Design Aspects of River Water, Ammonia Heat Pumps for District Heating

Eurammon at Home, 02/07/2020

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The 3 Secret Ingredients

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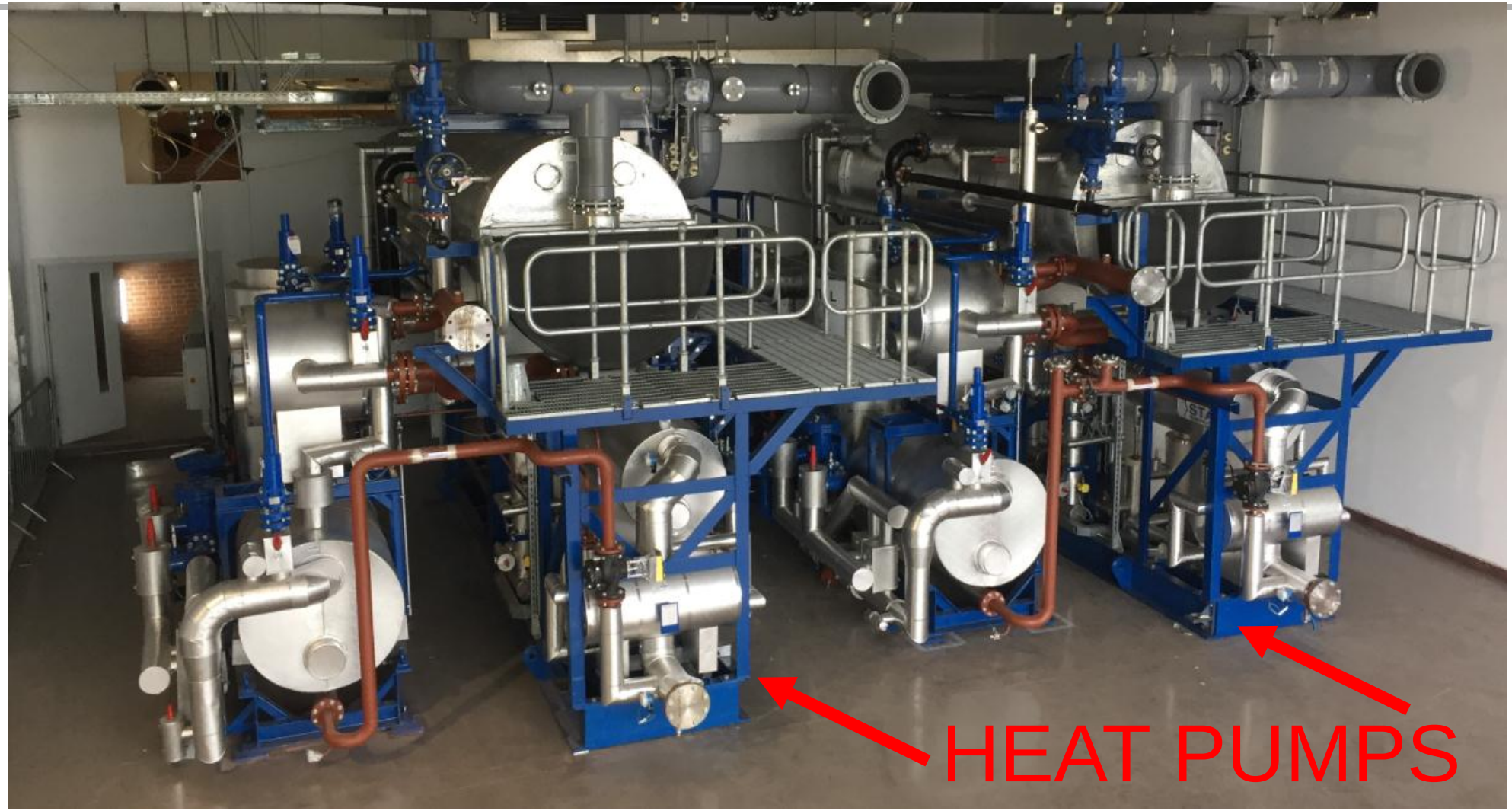
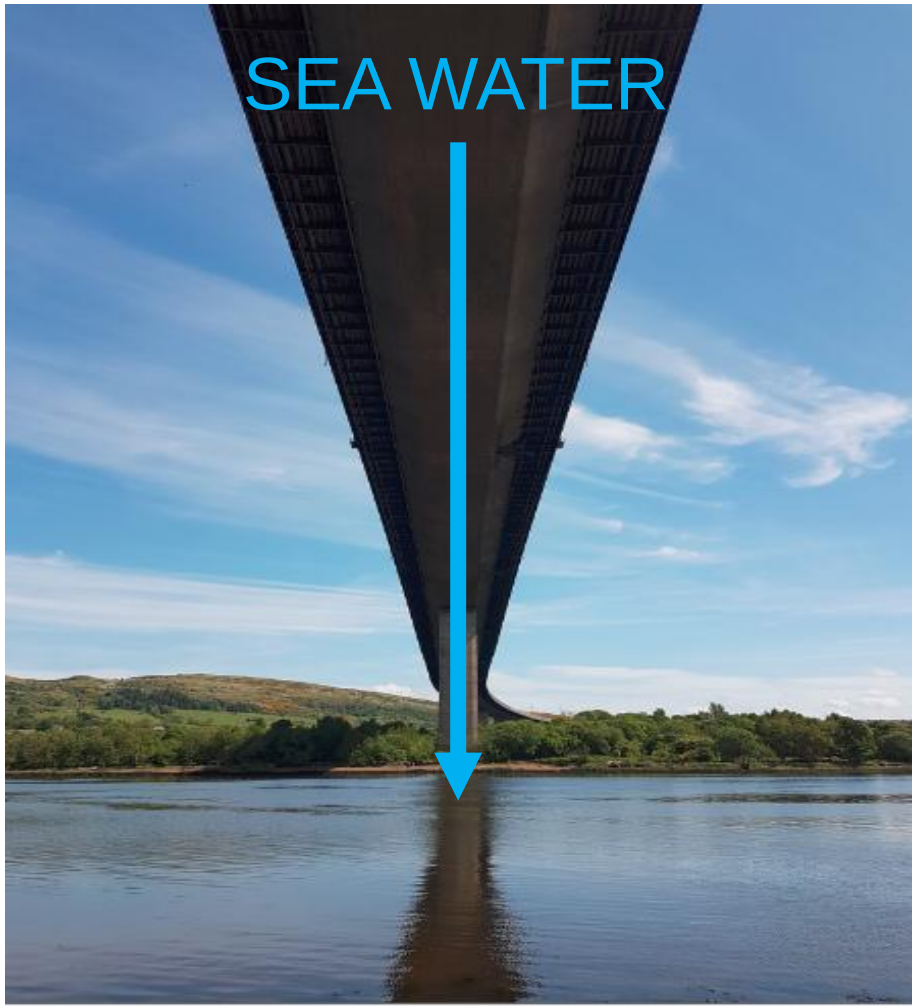


