ROCKY MOUNTAIN OILFIELD TESTING CENTER

PROJECT TEST RESULTS

AJUST A PUMP BEAM PUMPING UNIT

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ROCKY MOUNTAIN OILFIELD TESTING CENTER

AJUST A PUMP TEST
Rosemond Manufacturing, Inc. (RMI)

Prepared for:

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ABSTRACT

The Rocky Mountain Oilfield Testing Center (RMOTC) conducted a test of a Model-2000 Ajust A Pump system at the Naval Petroleum Reserve No. 3 (NPR-3). Rosemond Manufacturing, Inc. (RMI) manufactures compact beam-pumping units that incorporate energy-efficient gear boxes. The equipment is designed to reduce operating costs and minimize maintenance labor. This report documents the equipment performance and the results of the Ajust A Pump test.

The purpose of the test was to demonstrate claims of energy efficiency and reduced labor requirements. The test showed that the Ajust A Pump system is a simple, rugged, reliable, operator-friendly pumping unit that has the capability of reducing both electrical-demand and reactive-power requirements.

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INTRODUCTION:

The operational and maintenance costs associated with beam-pumping units are a significant factor in the economics of producing oilfields. Electrical consumption and labor costs can be critical to the longevity of marginal operations.

An innovative, beam-pumping unit, manufactured by RMI, was tested at the Rocky Mountain Oilfield Testing Center to demonstrate claims of energy efficiency and reduced labor requirements. The Ajust A Pump Model-2000 system was tested from 9/22/95 through 2/6/96 under various operating configurations, and then a conventional, **Model-25 (API 25B53E30)** beam-pumping unit was tested on the well as a comparison until **3/21/96.** The test included the operation of the Ajust A Pump utilizing both a 1/2-hp DC motor (with and without a wind turbine) and a 1/2-hp AC motor and then compared the operation of the Model-25 pumping unit with a 2-hp AC motor.

The compact beam-pumping unit, which incorporated an energy-efficient gear box, was installed on Well 8 5-S10, and a three-phase, 480-VAC, kWhr meter was installed upstream of the equipment for a comparison of energy consumption. Initially, the unit's 1/2-hp DC motor was powered by a wind turbine through an electronic DC controller. The controller rectified and "blended" utility power to supplement the output of the turbine when wind power was insufficient to drive the unit. For the second phase, the wind turbine was disconnected from the system for an evaluation of the DC system under utility power (through the DC controller). Next, the DC system was removed, and the Ajust A Pump performance (utilizing a 1/2-hp AC motor and utility power) was monitored. During the final phase of the test, the Model-25 pumping unit (with a 2-hp AC motor and utility power) was reinstalled on the well and evaluated.

The Ajust A Pump test was conducted to demonstrate system reliability, electrical demand, production capability, equipment adjustment, and wind-generator capability. The Ajust A Pump Model-2000 is designed for wells up to 2,500'deep and was oversized for the test well which has the seating nipple set at 463'. A smaller unit, the Model 1000, would have been more appropriate for testing, but none was available for the demonstration. The compromise may have adversely affected the results of the electrical-demand and production-capability tests.

The wind generator (turbine) was a Southwest Windpower, Model-503 Windseeker. The three-bladed turbine incorporates an effective, wind-force governor that is designed to prevent the generator from being overpowered by high winds, while retaining optimum power.

PROCEDURE:

1. System Reliability

During the field test, the Ajust A Pump system was subjected to Wyoming's high winds and bitter cold. Operators monitored system operations daily to verify system reliability.

2. Electrical Demand

Various tests were conducted to evaluate the electrical demand of the Model-25 and Ajust A Pump units. Test results for demand reflect average values over different time frames with fluctuating wind and production conditions and therefore can not be used to quantify precise performance of equipment.

A single-phase, 120-VAC, kWhr meter was installed downstream of the site's 480-240/120VAC transformer, and it provided data that does not reflect the transformer's electrical losses for Tests 1 and 2. The tests were originally designed to verify that the wind-generated power offsets utility power as a function of wind speed, but appropriate instrumentation and metering could not be obtained to specifically identify the wind turbine's contribution.

A three-phase, 480-VAC, kWhr meter was installed upstream of all system electrical components to measure the total site load. Comparisons of electrical load, utilizing the 480VAC meter's data, were conducted for the following: Wind generator's performance: Tests 3 and 4. Ajust A Pump's operation using 1/2-hp AC and DC motors: Tests 4 and 5. Ajust A Pump's DC configuration and the Model-25 unit: Tests 4 and 6. Ajust A Pump's AC configuration and the Model-25 unit: Tests 5 and 6. Model-25 unit for 50% and 100% time-clock settings: Tests 6 and 7.

