Process Description for Fractionation Section

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1. Introduction

Pars Petrochemical Company intends to build a propane Dehydrogenation (PDH) plant to produce 600 KTY propylene polymer grade based on UOP Oleflex technology in Pars south Special economic energy zone (PSEEZ), Asalouyeh , Bushehr Province, Iran.

EPCC contractor for PDH plant: Panah Sanat Part Co., and BINA Co. Consortium.

The plant consists of several main process units, including Feed Treatment, Dehydrogenation reactor CCR, Distillation, Hydrogenation reactor, refrigeration, Merox, utility, tankage, …

1.1. Terms and Definitions

PROJECT:	Propane Dehydrogenation Plant (PDH)
Contract Number:	39-402/685
OWNER:	Pars Petrochemical Company
MC:	Aria Pishro Gharn
CONTRACTOR:	Panah Sanat Part Co. and BINA Co. Consortium
PDP	
BASIC DESIGNER:	Sinowey Engineering Technology Co., Ltd.
Third Party Inspection	-
SITE:	Pars south Special economic energy zone (PSEEZ), Asalouyeh Bushehr Province, Iran.
SUBCONTRACTOR:	Organization/Party that CONTRACTOR hires to do a part of the WORK
GOODS:	Any and all equipment machinery, apparatus, material, and other PROJECT commodity described in the contractor's contract.
VENDOR:	Any manufacture/supplier selected by OWNER/CONTRACTOR to supply the GOODS

MANUFACTURER:	Any Company selected by OWNER/CONTRACTOR to fabricates GOODS according to the purchase order placed with the CONTRACTOR.
Shall:	Indicates mandatory requirements to be strictly followed.
Should:	Indicates that through several possibilities, one is recommended as practically suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required. Other possibilities may be applied subject to OWNER approval.
May:	It is used where a provision is completely discretionary

1.2 Scope of Document

The document is to describe the Fractionation Section process of the Plant.

2. Description

2.1 3981200-110-01 Process Flow Diagram-Feed Drier Section

The Oleflex unit feed treatment section is designed to remove nitrogen compounds, organometallic compounds and water from the propane feed. If these impurities are not removed, these materials can poison the catalyst or cause a variety of problems with the performance of the Oleflex unit.

The operation temperature of propane from out side battery limit is -40 ℃, the operation pressure is 31.5 barg. The cold propane first enters Feed-Deethanizer Rectifier Overhead Exchanger (81-E-216). After heated, the temperature increase to -1.4 ℃ and the pressure

is 31.2 barg. And then, the propane enters Feed-Depropanizer Net Overhead Exchanger (81-E-217), after which, the temperature is 30 ℃ and the pressure is 30.5 barg.

At the beginning of start-up, because there is no hot material flow at the hot side of the Feed-Deethanizer Rectifier Overhead Exchanger (81-E-216) and the Feed-Depropanizer Net Overhead Exchanger (81-E-217), a Propane Start-up Heater (81-E-223) is set to raise propane from -40℃ to 30℃. The shell side of the Propane Start-up Heater (81-E-223) is gas-phase hot Methanol. After liquid methanol is vaporized and heated by low-pressure steam on the tube side in Methanol Vaporizer Heater (81-E-222), and then enter the Propane Start-up Heater (81-E-223) to heat up the low-temperature propane.

After heating, the fresh propane first enters the Feed Guard Beds (81-D-201A/B), which is an adsorption bed made of resin, and the for all bed protection beds, and any one of them can be switched out. Feed guard bed removes ammonia, alkaline nitrides, and heavy metals in cationic form from fresh propane feed. Strong cation exchange resin is used to remove these pollutants. If not removed, ammonia will be converted into ammonium chloride in the reaction section and flow out with the reaction products. When the temperature of the reaction product decreases, ammonium chloride will precipitate in the form of salt downstream and corrode the equipment. Heavy metals can affect the performance of Oleflex catalysts. Both feed guard beds are equipped with exchange resin and are in front back mode, where the resin can be replaced during operation. Propane material flowing from the bottom of the Feed Guard Bed enters the top of Mercury Removal Bed (81-D-202) to remove the mercury. If there is a very low concentration of mercury in the feed, or if its presence is irregular and infrequent, a mercury protection bed needs to be provided upstream of the fresh feed dryer to remove mercury to unmeasurable levels (<0.01 wt. ppb). This adsorbent is none renewable, but can be replaced during operation. The adsorbent needs to be loaded in an inert nitrogen environment. Propane from the bottom of the Mercury Removal Bed enters the Feed Driers (81-D-203A/B) and go through two feed dryers from bottom to top to remove the water which could freeze in the Separation System and make the exchanger scaling. Both feed driers are provided with by-passes, so that either dryer can be switched out. The feed dryer removes water from fresh feed propane

