Summary

The soil removal efficiency of 17 sodium alkylbenzene sulfonates having alkyl residues ranging from six- to 18-carbon atoms, which have been synthesized and purified especially for this work, has been described. Evaluation has been accomplished by means of an ultrasonic cone transducer capable of producing mechanical action of a very highly reproducible character and at a measurable rate of expenditure of energy. Compounds having straight-chain alkyl residues produce generally greater detergency efficiency than the branch chain homolog. Detergent character becomes pronounced at about 10 carbon atoms in the alkyl residue, but detergency is diminished above about 14 to 16 carbon atoms in the alkyl group because of reduced solubility.

Acknowledgments

The authors are indebted to the Office of the Quartermaster General for financial assistance so generously given in support of this work. The imaginative criticisms and suggestions of Pauline Beery Mack, dean and director of research in the College of Household Arts and Sciences, and of Robert W. Higgins, head of the department of chemistry, are deeply appreciated.

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[Received August 13, 1956]

Slurry Storage of Light Soda Ash[1]

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LIGHT SODA ASH or sodium carbonate is a fluffy, dusty hygroscopic material with an angle of repose that sometimes exceeds 50 degrees. With increased use in the chemical, oil, non-ferrous metal, and pulp and paper industries, production of this basic chemical has climbed to about five and one-half million tons per year. This consumption could add up to a lot of headaches for the people who handle and store the onerous compound. This paper will deal with a recent development in storing soda ash as a slurry and with an economical, pneumatic unloading system adapted to this type of storage. The systems are of particular interest to those who use soda ash in a solution form.

Pilot Plant

The principle of converting dry sodium carbonate into a storable slurry has been known for years. It is merely one of transforming dry soda ash with a bulk density of 35 lbs. per cubic foot into a wet sodium carbonate monohydrate with a density of 56 lbs. per cubic foot. It was not until recent years that this principle was fully exploited and a practical system for storing soda ash as a monohydrate slurry was perfected.

Extensive research has been carried out to establish the basic data needed for the design and operation of a pilot-plant unit.

The large-scale work was carried out in a 5,000-gal. steel tank 9 ft. in diameter by 11 ft. high. The tank was equipped with a sparger or dissolving arrangement containing 11 check-valve type of nozzles. A screw conveyor discharging into a sluiceway or chute was used to charge the tank with soda ash. A pump circulated solution into the ash-charging chute to dissolve and wash soda ash into the tank. The suction hose of the pump was maintained just below the liquor surface to avoid circulating any solid particles of ash. Later the tank was equipped with a floating suction and swing joint, as shown in Figure 1.

Prior to the initial unloading the tank was charged with a predetermined quantity of water. As soda ash was added to the water, the resultant solution increased in concentration until it reached saturation. Saturated solution was then used to wet the incoming ash, and monohydrate was formed by both crystallization from the saturated solution and hydration of dry soda ash. The monohydrate formed was dense and settled rapidly, making available a clear saturated solution for recycle. Loading of the tank was continued until approximately 92% of its volume was composed of slurry. Dissolving of the monohydrate slurry was accomplished by introducing a metered water flow through the sparging nozzles.

Design Data

Preliminary design data for a commercial installation were determined from the pilot plant (Table I).

The slurry storage tank should be kept at 105°F. or above to avoid formation of heptahydrate and decahydrate. The hydrates of 7 and 10 moles of water have negative heats of solution of 178 and 270 Btu. per pound of sodium carbonate, respectively, and are difficult to dissolve. The monohydrate, with a positive heat of solution of 42.5 Btu., dissolves quite easily.

A considerable amount of heat is evolved in the charging process because of the heats of solution and monohydration. In the transition from water to a slurry occupying 92% of the tank volume, a tempera-

MECHANICAL PILOT PLANT

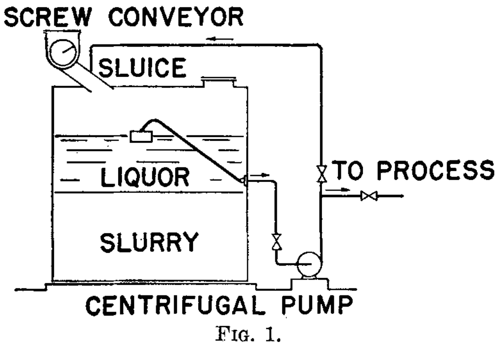

FIG. 1.

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[1] Presented at the 48th Annual Meeting, American Oil Chemists' Society, New Orleans, La., April 29–May 1, 1957.

