The Metals Used in a Modern Dairy

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There is little that is really new in this subject, but sometimes it is advantageous to assemble facts and consider them in their relation to each other.

PRESENT PRACTICE

Low Carbon Rolled Steel. This metal is the most used, and the most important in the industry. It is used for bodies of tanks, vats, bottle washers, conveyers, and frames of all kinds.

There has been no great change in the composition of this material, although some plates contain a small amount of copper, molybdenum, and other metals. The principal endeavor, in connection with the use of this material, is to find a surface coating that will endure and prevent rusting.

To coat the inside of spray pasteurizer bodies, we have lately been using an asphalt base with lacquer thinner as a vehicle, and the results have been fairly satisfactory.

When the surface is visible, aluminum lacquer is generally used.

Stainless Steel. Chrome-nickel steel 18/8 percent is in general the most satisfactory metal to use in contact with milk. The sheets are easily fabricated, the metal draws well, makes good welds, is nearly insoluble in milk, cleans easily, and is attractive in appearance.

Its chief fault is that it does not cast well. For the linings of tanks and vats, it is without doubt the best metal we know.

Chrome Iron, which is also called stainless steel, is sometimes used for outside coverings or veneers for vats or tanks, but is not entirely rustless.

Use With Brines. Stainless steel 18/8 percent cannot be guaranteed when used in connection with brine. It is apt to stand up for months, and then all of a sudden several small holes will appear that pierce the sheet or tube.

Molybdenum Stainless. This steel, containing 2 to 4 percent molybdenum, which is termed 18/8 S.M., is supposed to resist the action of brine better than the plain 18/8 percent, although the manufacturers will not guarantee this material.

Another material of similar appearance is Inconel, which is about 80 percent nickel, with around 13 percent chromium, and the balance mostly iron. This is an excellent metal to resist action of milk, both hot and cold, but is not immune to corrosion due to brines, and is not guaranteed by the manufacturers to resist brine. The most satisfactory metal to use in contact with brine is copper.

Resistance to Corrosion by Milk. Whereas 18/8 percent stainless steel is usually very satisfactory in resisting corrosion by milk, actually corrosion is apt to occur where two pieces of this metal are close together and partially in contact (contact corrosion) and the milk is hot. Both stainless steel containing molybdenum, and Inconel are more satisfactory under these conditions than the regular 18/8 percent chrome-nickel steel.

Sanitary Pipe and Fittings. For sanitary pipe lines, the 18/8 percent stainless has been very satisfactory. Users have hesitated to buy stainless steel fittings because of the high cost. A considerable number of copper nickel alloy fittings, in combination with stainless steel pipe, have proven satisfactory.

Statements have been made that no copper alloy should be used in contact with milk, but results seem to prove this too broad a statement. It depends upon how the copper is alloyed and how the metal is used.

With regard to the question as to what is the best copper-nickel alloy, it seems that there is no such single alloy. The problem depends upon what use is to be made of it.
For appearances, the trade desires a white alloy that will not easily tarnish; one that is fairly hard so as to resist bruises, that will cast free from blow holes, and that is practical to machine, but, unfortunately, the metal that seems to best answer these specifications, and which would be best for dressing up apparatus, is not the most insoluble in hot milk. Therefore the alloys that come in contact with hot milk have to sacrifice some of the whiteness.

We have, however, succeeded in obtaining an alloy that stands up well in contact with hot milk. Fittings made from this alloy do not easily give up copper to milk thus producing oxidized flavor. It should be remembered that milk normally contains a small amount of copper, about one-half part in a million, but we do not want to greatly increase this.

In passing through a pipe line, any particle of milk is in contact with the sanitary fittings only a very short time. Tinned Copper. Copper, tinned by the hot process, was in very common use in milk plants only a few years ago. It is now used much less. However, tubular coolers and certain other copper equipment, tinned by the electrolytic process, is finding a very satisfactory and increasing use. There is no better metal for contact with milk than tin. The trouble with it is that it is too soft to use by itself, and in the past it has too quickly worn off surfaces that have been coated with it. When a piece of copper is tinned by the hot process, the coating of tin is extremely thin, less than one thousandth of an inch. It is common with the electrolytic process to have the coating four or five thousandths of an inch thick. This equipment cannot ordinarily be soldered satisfactorily, because, in heating the copper, the tin runs off; therefore to make equipment coated with tin four thousandths of an inch thick, it is necessary first to completely fabricate the cooler, or other piece of equipment.

