IX - REFINING A BARREL OF PENNSYLVANIA GRADE CRUDE PRODUCED IN ALLEGANY COUNTY, NEW YORK

by Fred B. Emerson, Sinclair Refining Co.

The Pennsylvania Grade crude, which is received at the Refinery storage as it comes from the well, is a complex mixture containing hundreds of hydrocarbons ranging from the simplest compounds of gases, which are absorbed in the liquid components, to heavy resins.

The first step in converting crude oil into products suitable for consumer use is the separation of various components by a process known as fractional distillation. In this process crude is pumped from tank farm storage through a coil heater. As the oil passes through the coils, varying degrees of temperature are applied which causes the oil partially to vaporize in very much the same manner as boiling water in a kettle.

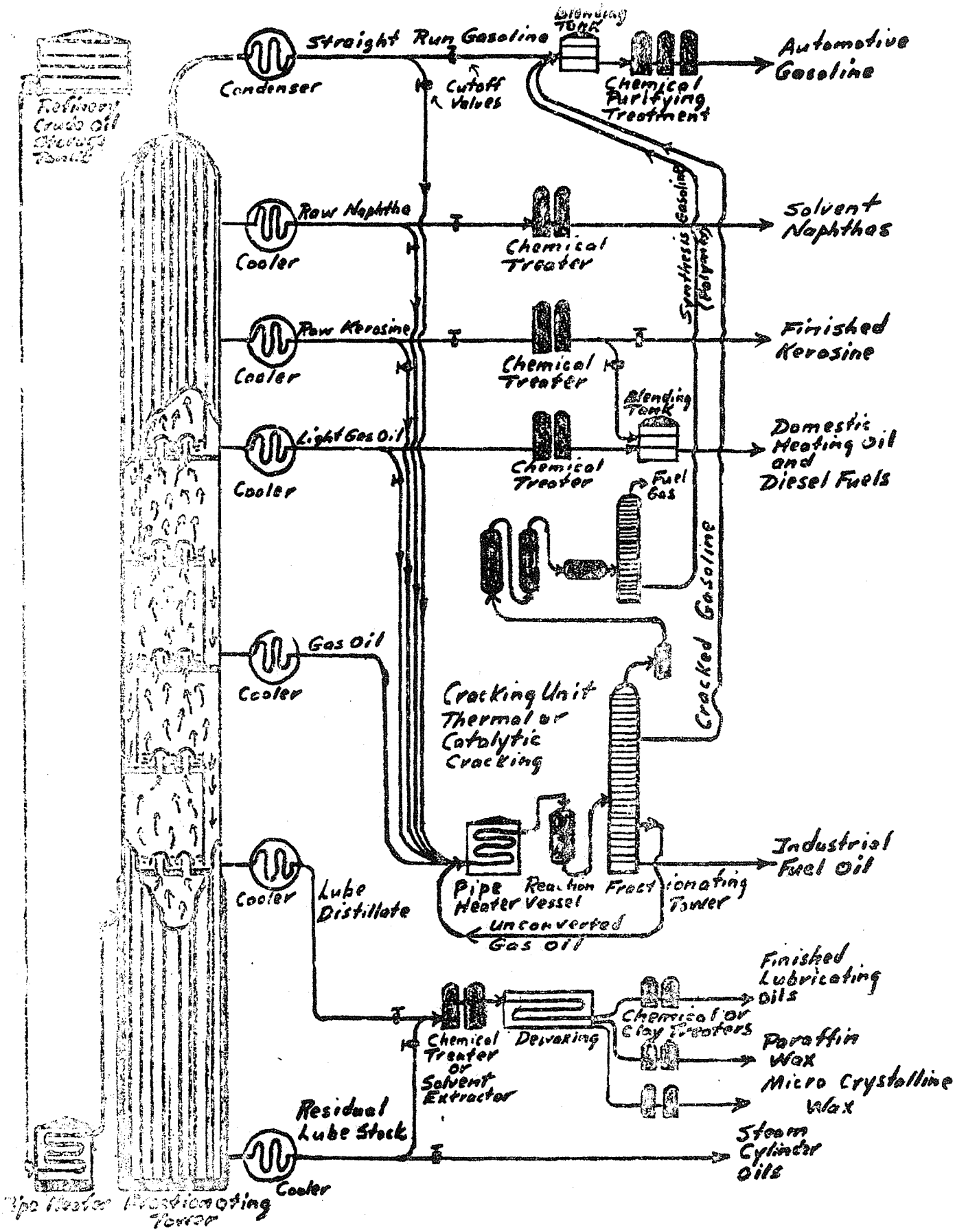
The mixture of hot vapors and liquid discharges into a fractionating tower, the vapors rising through a series of especially designed trays which are located at intervals from close to the bottom of the tower to near the top. Each tray is perforated by a number of holes and over each hole is a small pipe 2" to 4" high, which is fitted with a "bubble cap". The lower edges of these caps are immersed in the condensed liquid collected on the tray which is designed to prevent the liquid from escaping through the perforations, while forcing the rising vapors to enter and flow, or "bubble", in intimate contact with the pool of liquid on each tray.

