

Wire Mesh Entrainment Separators

J. E. COOLEY¹

Introduction

The liquid entrainment problem experienced within the beet sugar industry today is familiar to most of us. We have all realized the detrimental effects of sugar carryover in multieffect evaporators, concentrators, and vacuum pan operation.

During the evolution of these different phases of operation, many methods have been used in attempting to eliminate or control the problem of liquid entrainment. Some of the methods employed in attempting to control liquid entrainment are: (1) Baffles, either wooden or metal, (2) vanes, (3) catchalls, and (4) wire mesh entrainment separators. The first three methods are common and at times leave much to be desired. This paper is primarily concerned with the fourth method, wire mesh entrainment separators, which is one of the newer advances within the sugar industry for handling this problem.

First of all, it should be understood what detrimental effects are felt when entrainment is experienced. Probably the most glaring effect is the direct loss of sugar from production. This loss is cumulative from multieffect evaporator condensate systems and condenser water systems. This means the actual loss of sugar in terms of bags of sugar that cannot be recovered. In condenser water systems there are two ways in which losses may occur: (1) Sugar laden surplus condenser water goes to a sewer, and (2) sugar laden battery supply water that is taken from condenser water and causes higher sugar losses in beet pulp.

The second detrimental effect of sugar entrainment is the introduction of sugar contaminated condensate into boiler feed water. Sugar contaminated boiler feed water can result in:

1. Premature boiler tube failures and loss of productivity.
2. Reduction in beet slice from reduced boiler operating rates or failures.
3. High annual boiler cleaning costs from boiler tube fouling.
4. High chemical treatment costs to maintain the proper alkalinity of boiler feed water.

Finally, there will be the extra cost of defoaming agents that are used to combat foaming in evaporators.

Several years ago, the entrainment problem became critical within the petroleum industry. Resulting from experimental work, one of the best answers to the petroleum industry's entrainment problem was the wire mesh entrainment separator. Just recently, this type of entrainment separator was introduced to the sugar industry for use in the multieffect evaporators. The wire mesh entrainment separator is constructed of many layers the service for which the separator is to be used. This multilayer wire mesh is then mounted on a single grid and held in place by tie-down wires

¹ Chemical Engineering Associate, Spreckels Sugar Company, San Francisco, California.

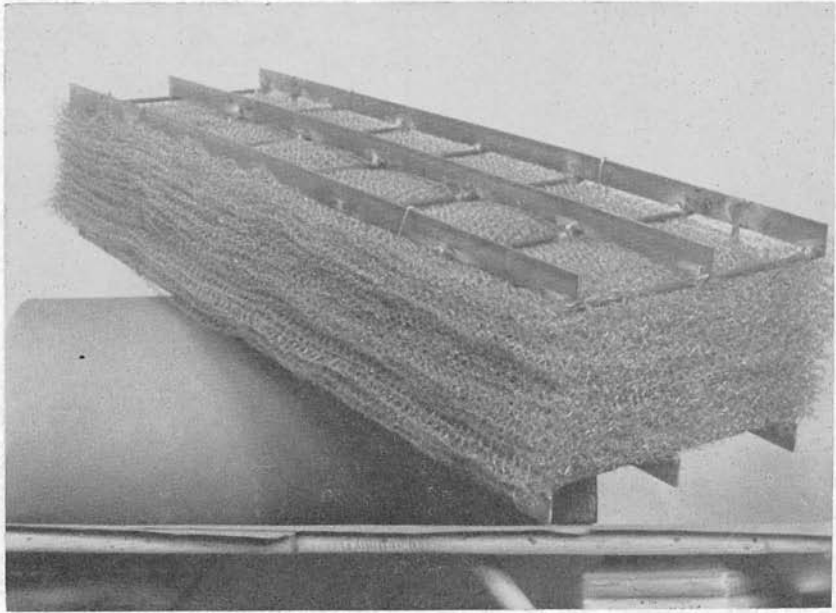


Figure 1.—Typical section of wire mesh entrainment separator of the double-grid design.

or, as an alternate, multilayer wire mesh is mounted between two grids which are welded together with spacer rods to maintain a constant-width type of sandwich unit. Figure 1 is an example of a typical wire mesh separator section of sandwich grid design. This particular section is approximately three feet long, and one foot wide, with the wire mesh being six inches thick. The wire mesh is quite porous offering little resistance to vapor flow. Light can be seen easily through the mesh. The materials of construction used in the manufacture of wire mesh entrainment separators naturally vary depending upon the service. This particular section is made completely of monel for use in juice evaporators where varying concentrations of hydrochloric acid are used for cleaning.

