STRATCO®
The Engineering and Technology Company

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# NEW USES FOR A VINTAGE MACHINE

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production of the soap concentrate for lubricating greases.[1] The Contactor significantly reduces manufacturing time while improving product yields and product quality when compared to the open kettle process. This is demonstrated by the fact that over 120 STRATCO Contactors have been utilized in lubricating grease service since 1929.

In the late 1930s, the alkylation process for production of high octane gasoline in petroleum refineries became quite important. This process reacts light olefins ($C_3$-$C_5$) with isobutane in the presence of a strong acid catalyst, usually $H_2SO_4$ or HF. To promote the desired alkylation reaction and suppress the undesirable polymerization reaction, the two reacting hydrocarbons and the acid catalyst must be intimately and continuously contacted. This is best accomplished in a tight acid/hydrocarbon emulsion. Also, since the reaction is quite exothermic and temperature dependent, an efficient means of heat removal and temperature control is required for the alkylation reactor. When it was determined that the STRATCO Contactor met these specifications, the Contactor was immediately adopted as the reactor of choice for light olefin alkylation. Today, the STRATCO Alkylation Contactor is used in nearly 70% of the worldwide $H_2SO_4$ alkylation production facilities resulting in over 550,000 BPD of high octane gasoline.

## STRATCO Contactor Design

The outstanding feature of the STRATCO Contactor is highly turbulent circulation in a closed cycle path. This circulating flow rate is substantially greater than the flow rate of the feed

into the machine. All energy input through the mixing impeller is expended within the materials being mixed and there is virtually no pressure differential between the Contactor inlet and outlet. Therefore, a homogeneous mixture is continuously maintained within the machine.

Frequent and forced changes in velocity and direction of flow occur around the impeller area. Liquid feed to the Contactor enters the circulating, turbulent mass at its center. The feed flows directly to the impeller from which it emerges uniformly mixed and dispersed. Turbulence is established between the stationary shear vanes and the blades of the impeller, resulting in a zone of high shear at the inlet to the impeller.

As the liquid passes through the impeller, its velocity is greatly increased. At the discharge side of the impeller, the slightly swirling stream is violently impinged against the diffuser vanes. These diffuser vanes then straighten the stream into axial turbulent flow. The direction of flow is reversed at the end of the Contactor and the circulating stream continues its flow in a closed circuit through an annular space provided with straightening vanes.

The degree of dispersion may be varied over a wide range. It may approach that of a colloidal suspension by proper selection of impellers or by the use of variable speed drivers to change the circulation rate.

STRATCO Contactors are available in two basic types: vertical and horizontal. The horizontal model uses a tube bundle for temperature control, is operated liquid full, and is usually limited to continuous processes. The vertical model may be operated open or closed, partially or completely full, and in batch or continuous processes. The size of the heat transfer surfaces in both models may be varied or eliminated depending upon the requirements of the specific application.

Contactors can be designed and fabricated for any operating capacity and in any appropriate metallurgy. Standard sizes of the Contactor range from the 300 cc laboratory model to the 1840 gallon vertical Contactor to the 11,500 gallon horizontal Contactor.

## STRATCO Contactor Applications

### Lubricating Greases

In addition to simple metallic soap concentrates, the Contactor has been found to be quite efficient in manufacturing complex greases. McCormick, Fasone and Kay reported the Contactor is very efficient in the production of lithium complex grease.[2] They found only about 3.5 hours is required to produce a 15,000 pound batch of lithium complex grease in the Contactor. The performance properties of the grease are excellent and improved yields are realized.

Recently, we completed a series of tests runs in our laboratory for a major non-domestic grease manufacturer. The objective of this work was to develop an operating procedure to produce their lithium complex grease in the Contactor. In these tests, their entire formula was loaded into the Contactor before it was closed. After proper adjustment of the operating conditions, the finished grease was very smooth and met all of their specifications. As a result of this work, this manufacturer is building a new grease plant based on the Contactor technology.

Other grease manufacturers employ the Contactor to produce specialty greases. In most cases, extensive work is completed in their 12.5 gallon pilot plant Contactor to develop the proper formulations and operating procedures prior to full scale production. Thus, it is evident this vintage machine is growing with the lubricating grease industry to effectively and efficiently produce the new generation grease products.

**Specially Surfacing Materials**

Another new application for the STRATCO Contactor is in the production of modified asphalt emulsions.

STRATCO was approached by a company that supplies a polymer modified asphalt emulsion to the road building industry. This material consists of asphalt modified with virgin or recycled low density polyethylene. The polyethylene must be emulsified into the continuous

asphalt phase in order for the finished product to have the desired mechanical and physical properties. Current production of this product is accomplished by multiple passes through a colloid mill. Product quality between batches is inconsistent and production time per batch cannot be accurately estimated. Using a modified grease Contactor, STRATCO designed a simple batch process that will produce this modified asphalt product. With this process, the product quality will be consistent and production capacity will be increased.

One of the current major environmental concerns in the U.S. and elsewhere is disposal of used vehicle tires. Most states have passed legislation prohibiting placing tires in solid landfills within the next few years. One of the most promising alternate methods of disposal is recycling the tires into other useful products. In this recycling effort, the rubber content of the tires is recovered as a material called "crumb rubber." This crumb rubber is then mixed with asphalt to produce a high quality, specialty asphalt cement. The current method of producing this rubberized asphalt is with a simple mixer. However, because of the variables involved, it is difficult to control product quality or production time. Recent work conducted in our laboratory indicates this important product of the future can be consistently and efficiently produced in the Contactor. Based on this experience, we believe other rubberized asphalts and similar products can be successfully manufactured in the Contactor. In most cases, only very slight modifications to a standard grease Contactor will be necessary.

