Advanced Materials Research *Online: 2010-11-11*
ISSN: 1662-8985, Vols. 160-162, pp 1095-1099
doi:10.4028/www.scientific.net/AMR.160-162.1095

Performance Test of N80 Expandable Casing

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Keywords: Expandable casing, experimental studies, collapse strength, wall thickness change,ovality

Abstract. A more comprehensive,systematic experimentical ground tests of the expansion process of expandable casing were performed. In the tests, 6 5 1/2"N80 casings were selected, of which five had been carried out expansion tests , another one casing was used to test the collapse strength , not been expanded. In the course of the tests,some important parameters of the expandable casing were measured before and after expansion,including the inner and outer diameter, wall thickness, ovality, wall thickness of inequality and the axial deformation, etc..These data provide a reliable basis for the mechanism research of the N80 casing expansion. After expansion tests, these six casing pipes had been performed the collapsing tests in Xi'an Tubular Goods Research Institute of CNPC.The test results show that after expansiong the collaps strength of expandable casing get decreased compared with unexpanded casing which provides a practical basis and reference for the design of expandable casing.

Introduction

Expandable casing technology is considered as one of the core technology in the oil drilling industry in the 21st century[1]. At home and abroad in recent years expandable casing technology have been successfully applied in drilling oil and gas well engineering, well completion and workover and other areas[2-7].It must be explained that the application of the expandable casing in petroleum engineering, including Solid Expandable Tubular, Slotted Expandable Tubular,etc.. This paper mainly aims to study solid expandble tubular(also called expandable casing) which is similar to the conventional casing, select the API N80 casing pipe as test sample to study the geometry and mechanical properties of expandable casing before and after expansion.

Nowadays,the studies of expandable casing technology mainly focus on casing material,connection, driving system and supporting technology, and casing material is the most basic and critical problem. Whether as repairing patch or as technical casing , the expandable casing after expansion should have the equivalent mechanical properties compared to the common casing, especially the external collapse resistance strength is its key parameters. To reduce development costs, speed up the progress,an existing pipe should selected as the object of study. Based on this,in this study API N80 casing was selected as the experiment casing.

Experimental device

This test equipment imported from Germany,a factory in Chengdu,shown in Figure 1. Figure 2 is a simplified diagram of the device, in the process of expansion ,the rail car can drag the pipe move right by the clamping device, and left end of the pipe is free. Cone rod and the expansion cone are fixed and moving right the diameter of the pipe is increased gradually. The technology of the device is similar to the actual expansion process of expandable casing. The difference is that the device is moving tube, expansion cone fixed, while in the actural borehole the expansion cone is moblie,the pipe is fixed. However, the pipe and the expansion cone is relative movement, so test results were consistent.

Casing program design: the upper casing is 7″N80 casing,expandable casing is 51/2″. Table 1 shows the specific design parameters.

Table 1. Expansion specfications

Upper casing		Expandable casing				
OD (mm)	ID (mm)	Before expansion		After expansion		IDExpansiaon ratio
		OD (mm)	ID (mm)	OD (mm)	ID (mm)	
177.8	157.07	139.7	124.26	153.49	138.7	11.6%

Results

Dimension changes of expandable casing before and after expansion

In this paper ,5 casings were expanded, and their number were in the order of 1 to 5, the specific test parameters shows in Table 2.The geometry parameters of five expansion casings were measured before and after expansion, each casing has 4 measurement sections. Figure 4a and 4c shows, each section has 8 measure measurement points which are uniformly distributed(corresponding to 4 group diameter), as shown in Figure 4b. In order to eliminate end effects, measurement sections are away from the pipe ends.

Wall thickness changes of casing

Wall thickness and related parameter (wall thickness nonuniformity,wall thinning rate) measurement results before and after expansion are shown in Table 3.As can be seen from Table 2,while the inner wall of expandable casing were expanded by the expansion rate of 11.6%,the average pipe wall thickness reduced (0.4~0.6)mm.

The changes of 5 casing wall thickness nonuniformity before and after expansion are shown in Table 2. It can be known from Table 2,the casing wall thickness nonuniformity have increased after expansion. Results and field practice have shown that uniform wall thickness of casing will affect the mechanical properties,especially the collapse strength,therefore to decrease the wall thickness nonuniformity after expansion,the pre-expansion nonuniformity wall thickness of casing and the expansion rate should be strictly controled.

Table 2. Wall thickness parameter measurement before and after expansion

No.	Before expansion		After expansion			
	Average wall thickness mm	Wall thickness nonuniformity %	Avg. wall thickness mm	Wall thickness nonuniformity %	Wall thickness reduction mm	Wall thickness reduction ratio %
1	7.83	3.53	7.38	6.43	0.45	5.75
2	7.78	4.2	7.25	6.18	0.53	6.82
3	7.93	4.4	7.33	6.13	0.60	7.57
4	7.93	3.48	7.53	3.53	0.40	5.05
5	7.70	3.25	7.10	3.83	0.60	7.79

Ovality of expandable casing

The changes of the largest pipe diameter, minimum diameter and ovality of expandable casing before and after expansion are shown in Table 3. From Table 3, it can be known, while the inner diameter of expandable casing were expanded by the expansion rate of 11.6%, the outer diameter of expansion did not produce the same expansion ratio, the actual outer diameter radial expansion rate is

(8.43 ~ 10.06) %, and all are smaller than the inner diameter of expansion, this directly led to the wall thickness value of expandable casing decreases after expansion.

