Conservation And Recovery Methods Of Stock Tank Vapors

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Introduction:

Oil may be lost from a tank in the gas or vapor phase form, a phenomenon which is known as vaporation loss. The evaporation loss to the atmosphere from lease tank batteries is a definite loss of our natural resources. The question, is this evaporation loss great enough to have any monetary value at the present time? Are there economical methods for recovering these vapor losses and are such methods profitable to oil producing operations? To these questions the answer is definitely yes, in lieu of the expansion of Gasoline Plants, Product Pipelines and the Petro-chemical Plants in the West Texas-New Mexico Area.

Basic Theory

The principles involved in the vaporization of fluids are based on the fundamental laws of physics and will not be discussed at this time. Liquids placed in closed containers such as stock tanks, will vaporize throughout the space above the liquid until equilibrium of pressures is reached. Vapor becomes saturated very quickly if liquid is placed into a space which contains a vacuum but, if the space contains air when the liquid is introduced, as is the case in the average stock tank, the diffusion is much slower. Although the air delays saturation, it does not affect the eventual amount of vapor which will vaporize into the closed space. In evaporation losses there is a wide divergence between predictions, which may be made on a basis of theoretical conditions, and actual losses known to occur. It becomes evident that conditions which lead to evaporation losses, and factors which affect their magnitude, are widely variable. Some of the factors affecting evaporation losses:

1. Physical properties of the crude oil.
2. Temperature of the crude oil (treating).
3. Method of stock tank entry.
4. Weather conditions and winds.
5. Occurrence of tank cycle.
6. Agitation.
7. Fill loss.

In order to point out many variables affecting evaporation losses, it may be well to follow the sequence of events through a 24-hour time cycle of an average stock tank. Assume for the purpose of illustration, a steel tank which has a tight fixed roof, with one open-vent connection and one thief hatch. Assume also that the daily cycle starts at 5 AM, a time which has been established by test as being, on the average, one when temperature conditions within and around the tank are most nearly uniform and stable.

At 5:00 AM the following conditions may be expected:

1. Average atmospheric temperature is the same as the average temperature in the tank vapor space.

2. There is no flow either in or out through the tank vent.

3. Temperatures throughout the body of oil are quite uniform and appreciably higher than the outside atmosphere.

4. There is no wind.

From 5:00 AM on throughout the day until early evening, the following conditions become typical:

1. Atmospheric temperatures are rising, and heat is delivered to the tank from the atmosphere by conduction.

2. Direct solar heat (radiant) warms the tank shell on the sunny side, and on the roof with the following effects:

a. Oil next to the shell is heated above the temperature of the balance of the oil body, causing convection flow Fig. 1, and increased vaporization.

b. Heat transferred through the shell and the roof increases the temperature of the vapor space by conduction and convection.

3. The contents of the vapor spaces, expanding with increased temperature, begin to discharge through tank vents.

4. Frequently the wind arises, and with open tank vents, increases the vapor losses.

During the late hours of the evening and until 5:00 AM, the above condition is reversed, Fig. 2.

Oil movements into and out of the tank will superimpose their affects on this daily thermal cycle.

Oil Inflow Will:

1. Increase vapor outflow in the vent during the period of thermal outbreathing.

2. Cause vapor outflow when there is no thermal breathing.

3. Decrease or offset airflow, or cause some vapor outflow during periods of thermal in-breathing.

Oil outflow will reverse the above conditions.

Economics:

With the above elements affecting the evaporation loss of the crude oil in the stock tank, another important point for consideration is the solution gas emanating from the crude oil as a ressult of approximately 20 psi pressure drop from the separator to the stock tank. The volume of solution gas emanating from the crude oil will vary with the type and physical characteristics of the crude produced, but it cannot be ignored. Thus the combination of the above factors does produce a sizeable volume of vapors. What is the value of these vapors? Assume an average 40 degree API gravity crude oil, dumping from a separator at a pressure of 20 psig, to a stock tank at atmospheric pressure. The average volume of vapors will range 20 to 30 cubic feet per barrel of oil produced into the stock tank. The GPM content of the stock tank vapor will range from 15 to 25 gallons per 1000 cubic feet of stock tank gas. For an example, assume a daily production of 500 barrels and use the lowest factors for gas and liquid volume.

