CONDENSATION INDUCED WATER HAMMER
NZ CASE STUDIES

Taupo Geothermal Week July 2024
(NZGWS 2019)

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Agenda

1. What is CIWH?
2. Examples
3. Recommendations
4. Q&A

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CIWH

Condensation

Induced

Water

Hammer

It is not

- Slug flow in two phase lines
- Pressure rise when water changes velocity

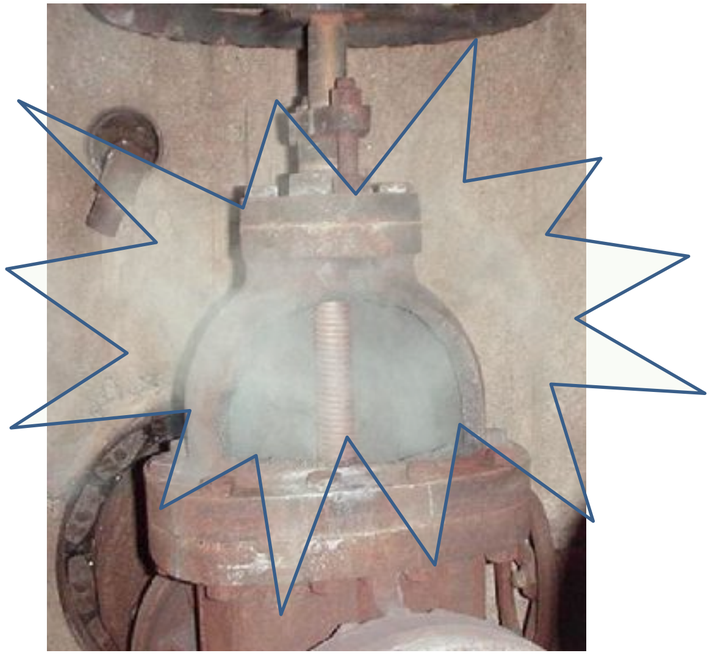
CIWH

Steam comes into contact with cooler fluid or surface

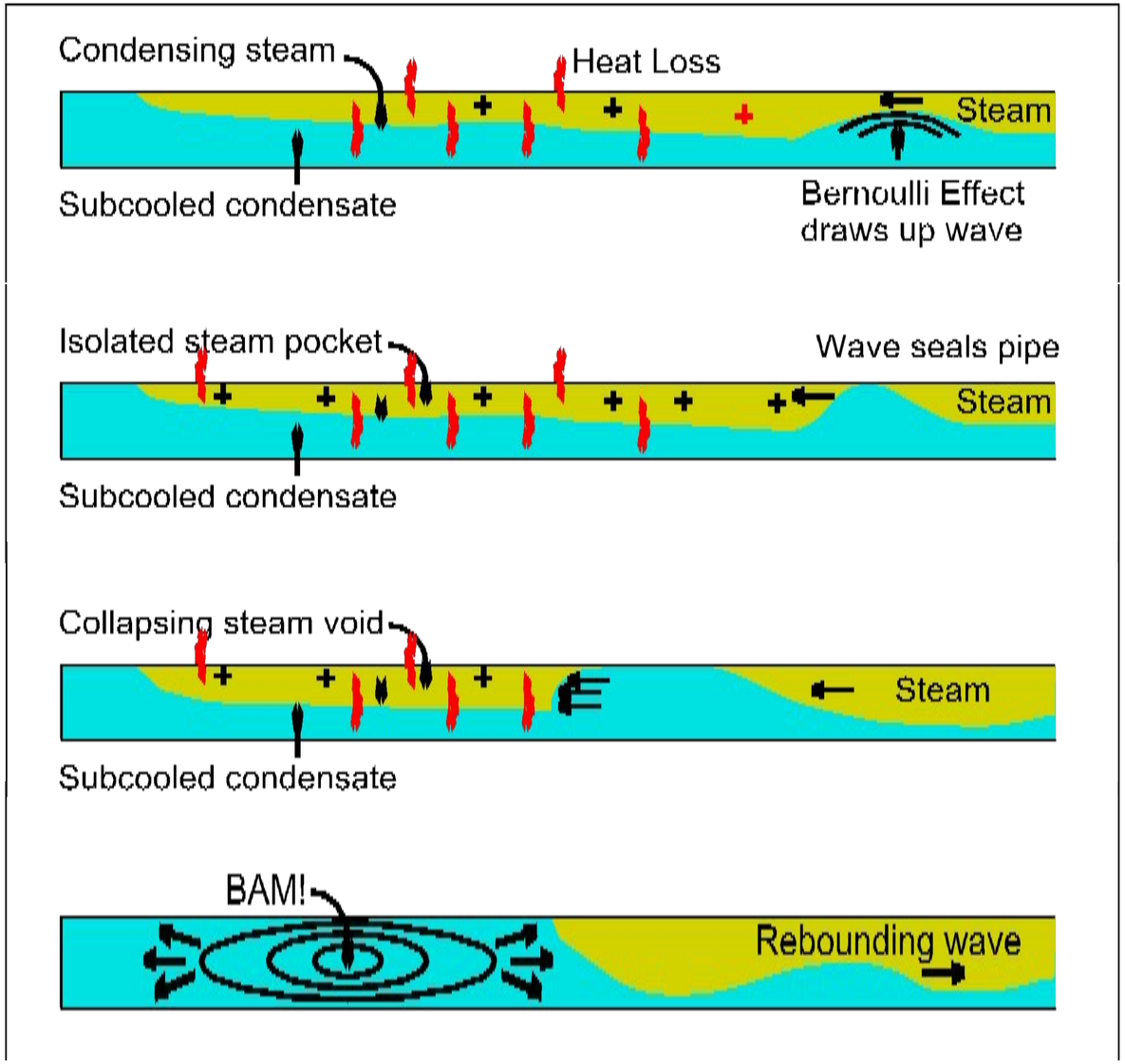
The steam condenses resulting a void and local reduction in pressure

