Continuous Sugar Detector

RUDOLPH H. LARSEN[1]

THE ESTIMATION of sucrose by the Molisch Reaction is well known to all of us. Many attempts at improved methods, or apparatus, had produced nothing of importance until the Continuous Sugar Detector was invented by P. W. Alston and E. E. Morse (U. S. Patent 2,408,900) of the Spreckels Sugar Company. The predecessor to the continuous sugar detector, for testing of various vapors, was the intermittent method. This apparatus has been mentioned in literature of Germany and the United Kingdom. It is non-continuous in operation; e.g., a fixed amount of condensate water was run into the cell, alpha napthol solution added and sulphuric acid run in, in consecutive steps. The intensity of the colored reaction products was measured by a photocell, then the cell was emptied and rinsed. Needless to say, this type of detector never came into prominence in that it was but slight improvement over a hand test by Molisch Reaction, and also to the fact that it was non-continuous.

The Continuous Sugar Detector is continuous in every respect, in that a continuous flow of condensate is constantly being run into the detector, together with a continuous feed of sulphuric acid and alpha naphthol. The reaction is continuously taking place as long as there are any sugars present. The colored reaction is constantly measured and the results recorded.

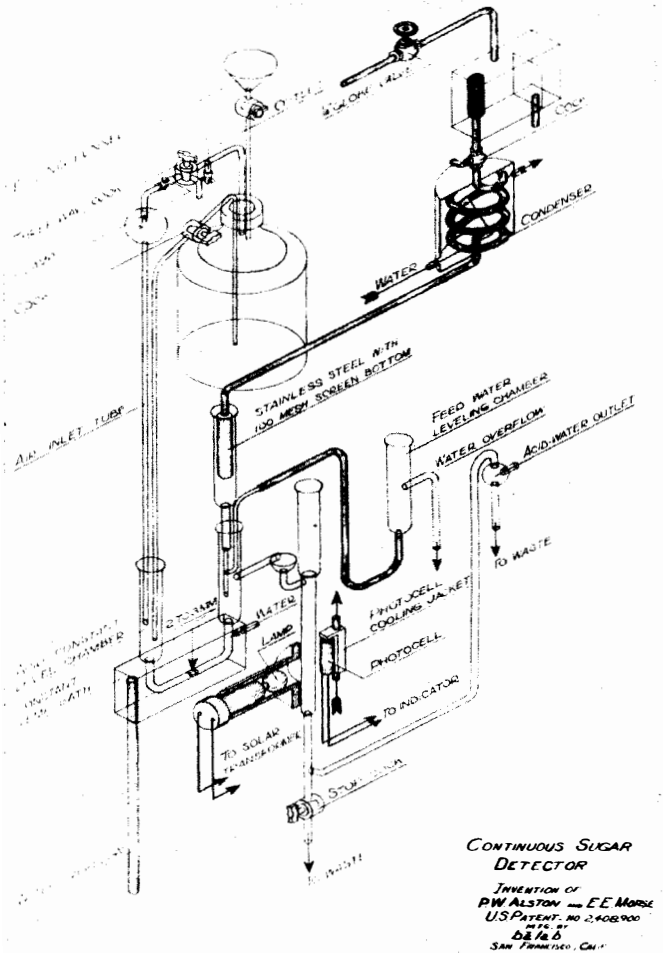
Various Components of Continuous Sugar Detector and Their Operation

A. Feed water portion.
   1. Filter paper.
   2. Throttling valve for overflow chamber.
   3. Constant head and overflow-control box.
   4. Cooler.
   5. Filter screen.
   6. Condensate flow-control nozzle.

B. Acid, alpha naphthol feed portion.
   1. Reservoir.
   2. Feed-control portion.
   3. Orifice to limit acid flow, and cooler.
   4. Alpha naphthol and sulphuric acid.

C. Reaction chamber.
   1. Chamber where condensate and acid-alpha naphthol mixture comes together.

[1]Field Chemist, Balab "Bubble-Breaker" Defoamer Division.



CONTINUOUS SUGAR DETECTOR

INVENTION OF
P.W. ALSTON AND E.E. MORSE
U.S. PATENT NO. 2,408,900
MFG. BY
B & L
SAN FRANCISCO, CALIF.

D. Absorption chamber and illuminant system.
1. Light source.
2. Photo-electric cell.
3. Warning signal.
4. Recording, or indicating, apparatus.

