SUCKER ROD PUMP FOR SAND AND GAS PROBLEMS

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ABSTRACT

This Sucker Rod Pump has a short primary plunger with a long barrel and hollow tube that slides inside a short barrel; the availability of a superior travelling valve turns the equipment into a double stage pump. A pressure compensating bushing connects the primary plunger and hollow tube. From the bushing connection to the end of the long barrel an annular space exists where the gas is compressed on the upstroke and the sand and gas is forced to move instead of settling. During the evaluation of this technology 15 equipments were installed in wells from 8-11 °API in Petróleos de Venezuela, in the Eastern Division. A considerable diminution of : GOR, interference by gas and the effect gas lock, were observed. Production increase on an average of 30% per well after the installation of this type pump.

BACKGROUND

Developed in 1998 and initially evaluated at Boscan field, Zulia State, Venezuela. On this evaluation the equipment was operated on wells with high levels of sand and operating times ranging from 142 to 910 days.

PURPOSE

- Reduce the problem of gas interference and gas blocking on the subsurface pump.
- Avoid the fine sand settling, giving it additional movement inside the pump barrel in order to handle it to the surface.

PUMP OPERATION

It's reciprocating equipment of inserted type with positive displacement and two stages, uses thin or thick barrel walls, piston and rod valve (hollow), lower or upper friction ring anchor. The plunger is short and is called primary piston. It displaces inside a standard primary barrel and an extensively long hollow rod valve, which receives the name of secondary piston that slides through a short secondary barrel. Both pistons are joined together by a pressure compensatory coupling bushing. See figure 1.

The presence of a hollow rod valve does not let its lower and superior tops go in contact with the short secondary barrel. Disallowing fluid discharge over the superior top of the primary piston as it happens on the API pumps, that shall allow the fines and sand sediments from the low compression inferior chamber into the production pipe. It has two travel valves, located on the lower and upper tops of the primary piston and the hollow rod valve respectively; this converts this pump into a two stage unit, differing from the conventional spool ring valve. "Normally subsurface pumps of single stage, they have a standing valve in the barrel and one or more travelling valves in the plunger; instead, two stage subsurface pumps, have an spool ring valve in addition to the ones mentioned before. The spool ring valve is located in the top of the barrel, and its function is to separate the fluid column that is located over the pump from the fluid located inside it" [1]

The annulus space (formed between the hollow rod valve and the primary barrel) lets transfer the gas presents in crude with high GOR, because it works as a high compression chamber. In its first run or up stroke, the oil the gas or the foamy crude from the well enters into the low-pressure long chamber formed underneath the lower travelling valve, due to the vacuum generated. This forces the standing valve to open and allow the fluid to pass through the inside of the pump. During the down stroke, the oil, water and gas are compressed and transferred into the primary barrel, through the lower travelling valve. Due to gas expansive capacity, part of the gassy foam is transferred into the high-pressure chamber and the rest of the fluid is transferred to the hollow rod valve. In the following stroke the oil with gas or the foamy crude again will gain access in the low-pressure long chamber that forms underneath the lower travel valve. At the same time, the gas contained in the high-pressure valve is compressed and forced onto the inside of the secondary piston through a pressure compensation bushing. As pressure rises in the interior of the secondary piston and builds pressure inside over the one found in the tubing, the upper travelling valve quickly opens and equalises pressures and transfers the fluids to the tubing string. This design was developed by IOSA, a Venezuelan manufacturer of sucker rod pumps

JUSTIFICATION FOR USAGE OF THE EQUIPMENT

A high average of the wells completed with mechanical pumping in the Bare and Melones Fields, Eastern Division – PDVSA, show blocking problems due to gas at the subsurface pump level, because the reservoir are saturated; for this reason, different mechanisms have been evaluated (equipment's) to minimise this problem. Among these equipment the Mechanical Pump to handle Sand and Gas was evaluated. The properties of crude can be observed in the Table 1.

