Development of Evaporated Salt Dissolver Employing a Porous Plastic Filter

John F. Heiss
Richard Kolasinski
Diamond Crystal Salt Co.
St. Clair, Michigan

ABSTRACT

Brine produced from evaporated salt is used in many food processing operations. In down-flow dissolvers, it has been common practice to use a gravel bed, serving as a filter for insolubles and undissolved salt particles.

In recent years, with the trend toward high-purity specifications for food processing brine, the replacement of the gravel bed became desirable. The availability of porous plastic materials made this replacement possible.

The fabrication and testing of porous plastic filter media, oriented in different positions in the salt bed in an up-flow dissolver, are discussed in this paper. The optimum positioning of the filter and water inlets, in order to give continuing high rates of brine production, is shown.

This porous filter-dissolver design has been developed from bench-scale to three-foot diameter Fiberglas ® tank units of 600-1200 gallons per hour, and recently to units holding 35 tons of salt, producing 2,000-4,000 gallons per hour of high-purity saturated brine.

INTRODUCTION

The present development concerns an improved method for dissolving and filtering evaporated salt in making a saturated brine solution.

One of the common procedures for dissolving evaporated salt utilizes a tank into which evaporated salt is added and stored. The brine is removed at the bottom of the tank through a collector placed underneath a gravel bed, which serves as a filter for insolubles and undissolved salt particles. A water spray ring is positioned above the gravel bed at a sufficient distance so that saturated brine will be produced at the collector.

The gravel bed has proved to be a nuisance in terms of maintenance, since it must be removed periodically for cleaning. Furthermore, when replaced, the gravel must be clean and properly graded so that filtration is effective.

With the trend towards higher-purity specifications for food processing brine and the need to reduce maintenance costs in brine-making, the replacement of the gravel bed became desirable.

The objective of this work was therefore to develop a "drop-in" filter unit, of FDA-accepted materials of construction, which would have a brine throughput equal to or greater than the existing gravel-bed unit. The steps involved in accomplishing this objective follow in this paper.

INITIAL FILTER TESTS IN COMMERCIAL DISSOLVER

Testing began with a commercial, 3-ft. diameter dissolver shown in Figure 1. It was adapted to use a porous ceramic or a porous plastic filter in a horizontal position, as shown in Figure 2.

Alberger Flake Salt and evaporated granulated salt were used in alternate runs.

At the start of each run, brine flow rates were commensurate with the area and porosity of the filter. Soon after start up, the flow rate began to drop off for each type of salt. After several hours of operation it was below our limit of 400 gal./hr. of saturated brine, for a commercial unit, even though the Alberger Flake Salt gave 25-50% higher throughputs than the cube-granulated salt.

