Advancing Reservoir Performance

Coiled Tubing Industry in a Major Downturn: Challenges & Solutions



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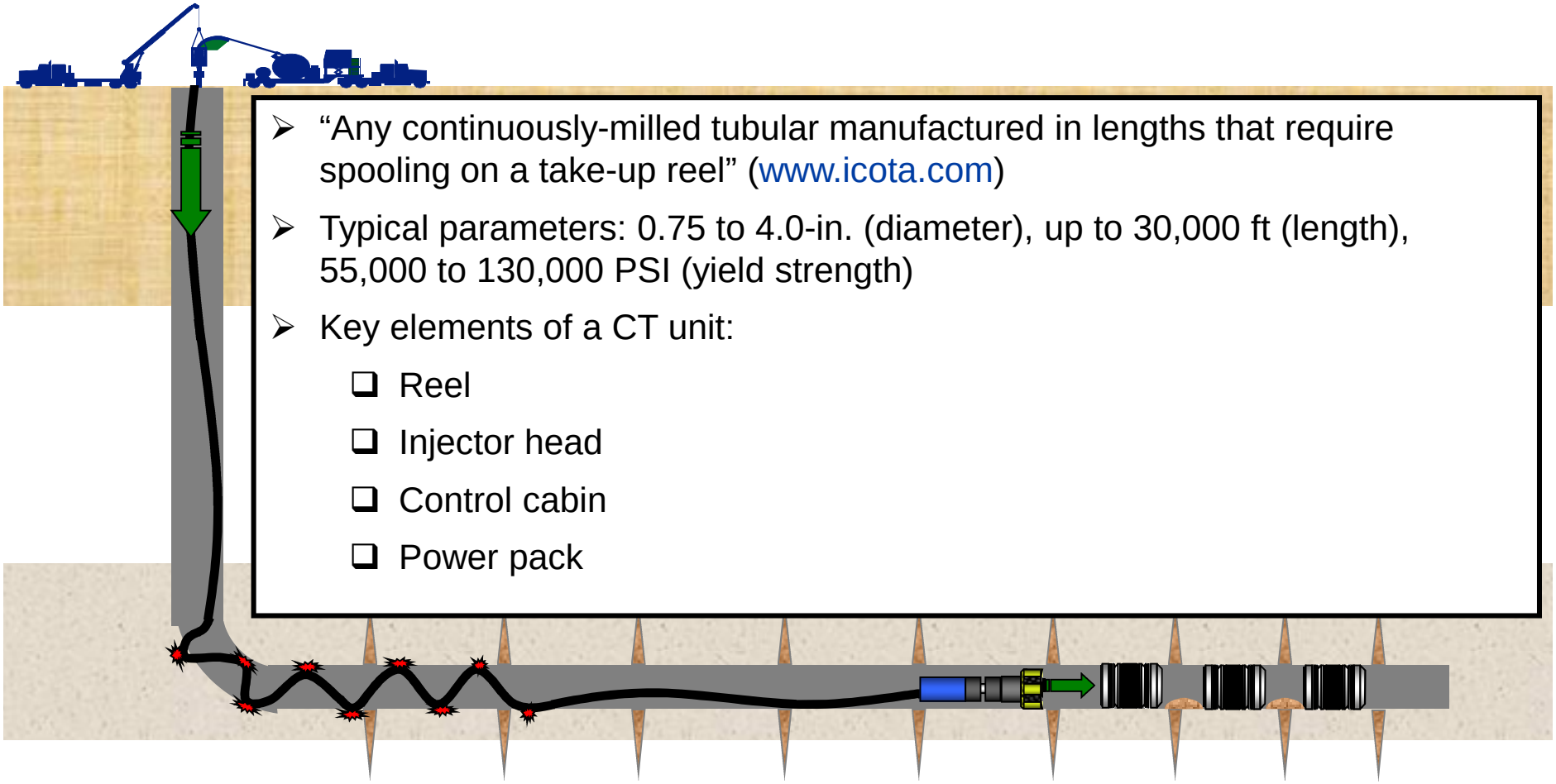
BAKER HUGHES

What is Coiled Tubing (CT)?