These are called "bubbletrays". Each is fitted with "down-comer" pipes, alternating trays having two pipes, one on each side, while the others have a single pipe set in the middle. These pipes extend from about 4" above the bottom of the tray downward to very nearly the bottom of the tray below. Their design prevents the passage of rising vapors but allows the free flow of down moving liquids. The length of the upward extension of these pipes governs the depth of liquid accumulation on the trays, and the downward movement of liquid is arrested until enough condensation is collected to cause an overflow to the tray below.

Since the temperature within the tower is progressively lower as the vapor ascends, a certain amount of condensation takes place at different tray levels. As the vapors condense and the liquid accumulates on each tray, it spills over through the down-comer pipe to the tray below, where it is again partly vaporized. As these vapors rise and pass through the liquids on the bubble tray above, they strip out those lighter portions of vapor that have been entrapped in the liquid through which they are passing and carry them on to trays above where they are either condensed, pass on to still higher trays, or, upon rising to the top, escape into the vapor line.

It will be noted that the vapor travels in cycles, vaporizing over and over until it finally is reformed into those portions of crude oil best suited as a base stock for producing the many refined petroleum products in demand today. At this stage of the distillation process, these portions are drawn from certain of the fractionating tower bubbletrays at predetermined levels, cooled and passed on for further refining. (See Chart 2). The lightest vapors do not condense, but rise immediately through the trays and pass through the vapor line to a condenser. This process is carried on in one continuous operation.

In the condensor, a major portion of the vapor is liquefied, becoming raw gasoline, and with the remaining fixed gases, passes into a separator. These fixed gases are drawn from the top of the separator and the liquefiable portions are made into light gasoline and the dry gas burned for Plant fuel. The raw gasoline is charged to the Cracking Still and goes through a reforming operation to raise the octane so that it is suitable for blending into base gasoline for automotive use.



Typical Refinery Flow Processing Penna Grade Crude

Chart 2

We will now consider the various cuts as they come from the fractionating tower. The top side stream taken from the tower is raw naphtha. This liquid goes through a cooler and then is chemically treated into solvent, a product of many uses. This solvent is used for dry cleaning and also the manufacture of paints and varnish and has many other uses.

The next two cuts, kerosine and light gas oil, receive practically the same treatment as the raw naphtha. The kerosine is used as fuel for heating, lighting and cooking purposes. Light gas oil is blended with kerosine and sold for home heating and for diesel fuel.

Then comes the gas oil fraction. This portion of the crude is either catalytically or thermally cracked at high temperature, thus splitting and rearranging the heavier molecules into desirable components in the gasoline boiling range. The fixed gases from this operation are taken to a Polymerization Plant, where it is processed by intimate contact with certain catalysts into high octane gasoline blending stock. The residue from this cracking process is a heavy fuel oil used for fuel by industrial plants.

The next portion of the crude oil from the fractionating tower is known as lubricating oil distillates. These oils are chemically or solvent treated to remove certain resinous and carbonaceous and unstable unsaturates which are undesirable in the finished Pennsylvania lubricating oil. The oil is then dewaxed so that the finished oil will flow freely at temperatures below $0^{\circ}F$. The final process is primarily a decolorizing operation. The lubricating oil is brought into intimate contact with certain adsorption clays at elevated temperatures and decolorized and stabilized for a finished, high grade, Pennsylvania lubricating oil.