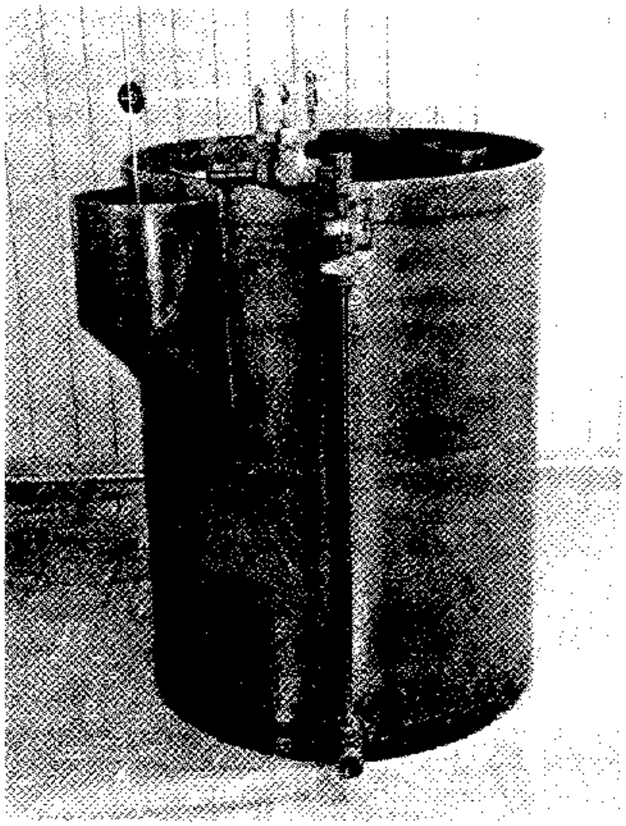

Figure 1. Evaporated salt dissolver (3-ft. dia.)

We assumed then that the filter pores were blinding with undissolved salt, and that a different filter configuration would be required if initial flow rates were to be maintained. Furthermore, backwashing experiments showed that filtration of brine, using a horizontal porous disc, took place mostly near the periphery of the disc, where brine could short-circuit. Thus, little benefit would be realized from increasing the filter diameter, since increase in brine output would be more nearly proportional to filter perimeter than to filter area. And even at a greater filter diameter, and higher initial flow rate, drop-off of flow rate with time would be expected.

SMALL-SCALE EXPERIMENTS

Inverted filter surface. At this point it appeared desirable that tests aimed at finding the right filter configuration should be performed with large beaker-sized equipment rather than a commercial dissolver in order to save time and permit better visual observation. Since the object of the tests was to find a filter configuration that would not blind, experiments were made using whatever materials were at hand for the filter surface, without considering the efficiency or commercial availability of the materials. These materials included Buchner funnels lined with cloth, wire mesh cylinders wrapped with toweling, and various other unorthodox materials that could be shaped readily in the laboratory.

A large number of these filter units were tried before a pattern appeared to develop. When the initial large-scale tests proved unsatisfactory, it had been concluded that the blinding of the filter was the result of the force of gravity operating on the salt mass in the same direction as the force exerted by the brine flowing through the filter. If these could be arranged to partially cancel each other perhaps blinding would be much less. In order to test this theory an inverted Buchner funnel, containing a 4½-inch diameter porous polyethylene or Alundum disc, was placed in the salt bed and used for a filter (Fig. 3).

Surprisingly, inverting the filter did not contribute materially to improved continuous flow. Evidently blinding of the filter was caused primarily by the movement and compaction of salt

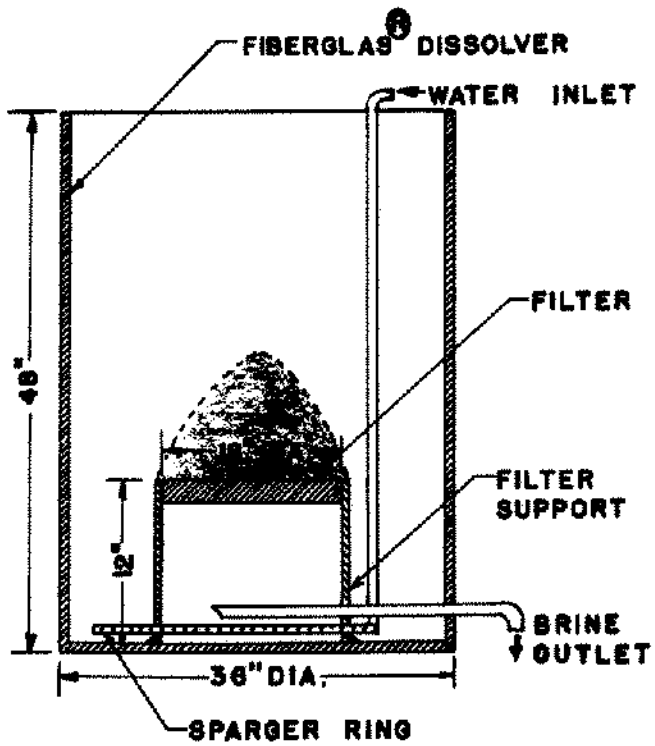

Figure 2. Initial horizontal filter and dissolver.