by adsorbing it in the adsorption bedto ensure that the water content of the mixed liquid propane feed to the Oleflex unit is lessthan 1ppm wt. Water will freeze in the cold separation system, affecting its performance.This desiccant is renewable. There are two fresh feed dryers operating in a series connection mode, with the front dryer periodically cutting out to enter the regeneration stage and servingas the rear dryer after regeneration.

The dried propane from the bottom of the Feed Driers enters the Arsine And Phosphate Guard Bed (81-D-204) to remove arsine and phosphate from the raw propane. After the arsine and phosphate is removed, the dried propane raw material is sent to mixed with SHP effluent and then goes to SHP EFFLUENCE exchanger(81-E-205) for cooling. After that sent to first depropanizer for propane refining. Feedstock goes into methanol guard bed to remove the methanol content less than 3ppm(mol%). One of the D-206A/B will be running normally and another one is standby accordingly.

A.Hoseingoo: (8/30/2025)
Shall be revised to Effluent.

The drier contains molecular sieves to remove the water in the propane and regenerate with dried propane in a closed loop. The drier is designed to regenerate every 24 hours. The regeneration of the dryer is completed with dry propane. A portion of dehydrated propane raw material enters Feed Drier Regenerant Vaporizer (81-E-201) for gasification, and the gasified propane enters the Feed Drier Regenerant Superheater (81-EH-201) to superheat to 232° C, and enters the top of the Feed Drier (81-D-203A/B) as regeneration gas in the opposite direction from the feed propane, and flow through the dryer from top to bottom. The water adsorbed by the adsorbent is desorbed at high temperature. The propane then enters Feed Drier Regenerant Condenser (81-E-219) for cooling, and Cool down to 50 ℃ then is sent to the Feed Drier Regenerant Coalescer (81-V-201) for separation of the water and regenerant propane. The propane in the coalescer returns to the inlet of the feed guard bed through the Feed Drier Regenerant Pumps (81-P-201A/B) and the water is sent to Spent Caustic Degassing Drum (81-T-104) (intermittently).

After drying at high temperature for a specified time, stop the Feed Drier Regenerant Superheater (81-EH-201) to reduce the gas phase propane to 65℃, and carry out gas phase cooling on Feed Drier to reduce the bed temperature of Feed Drier to 65℃. Then, the steam

at the hot side of Feed Drier Regenerant Vaporizer (81-E-201) is turned off, so that normal-temperature liquid propane enters Feed Drier to liquid cool the bed, and the bed is put into standby state after cooling to normal temperature, and this Feed Drier will be put into use when another Feed Drier is regenerated (please refer to the operating instructions provided by the adsorbent manufacturer for detailed drying time and standby time).

2.2 3981200-110-02 Process Flow Diagram-SHP Section

The Selective Hydrogenation Process (SHP) unit is used in the fractionation section of the Oleflex unit. The purpose of this process is to saturate the diolefins and acetylene in the circulating propane liquid from the bottom of the Propylene-Propane Splitter(81-T-204). These impurities are mainly methylacetylene and propadiene, which are formed in the reactor section. If these impurities remain in the product liquid, they may contaminate the propylene product. They may also affect the reactor section by recirculating to the reactor through unconverted recycled propane.

