HNG OIL COMPANY'S DEVELOPMENT AND PRODUCTION TECHNIQUES IN SUTTON COUNTY SAND PAYS

CHRISTOPHER R. WEAVER
HNG Oil Company

INTRODUCTION

The purpose of this paper is to discuss HNG Oil Company's drilling, completion, and producing operations in the Sawyer (Canyon) Field, Sutton County, Texas. The field is located south of Sonora, Texas as shown in Fig. 1. HNG has 134 productive wells, 60 percent of the field, on 58,000 acres with 220 offset proven locations yet to be drilled.

The Canyon in this area is characterized by limited extent low permeability lenticular sands. The average well stabilizes at approximately 300 MCFPD and has an initial bottomhole pressure of about 1900 psi. Because of these characteristics and the initially low gas price (18¢/MCF). the original economics were marginal. This necessitated a streamlining of operations to make the venture economical.

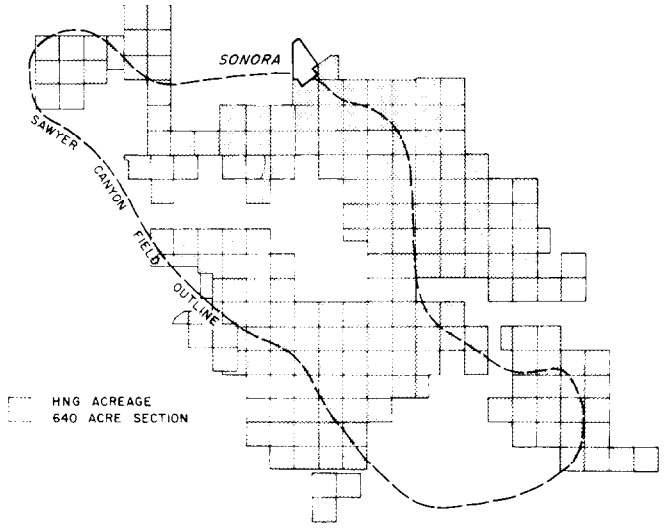

FIG. 1—SAWYER CANYON FIELD SUTTON COUNTY, TEXAS

AIR DRILLING

The wells in the Sawyer (Canyon) Field are now being drilled with air. The two big advantages of air drilling are increased penetration rate and location of productive gas sands. A typical well is spudded with an 8-3/4 in. OD bit and drilled to the base of the Cretaceous formation where 7-in. OD surface casing is set and cemented. A 6-1/4 in. ID hole is drilled to total depth using a mill tooth bit on the softer formations and a button bit on the abrasive Canyon Sands. When a productive interval is drilled, the gas will flow up the annulus and through the blooie line into the pit where it is ignited by a pilot light. Depth of the gas production is recorded on the driller's log. Several gas increases are generally noted during the drilling operation, and all are recorded. Upon reaching total depth the well is tested through a choke manifold to determine the openhole gas delivery rate. A temperature log is run while the well is flowing. The hole is then loaded with brine water and a gamma ray-acoustic log is run. The combined information from the driller's log, the temperature log, and the gamma ray-acoustic log, is used to pick the completion intervals.

Gas escaping from the drill pipe or the annulus would be hazardous. A check valve in the drill string prevents gas from flowing up the drill pipe while making a connection. Flowing air through a jet in the blooie line creates a differential pressure which causes the annular gas to flow to the pit where it is burned.

Water-productive sands are occasionally encountered and have to be mist-drilled. Water and soap are injected with the air to maintain circulation and to remove the cuttings. A booster pump is needed because the air, water, and soap mixture is heavier and requires more pressure to

circulate. A normal air drilling operation at 5500 ft would use 900 CFM at 350 psi as compared to 550 psi during mist operations.

COMPLETION

The 4-1/2 in. OD casing is run with centralizers across the pay intervals. The casing is cemented with lightweight cement and enough Class C cement to cover the productive intervals. The intervals to be perforated are determined by using data from the driller's log, the temperature log, and the gamma ray-acoustic log as shown in Fig. 2. Some intervals that the gamma ray-acoustic log indicate to have porosity do not produce gas when drilled. The temperature log will show these intervals to be nonproductive. These zones probably lack sufficient permeability to be productive and are not perforated. The wells are perforated in acid using a decentralized jet gun to obtain burr-free holes which are needed to ensure good ball action. The wells are fraced in stages using 2000 gal. gelled fresh water as a pad and 12,000 gal. gelled fresh water mixed with 1 pound of 20-40 sand per gallon. A guar gum gel complexed with a borate solution is used to obtain 30 cp viscosity fluid. It is necessary to use clean water and frac tanks to obtain the desired viscosity as the fluid is sensitive to pH and reducing agents which will prevent the fluid from gelling. The treating companies are responsible for the frac tanks and the base fluid to prevent gelling problems. This policy has worked well and the gels have been consistently good. Staging is accomplished using ball sealers followed by a small volume of 15% HCl to lower the breakdown pressure of the next interval. Staging with ball sealers has been consistently good, with the last 10 wells averaging 530 psi increase per stage. The casing hanger shown in Fig. 3 is threaded on the top and bottom so that a frac nipple can be screwed into the hanger. This permits frac pressures of 4000 psi while using a 2000 psi working wellhead pressure. This amounts to a savings of $268,000 on 134 wells.