Draws in the surrounding liquid at high velocity

High pressure and forces result when the fast traveling liquid has filled the void and stops suddenly

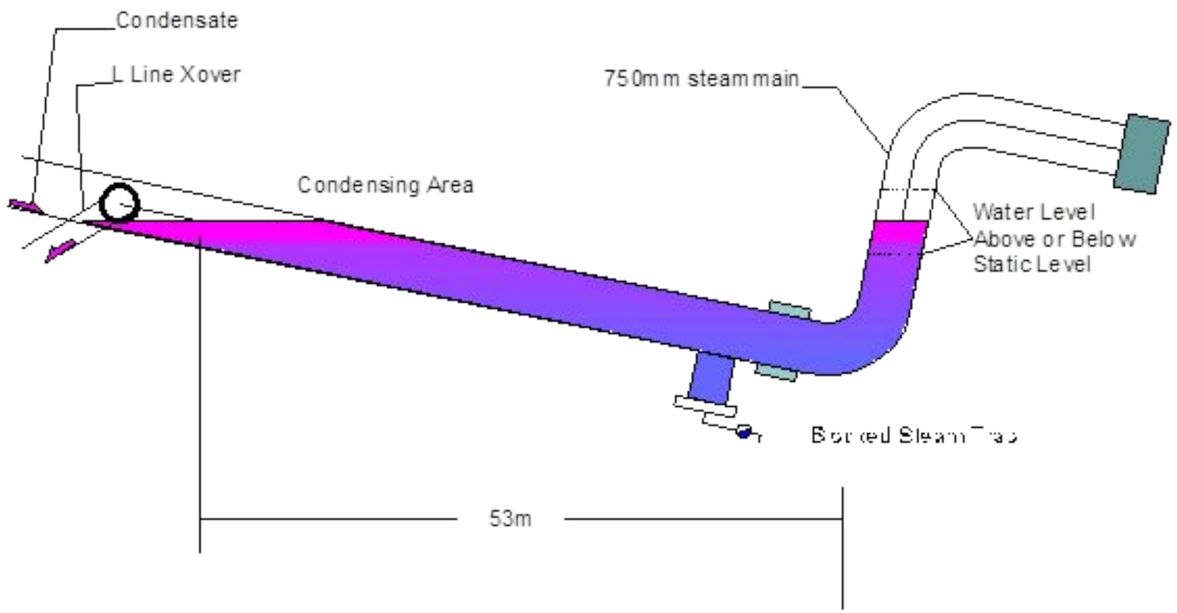


CIWH



- Steam comes into contract with cooler fluid or surface
- The steam condenses resulting local reduction in pressure
- Draws in the surrounding liquid at high velocity
- High pressure and forces result when the fast traveling liquid has filled the void and stops suddenly