The 3 Secret Ingredients

River Water – Two Types of Water



River Water – Three types of Abstraction

- Open Loop
  Abstracted water goes directly into the heat pumps evaporator

- Closed Loop
  Pipework with glycol solution coiled into the river (like a ground source slinky array)

- Break Loop
  The river water abstracted is sent to a heat exchanger where on the other side is a glycol loop that feeds the heat pump. River water not in direct contact with the evaporator.

SEA WATER FOCUS

- Are you sure you can use this river??? Is it not too cold???

  A common question but yes it can be used. It comes down to the grade of heat we can extract based on the rivers temperature profile. We can take heat from the river down to about 4°C

- Is taking heat out the river not a bad?

  In reality the amount of temperature change cuased on the river is almost ngligable. We have worked with the environment boides in the UK that have devloped some guidelies to follow in terms of % of flow we can utilise and temperature change we enact (around 25% of Q95 and 3K). The change in river temperature we create is actually is seen as a positive due to climate change effects

- What are we doing with the sea water?

  The evaporator is where we take the heat out for example if the sea water it 5°C we would return it at 2°C

SEA WATER FOCUS – THE CHALLENGES

- What do we know about the river in the location we are looking to put the heat pumps?

  Do we know the depth, is it tidal (if so how much), who owns it?

- The chemical composition itself

  Affects material selections (mainly the evaporator tubes – titanium best option as you do not want to go cheap here and regret it later)

- The location of the abstraction

  Where are we taking the water from has a big impact. This can lead to increased filtration requirements and innovative pumping solutions due to tidal fluctuations

- Flora and Fauna filtration challanges

  While there can be lots of different things living in the river our biggest challenge has been how to approach dealing with mussels (in particular, the mussel seeds – 20microns!)

