas Cooler. The vapors then pass through the secondary booster blower. The vapors pass through the second Gas Cooler and then enter the vacuum pump.

Cooling is provided to the vacuum pump system from the coolant system. A thermal fluid from the coolant system passes through the tube side of each cooler with the vapors passing through the shell side. The thermal fluid is also circulated around the vacuum pump seal to provide cooling. After use, the thermal fluid returns to the closed loop coolant system for cooling and re-use.

It is likely that a small amount of liquids will condense in the first and second gas coolers. These liquids are drawn from the system using drain lines and five-gallon receiver tanks attached to each cooler. Each five-gallon receiver is under vacuum and open to the drain connection of its associated cooler. When the level switch in the receiver indicates that it is about one-half full of liquid, the actuated valve connecting it to the cooler will close and the actuated three-way valve connected to the port side of the cooler changes state and vents the receiver to atmospheric pressure. After a preset time, the receiver's actuated drain valve opens allowing the receiver to drain for a preset time. Once this is completed, the drain valve is closed and the three-way valve reverts back to the original setting connecting the receiver to the cooler. This causes a vacuum to be drawn on the receiver. After a preset time, the valve connecting the receiver to the cooler drain opens, allowing any liquids to begin draining into the receiver again.

Vapors exit the vacuum pumps at approximately five psig. The vapors then flow through the second stage condenser. The cooled fluid and any remaining vapor flow to the second overhead accumulator which operates at approximately 4.75 psig.

Any uncondensed light hydrocarbon vapors and inert gases are released from the top of the second overhead accumulator under back pressure control (normally 4.75 psig) using a pressure indicator controller and pressure control valve. This stream vents to the fuel gas drum.

Condensed liquid in the first and second overhead accumulators consists of overhead water and light hydrocarbons. Overhead water collects in the boots that are connected to the bottom of the accumulators. This accumulated water is anticipated to be minimal and is manually dumped to the water drain system regularly as necessary by operators after checking the level in sight glasses.

The light hydrocarbon liquid is combined with the liquids collected in the sump and are pumped to storage via a connection with either the LVGO product stream or the VTB product stream. The final parameters of the light hydrocarbon liquids determine which connection is used.

The first product withdrawn from the lower vacuum tower chimney tray is heavy vacuum gas oil (HVGO). HVGO pumps draw the liquid from the tray.

The discharge HVGO stream splits with part of the flow returning below the HVGO chimney tray in the vacuum tower as recycle. The remainder of the HVGO flows through the shell side of the crude/HVGO exchanger where it is cooled while heating the crude oil feed.

The HVGO stream splits again with part of the cooled HVGO combining with LVGO recycle and returning above the HVGO chimney tray as recycle.

The balance of the HVGO stream flows through the HVGO cooler where it is cooled to its final product temperature. The HVGO product flow rate is controlled by a level controller that sends a signal to a control valve that opens or closes depending on the HVGO draw tray level. The total HVGO product flow rate is measured and totalized by a flow meter as it flows to storage.

The next product withdrawn from the upper vacuum tower chimney tray is light vacuum gas oil (LVGO). LVGO pumps draw the liquid from the tray.

The discharge LVGO stream splits with part of the flow combining with HVGO recycle returning below the LVGO chimney tray as recycle. The remainder of the LVGO flows through the shell side of crude/LVGO exchanger where it is cooled while heating the crude oil feed.

The LVGO stream then flows through the LVGO cooler where it is cooled to its final product temperature. The LVGO stream splits again with part of the cooled LVGO returning above the LVGO chimney tray as recycle.

The balance of the LVGO stream is final product. The LVGO product flow rate is controlled by a level controller that sends a signal to a control valve to open or close depending on the LVGO draw tray level. The total LVGO product flow rate is measured and totalized by a flow meter. The LVGO stream may have liquids from the vacuum pump overhead added to it before it flows to storage.

The liquid collecting in the bottom of the vacuum tower (vacuum tower bottoms or VTB) is pumped using the VTB pumps. Suction strainers prior to the pumps remove large particles that may collect in the bottom of the tower. Pressure indicators on either side of the suction strainers indicate the pressure drop across the strainers.

The VTB is pumped through the shell side of the crude/VTB exchanger where it is cooled while heating the crude oil feed.

The VTB stream then flows through the VTB cooler where it is cooled to its final product temperature. The VTB product flow rate is controlled by a level controller that sends a signal to a control valve that opens or closes depending on the level reading. The total VTB product flow rate is measured and totalized by a flow meter. The VTB stream may have liquids from the vacuum pump overhead added to it before it flows to storage.