Vapor Recovery Units –

An Environmentally Friendly Business

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ABSTRACT

Eni Dacion is currently operating a medium oil field in Venezuela, producing heavy and medium crude oil for obtaining a blend oil of 20°API. The produced fluids are treated to obtain specifications of less than 1% BS&W. Fluids are dehydrated by means of heating the water-oil mixture in heater treaters at temperatures around 165 °F, enough for braking oil water emulsions. After the dehydration process, the hot oil liberates light ends as vapors at atmospheric pressure from the storage tanks, with negative environmental and economic impacts.

Vapor Recovery units were installed in the main processing stations, where crude is dehydrated, for reducing the emission of Hazardous Air Pollutants (BTEX and others) from stabilization, storage tanks and TEG regeneration units.

Economic merits were foreseen by installing vapor recovery units in the main stations, due to projected increases in oil export volume and the API gravity obtained when adding recovered gasoline to the crude oil leaving the stations, as well as gas recovered not condensable at VRU conditions.

This paper reports field results after VRU units have been started up and stabilized, resulting in good business opportunities for other Eni locations, due to the confirmation on production rates of gasoline. The suppression of environmental problems and economical attractiveness of recovering substantial volumes of gasoline in Dacion field is considered an opportunity to be evaluated in other fields operated by Eni around the world.

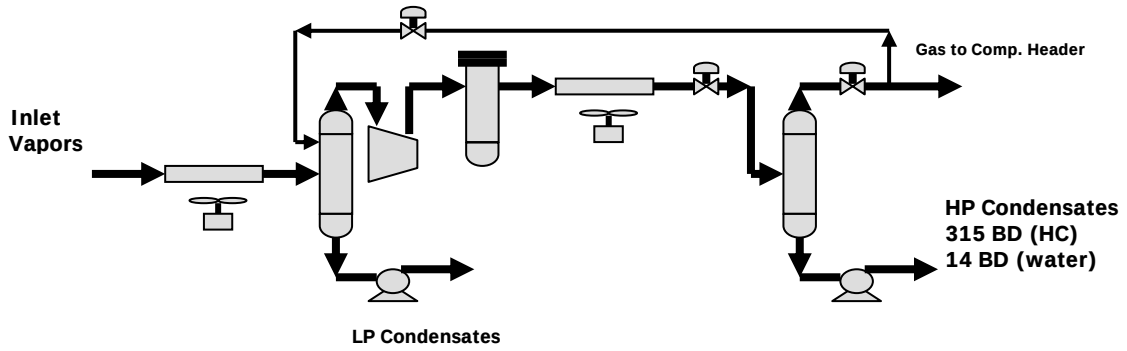
1. INTRODUCTION

A proven method to dehydrate medium and heavy crude oil is by means of heating up production fluids above the emulsion breaking point. Dacion field produces crude oil of different qualities with around 70 % water content and obtains commercial specification by heating to 165°F before sending treated oil to tanks where it is stabilized to a Reid Vapor Pressure less than 11 Psia. As a result of high temperature and atmospheric pressure conditions in the settling tanks, water and hydrocarbon light fractions are released to the vent system.

The natural gas associated with the crude oil production is compressed to 1350 Psig and dehydrated using TEG before returning the gas for use in gas lift operations. The TEG dehydration plant is equipped with a BTX unit that partially condenses BTX´s, sending the non-condensable vapors to the vent system.
Both vapor streams coming from settling tanks and BTX units have economic value and may also cause environmental impacts if they are released to the atmosphere.
Eni Dacion decided to install Vapor Recovery Units for compressing these vapors, condensing the heaviest hydrocarbons and water, and returning the non-condensable fractions back to main compressors.
Main treatment facilities were equipped with vapor recovery units, commissioned and started up this year.
This paper presents the experience obtained during commissioning and start up of the units. Daily gasoline production and characteristics are reported by station. The results provide a reference to the potential profitability of the installation of additional Vapor Recovery Units in other production facilities where tank vapors are released to the ambient.

