Mini Modular Refineries 1000-9000BPD

1000BPD Unit being installed

The Mini-Refineries are skid mounted, modular crude oil distillation units (CDU) which process from 50,000 to 450,000 metric tons (1000 - 9,000 BPD) of crude oil per year and are capable of producing a variety of finished products including naphtha (straight run gasoline), kerosene, arctic and summer diesel and fuel oil.

Two or more plants can be installed on a single site allowing the simultaneous processing of more than one type of crude oil; and one plant can still be in operation in the event one plant has a breakdown.

- Can be set up and in operation within a very short time after arrival at a site where the foundation and storage tanks are in place.
- A single operator may restart the plant from a cold start and have the plant in full operation in less than two hours.
- Are completely automated and once an operator sets all the controlling points, all product temperatures and flows are controlled automatically. If a product specification drifts off or if a potentially hazardous condition develops, the plant automatically adjusts itself to a safe condition, without the help of an operator

and a “first out” annunciator signals the reason for the shutdown by a flashing red light. The operator can then make the necessary adjustment or the plant will automatically shut down.

- Only a flat support area or concrete slab without anchor bolts is required to support the plant.
- **Requires no water, steam, or instrument air**. Fuel supply can be off-gas, natural gas, naphtha, diesel fuel oil or a combination of these fuels.

We also build the following additional optional equipment for our Mini-Refineries:

- Special alloy(s) may be included in the plant design
- De-salter packages for removing salt from the crude
- Naphtha, jet fuel, and diesel hydrotreaters for removing sulphur from the products
- Reformers for producing high octane gasoline motor fuels(10,000BPD+)
- Gasoline stabilizers for reducing the Reid vapor pressure of motor fuels
- Asphalt vacuum units for producing U.S. specification AC-10 asphalt
- Winterized skids for operation in Arctic weather
- Portable laboratory and control buildings with supplies.

The manufacturers and their associated engineering and manufacturing groups have designed and manufactured oil and gas equipment since 1978. They have completed numerous international projects, including oil and gas production flow stations and mini refineries.

Mini-Refinery Applications

Traditionally, the petroleum industry has constructed large-scale refineries at centralized locations, supplying them with crude oil and gas condensate via pipeline and transport truck.

Refined grades of products are subsequently transported from the refinery to consumer markets, primarily by transport truck.

While large-scale refineries provide the bulk of refined products to the world marketplace, the majority of new hydrocarbon discoveries by industry majors and large independents occur in areas where there is limited or no available infrastructure for transportation and refining.

Therefore, producers are forced to construct expensive infrastructures for transporting the hydrocarbons to an available refinery, or construct a new refinery at a location near the production site. Under the best of circumstances this process can take several years.

In populated areas near a pipeline or oil field and not near a refinery, a small mini refinery can be installed that will process crude from the pipeline.

This plant can “thief the diesel” or desired distillate for local consumption, and then inject the unused portion of the crude back into the pipeline.

Following Page:

Two 1,000 BPD units, one crated for overseas shipping

REFINING EQUIPMENT

Our group designs, manufactures and markets equipment capable of processing from 1000 to 9,000 barrels of crude per day (BPD).

Multiple product streams can be drawn from the distillation process yielding light naphtha, heavy naphtha, kerosene /jet fuel, diesel and residual fuel oil, **based on the crude being refined and customer's preferred product slate**. An assay of the crude to be refined must be provided.

Each process plant is skid mounted, modular in design and transportable to the source of crude production or a pipeline location. System commissioning at the site, on the small units, can be complete within a few weeks after arrival at the completed site.

These units are easily relocated with a minimum amount of field construction.

Refined products produced from a mini-refinery processing plant can be sold to local markets or supplied as a feedstock for further processing and the residual oil returned to the crude pipelines.

Additionally, the residual oil product can be used to fuel diesel-electric cogeneration plants for the production of electricity or any heavy oil fired process equipment such as boilers, heaters and etc.

Mini-refineries are particularly effective in areas where there is a ready supply of crude but limited product distribution or refining capacity, where transportation costs or capability present a problem, such as remote areas or offshore platforms.