TABLE I

Preliminary Design Data

Charge of Ash Slurry to Tank	
Loading (maximum)	10 lbs. ash per gallon recycle
Weight ratio, in filled tank	1.2 lbs. ash per lb. water or 10 lbs. ash per gallon water
Density of slurry	56.0 lbs. per cubic foot or 7.5 lbs. per gallon
Clear liquor in full tank	8.0% of tank height
Control temperature (minimum)	105°F.
Volume increase—starting with water	33%
Volume increase—starting with 30% solution	23%
Dissolving of Slurry to Produce Soda Ash Solution	
Water flow rate (maximum)	0.65 gal. per minute per sq. ft. of tank area
Spacing of water nozzles	1 nozzle per 5 sq. ft. of tank area
Concentration of soda ash solution	30.0% ± 0.5% at a specific gravity of 1.33, temperature of 105°F.
Dissolving rate	2.32 lbs. ash per minute per sq. ft. of tank area

ture rise of 60°F. will take place. This temperature increase is sufficient to raise the slurry temperature above the transition point (95.7°F.) for forming other hydrates.

With this heat source and reservoir, steam consumption to maintain the slurry is negligible. Steam costs on a typical installation are only about $150 per year, even with a winter temperature of —20°F.

Advantages

From a monetary standpoint the greatest advantage appears to those who are presently using bagged soda ash and whose consumption warrants a conversion to slurry or bulk storage. The savings of $6 per ton can pay for an unloading system and slurry storage in about two years, providing soda-ash consumption is 70 to 100 tons per month. Those who consume a carload each month could realize savings of $2,500 a year after about four years of using bulk or slurry storage.

From the operation of a pilot plant many other advantages of a slurry storage system for soda ash became apparent. Some of the advantages of particular interest are listed below.

Soda ash can be stored at a higher density than is possible with solution or dry storage.

Type of Storage	Density lbs./cu. ft.	Storage volume of 35-ton car of soda ash (gal.)	Capacity d. b. of 10,000-gal. tank (lbs.)
Slurry	56	9,400	75,000
Dry	33–35	15,000	47,000
Saturated solution	24–25	22,000	33,000

In actual investment it would cost about $46 to store one ton of soda ash as dry material as against $27 to store a ton once it has been slurried.

The slurry storage tank is actually a combination storage and dissolving tank. The simplicity of the operation affords a chance for labor saving as well as reduction in capital expenditure. The use of the tank for both purposes eliminates the need for a transfer conveyor, a separate dissolving tank, and a mixer to effect the solution of soda ash. It also eliminates the dust that normally occurs in the transfer of dry soda ash from the storage bin to the dissolving tank.

Another advantage of the slurry storage system is the ease with which the soda ash may be withdrawn from storage. Water is distributed over the bottom of the tank through the sparging nozzles and percolates up through the bed of soda ash monohydrate. This action dissolves the monohydrate and forms saturated soda-ash solution. The layer of clear solution may be withdrawn from the upper portion of the tank by floating suction or overflow and pumped to a point of usage. From an operational standpoint, material can be handled more economically and controlled more easily in a liquid than in a solid form.

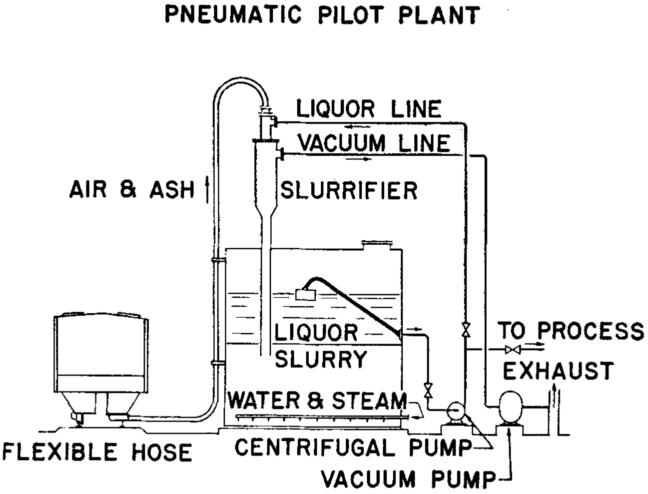
PNEUMATIC PILOT PLANT

FIG. 2.

The soda ash solution which is pumped from the slurry tank is of practically uniform concentration (30.0% ± 0.5% soda ash). For this reason relatively simple control equipment is required when further dilution of the saturated solution is desirable.

Light soda ash, even in its driest condition, tends to cling or adhere to the sides of bins. Light ash also absorbs moisture slowly when exposed to the atmosphere, as much as 3.5% in 60 days under average storage conditions. As moisture is absorbed, carbon dioxide normally present in air reacts with soda ash to form sodium bicarbonate. These conditions are responsible for the caking of dry light ash, necessitating hoeing or mechanical vibration to discharge it from storage. Slurry storage of soda ash maintains a fluid form, thereby eliminating the problem of caking and sluggish flowability.

These operational advantages are all labor-saving devices which can materially reduce the cost of soda ash after it is in your plant.

Pneumatic System

The original pilot-plant work was concerned entirely with a mechanical system for unloading soda ash and charging slurry to the tank. Since the dust created by a mechanical system is usually objectionable, it was decided to investigate a pneumatic system which could unload and slurry in the same operation. The system was based on the principles that an abrupt change in direction and a rapid decrease in velocity will remove dust from an air stream. These facts, coupled with the method of scrubbing dust from air, were incorporated into the design of a pneumatic, wet separator.

