

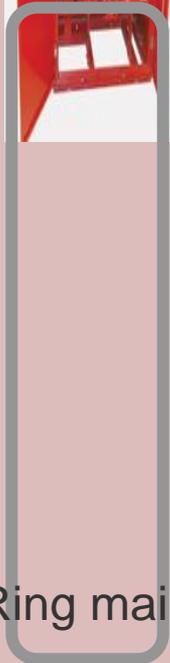


What about firewater in the Arctic?

Closing knowledge gaps

The challenge

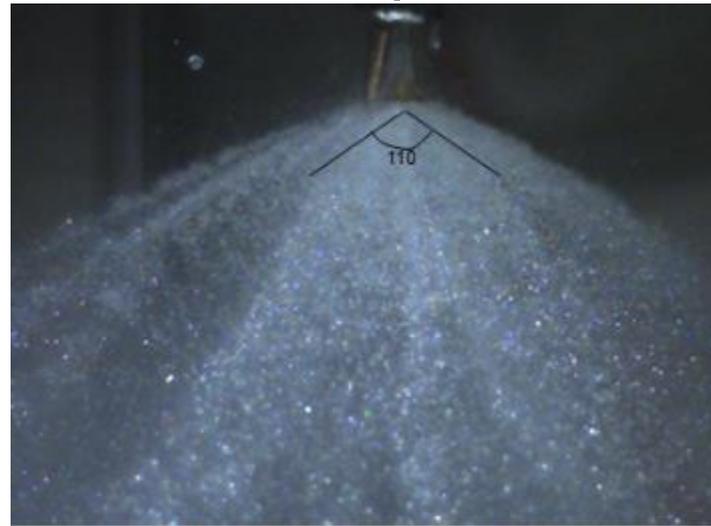
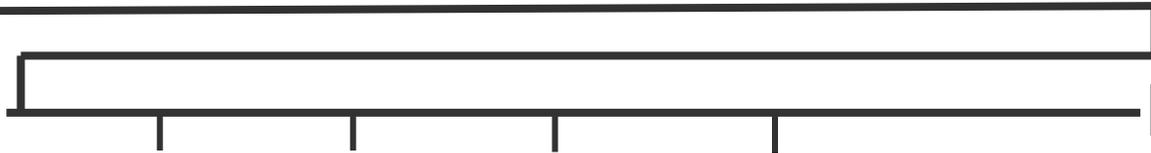
Deluge skid



Assumed heated

Assumed not heated

Pipes incl. nozzles is normally dry



Ice accretion (on deck)



Drain



Background

- x-Hydro prospects in Alaska, in Kara Sea and on Kharyaga onshore:
 - Fire water of great concern
- Alternatives
 - Additives
 - Glycols? Environment? Energy?
 - Potassium formate (CHKO_2) – «Aviform» - 50 % solution
- Land-based experience Norway - «Challenge starts at $-25\text{ }^\circ\text{C}$ »



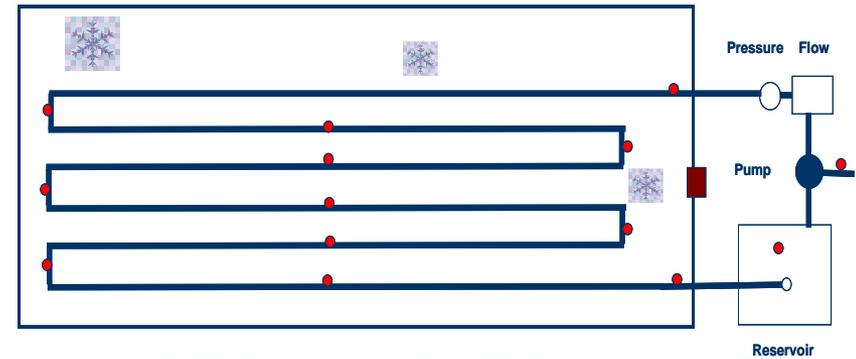
Daily mail: From a fire in Chicago 2006

Work so far – in Statoil

- Several literature studies from x-Hydro on alternatives/additives
- Pre-study for x-Hydro at SINTEF (simple water pipe transport at ca. -35 °C)
- Simple mathematical model developed for Brilliant/Vessfire (Petrell)
- Decision to contract preparation for experiments
 - Goal: Model development for freezing of water
 - Simplification: Fresh water – salt water complicates model development
 - Modellers
 - Acona (Fluent/OpenFoam)
 - ComputIT (KFX)
- Status: Two separate proposals for experimental campaign

