

## **CORING IN THE NEW MILLENNIUM**

Abdel-Hamid Anis, Corpro Systems Ltd.

### **ABSTRACT**

Improved performance within the oil industry is underpinned by new or revised technologies. Coring is no exception and a novel design that eliminates weaknesses of the existing forty-year-old systems is shown to enhance coring results. A new core barrel and inner tube system provided improved core quality and facilitated core inspection at the well site with a minimum of core handling. A comparison made with cores obtained using alternative coring systems showed significant improvement in recovering better quality core, delivering over 30% more usable core, particularly from the fragile zones.

### **INTRODUCTION**

Core damage has always been a major concern in the direct measurement of rock properties from cores. Changes to rock properties greatly affect the quality of information obtained from cores, with misleading petrophysical parameters and rock mechanics properties, in addition to the potential effect on the validity of in-situ fluid saturation in reservoir rocks.

The new inner tube system comprises two 'half shells' which can be separated to allow an immediate inspection of the core, leading to improved sample selection for preservation and the immediate collection of geological information.

### **NOVEL CORE BARREL AND INNER TUBE DESIGN**

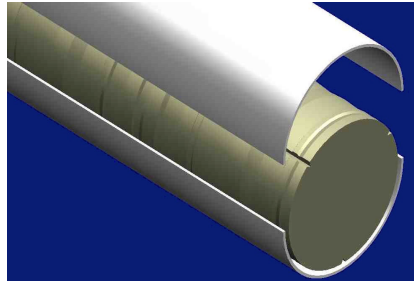
Prior the advent of fiberglass inner tubes, some of the early core barrel systems incorporated disposable plastic / Aluminium liners that were placed inside the conventional steel tube of old dual tube core barrels, hence they were referred to as triple-tube core barrels. In addition to limitations of barrel lengths and temperature tolerance, the main disadvantage of these early generation triple-tube barrels was the reduced core diameter (e.g. from 4" to 3½" size in 8½" coring, and from 5¼" to 4¾" in 12¼" hole coring).

The new core barrel design improved the resistance to flexure by a 4-fold factor, being manufactured in 10-20ft sections with full gauge stabilisers fitted at each tool joint, thus producing an ideal assembly capable of transferring the drill collar load to the bit without causing deformation and buckling the tube. The corehead can thus rotate around a true axis without transmitting lateral loads that can cause core damage and promote jamming. Buckling is inevitable in existing barrel systems, and in some cases becomes sufficient to impact core and well bore, resulting in over-gauge hole, core damage and sometimes under-gauge core.

An original bearing placement represents breakthrough improvement over traditional systems. The inner barrel is no longer hanging using top bearings only. Instead, the inner barrel is supported at the top and bottom, with unique bottom bearing cells that fully

support and enhance the stability of the inner barrel, and provide better rotational independence of the inner tubes from the outer barrel.

The new triple-tube barrel provided the ideal platform to develop the breakthrough inner tubes, which comprises two 'half-shells', pre-separated as shown on figure 1.



**Figure 1 New Breakthrough, Pre-Split Inner Tube System**

The value gained and main advantages are:

- Eliminate the lengthy, cumbersome operations of sawing standard inner barrels, and the associated safety hazards and mechanical disturbances.
- Minimise core exposure, which can irreversibly damage and degrade the core.
- Quick view of the full length of undisturbed whole core.
- Speed up field operational decisions.
- Avoid 'blind' sawing of inner tubes and cutting in the middle of zones of interest and damaging good whole core reservoir samples.
- Selective core sampling of highest quality core material.
- Rapid core alignment, for core reorientation, structural analysis and fracture description.
- Recover and process core material quickly.
- Eliminates problems associated with longitudinal cuts.
- Vented by default; Gas venting superior to valve systems.
- Eliminates the damage due to pushing of core out of inner tubes.
- Significantly reduced surface operating time.
- Reduced potential for lost time accidents associated with inner tube sawing operation.
- Improves overall safety, core quality, and provides more usable core.

