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A New Test Apparatus for Evaluating Premium Screen Performance

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Abstract
Premium screen performances under particular reservoir are hardly available and required to be carefully evaluated via laboratory test instead of experience, and then a new test apparatus is developed. The apparatus installs full size screen sample and can evaluate performances of integrated screen pipe. A case study is performed to select the most appropriate premium screen from 4 different types for a target block, analysis results are compared with those of small disk samples, and show that: Performance of both multilayer dense weave screen and cemented corundum sand screen are acceptable, the former is the best if moderate sanding is allowed, while the latter is the best if sand production should be limited; pressure drop across inlaid weave block screen and nominal opening size of folded weave screen are too large and should not be applied; small disk sample test wrongly selected inlaid weave block screen as the proper type which is easy to be plugged in target formation, mainly because it can not reflect the fact that the total filtration area of this kind of integrated pipe is small and only equal to summated area of all the predrilled holes in base pipe wall.

Key words: Premium screen; Performance evaluation; New test apparatus; Full size screen sample; Artificial sand

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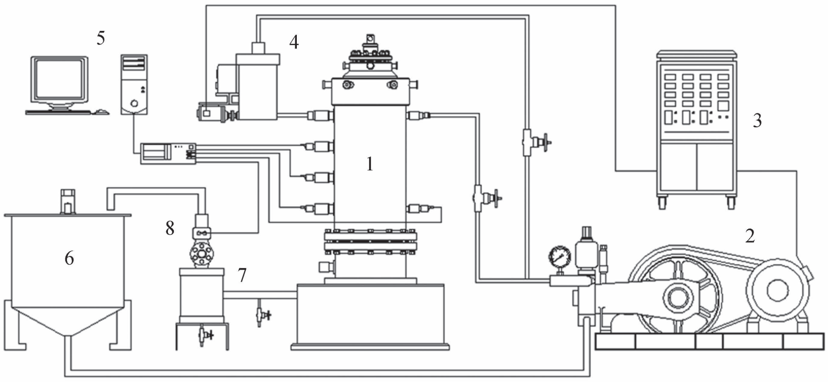
INTRODUCTION

Premium screen technology has been widely applied to directly retain formation sand in Shengli Oilfield. Completion engineers should select proper screen to ensure a successful sand control completion. Screen performances under target reservoir characteristics are hardly available from manufacturers. Therefore the performances are required to be carefully evaluated via laboratory test instead of experience. In general, special weave mesh of premium screen to be tested is always cut into small disk and installed in housing, as those works reported by Gillespie[1], Underdown[2], Luo[3] and Agunloye[4]. Although this approach is convenient and low cost, it only test the nominal opening size and pressure drop of local screen material, and could not effectively reflect performance of integrated screen pipes run in well bore. To overcome this disadvantage, a new test apparatus has been developed to offer a more accurate access to premium screen performance evaluation.

1. CHARACTERISTIC OF THE NEW TEST APPARATUS

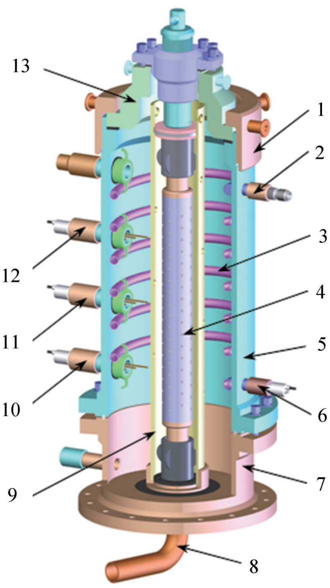
1.1 Principle of Design



1-Apparatus main body, 2-High pressure piston pump, 3-Digital control box, 4-Sand feeder, 5-Data processor, 6-Liquid storage tank, 7-Test fluid sampler, 8-Flow meter
Figure 1
The Premium Screen Performance Test Apparatus

The new apparatus, as shown in Figure 1, is designed to select suitable type of premium screen to extend its validity period and meet sand retention requirements in target block before running into well bore. This apparatus can simulate real and severe sanding process (rock totally collapsed in well bore), and evaluate the performance of integrated premium screen pipe, while small disk sample can not. So far, this apparatus has provided effective sand retention guidance for 429 wells of 15 blocks in Shengli Oilfield, and achieved significant economic benefits.

