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Open Cell Matrix Polymer Filter as 'Fit for Purpose' Alternative of Thru Tubing Sand Consolidation

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Abstract

There are three main challenges on sand control with mechanical screen namely erosion, pass-through, and plugging. Pass-through and plugging are common issues related to the particle size distribution (PSD); meanwhile, erosion is caused by the high production rate. So far, there is no established screen that could tackle sand issues related to the PSD dependencies. This paper is aimed to present an OCMP filter as an alternative screen to tackle pass-through and plugging challenges due to improper screen slot opening size and high uniformity coefficient (UC).

Conventional sand screen requires natural sand packing (NSP) to create an effective sand filter and optimal flow. Thus, it depends on the screen slot opening size to provide a good NSP. On the other hand, the data for defining slot opening size is not readily available for every reservoir. NSP is limited to the PSD of sand with a high UC and high fines. An open cell matrix polymer (OCMP) filter was introduced to solve this problem. OCMP filter was designed to allow combinations of multiple distinct layers with a range of pore sizes ranging from 180 – 565 microns. Hence, it could be an answer to the PSD-dependent screen selection. OCMP filter was conveyed by slickline and run compressed within the sleeve to allow passage through tight restrictions which then decompressed to be conformant with a significantly large inner diameter (ID) of the area requiring sand control when the sleeve is removed.

OCMP filters had been successfully installed in three (3) Mahakam wells using slickline and an LCT barge. It can produce up to 600 bopd and 2.6 mmscfd of gas. In terms of production parameters, an OCMP can compete with the established Sand Consolidation in its first installations, and has a high potential to outperform most of the developed sand control technologies in Mahakam Field.

Keyword(s): sand screen, expandable screen, polymer screen, thru tubing

1 Introduction

The urgency in developing reliable sand control that is irrespective of particle sand distribution (PSD) has become prominent. Particularly in Mahakam Field, mature oil and gas fields drive development strategy to produce shallower zones with unconsolidated formation. Due to this characteristic, this type of formation is imposed to greater risk of sand problems, where high shear value will result in a great deal of produced sand during initial production or second cycle production after initial shut-in [1].

Sand production has significant negative effects on the economy and the environment [2]. Unrecovered reserves, equipment failure, increased lifting cost and suboptimal production rate that lead to loss of revenue and become inevitable if the issues are not resolved. As a result, sand control is highly important and necessary as the value of oil resources and the cost of remedial action rise [3] [4].
Nevertheless, effective design for sand control, especially mechanical sand control, heavily depends on the PSD of the formation. This becomes problematic in the condition of PSD data scarcity. Incorrect slot opening size results in inability to provide a good NSP, create an effective sand filter and produce in optimal flow. Eventually sand passes through to the surface or well does not flow due to plugging [5]. Furthermore, NSP is also limited to the PSD of sand with a high UC and high fines. To solve the PSD-related challenges, an OCMP filter was introduced [6]. This study is aim to highlight the OCMP sand screen performance in Mahakam Field.

2 Methodology

Open cell matrix polymer sand screen is recently introduced as an addition to the selection of mechanical screen [6]. To test its effectiveness and functionality, a field trial was conducted in Mahakam Field. The process started by evaluating the technical design of the OCMP, selecting candidates based on varied characteristics and determining deployment method. Deployment method was critical to ensure installation conditions in which the screen would be conveyed and set. Lastly, production monitoring is continuously performed to evaluate its performance as the final piece of the process.

2.1 Design and Features

The OCMP filter acts as mechanical barrier and a tortuous path for sand by enclosing a length of perforated base pipe. The system was fabricated to facilitate combination of several different layers with a various pore sizes covering 180 – 565 micron. This is to ensure the OCMP is able to provide an effective sand retention for the development of the NSP with minimal pressure drop in various appropriate formation characteristic [6]

Figure 1. OCMP sand screen

Prior to deployment, OCMP is to be compressed within a compression sleeve as part of the running tool, which will pass through typical completion restrictions easily. Once it is set, and the sleeve is removed, OCMP will be decompressed to be conformant with a significantly large inner diameter (ID) of the area requiring sand control. Without affecting its capacity to retain sand, the OCMP filter can expand by more than 85%. The more compressed an OCMP, the lower permeability it will have; thus, it is expected to produce less sand in comparison to the more expanded OCMP filter [6]. In addition, based on previous study on the correlation between compression and sand retention, the optimum expansion is 50% above the compressed volume.

