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Operations II

The Use of DP Assisted FPSOs for Offshore Well Testing Services

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THE USE OF DP-ASSISTED FPSOS FOR OFFSHORE WELL TESTING SERVICES

Presented by

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Summary

In April 2004 [1] it was reported that PEMEX Exploración y Producción (PEP), by means of two four-year long contracts, had incorporated two (2) FPSOs with Dynamic Positioning capabilities into their operations in the Bay of Campeche. These vessels were conceived to attend services during the well completion, repair, and stimulation, as well as well production characterization, mainly to collect and process all the fluids emanating from these services. At the time [1] the results reported were limited; the first of the vessels had been in operations for less than two months, and the second vessel was in the commissioning stages. A preliminary report of these vessels was also published in [2]

The vessels have now been in continuous operations for over one year, results have exceeded the original expectations set by PEP, and a continuous service is expected, mainly due to the DP capabilities installed on the vessels.

The following document describes briefly the concept of these DP assisted Well Testing Services Vessels (WTSV), background, capabilities and results obtained to date.

1.0 Background

PEP is the only entity that can explore and exploit hydrocarbons in Mexico, therefore all the exploration and production facilities are either owned or operated for/through PEP. This creates a unique market for specialized vessels which are designed around their particular needs.

Such is the case of the WTSVs; as early as 1994 PEP had considered the use of a well testing unit, mounted on a DP vessel that could provide services to multiple locations. The first contract was awarded in 1997, for which a 10,000 BPD production unit was installed on the DP vessel “Cora”. This 1972 built/1997 converted vessel served during 7 years, and attended more than 800 locations. The vessel was decommissioned in 2004.

The main limitation of the “Cora” was the lack of systems for the reception and processing of fluids from well completion, stimulation and repair; so a second generation vessel was proposed and awarded via an public international tender; the contract was awarded to Marecsa in January 2003, the vessel *Toisa Pisces* was converted over a period of 12 months, and began operations in early March 2004. The third vessel was also awarded in November 2003 to Marecsa via a public-international tender, and the vessel *Bourbon Opale* began operations in July, 2004. Both contracts will continue until mid-2008.

It is important to note that not until these vessels were commissioned, PEP provided well testing by means of its own test separators installed onboard the production/exploration platforms, or by means of portable systems, which are mobilized by supply vessels. The problem of the last option is that it becomes inefficient, as the time and cost to mobilize test packages can be long and high. The second disadvantage is: What to do with the emanating fluids?

The advantage of a WTSV is that, with the DP system installed on the vessel, the test package does not have to be assembled/disassembled continuously, there is no need for supply vessels, weather delays, etc., and the fluids can be processed and/or stored onboard; including remote and unmanned production platforms. In the case of exploration, the possibility of testing a well, with fluids reception and process capabilities becomes even more attractive. Considering that PEMEX has hundreds of producing wells, and their new field development is one of the expanding production areas in the world, the alternative for the traditional approach using portable equipment transported via PSVs became very inefficient due to

limited number of services that can be provided with each test package, normally 2 to 3 locations per month.

2.0 Concept of a WTSV

The WTSV is a vessel designed to receive, control and process the products emanating from services to marine wells during:

- Well termination
- Well stimulation
- Well repair (work-over)
- Well measurement.

It has the capability of processing, storing or offloading the products and disposing them in an ecological (clean) manner, therefore the vessel is also defined as a Floating Production, Storage and Offloading vessel (FPSO). It must be capable of supporting early production for relatively long periods of time, as long as there is an offloading pipeline or satellite barge to offload the product and the weather is such that allows continuous operations. It will also be capable of providing assistance to the production whenever the client requires maintenance or repair of their facilities.

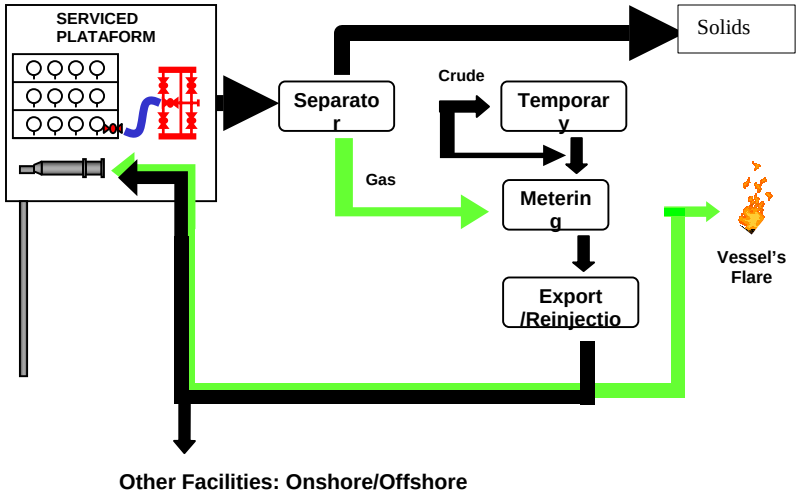
The WTSV's capabilities include:

