PLANT CONTROL OF THE ENGINEERING OPERATIONS

AT THE

CALVERT DISTILLERIES, RELAY, MARYLAND

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I. SUMMARY.

The completely modern distillery of the Calvert Company at Relay, Maryland was designed to facilitate operation by the use of central control stations. Liberal use of automatic recorders and regulators mechanizes process control to a highly efficient degree.

The production of alcohol by bacteriological processes requires a careful and systematic regulation which can only be maintained by complete chemical knowledge of conditions of reaction determined from tests and analysis. For this reason, the Calvert plant employs a staff of trained technicians to keep constant check on the chemical processes of the production.

The transformation of grain into alcohol involves the conversion of the grain starch to sugar and fermentation of the sugar into alcohol and carbon dioxide by the action of yeast. These reactions require careful regulation of temperatures and pressures to give maximum yields.

All raw materials, as they arrive at the plant, must be tested for quality and to meet certain standards before their use in production is permitted.

In the main process, samples are withdrawn for test at every point where it is advantageous to know the condition of the product. The preparation of fusel oil and cattle feed require observation as well.

The process of aging and blending the liquors is carried out under the supervision of the plant chemists. Careful tests

for quality control aid in the production of a uniform product.

The up-to-date equipment used and careful maintenance of control make the Calvert Distilleries one of the most modern plants in the world.

II. INTRODUCTION.

Careful and systematic control of the plant operations at the Calvert Distilleries of Relay, Maryland has been established to insure the production of a whiskey of uniform quality. The completely modern plant, situated on the Washington-Baltimore Boulevard in the valley of the Patapaco River, has adequate and up-to-date facilities for careful testing and control of the entire process from examination of the raw materials as they are received at the plant to the testing of the final product as it leaves the blending department. The plant makes liberal use of automatic recorders and regulators for complete control of all operations involved in the production of spirits of grain and the by-products, fusel oil and feed for live stock.

Obviously production of any material for human consumption requires close supervision of the purity of starting materials and careful control throughout the entire process to prevent possible contamination. In addition to the control of quality, a knowledge of the condition of the product at each stage of production is vital before proceeding to the next step. Adjustment of the operating conditions to those that have been found by experience to be superior is necessary if the plant is to operate at maximum efficiency and at the same time produce a quality product. With this thought in mind, the Calvert plant was designed to mechanize control of the engineering operations by bringing together the means of adjustment and the instrument readings on central control

CONTROL LABORATORY

CALVERT DISTILLERY

boards for each individual unit. This enables the operator to have before him all the necessary data showing the conditions of the process, and, by remote control, a way to make corrections. The operations involved in the production of distilled spirits are of the nature that require constant coordination of temperatures and pressures for optimum conditions of production.

Briefly, the production of alcohol by fermentation is a bacteriological process in which the natural starch occurring in varied types of grain is converted to sugar by the action of diastase present in malt. The sugar formed is then allowed to ferment from the action of yeast and the decomposition products, ethyl alcohol and carbon dioxide, are produced.

III. RAW MATERIAL TESTS

A. GRAIN

Starting their tests with the grain as it arrives at the plant, the Calvert chemists sample each carload to be sure that it is up to standard in every detail. These tests involve measurement of apparent grain density, moisture content, per cent dockage, bacteria count, per cent starch, etc. The density is measured by means of a standard Government balance that is calibrated to read directly in bushel weight from the weight of the fraction used. By passing a typical sample of the grain through revolving electrodes, between which there is a standard impressed voltage, it is possible to obtain an accurate indication of the

moisture present from the amount of current flowing. The grain is then passed through a sifter to separate it into particle sizes and to measure the amount of fine material present that must be discarded. This facilitates the examination for damaged kernels.

The bacteria count must be taken for every carload of grain to be sure the grain meets the standard specifications of the industry.

In order to be able to calculate plant efficiency, the starch content is determined quantitatively on an average sample of the rye, corn and malt used. This determination is made weekly.

Various other tests of a specialized nature are applied to the grains as they are received. For example, malt is extracted to measure the per cent sugars in water solution and, when needed, the quantity of diastase present is run.

The grains used must necessarily meet certain requirements or they are rejected because use of a poorer grade of raw material results in an inferior product of low yield.