RESULTS OF EQUIPMENT EVALUATION IN BARE AND MELONES FIELDS

With the installation of 16 equipment in the fields mentioned before, production increased in average of 30%. Additionally, a diminution of the average GOR from 834 to 664 SCF/STB was registered. During the evaluation process dynagraph charts were kept before and after the installation of the equipment, observing in most cases an increase in the pump fullness percentage. "The main objective of taking dynagraph charts is to know the real load in any point of the pumping cycle, with the objective of determining the operational conditions of the well" [2].

The installation was completed on the following wells: MEL-072, MEL-092, MG-619, MM-584, MEL-143, MFB-171 from Melones field and MFB-359, MFA-073, MFB-233, MFB-272, MFB-341, MFB-348, MFB-314, MFB-138, MFB-537, MFB-469 from Bare field. See Tables: 2, 3

In summary the following aspects of the evaluation in each well, can be mentioned:

- **MEL-072**, Production increment of 20 BOPD and improvements of 15% in filling of the dynagraphics, effective duration of 650 days.
- **MEL-092** maintained well production, which showed excess friction between the piston and the barrel as shown in the dynagraphic charts.
- **MG-619**, increase in production of 86 BOPD, effective duration of593 days (still active).
- **MM-584**, active, showing an up time of 392 days.
- **MEL-143**, Gas blocking effect which was frequently present diminishing the differed production of the well was eliminated. Well is active with a duration of 333 days.
- **MFB-171**, Gas blocking effect which was frequently present diminishing the differed production of the well was eliminated. Well is active with a duration of 280 days.
- **MFB-359**, maintains production without any noticeable changes.
- **MFA-073**, increase in production of 88 BOPD, excellent service life of 472 days.
- **MFB-233**, increase production of 94 BOPD, excellent service life of 602 days (still active).
- **MFB-272**, increase production of 105 BOPD, production history of sands and gravel pack failure, service life of 264 days.
- **MFB-341**, increase in production of 88 BOPD, production history of sands and gravel pack failure, excellent service life of 674 days (still active).
- **MFB-348**, increase in production of 53 BOPD and improvement of 10% in the filling of the pump, excellent service life of 681 days (still active).
- **MFB-314**, premature failure with service life of 90 days.
- **MFB-138**, maintains production, during evaluation period. Service life of 173 days (still active).
- **MFB-537**, maintains production, during evaluation period. Service life of 170 days (still active).
- **MFB-469**, operational failure during rig service for pipe replacement with a duration of 98 days.

CONCLUSIONS

- With the installation of these pumps a production increase of 30% average per well was obtained, in wells with a history of gas and sand problems.
- With the installation of this pump model the run life was increased in a 22% average per well.
- The equipment is an excellent alternative for well with interference or gas blocking problems.
- The pump helped to handled sand in wells with a known history of this problem.

RECOMMENDATIONS

- Use the pump in wells with interference and or gas blocking problems.
- Install the equipment in wells with sand history.
- Install this type of pump in projects with steam injection to handle gas and possible sand produced.

REFERENCES

1. A. Vadasz, "Subsurface pumping in Venezuela – Advanced State ", INTEVEP, Los Teques, (1981).
2. J. H. Russell, JR, "Interpretation of Dynamometer Cards" Houston, (1953).

Table 1
Properties of Crude

° API	SURFACE TEMPERATURE (°F)	FORMATION TEMPERATURE (°F)	SURFACE VISCOSITY (CPS)	FORMATION VISCOSITY (CPS)
8 - 11	90 - 100	145 - 160	5000	700

Table 2
Status and Run Life of installed equipment

WELL	INST. DATE	FAIL. DATE	RUN LIFE BEFORE	RUN LIFE
MEL-072	15/10/2003	16/07/2005	489	650
MEL-092	03/08/2004	24/01/2005	327	174
MG-619	14/02/2004	ACTIVE	203	706
MM-584	21/12/2004	ACTIVE	123	392
MEL-143	21/02/2005	ACTIVE	182	333
MFB-171	15/04/2005	ACTIVE	305	280
MFB-359	16/08/2005	ACTIVE	81	157
MFA-073	24/09/2003	08/01/2005	72	472
MFB-233	28/05/2004	ACTIVE	390	602
MFB-272	04/08/2004	25/04/2005	129	264
MFB-341	17/03/2004	ACTIVE	806	674
MFB-348	10/03/2004	ACTIVE	718	681
MFB-314	07/03/2004	05/06/2004	9	90
MFB-138	31/07/2005	ACTIVE	646	173
MFB-537	03/08/2005	ACTIVE	610	170
MFB-469	14/04/2005	21/07/2005	351	98

