A Unitized, One-Well Hydraulic Pumping System

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INTRODUCTION

Diversified efforts are continually being made to reduce artificial lift operating costs and/or increase oil production. The intent of these efforts is to put more profit in producing operations and prolong the economic life of present oil properties. Also, a greater ultimate recovery means more efficient use of our natural resources.

Fluid Packed Pump has become a part of an artificial lift revolution with the development of the Unidraulic—a unitized, one-well hydraulic pumping system which can economically compete across the board with rod pumping equipment particularly in the larger sizes and in addition can offer several operating advantages. Let's face it, large volume lift is on the increase due to expanded secondary recovery operations, higher allowables and the desire to produce wells at their maximum capability rather than at a lesser volume due to inadequate lift equipment.

The Unidraulic concept was discussed briefly in a paper which was presented at the 1971 Southwestern Petroleum Short Course.[1] It began taking shape in April, 1969, following the approval of development money, engineering time, and a testing program. The first unit was actually installed on a 5100-ft well in South Texas on January 20, 1970. There are now in excess of 50 Unidraulic installations throughout the Mid-Continent, West Texas, California and Rocky Mountain areas.

The heart of the Unidraulic hydraulic pumping system is the power fluid conditioning unit which has been designed and assembled to provide a solid-free fluid which can be used to transmit horsepower hydraulically. Other required items of equipment are those normally associated with a central-battery installation—the surface wellhead control, the subsurface production unit and the associated accessory items.

ADVANTAGES

Discussions regarding the hydraulic pumping method of artificial lift always cite the advantage this lift system offers by the use of the free-type production unit since this eliminates the costs normally incurred with pulling other pumps for inspection or repair. Additional advantages offered by the Unidraulic hydraulic pumping system are: (1) increased production (2) elimination of power oil inventory (3) eliminates the cost of a power oil tank (4) does not require additional surface treating facilities (5) well tests more accurate and easier to make (6) lift additional wells without overloading central system (7) fire hazards considerably reduced with the use of power water and (8) eliminates long, high-pressure power fluid lines.

The concept of conditioning produced well fluid near the well to be used for power fluid for lifting a single well is a safe, flexible and economical method of producing an oil well. It merits full consideration when a well requires artificial lift.

OPERATION

During the last year, several changes have been made in the Unidraulic flow pattern as well as in the selection and the location of the control equipment. Figure 1 schematically represents the current design. Figure 2 shows an actual installation.

Produced well fluids and exhausted power fluid (oil, water and gas) enter the pressure-charging accumulator where most of the gas being produced is separated from the liquid and is discharged into the flow line through a back pressure valve. The liquids from the pressure-charging accumulator are directed to the inlet of the cyclone separator at an optimum pressure to give the appropriate pressure drop across the cyclone to effect adequate cleaning. The solids separated by the cyclone are discharged with controlled underflow into the flow line. The clean liquid is discharged out of the upper end of the cyclone into the reservoir separator-accumulator. Gravity separation of water, oil and gas takes place in this pressure vessel. Any additional free gas is discharged from this vessel into the flow line through a second back pressure valve. The water and/or oil in this tank, which is in excess of that required to furnish the suction of the power pump, is discharged into the flow line through a liquid level control valve. Selection of the proper tank outlet for this purpose assures the power pump receives the desired power fluid—that is, water or oil.