SEA WATER FOCUS – ABSTRACTING THE WATER

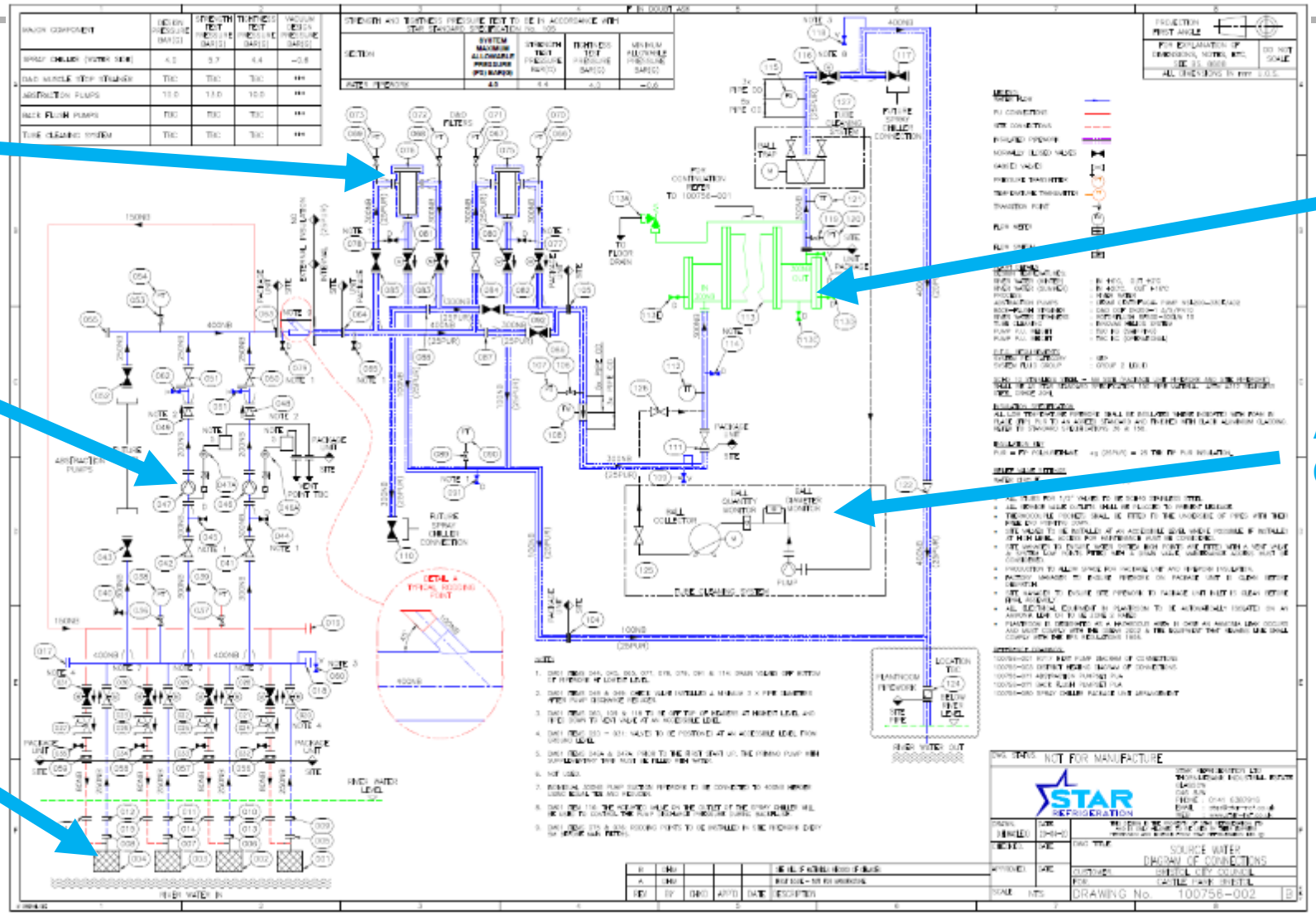
MUSSEL STOP

ABSTRACTION PUMPS

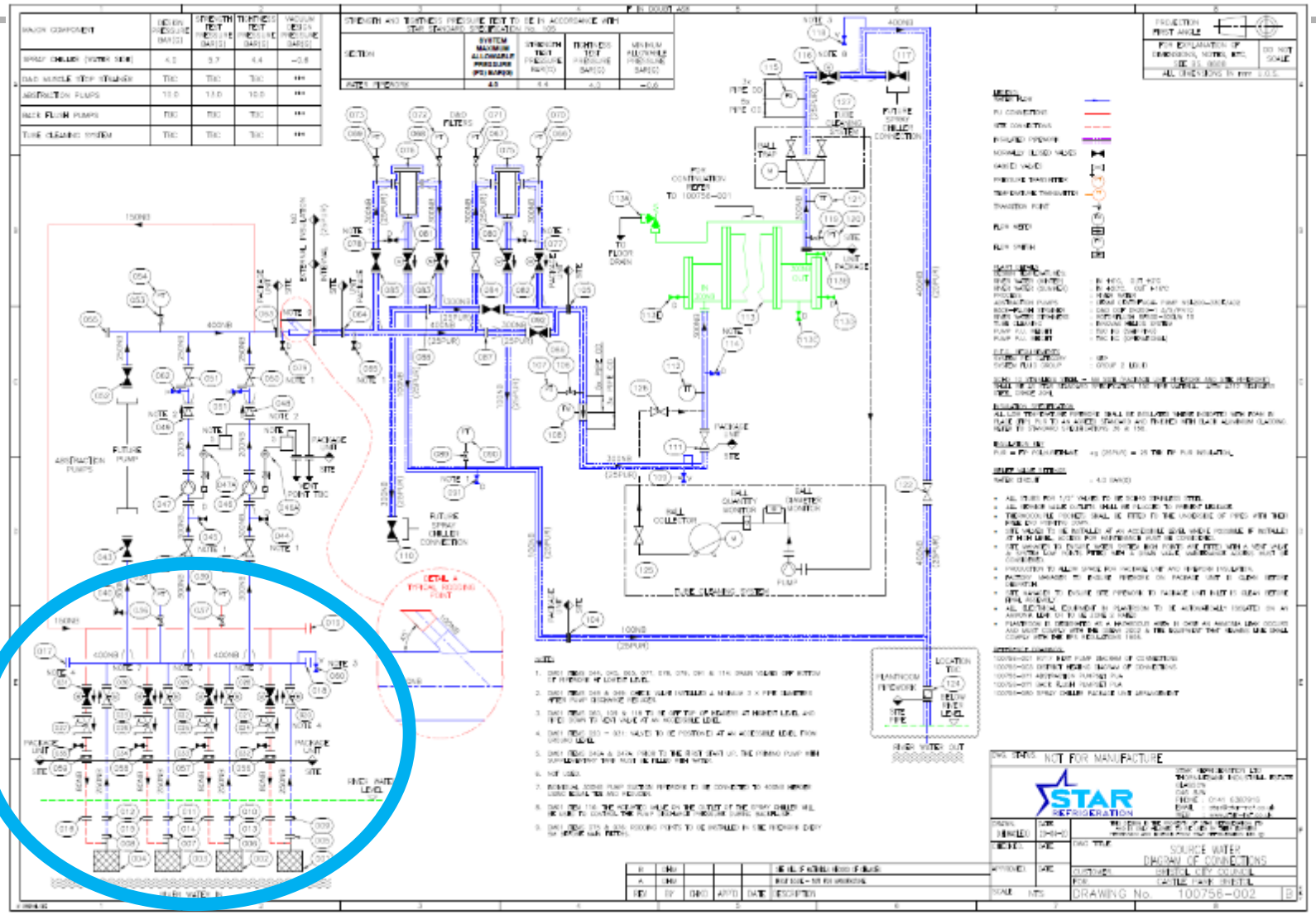
FILTERS IN RIVER

EVAPORATOR

AUTOMATIC TUBE CLEANING SYSTEM



SEA WATER FOCUS – SELF CLEANING FILTERS