From Table 3 one can know,after expansion, the casing ovality decreased in varying degrees, indicating its "roundness" to be improved, and this variation is consistent with the pipe drawing in the metal plastic processing. Analysis of the reasons may be: in the test the size of the expansion cone has high precision, and it's hardness is much higher than the expandable casing ,it played the role of reducing the ovality in the course of expansion forming. Results and field practice shows that casing ovality can decrease the collapse strength of casing ,so in order to ensure the strength of casing after expansion the lower initial ovality casing and the higher precison cone should be chosed.

Table 3. Diameter and ovality before and after expansion

N0.	Before expansion				After expansion			
	Maximum OD (mm)	Minimum OD (mm)	Avg. OD (mm)	Ovality (%)	Maximum OD (mm)	Minimum OD (mm)	Avg. OD (mm)	Ovality (%)
1	141.02	140.36	140.71	0.47	153.29	152.7	152.97	0.34
2	141.01	140.41	140.78	0.41	154.89	154.33	154.58	0.31
3	140.70	140.13	140.40	0.33	154.28	153.61	153.90	0.23
4	140.76	140.30	140.59	0.33	153.55	153.23	153.39	0.14
5	140.93	140.37	140.69	0.37	153.41	152.81	153.09	0.35

Casing axial deformation

Figure 3,taking into account the end effect and the flared section of length can not be accurately measured ,in the study of the changes of axial length of casing, the length between the section 1 and the section 4 in Figure 4b is selected as the object of the study.. The changes of 5 casings in axial length before and after expansion are shown in table 4. Table 4 shows, after expansion the axial length of all the casings are reduced, the axial length shortening is in the range of (1.87~3.04)%.

Table 4. Axial length changes before and after expansion

No.	1	2	3	4	5
Length before expansion(mm)	2300	2300	2300	1400	2300
Length after expansion(mm)	2235	2230	2230	1360	2257
Length shortening(mm)	65	70	70	40	43
Length shorten ratio(%)	2.83	3.04	3.04	2.86	1.87

Collapse strength before and after expansion

After the expansion test had been completed, the collapsing tests of 6 casings were performed in Xi'an Goods Research Institute of CNPC. The test methods refer to API RP 5C5 ,the results shown in Table 5. Table 5, sample 6 # is not been expanded, it's collapse strength is 51.3MPa,while the sample 1# and sample 2# and sample 5# have been expanded, the average collapse strength is 28.67MPa, and the collapse strength after expansion decreases by 44.1% compared with the collapse strength before expansion.

Table 5.Collapse strength before and after expansion

No.	Outer pressure (MPa)	Failure form
1#	28.7	Collapsing
2#	29.4	Collapsing
3#	Faild test	
4#	Faild test	
5#	27.9	Collapsing
6#	51.3	Collapsing
Collapsing decreased 44.1％		

Summary and Conclusions

Under the experimental conditions, the expansion test of 6 5 1/2"N80 casings have been performed .The following conclusions can be drawn:

1) A more comprehensive,systematic experimentical ground tests of the expansion process of expandable casing were performed .The test results show that:the existing API N80 casing can be selected as expandable casing,but it's mechanical properties should be further improved.

2)While the inner wall of expandable casing were expanded by the expansion rate of 11.6%,the average pipe wall thickness reduced (0.4~0.6)mm.

3)While the inner diameter of expandable casing were expanded by the expansion rate of 11.6%, the outer diameter of expansion did not produce the same expansion ratio, the actual outer diameter radial expansion rate is (8.43 ~ 10.06) %, and all are smaller than the inner diameter of expansion, this directly led to the wall thickness value of expandable casing decreases after expansion.

4)After expansion, the casing ovality decreased in varying degrees

5)After expansion the axial length of all the casings are reduced, the axial length shortening is in the range of (1.87~3.04)%

6)The collapse strength of expandable casing after expansion decreases by 44.1% compared with the collapse strength before expansion.

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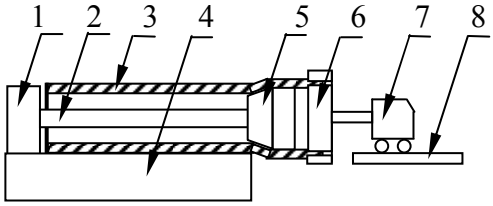
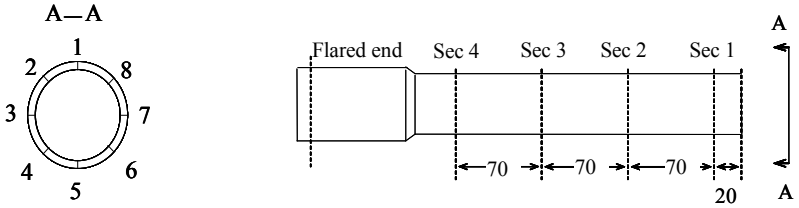
Figure 1: Expandable casing test device



1, core rod fixtures; 2, the core rod; 3, was inflated tube; 4, place the tube platform; 5, core head; 6, clamping device; 7,car; 8, dolly track.

Figure 2:Schematic of experimental device for expansion

a. Cross-section photo of the measurement



b.Diameter and wall-thickness c. Cross-section diagram of the measurement

Figure 3:Measurement cross-section diagram of expandable casing