In making cooler sections, the tubes and headers are brazed together, and completely finished, then this is electro-tinned, covering the sections with pure tin four thousandths of an inch thick. This gives a beautiful looking surface, and one that stands up in use for a considerable time. When the tin finally does wear off, it can be retinned.

Galvanizing. This means coating with zinc. It is common practice to use hot galvanized iron sheets and steel rolled pieces. Also zinc can be placed on other metals electrolytically, and this process is in common use. A third way is the Metallizing Process where the zinc is shot onto the surface as a molten spray. This was formerly known as the Schoop Process. With this process, the thickness of the layer can be controlled, and much more zinc put on than is possible with the Hot Process. It is possible, also, to spray other metals or alloys. Defective or injured shafts can be brought up to size by spraying steel to the damaged part, and then grinding to size.

Abroad, copper vats and coils are coated with an alloy of tin, copper, and antimony. This made a surface which was not as bright and shifty as a pure tin surface. Users claimed that it would never develop black spots which so often appear on tinned copper surfaces. It is, also, considerably harder than pure tin.

It is to be supposed that antimony is unobjectionable if it does not go into solution in the milk. However, in this country there would be some prejudice against the use of a coating of that kind.

Chromium Plating. Another coating that has been used in connection with milk equipment, but to rather a small extent, is pure chromium. In the past, a number of pieces of equipment have been electro-plated with chromium. Where the chromium has been put on thick enough, satisfactory results have been obtained, but it is rather expensive.

Aluminum. Aluminum has been used some in this country for tanks, particularly truck tanks, where its light weight is of decided advantage; also it is used for vat covers and cooler covers. It is easy to fabricate. Another very good quality of aluminum is that it does not
produce off-flavors when milk stands in contact with it.

The declining use of aluminum for vats abroad is probably on account of the increasing popularity of stainless steel. The latter is a much harder and more enduring metal, and is easier to clean.

One difficulty of aluminum in this country has been that dairy plant operators will not take the pains necessary in cleaning. Also, care must be exercised as to how it is connected with other metals because of electrolytic action.

There is an important and increasing use of aluminum in milk bottle caps.

*Nickel.* Nickel is used in almost every piece of equipment that is found in the dairy plant. Probably the greatest use of nickel is in stainless steel, and then in copper-nickel alloys, sanitary fittings, vat and tank outlets, manhole casings, pumps, and other equipment.

Pure nickel is an excellent metal for ice cream freezer cylinders. In the Vogt Freezer, it has proven the most satisfactory material.

At one time, pure nickel had a wider use. It was found unsatisfactory, however, for coolers, or for contact with milk when the metal is cooler than the milk, unless both are cold. Some Spray Pasteurizers, the linings of which are Pure Nickel, have been in regular use for many years, and are still in good condition. In that case, the milk was heated and held in the pure nickel, and cooled over a surface cooler.

One of the most surprising things is the way a pure nickel cooler tube is dissolved by the hot milk running over it. For heater tubes, nickel is excellent. Also it is excellent for handling cold milk. Nickel is another metal that does not give milk bad flavors.

*Solder.* The ordinary solder that has been used for many years is half tin and half lead. That was generally used for soldering together the tinned iron sheets that went into cheese vats many years ago, and was later used to hold together tinned copper equipment. Under ordinary circumstances, it is quite insoluble in milk. Many old vats have been used for a great many years where the solder has stood years of use. However, some health officers refuse to permit its use on account of the lead content, and have suggested the use of pure tin as solder. This is not a satisfactory substitute. It is very apt to crack, does not stand nearly as well as the half tin and half lead solder, and is not as strong. This objection to the use of solder arose from some popsicle molds that were tinned largely with lead. In that case, with the lead alloy covering the entire surface of the mold, the action is quite different, because the material to be frozen, containing fruit juices and sugar, is kept in contact with the metal for some time.

For many years certain people, where they wanted to reduce the cost of tinning, have used a mixture of tin and lead, with an increasing percentage of lead where price required it. Half and half tin-lead solder, where properly used, is a good solder from a health standpoint. It is not recommended that containers be tinned with a mixture of this kind. When it comes to coating a surface, the metal should be pure tin.