3. Production Capability

Production evaluations were made by comparing actual Ajust A Pump test data for total fluid production (oil + water) to data for follow-up tests, when the Model-25 unit was in operation.

4. Equipment Adjustment

Beam-pumping unit operations can be varied through equipment adjustments to stroke length, strokes per minute (SPM), and counter weight. Adjustments of each were specifically performed to evaluate the maintenance operations.

5. Wind-Generator Capability

The project was initially designed to identify wind-power contributions, but appropriate instrumentation and metering could not be obtained to correlate generator output to wind speed. The kWhr meters were used to verify the generator's output.

TESTING DETAILS:

1. System Reliability

With the exception of minor "bugs" that were worked out, the mechanical and electrical components were very reliable. The Ajust A Pump Model-2000 system is a rugged unit that the operators found easy to work on, because of its simple, compact design (weight = 575 lbs). Balance problems were encountered with a prototype DC-motor flywheel which incorporated cooling fins, but the fin design has since been modified to eliminate the vibrations. An internal loose connection was identified during installation of the wind turbine, but after the alternator was replaced, no other problems materialized throughout the test.

2. Electrical Demand

The Model-2000 Ajust A Pump was tested utilizing both a 1/2-hp DC motor (with and without a wind turbine) and a 1/2-hp AC motor. Following the Ajust A Pump portion of the test, a Model-25 pumping unit with a 2-hp AC motor was tested. The 2-hp motor (3-phase, 480-V, Design-B) was properly sized for the well according to a University of Wyoming motor study. Average demands for the various tests are tabulated in Table 1. A summary of the test comparisons follows:

Test 1:2 compared the performance of the Ajust A Pump (1/2-hp DC motor) with and without the wind turbine, using the 1 20-VAC meter which did not include transformer losses. Operation without the wind turbine resulted in:

20% higher kW
15% higher kVAR 78% higher kVA
32% lower power factor

Test 3:4 compared the performance of the Ajust A Pump (1 /2-hp DC motor) with and without the wind turbine. Operation without the wind turbine resulted in slightly-higher demand:

4% higher kW
3% higher kVAR 3% higher kVA
1 % higher power factor

Test 4:5 compared the performance of the Ajust A Pump with a 1/2-hp DC motor versus a 1/2-hp AC motor. Operation with the 1/2-hp AC motor resulted in higher electrical demand and power factor:

90% higher kW
43% higher kVAR 49% higher kVA
28% higher power factor

Test 4:6 compared the performance of the Ajust A Pump with a 1/2-hp DC motor versus the Model-25 with a 2-hp AC motor. Operation with the Model-25 resulted in significantly-higher demand and significantly-lower power factor:

94% higher kW
296% higher kVAR 278% higher kVA
49% lower power factor

Test 5:6 compared the performance of the Ajust A Pump with a 1/2-hp AC motor versus the Model-25 with a 2-hp AC motor. Operation with the Model-25 unit resulted in significantlyhigher reactive power and significantly-lower power factor:

2% higher kW
177% higher kVAR 154% higher kVA
60% lower power factor

Test 6:7 compared the performance of the Model-25 (2-hp AC motor) at 100% time clock Versus 50% time clock. Operation at the 50% time clock resulted in anticipated lower demand. In-rush current from increased motor start-ups did not appreciably increase demand.

42% lower kW
48% lower kVAR 48% lower kVA
11% higher power factor

Electrical demand is related to the specific operating parameters of each test, such as motor load, wind speed, or equipment adjustment. Variation of any parameter could impact the results, e.g., increasing the strokes per minute would have also resulted in increased electrical demand.

3. Production Capability

The average pumping efficiency of the Ajust A Pump system was 28% higher than the conventional-unit's efficiency; although, production was lower during the Ajust A Pump portion of the test. The range of tested strokes per minute was 6 to 19, while the manufacturer's recommended setting for a well of this depth is 18 SPM with the AC motor and 9 SPM with the DC motor. Maximizing production may require optimization of pumpingunit parameters. Test-production data is tabulated in Table 2.

4. Equipment Adjustment

The Ajust A Pump's stroke length was initially adjusted from 8-1/2" to 10-1/4" by a threeman crew in twelve minutes and was readjusted back to 8-1/2" in six minutes. The third man was utilized only as a safety measure to prevent equipment rotation. The ease of adjusting stroke length is apparent, and it increases as familiarity with the compact equipment improves. Stroke length adjustment on a Model-25 is typically accomplished by two men in one hour by changing the position of the pitman arm on the crank.