Case 1A



- Two parallel lines connected upstream and downstream with vertical expansion loops.
- Leading up to the CIWH event, one of the steam trap blocked and filled with steam condensate.
- The steam flow diverted to the parallel line.
- The piping continued to fill with condensate, fully blocking this section of the line. The condensate cooled

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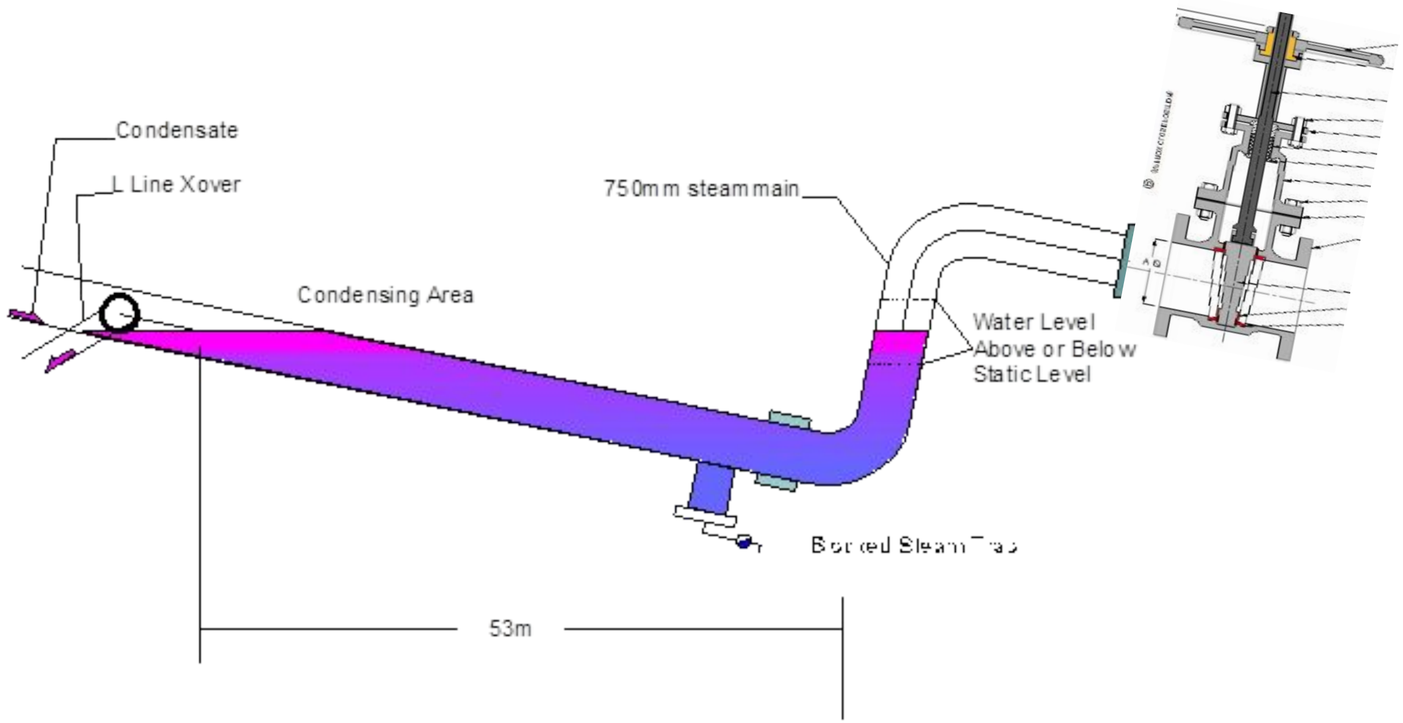
Case 1A



- Isolated the flooded area by closing an upstream valve. This isolated a pocket of steam between the valve and the cool condensate. Void colipase and a large hammer event
- The momentum of the condensate slug was transferred when the slug hit the valve gate.
- Calculated force 7000 kN (700 ton) or a pressure on the valve disc of 160 bar, 10 times the design pressure of the line..