1.2 Component Introduction



1-Locking mechanism, 2-Liquid inlet, 3-Radial flowing guide control, 4-Screen sample, 5-Outer case, 6-Pressure sensor at main body liquid inlet, 7-Base of outer case, 8-Liquid outlet, 9-Casing pipe, 10-Pressure sensor group No. 1, 11-Pressure sensor group No. 2, 12-Pressure sensor group No. 3, 13-Sealed cap
Figure 2
Main Body of Test Apparatus

The main body shown in Figure 2 works as container for test. What to be installed in center of main body is full size sample (Component 4 in Figure 2). It's a short screen pipe especially manufactured to fit the height of main body. Artificial sand is fully and loosely filled in annular space between sample and outer case (Component 5 in Figure 2) before test. Radial flowing guide control (Component 3 in Figure 2) guides test liquid radially flushes artificial sand and flows through screen sample. Sand slurry passed through sample can be collected from the bypass valve connect with test fluid sampler (Component 7 in Figure 1). Pressure and flow rate data in main body are automatically gathered and saved. Apparatus available working parameters are shown in Table 1.

Table 1
Apparatus Available Working Parameters

Working parameter	Value or range
Apparatus working pressure, MPa	0.1~12
Test liquid viscosity, cp	1~100
Flow rate of piston pump, L/h	100~2,000
Size of the main body, mm	Φ460×H1,200
Size of radial flowing guide control, mm	Φ420×H605
Screen sample diameter, in	$2^3/_8$, $2^7/_8$, $3^1/_2$, 4, $4^1/_2$, 5, $5^1/_2$, $6^5/_8$, 7
Liquid storage tank volume, m^3	1.5

2. CASE STUDY

2.1 Basic Situation

Sand particle size distribution of a target block in Shengli Oilfield is shown in Figure 4. Performances of 4 different types of premium screen products need to be evaluated, the most proper screen should be selected to meet the sand retention requirement.

Figure 3
Screen Samples to Be Tested

The 4 screen samples to be tested are shown in Figure 3 and have different structures as follow:

(a) Sample #1, multilayer dense weave screen: Several layers of stainless steel dense weave with triangular openings tightly wrapped around base pipe, the filter layer is covered by an outer tube densely drilled with oblique drainage square holes. This screen pipe has medium filtration area and strong pressure bearing ability.

(b) Sample #2, cemented corundum sand screen: Perforated pipe wrapped by sand retention material made of strongly cemented corundum sand. Particle size, sphericity and hardness of corundum sand as well as cemented layer thickness are critical parameters influencing sand retention results. Medium filtration area, strong pressure bearing capability.

(c) Sample #3, inlaid weave block screen: A certain number of regularly arranged holes are drilled in a thick wall casing pipe, special weave mesh is processed into small blocks and set in each hole. Small filtration area, strong pressure bearing capability.

(d) Sample #4, folded weave screen: Repeatedly folded stainless steel dense weave with square openings to form a filter layer wrapped around base pipe, the layer is covered and protected by an outer perforated pipe. Large filtration area, medium pressure bearing capability.

The most appropriate premium screen is selected based on following criteria:

(a) Retain most of the formation sand, i.e. the particle size distribution of sand passed through screen samples should be sufficiently far away from that of target formation.

(b) Pressure drop across screen and deposited filter cake should be as low as possible to avoid over reduced production.

2.2 Test Procedure

(a) Sands of different mesh numbers are weighed in same quality, and then artificial sand for test is prepared by mixing them, whose particle size distribution range is the same as that of target formation sand. Prepare adequate sodium carboxymethyl cellulose working as test fluid with viscosity of 40 cp. Nominal diameters of all the screen samples are $5^1/_2$ in.