The paraffin wax that has been removed from the oil during the dewaxing operation is further refined to lower the oil content and decolorized by filtering through a bed of filter clay at elevated temperatures. This paraffin wax is used for making candles and bread wrap, and has many uses too numberable to mention.

The last portion of the crude oil to be drawn off is known as steam refined cylinder oil and is used for making various grades of steam cylinder oils for lubricating steam pumps and steam locomotives. This residual lubricating oil stock is treated in much the same manner as the lube distillate fraction. The difference in the finished products is in their viscosity, the lube distillate producing a light body, low viscosity lubricating oil, and the residual lube stock a heavy body, high viscosity lubricating oil. The wax removed from the residual lube stock is micro-crystalline in nature and is decolorized and deodorized much the same as the crystalline paraffin wax. The micro-crystalline wax has many uses, one very important use is for food wrap in the frozen food industry. The outstanding physical characteristic of micro-crystalline wax is its ability to not become brittle at the sub zero temperatures at which frozen foods are stored.

The light lubricating oils refined from lube distillate and the heavy lubricating oils refined from the residual lube stock are moved into tankage at the Compounding and Packaging Plant. At this point the light and heavy lubricating oils are blended together in varying percentages to produce different grades of lubricating oils. The blended oils are then compounded with additives into exceptionally high quality specialized lubricants.

The refining of the Pennsylvania Grade crude oil produced in Allegany County is essentially for the high grade lubricating oil obtained from this type crude. It is desirable to yield as much high grade lubricants from the crude as possible with the hope that it can be marketed at a price that gives a fair margin of profit. However, the oil refiner is at the mercy of the market and therefore has to adjust his operations to meet the demand. A refinery is a very flexible manufacturing plant and can control its output, within limits, of course, to meet this condition. It is unfortunate, however,

that some operations are not economically sound and a refiner, especially a small one, must be constantly bettering his operations so as to yield as high a percentage as possible of those products that give the best returns on his investment. The alternate use for these higher valued products such as lubricants and waxes is cracking them into gasoline and industrial fuels. This operation is not basically sound as a premium is paid for Pennsylvania Crude Oil because of this high grade lubricating fraction contained in the crude.

The weather is another factor that greatly affects a refiner's market, but we can do something about it. Gasoline consumption decreases in the winter and heating oil demand increases, and we adjust our operations to meet this change by blending Cracking Still charge stock into fuel oils, thereby reducing gasoline production and increasing heating oil production.

It can be seen that the yield from a barrel of Allegany County crude oil varies within certain limits with conditions. However, a typical refinery yield from a barrel of Allegany crude oil, as shown on page 272 of "Empire Oil" is:

Product	Gallons
Gasoline	12.5
Distillate Fuels	9.0
Lubricating Oils	11.5
Wax	1.0
Residual Fuel	7.5
Loss in Refining	0.5
Total	42.0

The markets supplied with the high grade lubricants and waxes manufactured from Allegany crude oil are world wide. Railroads consume large quantities of lubricants and diesel fuel refined from Allegany County crude oil. The service stations dispense packaged and branded oils direct to the motoring public. Large quantities of paraffin wax are exported for use in the candle making industries. The micro-crystalline wax readily finds a market both domestic and foreign. It is used extensively in the frozen food industry for package wrap due to its ability to be chilled to sub zero temperatures without becoming brittle and chipping off the package when handled. The gasoline, heating oils, and industrial fuel oils are sold in nearby markets, say within a hundred mile radius.

The prices that the refiner receives for finished products have not kept pace with the prices that he pays for charge stocks and other operating costs. This reduces his potential per barrel of crude oil run, and the small refiner (all refineries processing Pennsylvania Grade crude oil are comparatively small) is in the position of diminishing returns on his investment. The prices obtained by the refiner for high grade Pennsylvania lubricants are, in many cases, less than were received a decade ago. While commodities other than petroleum have increased greatly, petroleum prices have advanced moderately. Even the price paid at the service station for gasoline is little more than that paid ten years ago (excluding taxes paid by the consumer at the pump). The requirements of both fuel and lubricants for the modern high compression engine used in today's automobile have been met by the refiner through the investment of huge sums of money for both research and equipment.