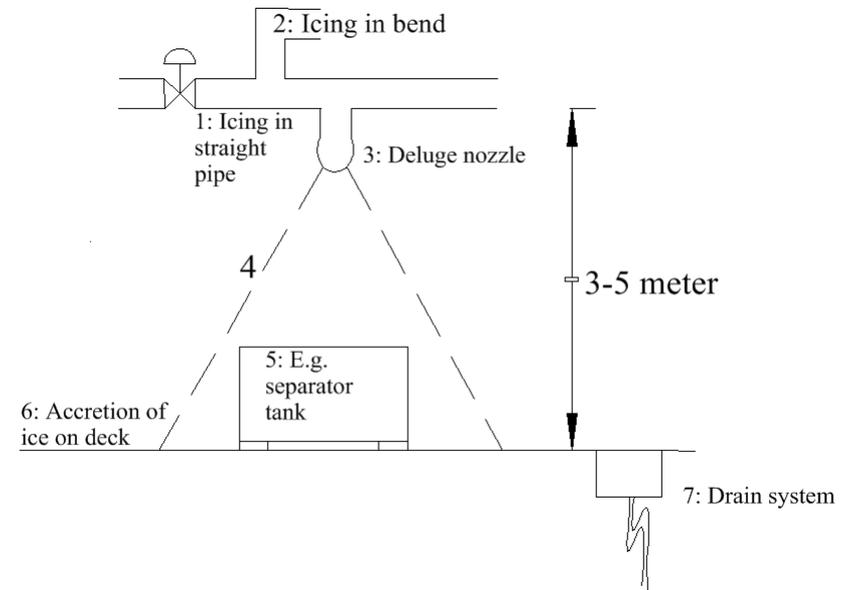
What has been done (2007)

- Freeze experiments for water transport in pipelines and nozzles down to ca. -35°C
 - Diameters
 - Flow
 - Material
 - Nozzles
- Results indicates that with sufficiently big flow the pipes will not freeze.
- There seems to be significant deviations from one piping material to another.



What has been done (2013)

- The studies by Acona and ComputIT
- They were asked to set up tests for 7 different issues:
 - Pipes
 - Bends
 - Deluge nozzles
 - Water spray
 - Ice accretion on process equipment
 - Ice accretion on deck
 - Drain system



Test parameters – possibilities

- Transport (piping)
 - Flow velocity 3 – 10 m/s
 - Diameter 1” – 2”
 - Length – up to 40 m
 - Piping material? Elastopipe, GRP, steel
 - No. of bends? (Recirculation zones) < 10
 - Look into/including T-s
 - Horizontal/vertical transport? Mostly horizontal
 - Nozzle? Yes, practical engineering. HV **and** MV
- Water spread – nozzle to deck
 - Experiments needed?
 - Foam?
- Ice accretion (on deck) – later experimental campaign?
 - Large, complex and expensive experiments
 - Drain?
- Wind?
 - Will probably have effect