B. YEAST

While the yeast may seem to be of secondary importance to the main raw material used, its preparation is one of the more difficult operations, requiring delicate control. Since it is the enzymes in the yeast that are responsible for the fermentation of sugars into the desired alcohol, it is of utmost importance that the yeast culture be free from contamina-

tion. The yeast is first prepared in the Bacteriological Labratory from pure cultured stock. After sufficient time, it is transferred to larger containers and allowed to ferment and grow, using malt extract as a culture medium. The final growth is carried out in 3,000 gallon tinned copper-bearing steel vessels before being planted on the bulk of the mash. A culture of lactic acid-producing bacteria is used to inoculate the fermenting mash in order to produce what is known as "lactic sour" to protect the yeast from action of common bacteria.

C. WATER.

A discussion of raw material control would be incomplete for the distillation industry without mention of the water used, for the reactions involved require large amounts. At the Calvert plant, water from five deep wells is pumped to supply a one and one-half million gallon resevoir, which can be spring fed if needed. The water is treated with coagulating alum and the floc formed is allowed to settle. From the settling basin, the water passes to the filters for further purification. Chlorination is the final process.

The boiler feed water is tested for hardness and treated in an 8,000 gallon per hour "hot lime-soda" softener for the protection of the boiler. Sodium sulfite is here added to combat oxygen that might be present in the water.

The water to be used in the blending process is distilled

in a 1300 gallon per day steam-heated still. Analysis of this water is made for the presence of copper, iron and residue. Since it is to be used for dilution of the final product to the desired proof, it is necessary to know the pH value as well.

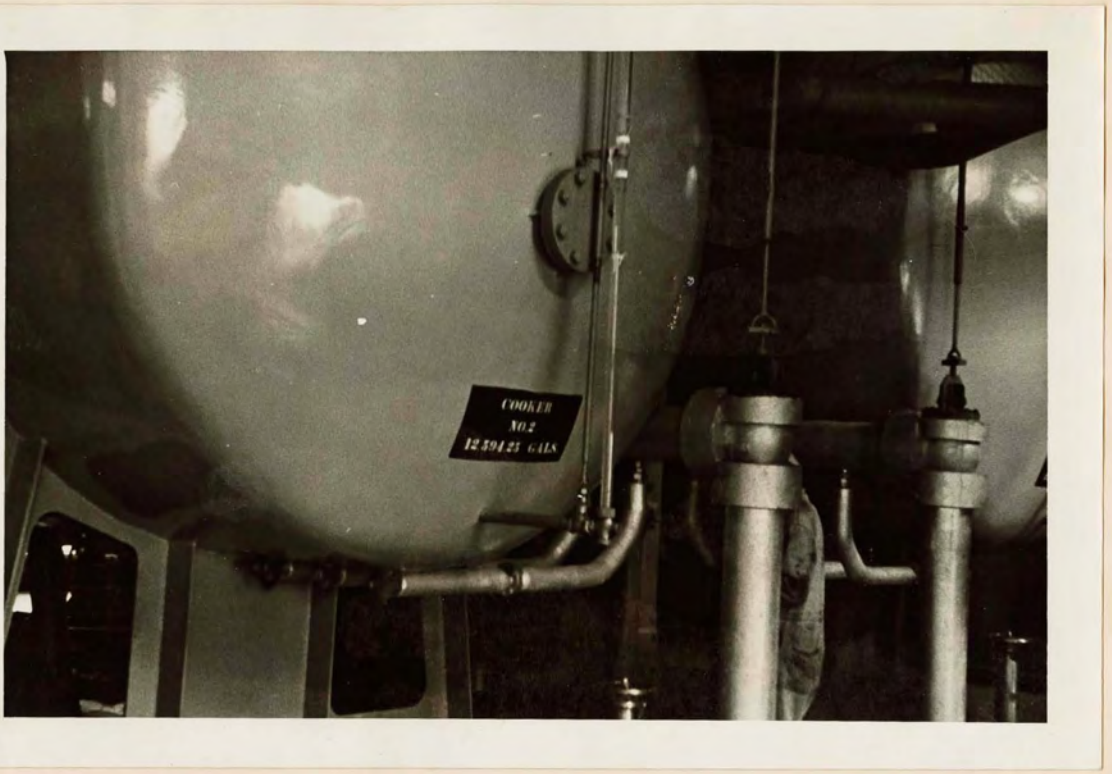
D. FUELS.