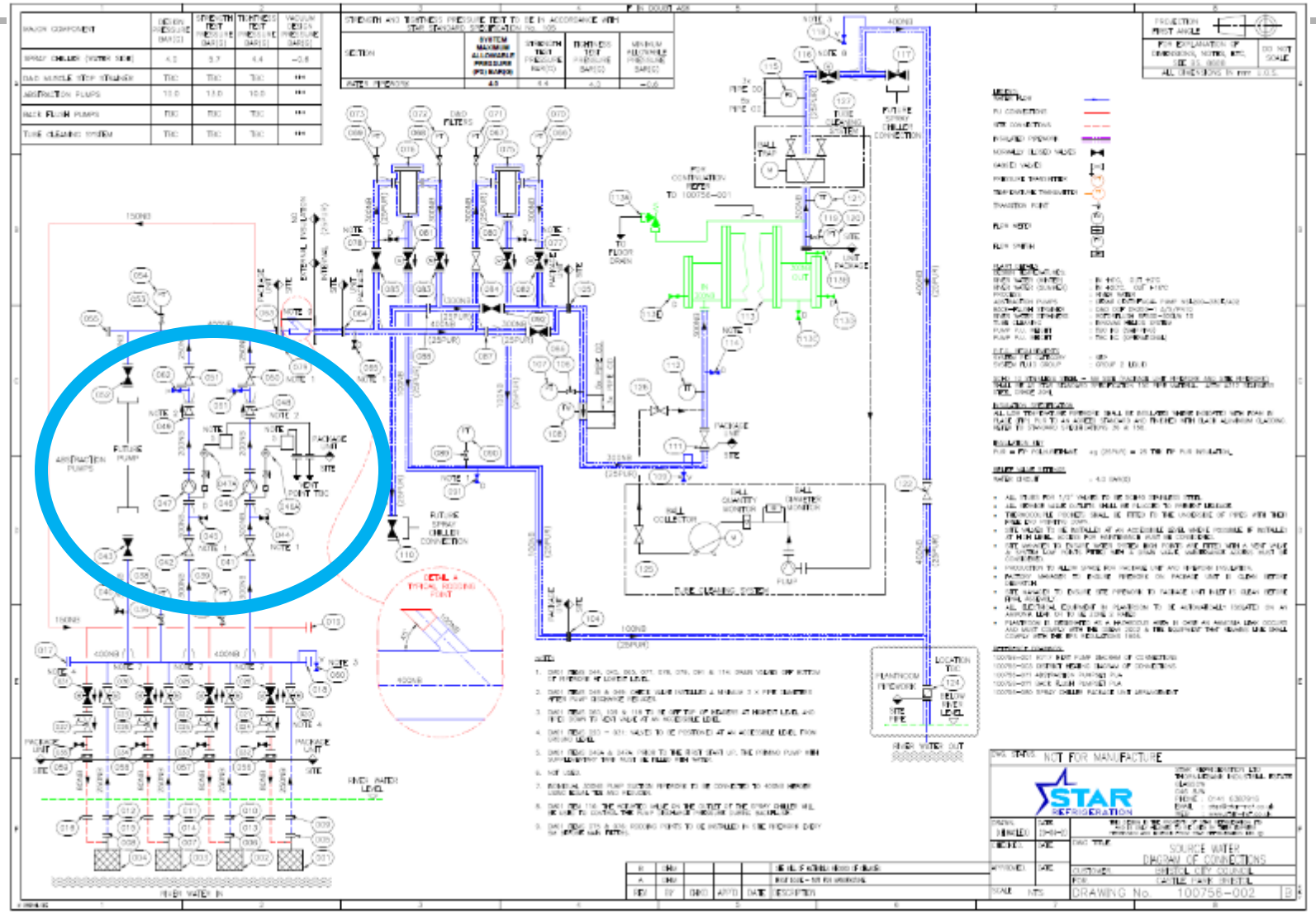
SEA WATER FOCUS – SELF CLEANING FILTERS

The self cleaning filter:

Whats its purpose?

- Initial filtration screen – 1mm woven mesh
- Self cleans through backwashing
- Must comply with eel regulation (velocity restriction)