- "Any continuously-milled tubular manufactured in lengths that require spooling on a take-up reel" (www.icota.com)
- Typical parameters: 0.75 to 4.0-in. (diameter), up to 30,000 ft (length), 55,000 to 130,000 PSI (yield strength)
- Key elements of a CT unit:
  - Reel
  - Injector head
  - Control cabin
  - Power pack

CT Applications

Pumping Applications	Mechanical Applications
➢ Removing sand or fill from a wellbore ➢ Fracturing/acidizing a formation ➢ Unloading a well with nitrogen ➢ Gravel packing ➢ Cutting tubulars with fluid ➢ Pumping slurry plugs ➢ Zone isolation (to control flow profiles) ➢ Scale removal (hydraulic) ➢ Removal of wax, hydrocarbon, or hydrate plugs	➢ Setting a plug or packer ➢ Fishing ➢ Perforating ➢ Logging ➢ Scale removal (mechanical) ➢ Cutting tubulars (mechanical) ➢ Sliding sleeve operation ➢ Running a completion ➢ Straddles for zonal isolation ➢ Drilling

CT Advantages

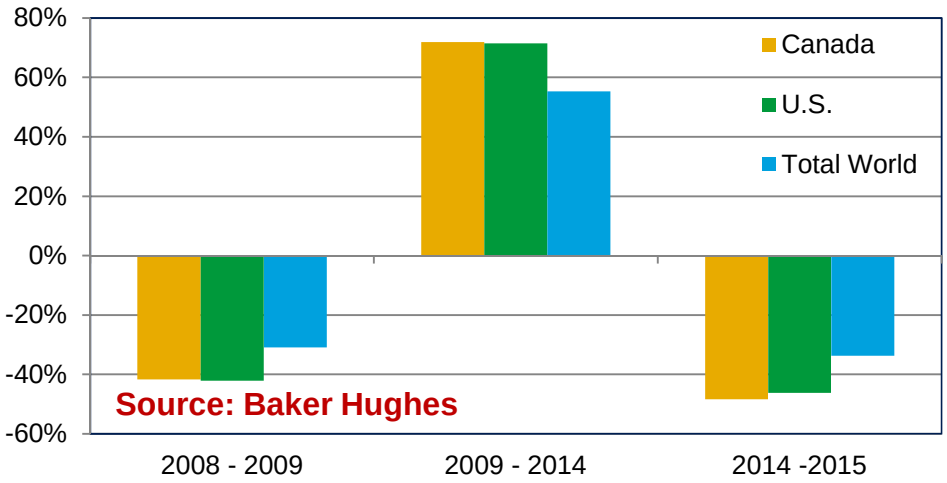
- Deployment and retrievability while continuously circulating fluids
- No need to kill the well
- Minimized formation damage when operation is performed without killing the well
- Reduced service time as compared to jointed tubing rigs
- Highly mobile and compact
- Increased personnel safety because of reduced pipe handling needs
- Existing completion tubulars remaining in place
- Ability to perform continuous well-control operations

CT Disadvantages

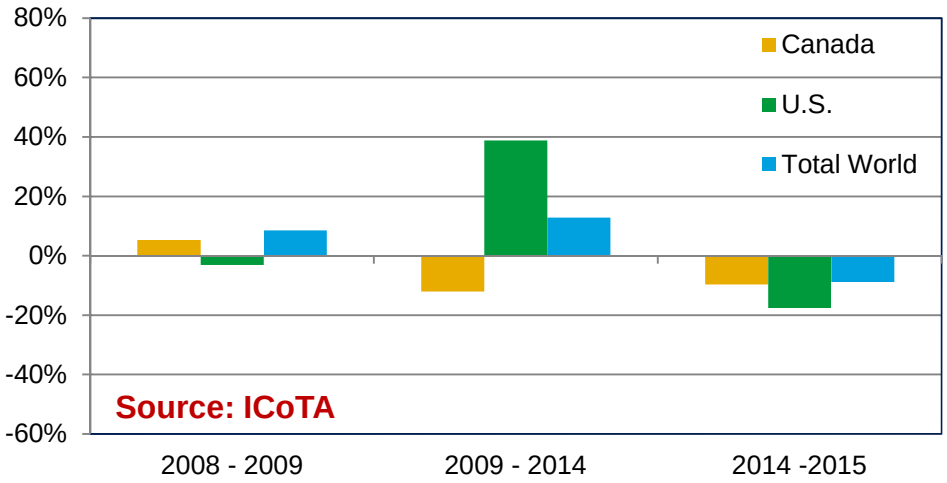
- Fatigue damage and reduced service life due to plastic deformation during bend-cycling operations
- Logistical challenges with both road transport and offshore crane lifting/deck loading limitations
- High pressure losses when pumping fluids
- CT corrosion and wear
- CT rotation inability