## **RECENT CASE HISTORIES**

The same non-damaging coring fluid was used in all the studied applications to eliminate damage that can be attributed to effect of mud systems. Case histories were studied from various Gulf area reservoirs, with barrel lengths ranging from 40ft to 180ft.

Of particular interest were the case histories from the Thamama and Arab reservoirs. Core recovery using the new barrel design and inner tube system averaged 98.7%. The main advantages, however, were the significant reduction in mechanical damage and the ability

to recover better quality core, delivering over 30% more usable core, particularly from the fragile zones.

The weak rocks from the Thamama carbonates can have cohesive strength as low as 150-200 psi, with a friction angle of 35°, and failure angle of 1.921, with strength in the range of 570-770 psi. The normal strength values in the area are between 1500 and 5000 psi. The weak zones will thus, when unloaded from the confining stresses downhole, have a tendency to expand in the core barrel when brought up to surface.

In traditional core barrels, an average of 8-12% of the recovered cores were often becoming stuck, particularly the high porosity and high permeability zones, and were difficult to extract out of the inner tube. As shown in figure 1, severe damage sometimes took place during core extraction, delivering samples far from representative for the rocks in situ. With the new core barrel concept, the pre-split inner core barrel can be open by just lifting the top half, thus minimising or even eliminating such damage.

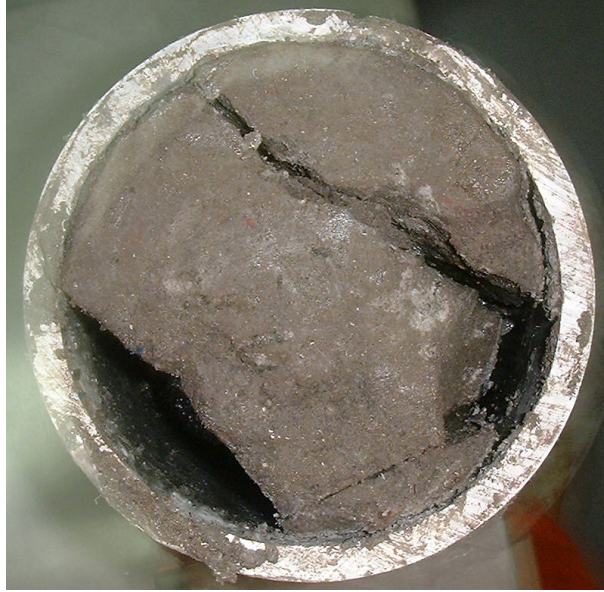


**Figure 2 Core Damage During Extracting Weak Rock From Fibreglass Inner Tubes**

In oriented coring case histories through fractured carbonates of the Thamama and Arab reservoirs, ready access to the entire cored interval facilitated onsite core inspection and rapid implementation of structural and geological studies, with a minimum of core handling.

Figure 3 clearly shows a core stuck inside a conventional inner barrel due to the presence of natural vertical fractures, and demonstrates the drawback of 'blind' sawing of inner tubes and cutting in the middle of zones of interest (the fracture in this case) and damaging good whole core reservoir samples.

As illustrated in figure 4, totally eliminating the disturbances resulting from core saws and of longitudinal cuts, and maintaining the integrity of core samples before the core is cut into short lengths and transported, allowed the inspection and study of a complex fracture network to provide almost real time structural analysis, and resulted in superior core quality. The deliverables included key information to predict the optimum drilling direction to maximise reservoir performance.



**Figure 3 Natural Vertical Fractures, Core Stuck Inside Conventional Inner Tube System**



**Figure 4 New Pre-Split Inner Tube System Facilitates Studying Natural Fracture Network**

## **CONCLUSION**

Minimising vibration related core damage and mechanical disturbance have been successfully achieved using new core barrel and inner tube technology. The enhanced stability features combined with the breakthrough inner tube system represented radical improvement toward obtaining representative core samples and effectively preserving the petrophysical and rock mechanics properties of recovered samples.