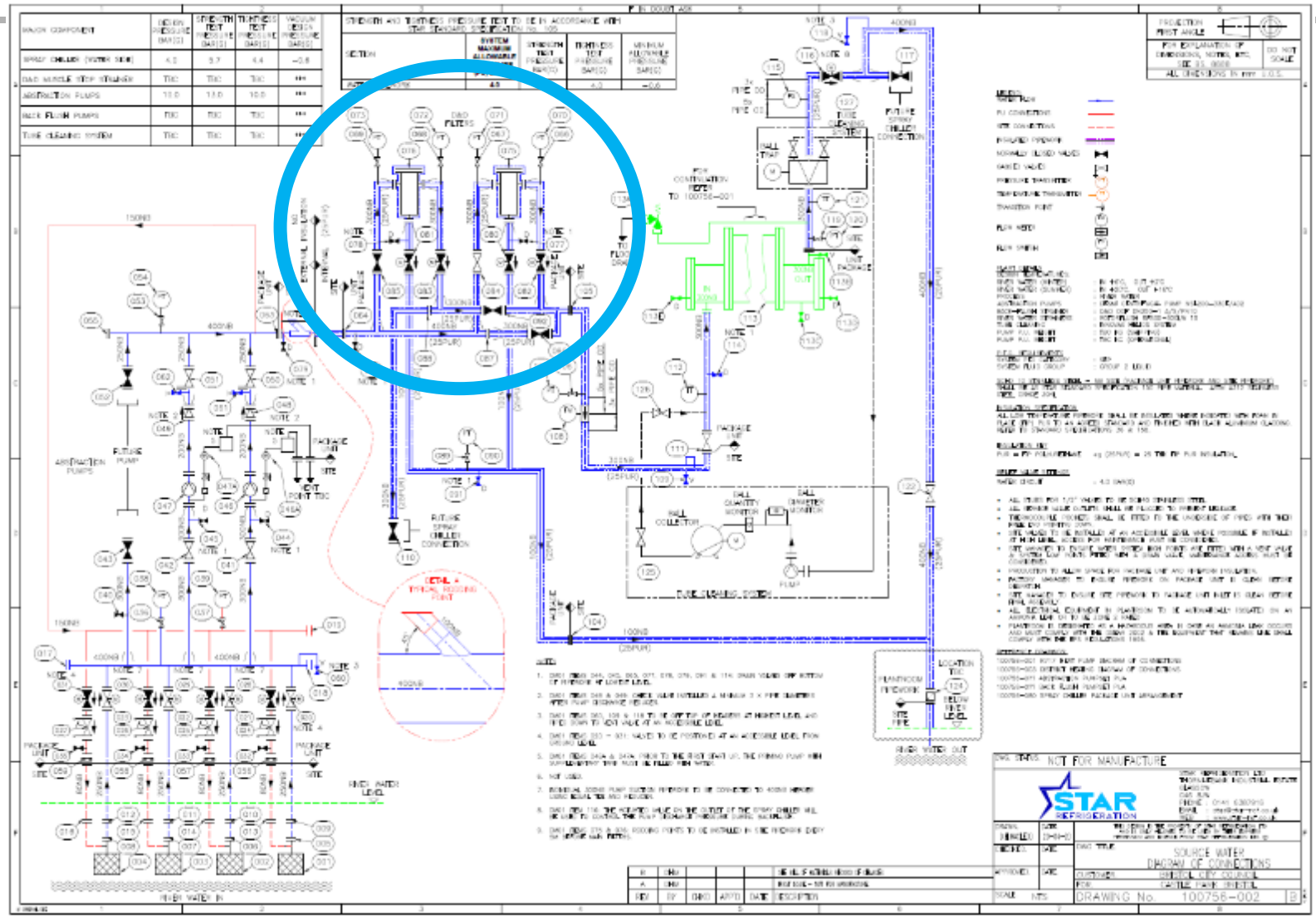
SEA WATER FOCUS – ABSTRACTION PUMPS



SEA WATER FOCUS – ABSTRACTION PUMPS

- Self priming Abstraction pumps
- Pump has an additional pump (vaccum) to prime it
- Variable speed
- Theoretical vertical lift 10m but reality is about 5 to 6m