The Calvert Distilleries operate their own power plant so their organization of chemists checks the fuels used for power as a further means of extending control. Moisture, fixed carbon, fusion point, B.T.U. content, volatile material, and ash are all determined.

IV. MAIN PROCESS.

On the accompanying flow sheets the points in the process where samples are withdrawn for test are marked in red to give an idea of the completeness of the supervision given production in a modern plant. The tests conducted are designed to indicate the condition of the entire batch of material.

Grain from the railroad siding is unloaded by means of a screw conveyor, capable of handling 1000 bushels per hour, and carried to the top of an elevator, where it is cleaned and screened to discard about two per cent. As needed, the grains are allowed to descend over magnetic separators to remove metal particles and passed to the high speed mills for grinding.



MASH COOKERS

CALVERT DISTILLERY

The meals thus prepared are sent to bins for future use. It is at this point that starch content is determined. As needed, the meal is conveyed to the top of the main process building, where it is weighed continuously to the proper proportions by control from a central panel on the third floor. This is approximately 85 per cent rye and 15 per cent malt, which is mixed with warm water on its way to the cookers. The mash is brought quickly up to 150° F. by the entrance of live steam and held for an hour at which time it is lowered into drop tubs to continue conversion of the starch to sugar. Here in the process the pH value (about 5.5 is right for best conversion), acidity, and the ratio of maltose to dextrine are determined.

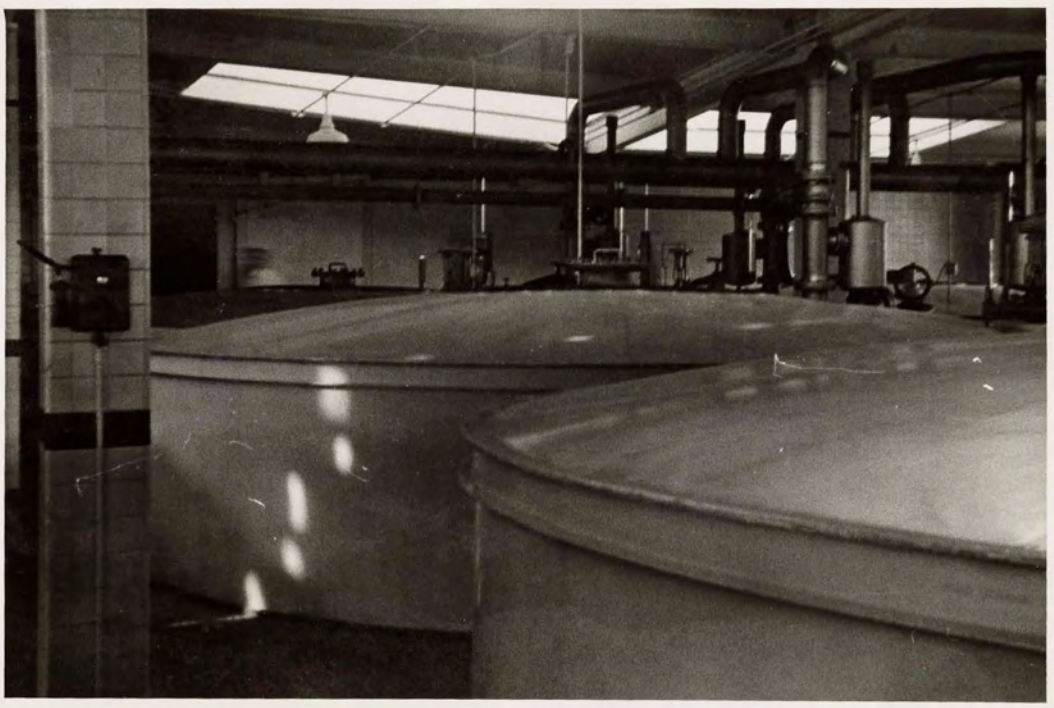
The mash, as it leaves the drop tubs, is again sampled and tested on its way to the coolers where the temperature is lowered to about 80° F. From the coolers, the mash is piped to one of the fifteen large fermenters to be inoculated with yeast.

