

IMPACT OF REAL TIME CONTROL CONVEYOR SYSTEM IN AUTOMATION BEVERAGE INDUSTRY

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Abstract: Automation in production industries leads to unimaginable gains. The phenomenon of real time control conveyor system in automation beverage industry is not only a deviation from the basic mechanized production process but also an improvement with obvious advantages and economic results. This paper discusses the processes involved in a real time production in a beverage industry such as a brewery. A start button at the operator panel starts the operation when pressed, sending the desired signal to a Programmable Logic Controller (PLC). This is designed to energize the inverter to supply the required voltage to the motor which runs the conveyor. System parameters are observed measured and recorded a number of times to ensure a consistency with design standards and expectations. In real time, the process provides solutions to inadequacies of manpower shortcomings associated with ordinary mechanization. It also obviates the possibility of system breakdown analysis compensation technique. Positive impact is created by this technique in the conveyor line resulting in optimization and cost effectiveness.

Keywords: Automation, Programmable Logic Controllers (PLC), conveyor, inverter, optimization

1.0 INTRODUCTION

The overview of the conveyor line in the beverage industry is an important issue related to the automation control system and the real time system. Control valve operating mechanism, electric drives and significance of Programmable Logic Controller (PLCs) are also discussed. A Programmable Logic Controller (PLC) is a digital device used for automation of electrical as well as mechanical. An innovative Passler Router Traffic Grapher (PRTG) approach implemented in a specific

industry is discussed as a real time. This paper is aimed to provide first hand quality information to the beginners with reference to conveyor in the beverage industries. The highly growing technology, automation has become so much mandatory in almost each and every field, especially in beverage industries for conveying purpose. Programmable Logic Controller (PLC) are most widely used for automation in many industries in order to increase productivity and to reduce cost. A PLC enables system to provide

necessary information to the operator as soon as times are rolled on, the system captures data from the work station and generate the report to the operator then processing raw data in computer (software). Once data is being captured it is used in many ways to take action for improving production process, majority of the local industries struggles for getting production status on time. There is no transparency in sharing information. There are too many machines required in this line starting from unloading of used bottles to conveying of filled bottles. All these functions are carried out automatically in a logical sequential manner. All these machines have different functionalities for different applications. Different types of sensors are used for object detection, fault detection, safety purpose etc. Variable frequency drives are used for speed control of motors. Different types of control valves are also used for subsequent

control actions. Based on the type of the crate used in specific application area, the corresponding conveying lines constitute of different machines. The mainly used type of bottles, Renewable Glass Bottle (RGB) and KRONE machinery offers customized solution in conveying technology for the beverage industry in Nigeria. The automation covers the production line. Various processes involved in the conveying lines are controlled using PLC. The functionality of the PLC has developed over the years to include sequential relay logic, motion control, process control, distributed control systems and networking. PLCs are mainly designed for applications which require multiple inputs and outputs, better temperature ranges, protection to electrical noise, and resistance to vibration. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory.