500 barrels x 20 cubic feet/barrel equals 10,000 cubic feet/day.

$0.10/MCF x 10.0 MCF equals $1.00 per day gas sales.

15 GPM x 10.0 MCF equals 150.0 gallons per day.

STOCK TANK CONVECTION CURRENTS

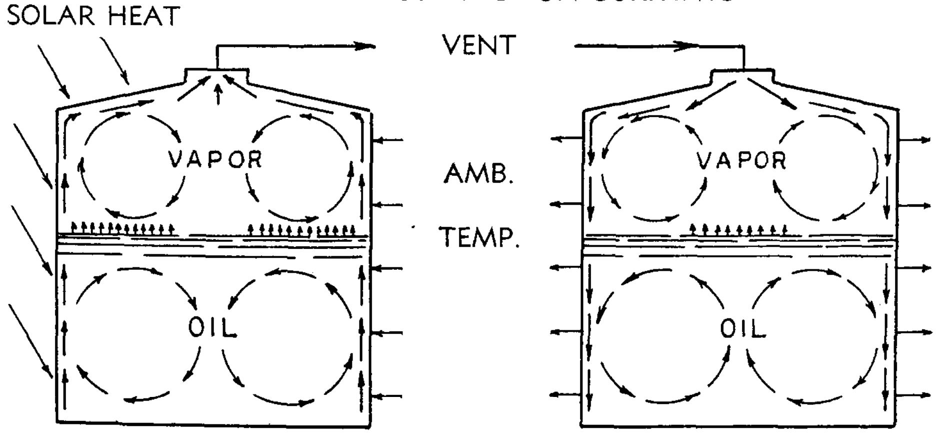
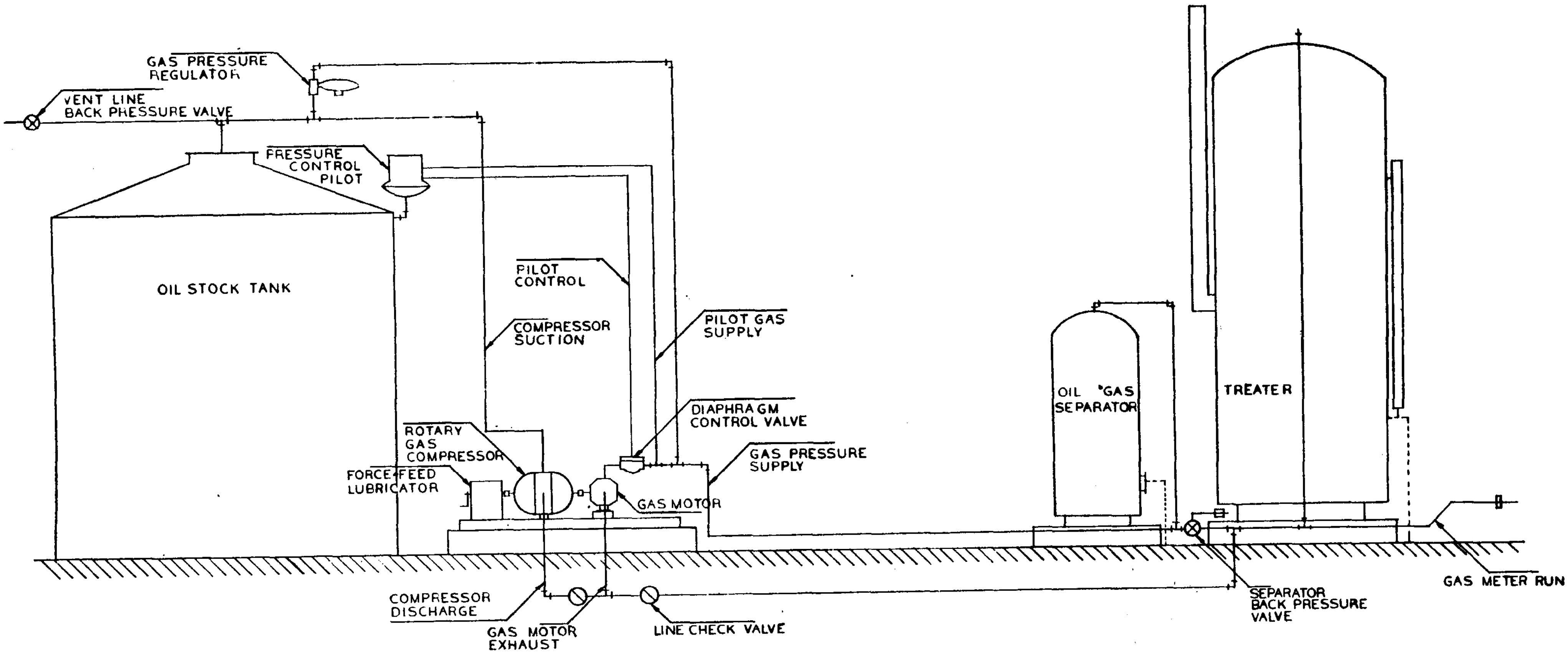