(b) Install screen sample #1 into main body, fill the artificial sand.

(c) Pump the test fluid at an initial flow rate of 400 L/h, and start gathering data when hydraulic circulation is stable. Increase flow rate about every two hours, from 400 L/h to 1,200 L/h at step of 400 L/h.

(d) Collect about 1 L of sand slurry from test fluid sampler at the end of run.

(e) Test the next screen sample following step (b) to (d).

2.3 Analysis Result

Particle size distribution of sand passed through screen sampler is obtained by laser particle analysis on the sand slurry collected from test fluid sampler, as shown in Figure 4.

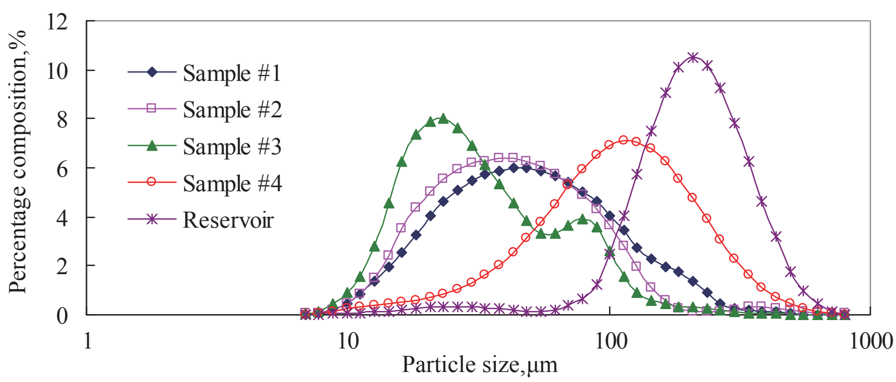


Figure 4
Particle Size Distributions of Screen Samples and Target Reservoir

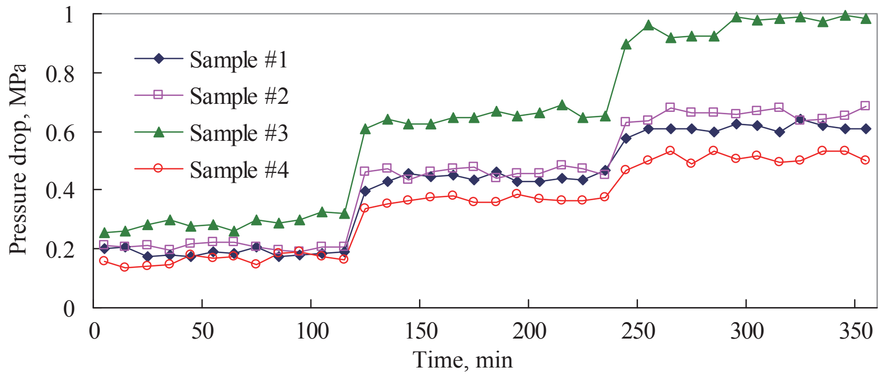


Figure 5
Pressure Drop Across Screen Sampler vs. Time

Data of pressure drop through screen sampler vs. time is plotted in Figure 5.

Figures 4 and 5 show that:

(a) Screen Sample #1 and #2: Compared with Sample #2, pressure drop across Sample #1 is a little lower while the sand passed through Sample #1 is a little coarser.

(b) Screen Sample #3: The distribution curve of Sample #3 is the most far away from that of formation sand, and only very fine sand can pass through the screen sample, but its pressure drop is too high, which will over reduce well productivity.

(c) Screen Sample #4: Pressure drop across Sample #4 is the lowest, but there are large overlapped area between particle size distribution curves of passed sand and formation sand, which will cause failed sand retention.

Then it can be concluded:

(a) Performance of both Sample #1 and #2 are acceptable for target reservoir. Sample #1 is the best if moderate sanding is allowed, while Sample #2 is the best if sand production should be limited.