Variation of strokes per minute can be immediately achieved with the Ajust A Pump's DC system by an operator's adjustment of the potentiometer on the Focus-1 DC controller. The AC motors on conventional units require sheave changes to vary strokes per minute. One man can change out the sheave on a Model-25 in approximately one hour.

Balancing of rod string load is accomplished with counterweights. Adjustment of the Ajust A Pump counterweights required one man about one minute to accomplish. An end wrench was used to loosen two bolts which held the 60-pound weight in place, and the weight was easily moved along the horizontal beam to its new position. Adjustment of counter weights on a Model-25 can typically be made by one man in one-half hour.

5. Wind-Generator Capability

The kWhr meters indicated that the wind turbine successfully reduced electrical-utility power. However, wind speed could not be correlated to generator output, because appropriate instrumentation and metering could not be obtained to specifically identify the wind turbine's contribution.

CONCLUSIONS:

The test demonstrated that:

- The Ajust A Pump system is a simple, rugged, reliable, operator-friendly pumping unit.

- The 1/2-hp Ajust A Pump systems utilized 1/4 the horsepower of the conventional beam-pumping unit, for this particular test. The electrical load of the Ajust A Pump DC system averaged .2520 kW; whereas, the conventional beam-pumping system averaged .4887 kW. The Model-25's electrical-power requirement was 94% higher than the Ajust A Pump's DC system.

- The Model-25 system resulted in significantly-higher reactive power and significantly-lower power factor than either the AC or DC Ajust A Pump system that was tested.

- Maximizing production may require optimization of pumping-unit parameters.

- Potential benefits of the Ajust A Pump system include:

- Adjustment of the compact system requires minimal labor.

- The system could provide economic benefits over conventional beam-pumping units through reduced electrical consumption and operator labor.

- The wind-powered system could provide a viable option for remote locations that are not tied to electric-utility grids, if wind conditions were favorable.

ACKNOWLEDGEMENTS:

This report was prepared by the Rocky Mountain Oilfield Testing Center (RMOTC) based on field testing conducted at the Naval Petroleum Reserve No. 3 (NPR-3), located 35 miles north of Casper in Natrona County, Wyoming, in cooperation with the U.S. Department of Energy (DOE). Testing was funded jointly by Rosemond Manufacturing, Inc. (RMI) of Spring, Texas, the State of Wyoming, and RMOTC.

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RMOTC's goal is to partner with the oil and gas industry to improve productivity, by field testing new petroleum technology, evaluating new equipment and techniques, disseminating information to industry, and conducting training. For more information, contact the Rocky Mountain Oilfield Testing Center, 907 North Poplar, Suite 100, Casper, Wyoming 82601; phone (307) 261-5000, ext. 5170.

For information about the Ajust A Pump, contact Chuck Rosemond of Rosemond Manufacturing, Inc., P.O. Box 2196, Spring, Texas 77383-2196; phone (800) 353-7540 /fax (713) 939-8973.

ELECTRICAL DEMAND

	AJUST A PUMP UNIT	MODEL 25 UNIT	1/2-HP DC MOTOR	1/2-HP AC MOTOR	1 HP AC MOTOR	WIND TURBINE	TC = 100%	TC = 80%	120V METER	480V METER	DATA DAYS	TEST DAYS	START DATE	END DATE	AVERAGE kW	AVERAGE kVAR	AVERAGE kVA	POWER FACTOR
TEST 1	*		*			*	*		*		[illegible]	60	9/22/96	11/20/96	0.1596	0.5650	0.5877	0.27
TEST 2	*		*				*		*		27	29	11/22/96	12/20/96	0.1922	0.6475	1.0432	0.18
TEST 3	*		*			*	*			*	33	27	10/25/96	11/20/96	0.2416	0.6726	0.7149	0.34
TEST 4	*		*				*			*	30	47	11/22/96	1/7/96	0.2520	0.6918	0.7365	0.34
TEST 5	*			*			*			*	26	28	1/10/96	2/6/96	0.4786	0.9866	1.0970	0.44
TEST 6		*			*		*			*	9	9	2/13/96	2/21/96	0.4887	2.7375	2.7811	0.18
TEST 7		*			*			*		*	27	27	2/23/96	3/20/96	0.2831	1.4235	1.4519	0.20
* = YES																		
x = NO															PERCENT DIFFERENCE (base : 2nd)			
TEST 1 : 2	* : *		* : *			* : x	* : *		* : *						20.28%	14.59%	77.51%	-32.24%
TEST 3 : 4	* : *		* : *			* : x	* : *			* : *					4.30%	2.85%	3.02%	1.25%
TEST 4 : 5	* : *		* : x	x : *			* : *			* : *					89.92%	42.61%	48.95%	27.52%
TEST 4 : 6	* : x	x : *	* : x		x : *		* : *			* : *					93.93%	295.71%	277.61%	-48.65%
TEST 5 : 6	* : x	x : *		* : x	x : *		* : *			* : *					2.11%	177.47%	153.52%	-59.73%
TEST 6 : 7		* : *			* : *		* : x	x : *		* : *					-42.07%	-48.00%	-47.79%	10.99%