The unconverted recycled propane from the Propylene-Propane Splitter(81-T-204) is first sent to the SHP Feed Exchanger(81-E-206) to raise the feed temperature to the desired reaction temperature(63℃). High purity hydrogen from Hydrogen Purification System(81-W-106) after filtration by SHP Hydrogen Filters (81-S-201A/B)（It is a simply a gas filter that prevents solids from entering the SHP reactor along with hydrogen） enters SHP Mixing Nozzle (81-W-201) to well disperse the hydrocarbon from the bottom of the Propane-Propylene Splitter (81-T-204).. Then, the stream enters SHP Static Mixer (81-W-202), this is a static mixer design to ensure that the small amount of hydrogen added is well dispersed in the hydrocarbon liquid. And finally enters SHP Reactor (81-R-201) to MAPD value at the outlet of 81-R-201. After the reaction, the product from SHP Reactor merging with the fresh propane from Methanol Guard Bed （81-D-206A/B）, is heated by stream from bottom of Deethanizer Stripper (81-T-202) in SHP Effluent Exchanger (81-E-205), and then, goes to the Depropanizer Feed Preheater (81-E-207).

During inspection and maintenance, the catalyst in SHP needs to be regenerated by hot hydrogen stripping. The hydrogen at a pressure of 0.212Mpa(g) and 45℃ from CCR

Regeneration Section is heated to 150℃ by SHP Stripping Heater(81-E-204), and then enters the SHP reactor for stripping regeneration. The specific regeneration time is given by the SHP catalyst manufacturer, and the regenerated gas is discharged to the flare system from the safety valve auxiliary line.

According to the operating experience of other plants, the SHP catalyst has a long life, and it is generally hot hydrogen stripping when it is stopped for maintenance.

2.3 3981200-110-03 Process Flow Diagram-Depropanizer Section

Raw propane after removal of Methanol Guard Bed(81-D-206A/B) and the propane from SHP Effluent Exchanger (81-E-205) goes to the Depropanizer Feed Preheater (81-E-207) for heating and partial of the stream is gasified, and then, goes to Depropanizer (81-T-201). C4+ material is discharged from bottom of the depropanizer, a part of which circulate back to depropanizer from Depropanizer Steam Reboiler (81-E-210) and the rest is sent to Depropanizer Bottoms Stripper (81-T-107). The Depropanizer Steam Reboiler (81-E-210) and Depropanizer Heat Recovery Reboiler (81-E-208) provide the heat for depropanizer. Depropanizer Heat Recovery Reboiler (81-E-208) recover the heat from stream from Heat Pump Compressor (81-C-201), and then, the stream back to Heat Pump Compressor Stage 2 Suction Drum (81-V-205) through Propylene Trim Cooler (81-E-209).

The gas at the top of the Depropanizer condense through the Depropanizer Condensers (81-E-211A-H) and enters the Depropanizer Receiver (81-V-202). A portion of the material from the Depropanizer Receiver is returned to the top of the depropanizer through the Depropanizer Overhead Pumps (81-P-202A/B) as the reflux, and the other portion is sent to the Separation System through Feed-Depropanizer Net Overhead Exchanger (81-E-217).

C4+ discharged from bottom of Depropanizer enters Depropanizer Bottom Stripper (81-T-107). The tail gas of PSA enter the Depropanizer Bottom Stripper (81-T-107) after Stripping Hydrogen Heater (81-E-109) to stripper the light hydrocarbon in C4+. The gas is sent to Fuel gas Preparation System. A partial of the heavy component from the bottom

of the stripper is sent to Solvent Recovery Column (81-T-106), the rest is sent to Spent Solvent storage after cooing by Spent Solvent Cooler (81-E-114).

2.4 3981200-110-04 Process Flow Diagram-Deethanizer Section

Deethanizer (81-T-203) is designed to remove ethane and lighter materials from the product liquid of a Separation System(81-W-104) to meet propylene product purity specifications. The stripping and distillation sections of the Deethanizer Rectifier(81-T-203) are two separate fractionators, with the distillation section connected to the top of the stripping section receiver to allow for an additional air-cooled condenser between the two sections and to minimize the utility consumption of the refrigeration system. This air-cooled stripper column condenser allows for the reduced size and utility consumption of the refrigeration system，which is required to condense the Deethanizer Rectifier(81-T-2022) top material and recover the C3 material from the C2 by-product.

A.hoseingoo: (8/30/2025)
Shall be revised to 203.