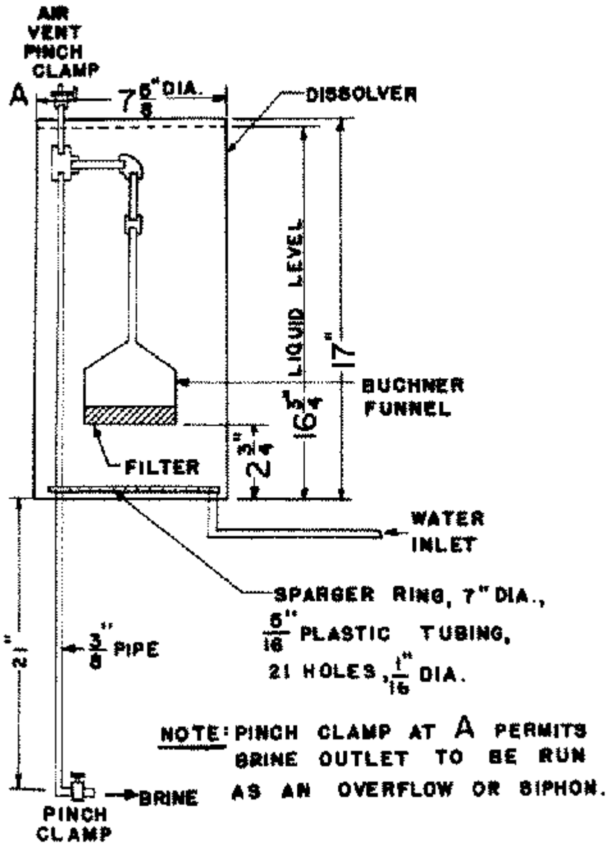

Figure 3. Inverted Buchner funnel filter.

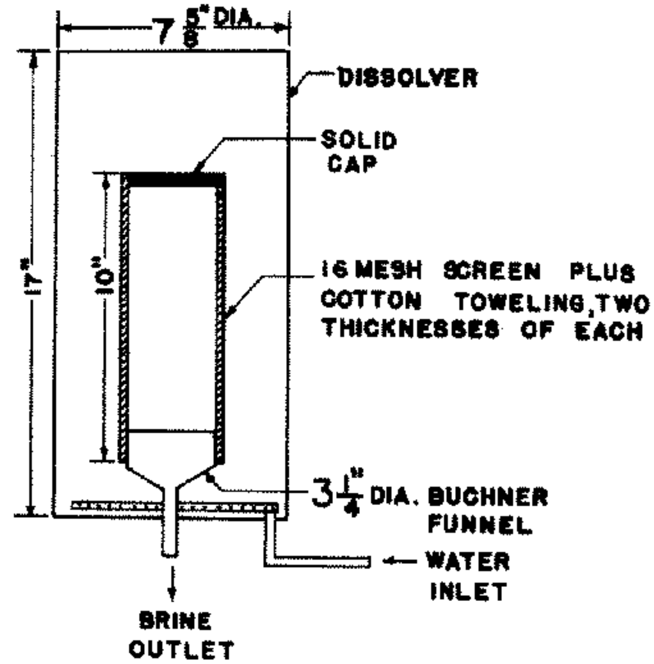

Figure 4. Vertical, cloth-wrapped cylindrical filter.

particles against the filter face in the direction of the brine flow. The expected gravity effect, which was to prevent packing of salt against the inverted filter face, did not occur.

Vertical filter surface. If the filter could be arranged so that the salt mass at the filter surface would be continually disturbed in an action similar to that in wiped filters, but without any mechanical wiping devices, the blinding of the filter might decrease. The filter face would have to be in a vertical plane if this wiping was to be done by the salt itself. Also, water for dissolving the salt would have to be added at points below the filter, so that salt would dissolve there, resulting in a downward movement of salt across the face of the filter. Therefore, the next test was with a wire mesh cylinder wrapped in cloth (Fig. 4).

