

ENGINE workshop 4





Top-down cementing of geothermal wells in Iceland

Sturla Fanndal Birkisson, Iceland
Drilling Company
Sverrir Thorhallsson, Iceland
GeoSurvey (ÍSOR)



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PURPOSE OF CASING CEMENTING:



- Hold the casing in the well
- Prevent fluid migration outside the casing
- Corrosion protection.



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DIFFERENT CEMENTING METHODS IN ICELAND



- 1. The inner-string cementing
- 2. Inner-string followed by backfill to known loss depth
- 3. “The milky way”, or better known as top down cementing



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1. INNER STRING



- The inner-string cementing method is the rule
- Cementing through DP, stab in float collar, float shoe and up the annulus
- Frequently topping up when no returns are received or the cement level goes down
- This is due to losses of cement to the formation.



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1. INNER STRING



- Can pump until cement returns are obtained
- Cementing through DP, stab in float collar, float shoe and up the annulus to known loss zone
- Keep loss zone open by pumping water down the annulus
- Shorter pumping time



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1. INNER STRING



- Especially useful for large diameter casings and long strings



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2. INNER STRING FOLLOWED BY BACK FILL



- Cementing through DP, stab in float collar, float shoe and up the annulus to known loss zone
- Keep loss zone open by pumping water down the annulus while pumping cement on the string



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2. INNER STRING FOLLOWED BY BACK FILL



- Immediately followed by back fill, add LCM to the cement blend
- Pump at least the calculated volume down to the loss zone
- Repeat until annulus is full



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DOWN SIDE OF INNERSTRING METHODE 1. and 2

- Places great pressure on the formation, with the danger of creating new fractures
- Collapse force on the casing from the slurry having a density of 1.65 g/cm³.



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DOWN SIDE OF INNERSTRING METHODE 1. and 2

- In standard well design in Iceland the collapse force becomes an issue for both 18 5/8" 87,5# and 13 3/8" 68# casing
- In most cases this collapse force during inner-string cementing is what determines the required casing thickness



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DOWN SIDE OF INNERSTRING METHODE 1. and 2

- The cement can freeze in large cement jobs, causing the cement top to stop inside the casing
- Resulting in spaghetti job that always is a risky operation, not being able to reach the top of cement coming from below.



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DOWN SIDE OF INNERSTRING METHODE 1. and 2

- The cement that has the purpose of making solid fill between casings, where we do not want any free water, has to travel the longest distance



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3.TOP DOWN CEMENTING

- All cement slurry is pumped down the annulus and displaced water allowed to flow up inside casing and out through a cement head on top of the casing.
- This flow is throttled by two choke valves to match the cement slurry volume being pumped.



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3.TOP DOWN CEMENTING

- Water meters are placed on the return flow lines and there is also a totalizer on the cement pump to allow proper control of the chokes.
- There is therefore no „free fall“ of the slurry and a backpressure built gradually up at the cement head from the weight of the cement column



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3.TOP DOWN CEMENTING

- Cement slurry is pumped to annulus through kill-lines on the wellhead with the annular BOP's closed in order that no air is sucked in.
- Casing shoe without a float valve is used to allow return flow.
- Milk tracer is used to give notice that the cement has reached the casing shoe.



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3.TOP DOWN CEMENTING

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3.TOP DOWN CEMENTING

- Reversing of pressure build-up at wellhead also reveals when cement has reached the shoe and starts travelling up inside the casing
- Milk tracer is used as indicator to give notice when cement has reached casing shoe



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3.TOP DOWN CEMENTING

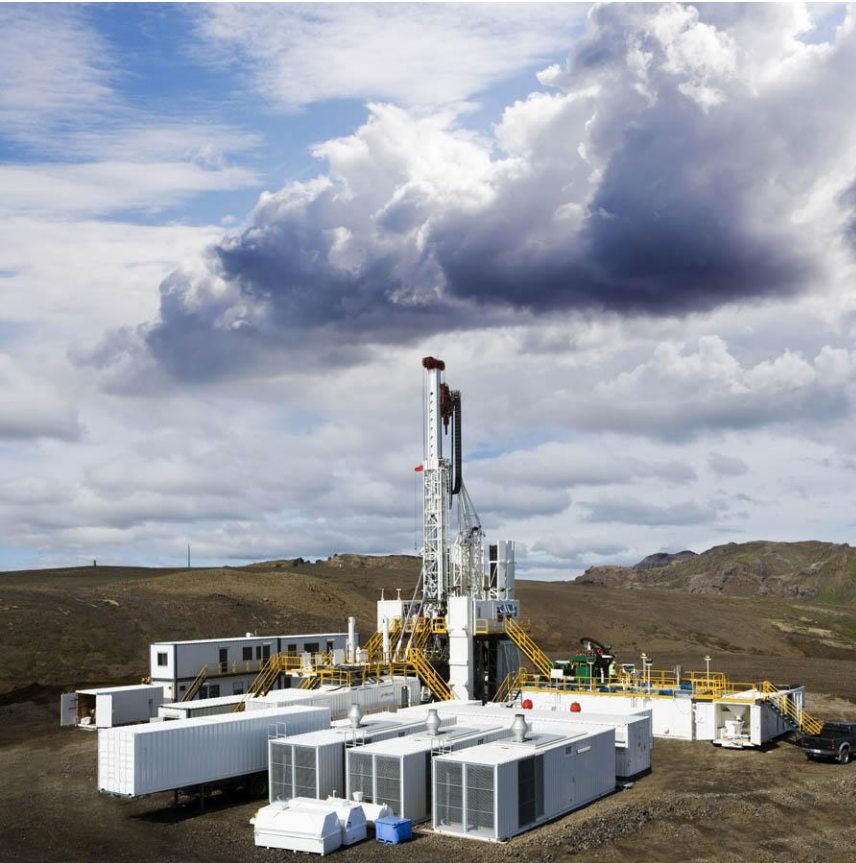
- As pressure on the wellhead goes up as the job progresses the choke needs to be adjusted to insure that volumes are in balance
- Instrumentation is required to allow proper flow control
- Three successful attempts have been made in Iceland so far.