Generation of layout of Bottle and Crate Conveyor line for beverage industry

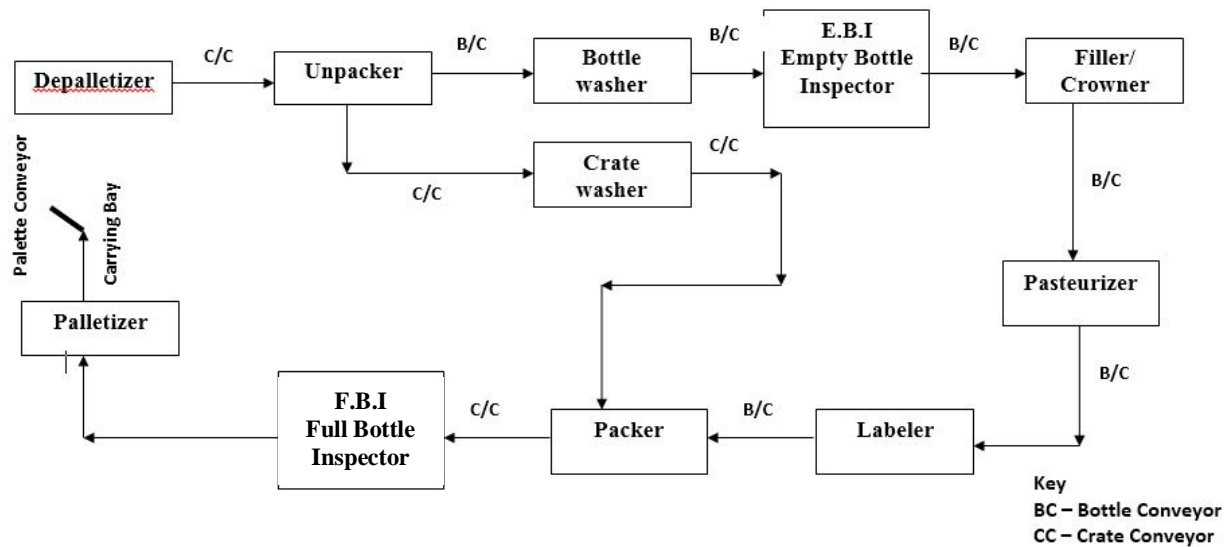


Figure 1: Sequence of conveyor operation

SEQUENCE OF CONVEYOR OPERATION IN PACKAGING PROCESS

In a typical conveyor line, the first operation is to unload the empty used bottles from the crates onto a crate conveyor. A depalletizer is the machine used to remove each layer of crates from the pallet and send them to the unpacker for unloading of the bottles from the crate to the bottle conveyors. From the unpacker, bottles are fed to a bottle washer through bottle conveyor, which fully washes the returnable glass bottles to reduce microbiological contamination of the product to be packaged into the container, ensuring that no extraneous objects such as pieces of glass, etc.

are present, and removing any old labels, inkjet coding and small particulates such as sand and dust. After this washing process it is necessary to inspect bottles for soiling, broken necks, leftover liquid and foreign objects usually down to some 2.5 mm which is the optical limit of most empty bottle inspector (E.B.I.). It is also possible to remove scuffed bottles. After that, bottles are fed to filler and after filling, bottles are directed towards labeller. After labelling, bottles are again checked for liquid level, proper label position etc. Then bottles are fed to the packer through the crate conveyor. Moreover, the crate conveyor from unpacker will send the crate to the

crate washer where the crates will be washed and moved to the packing zone in order to position for the bottles from the labeler to the crates.

Thereafter, the crate conveyor will now move the crates filled with bottles to the full bottle inspector (F.B.I.) where the machine will check if the number of the bottles that are supposed to be inside the crate are complete, then the crate will now move to palletizer where the crate are arrange for fork lift to stack the crates at Full Pack Store (F.P.S.). Sensors, control valves, motors and drives-all these terms are related to instrumentation of most of the machines.

Sensors are invariably necessary in any industry for tasks like fault detection, object detection, safety and the like. Depending on the applications, different types of sensors are used. Different control valves are used to control various process parameters such as pressure, temperature, flow and liquid level by fully or partially opening or closing in response to signals received from controllers. The controllers compare a

"set-point" with a "process variable", whose value is provided by sensors, which monitor changes in such conditions. Filling the beverages into bottle is the most important and critical process because during this process level, pressure, temperature and flow - all these parameters of beverage should be maintained at some fixed point, so opening and closing of valves play most important role. These valves can be operated using three different mechanisms:

- Mechanical
- Electro-pneumatic and
- Electronic

In a mechanically operated valve all movements are controlled mechanically. Component parts of the filling valve which are inside the filler bowl (the product valve and gas needle) are operated by a control lever which, in turn, is raised and lowered by cams external to the ring bowl. Pressurization and filling phases are controlled by this operation.

The electro-pneumatic type consists of mechanical filling valves with electro - pneumatic control. This type of filling valve has a product

valve and gas needle controlled by a pneumatic cylinder on top of the filler bowl. All operations are electronically controlled, eliminating the control cams outside the filler bowl. As filling phases are controlled electronically, optimum filling is possible at varying speeds. In the electronic type, a level probe is integrated into the vent tube. This allows the level control to be operated from the level probe. This type of valve is particularly suitable when bottles with different fill points are being filled as the fill level can be adjusted electronically.

DC and/or AC motors are most widely used in beverage industries in conveyor application to transfer materials, bottles, crates or boxes from one position/ location to another. DC and/or AC variable frequency drives are used to control the motor speed and torque by varying motor input frequency and input voltage.

Currently AC drives are widely used in all kinds of processes. Variety of applications of AC drives range from the raw material handling to pumping and mixing of ingredients;

from processing to conveyor and fan control; as well as during packing and storage. The advantages of AC drives are considerable improvements in plant efficiency, energy savings and reduced wear on moving equipment. All AC drives convert AC to DC, and then through various switching techniques invert the DC into a variable voltage, variable frequency output.

In typical DC drive, the SCR converts the fixed voltage alternating current (AC) of the power source to an adjustable voltage controlled direct current (DC) output, which is applied to the armature of a DC motor.

2.0 AUTOMATION

The field of automation has a notable impact in a wide range of industries beyond manufacturing. Automation is nothing but the utilization of control systems and information technologies to minimize the need for human work in the production of goods and services.