With such a crude filter numerous problems were encountered. In spite of these problems the flow after a period of operation was about the same as the initial flow. A vertical surface filter made of better materials was indicated. A configuration giving maximum usable filter surface with minimum volume had to be devised before the filter could be fabricated.

Annular filter. The space within the filter previously was considered to be a reservoir for brine. This filtered brine cannot be removed from the filter unit any faster than new brine enters in through the filter. Therefore, the space within the filter unit is waste space, and not required for brine storage. Further, it is possible to almost double the filter surface without appreciably increasing the filter size by making an annular-type filter (Fig. 5).

All the filter faces in this design are smooth. There are no projections that would interfere with the "wiping" action of the salt mass moving downwardly across the filter face. Such a filter design allowed our theory to be checked.

This was done by operating a small brine dissolver using an annular porous plastic filter with a concentric sparger around the filter only with both the concentric sparger and a second inlet located centrally below the filter (Fig. 5).

At constant head, brine flow using both inner and outer water inlets was substantially greater than when using the outer water inlet, only. This seems to indicate that with an outer sparger ring only, the moving salt bed around the outside of the

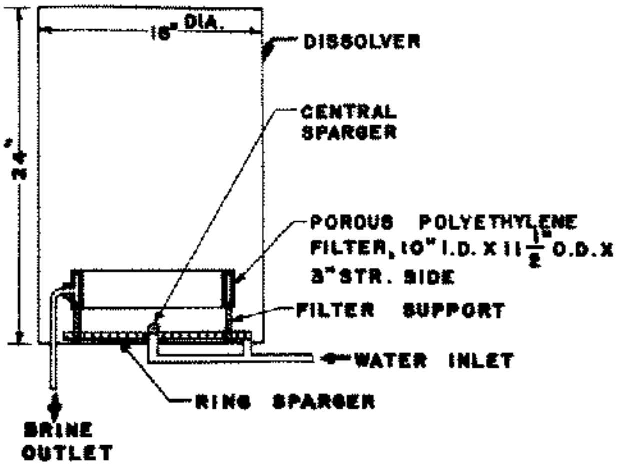

Figure 5. Annular filter with central and concentric spargers.

filter continually disturbs the salt there, lessening blinding, while the undisturbed salt at the inner face of the filter compacts and blinds that surface.

GENERAL OBSERVATIONS

It had been observed during the initial work with a horizontal filter in a commercial dissolver that a conical quantity of densely-packed salt remained on the filter face after all the other salt had dissolved (Fig. 2).

This supports our belief that the improvement in flow achieved with the vertical-face filter unit is at least in part due to some sort of "wiping" action. The improvement in flow is the result of the upflow of liquid, which dissolves salt below the filter, allowing more salt to move down.

Since the filter surfaces are always positioned above the water inlet points, a porous salt bed results during operation. The increase in permeability allows relatively high rates of brine flow, compared with down-flow through a bed of fine salt, which tends to cause compression of the bed reducing the flow rate.

Although the porosity of the filter media exceeded the screen size of the smallest salt particles (65 mesh Tyler, 208-microns) no salt crystals were observed passing through the vertical-face filters, which ranged from 100-720 microns. Originally we speculated that such small salt particles after partial dissolving might be sucked into, or through, the pores of the filter. Experience has confirmed that filter media of pore diameter equal to about 65 mesh Tyler, will prevent salt particles from passing through.

LARGE-SCALE COMMERCIAL DISSOLVERS

The filter principles demonstrated on, small-scale models were then applied by Diamond Crystal's Sales Engineers in scaling-up to a 3-ft. diameter Fiberglas ® dissolver, containing an annular porous plastic filter, 20-inch outside diameter and 5-inch straight side.