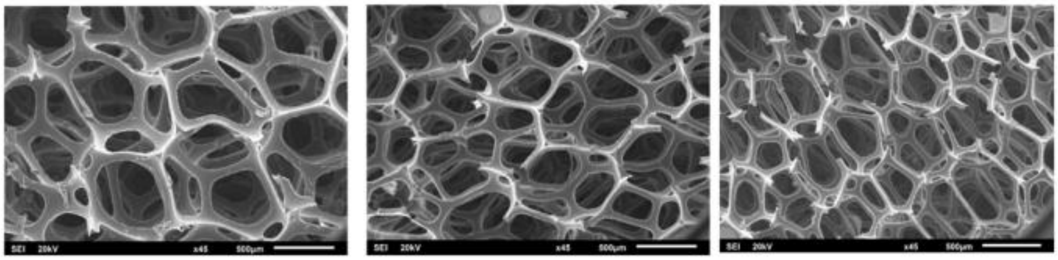

Figure 2. OCMP polymer microscopic view (Barclay, 2020)

2.2 Candidate Selection

As Open cell polymer matrix has a range of pore sizes ranging from 180 – 565 micron, characteristic of reservoir candidates shall vary in terms of grain size. A close approach, using volume of wet clay from open hole logging interpretation to predict grain size data [7], resulted in three (3) well candidates in Mahakam Field with different shale volume. Production fluid – gas and oil – became another variable to confirm the compatibility of the screen in relation to the production fluid. However, as most of the Mahakam Delta Field has 3-1/2" completion, the effectiveness of the different polymer compression was not observed.

2.3 Deployment Method

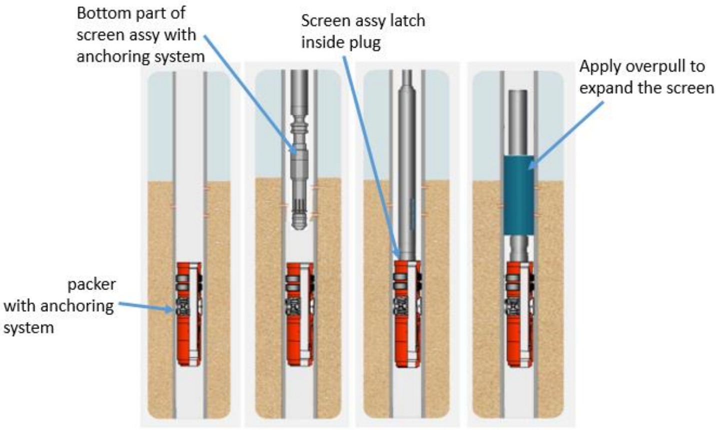

Figure 3. OCMP screen installation process (Barclay, 2020)

OCMP filter is commonly installed using coiled tubing as conveyance and deployment method. However, most of the thru tubing sand screen installation in Mahakam Field are deployed by slickline, which has advantages in terms of simplicity, cost, and duration. Thus, the tool to deploy OCMP by removing the compression sleeve to expose the OCMP filter using slickline was developed [6]. A packer is pre-set at the pre-determined depth below OCMP filter to function as the anchoring system. The OCMP sand screen will then latch onto this packer. As soon as the tool has been set and anchored, the running tool is pulled off to retrieve the compression sleeve and exposing the OCMP filter. [6]

2.4 Performance Evaluation

After the OCMP sand screen has been installed in three (3) Mahakam wells, production monitoring was performed to evaluate the screen performance. The parameters include production rate, reserve recovery, and sand rate. These parameters also determined the success criteria of the first OCMP sand screen installation in Mahakam Field. The first OCMP sand screen installation in Mahakam Field is deemed success if it is able to produce at minimum of 1 MMscfd in gas well or 150 BOPD in oil well, recover 50% of reserves within 2 months and retain sand with the maximum allowable sand rate at 0.01 gr/sec.

3 Result and Discussion

Table 1. Variation of reservoir characteristic in selected candidate

No	Well	Fluid	Stakes	Perfo interval (m)	P Res (psi)	Permeability (mD)	Porosity (%)	Vshale (%)	D10 Approach
1	AX-1	Oil	21 kkbl	1.5	1529	385.9	26	15	300 micron
2	AX-2	Gas	0.04 bcf	2	1066	1594	28.4	21.6	250 micron
3	AX-3	Gas	0.05 bcf	1	1286	39	26.3	56.7	175 micron

The determination of D10 size using wet clay volume [7] became the basis for sand control engineering and three (3) reservoir candidates with different characteristic are selected as shown in Table 1. The OCMP sand screens, with specification listed in table 2, were successfully installed using slickline (Figure 4). Thru tubing packer was chosen as anchor for the OCMP filter and pre-set at the determined depth which enabled accurate positioning of OCMP filter in front of reservoir. This was important to accommodate an optimum filter overlap above and below the perforation interval. After the OCMP sand screen has been set above the packer using an anchor latch system at the bottom of the sand screen, the sleeve was easily pulled up by applying tension up to 1600 lbs. Upper packer were not used in these three (3) well, as the expanded polymer filled the annulus between base pipe to tubing. Hence, the hydrocarbon shall less likely flow through the gap between screen to tubing.