TABLE 1

TEST PRODUCTION

Well 85-S-10	Test Date	Oil Actual (bpd)	Water Actual (bpd)	Fluid Total (bpd)	Strokes /Minute	Stroke Length (inches)	Time Clock (%)	Pumping Capacity (bpd)	Pumping Efficiency (%)
Ajust A Pump	7/29/95	5.4	0.8	6.2	13.5	5.5	100.0	19.5	31.9
	7/30/95	2.7	0.0	2.7	13.0	5.5	100.0	18.7	14.4
	7/31/95	8.5	0.0	8.5	13.0	5.5	100.0	18.7	45.4
	8/8/95	5.2	2.6	7.8	13.0	5.5	100.0	18.7	41.6
	8/22/95	4.8	1.1	5.9	13.0	5.5	100.0	18.7	31.5
	8/23/95	6.2	0.3	6.5	13.5	5.5	100.0	19.5	33.4
	9/1/95	1.1	1.2	2.3	13.0	5.5	100.0	18.7	12.3
	9/2/95	6.0	0.0	6.0	13.0	5.5	100.0	18.7	32.0
	9/8/95	2.4	1.6	4.0	13.0	5.5	100.0	18.7	21.4
	10/2/95	2.0	2.1	4.1	8.3	5.5	100.0	11.9	34.5
	10/14/95	5.4	1.1	6.5	6.0	5.5	100.0	8.6	75.2
	10/24/95	8.0	0.0	8.0	7.5	5.5	100.0	10.8	74.0
	11/6/95	2.9	1.4	4.3	7.8	5.5	100.0	11.2	38.5
	11/27/95	1.0	1.1	2.1	7.8	5.5	100.0	11.2	18.8
	1/23/96	2.1	1.4	3.5	18.8	5.5	100.0	27.0	13.0
	1/31/96	2.1	0.4	2.5	18.8	5.5	100.0	27.0	9.3
Ajust A Pump	2/6/96	5.1	0.9	6.0	18.8	5.5	100.0	27.0	22.2
Follow-up Test	2/14/96	11.5	0.4	11.9	7.0	30.0	100.0	55.0	21.6
	3/6/96	7.4	0.0	7.4	7.0	30.0	50.0	27.5	26.9
	3/22/96	6.5	0.0	6.5	7.0	30.0	50.0	27.5	23.6
	3/23/96	7.9	0.0	7.9	7.0	30.0	50.0	27.5	28.7
	3/26/96	7.8	1.2	9.0	7.0	30.0	50.0	27.5	32.7
	4/8/96	7.7	0.7	8.4	7.0	30.0	50.0	27.5	30.5
	5/7/96	6.6	0.0	6.6	7.0	30.0	50.0	27.5	24.0
	6/6/96	6.5	1.0	7.5	7.0	30.0	50.0	27.5	27.3
	7/5/96	4.2	0.3	4.5	7.0	30.0	50.0	27.5	16.4
	7/16/96	6.6	0.6	7.2	7.0	30.0	50.0	27.5	26.2
	8/9/96	5.3	1.9	7.2	7.0	30.0	50.0	27.5	26.2
	9/13/96	5.6	1.0	6.6	7.0	30.0	50.0	27.5	24.0
	10/10/96	6.2	0.0	6.2	7.0	30.0	50.0	27.5	22.5
Follow-up Test	11/6/96	5.0	1.1	6.1	7.0	30.0	50.0	27.5	22.2
Average Test Values	Start Date	Stop Date	Test Days	Fluid (bpd)				Capacity (bpd)	Efficiency (%)
Ajust A Pump Total Fluid	7/29/95	2/6/96	193	5.1				17.9	32.3
Follow-up Test Total Fluid	2/14/96	11/6/96	267	7.4				29.5	25.2

TABLE 2