Rig and CT Unit Count Variations, 2005 – 2015
CT Total Available Market (TAM) Variation, 2014 – 2016

Rig Count Changes



CT Unit Count Changes



2014 vs 2015 CT TAM Variation	
Canada	-75%
US Land	-60%
US Gulf Coast	-32%
Europe	-31%
Russia Caspian	-30%
Africa	-16%
Latin America	-14%
Asia Pacific	-8%
Middle East	-8%
Global	**-32%**

CT TAM, Billions	
2014	$5.4
2015	$3.7
2016 (est.)	$3.1

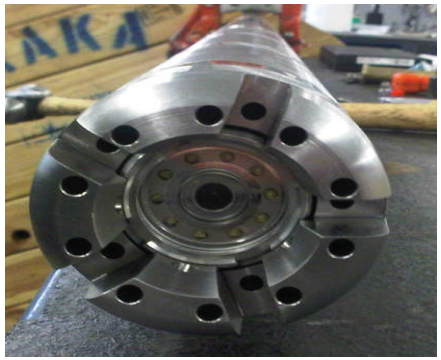
- 55 CT operators in Canada
- 39 CT operators in US
- 28 CT operators in Middle East

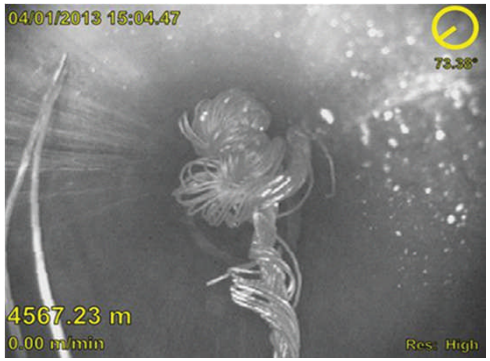
CT Market Current Conditions

- In prior industry cycles, declines in rig activity have not affected the CT market immediately
- The focus in the US CT market has shifted to supporting completion operations in the shale plays
- CT market in Canada has been commoditized
- In 2015, CT industry in North America had already had its 2008, with more activity reduction expected in 2016
- In 2015, international CT activity reduction was less drastic than in North America
- What lessons could the CT industry learn from this downturn?

Case Study: 2015 CT Applications in Norway

- 100% applications performed with an intelligent CT (ICT) technology introduced in 2015
- 52M Nok = CAD$8.25M estimated cost savings to operator
- First multi well-campaign where the ICT system replaced wireline for
  - Perforating
  - Logging
  - Camera service for casing collapse investigation
- Used smaller volumes of chemicals
  - Decreased fluid friction reducer usage by 70–75%
  - For instance, in only one well, total usage was 5,194 liter and saved 15,582 liters





One Solution: What is an ICT?