Table 3
Production behavior and GOR

	BEFORE		AFTER	
WELL	BOPD	GOR	BOPD	GOR
MEL-072	88	375	108	370
MEL-092	194	206	196	219
MG-619	45	1467	131	168
MM-584	74	324	84	131
MEL-143	156	359	152	349
MFB-171	45	1333	37	1662
MFB-359	100	410	100	410
MFA-073	39	1795	127	551
MFB-233	150	898	244	898
MFB-272	160	264	265	264
MFB-341	150	273	238	273
MFB-348	191	853	244	542
MFB-314	164	915	164	915
MFB-138	65	1246	65	1246
MFB-537	25	1560	25	1560
MFB-469	100	1070	100	1070

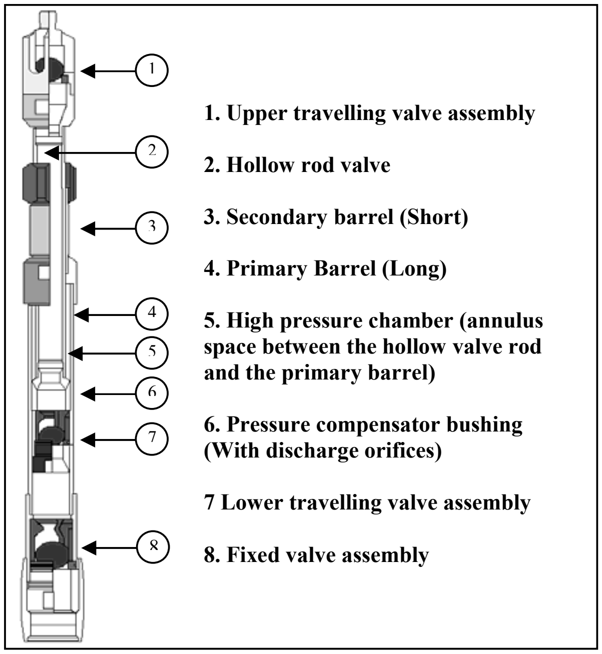

Figure1. Mechanical diagram of the equipment.

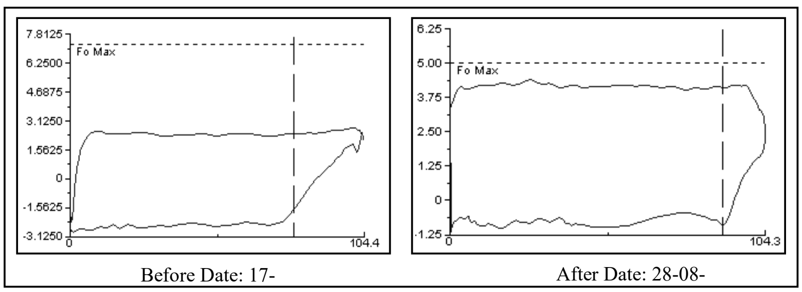

Figure 1. Dynagraphic charts before and after on well MEL-72

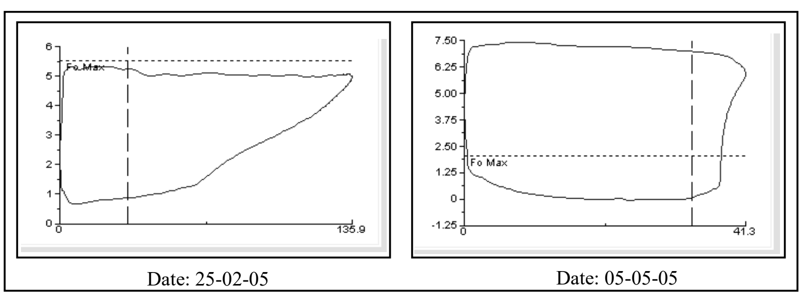

Figure 2. Dynagraphic charts before and after on well MFA-073