The product liquid from Separation System (81-W-104) is sent to the Deethanizer Stripper (81-T-202), and most of the gas at the top of the stripper is condensed in the Deethanizer Stripper Condenser（81-E-202A/B）. And sent to the Deethanizer Rectifier (81-T-203). The remaining overhead gas is directly sent to the Deethanizer Rectifier (81-T-203) as steam. Since the gas phase at the top of the Deethanizer Stripper (81-T-202) tower is the only heat source for Deethanizer Rectifier (81-T-203), Therefore, the heat entering Deethanizer Rectifier 81-T-203 should be controlled by controlling the flow rate entering Deethanizer Stripper Condenser 81-E-202A/B, so as to achieve the best separation effect.

Bottom material from the Deethanizer Stripper(81-T-202) is sent to the SHP effluent heat exchanger（81-E-205） and then to the SHP Feed Exchanger(81-E-206) to remove heat from the Propane-Propylene Splitter (81-T-204) feed and to reduce steam flashing from the Propane-Propylene Splitter (81-T-204) feed valves. SHP heat exchangers allow the temperature of the SHP to be adjusted by using a bypass and relying exclusively on process heat (no external heat source is required).

The liquid at the bottom of the stripper is sent Propane-Propylene Splitter (81-T-204) after cooling by SHP Effluent Exchanger (81-E-205) and SHP Feed Exchanger (81-E-206).

The gas at the top of the Deethanizer Rectifier (81-T-203) is sent to Feed-Deethanizer Rectifier Overhead Exchanger (81-E-216) and cooled by the raw material of propane, then, sent to Refrigeration Equipment (81-W-203). Condensation is carried out in the refrigeration equipment of Deethanizer Rectifier Condenser (81-E-214). Then it enters the Deethanizer Rectifier Receiver (81-V-203) of the deethanizer for separation.

The liquid at the bottom of the Deethanizer Rectifier (81-T-203) was pressurized by the Deethanizer Stripper Reflux Pump (81-P-203A/B). A small part of the reflux liquid enters the Deethanizer Offgas Exchanger (81-E-213) to exchange heat with the gas-phase tail gas at the top of the Deethanizer Rectifier Receiver (81-V-203), and it flows into most of the remaining reflux liquid and is sent together to the Deethanizer Stripper (81-T-202) for reflux.

The liquid in the Deethanizer Rectifier Receivers (81-V-203) is pressurized by the Deethanizer Rectifier Reflex Pumps (81-P-204A/B) and refluxed to the Deethanizer Rectifier (81-T-203). The off gas at the upper of the Deethanizer Rectifier Receiver (81-V-203) undergoes heat exchange with the reflux liquid of the Deethanizer Stripper through the Deethanizer Offgas Exchanger (81-E-213), then sent to the Fuel Gas Preparation System (81-W-105) of the reaction unit.

According to the information given by the general contractor, a small amount of circulating propane from PP plant will be mixed with the feed of Deethanizer Stripper(81-T-202) to enter Deethanizer Stripper(81-T-202) to recover this propane and propylene intermittently.

2.5 3981200-110-05 Process Flow Diagram-Propylene-Propane Splitter Section

The material at the bottom of the Deethanizer Stripper (81-T-202) enters the SHP Effluent Exchanger (81-E-205) and the SHP Feed Exchanger (81-E-206) for cooling, and then enters the Propylene-Propane Splitter (81-T-204) for propane propylene separation. Here, the propylene product is separated from the un-reaction propane. Due to the low relative volatility of propylene and propane, a large number of trays and a high reflux ratio are required to achieve the propylene product purity. A small partial of stream is extracted

from the side line in the middle of the splitter and transported together with the propane at the splitter bottom through the Propane Recycle Pumps (81-P-205A/B) at the splitter bottom to the SHP Feed Exchanger (81-E-206) for heating before entering the SHP Reactor (81-R-201) for further SHP hydrogenation reaction. Liquid propane at the bottom of the splitter is heated in the shell side of the reboiler (81-E-215A/B/C/D) of the PP splitter and then returned to the PP splitter.