The Modular Refinery will consist of an Atmospheric Distillation Unit (ADU) or Topping Plant, including the following:

- Air- cooled fin fans so **no water is required for cooling**.
- Instrument air compressor if required after final design.
- Furnace with a single or multi-burner management system with a high pressure burner feed pump to atomize the fuel for the burner system. All fuel for running the furnace will be produced by the refining process, except during black start.
- PLC / PAC computer based control system for the balance of plant.
- Multipurpose distillation column to fractionate a wide range of crude oil and crude oil blends.

Final equipment design and calculations for the refined product yields require a complete assay for the crude oil to be used as feedstock.

Following Page:

An installation incorporating one 6,000 and four 1,000 BPD systems and related supporting equipment.

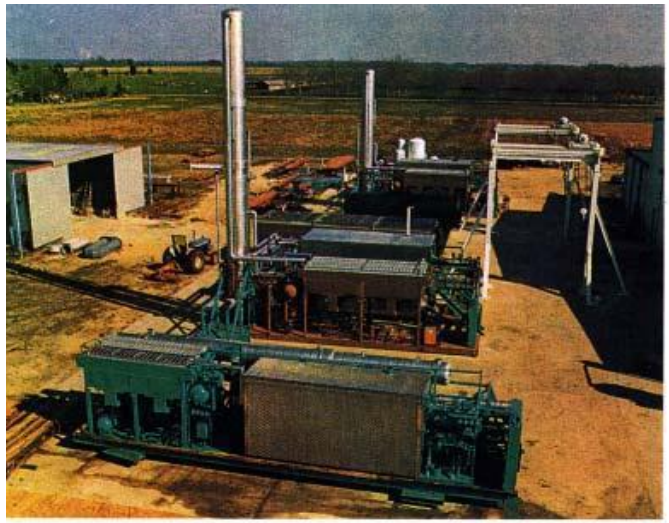
New ADU Plant

The first mini-refinery was installed thirty years ago. This plant was a 1,000 BPD plant on a single skid containing an electric generator, a horizontally mounted tower for hand cranking to a vertical position, and permanently mounted hand jacks for jacking the skid off a truck.
The intent was that the plant could be in operation in one day after arrival at the new location, without the need for a crane, concrete foundation or a power supply. We thought the plant would be moved monthly.

As time went by, it has been learned:
1. The plants stayed in the same location for years.
2. Most sites had to be substantially larger to support other facilities.
3. Cranes were available at most sites, so hand jacks are not required. And since cranes were available to set the skids, it was acceptable to use multiple skids to allow more room for operating the equipment. These skids could be assembled and tested in the shop and reassembled by crane at the site without the need for welders or special technicians.
With all of the above in mind, a Topping Plant was designed with the following special features:
1. A recent development in the process design allows the elimination of level control valves, level controllers, gauge glasses, some pumps, and all of the associated piping, electrical, instrumentation and spare parts. The elimination of such equipment substantially reduces the plant requirements for operation and maintenance.
2. Completely automated for self-operation and self-monitoring so that if a potentially hazardous situation develops, the plant automatically shuts down and the “first-out” annunciator, signals the operator the reason for the shut down.
3. An enclosed control room and lab space.
4. A supply of hand tools and lab equipment.
5. Two years supply of spare parts.
6. The unit can be operated in arctic or tropical locations.

The following standard sizes are offered:

Barrels Per Day	No. of Skids	Hours Required for Commissioning
1000	**3**	**48**
3000	**5**	**96**
6000	**8**	**168**
9000 – New Model		



Various models being tested and prepared for shipment

Four 1000 BPD plants and one 6000 BPD plant

One model 1500T being tested prior to shipment

New ADU Plant(Continued)

The above installation times are based on offsite facilities being complete and having a crane available when the plant arrives at the site.
To obtain the daily rate in metric tons, multiply the BPD rate by .15893 by the specific gravity of the crude. (BPD x .15893 x SG)
In addition to the above we have a standard 6,000 BPD design with the following extras:

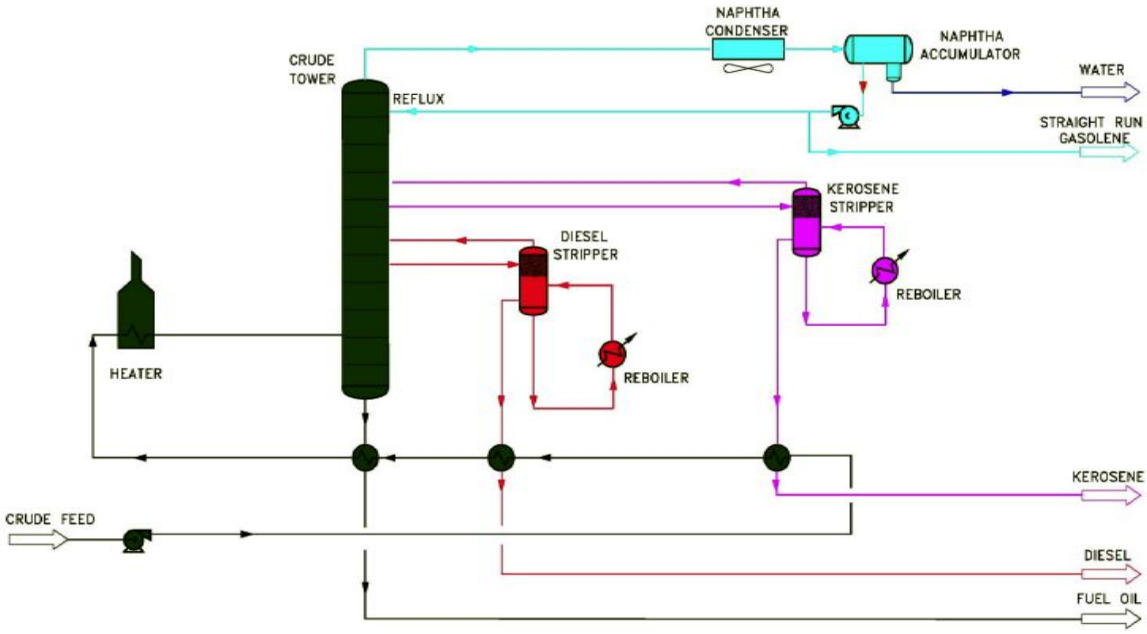
- Additional Side Draws
- De-salter Skid
- Caustic Water Wash Skid
- Catalytic Reformer complete with Splitter, Hydrotreater, Reformer, and Stabilizer
- Jet and / or Diesel Hydrotreater(s)
- Asphalt Plant

Technical Addendum – Operation

Typically, cold crude oil from off-site storage is received at the topping plant battery limits and pumped by the crude charge pump on flow control. The crude oil exchanges heat with the atmospheric tower product streams.
The crude then flows to the crude heater where it is further heated and partially vaporized.
The crude heater is a direct-fired radiant-convection heater, designed to burn off gas, natural gas and/or liquid fuel, or a combination of these fuels. Constant heater outlet temperature is maintained automatically by controlling the fuel to the heater.
Partially vaporized crude oil from the crude heater flows to the flash zone of the atmospheric tower where the vapor and liquid separate. The vapor flows up the tower where it is cooled and partially condensed by reflux to form the side stream products. The liquid joins with the over flash liquid from the first tray above the flash zone and flows to the reduced crude stripping section in the bottom of the atmospheric tower.
The overhead vapor from the atmospheric tower is cooled and partially condensed in the overhead condenser and flows to the overhead accumulator where liquid unstabilized naphtha, water and uncondensed gas separate.
The water is automatically withdrawn from a boot on the overhead accumulator and flows off-site.
A portion of the liquid naphtha from the accumulator is returned to the top of the atmospheric tower as reflux to maintain the overhead vapor at a constant temperature and the remainder flows to off-site storage. Uncondensed gas from the accumulator flows on backpressure control to be used as supple-mental fuel for the crude heater.
Un-stripped side draw product flows on tower temperature control from its draw tray on the atmospheric tower to its stripper. The side draw product is stripped with re-boiled vapor to control the flash point. Product flows from the bottom of

the stripper on level control, is cooled by exchanging heat with crude, and then flows to battery limits.
Reduced crude product is pumped from the bottom of the atmospheric tower on level control through the re-boiler, and is then further cooled by the reduced crude/crude exchangers before flowing outbound to battery limits.
Since the side stream stripper is re-boiled with hot tower bottoms, the plant does not require steam.
However, nozzles are provided on the tower and stripper for steam stripping, if required.
The only requirement for water is for a de-salter if one is included.
Below:
Daybreak at a new 6,000 BPD installation. Over $1million in CR-9 and special alloys were used in this processing plant to combat corrosion