This fermentation process occurs in 40,000 gallon tanks equipped with air pipes, cooling coils and live steam outlets for sterilization.

Tests are run daily to determine the degree of fermentation on what is known as 24, 48 and 72 hour beer. These include specific gravity, acidity, and pH.

No attempt is made to recover the CO_2 formed in the fermentation, for it is believed that the reaction is more complete when open to the atmosphere.

The mash is pumped from the fermenters to the "beer wells" in preparation for distillation.



MASH FERMENTERS

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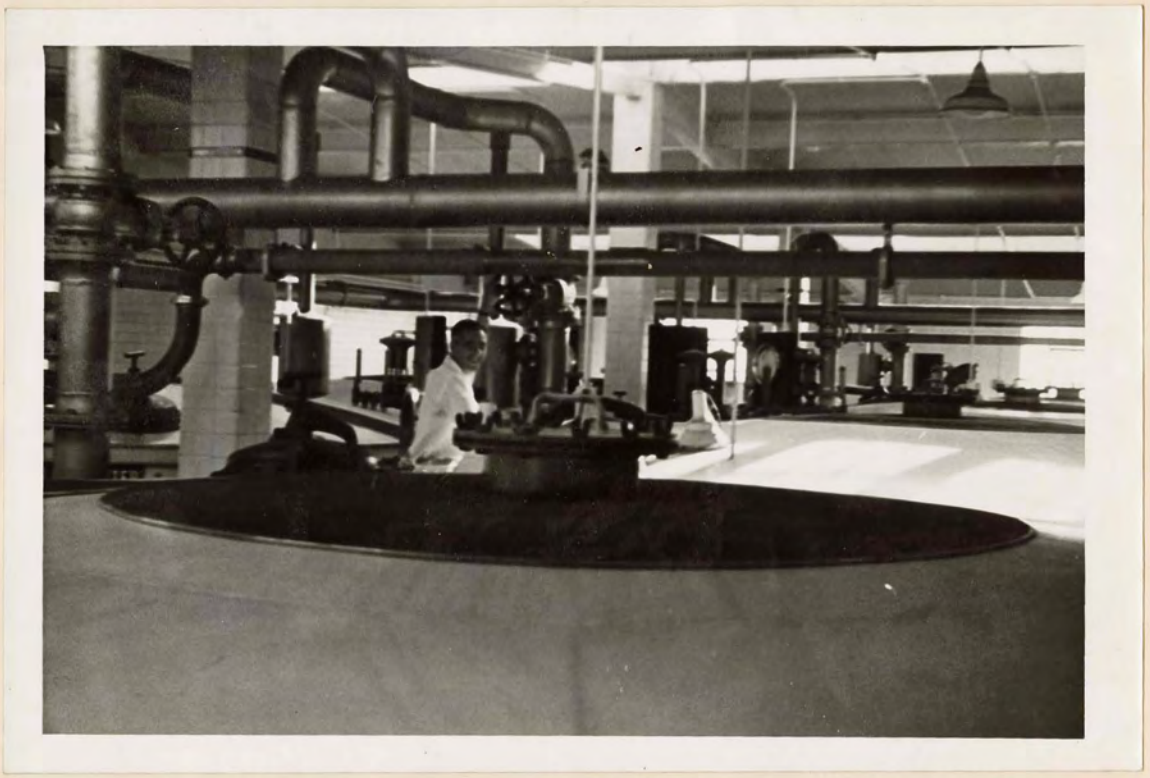


BEER WELLS

CALVERT DISTILLERY

DISTILLATION CONTROL PANEL OF

CALVERT DISTILLERY

The equipment for the distillation of the prepared mash is a five column unit consisting of beer, aldehyde, rectifying, pasturizing and fusel oil columns for the separation and purification of the ethyl alcohol formed from the other products of fermentation. The residue, or spent beer, is tested for the per cent alcohol present as it leaves the beer column.