FIG. 1 FIG. 2

NOTICE: SCHEMATIC DRAWING ONLY
ALL PIPING, PIPE SIZE,
SUBJECT TO APPLICATION



NOTE: AVAILABLE IN PNEUMATIC
OR ELECTRIC SYSTEM

FIG 3

AUTOMATIC CONTROLLED
TANK BATTERY VAPOR
RECOVERY SYSTEM

$0.05/gal. x 150.0 Gal. equals $7.50 per day gas sales.

Total value per day equals $8.50.

Yearly total over equals $3,000.00.

Application of Recovery Method

One of the most practical methods of recovering this vapor loss is a closed system using a single stage rotary type compressor and a gas repressuring line to avoid a vacuum condition in the stock tanks. This combination will handle the outflow and inflow of stock tank vapors maaintaining the tanks at a constant preset pressure and the oil at its optimum gravity, Fig. 3. The gas at 20 pounds pressure from the oil and gas separator is the source of power to operate a rotary Gas Motor and to supply gas to the stock tank when needed to avoid a vacuum condition. The Gas Motor operates the rotary fluid-gas compressssor which compresses the stock tank vapors. The rotary fluid-gas compressor is designed for sour gas operation and has the ability to handle varying volumes of fluid. The special bearings on the compressor are forced-feed lubricated to insure maximum life in this service. The exhaust from the compressor is co-mingled with the exhaust of the Gas Motor and flows to the gas meter run on the sales line. The exhaust from the Gas Motor is the vaporizing and carrying medium for the liquids resulting from compression of the stock tank vapors. The Gas Motor is designed to operate on sour wet gas and it is permanently lubricated, sealed roller bearing unit. The pressure control valve maintains a constant tank pressure within one inch water column and operates the compressor only as required. This complete, skid mounted, tank battery vapor recovery system was designed for "sour" gas operation but is so flexible as to meet any operating condition or stock tank pressure. In using the above operating condition, Fig. 4, and the previous economic values, this unit would have a direct payout of approximately two to three months. Electrical units are available with the same components except electrical prime mover and controls.

In closing, we wish to point out one other important point, i.e., reducing tank corrosion. Much of the tank deck corrosion is the result of oxygen and moisture in the air entering the tank through the vent line during a period of inflow. This has long been recognized as a big factor in tank top corrosion. Thus the closed vapor recovery system will aid in elimination of this corrosion factor, resulting in even greater savings to the producer.