ADU Process Flow Diagram



Codes and Standards

The following are the prevailing codes and standards in the United States for engineering and design. These codes are adhered to in the processing, layout and selection of the various component parts used in the fabrication and assembly of this plant:

- ASME Code Section VIII, Division 1, Pressure Vessels and Heat Exchangers
- ANSI B31.3 Petroleum Refinery Piping
- FM Requirements for Burner Control
- API-RP520, Parts I and II, Design and Installation of Pressure Relieving Systems in Refineries
- API-500A Classification of Areas for Electrical Equipment in Petroleum Refineries (Class 1, Group D, Division 2) on the process
  end of the skid The heater is located at least 50 feet from the other process equipment and control room.

All process vessels are designed and fabricated in accordance with the ASME Code, Section VIII, Division 1. The tower and strippers

are carbon steel, with associated trays being 316 stainless steel as required. Fabrication shops for the vessels are tested and certified by ASME, insurance companies and other regulatory agencies to perform fabrication in accordance with the ASME Code, Section VIII, Division 1. These shops are provided with a certificate having a certificate number and they are audited and re-certified every three years. Copies of the shop's certificate are available after a purchase order has been issued for the coded vessels.

The fabrication shops must use certified welders who are tested and certified in accordance with the ASME Code, Section IX.

Pressure gauges, in accordance with standards are calibrated annually with a dead weight tester.

Certified mill test reports on materials used on ASME Code vessels are provided and shipped with each vessel for the buyer's and customs use.

Sufficient surge capacity is provided in all vessels to assure stable control and allow corrective action to be taken in the event of a process upset or equipment failure. Sufficient elevation is provided for all vessels to assure adequate suction head at low liquid level for pumps.

The heater is a horizontal cabin-type with a convection section. Certified mill test reports on materials used to build the heater are provided and shipped with the heater for the buyer's and customs use. Burners can be designed to meet the needs of multiple fuel sources.

The heater is built in accordance with the following codes:

- Coil: ASME Section I;
- Tubes: ASTM A-106 Grade B;
- Fittings: ANSI B16.9;
- Flanges: ANSI B16.5; and
- Burner: FM Requirements

All piping and valves required within the process battery limits are provided, fabricated and installed to the maximum practical extent.

Piping design is according to ANSI B31.3. All process piping is A-106, Grade B seamless unless otherwise specified.

**** Codes and Standards above will be determined by the manufacturer and are subject to revision based on final destination and overall product safety.***

Environmental Impact

The ADU will not make a significant contribution of air contamination to the atmosphere. Fugitive emissions are minimal due to the small number of flanged connections and pumps. Since these plants use air cooling, the only other effects on the local environment are the products of combustion exhausted into the air by the plant heater and the water that is brought in with the crude oil.

For each 1/10th of 1% of water in the crude feed, one barrel of distilled water will be produced for each 1,000 barrels of crude processed (1 kg per metric ton). Since the water is in equilibrium with the distillate, the water may contain up to 500 mg per litre of total organic carbon (TOC).

If a de-salter is used, depending on the amount of salt in the crude, from 30 to 130 gallons per hour of brine water is discharged per 1,000 barrels of crude processed (from 0.9 to 4 litres per hour for each metric ton per day).