Table 2. OCMP screen specification

Tool OD	Min Restriction	Screen Length	Effective Length
2.74"	2.81"	120.8"	100"

Specific clean-up procedure was not designed for OCMP sand screen. Clean-up was basically performed with a small incremental drawdown and a short time interval between the choke increment as preferred to its higher and longer counterpart [8]. The clean-up started at 8/64" choke opening and the choke opening was increased by 2/64" every three (3) hours for gas well while the choke increment for oil well was 2/64" every hour.

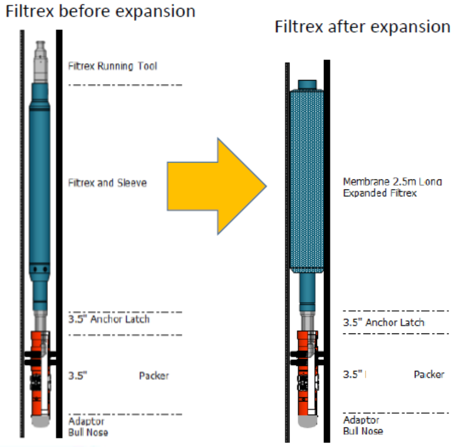

Figure 4. Installed OCMP sand screen using thru tubing packer

3.1 Well Ax-1

Well Ax-1 is an oil producer well with high critical sand risk and production target of 150 BOPD. OCMP filter is set inside 3-1/2" tubingless completion with depth at 1127.5 mBRT and inclination of 12°. Clean-up result showed that no sand was detected during its targeted production rate and the well remained sand free at ~600 bopd withWHFP at 48.4 B and choke opening at 20/64". In cumulative, Ax-1 well has been producing sand free longer than the 1-month target, for 5 months and 155% recovery factor.

3.2 Well Ax-2 and Well Ax-3

Tabel 3. Ax-2, Ax-3 Clean up result

Well	Choke	WHFP (Bar)	WHFT (°C)	Qgas (mmscfd)	Qoil (bopd)	Qwater (bwpd)	Sand (cc/hr)
Ax-2	24/64	57.6	41	2.236	2.4	40.8	0
Ax-3	22/64	67.8	40	2.5	0	0	0

Well Ax-2 and Ax-3 were completed with 3-1/2" tubingless completion. It targeted the shallow gas reservoir at 1126 mBRT and 958 mBRT respectively. After OCMP screen installation, both well had satisfying clean up result as shown in Table 3. The sand free rate resulted in production rate at 2.55 MMscfd. It was an achievement itself to outperform the established chemical sand control, SCON, where the recommended production rate is limited at 2.5 MMscfd. Lower WHFP or higher drawdown was observed at Well Ax-3 due to suspected higher shale content in comparison to the other two (2) wells.

Similar to most of the thru tubing sand screen, OCMP also faced more challenging condition in gas well. After 1 month of production using OCMP screen, sand alarm was detected at Well Ax-2 and Ax-3. Sand was eventually found at surface. Apparently, after conducting sand free rate test, both wells have experienced water breakthrough with Ax-3 no longer producing while Ax-2 could continue producing at 1 MMscfd sand free rate. OCMP screens are able to recover 60% and 300% of stakes at both well respectively.

From the three (3) installation, OCMP sand screen demonstrated outstanding performance at oil well while some works still needed to be done on OCMP sand screen in order to become a robust sand control for gas well.

4 Conclusion

In conclusion, this campaign successfully deployed three (3) OCMP sand screens in three (3) well of Mahakam field. This marked the first slickline-conveyed deployment in Mahakam field and the World. The feature of open cell polymer matrix provides "one size for all" benefit and proficiently covers reservoirs with different sand particle size. Furthermore, OCMP sand screen is able to exceed production target at 150 BOPD and produce at 600 BOPD in oil well while the initial target for gas well at 1 MMscfd was surpassed by producing at 2.6 MMscfd. For the bigger picture, OCMP sand screed successfully recovered 50%-300% of reserves within two (2) months. Moreover, it is capable of retaining sand with the maximum allowable sand rate at 0.01 gr/s in oil well even though sand retention in gas well has become the homework for future deployment and needed to be improved.

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