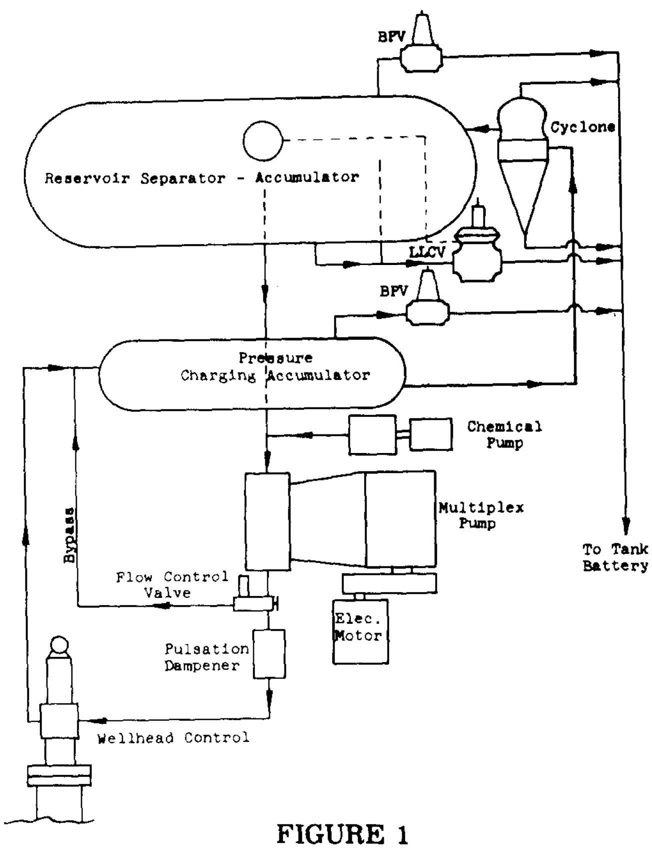

FIGURE 1
SYSTEM FLOW DIAGRAM

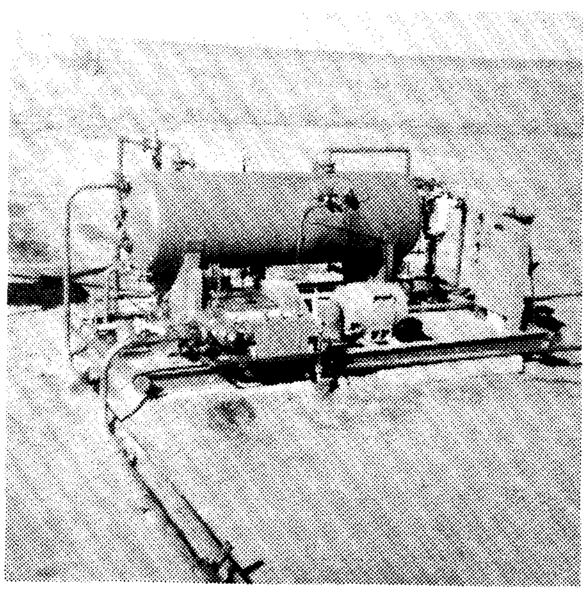

FIGURE 2
100 HP WEST TEXAS INSTALLATION

The output of the multiplex pump is directed down the well to operate the subsurface production unit. The speed of the production unit can be controlled by the speed of the multiplex pump if driven by a gas engine. If the multiplex pump is driven at a constant speed by an electric motor, then the production unit speed is controlled by bypassing excess power fluid back to the power fluid conditioning unit with an automatic flow control valve.

In summary, only actual production from the well (oil, water and gas) is discharged into the flow line for processing by lease treating facilities. It reaches the flow line by being discharged either through the back pressure valves on each of the pressure vessels, through the liquid level control valve on the separator-accumulator or through the cyclone underflow.

APPLICATION

The Unidraulic hydraulic pumping system can meet the artifical lift need of a variety of wells with varying producing volumes and depths of lift. Use the same criteria regarding the necessity to vent formation gas with the appropriate subsurface arrangement as previously used with central battery hydraulic installations.

Figure 3 has been prepared as a guide for the selection of a Unidraulic unit. Based on the desired producing rate and pump setting depth, this chart permits the selection of the size surface unit (horsepower) required as well as the size subsurface production unit necessary for the particular application.

The information shown on Fig. 3 indicates the wide range of flexibility possible with this lift concept for changing well conditions or reuse of the equipment. This data is based on 50 percent water-cut production, a wellhead operating pressure of 2500 psi and the installations made in 5-½-in. casing. The 150-HP range includes a variety of large subsurface hydraulic production units (2½-in, 3-in. and 4-in.) run in 7-in casing.

COMPARATIVE INSTALLATION COSTS

Installation costs as a function of API pumping unit size and the apparent savings possible with the use of the Unidraulic hydraulic pumping system are shown on Fig. 4. The installation costs for the beam pumping equipment were developed from some cost information which was included