2. PROCESS DESCRIPTION

Vapors produced in settling tanks and gas dehydration BTX units are routed to a low-pressure collection header, operating at 4" H_2O, before being disposed in a vertical stack. It was decided to install Vapor Recovery Units in each main processing facility, formed by an inlet fin fan cooler, designed to cool down the vapors from 155-185 °F to 120°F (or less, depending of the ambient temperature and humidity). Each VRU package contained two oil flooded screw compressors, each one of 50% of plant capacity, a discharge fin fan cooler, scrubbers and lube oil vessels (see figure N°1). Liquids obtained as result of compression and cooling are routed to the process (low-pressure condensates) and the export line (high pressure condensates). Non-condensable compressed vapors are routed to the suction of the compression plants for use as fuel gas or in the gas lift system.



Two Vapor Recovery Units were purchased from Hy-Bon Engineering Company, Midland Texas. The Hy-Bon Model HB-(2)HG24105VIE-(2)250-18D Gas

Recovery System employs two LeRoi oil flooded Screw Compressors that compress low pressure tank vapors to 230 Psig. Each compressor contains four poppet valves that allow the control system to vary compressor throughput from 52% to 100% according to suction pressure conditions. Each compressor is directly coupled to a 250 HP, 4160 VAC, 3 phase electric motor. The unit is capable of handling volumes from 0.57 MMSCFD to 1.4 MMSCFD, with each compressor operating at or about 196 HP (78%).
One control panel containing an Allen Bradley SLC-504 Processor with rack mounted Discrete and Analog I/O is used to control compressor operation, analog signal processing, and the capacity poppets. There is an interconnection between the Control Panel and all motor starters via a RS485 Modbus protocol. Communication with the DCS is via DH+ protocol.

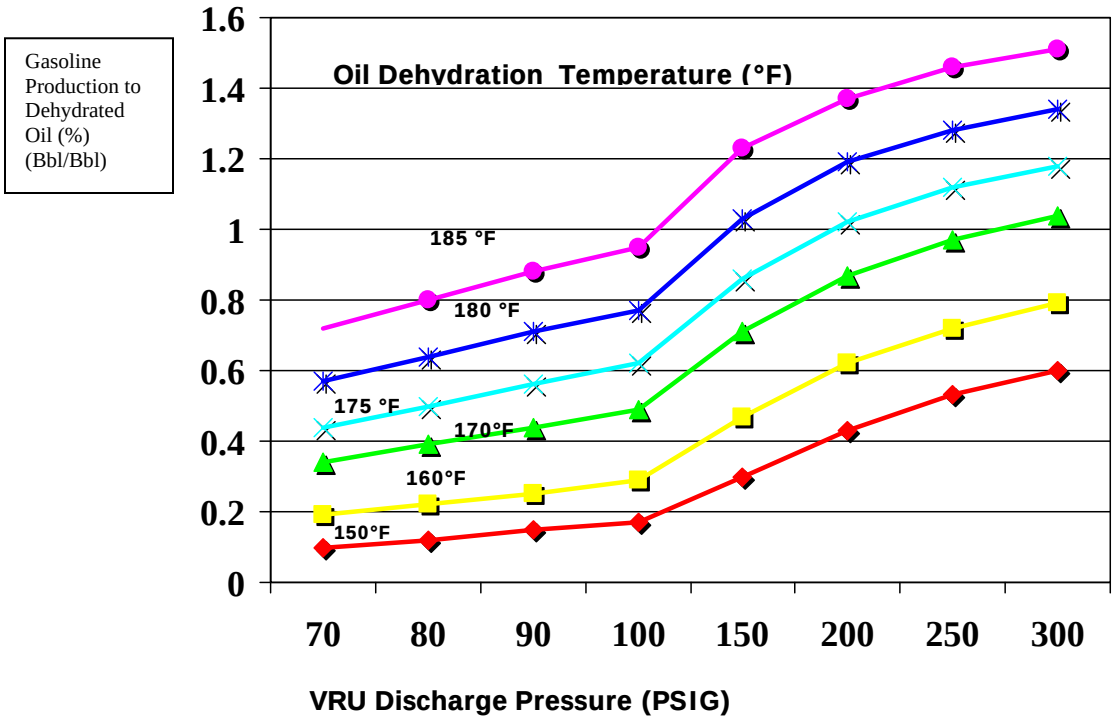
3. ECONOMICS

The Economic Evaluation performed for supporting the installation of Vapor Recovery Units was based on the following base case:

- Gas Price equals zero (vented if not recovered)
- Net Oil price variable, 10,12 and 15$/Bl
- Discount Rate variable, 5,10,12 and 15%
- Operating costs equals $ 0.08/Bl of recovered condensate
- Electricity cost equals $ 0.0139/HP hour
- Condensate recovery factor equals 0.85
- Total installed capital cost of $ 1.100.000

The hydrocarbon condensate recovery was based on the compressors operating at 250 psig, corrected by a factor to take into consideration the possibility of having less rich gas than the one used for simulation purposes. Sensitivity to discharge pressure and heater treater temperature was simulated with the following results.

Natural Gasoline Production in VRU



The Vapor Recovery Units allow optimizing the relationship between crude oil variables like chemical injection and Dehydration Temperature. Without the VRU, all light fractions evaporated in tanks are directed to the vent, resulting in economical losses.
Current Dacion East operating conditions are 35000 BD, dehydrated at 160°F and VRU discharging at 230 Psig, operating at 50% of capacity (one of two compressors), with a daily production of gasoline in the range of 100 to 150 barrels (70 °API).

3.1 Variables used in economic calculations

- **Gasoline Recovery**

Gasoline Recovery is as follows
NGR= 125/350= 0.36%
Note: VRU working at 50% due to compressor problems detected during the pre commissioning of the unit. The gasoline recovery matches with simulation predictions.

- **Net Oil Price**

The unit only has a month of operation, and there has not been enough time for making conclusions on prices, nevertheless oil prices have been above the maximum range, 15 $/Bbl for more than one year.
The production of 400-600 BD of 70° API gasoline in Dacion allows Eni to increase 15° API heavy oil production in more than 1500 BD for blending purposes before delivering 20° API oil as per contract.

There is no evidence of asphaltene precipitations in the export crude oil, where the gasoline is is added to the stream. Note that recovered gasoline comes from heavy oil vapors, not from natural gas liquids.

- **Total Installed Capital Cost**

The installed capital cost was $ 1.461.000 instead of $ 1.100.000 (33% higher).

- **Net Present Value (NPV)**

The main variations in variables influencing the NPV calculations are gasoline production, oil price and capital cost. It is not the intention of this paper to make a post mortem report with only one month of operation, but the difference in oil prices cover the increase in capital cost in six months of operation with a discount rate of 15%.

- **Internal Rate of Return (IRR)**

The project was justified with 48% of IRR at a discount of 15% in a period of three years, with an oil price of $ 15/Bbl. It is recommended to evaluate IRR after six months of operation, when the units are intended to be operating at 100% of capacity.

4. Conclusions and Recommendations

4.1 VRU Expected condensate recovery has been confirmed after one month of operation both in DEPE and DEPO process facilities. Highly valuable, 70 °API condensate is currently produced at an approximate daily rate of 100 to 150 barrels per compressor.

4.2 After solving problems with compressors, the technology has been proven as effective. Oil Flooded Screw compressor are in normal operation with a suction pressure of 0 PSIG and a discharge pressure of about 230 Psig.

4.3 Asphaltene deposition due to the mixing of condensates and export oil has been neglibible.

4.4 Highly favorable economics, together with the environmental benefits of significantly reducing the atmospheric release of BTX´s and HAP´s, makes the installation of Vapor Recovery Units a subject to evaluate as a

possible business alternative, in production facilities where hydrocarbons are currently vented.