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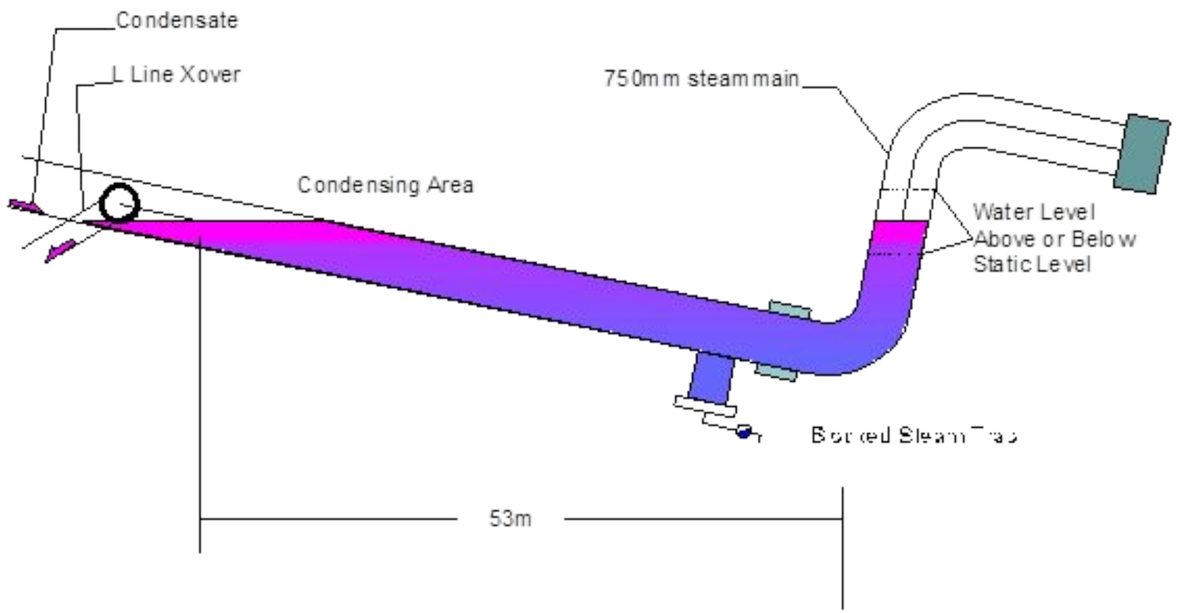
Case 1B & IC



- Piping not changed
- Blocked again
- Realised the danger

- Safe plan to remove the condensate

- Drain the water

- 1b, external heating
- 1c, steam injection

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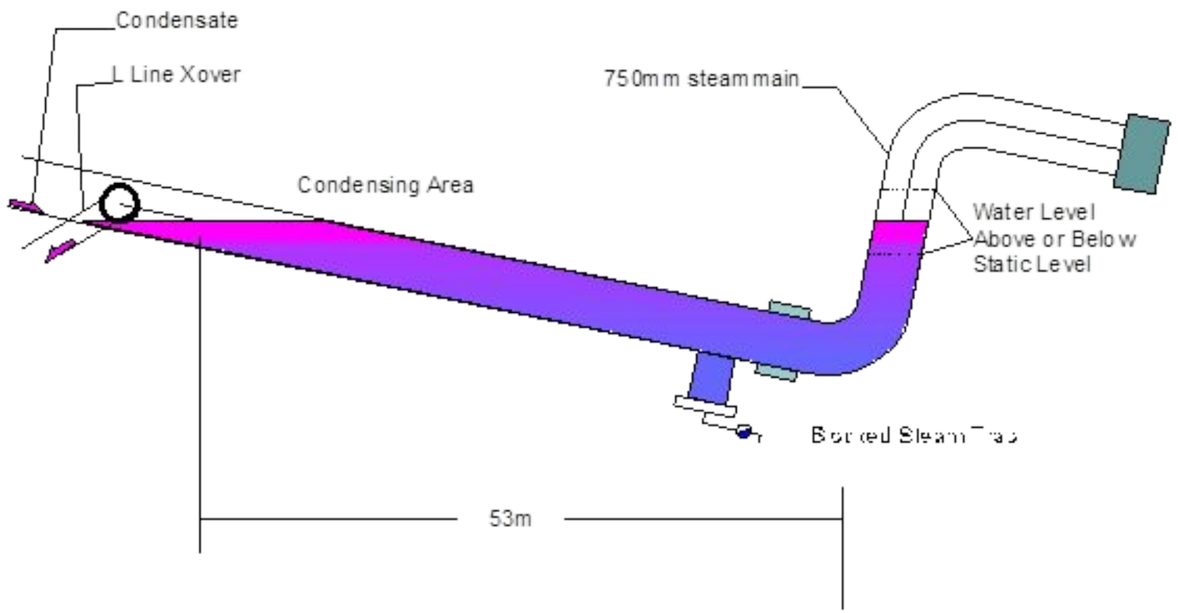
Case 1