The tubing is 1.9-in. OD 10-Rd upset and is run open-ended to a point just below the bottom perforation. An ID gauge ring is used during the running of the tubing to eliminate under-gauge tubing so that the well is ready for a plunger installation if it becomes necessary.

PRODUCTION

HNG has 134 wells completed in the Sawyer

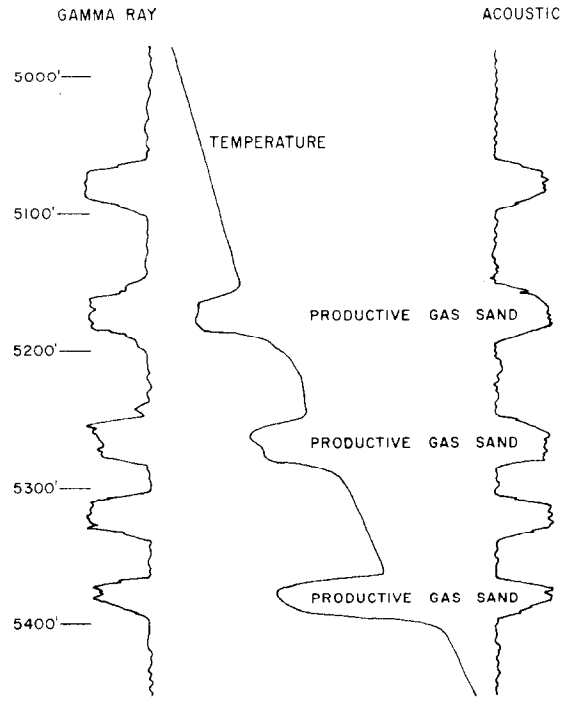

FIG. 2—TYPICAL SAWYER CANYON LOG

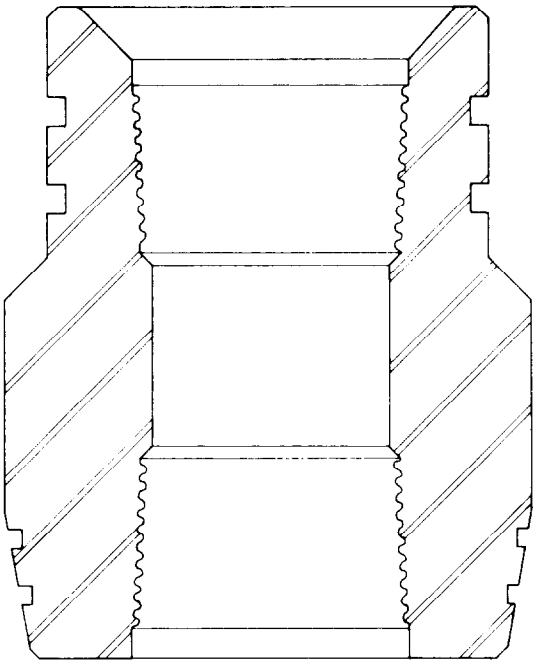

FIG. 3—CASING HANGER

(Canyon) Field and 105 of these wells are connected to the 500-psi sales line. They deliver an average of 300 MCFPD with 5 bbl/MMCF of 61° API gravity condensate. The other 29 completed wells will be placed on the sales line as soon as the flowlines and production centers are completed.

Most of the wells produce some water and have a tendency to load up because the flow rates are below the critical velocity required to continually remove liquids. Because of these low velocities, 82% of the wells are producing on a time cycle intermitter. In some cases plunger lifts, see Fig. 4, have been installed. The plungers have kept the wells unloaded, increased the gas production, and prevented losses incurred while unloading water to the pits. The first four plunger lift installations averaged 192 MCFPD prior to and 325 MCFPD following installation—a 70% increase in production. Although this high increase is not expected on all installations, it is reasonable to anticipate numerous additional installations in the future.