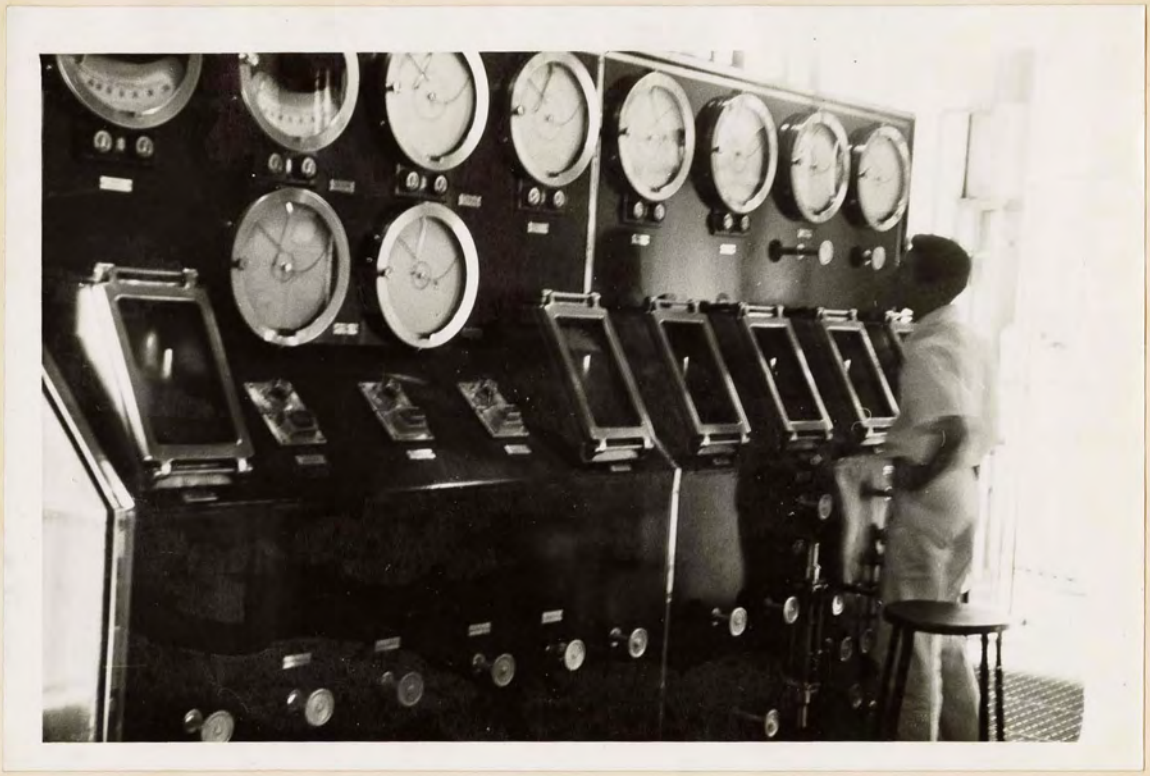
V. BY-PRODUCTS.

No distillery for the production of grain spirits would be complete without a plant for the recovery of the grain tissue remaining for use as cattle food. At the Calvert plant, the spent grain travels to a separate building where it is screened and pressed to separate a large amount of cake from the beer. The remaining liquid is then evaporated to a thick syrup and mixed with dried meal to pass into a revolving steam-heated dryer. Testing is necessary of the final product to be sure that certain requirements are met. Bushel weight, moisture, protein, fat and fibre are among the items controlled.

The fusel oil that is recovered from the distillation consists of a mixture of higher alcohols and is sold to chemical companies for their recovery.

VI. AGING

As it comes from the stills, the alcohol is approximately 110 proof and water white. It must now be aged in charred



BEER COLUMN CONTROL PANEL

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white oak barrels for at least four years, during which time it absorbs certain tannates from the wood to acquire a color and flavor, and at the same time loses some of its undesirable properties. For this reason, the barrels must be of a high grade, tested and examined wood, or the process of aging will be a failure. The barrels are filled, under Government supervision, and stored in bonded rack houses. The Calvert warehouses have a total capacity of 308,000 barrels, kept at constant temperature and humidity throughout the four years of aging.