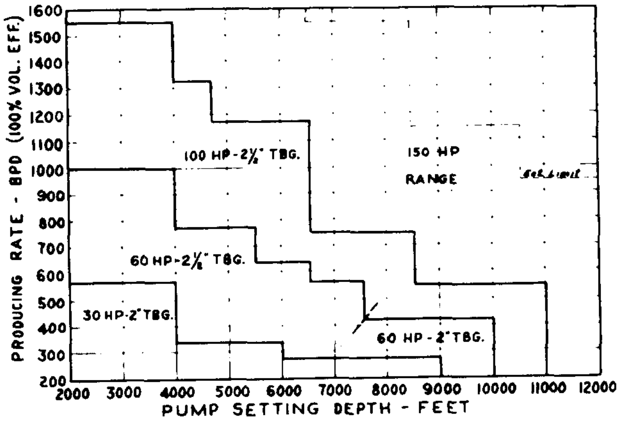

FIGURE 3
SELECTION CHART

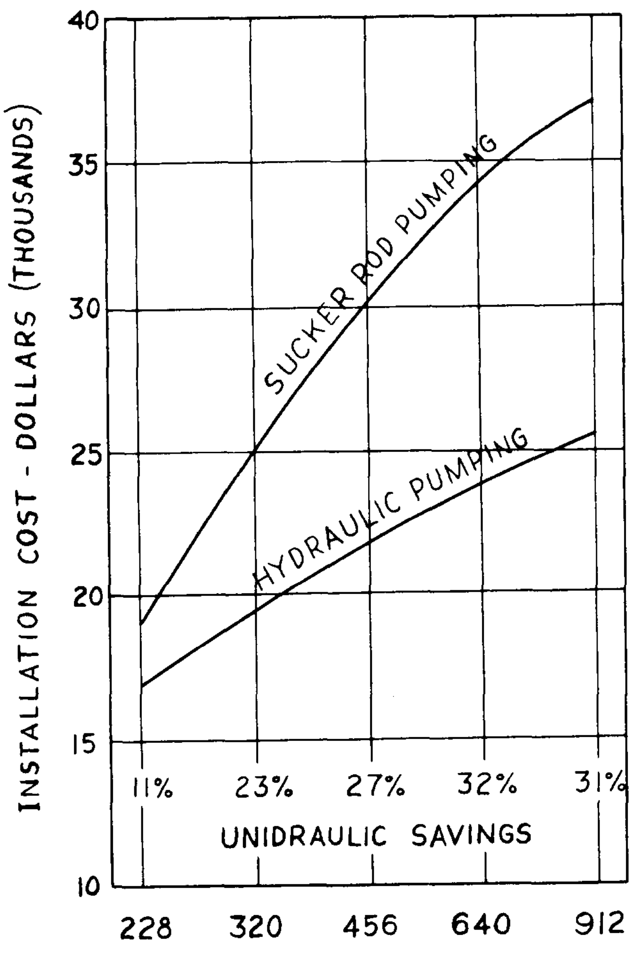

FIGURE 4
INSTALLATION COSTS

in a previous paper presented at the 1968 Southwestern Petroleum Short Course.[2]

These installation costs cover the necessary surface and subsurface equipment associated with the two types of artificial lift as well as the necessary size tubing string for the proposed installation. Hydraulic pumping costs reflect the installation of a casing-free installation which requires only a single tubing string. However, in some instances, it may be a size smaller than would be required for a beam pumping installation having the same displacement ability.

PERFORMANCE DATA

The unitized, one-well hydraulic pumping system has found application as a replacement lift installation for undersized or overloaded beam units and for gas lift installations which lack sufficient pressure or volume.

Tabulated below is comparative production data which has been reported on several of the present installations. Other installations have been made on wells which have had only a modest production increase but the displacement ability of the lift equipment has been doubled in anticipation of receiving a very excellent flood response.

Finite information is not available, but pump repairmen report that inspection of subsurface production units indicates the cyclone does as good and possibly even a better job in cleaning power fluid as is done with a standard power oil tank. The cyclone is more desirable since continuous underflow removes the insolubles from the system, making the cleaning procedure somewhat automatic.

Use of water as the power fluid necessitates the use of treating chemicals to provide lubricity and corrosion protection.

Well No.	Unidraulic		Beam Unit		Production Increase
	Size	Production	Size	Production	
1	60	720 BPD	114	180 BPD	540 BPD
2	60	760 BPD	114	210 BPD	550 BPD
3	100	680 BPD	456	410 BPD	270 BPD
4	150	1080 BPD	640	780 BPD	300 BPD
5	100	760 BPD	640	480 BPD	280 BPD
6	60	1050 BPD	228	600 BPD	450 BPD
7	30	280 BPD	228	160 BPD	120 BPD
8	100	520 BPD	320	240 BPD	280 BPD
9	100	500 BPD	640	300 BPD	200 BPD

REFERENCES

1. Palmour, Harold H.: Produced Water Power Fluid Conditioning Unit, Southwestern Petroleum Short Course, 1971.
2. Johnson, L. D.: Selection of Artificial Lift for a Permian Basin Waterflood Project, Southwestern Petroleum Short Course, 1968.