Development of Thermal Energy Storage Systems in Abandoned Mine Workings

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Thermal Energy Storage in water, earth and rock
Timmins, Ontario

HEADFRAME
McIntyre Shaft # 11

- Tav. = 1.3°C
- Pav. = 558 mm
- HDD = 6200
- MV = $1 \times 10^6$ m$^3$ per mine @ 20%
- WC = Ca-Mg-SO$_4$
Timmins and District Hospital
## Energy Use

<table>
<thead>
<tr>
<th></th>
<th>TDH</th>
<th>MC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (yr)</strong></td>
<td>9</td>
<td>60</td>
</tr>
<tr>
<td><strong>Floor area (m²)</strong></td>
<td>28,800</td>
<td>8,430</td>
</tr>
<tr>
<td><strong>Energy Consumption Rate</strong></td>
<td>1,430</td>
<td>668</td>
</tr>
<tr>
<td>(kWh/m²/yr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Natural Gas</td>
<td>1,135</td>
<td>511</td>
</tr>
<tr>
<td>- Electricity</td>
<td>295</td>
<td>157</td>
</tr>
</tbody>
</table>
Energy Use (continued)

<table>
<thead>
<tr>
<th></th>
<th>TDH</th>
<th>MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Energy Consumption (MWh/yr)</td>
<td>41,172</td>
<td>5,626</td>
</tr>
<tr>
<td>Total Energy Cost for 2000 ($)</td>
<td>900,000</td>
<td>190,000</td>
</tr>
<tr>
<td>($/m²/yr)</td>
<td>31.25</td>
<td>22.50</td>
</tr>
</tbody>
</table>
Energy Potential

- Need to consider
  - Air Temperature
  - Water Temperature
  - Flow rate of water

- Calculate energy potential based on the monthly average temperature differential between ambient air and water temperatures plus flow rates
Energy Potential (continued)

- For a temperature difference of 10°C and a flow rate of 10 L/S:

\[
10^\circ C \times 4200J/L \times 864,000L/d \times 0.2778\times10^{-6}kWh/J
\]

\[
= 10.1\text{MWh/d}
\]
Annual Energy Potential

<table>
<thead>
<tr>
<th>Cavern Water Flow - Litres/second</th>
<th>MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5000</td>
</tr>
<tr>
<td>30</td>
<td>10000</td>
</tr>
<tr>
<td>50</td>
<td>20000</td>
</tr>
<tr>
<td>70</td>
<td>30000</td>
</tr>
</tbody>
</table>
Springhill, Nova Scotia

- Tav. = 5.9°C
- Pav. = 1100 mm
- HDD = 4518
- CDD = 92
- MV = 5,600,000 m³ (seam #2)
- WC = Ca-HCO₃ to CaSO₄ + Fe, -ve Eh
Springhill N.S. Coal Field

Figure 3. Schematic cross-section through main slope pillar, Springhill coalfield, N.S. (Drawn in part from sections and plans of Cumberland Rail and Coal Co.)
Plan of Underground Workings
Springhill, N.S.

Figure 2: Composite plan showing extent of underground workings at Springhill for seven levels of mining operations. (From Nova Scotia Department of Natural Resources).
Geothermal wells at Springhill, N.S.

Figure No. 2: Geothermal Borehole Locations
Dr. Carson and Marion Murray Community Centre
Springhill Arena Well Water Temperatures
Major Issues

- Detailed knowledge of mine workings
  - drilling, interconnection, circulation pathways
- Well Interference
- Maintenance of water temperatures
- Water chemistry
- Subsidence and roof collapse near surface
Critical Issues

- Resource Ownership
  - designated Geothermal Resource Area (GRA)
  - public versus private

- Resource Development
  - individual or collective

- Resource Management
  - operation and maintenance, sustainability
  - conflicts
Environmental Benefits

- Substantial savings in conventional fuel and energy consumption (natural gas and electricity);
- A renewable energy resource, Reduced use of fossil fuels;
- Lower CO₂, sulfur and nitrogen Compound emissions;
Conclusions

- CTES potential from old mines is enormous with thousands of MWh/yr per mine
- Renewable energy source, sustainable, environmentally friendly
- Several major issues require further research
- Legacy from the miners
Acknowledgements

- Don Jones, N. S. Dept. of Natural Resources
- Town of Springhill, Nova Scotia
- Town of Timmins, Ontario
- Kinross Gold Corp. (Timmins)