Surface Bulkhead

Slip Ring

Data Processing

ICT Wire
or
Optic Fiber

Pressure/Temperature Transducer

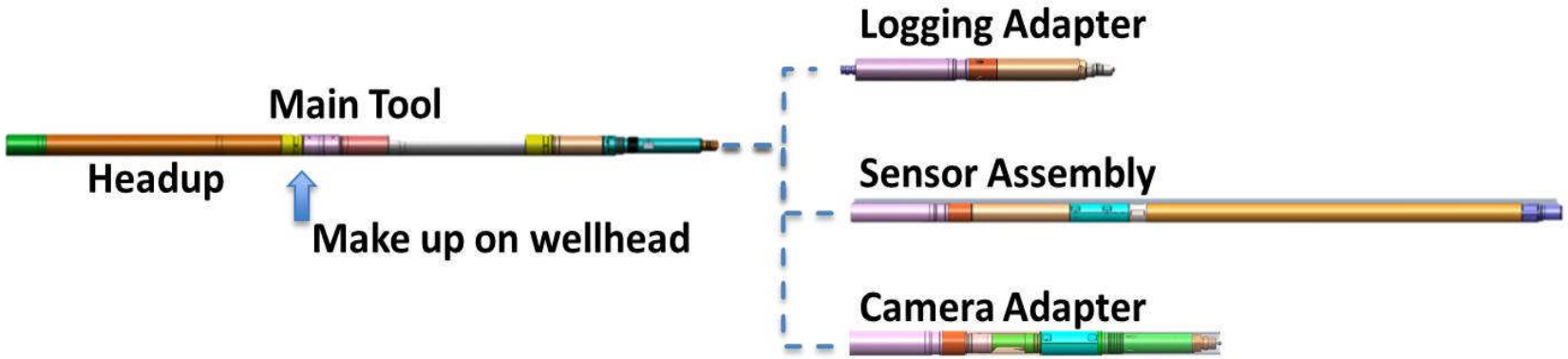
Data Interpretation

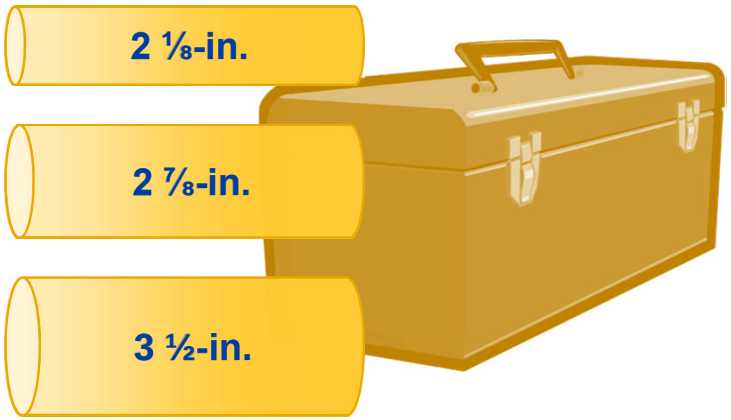
Electronics Module

Casing Collar Locator

Pressure/Temperature Transducer

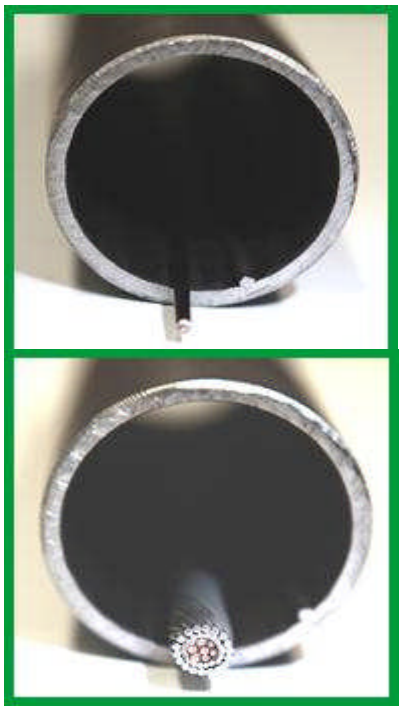
ICT Downhole Tools





ICT Wire

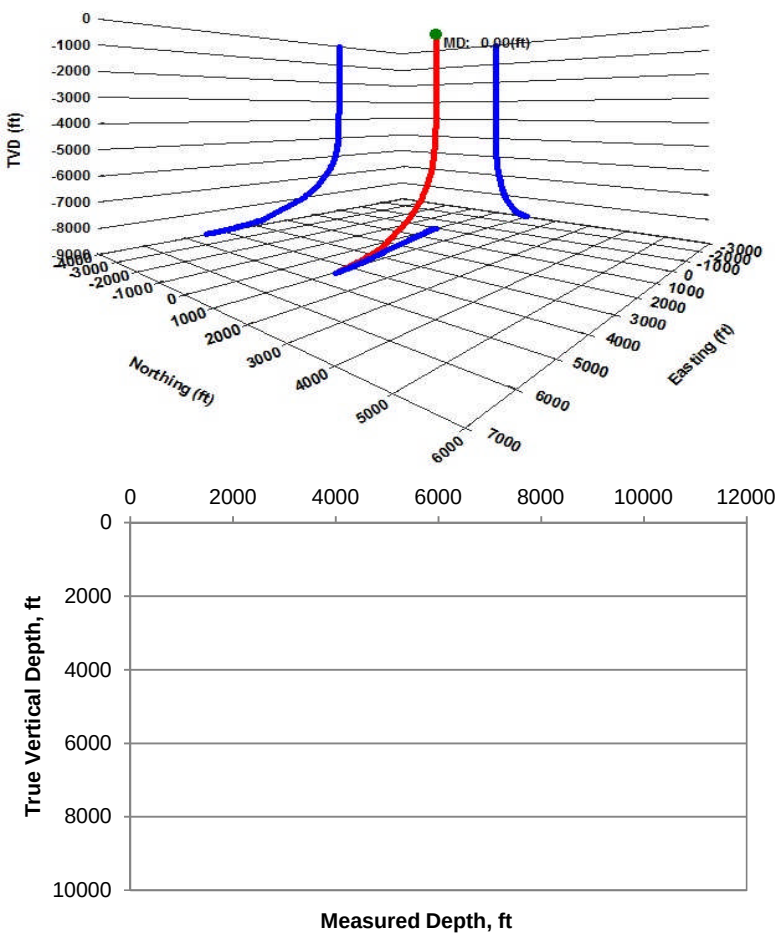
- 1/8-in. outside diameter (OD) corrosion resistant alloy tube
- Housing insulated electrical conductor
- Non-intrusive
- Passage of activation balls