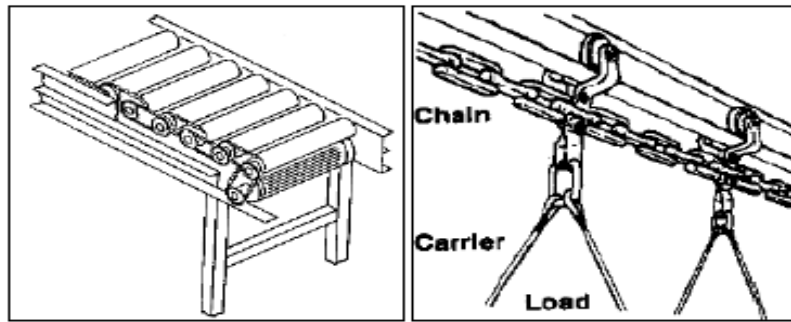


Figure 2: Conveyor automation system

Decentralized Installation

In the scope of industrialization, automation is a step ahead of mechanization. Mechanization generally refers to human operators with machinery to assist them with the muscular requirements to work, where as automation greatly decreases the need for human sensory and mental requirements as well.

Traditional approach of conveyor involves placing bottles and crate onto a conveyor and filling only one bottle at a time and further moving it for packaging. This approach is very time consuming and expensive. So, automating this area proves to be very much useful as it reduces the cost, saves time and

also improves quality and productivity.

Programmable Logic Controller (PLC) is one of the most widely used control equipment for automation in various industries. Leading manufacturers of PLCs in today's market are Allen Bradley, B&R, Delta, Siemens, Mitsubishi,

Motorola, Omron etc. The Siemens PLC called SIMATIC S7-300 universal controller is specially designed for innovative system solutions in manufacturing, distinctively the automotive and packaging industries. This modular controller serves as an ideal universal automation system for centralized and decentralized configurations.

The S7-Controller consists of a power supply (PS), a central processing unit (CPU) and signal

modules for in and/or output devices (I/O devices). If necessary, communication processors (CPs) and function modules (FMs) can also be used for specific tasks (e.g. stepping motor control).

STEP 7 is the standard software package used for configuring and

programming SIMATIC programmable logic controller. With STEP 7, one can create S7 programs in below mentioned standard languages:

- Ladder Logic (LAD)
- Statement List (STL)
- Function Block Diagram (FBD)

