Conservation With Vapor Recovery

By RALPH NELSON
Hy-bon Engineering Co.

Introduction

The present and future concern of the crude oil producer is efficiency of primary and secondary oil recovery. To obtain maximum efficiency from a specific tank battery, all saleable products of production must be recognized and marketed. This paper will be concerned with recovery and marketing of crude oil vapors, as a saleable product; it is well-known that, today, a great loss of stock tank vapors to atmosphere exists throughout the industry.

Application of a Vapor Recovery System

During the past few years consolidation of leases, field unitization, and commingling of producing zones have centralized crude oil storage tanks, where the crude oil production is processed and marketed at a high daily volume. The centralized tank battery becomes an ideal location for consideration of a vapor recovery unit, since the product and market are generally "on location".

To utilize vapor recovery with an extremely short investment payout the applications available at a central battery have been numerous. To attain 100 per cent vapor loss recovery, good sound engineering principles must be adhered to and a positive approach made in design. The following applications have been installed and successfully operating for several crude oil producers:

(1) Stock tank vapor recovery
(2) Pipeline storage vapor recovery
(3) Treating system vapor recovery
(4) Free water knockout and salt water disposal vapor recovery
(5) High gravity crude oil stabilization and gravity reduction
(6) Well casing pressure control

Design of Vapor Recovery System

A basis for consideration of a vapor recovery system will require electric power or a gas pressure differential for the prime mover, low pressure gas sales line, and sufficient volume of vapor to load one of several size compressors. The units should be designed to operate unattended and the components should be selected to provide normal safety precautions in construction and operation.

Under actual flowing conditions and ambient temperature, an accurate measurement of the vapor loss volume should be determined for proper selection of the size compressor required. Theoretical calculation of the vapor volume can be made with known values of similar crude oil, gas oil ratio, controlled shrinkage tests and laboratory analysis. However, the theoretical calculation has not been too accurate in most cases; if these are used in design, sufficient compressor capacity should be available for any miscalculation. Actual measurement of the vapor loss during operating conditions can be made with use of a recording manometer and orifice well tester or positive displacement meter. This type unit can be installed and left for a period of time to cover the day and night cycle of ambient temperature. This daily change in temperature is a measure of actual vapor volume lost under operating conditions; but consideration should still be taken for additional compressor capacity.

The variable of gas sales line pressure will be of prime consideration to determine the compressor capacity and horsepower requirement. To measure this variable the static pressure records of the existing meter run can normally be used. Intermittent high discharge pressure can be a problem if proper precautions are not taken.

Stock Tank Vapor Recovery System

A typical closed system is best illustrated by Figure 1. The skid mounted compressor unit, with components, is located at a convenient distance from the existing stock tank and requires installation of the vapor suction

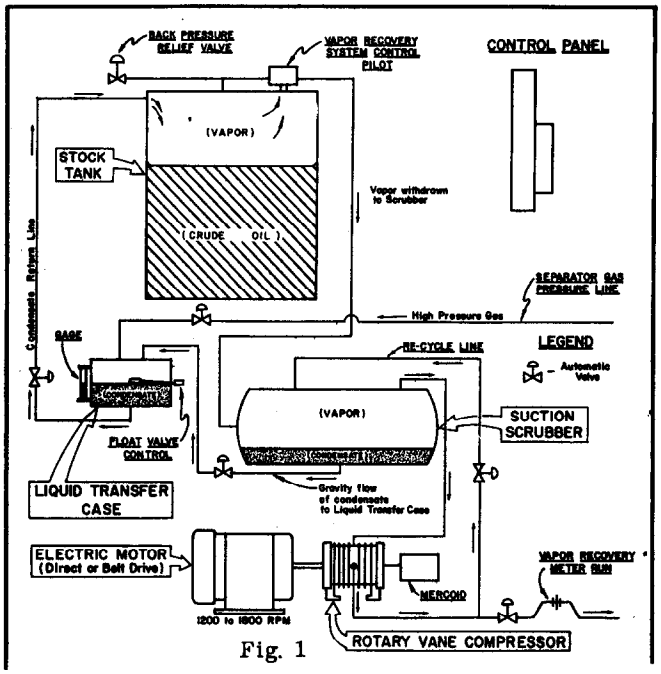

Fig. 1

and discharge piping, electrical service, and control circuits. The suction line is connected from the existing gas vent line to the suction scrubber inlet, and this line is elevated to allow liquid drainage to the suction scrubber. The amount of liquid recovery will depend upon the physical properties of the vapor, ambient temperature, and length of suction line. It has been experienced that during the winter months, large accumulation of liquid can be recovered from most installations. Automatically controlled equipment can be installed for this purpose. The seasonal change of ambient temperature has a definite effect upon the volume of vapor loss in most installations; thus, proper selection of the compressor capacity must be determined. The direct-driven compressor unit will normally suffice up to 40 per cent in volume fluctuations. The belt driven unit will provide more flexibility when ambient temperature variations cause extreme changes in vapor volume; generally a winter and summer sheave change will suffice. The control of this system is derived from

a control pilot that is pneumatically or electrically actuated and that functions from the vapor pressure of the stock tank. (To eliminate overriding of the safety shutdown features, manual control is not incorporated in the system). The control pilot is responsible for control of precise pressure variations in the magnitude of fractional inch water column pressure; thus, repeatability reliability and positive preset pressure settings must be obtained. The standard control pilot has three functions: (1) cycle compressor ON or compression cycle at preset high vapor pressure; (2) open unloading valve for compression cycle OFF at preset vapor pressure; (3) shut down prime mover at preset safety shutdown pressure. The control panel is self containing for all electrical components used in the system, except the control pilot switch contacts.