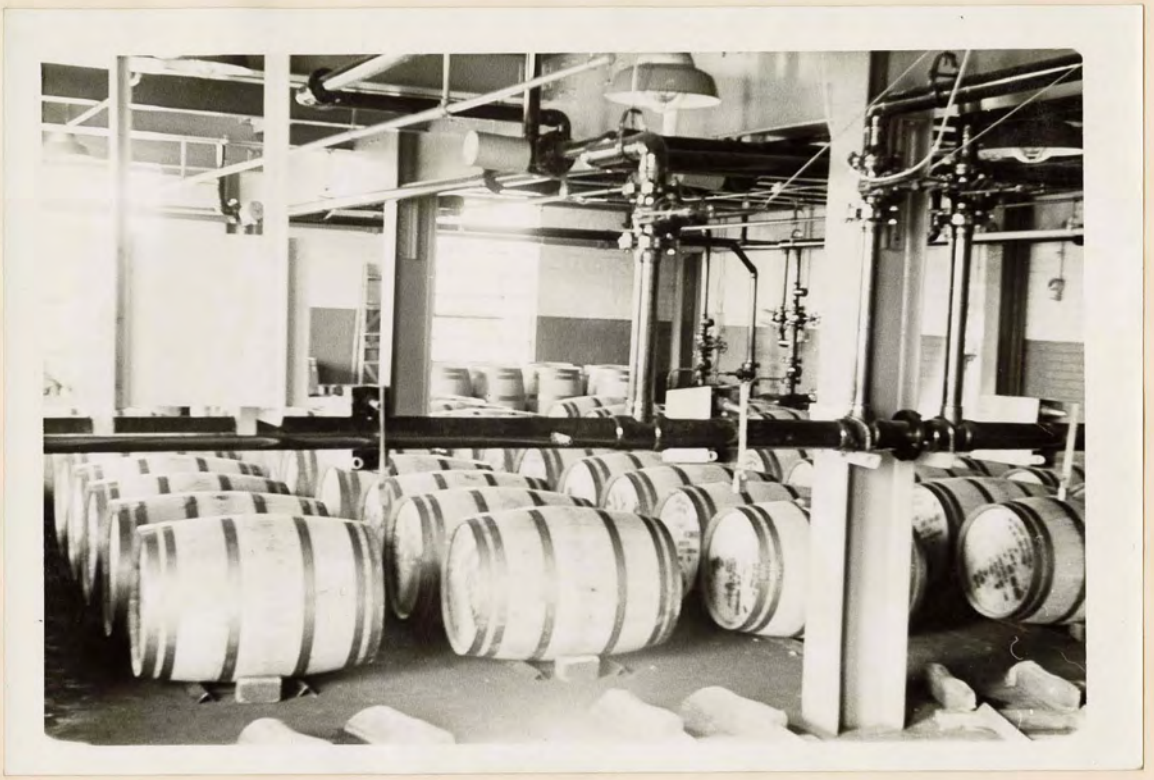
VII. BLENDING.

Liquors of the same type from many barrels are tapped and mixed in large vats to be used in blending a uniform product. Tests are made to know the exact nature of the constituent types in order to control the final blend. The bottles to receive the whiskey are titrated for alkalinity because an excessive alkaline condition will darken tannins present and cause precipitation of small amounts of metals.

To complete the path from grain to alcohol under careful chemical observation, the final product is checked by Calvert chemists for color, hydrometer proof, boiling point, pH value and per cent fill of bottles.

VIII. ENGINEERING CONTROL.

Operation of the processes of production at the Calvert Distilleries exemplifies modern industry where maintenance of a



CISTERN ROOM

CALVERT DISTILLERY

highly skilled staff of technicians for the control of the conditions of production is essential. It is highly advantageous to produce under such conditions of control both economically and from consideration of the purity of product.

The unit processes are greatly simplified in their operation from an engineering point of view by having central stations to control entire units. Such has been the experience of modern engineering practice at the Calvert Distilleries.

The materials to be used in production are mechanically conveyed to the points in the process where they are needed and the amounts used are automatically weighed and recorded. An ample supply of temperature-measuring devices, pressure recorders and flow meters are used to know the exact quantities of materials used and the conditions of their reaction. The plant has therefore a simplified control of operation, combined with a complete chemical check to make it one of the most modern distilleries of the world.

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WHISKEY DISTILLERY AND BY PRODUCTS

THE CALVERT DISTILLING COMPANY