**FUTURE EQUIPMENT AND PROCESSES**

*Pasteurization.* Continuing changes in pasteurization may be expected. Cities will probably require that all milk be pasteurized, and there will be a decided trend towards shorter time holding than thirty minutes, and with temperature higher than 144° F.

Last summer in Berlin it was interesting to notice the absence of holders, except single pasteurizing vats. When it comes to large capacities, they were using short time, high temperature pasteurization.

Recently Cherry-Burrell has been introducing a process which we term Duo-Shortime Pasteurizing Process. This was worked out by Mr. Rolan J. Wightman. The milk is heated quickly to about 158° F., cooled to about 145°, then heated to 160° or 161° F., held for 15 seconds, and then cooled.

In tests made of that process, the cream line was as good and usually better than when the milk was heated directly to 160°
or 161° F., held for 15 seconds, and then cooled. There was considerable improvement in the destruction of bacteria.

At one well-known plant in an important city, the average bacteria plate count for 84 samples, using the single short time system, was 12,600 organisms per milliliter with cream layer varying from 15½ to 16 percent. After this same unit was changed over to the Duo-Shortime System, the results showed, in 84 samples, an average bacteria count of 6,830, with the raw milk having a higher initial bacteria content than when the single shorttime system was used. The cream layer, after the change was made to the Duo-Shortime System, averaged between 17 and 19 percent.

At another well known plant, the bacteria counts were reduced approximately 40 percent, with maintenance of slightly better cream layer after the Duo-Shortime Pasteurizing System was started.

On the Continent of Europe where they are not so particular about the cream line as we are in this country, they were pasteurizing at a higher temperature, namely, about 162° F., and holding for about 40 seconds.

If we could adopt a required temperature of 150° F., and hold for 5 minutes, it would be very practical. In Dr. Dahlberg's New York State Agricultural Experiment Station Bulletin, No. 203, it shows that the tubercle bacillus is destroyed at 150° F. after holding for 3½ minutes.

**Homogenizer.** The talk about the cream line brings up another subject. There will be an increase in the use of homogenized milk where the cream line is entirely done away with. The reasons for this are the improved flavor, and uniform distribution of cream. Many people believe it is more easily digested.

**Discoveries by Professor Sharp, Guthrie and others.** Some experiments conducted by Professors Sharp, Guthrie and others at Cornell University have shown that if the oxygen or air is removed from the milk at the time it is pasteurized, and if it is bottled without exposure to air, the oxidized flavor will not develop.

**Packaging and Distribution.** Changes will also occur in the packaging and distribution of milk. For some years, there has been the hope among health officers that the top of the bottle of milk will be covered at the dairy to prevent contamination of the pouring lip. There has been hesitancy about requiring this because of cost.

In England, there has been a very surprising swing to the use of Small Mouth Bottles with aluminum caps.

Two years ago, the Borden Farm Products Co. started an experiment along this line at their Utica, N. Y., plant, where bottles having an outside diameter of 38 mm. were used. In the meantime, other plants have been started. For instance, at South Norwalk, a bottle that they call 41 mm. diameter is used. This diameter is measured at the very top of the bottle. Lower down, where the skirt of the cap touches the bottle, it measures about 43 mm. in diameter. Caps of this size, out of plain aluminum foil, cost about 76 cents per thousand, and make a tight seal for the bottle without using a cardboard disc.

There has also been recently a considerable swing towards paper bottles for milk that is sold wholesale to retail stores.

**Packaging of Ice Cream.** There is a rapidly increasing custom of putting ice cream in paper cartons, or cups, as it comes from continuous freezers. Two or three different flavors are run in at the same time in layers, and fancy shaped centers can be made.

**General Improvements in Design of Equipment for Sanitary Reasons.** There has been given increased thought to sanitation. The desire to get away from stuffing boxes has brought forth the rotary seal, as for instance, around the shaft of the centrifugal pump and freezer, and also the improved packings in the viscolizer. The propeller shaft for the agitator in storage tanks is now arranged to come down through the top of the tank, and can be readily disconnected and taken out for cleaning. Also, the corners of equipment in general are made more rounding, and the surfaces smoother.