- Extremely quick head up (<30 minutes)
- Compatible with common oilfield fluids / slurries
- Minimal effect on flow rates, friction pressures
- Minimal weight (about 1/10th of braided cable)
- Compatible with most single conductor cased hole wireline tools



ICT Case Histories

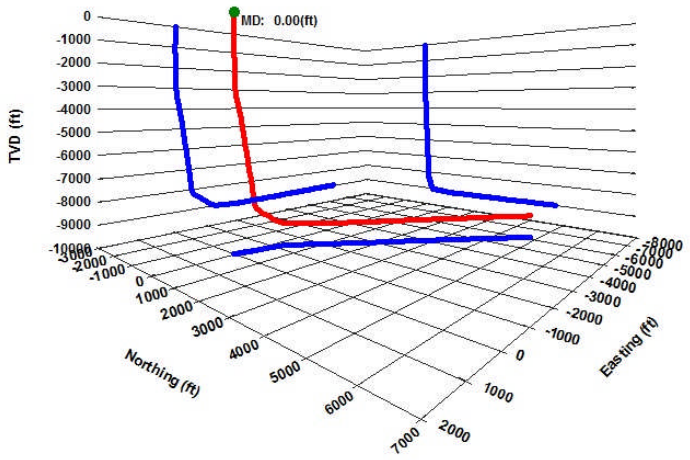
- **Case History 1 - Drifting, Logging, Jetting, Zonal Isolation, and Scale Removal**
- **Case History 2 - ICT Conveyed Camera Operation**

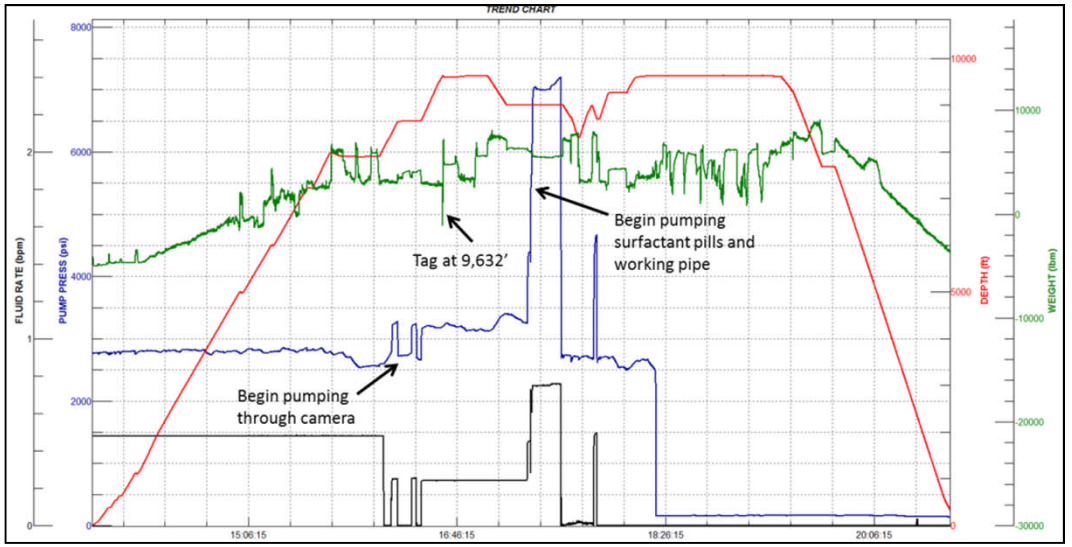
CH1 - Drifting, Logging, Jetting, Zonal Isolation, and Scale Removal (SPE-174850)