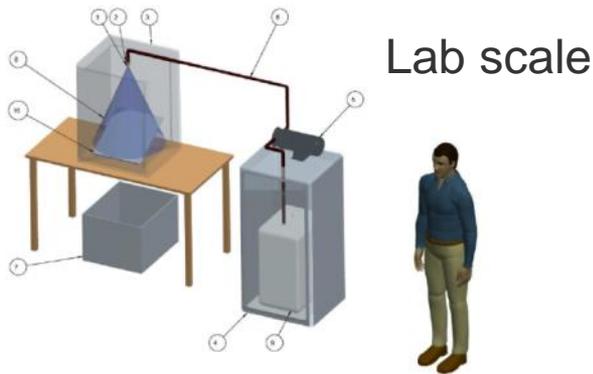


Daily mail: From a fire in Chicago 2006

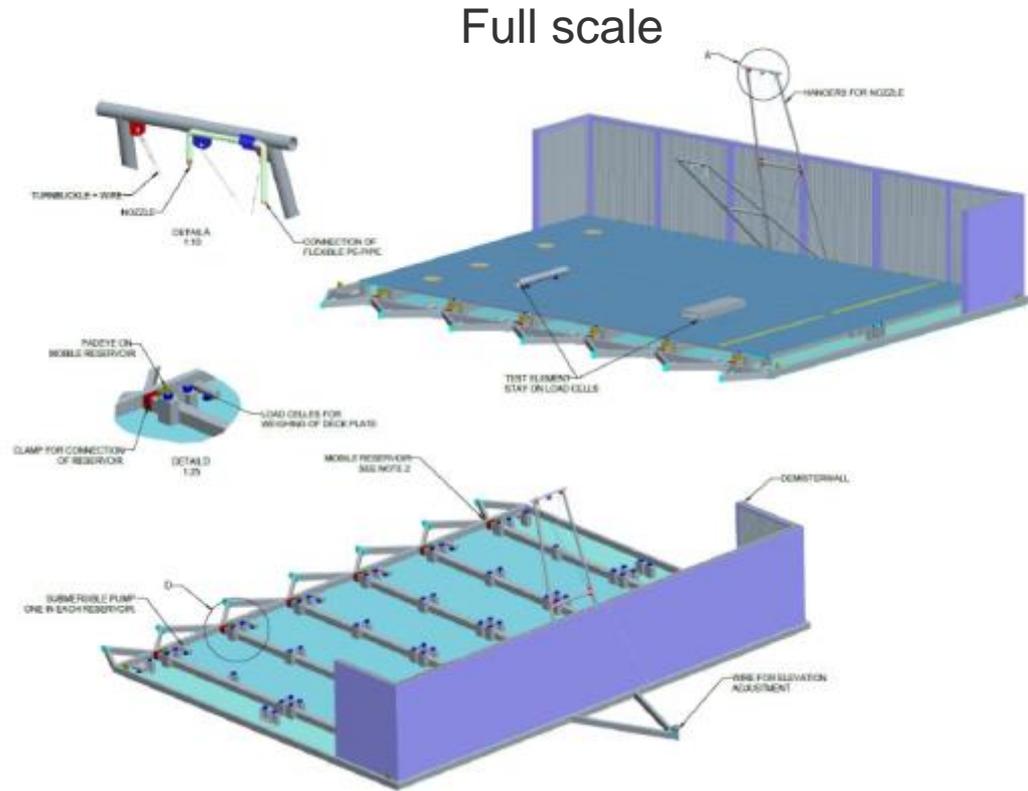
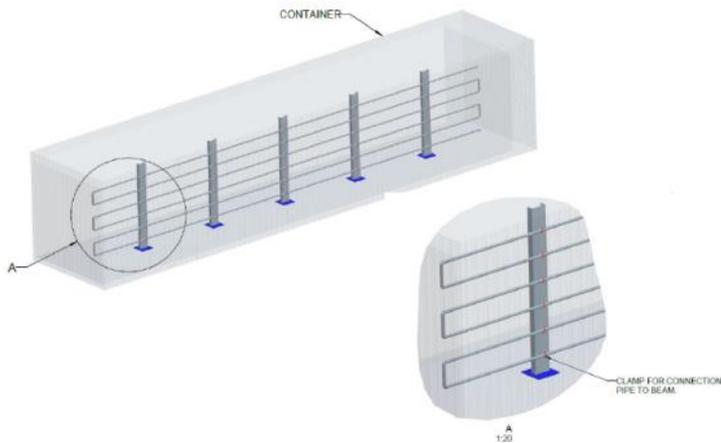
Status

- Acona proposal
 - Small scale lab test of nozzle and ice accretion
 - Medium scale container test of freezing in pipe
 - Large scale hall test for «realistic» layout
- ComputIT proposal
 - Pre-experiments to investigate instrumentation possibilities
 - Small/medium scale «water bed» tests to look into basic freezing physics
 - Combined medium/large scale hall test for all challenges

Acona proposal (Fluent, OpenFOAM)