Treating System Vapor Recovery System

Installation of a centralized tank battery in conjunction with lease consolidation have resulted in treating system problems for numerous installations. The treating pressure at the battery is required to be as low as possible, so the satellite stations can flow at normal pressure. Whenever the gas sales line pressure fluctuates and becomes high, the treating system vapor will be intermittently vented; the frequency of venting may easily justify installation of a recovery or booster compressor unit. The system normally used is similar to that illustrated in Figure 1 with modification of the control system and components; functionally, the system will boost treating system gas into the gas sales line at preset pressure points. The volume of gas will vary over a wide range, with intermittent type lifting devices and long flow lines unloading. To handle erratic flow rates, a multiple compressor unit can be installed to cycle at overlapping pressure settings; this will require proper selection of the compressor capacity. A belt driven compressor unit will, with a minimum of mechanical modification, tend to give flexibility for this cycling requirement. In the event of a complex treating system utilizing a free water knockout, salt water disposal tank and normal heating facilities, a closed system can be installed and economically justified to gather and compress for sale all vapors lost in normal treating methods. The control system for most all type installations used in this application can be designed for many functional conditions; thus, safety is stressed because of the variable suction pressures encountered in the unattended operation.

High Gravity Crude Oil Stabilization

The centralized tank battery with relatively high flow rates and high crude oil gravity becomes an application for crude oil gravity reduction and stabilization. The basic system as used in Figure 1, with modification of components and control system, will indicate the flow diagram. Pipeline crude oil is dumped into the compressor suction scrubber, which has been treated at a controlled temperature; the suction scrubber is held to preset vacuum limits, and with the two variables of temperature and pressure, reduction of the crude oil gravity is maintained at predetermined limits. The resultant vapor flashed in the suction scrubber is compressed to gas sales; and stabilized crude oil is recovered for pipeline sale. Within determined limits, the feature of controlling the crude oil gravity from one production zone can become the means of controlling a commingled crude oil gravity going to pipeline sales. The resultant high "GPM" content of low pressure high temperature separation vapor will normally command a high price bracket in the standard casinghead gas sales contract. It has been found that an installation of this type would justify a shorter payout than will the standard stock tank vapor recovery unit because of physical factors and because of the vapor not becoming subject to proration. Evaluation of the vapor volume at various temperature and vapor pressure require a fractional distallation curve for the specific crude oil. Present installations have reached 15 in. Hg at 160 F in field operating conditions. This system should be given serious consideration whenever high gravity crude oil becomes penalized and sale of the vapor versus equivalent liquid volume can be justified economically.

Well Casing Pressure Control

Consolidation of leases containing marginal or "stripper" wells has caused a problem of production loss; precisely, high casing pressure because of the longer flow line and common problems of paraffin, gas blocks, friction loss and intermittent flow rates. It has been found that certain wells effected by 10 to 20 psi casing pressure increases will have a decided effect upon the production rate, apparently because of the fluid level fluctuation. This application for a vapor recovery unit can be very profitable since loss of production below the monthly allowable is uncommon during these days. With elimination of the suction scrubber, the basic system (Figure 1) can be used in an individual well application. The compressor suction will be connected to the casing, and the discharging fluid to the flow line. With an adequate control system, preset pressures can be maintained on the casing during pumping and down time. The resulting closed system will maintain the desired pressure with no loss of vapor and will also displace excess vapor to the gas sales line. This system has been used under vacuum conditions whenever permitted. The application of a central vapor recovery unit with a gathering system on the various pumping well casing can be installed by utilizing the components in Figure 1, with modification of the control system. The economic justification of control system modification can be easily obtained with the proper measuring devices and well testing equipment to record casing pressure versus production rate for individual wells. Whenever the desired casing pressure is obtained the application of the vapor recovery unit becomes apparent. This type of installation has application on most type primary lift wells where high fluid levels are encouraged for lifting cost reduction.

Summary

The economics of a vapor recovery system is derived from the sale of recoverable gas and liquid products, lease safety by collection and disposal of lethal gas, reduction in tank deck corrosion, crude oil gravity stabilization, sale of liquids as condensate allowable, control of lease vapor for townsite locations, control of crude oil gravity for pipeline sales, and production increase through well casing pressure control. The system is fully automatic and designed for unattended operation. It is field proven by several years service, and sufficient data are available from experience to determine the most economical system for all applications.