- Objective: restore hydrocarbon production in a mature offshore well in Brazil
- 2 ⅛-in. sensor assembly and logging adapter were installed on 1 ¼-in. CT; a 1 11/16-in. positive displacement motor (PDM), two 2 ½-in. inflatable bridge plugs, and a 1 ¾-in. rotary jetting tool were used
- Total run time was 336 hours
- 2 ⅛-in. ICT waiting time was 9 hours; conventional CT potential waiting time would have been 92 hours
- Multiple advantages for job efficiency and accuracy due to downhole pressure, temperature, and depth data

CH2 - ICT Conveyed Camera Operation (SPE-174850)

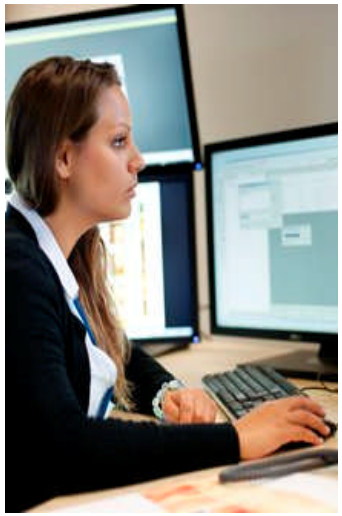




- Objective: identify collapsed casing during a multi-stage fracturing operation in Texas, USA
- Operational time for five unsuccessful runs with wireline, tractor, and camera was 27 hours plus 23 hours of standby
- ICT conveyed camera identified the collapsed tubing in 21 hours

Another Solution: Real-Time CT Modeling Software

Pre Job Engineering



Plan

Job Monitoring Dynamic Limits

Re-Tune

Injector Control Limits

Control

Downhole Feedback

Optimize

Controlled Performance

Automate

Conclusions

- North America CT industry is in a major downturn
  - In US, the focus has shifted from maintaining production to supporting completion operations in shale plays
  - In Canada, CT market has been commoditized
- International CT activity reduction is not as severe as in North America
- Long-term planning and innovation give competitive advantage in a downturn
- In 2015, an integrated, high-tech ICT system has been used 100% in Norway
  - Real-time depth, temperature, and pressure data eliminate the downhole uncertainties
  - Using the ICT system guarantees the predictability of successful operations and saves costs and time to operators
- A CT modeling software uses field data to update critical operational parameters in real time, dramatically enhancing safety, improving efficiency, and increasing certainty of success