- Avoid designing parallel steam lines with low points.
- Interconnecting the drain pots
- Level monitoring alarms on drain pots

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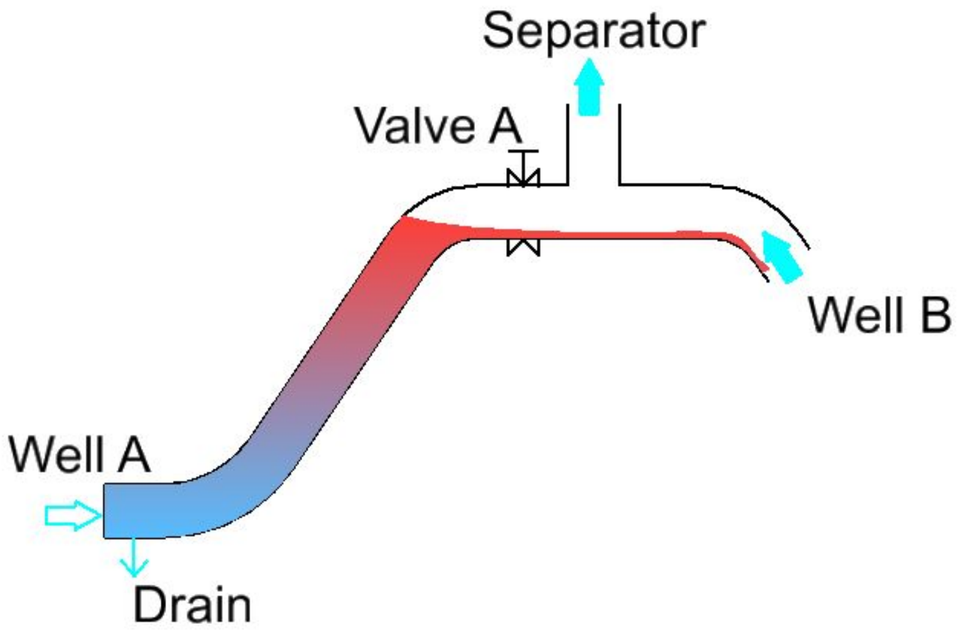
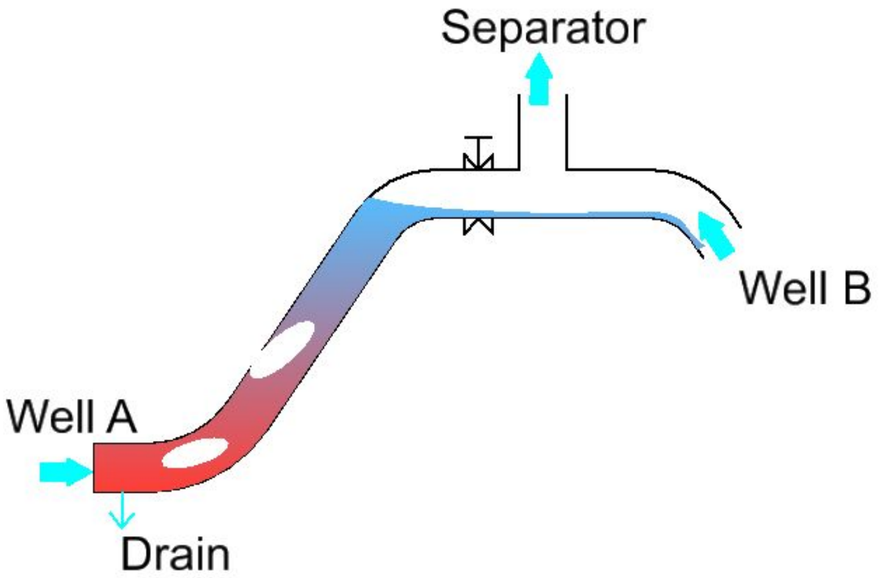
Case 5



- Two two phase lines feeding a separation plant at the top of a hill
- Well B on production. Well A closed
- Well A leg full of water. small drain at and of line
- Water cools at travels down well A line
- Water at well A subcooled in respect to hydrostatic pressure