- Reception of the products from the well via flexible hoses connecting the well to the production system installed on the ship.
- Process and separate water, wasted and un-wasted chemicals, gas, crude oil and solids. The water will be stored in the WTSV's tanks and later re-injected into industrial waste well or offloaded to a processing facility onshore.
- The crude and gas will be measured in quantity and quality. The combination may be returned to the export line, or if this last is not available, the gas will be flared and the crude stored in the WTSV's tanks to later be exported to an onshore or an offshore offloading terminal.
- The solids are stored in containers to be disposed to shore.
- The vessel has dynamic positioning capabilities to provide autonomy in motions and the possibility of attending multiple locations as per the client's well testing program or service requirements.
- It will have all the auxiliary services for its operation and for the crew.
- Crude ranges are from low to high (12 to 43^{O}) API. Pressures up to 10,000 psi at the well head.

The main objectives of these vessels are:

a) Avoid air and sea pollution during well services, in particular during well completion, repair and stimulation
b) Recover a commercially valuable product that would normally be flared
c) Quantify and qualify well production and trends.

The (simplified) process is described in figure No. 1 below.



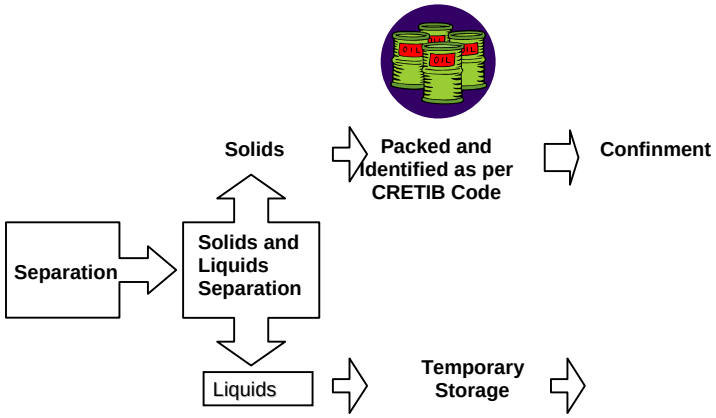


Figure No 1

3.0 Main Requirements for the WTSVs

To define the characteristics that could serve all the expected products, and at the same time be flexible and to not impose unrealistic characteristics, a work group was established, which during 2001-2002 worked on the collection of data and locations to be serviced, and to produce the specifications of the vessel to be tendered.

The specifications considered:

a) The vessel should be classed by a Classification Society member of the IACS.
b) The WTSV should consider an FPSO "Floating, Production, Storage and Offloading" notation
c) Dynamic Positioning DP-2 or equivalent as a minimum should be obtained
d) Automation for the following systems (minimum) should be incorporated
   - Engine Room
   - Process Control (PCS)
   - Fire and Gas (F&G)
   - Emergency Shutdown (ESD)
e) Product ranges: 14^{O} to 43^{O} API
f) Pressures well head 10,000psi

g) Process pressure 1,412 psi
h) Maximum % water content 2%
i) Salinity: 50 lbs/mbls
j) Crude Export: 12,000 bbls/day at 580 psi (maximum)
k) Water re-injection: 6,000 bbls/day at 3,000 psi (maximum)

Each of the vessels was specified with the same basic technical characteristics and capabilities, but slightly different in size as follows.

4.0 FPSO-DP2 *Toisa Pisces*

The *Toisa Pisces* was converted form an existing Cable Laying vessel, based on UT-736 design with DP Class 2. The conversion time, including engineering, vessel modification and production system design and fabrication was 12 months; the vessel's main particulars are:

- Process capacity 15,000 BPD Nominal. 20,000 BPD Maximum
- Gas separation and processing 31.83 MMSCFD
- Oily water processing 4,800 BPD
- Chemical products 2,500 BPD
- Crude storage: 24,000 bbls
- Oily water storage: 6,000 bbls
- Capacity for storage and disposal of solids as per CRETIB Code
- Crude density range: 14 to 43^{O} API
- NACE compliance (H2S)
- Maximum temperature: 130^{O} C
- LOA 103.5 m
- Breadth 23.2 m
- Depth 9.1 m
- Living Quarters: 70
- Year Built/Converted 1997/2004
- Helideck Bell-412
- Class: DNV 1A1 Ship Shaped Oil Production and Storage. Offloading PROD E0 Dynpos-AUTR HELDK