Acknowledgements

- Jeyhun Najafov
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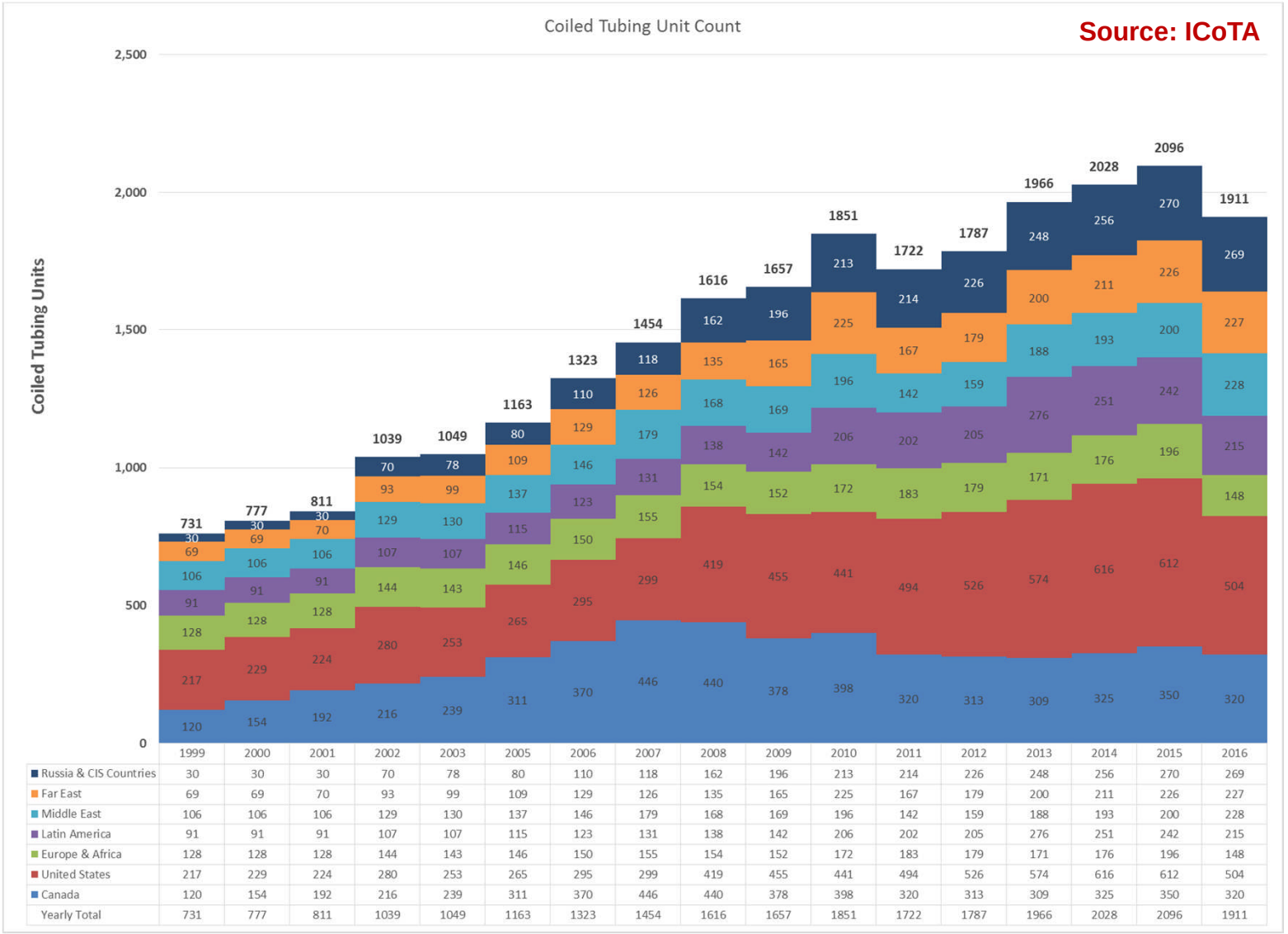
Questions?

Worldwide CT Unit Count, 2005 – 2016



	1999	2000	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Russia & CIS Countries	30	30	30	70	78	80	110	118	162	196	213	214	226	248	256	270	269
Far East	69	69	70	93	99	109	129	126	135	165	225	167	179	200	211	226	227
Middle East	106	106	106	129	130	137	146	179	168	169	196	142	159	188	193	200	228
Latin America	91	91	91	107	107	115	123	131	138	142	206	202	205	276	251	242	215
Europe & Africa	128	128	128	144	143	146	150	155	154	152	172	183	179	171	176	196	148
United States	217	229	224	280	253	265	295	299	419	455	441	494	526	574	616	612	504
Canada	120	154	192	216	239	311	370	446	440	378	398	320	313	309	325	350	320
Yearly Total	731	777	811	1039	1049	1163	1323	1454	1616	1657	1851	1722	1787	1966	2028	2096	1911