Figure 2, shows a typical wire mesh separator installation in a horizontal tube evaporator body. One section has been removed to show how the individual sections are installed. The ends of the strap which make up the bottom grid are held in place with monel tie-down wires. In the installation of this separator, as much head room as possible should be provided between liquid level and bottom of the wire mesh entrainment separator to reduce the possibility of foam actually reaching the separator.

The Spreckels Sugar Company has had a wire mesh entrainment separator of the single or bottom, grid design in operation for approximately 240 days and a wire mesh separator of the double or sandwich grid design for 100 days. After the first 100 days' operation with the single grid separator

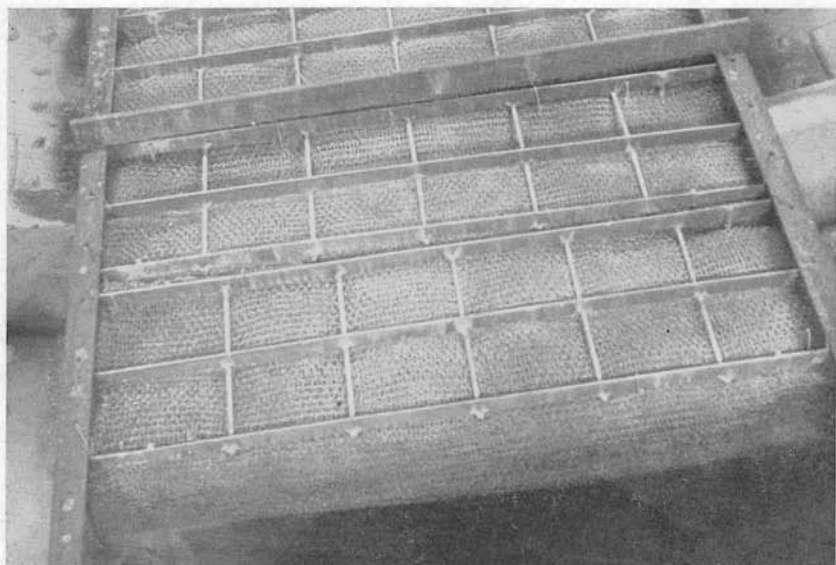


Figure 2.—Horizontal tube evaporator showing the method of installation of wire mesh entrainment separator sections within the body.

some loosening of the wire mesh away from the grid was noticed, while after 100 days' operation with the double grid separator, its condition had not changed. It is concluded, therefore, that the double grid wire mesh entrainment separator will have a longer life and require less maintenance than the single grid design.

Physical inspection revealed that no solid deposits appeared on or within either type of grid design. The results of these findings relieve concern about the possibility of gradual buildup of deposits.

When determining the cross-sectional area requirements for each body of the evaporator, an established formula is used which combines the liquid density and the vapor density to determine the allowable velocity and thus the required area. Arbitrarily, with the sanction of the manufacturer, a figure of 125 percent of the minimum required area was used. This was done to reduce the possibility of excessive pressure drop across a wire mesh separator and the possibility of excessive vapor velocity through a wire mesh separator because of liquid holdup within the wire mesh. The converse is also true in the application of this mesh to a particular piece of equipment in that excessively low velocities reduce entrainment efficiency.

Detailed tests were conducted on a horizontal tube evaporator body with a wire mesh entrainment separator on which data were collected hourly, for an eighteen-day period. The amount of sugar in condensate, temperature, and pressure of the body, and pressure drop across the wire

mesh separator were recorded. Similar data were collected at the same time on another identical evaporator body having no wire mesh entrainment separator. The parallel unit was operated under as near the same operating conditions as possible with respect to temperature, pressure, and evaporation load. The results of this test show that the wire mesh entrainment separator reduced sugar entrainment by 85 percent and that the pressure drop across the separator was approximately 0.3 inch of water. These data represent average figures. It was interesting to note that the amount of entrainment varied considerably on the unit without the wire mesh entrainment separator, while the amount of entrainment in the unit with the wire mesh was low and relatively uniform. Similarly, when the unit without the separator had very high surges of entrainment the unit with the wire mesh separator remained relatively free of entrainment. Since the wire mesh entrainment separator has the ability to stop sudden surges of entrainment, condensates for boiler feed water can now be had that are more stable with respect to sugar contamination. It is the sudden surges of large quantities of sugar that cause the most detrimental effect in boiler operation since the contaminated boiler feed water may get into the boiler before it can be detected.