The porosity of the filter used allows continuous throughput of 600-1200 gal./hr. of saturated high-purity brine, with no penetration or blinding by evaporated salt crystals. Piping is installed to allow periodic backwashing of extraneous material. The filters can be acid-washed, also, to remove iron deposits, which might occur over extended usage in high-iron water areas.

The largest filter of this design now in use is 5-ft. outside diameter by 6-in. straight side, conservatively rated at 2,000-4,000 gal./hr. of saturated brine (Personal communication, H.I. Keves, March 3, 1969).

Portions of the above subject matter are proprietary and covered by U.S. Patent No. 3,307,914., (March 7, 1967), and Canadian Patent No. 807, 987 (March 11, 1969).

SUMMARY

The steps involved in the development of a porous plastic filter for an evaporated salt dissolver have been described. Decreasing flow rates through horizontal filters, tested first, led to fabrication and testing of vertical-face filters. With the vertical filter located above the water sparger, a high continuous rate of brine production was demonstrated. Scale-up from bench-scale to large, commercial 12-ft. diameter dissolvers (Fig. 6) with no major difficulties shows the utility of such prototype testing.

ACKNOWLEDGMENT

The close cooperation of Mr. H.I. Keves, Sales Engineering Department, Diamond Crystal Salt Company, in obtaining some of the ceramic filter materials tested is gratefully acknowledged.

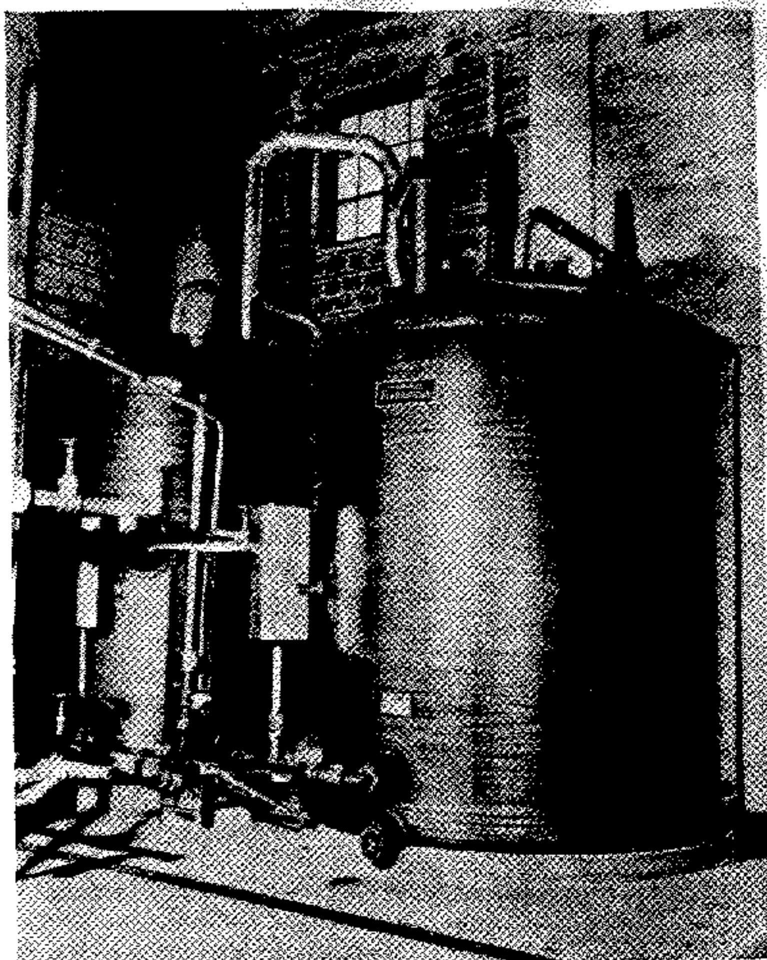

Figure 6. Large evaporated salt dissolvers (each 12-ft. dia.).