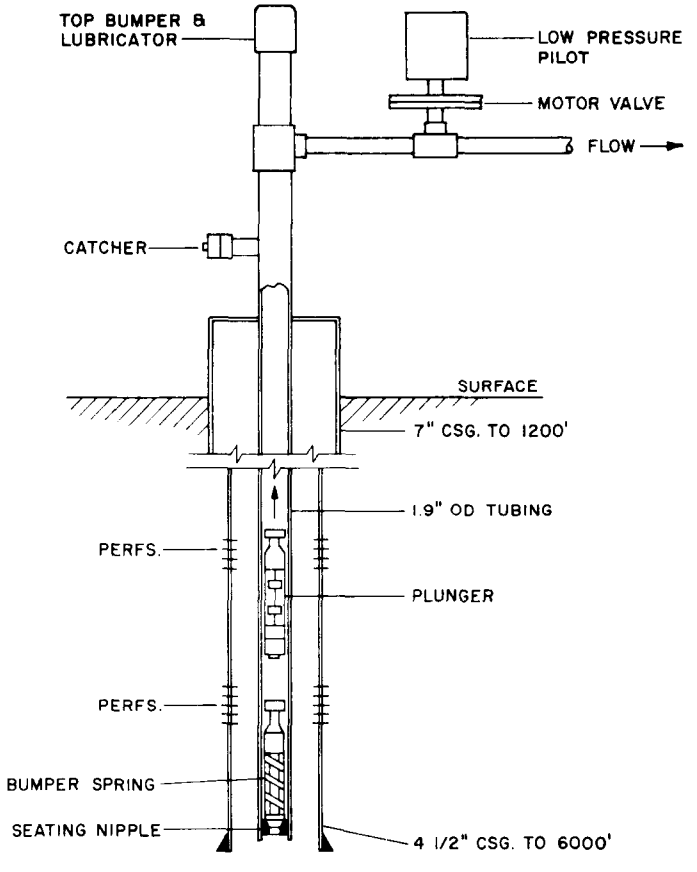

FIG. 4—TYPICAL PLUNGER INSTALLATION

Barium sulfate scale deposition has caused some production problems. This scale has been found in the casing and tubing across the perforated intervals. To prevent this deposition, a combination organic phosphonate and organic polymer inhibitor has been included in the frac pad. This problem is not field-wide, but all wells are being initially inhibited until the scale problem areas are isolated. Inhibition costs $276 when incorporated into the initial treatment. A squeeze inhibitor treatment after the problem becomes evident would cost $4500. This cost is high because of the treating procedure; each zone must be straddled and selectively squeezed. Should refracing become necessary, an additional expenditure of $5000 would be required.

PRODUCTION FACILITIES

The production facilities in Sutton County are located at central points as shown in Fig. 5. The individual full wellstream mixtures of gas, water, and condensate flow from the wells to the production centers where they enter a multiwell indirect fired heater. After passing through the

