Gas-driven MVC (Mechanical Vapor Compression)

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In a time that gas prices are plummeting across the globe, traditional methods employed in many industries must be reexamined from a techno-economic standpoint. One such example is the water desalination industry, and more specifically - the Mechanical Vapor Compression (MVC) application.

Conventionally, an MVC unit utilizes an electric motor to drive its compressor, which is the central component in this desalination method. The compressor induces the temperature difference required for the evaporation-condensation process, in which seawater is converted to high-quality distillate.

Animation of the MVC process is available on: https://youtu.be/GVDKimUkHj4

The electric motor driving the compressor (which is responsible for ~80% of the unit energy consumption) could be replaced with a gas engine, thus dramatically reducing the operation costs.

The gas engine (which is standard industrial equipment) utilizes all sorts of gas – from petroleum gas to natural gas, in an inner-combustion chamber, to facilitate the mechanical drive to the compressor. The dimensions of the gas engine are similar to those of an electric motor, so it could be installed on top of the unit, as is generally done in IDE Technologies’ units. A gas infrastructure is required on site, with pressure of 1.5-50 psig, depending on the engine size.

The waste heat from the gas engine could be further utilized in the MVC unit to reduce heat transfer area, which in turn reduces the capital costs of the unit, making the investment all the more worthwhile. Another use of the waste heat could be production of steam by the exhaust gases of the engine. This steam could be employed to heat the MVC unit at start-up, to assist a stripping process or to be sent to other industrial processes (thus improving the heat rate of the plant).

An additional benefit from the exhaust gas stems from its chemical composition. The main emission product from natural gas combustion is carbon dioxide [CO2], which can be harnessed to increase the plant’s value, by using it in a post-treatment process. The CO2 will decrease the pH level of the product water in order to initiate dissolution of limestone, which in turn decreases the corrosion potential of the water (LSI).

Such modification could be implemented in new plants, or as a retrofit to existing plants.
Techno-economic Evaluation

In the table below, the comparison between electric-driven MVC, gas-driven MVC and RO plants is shown:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>MVC Electric</th>
<th>MVC Gas</th>
<th>RO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>m³/day (kgal/day)</td>
<td>1000 (264)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Consumption</td>
<td>kW</td>
<td>450</td>
<td>55</td>
<td>125</td>
</tr>
<tr>
<td>Gas Consumption</td>
<td>MMBtu/m³ (MMBtu/kgal)</td>
<td>-</td>
<td>0.085 (0.322)</td>
<td>-</td>
</tr>
<tr>
<td>OPEX*</td>
<td>$/m³ ($/kgal)</td>
<td>1.3 (4.9)</td>
<td>0.55 (2.1)</td>
<td>0.4 (1.5)</td>
</tr>
<tr>
<td>CAPEX**</td>
<td>M$</td>
<td>3.7</td>
<td>3.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Estimated Water Cost*</td>
<td>$/m³ ($/kgal)</td>
<td>2.15 (8.15)</td>
<td>1.40 (5.30)</td>
<td>0.6 (2.25)</td>
</tr>
</tbody>
</table>

* Assuming 0.10 $/kWhelec, 2.0 $/MMBtu gas, return period of 25 years and 6% interest.
** Estimated costs, including Balance of Plant

As can be seen in the comparison table, the operational expenses are reduced by more than 55%, and the total water cost by a third, which yields an ROI of about 1 year.
With an integrated heat recovery, the costs reduction is even higher.

Added Value

1. **OPEX and water cost reduction**
   Integrating a gas engine to drive the MVC compressor leads to a 55% reduction in OPEX and 35% reduction in water cost.

2. **Short ROI**
   ROI of about 1 year.

3. **Unit efficiency and heat rate improvement**
   a. Waste heat can be recovered from the gas engine to decrease the specific cost of the MVC unit (by minimizing the heat transfer area).
   b. At the same time, the waste heat can be used for steam production, thus increasing the heat rate of the plant.
   c. CO₂ can be recovered to the post-treatment (remineralization) process, to decrease the OPEX of the plant.

4. **Electric infrastructure minimization**
   No need for medium voltage transformer, switchgear, MCC, cables and conduits.

5. **Easy refurbishment of existing plants**
   As weight and dimensions are comparable in size, it is easy to replace the electric motor with a gas engine.

In summary, as gas prices nosedive, it becomes evident that the integration of a gas engine to an MVC unit is worthwhile and increases the attractiveness of the MVC technology, compared to other desalination technologies.