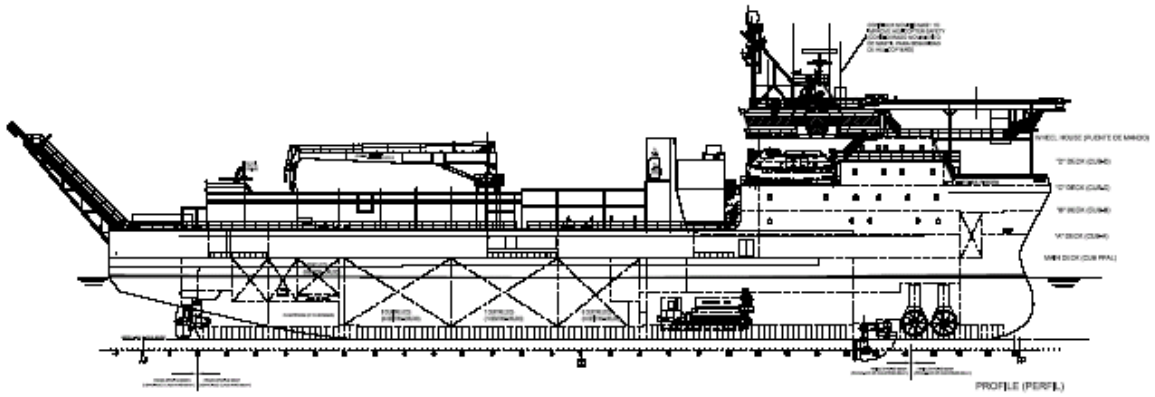


Figure 2. FPSO – DP2 *Toisa Pisces*

5.0 FPSO-DP2 *Bourbon Opale*

The *Bourbon Opale* is based on a UT-745E design, also with DP Class 2. The conversion time, including engineering, vessel modification and production system design and fabrication was 9 months; the main characteristics are:

- Process capacity 10,000 BPD Nominal. 15,000 BPD Maximum
- Gas separation and processing 24.0 MMSCFD
- Oily water processing 2,800 BPD
- Chemical products 1,800 BPD
- Crude storage: 10,500 bbls
- Oily water storage: 3,000 bbls
- Capacity for storage and disposal of solids as per CRETIB Code
- Crude density range: 14 to 43^{O} API
- NACE compliance (H2S)
- Maximum temperature: 130^{O} C
- LOA 90.7 m
- Breadth 18.8 m
- Depth 7.6 m
- Living Quarters: 50
- Year Built 2004
- Class: DNV 1A1 Ship Shaped Oil Production and Storage. Offloading PROD E0 Dynpos-AUTR

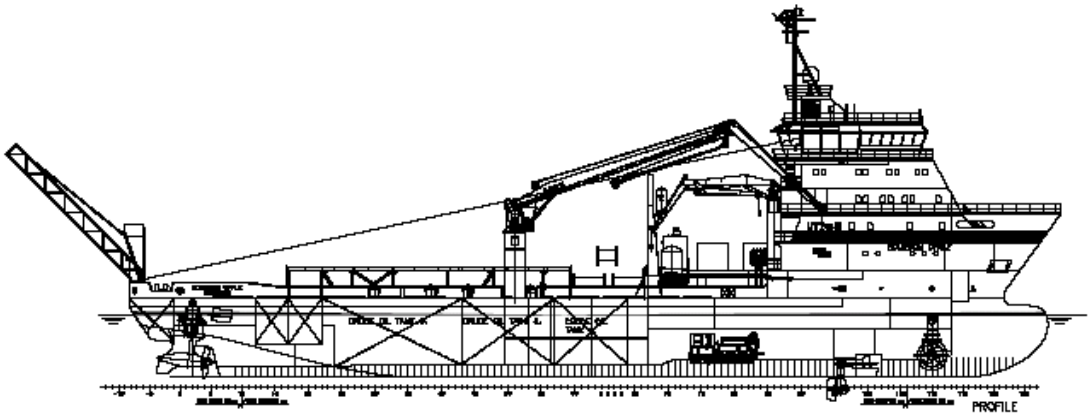


Figure 3. FPSO – DP2 *Bourbon Opale*

The main difference between a typical FPSO and these two vessels are:

- The size of the *Bourbon Opale* and the *Toisa Pisces* are significantly smaller than a normal production FPSO, although objectives are not the same. The first two are intended for a non-continuous production at multiple locations, whereas the typical FPSO is intended for a continuous production at a particular location.
- The product range for the *Bourbon Opale* and the *Toisa Pisces* is very wide. The vessels can process fluids and hydrocarbons with API as low as 14^{O} up to 43^{O}. Reality has proven that both

vessels have been able to process as low as 6^{O} to 7^{O} API. Normally a typical FPSO is intended for a narrow product range for a particular location.