(b) Manufacturer should be advised to optimize the critical parameters of sand retention layers of Sample #3 and #4 to meet the sand control completion requirement of target reservoir.

3. COMPARED WITH SMALL DISK SAMPLES

The 4 types of premium screen are cut into small disks to evaluate their performances using method reported by Underdown[2]. Artificial sand and test fluid are those prepared for full size samples. Figure 6 shows test results in form of SE Plot which presents relative level of pressure drop and sand retention among all the tested small disk samples.

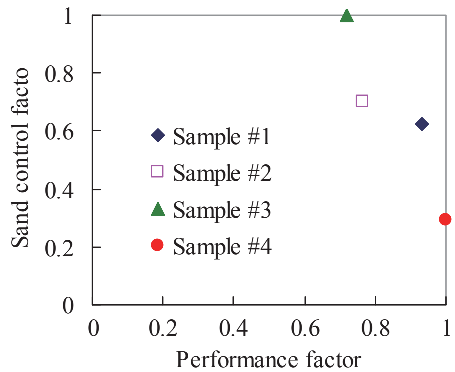


Figure 6
SE Plot of Small Disk Samples

In Figure 6, performance factor (Axis *X*) and sand control factor (Axis *Y*) stand for screen permeability and sand retention capability respectively, both of which vary in range from 0 to 1. A bigger factor means better screen performance, sample with factor value of 1 has the lowest pressure drop/highest sand retention capability among all the samples being tested.

There are two main aspects in Figure 6 obviously different from full size sample results. First, Sample #3 performance factor is nearly the same as that of Sample #2, while for full size sample, pressure drop through Sample #3 is much higher than others mainly because the total filtration area of its integrated pipe is only equal to summated area of all the predrilled hole in base pipe wall; Second, compared with Sample #1, performance factor of Sample #4 is just a little bigger, because small disk can not reflect advantage of repeatedly folded metal weave, which effectively helps to increase filtration area and decrease pressure drop.

Sample #3 is wrongly selected as the most proper screen according to Figure 6, full size sample test results show that this type of screen is likely to be plugged in target reservoir.

CONCLUSION

(a) A new test apparatus for evaluating integrated premium screen performance has been developed, it installs full size screen sample and can simulate real well bore sanding process.

(b) The new test apparatus performed a case study to select the most appropriate premium screen from 4 different types for a target reservoir in Shengli Oilfield, analysis results show that: Performance of both Sample #1 and #2 are acceptable for target reservoir. Sample #1 is the best if moderate sanding is allowed, while Sample #2 is the best if sand production should be limited. Pressure drop across Sample #3 and nominal opening size of Sample #4 are too large and should not be applied.

(c) Sample #3 is wrongly selected as the proper screen for target reservoir in small disk sample test, which is easy to be plugged in production according to test result of full size sample. This mainly caused by neglecting the fact that real total filtration area of its integrated pipe is only equal to summated area of all the predrilled hole in base pipe wall, after all, small disk sample can only reflect performances of local sand retention material.

REFERENCES

[1] Gillespie, G., Deem, C. K., & Malbrel, C. (2000, October). *Screen selection for sand control based on laboratory tests*. Paper presented at SPE Asia Pacific Oil and Gas Conference and Exhibition, Brisbane, Australia.

[2] Underdown, D. R., Dickerson, R. C., & Vaughan, W. (2001). The nominal sand-control screen: A critical evaluation of screen performance. *SPE Drilling & Completion, 16*(4), 252-260.

[3] Luo, W., Xu, S., & Torabi, F. (2012, October). *Laboratory study of sand production in unconsolidated reservoir*. Paper presented at SPE Annual Technical Conference and Exhibition, San Antonio, Texas, USA.

[4] Agunloye, E., & Utunedi, E. (2014, August). *Optimizing sand control design using sand screen retention testing*. Paper presented at SPE Nigeria Annual International Conference and Exhibition, Lagos, Nigeria.