Conservation With Stock Tank Vapor Recovery

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INTRODUCTION

Efficiency of primary and secondary oil recovery has become a major economic requirement for all crude oil producers. The phase of crude oil production this paper will consider is final gas-oil separation with the stock or surge tank and recovery of the resultant vapor.

A basis for consideration of stock tank vapor recovery will require a gas sales outlet at a centralized location where crude oil is treated for pipeline sale or storage. The loss of tank vapor to atmosphere is familiar to most production personnel; thus, with the current trend of lease custody transfer and/or tank battery consolidation, the volume of vapor loss becomes a factor worthy of consideration.

PRINCIPLE BASED ON LAWS OF PHYSICS

The principle involved in the vaporization of fluid is based upon the fundamental laws of physics. Liquids placed in a closed container, such as a stock tank, will vaporize throughout the space above the liquid until equilibrium of pressure is attained at a constant temperature.

Vapor becomes saturated very quickly if liquid is placed in a vessel containing a vacuum; if the vapor space contains air when liquid is introduced, the diffusion is much slower.

There are many conditions affecting the loss of crude oil volume in the form of vapor loss which will occur in all normal installations of crude oil storage. Ambient temperature fluctuation and solar radiation are prime factors affecting the vapor space pressure and fluid temperature. Pnysical properties of the crude oil, such as solution gas-oil ratio, API gravity and vapor pressure are to be considered in ascertaining the volume of vapor. The treating system temperature and pressure will be of concern due to fluid flow into a tank of less temperature and pressure. The piping arrangement for fluid entry into the tank will effect agitation of the fluid. The cycle of fluid displacement and fill for a pipeline run will affect the vapor pressure.

There are production methods to partially control the loss of stock tank vapor to atmosphere, but an adequate vapor recovery system will maintain a vapor pressure within preset limits and any excess vapor volume is collected, compressed and sold. A successful design of a system will naturally depend upon the known specifications of vapor volume and sales line pressure.

Accurate Measurement of Content

An accurate measurement of the gpm. content within the stock tank vapor is readily obtained with the use of test car equipment. This test can be obtained by contract service or from gasoline plant facilities. The most significant and difficult specification to obtain is the volume of vapor loss for a given time; this can be obtained by empirical calculation or physical measurement. The equipment used to measure the volume during 24 hour testing is usually an orifice meter, with an element in inches of water, or a displacement meter.

In all measurement methods liquids must be considered as being present and facilities made available to handle them. The volume of vapor loss is generally a condition existing at the individual tank battery; it can vary from location to location even under similar crude oil conditions of treating, storage, and pipeline sales. An accurate measurement of the vapor volume for the specific tank battery will normally be required, or at least an adequate factor applied to the empirical calculation. In most applications the installation will be designed to recover the maximum volume of vapor available during seasonal ambient temperature fluctuation.

The variable of sales line pressure will be of prime consideration in order to determine compressor capacity and horsepower of the prime mover. The average pressure of the sales line can generally be obtained from past records and equipment installed for any peak pressure conditions arising, to safeguard maximum compressor discharge pressure. Consideration must be made of the sales line pressure at a low domestic production rate or of the possibility of an increase in the future.

Further Requirements

In order to obtain maximum efficiency from a vapor recovery unit, a closed system to operate under all known conditions is required. The installation of such a system can be made with a minimum of renovation to the present stock tank battery. An ideal installation for efficient conservation of crude oil is in conjunction with lease custody transfer. The control of vapor pressure in the surge tank will tend to stabilize the crude oil under all ambient conditions and will allow the pipeline metering device a minimum range to correct for temperature, BS&W and specific gravity change.

The pressure rating of the oil vessel and its ability to withstand the preset vapor pressure without leakage is required. Normal installations will retain an adequate back pressure valve on the gas vent line to serve as a safety relief valve. The control pilot can be preset to allow blanket gas to enter the oil vessel if a condition approaching a vacuum occurs; thus, a positive gas pressure is maintained within the vessel during all possible operating conditions.

A suction line is connected from the present vapor vent line to the suction scrubber on the skid unit. The collection and disposal of liquids formed in the suction line is accomplished with the scrubber and liquid dumping facilities. In order to minimize friction loss in the suction line, adequate drainage of liquid to the suction scrubber and diameter of line should be considered. The type compressor selected will generally be determined by the specifications, but, in all applications, compressor efficiency must be considered to minimize operating costs.

The specifications of most installations will allow the use of an air cooled compressor, rotary or reciprocating type. Safety precautions of high temperature and pressure shutdown can be utilized in the system, pneumatically or elec-

trically actuated. The type of prime mover normally used is an electric motor although application of an engine or gas motor can be utilized.

An adequate control pilot is the basic requirement of a vapor recovery installation due to the precise control requiring a fraction of an inch water column pressure sensitivity. In order to be adaptable to all requirements, the basic control must furnish a pneumatic signal to control the functions required by all installations. The function of a control pilot will be to cycle the compressor discharge on and off and maintain a positive gas blanket pressure within the oil vessel; it must accomplish these functions within a fraction of an inch water column pressure variation, provide repetition under all ambient conditions, conform with NEMA electric code and fail safe in an emergency. The use of dead weight to preset and accomplish repetition of the required functions has proved to be most practical in the field, eliminating springs which are affected by temperature variation.

ECONOMICS OF VAPOR RECOVERY SYSTEM

The economics of a vapor recovery system is derived from the sale of recoverable gas and products, reduction in tank deck corrosion by eliminating air, lease safety by collection and disposal of lethal gas, and sale of liquids collected as condensage allowable. Selection of an application for vapor recovery will generally be made where crude oil storage is in excess of a 800 barrel per day rate. The installation of compressor capacity to handle 50 to 300 MCFD will normally be the most economical in payout. The initial installation cost is generally fixed for any volume less than 50 MCFD; thus the extra cost for compressor capacity in excess of this volume is a small percent of the total cost.

The normal vapor recovery installations will have an initial installation payout of seven to ten months as indicated from installations handling 50 to 250 MCFD and based upon revenue from gas sale alone. The actual payout calculation for a system is generally in relation to the type of gas sales contract prevailing. A simple work sheet has been made available to insert the known factors for an installation and a theoretical calculation can be made obtaining the revenue due from gas sales. The majority of gasoline plant operators cooperate in obtaining the higher gpm. sales gas and the settlement test is equitable for all concerned.

The installation of stock tank vapor recovery will increase production efficiency since basically it consists of recovering a normally spent, marketable product and increasing the revenue derived from sale of the produced barrel of crude oil. In order to combat higher lifting costs, increased revenue from the sale of each barrel of crude oil must be obtained.