

CONFIDENTIAL

February 12, 2014

1651 – 94 Street NW • Edmonton • AB T6N 1E6 • Canada

• Tel 780.462.0707 • Fax 780.465.6603

info@quantiam.com • www.quantiam.com

Innovative Internal Coatings for HPHT Environments – Field Testing for the Future

Robert Deuis, David Waldbillig, Daniel Pilon, Craig Metcalfe and Steve Petrone

Abstract

Due to severe operating environments and sucker rod movement, the internal surfaces of oil well production tubing suffer material degradation from the influences of wear and corrosion that limit their service life. Imparting a wear/corrosion-resistant coating onto the internal surfaces of steel production tubing installed in mechanically pumped oil wells would: (a) minimize the wear damage caused by extensive side loads applied by the rod coupling onto the tubing inner wall during the rod down-stroke motion; and (b) reduce the frequency of expensive well overhauls to replace worn tube string sections.

Quantiam has developed an innovative and low cost internal coating technology that allows for a range of wear and corrosion resistant coatings to be deposited onto the surfaces of steel tubulars or complex shapes in general at coating thicknesses between 50 and 4,000 microns (~2 to 160 thousandths of an inch). Quantiam's coating process technology is non-line-of-sight and can be used to deposit advanced coatings on both internal and external surfaces. The metallic nature of Quantiam's coatings enables excellent high temperature and pressure properties and metallurgical bonding to the substrate.

Using this platform technology, a range of wear resistance coatings have been developed that exhibit high hardness, high fracture toughness, and good ductility. A series of corrosion resistant coatings have also been formulated that demonstrate corrosion resistances comparable to Inconel or Hastelloy alloys. The coating formulations were evaluated at a laboratory-scale in 2013 through a series of industry standard wear tests: ASTM G65 (standard test method for measuring abrasion using the dry sand/rubber wheel apparatus); ASTM G99 (standard test method for wear testing with a pin-on-disk apparatus); and in-house aqueous corrosion studies.

After the successful validation of laboratory-scale coating properties, field trials are advancing with a major oil producer in the Bakken region in 2014. A wear and corrosion resistant formulation was selected with a strong focus on improving wear resistance. In comparison to API 5CT J55 steel, the coating exhibited the following superior performance properties: by ASTM G65, a fifteen (15) fold improvement; by ASTM G99, a fifty (50) fold improvement; and by an accelerated corrosion test, a five (5) fold improvement. An initial field trial is being advanced with ten foot coated 2-7/8 inch OD J55 production tube pups totaling 500-1,000 linear feet, positioned at a location directly above the rod pump, a location where tube failures are common. Additional field trials in other related applications are being planned. Quantiam's internal tubular coating capacity for all applications is currently engineered at 3 million-inch²/year, expandable to 12 million-inch²/year (~127,000 linear feet [24 miles] of 2-7/8 inch OD tubulars).