The propylene at the top of the splitter is buffered by the Heat Pump Compressor Stage 1 Suction Drum (81-V-204) before entering the Heat Pump Compressor (81-C-201). After being pressurized by primary Heat Pump Compressor (81-C-201), a portion enters the PP splitter reboilers/ condensers (81-E-215A/B/C/D) as a heat source which is the main reflux of the splitter after condensation, and the other portion is sent to the Heat Pump Compressor Stage 2 Suction Drum (81-V-205). A small portion of the liquid phase at the bottom of the drum merges with the outlet of the PP splitter reboilers/ condensers (81-E-215A/B/C/D) as a reflux and returns to the top of the PP splitter (81-T-204). The remaining portion is pressurized by the Propylene Product Pumps (81-P-206A/B) and then is sent to Propylene Treater Section. The top gas of the Stage 2 Suction Drum (81-V-205) of the heat pump compressor is compressed by the heat pump compressor and sent to the Heat Recovery Reboiler (81-E-208) of the depropanizer. It is then cooled by the Propylene Trim Cooler (81-E-209) and returned to the secondary inlet tank of the heat pump compressor.

2.6 3981200-110-06 Process Flow Diagram-Propylene Treater Section

The propylene product from Propylene-Propane Splitter (81-T-204) enters COS/CO2 Propylene Treater to decrease the content of COS below 1 ppm and the CO2 below 0.03 ppm, then the Propylene is sent to battery limit.

COS/CO2 Propylene Treaters (81-D-205A A,B) are designed to remove trace amounts of sulfur compounds (carbonyl sulfur COS) and CO2 from propylene products before they are sent out of bounds. The removal of carbonyl sulfur COS and CO2 is necessary to meet strict product specifications.

The equipment in this system includes two product treatment beds. Two COS/CO2 Propylene Treaters can be operated in series or in standby mode. Under normal situations, the two treaters are operated in series online state (one front/one after configuration). Each treater is filled with DCH-02 adsorbent, and the spherical alumina molecular sieve composite adsorbent has high selectivity and adsorption capacity for various acidic impurities such as COS, CO2 and H2S in materials such as ethylene, propylene and propane. An online analyzer is provided to analyze the contents of COS and CO2 in the incoming and outgoing materials of each COS/CO2 Propylene Treaters.When sulfur penetration is detected from the previous processor, the program regeneration operation is performed for about 60 hours. After regeneration, the treater is put into use again (downstream rear position). The regeneration operation of this program can be completed by DCS or PLC.

Regeneration of propylene product treatment bed is completed by circulating nitrogen as regeneration gas through absorbent bed. Regeneration gas is first heated in Regeneration Gas Feed/Effluent Exchanger (81-E-218) by exchanging heat with hot nitrogen effluent from regeneration, and then heated to 295℃ in COS/CO2 Propylene Treater Regenerative Superheater (81-EH-202). After the regeneration gas flows through COS/CO2 Propylene Treaters, the regeneration gas flow will be cooled by regeneration gas of the heating inlet in Regeneration Gas Feed/Effective Exchanger (81-E-218).Circulating nitrogen is further cooled to 45℃ by heat exchange with cooling water in Regeneration Gas Cooler(81-E-220), and then transported to COS/CO2 Propylene Treater Regeneration Receiver (81-V-206). At the top of COS/CO2 Propylene Treater Regeneration Receiver (81-V-206), nitrogen containing COS and CO2 is discharged to the flare header through pressure control, and fresh nitrogen is supplemented at the entrance of COS/CO2 Propylene Treater Regeneration Receiver (81-V-206) to keep the total amount of circulating regeneration gas unchanged. The recycled regeneration gas is pressurized by the Recycle Nitrogen Compressor (81-C-202) to maintain the regeneration operation of the propylene product treatment bed.

The cooling gas of COS/CO2 Propylene Treaters after the regeneration step cannot flow in the same direction as the hot regeneration gas. Because circulating nitrogen contains trace carbonyl sulfur, the adsorbent can be reabsorbed at low temperature. Therefore, the cold regeneration gas flows from the bottom to the top of the propylene product treatment bed, and it is cooled to ambient temperature in Regeneration Nitrogen Cooler (81-E-221) by exchanging heat with cooling water until COS/CO2 Propylene Treaters are cooled to ambient temperature.