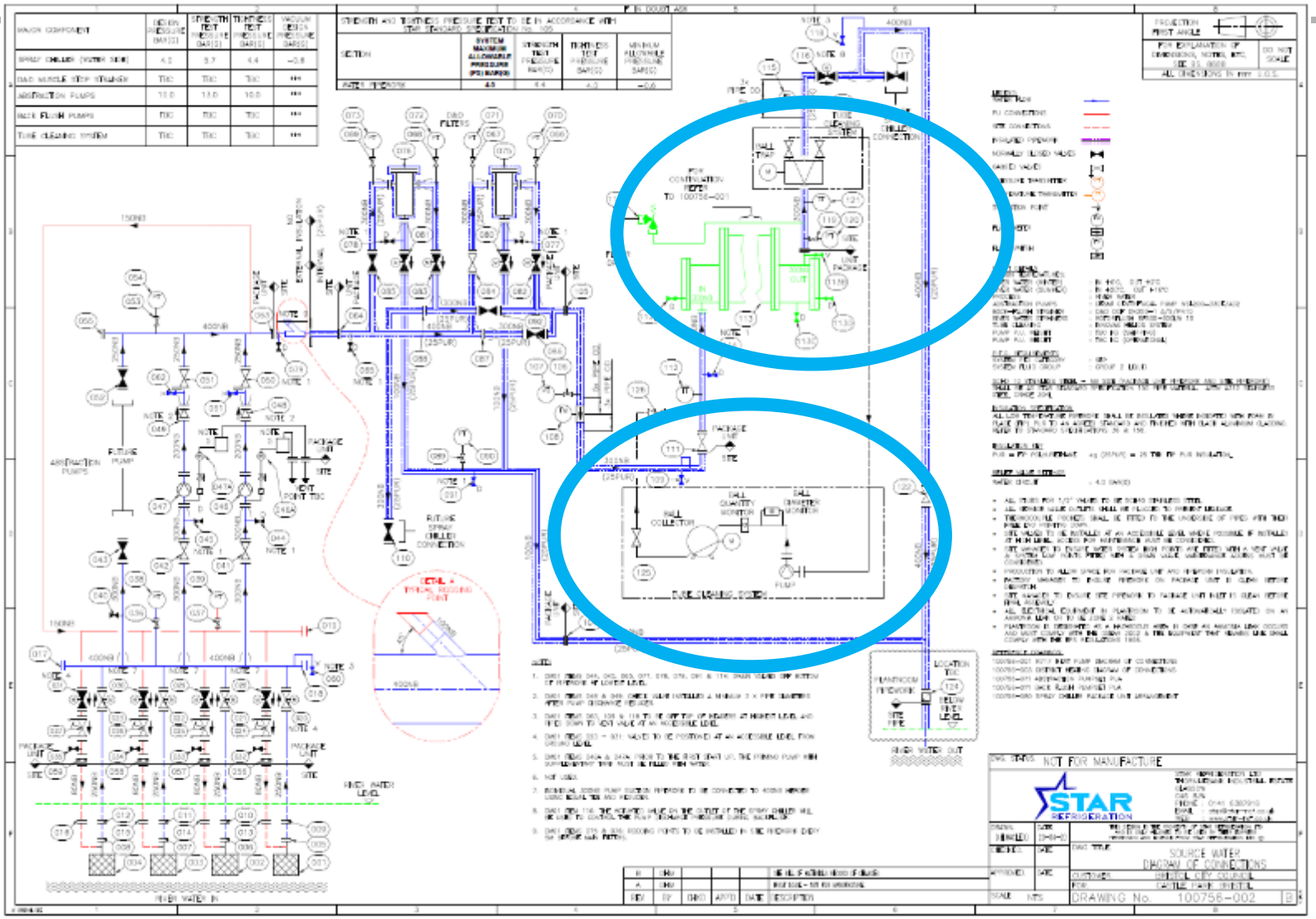
SEA WATER FOCUS – MUSSLE STOPPING



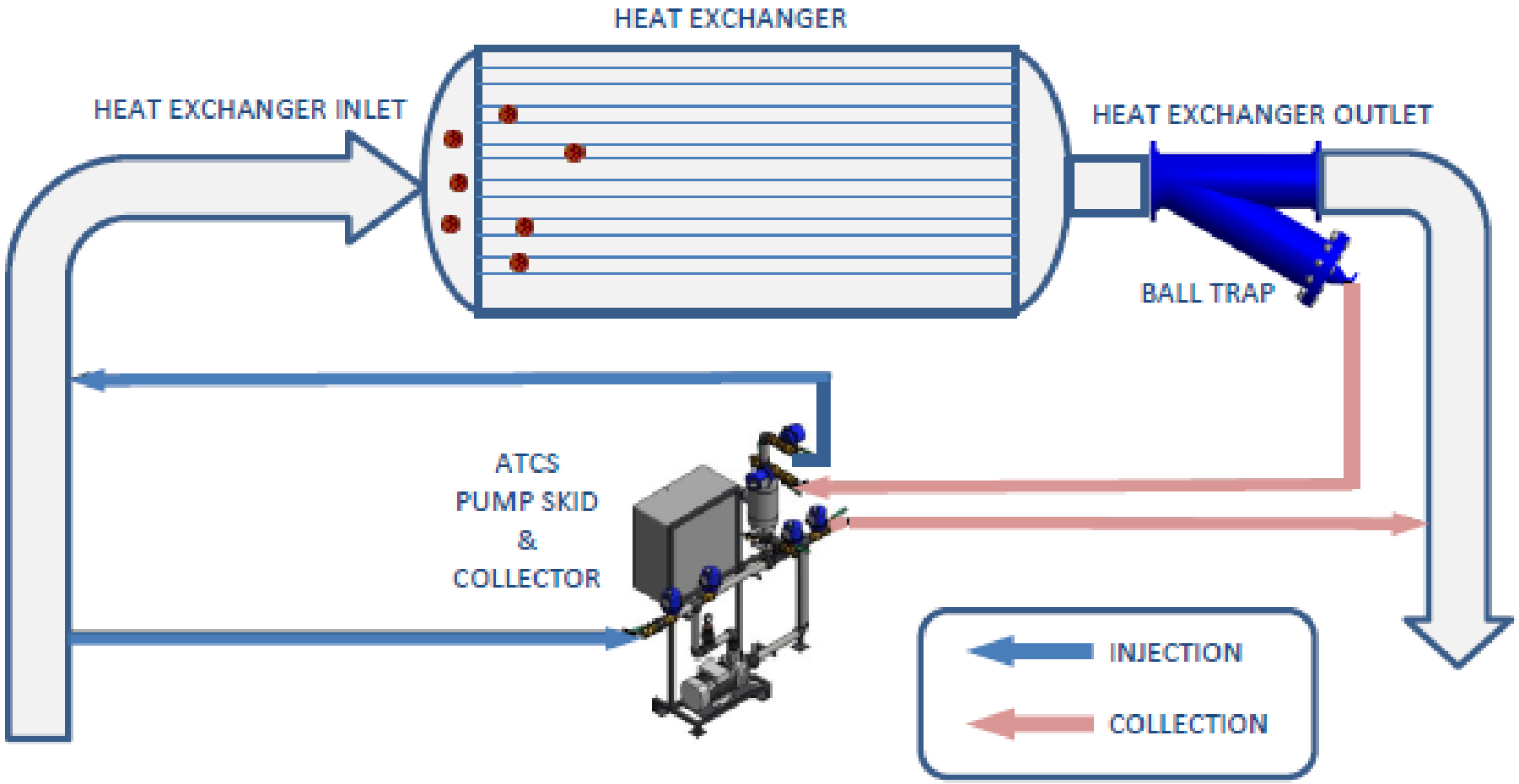
SEA WATER FOCUS – MUSSEL STOP

- Instead of filtering to 20microns for mussel seeds we are using a self cleaning filter with a continuous rotating drum to stop any mussels making their way to the heat pump

SEA WATER FOCUS – ABSTRACTING THE WATER



SEA WATER FOCUS – ATCS



SEA WATER FOCUS – ATCS

- ATCS – Automatic Tube Cleaning System
- Works by injecting balls into the river intake stream and they make their way through the evaporators tubes cleaning the interal pipe wall of any silt/biofilm build up
- Balls slightly bigger than tube
- Strainer on the evaporator outlet diverts the balls back to a collection pot where they wait to be reinjected as per the cleaning time cycle.