## Personal Care Products

Creams, lotions, soaps, detergents and many other health and beauty aids are the result of chemical reactions, require emulsification, or both. The principal chemical reaction required in the production of hand and body soaps is saponification of an appropriate fat with a caustic material to produce the desired soap product. The reaction conditions are similar but less severe than those required to produce the metallic soaps for lubricating greases.

## Soaps

STRATCO, in conjunction with a leading international soap and cosmetic manufacturer, is developing a continuous saponification process for their premium quality beauty bar. To date, the commercial production facilities of this Fortune 500 company utilize a batch process. This is quite labor intensive and product inconsistency between batches requires substantial reworking. A continuous process that yields a consistent, high quality, on-specification product will reduce their costs and improve their manufacturing efficiency.

A substantial amount of work has been completed in our laboratory pilot plant in this effort. We have successfully demonstrated that their product can be consistently produced on a continuous basis using the STRATCO Contactor as the saponification reactor. Production rates exceeded expectations and finished product quality met their stringent specifications. This manufacturer is currently constructing a completely continuous pilot plant facility to

produce their product. In addition to continuous manufacturing of the luxury soap product, their pilot plant will include continuous bar forming and packaging equipment.

## Lotions

While most creams and lotions are thickened by gums and polymers, they still require good emulsification for stability. Lotions usually fall into the oil-in-water emulsion category. The following table shows a simple moisturizing lotion formula we processed in our pilot plant as part of a feasibility test for a major cosmetic company.

### MOISTURIZING LOTION

| **Water Phase** | % |
|---|---|
| Water | 40 |
| Polyol | 4 |
| Emulsifier | 7 |
| | 51 |

| **Oil Phase** | % |
|---|---|
| Beeswax | 5 |
| Mineral Oil | 26 |
| Hydrogenated Vegetable Oil | 18 |
| | 49 |

In the pilot plant (Figure 2), the water phase and the oil phase ingredients were heated to the proper mixing temperature and then continuously metered into a 300 cc Contactor. To determine the capacity of the Contactor in this application, residence times were continually

reduced until the product quality was less than required by the client's specifications. We found that the Contactor residence time can be reduced to approximately 5 seconds before poor quality product is produced. At this residence time, the 300 cc Contactor can produce over 400 lb/hr of moisturizing lotion. Average oil droplet diameter is less than 5 microns. The lotion produced is stable and was judged by the client to be higher quality than their current commercial production.

**Food**

Many food products are emulsions or have an emulsion formed during their process. Salad dressing, cake batter and non-dairy creamer are a few examples. Most food emulsions are the easier to produce oil-in-water type. That is, the fats, oils and other lipophilic ingredients are finely dispersed into a continuous phase of hydrophilic (water-loving) ingredients. Other foods are water-in-oil emulsions, where the water phase is dispersed within the continuous oil phase. Mayonnaise is an example of a water-in-oil emulsion.

No chemical reaction is necessary to produce most emulsions. However, good emulsification is important for product consistency and stability. Usually, the dispersed phase particle size should be about 3-5 microns and a surfactant is required to help prevent coalescing. In mayonnaise, the egg yolks act as the surfactant. The following table shows a typical mayonnaise formula divided into oil and aqueous components.

## TYPICAL MAYONNAISE FORMULA

| **Brine** | % |
|---|---|
| **Water** | 6.83 |
| 120 Grain Vinegar | 2.55 |
| Corn Syrup | 2.33 |
| Mustard Flour | 0.70 |
| Salt | 0.53 |
| Lemon Juice Powder | 0.05 |
| Calcium Disodium EDTA | 0.01 |
| | 13.00 |
| **Salted Egg Yolks** | 7.00 |
| **Soybean Oil** | 80.00 |

Figure 3 shows a flow diagram of STRATCO's mayonnaise pilot plant. Ingredients are continuously metered into a 300 cc Contactor and finished product is continuously withdrawn. In the pilot plant, all aqueous ingredients (egg yolk and brine) are pre-blended before being pumped into the Contactor.

Results of our mayonnaise production experiments were excellent. Premium quality mayonnaise was produced at a rate of approximately 2 liters/min. Viscosity was comparable to commercially available mayonnaise and organoleptic properties were excellent. As a result of these tests, we are working with a regional manufacturer of mayonnaise and other food products to utilize the Contactor in their manufacturing facility.

## Other Applications

Other new applications being evaluated for this vintage machine include:

1. Chemically treating non-hazardous and hazardous wastes.
2. Blending of chemical wastes for future incineration or other disposal.
3. Chemical synthesis of lubricating oil additives.
4. Production of pharmaceutical creams and specialty drugs.

## SUMMARY

In summary, the STRATCO Contactor is a very versatile and efficient machine. Any process that requires emulsification or mixing of dissimilar liquids or reactants, that may or may not need precise temperature control during processing, can be efficiently and effectively accomplished in the STRATCO Contactor.

Some of the advantages of the Contactor over other types of equipment are:

1. Efficient emulsification of dissimilar liquids.
2. Rapid dispersion of a small amount of one ingredient into a large mass of a second ingredient.
3. Efficient temperature control of the material it contains and/or the ability to take this material through any desired temperature cycle.
4. Pressure or vacuum operation.

5. Flexibility for either batch or continuous processes and/or several processes in one manufacturing plant.

6. Multiple sizes and metallurgy.

In short, it is apparent this vintage machine is not getting older, it's getting better!

**Literature Cited:**


1. Graham, S.D. and Meyer, D.W.., "Today's Decision in Grease Manufacturing, Kettles vs. a Contactor", NLGI SPOKESMAN, September, 1984.

2. McCormick, Martin, Fasone, Sal, and Kay, Keith D., "Contactor Process for Lithium Grease", NLGI SPOKESMAN, July, 1985.