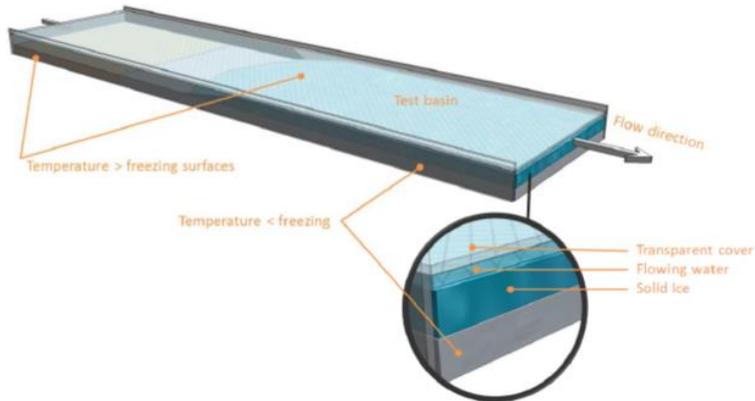
Container scale



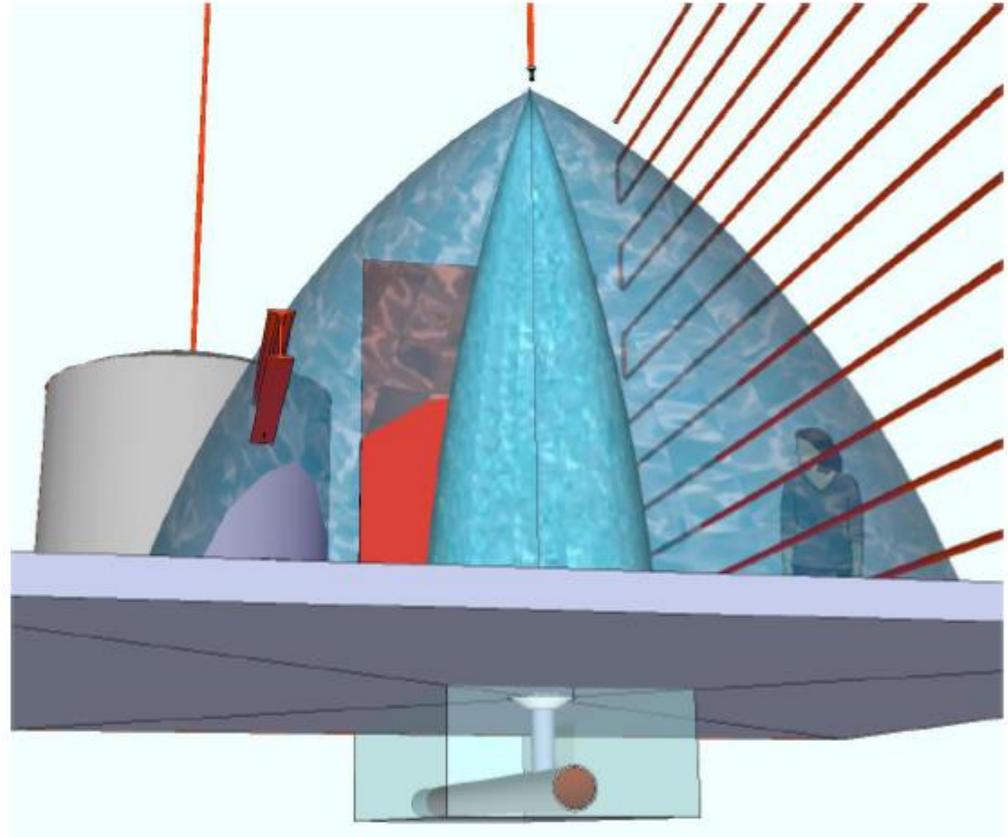
ComputIT proposal (KFX)

(Basic instrumentation tests)

Basic freezing of running water



Real scale tests



What will be done – 2014-

- ENI and Statoil join forces – costly experiments
- We will invite consultants companies to participate in an open tender for experiments
- We also recognize the need to develop models that can predict behaviour at other temperatures
- This will make us able to predict what will happen in other systems with other flows, temperatures, diameters, etc.

Challenges - Winterized and enclosed the installations

- Drilling and production installations in the Arctic will have to be winterized i.e. you have to close modules to be able to work there
- This way the temperature can always be above freezing – so the problems are solved?
- The philosophy on the NCS is to have open installations to have a good ventilation in case of a gas leakage – any gas leakage will be sufficiently diluted to prevent severe consequences.
- So we need to have an open installation?

The practical approach

- Winterize and close all areas that do not have higher risk for gas leakages
- Minimize the areas that have to be open/ventilated and try to reduce the need for maintenance/work in these areas
- Develop better clothing and PPEs for cold climate
- Develop active wall panels that opens on confirmed gas detection?

What else can we do?

- Re-look into alternatives and/or additives?
 - Requires enclosures
 - Water mist – mist or fog?
 - Inergen
 - Do we want to extinguish fires?
 - Requires storage space
 - Glycol, *e.g.* MEG
 - Requires energy
 - Heat tracing
- «Wait and burn out»?
 - Passive fire protection always required anyway



There's never been a better
time for **good ideas**

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Steingrim Bosheim

Leading researcher

E-mail address: sbos@statoil.com

Tel: +47 913 10 317

www.statoil.com