- But probably the biggest difference is the Dynamic Positioning capabilities that the *Toisa Pisces* and the *Bourbon Opale* have. This characteristic provides the flexibility of multiple location/short term production with no need for external positioning devices, such as turrets, anchors, AHT, etc.

6.0 Original Expectations

The base needs stated by PEP, for which the WTSVs were conceived were the following number of wells/services per vessel:

Service/Year	2003	2004	2005	2006	2007
Well Completion	30	59	56	54	42
Well Repair. Short term	10	27	22	15	13
Well Repair. Long term	14	23	31	37	58
High %. Water Producing Well	2	3	3	3	3
Total	56	112	112	109	116

Table No. 1

7.0 Operations Results

The *Toisa Pisces* began operations in March 2004. The results are as follows:

Service	**March/04 to July/05**
Heavy Crude Oil Measurement	11
Oily Water Re-injection	13
Well Completion	11
Crude Oil Export	29
Well Stimulation/Repair	98
Other Services	6
Total Number of Services	**168**

Table No. 2

The percentage distribution of the services provided is shown in figure No. 4 below. It is observed that most of the time the vessel has been providing well stimulation/repair fluid reception, thus assisting mainly in pollution control.

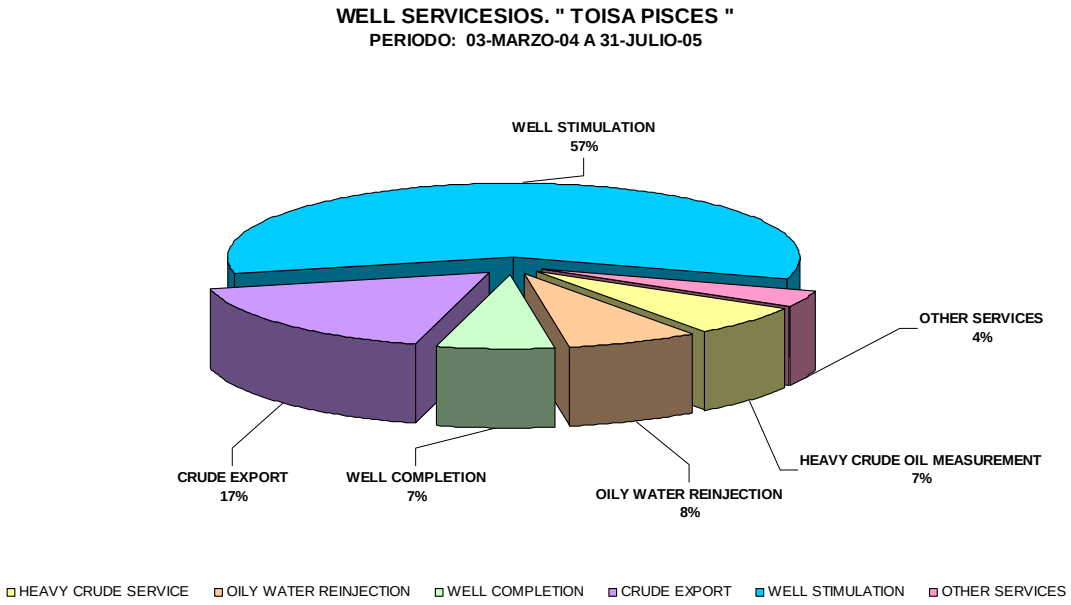


Figure No. 4

In addition, that the amount of Crude Oil and Oily Water recovered from these services has been, until July 2005:

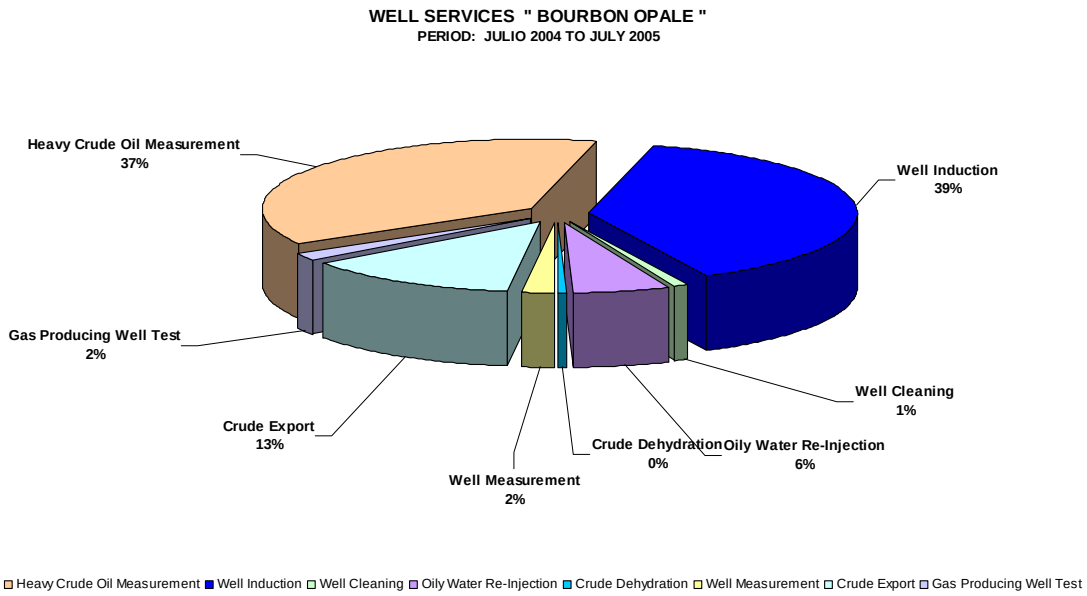
- Crude Oil: 258,000 bbls
- Oily Water: 125,000 bbls

The *Bourbon Opale* in turn was commissioned in July, 2004 and has provided the following results:

Service	**July-04 to July/05**
Heavy Crude Oil Measurement	57
Well Induction	62
Well Cleaning	2
Oily Water Re-Injection	12
Crude Dehydration	1
Well Measurement	5
Crude Export	16
Gas Producing Well Test	2
Total Number of Services	**157**

Table No. 3

The service distribution is shown in figure No. 5 below. It is observed that the *Bourbon Opale* has provided a more varied type of services, the main reason being that it is working at earlier developed fields, as compared to the *Toisa Pisces*, which is providing services at new and developing fields.



As per fluid recovered, the *Bourbon Opale* has exported and re-injected the following volumes:

- Crude Oil: 187,000 bbls
- Oily Water: 98,500 bbls

The vessels have worked uninterrupted since commissioned and have provided results above expectations. Average service is ten (10) locations per month per vessel, therefore, an approximate average of three (3) days per location has been observed. This time include:

- Sailing into location
- Meetings at location. Safety and service, work permit clearance
- Rig-up of portable pipe, choke and flexible hoses installation
- Service
- Disassemble of rig-up,
- Closing of the service and report.

These results were only achieved due to the DP system installed on the vessels. If traditional-portable systems had been considered, the number of services could have not been obtained.

Regarding the operations cost, approximately 45% of the cost is amortized by the crude oil recovered and the oily water re-injected. But more than the fluids recovered, the ecological impact is greater, considering that until the time that these vessels were incorporated into the service, most of these products would have been flared, and this cost and impact is very hard to quantify.

8.0 Final Remarks

As these lines are written, reference to other vessels have been researched, only two (2) other vessels of similar characteristics have been located, but neither of the two have worked as a well testing/fluid reception vessel for a significant period of time that could serve as additional reference or benchmark. It would be very interesting to determine if other vessels are available which could be used as additional reference for future use of these type of vessels.

The *Toisa Pisces* and the *Bourbon Opale* are two of the four (presently known) vessels in this size and classification, but are the only two presently known that have worked continuously, and have proven the benefits that a DP assisted vessel can provide to offshore industry for well testing.

It is expected that the two vessels will continue in operations as long as PEP has wells in service. The well stimulation and clean-up will continue; exploration into deeper water or unexplored/unexploited areas is expected to continue over the next years.

9.0 References

[1] Gabriel Delgado-Saldivar. "The *M/V TOISA PISCES* and the *M/V BOURBON OPALE* A Solution for Well testing Services and Pollution Problems" Society of Naval Architects and Marine Engineers (SNAME) Gulf Section (Texas). April, 2004

[2] Jeremy Beckman. Offshore Magazine. Penwell Publications. . September 2004. Page 31-34