Helium Recycling

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Overview

• Background into UoNs requirements
• Economics of the project
• Technical considerations
• Pitfalls, and issues
Background: Helium dependence

• The University consumes about 80,000 l of helium per year.
• Most of this is from MRI and physics research
• Our 3 'NMR' Sites. Each consume about 2-3000 l.
• Currently recycle ca 50,000 to a liquifier in physics. Currently only from MRI and Physics labs but back pressures is an issue.
Background: The Problem

• In 2012 the supply issue became critical. It has since 'got better' (then worse then better again).
• Costs increased.
• The charging landscape has become uncertain
• The supply has been put 'at risk' a number of times.
Background: The risks

- Some equipment have tight fill windows. Ideal time to fill \(\rightarrow\) quench point.
- Volatile prices are difficult to cope with when grants are over 3-5 years.
- Supply issues.
Solutions

• Working with Procurement we flagged up the supply chain risk for the University as a whole. The primary aim was to manage the risk to fluctuations on the open market.

• The aim was to coordinate all our helium recycling across the University building on existing resources.

• Physics at the time were also considering increasing the efficiency of plant
Economics and payback

- Pick a number!
- 11.5% compounded costs: >10 years payback
- 20% compounded costs: ~ 8 Years payback
- Nobody cares on payback outside of 5 years
Proposal

- It cannot be made on ‘payback’ arguments
- You must use risk arguments – potential loss of income and margin.
Grant income at risk

- Research at risk - Calculated as a reduced capacity to do research due to reduced instrumentation.

<table>
<thead>
<tr>
<th>Research Dependent on Superconducting Magnets/Liquid Helium</th>
<th>Annual Grant Income</th>
<th>Annual Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual losses due to supply disruption</td>
<td>£</td>
<td>2.8</td>
</tr>
<tr>
<td>Total Losses Over Initial Project Lifetime (5 years)</td>
<td>£</td>
<td>14.1</td>
</tr>
</tbody>
</table>
Requirements

• Collect Helium gas from the majority of sites
• Aim to get high levels of recovery - Capture fill and general boil off.
• Ok return is 80%, good return 90%
Scope

- 6 Sites using helium
- 1 liquifier (Red)
- 4 sites using pipelines (Blue)
- 2 using remote gas collection (Green)
Budget

- About £40k (2012) per site.
- Includes about £1000 per magnet to couple up.
- Then you need a liquifier.
Technical Considerations

• Back pressures and gas volumes
• Pipeline or Gas collection
Gas Volumes - Back of envelope numbers

- **400 MHz**
  - Fill: 40 l He 100 days
  - 0.3 m$^3$ per day (0.01 m$^3$/h)
  - Fill time: ca 20min
  - Fill Loss: 20% = 6 m$^3$ (18 m$^3$/h)
  - BP: 20-30 mbar

- **800 MHz**
  - Fill: 180 l He 50 days
  - 2.1 m$^3$ per day (0.04 m$^3$/h)
  - Fill time: ca 40 min
  - Fill Loss: 20% = 27 m$^3$ (40 m$^3$/h)
  - BP: 100 mbar
Technical Options: Collection

- **Gas Bag Holds ca 6 m³**
- **Compresses cylinders to ca 200 Bar**
- **Solenoid valves on inlet close on over inflation**
Trailer

- Capacity of 5 x 10m³
- 65 l (liquid)
- Could use 6 cylinders at 300 Bar = 120 l (liquid)

- Pressure vessel regulations
- ADR regulations
- Breakaway Hose
Pipeline

- 63mm PE pipe
- Solenoid valves on input.
- Blower 3-phase
- Need annual static pressure test
Magnet coupling

Heat Exchanger.  
560mm 28mm Cu Pipe

Stacked valves for fill

NRV 10mbar

kf25

NRV 10mbar

Magnet

Gas Meter

Pressure Gauge
Technical Options: Pipeline or Collection

**Pipeline**
- ✗ Installation and routing.
- ✓ Ongoing maintenance.
- ✗ Tracing future faults - leaks!
- ✓ no cost increase at high flow.

**Collection**
- ✗ Site planning, space noise.
- ✗ Ongoing maintenance.
- ✗ Attended operation.
- ✓ Routing issues and distance to recovery.
- ✗ For high flow cost increases.
State so far

- Run some tests with fills on 400 system upto gas bag.
- All pipe lines have been installed. Gas bag and blowers being installed over the next month...
Pitfalls, barriers and 'issues'

• Cost.
• Time - who leads the project.
• Single point of failure - cooperation with other Universities.
• Co-ordination across multiple schools departments, and external consultants.
• Responsibility with-out authority - (Most risk so most motivated)
Other Advantages

- Recycling a non-renewable resource.
- Closer co-operation between all helium users.
  - Reduced costs on deliveries.
- Improved helium planning - local source of helium.
- Ability to use gas or liquid.
- Small reserve of helium.
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