HEAT PUMP FOCUS

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HEAT PUMP FOCUS - EVAPORATOR

- Utilisings a SPRAY CHILLER EVAPORATOR
- Shell and Tube style where R717 is sprayed onto tubes to evaporate
- Only part of system in direct contact with sea water
- Internally and externally enchanced tubes
- Titanium tubes
- Titanium coated tubesheets
- Super duplex end boxes

HEAT PUMP FOCUS – Electric Motor

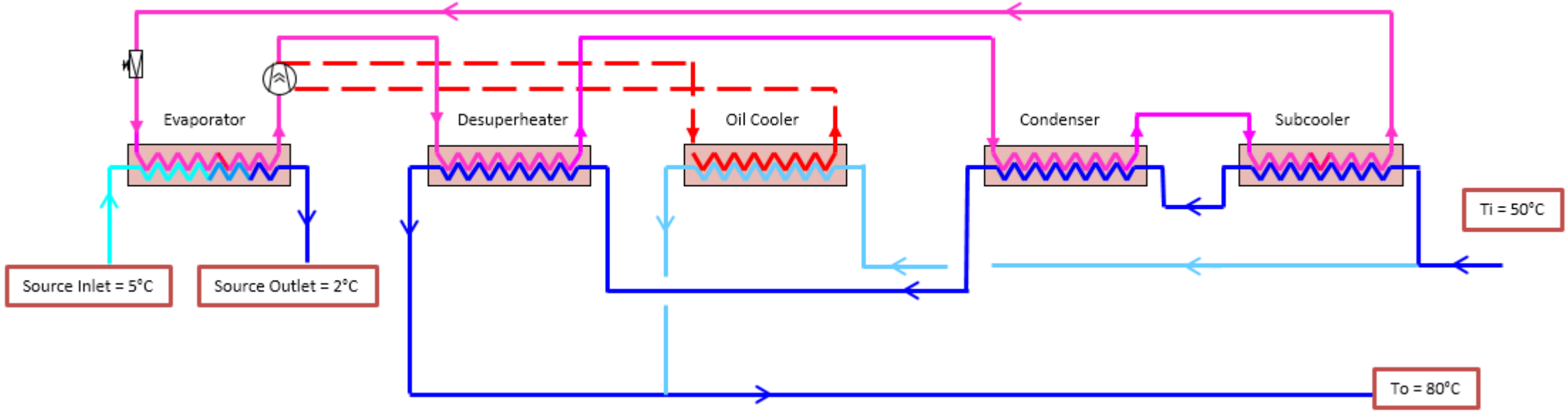
- Typically Air Cooled
- Bigger capacity motors require alot of cooling!
- Water cooled an option but need to find someway to utilise the heat or reject it which adds in system complexity
- Inverters typically used. Given the size of the projects an inverter can help avoid MASSIVE in rush current. If not required for operation you can bypass it to prevent incurring additional losses

HEAT PUMP FOCUS - COMPRESSOR

- Twin Screw Compressor
- Typicaly 52 bar rated (some versions 63 Bar)
- Have used single screw previously
- Have also used semi hermetic in ASHP
- Pistons also an option but current experience has limited our use due to having to swtich to two stage at much lower condensing temperatures than twin screws

HEAT PUMP FOCUS – THE HOT SIDE HEAT EXCHANGERS

- Desuperheater, Condenser, Subcool and Oil cooler make up the hot side loop



HEAT PUMP FOCUS – THE HOT SIDE HEAT EXCHANGERS

- Plate and Shell utilised most often due to compact size and higher pressure rating.
- Desuperheater, condenser and subcooler quite straightforward
- Oil on temperature to the compressor for Twin Screws can add level of complexity to high temperature, small delta T district heating systems (for example where a gas CHP might currently be installed and the client wishes to add a heat pump in – network might be 80°C flor/73°C return but we need oil on to compressor at 65°C)
- Carful consideration to oil cooler materials and plate thickness. High chloride content could lead to stress corrosion cracking on 316L if not accounted for. This is because of the high wall temperature.

THE DISTRICT HEATING NETWORK

- Where we are putting the heat generated from the heat pump.
- This is circulated to peoples homes, buisness etc (even heats a bridge in Drammen!)
- Flow and return tempertaures set by the control of the network.
- A lower required flow tempertaure is better for the heat pump (roughly 1.5% increase in COP for every degree reduced)
- A bigger delta T across the network is better for the heat pump (allows more subcooling)
- A high return temperature needs to be acoutned for in the oil cooler design.

BONUS ROUND

- Finidng somewhere to utilise the cold stream (smart city planning)
- Utilise thermal storage and maximise tarrif prices and avoid COP drops during part load

(instead of putting heat pump down to 50%, run it at 100% to fill a thermal store and switch the heat pump off. These are not like boiler, biomass or CHP which are not a fan of the on/off strategy)

- If in the UK do it now so you can still obtain RHI!

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