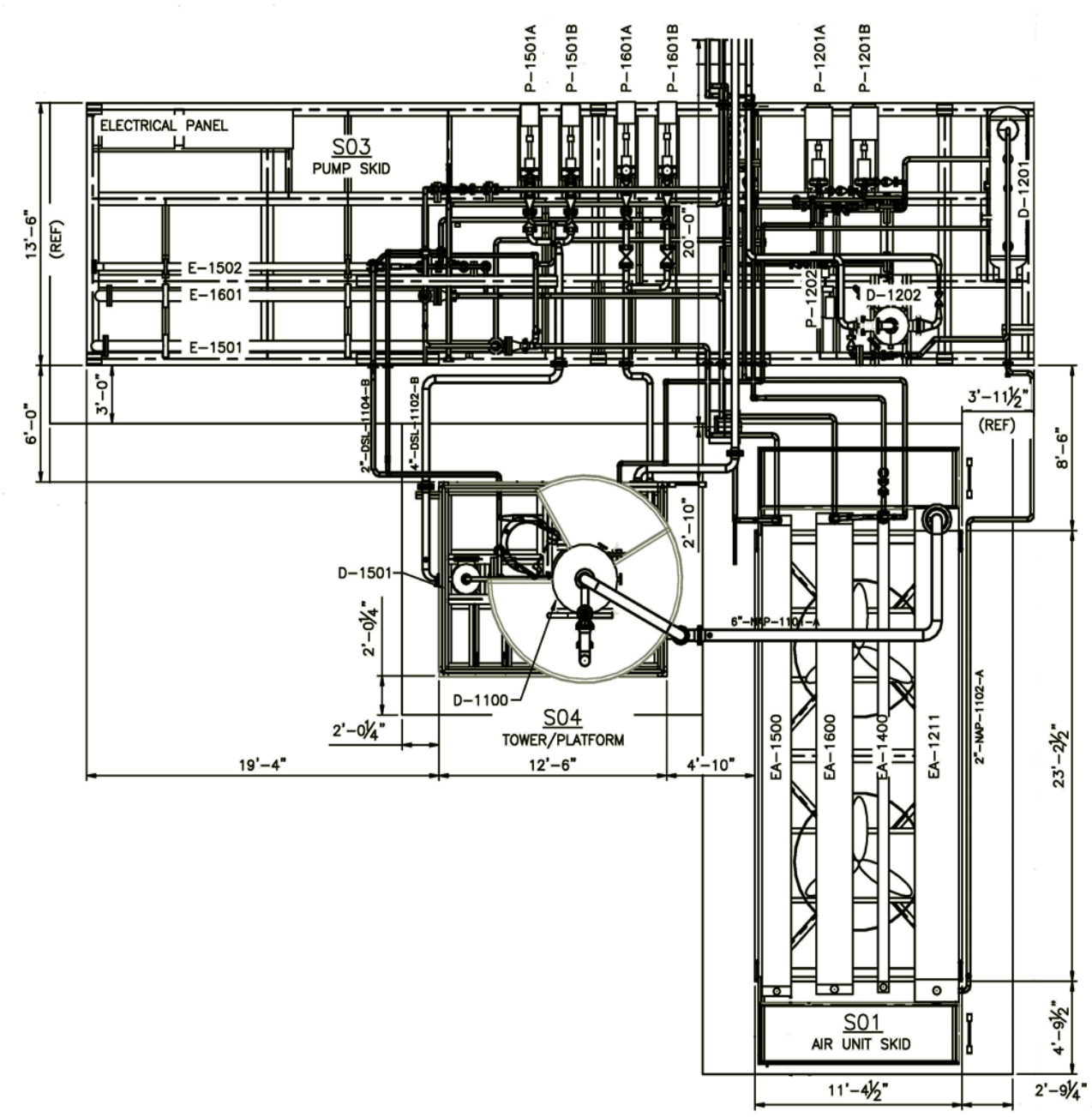
Equipment List (varies per process flow design):

1. Fuel Gas Drum
2. Naphtha Cooler
3. Diesel Cooler
4. Residual Cooler
6. Crude/Naphtha Exchanger
7. Crude/Diesel Exchanger
8. Crude/Residual Exchanger
9. Crude Oil Heater
10. Burner management control system

11. Balance of plant control system
12. Crude Fractionator
13. Overhead Condenser
14. Naphtha Stripper
15. Diesel Stripper
16. Stripper Reboiler's
17. Overhead Accumulator
18. Process pump skid
19. Interconnect piping

Photos of 3000 BPD Plant Site in Operation:

Refinery Site Layout



Storage Tanks:

These can be supplied with fixed or floating roofs for crude or product storage and will be assembled on site. The number of tanks and construction will be determined after discussions with the client. All civil works for tanks (foundations etc.) must be done by the client. They are designed by a UK manufacturer and will be constructed under the supervision of their construction foreman.