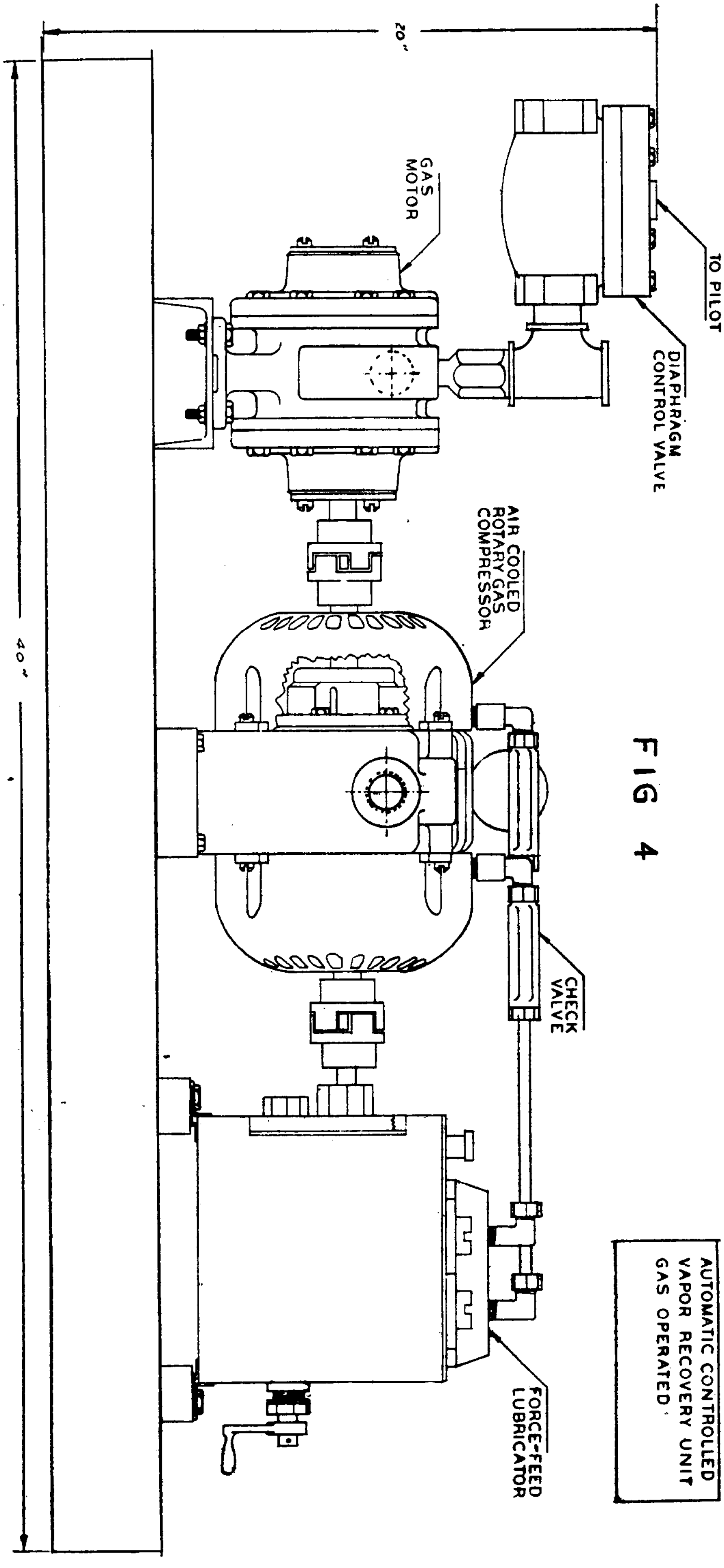


FIG 4

AUTOMATIC CONTROLLED VAPOR RECOVERY UNIT GAS OPERATED