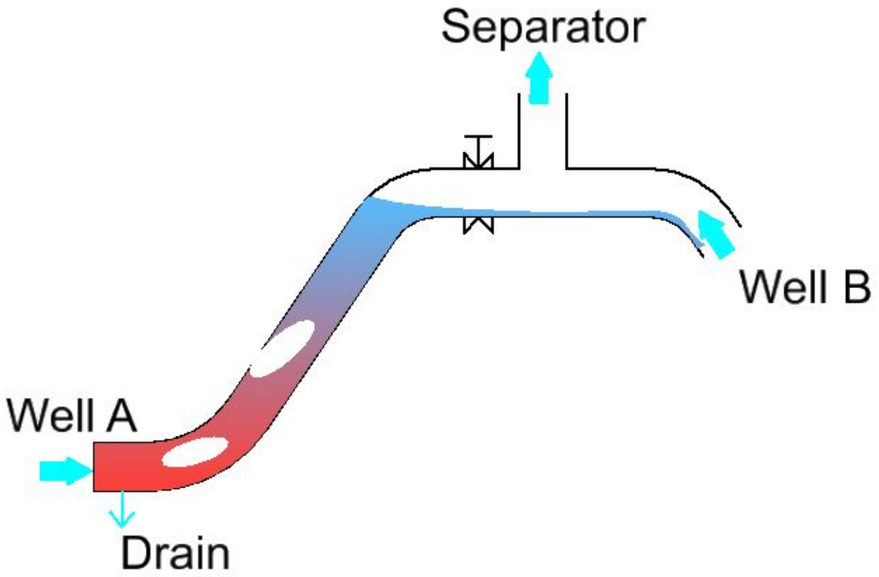
Case 5



- Open well A
- Steam phase from Well A condenses in the subcooled water
- Heats up water at end of pipe

- Steam bubbles form in the hot water and travel up into cooler water and collapse.
- Pressure wave travels up the line. Burst disk rupture

Case 5



- Operator closed valve A
- Trapped steam void colipases

940 kN
94 000 kg

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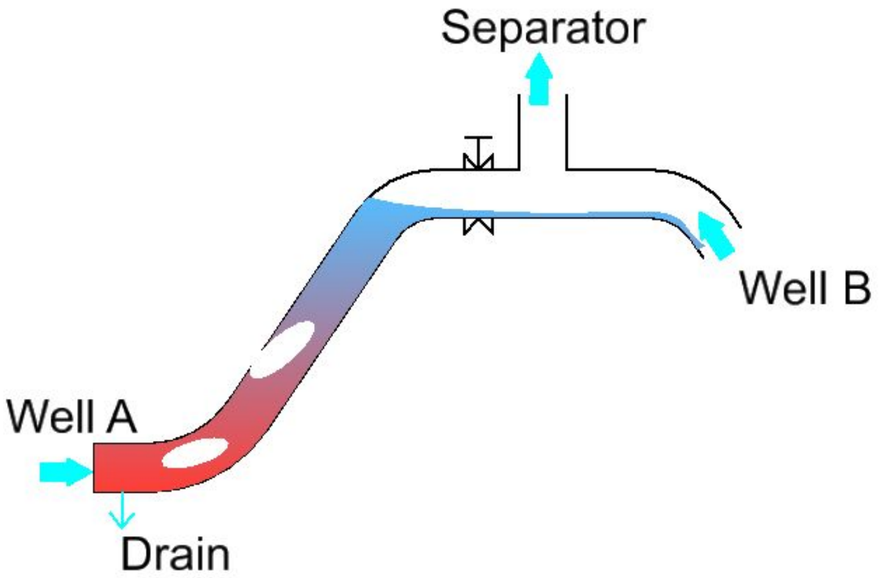
Case 5



The lessons from this event include;

- Avoid uphill two-phase lines
- Heat uphill lines from the bottom
- Improved operator procedures and training

DISCUSSION

- Awareness of CIWH by plant operators and engineers is important in reducing the risks to safety and business.

- CIWH should be included in your plant HAZID and HAZOP studies and design reviews.

- Design to avoid the initiating process
  (forces are large and difficult to predict and design for)

- Sharing experiences will lead to safer plant operation for all plant owners.

Acknowledgements – Questions please

The permissions to publish the details of these case studies from the plant owners is much appreciated.

The time provided the engineers from these owners to discuss the events and support this paper is also appreciated.

References:

CONDENSATION INDUCED WATER HAMMER, NEW ZEALAND GEOTHERMAL STEAMFIELD PIPING CASE STUDIES, Kevin Koorey, 2019

https://www.geothermal-energy.org/pdf/IGAstandard/NZGW/2019/023.pdf

www.kirsner.org

Thank you

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