The separator was first pilot-planted in glass so that the scrubbing action and separation of soda ash from an air stream could be observed. The action of the separator looked promising, and a larger unit was designed to unload five tons per hour. The wet separator was installed on the 5,000-gal. slurry storage tank as shown in Figure 2.

With the exception of the wet separator, the pneumatic system operates on the same principle as others that are in common use. Air is admitted and controlled through ports in the unloading hopper attachment. This attachment is an extension of the railroad-car hopper and provides a controlled outlet for the soda ash. Air fluidizes soda ash and carries it into the top of the separator. Recycle solution is pumped from the tank into the nozzle of the separator. Here the solution forms a curtain through which air and soda ash must pass. The solution scrubs soda ash from the air stream and washes the soda ash down the tail pipe into the tank. The direction of the air stream is then changed 180° as air is pulled into the disengaging chamber of the separator. The air velocity is reduced considerably in this chamber allowing soda ash dust and entrained solution to drop from suspension. The dust-free air is then pulled through the vacuum pump and discharged along with the seal water.

The pneumatic system operates at 10 in. of mercury and is capable of unloading approximately 0.7 lbs. of soda ash per minute for each cubic foot of air. The air velocity in the unloading line should be 90 to 110 ft. per second. The velocity is decreased to approximately 10 ft. per scond in the disengaging chamber of the separator. Velocity of the solution is maintained at approximately 15 ft. per second at the nozzle of the separator.

The wet separator (patent rights held by Diamond Alkali Company) is a fabricated piece of equipment which replaces costly bag-cyclone type of filters, thereby materially reducing the capital cost of a pneumatic system.

Many commercial units have been designed, utilizing the data obtained from pilot-plant operation. The completed installations vary in storage capacity from 70 to 1,200 tons of soda ash. The unloading systems have been designed and operated at rates of 5 to 20 tons of soda ash per hour.

[Received April 26, 1957]

Nutritional Properties of the Triglycerides of Saturated Fatty Acids of Medium Chain-Length[1]

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NUTRITIONAL STUDIES with rats have revealed that the inclusion in the diet of autoxidized fats or their polymeric fractions increases the amount of food which the animal needs to maintain its weight and that this effect does not result from poor absorption (7). This observation suggested the search for other fats which might also boost the maintenance requirements and, at the the same time, be atoxic and more palatable.

This report will describe some of the biological properties of the saturated, medium chain-length (6 to 12 carbons) triglycerides (MCT) derived from coconut oil. Such triglycerides, which occur mainly in coconut and other palm kernel oils and in butter, have received the attention of several nutritionists (8, 10).

In the studies reported below MCT was compared with natural fats and fat-free diets as to growth, weight maintenance requirements, serum cholesterol, and relation to unsaturated fatty acids.

Present Study

The MCT which was used throughout these experiments was a clear, thin oil containing the triglycerides of saturated fatty acids of 6 to 12 carbons. It was derived from coconut oil by fractionation of the split fatty acids and reconstitution of the desired fraction into triglycerides and represented 15% of the original coconut oil. It had a melting point below 0°C. and an iodine number less than 1.

The experiments were carried out on albino rats from a homogeneous colony of the Sherman strain. Until such time as they were placed on the experimental diets (usually at about five weeks), the rats were fed an adequate diet containing 30% lactalbumin and 10% lard. The procedure used in this laboratory for making up well-matched groups has been previously described in detail (6).

The experimental diets were composed of 30% casein (G.B.I. vitamin-free, test casein), 4% salt mixture (U.S.P. XIII), 2% cellulose (Alphacel), the desired percentage of fat and dextrose (Cerelose) to make 100%. To this were added, per kilogram of diet, 1 g. choline chloride, 1 g. inositol, 300 mg. PABA, 100 mg. nicotinic acid, 2 mg. thiamin chloride, 4 mg. riboflavin, 4 mg. pyridoxine, 10 mg. calcium pantothenate, 2.5 mg. folic acid, .025 mg. biotin, 5 mg. 0.1% trituration of vitamin B_{12} in mannose, and 25 mg. ascorbic acid. Fat-soluble vitamins were added in the form of a linoleic acid[2] suspension at the rate of 1 cc. per kilogram of diet to supply the diet with, per kilo, 5 mg. beta-carotene, 50 mg. alpha tocopherol acetate, 10 mg. free alpha tocopherol, and 0.5 mg. vitamin D_2. The basic diet contained no linoleic acid other than the 900 mg. per kilogram of diet used as the carrier of the vitamins. Inasmuch as the rats fed this diet ate approximately 12 g. per day, their linoleic acid intake was about 10 mg. per day. In certain experiments the linoleic acid supplement was increased to 2% of the total diet; the daily intake of rats eating this diet was more than

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[1] Presented at the 48th Annual Meeting, American Oil Chemists' Society, April 28 to May 1, 1957, New Orleans, La.

[2] A concentrate prepared from safflower oil and containing 95% of unoxidized linoleic acid.