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TOP DOWN CEMENTING IN THE FUTURE



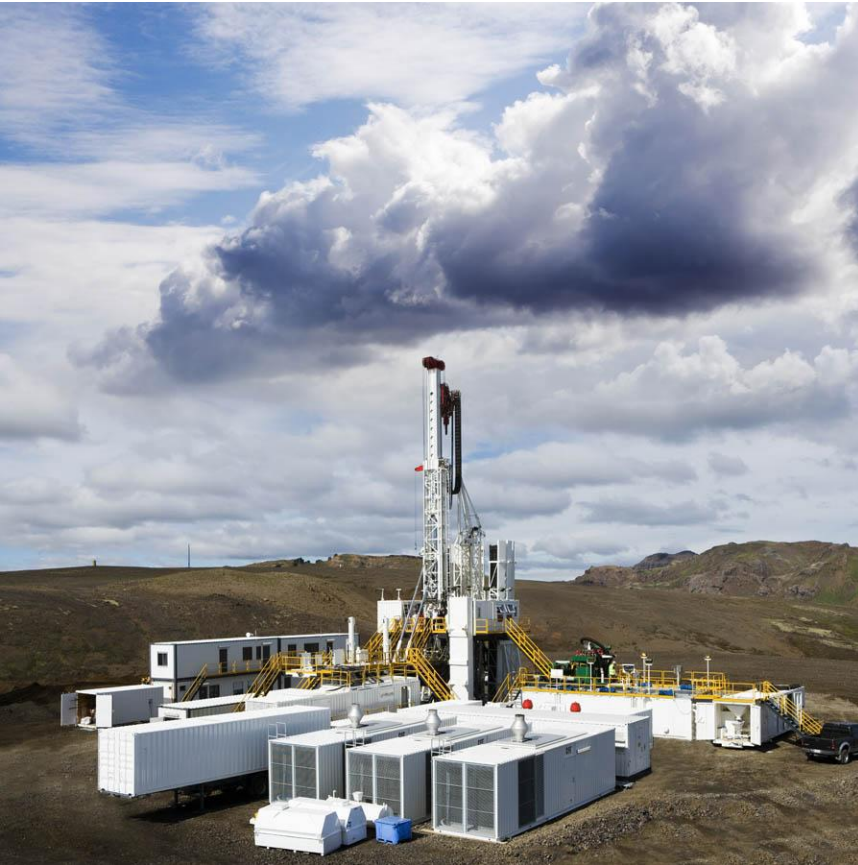
Longer casings will have to be run in the future and loss zones are frequently encountered. Therefore it is likely that the reverse circulation method will find wider use. The main benefits for geothermal wells are the following:



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TOP DOWN CEMENTING IN THE FUTURE



- Wells with loss zones can be cemented as gravity aids the flow and less pressure is exerted on the formation
- Less collapse pressure exerted on the casing as compared to inner-string cementing. Because the cement column pressure is partly being balanced inside the casing by the wellhead pressure.



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TOP DOWN CEMENTING IN THE FUTURE



- The wells can thus be designed with thinner walled casings
- Long casing strings can be cemented without reverting to 2-stage cementing.
- The slurry tail can be of high density to insure that there be no free water which can result in a casing collapse.



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TOP DOWN CEMENTING IN THE FUTURE



- No float equipment (float shoe and float collar) is required.
- Less time spent on cementing as the drill string does not have to be tripped in for an inner-string job.
- Low pressure cement slurry pumps can be used as there is no pressure build-up



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TOP DOWN CEMENTING IN THE FUTURE



- There is less heating-up of the cement slurry, allowing longer pumping times or less use of retarders.



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Hágöngur



Sleggjubeinsskarð



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Skarðsmýrarfjall



Properties: **Drilling rigs**



- Gardner Denver, upgrading 2003
- Drilmec HH-100 rig, 1998
- Drilmec G-55 rig, 2001
- Drilmec HH-220 1500 hp rig, 2004
- Drilmec HH-220 1500 hp rig, 2006
- Drilmec HH-300 3000 hp rig, (5) 2007
- Drilmec HH-300 3000 hp rig, (12) 2007



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Company History

- State Drilling Contractors (SDC) established 1945
- Iceland Drilling Limited company established 1986
- The share capital offered to the general public 1992
- The company put on sale on the stock market, Iceland Stock Exchange, 29. January 1993
- The State Treasury sells its shares 1996
- Iceland Drilling (UK) Ltd. established 1998
- Atorka Group takes over the company January 2005
- IDC delisted from Iceland Stock Exchange January 2005



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Human Resources

- **Management and Financial**
 - Chartered Accountant
 - Civil Economists
 - MBA
- **Technical**
 - Industrial Engineer
 - Geologists
 - Engineers
 - Mechanics
- **Foremen and Drillers**
 - with over 40 years job experience



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Customers