Wire mesh entrainment separators with a 6-inch thickness, used in horizontal tube evaporators or vacuum pans, will cost approximately \$30 per square foot and approximately \$25 per square foot in vertical tube or circular pieces of equipment. These figures include both material and labor costs. Thus, an installation will have an average cost of \$2000 per 1000 tons of beets sliced per day.

A means is available whereby proper entrainment separation can be obtained. However, before consideration is given to converting to this newer method of separation, consideration must be given to the potential savings that will result from improved entrainment removal. The following are the annual potential savings that can be anticipated, based on a typical horizontal tube evaporator installation, where all figures have been reduced to a common factor, the amount of savings per square foot of wire mesh entrainment separator. Figure 3 graphically illustrates the cost and potential savings for this particular installation.

1. Sugar losses in boiler feed water with 85 percent entrainment removal or \$1.19/sq. ft. of wire mesh separator area.
2. Chemical costs to neutralize boiler feed water acidity or \$0.08/sq. ft.
3. Annual boiler acid cleaning costs, currently required to remove scale primarily composed of precipitates from evaporator condensate or \$2.10/sq. ft.
4. Cost of delays to factory operation due to sugar in boilers causing reduced boiler loads or \$2.10/sq. ft.
5. Cost of evaporator defoaming agents can be reduced by 50 percent to 75 percent or \$3.76/sq. ft.

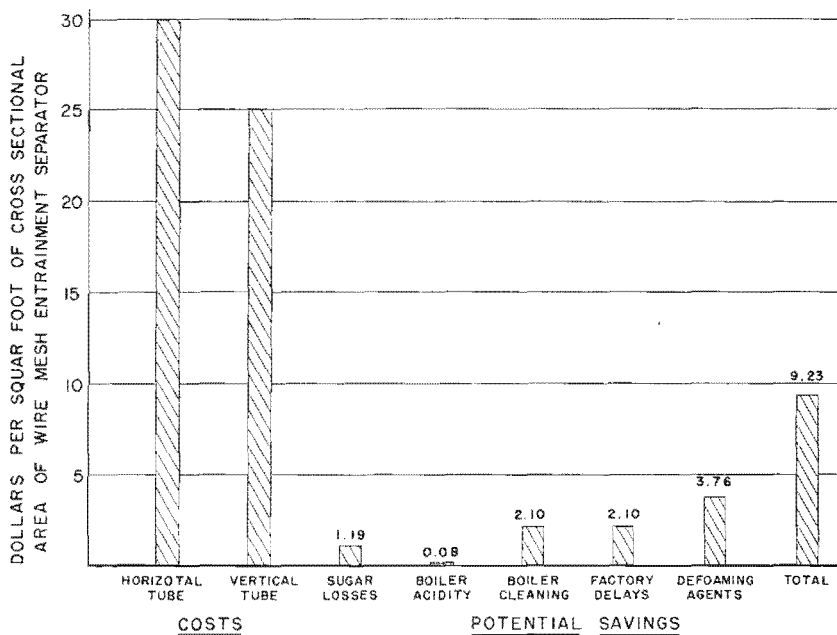


Figure 3.—Costs and potential savings per unit area of wire mesh entrainment separator.

The total annual potential savings, then, amount to \$9.23/sq. ft. The anticipated life of wire mesh entrainment separators is from 10 to 15 years. By comparing the cost, life, and potential savings involved in installing wire mesh entrainment separators, a \$9.23/sq. ft. annual savings for \$25 to \$30 investment is noted and the economic soundness of converting to this newer type of entrainment separator is clearly realized.

In addition to the potential savings just mentioned, there are irreducible savings that nevertheless make the installation of wire mesh separators more attractive. These are:

1. Reduced danger of internal damage to a boiler because of excessive sugar in boiler feed water.
2. Anticipation of an increase in boiler capacity in those instances where boilers have been operating under reduced capacities due to contaminated boiler feed water.
3. Longer life of vapor and condensate lines because of the absence of most of the corrosive substances, as with acid during boilouts.
4. Longer life of condensate pumps for the same reason as noted in 3 above.

Cost and potential savings that have been discussed reflect an optimistic outlook for the particular case cited. Each separate installation has its own application so that the potential savings may vary.

There has not been an opportunity to observe the use of the wire mesh entrainment separators within vacuum pans, but it is felt that the results obtained warrant serious consideration for this application.

Summary

In summary, the following points have been presented:

1. That a new method for controlling liquid entrainment has been introduced which is the wire mesh entrainment separator. The advantages of a double grid design over the single grid design have been noted.
 2. That better boiler operation will result with a definite reduction in the danger of boiler damage because of a better quality boiler feed water.
 3. That a monetary savings can be realized which will justify conversion of many pieces of equipment to this method of entrainment removal.
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