A. *Discussion of Feed Water Portion*

Second condensate, or other solution or solutions, to be tested is obtained through a 1/8-inch line from the discharge of the condensate pumps. The flow is controlled by a valve near the apparatus; the condensate is first filtered and then passes into a small, constant level box with an overflow. From this box the water runs into the cooler through a control valve. The cooler is a heat exchanger with a cylindrical outer casing 4 inches in diameter by 10 inches long. It contains a 12-foot coil of 1/4 inch O. D. copper tubing, and is considerably over-designed as to capacity. The condensate must be cooled to approximately room temperature to enable the color reaction to take place. The cooling system is supplied with water from the domestic house cold-water system. From the cooler the condensate flows through a fine screen and into the nozzle tube. A feed water leveling chamber is used to control the head on the nozzle. For the nozzle a piece of 7-millimeter glass tubing is drawn out and a tip formed so a 4-inch head of cooled condensate on the nozzle will deliver, into the air, 15 milliliters per minute.

B. *Sulphuric Acid—Alpha Naphthol Portion*

As a reservoir for the acid mixture a 5-gallon Pyrex bottle is used; the acid and alpha naphthol are mixed in the proportion of 1 gram of alpha naphthol to 1 pound of acid. To facilitate mixing, the alpha naphthol is dissolved in methyl alcohol. The mixture must be shaken up immediately; otherwise an insoluble solid is formed, the nature of which is unknown. A mixture so prepared will have identical reaction properties over an interval of at least a week. The acid used is nitrate free sulphuric acid, regular CP—ACS standard. The alpha naphthol used is special alpha naphthol for sugar testing.

C. *Reaction Chamber*

The acid is delivered to the constant-level chamber by means of a siphon line. In order to limit the acid flow it is necessary to have a constriction in the tube leading to the reaction chamber. The constriction in this tube is 2 millimeters; the tube is cooled by means of a condenser which is blown around the constricted tube. The reaction chamber is the place where the acid, alpha naphthol and condensate come together; the condensate from the nozzle should "plow up" the acid level to a depth of about 1/8-inch under the interface.

D. *Absorption Chamber and Illuminant*

An overflow takes place from the reaction chamber to a tube which passes a photo-electric cell, by which the intensity of color is measured. The illuminant in this case is a 100-watt bulb mounted in a sliding receptacle to actuate the cell properly. The electrical supply is maintained uniformly by means of a constant voltage Sola transformer.

Since great heat is evolved in this reaction and photocells, of the type used are damaged by temperatures above 120° F., it is necessary to water-jacket the photocell housing; and also, the detector may be placed in the mill, the house temperature of which can well be 120° F., so hence the cell must be cooled.

D-4. *Recording or Indicating Apparatus*

The output of the photo-electric cell is brought out to a Brown Electronik Continuous Balance Potentiometer instrument. The instrument is provided with a suitable calibration to match the photo-electric cell output and is calibrated in parts per million of sugar. It contains a large indicating pointer that can easily be seen to distances up to 150 feet. It also gives a record of the condition of the boiler feed water over a 24-hour period. The instrument responds immediately to any unbalance that is transmitted by the photocell. In terms of pointer travel the large black indicating pointer travels from 0 on the scale to full scale in 12 seconds. That is the speed that the driving unit is capable of moving the recording mechanism and the indicating pointer. However, in all normal applications, this speed is more than ample since there is no lag in the instrument between the time the unbalance occurs and movement of the pointer begins.

The instrument can be purchased in the form of an indicator or recording instrument. The recording instrument is available in any type of control form, either air or electric actuation. The indication type of instrument is only available in electric control form. The control on the instrument can be used to sound an alarm and to indicate on an alarm light when the sugar content has reached a dangerous level. It can also be used to immediately stop the flow of boiler feed water by means of closing a shut-off valve and at the same time open a feed-water valve from an unpolluted source. Or it can operate a mixing valve that will mix the feed water from various sources so that the sugar content can be held to a predetermined maximum. The controller can be provided with either an internal or external control point setting so the alarm contact or the control contact will actuate at any value that has been determined to be the maximum safe value for the boiler in question.

Maintenance and Cost of Operation

Over a 24-hour period the approximate cost of acid, alpha naphthol and labor amounts to $4.00. This cost is figured on use of 9-pound bottles of

sulfuric acid, but cost can be reduced considerably by purchasing sulfuric acid in carboys. However, 9-pound bottles are preferred for convenience of handling and safety.

Replacement of Light Source

The 100-watt bulb should be replaced when there is a noticeable darkening of the bulb.

Conclusion

The present continuous sugar detector has been in successful operation at three Spreckels Sugar Factories for a period of 7 years. When this instrument has been in use no shut down of boilers, due to sugar in the condensates, has been experienced. Thus, the instrument easily pays for itself, as one flash of sugar in the condensate could cause a shut down amounting to several thousand dollars. The general field and use of the continuous sugar detector should be more than ever now, especially with the advent of high pressure steam generating plants. Needless to say a factory can ill afford to take a chance on having sugar in condensate cause a costly shutdown.