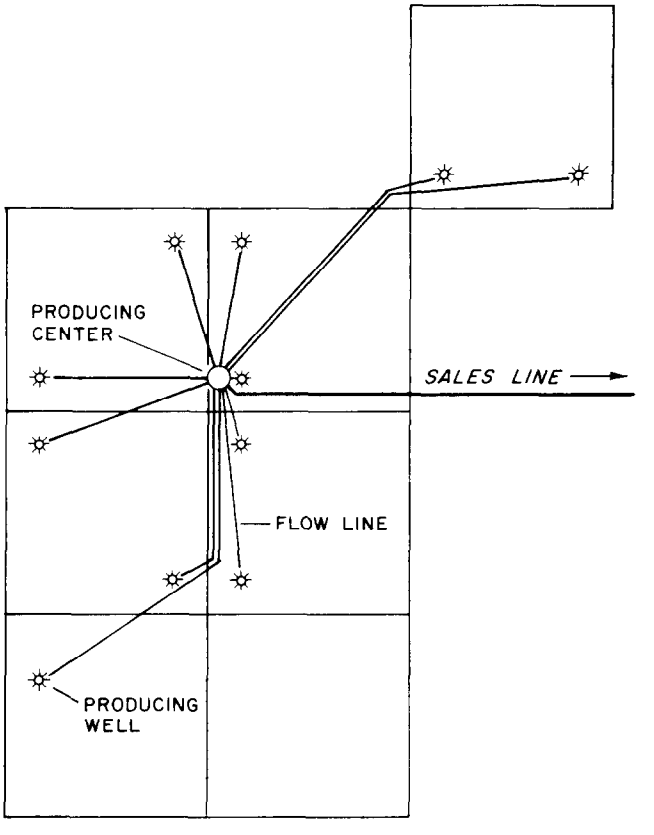

FIG. 5—TYPICAL GATHERING SYSTEM

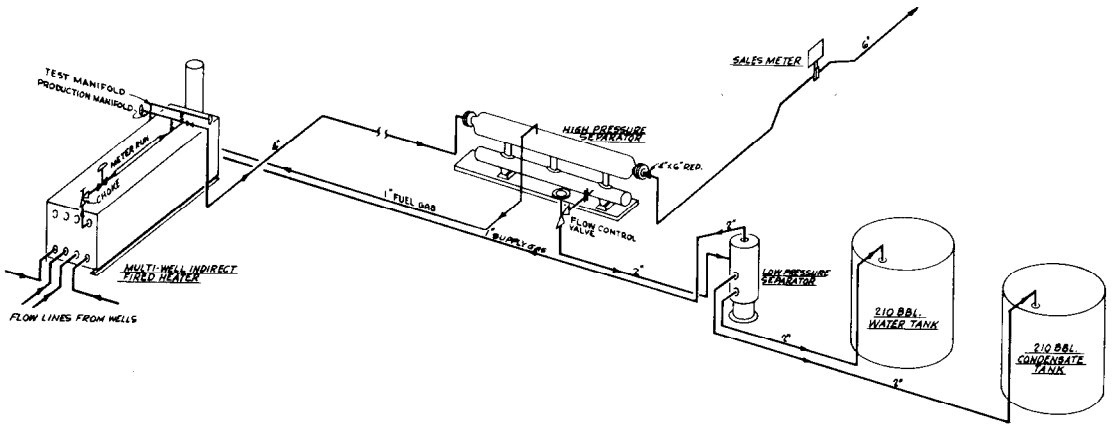

FIG. 6—CENTER SCHEMATIC OF PRODUCTION EQUIPMENT

coils in the heater, the wellstreams are choked and metered individually (see Fig. 6). They are then commingled prior to flowing into the high-pressure separator. Gas flows from the high-pressure separator into the sales line and the liquids are dumped into a three-phase, low-pressure separator. From here the water and condensate are dumped into their respective tanks. Gas from the low-pressure separator is scrubbed to remove moisture and used as supply gas for the controls at the center. Some high-pressure gas is diverted to be used as fuel gas for the heaters.

The chokes, time cycle intermitters, and meter runs are mounted on the heaters (see Fig. 7). From the production center the pumper can look at the orifice meter charts, and adjust the chokes and intermitting cycles for several wells without going to the well sites. This reduces the number of people and amount of equipment needed to operate the wells.

A safety system is used to prevent production losses and equipment failures. All wells have low-pressure shut-in controls, consisting of low-pressure pilots and motor valves at each well. A drop in flowline pressure will close the valve and when the pressure returns, the valve will open. The centers have a high-low pilot controlling the supply gas to the motor valves on the heater. Should the separator pressure drop, the pilot will close the motor valves. Should the separator pressure increase above the set value, the pilot will again close the motor valves. This prevents the equipment from being damaged by the full well stream pressures which are carried on the system.

CONCLUSIONS

1. The technique of air drilling to increase penetration rate and to determine pay intervals is effective.
2. Temperature logs in air and mist drilled holes used in conjunction with drilling data and gamma ray-acoustic logs are an effective method for selecting completion intervals.
3. Multistage water frac jobs are effective in the Sawyer (Canyon) Field.
4. The use of plunger lift installations to remove liquids from the wells is economical.
5. Central production facilities for gas wells are effective and economical.

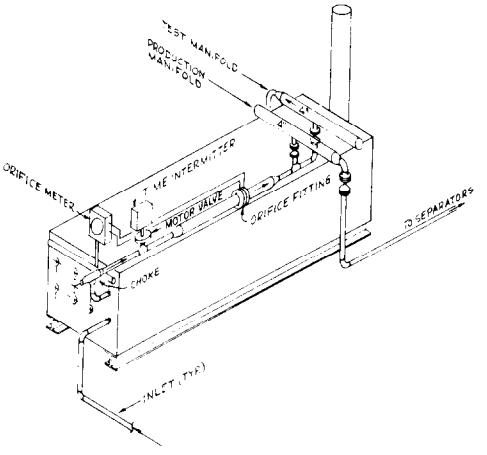

FIG. 7—MULTI-WELL INDIRECT FIRED HEATER

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