Dehydrated Alfalfa Prevents Scale in Sea Water Evaporators

The most economical method of obtaining potable water from sea water is distillation. This method would be more economical if scale formation in evaporators could be eliminated. The present article suggests a completely new and different approach to the problem of eliminating scale in sea water evaporators.

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When hard water or sea water is evaporated in an evaporator to produce distilled water, it is a well-known fact that the instrument soon becomes coated with scale. Industry tries to minimize this nuisance by "blowing down" or rejecting one-half of the residual heated water and in that manner getting rid of the scale-forming chemicals. This "blow down" system does not entirely eliminate the scaling of evaporators.

It was noted that if powdered dehydrated alfalfa was added to water to be distilled, no scale lined the evaporator. A series of experiments showed that if 0.1% of dehydrated alfalfa was added to the water, scaling could be prevented.

This was first tested with two evaporators in Waukesha County, Wisconsin, using the very hard water found in that locality. The two evaporators were operated continuously for 72 hours; one was fed the hard water, the other was fed the hard water with 0.1% of dehydrated alfalfa. The 50% "blow down" principle was used with these evaporators. At the end of 72 hours the instrument fed the plain hard water was found to be heavily scaled, while the one that was fed the water containing the alfalfa was scale-free.

Plant foliage is not commonly used as a boiler compound or as an anti-scale compound, as described in this paper. The patents that have been issued since 1860 show that only one claims that dehydrated plant foliage can prevent scale. In a patent specification, dated January 14, 1890, Erastus C. Nolands claimed "that a mixture of wheat straw, wheat chaff and thrashed wheat, if placed in a porous sack and hung in a boiler, would not only prevent scale, but would effectually remove the burned iron or incrustation from the boiler walls" (1).

The successful manner in which alfalfa prevented formation of scale in producing distilled water from hard ground water led to the evaporating of sea water in these same evaporators. One was fed sea water, while the other was supplied with sea water with added alfalfa. After a 144-hour run the evaporators were shut down and dismantled. Upon inspection the evaporator supplied with plain sea water was heavily scaled, while the evaporator using water treated with alfalfa showed no evidence of scale.

The problem that presented itself was to find the component or group of components present in alfalfa that prevented formation of scale when water with a large amount of dissolved mineral matter was distilled with a 50% blowdown system during the distillation.
The quantitative experiments used to prove the scale-preventing properties of the various components of alfalfa were very simple, yet conclusive. A description of the experimental procedure follows:

A numbered plate of Admiralty metal, an alloy of 70% copper, 29% zinc and 1% tin, commonly used in sea water evaporators, was bent into a — shape. Before bending, the dimensions of the plate were 6.5 by 10.5 cm. The plate was cleaned with acid, washed with distilled water and boiled repeatedly in distilled water until its dry weight became constant within two tenths of a milligram. The plate was then placed in a 1000-ml. beaker in such a manner that the wide surface of the plate was not in contact with the bottom of the beaker. 700 ml. of sea water were put in the beaker. The sea water used was artificial, since the natural sea water available was greatly contaminated with iron hydroxide. The formula of Brujewicz (Subow 1931) was used. The beaker was heated until 350 ml. of water had evaporated, the remaining water was siphoned off and a fresh volume of 700 ml. of sea water was added. In this way was the 50% blow down simulated. Ten boilings of this kind were conducted for each test. At the end of ten boilings, the plate was removed, washed with distilled water, dried and weighed. Any gain in weight would be the scale formed while 700 ml. of sea water had been concentrated to 350 ml. Any loss in weight would be due to corrosion of the metal. In the rest of this paper this method will be referred to as the ten boiling scale cycle.

Treatment of the sea water for the various tests was made to simulate reported conditions with regard to dehydrated alfalfa. To secure a 0.1% concentration, 0.7 g. of alfalfa was added to each 700 ml. of sea water.

To determine the active component of alfalfa various hypotheses were made initially and these hypotheses were then tested.

**Hypothesis I**

*Dehydrated alfalfa is of no value in preventing scale formation.*

This hypothesis was tested to settle any questions concerning the claims for alfalfa based on the work completed on the two evaporators in Waukesha County mentioned previously. Ten cycles of evaporation were conducted on sea water without treatment with alfalfa, and ten cycles with sea water having a 0.1% concentration of alfalfa.

<table>
<thead>
<tr>
<th>Plate No.</th>
<th>Original Weight</th>
<th>Final Weight</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>59.1087 g.</td>
<td>59.1441 g.</td>
<td>0.0354 g.</td>
</tr>
<tr>
<td>6</td>
<td>74.9923 g.</td>
<td>74.9796 g.</td>
<td>0.0127 g.</td>
</tr>
</tbody>
</table>

Hypothesis rejected.

**Hypothesis II**

*Addition of 0.1% alfalfa lowers the pH of sea water to such an extent that deposition of scale is impossible.*

To answer this the pH of the solutions used in testing hypothesis I was measured at various times with the following results:

a) Original sea water, pH 7.2 (subsequent tests on other samples of untreated sea water showed that the pH varied from 6.8 to 8.3).

b) Sea water evaporated to half volume, pH 8.2 (subsequent evaporations showed that this value varied from 7.9 to 8.2).