Procedure in using step 7 in a real time control system to create a project

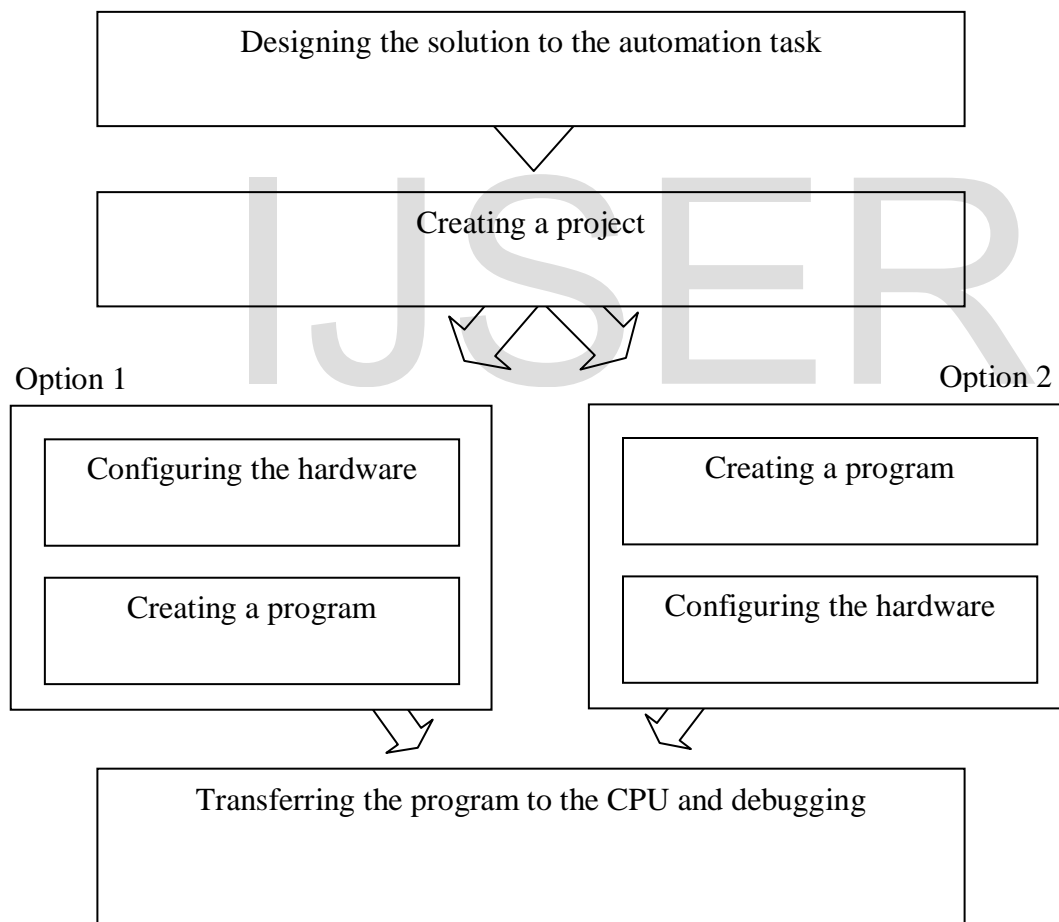


Figure 3: Procedure in using step 7 in a real time control system to create a project

If one is creating comprehensive programs with many inputs and outputs, it is recommended to

configure the hardware first. The advantage of this is that STEP 7

displays the possible addresses in the Hardware Configuration Editor.

If you choose the second option, you have to determine each address yourself, depending on your selected components and you cannot call these addresses via STEP 7.

In the hardware configuration, not only can one define addresses, but one can also change the parameters and properties of modules. If one wants to operate several CPUs, for example, one has to match up the MPI addresses of the CPUs.

Since we have only a small number of inputs and outputs in the Getting Started manual, we will skip the hardware configuration for now and start with the programming.

The programmable logic controller supervises and controls a machine or a process in concurrence with an S7 program as shown in Figure 4. The I/O devices are addressed in the S7-Program via the Input (I) and Output addresses (Q).

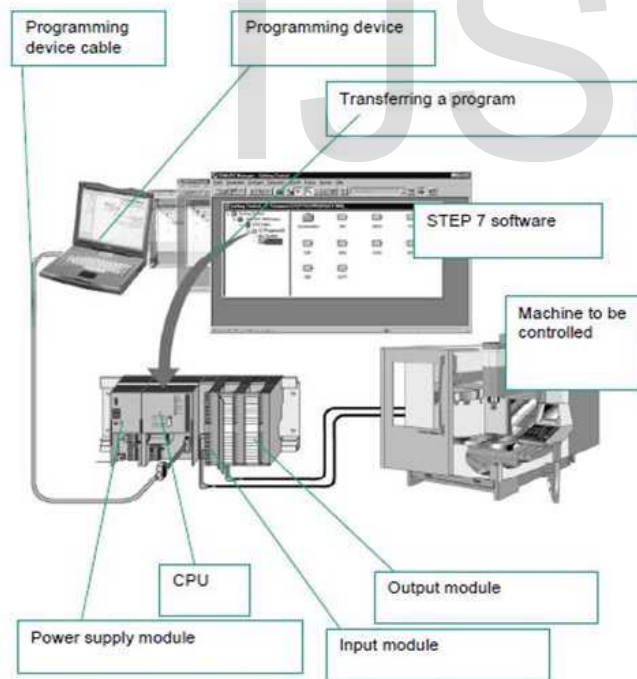


Figure 4: Machine automation

Automation of a Machine

The comparison between different CPU modules which are available for S7 - 300 series. Depending on requirement and application, CPU module can be chosen. CPU 317 - 2 PN / DP is in use for most of the application nowadays as it has some advanced features compare to others like:

- Increased RAM
- Lesser command runtime
- More number of timers and counters

- Large number of analog and digital channel I/Os
- It supports both Ethernet and Profibus communication interfaces

Signal modules are the interface of the SIMATIC S7-300 to the process. A host of different digital and analog modules provide exactly the inputs/outputs required for each task. Digital and analog modules differ with reference to the number of channels, voltage and current ranges, electrical isolation, diagnostics and alarm functions, etc.

Table 1: Comparison of different CPU modules

	CPU312	CPU314	CPU315-2DP	CPU 317-2 DP
			CPU 315-2 PN/DP	CPU 317-2 PN/DP
RAM	32 kB	96 kB	128 /256 kB	512 /1024 kB
Instructions	10 k	32 k	42k /84k	170k /340k
LoadMemory	MMC (Max 4 MB)	MMC (Max 8 MB)	MMC (Max 8 MB)	MMC (Max 8 MB)
CommandRuntime	Min 0.2 us	Min 0.1 us	Min 0.1 us	Min 0.05 us
FB / FC	512	2048	2048	2048
DataBlocks	511	511	1023	2047
Timers /Counters	128 /128	256 /256	256 /256	512 /512
AddressSpace I/O	1k /1k	1k /1k	2k / 2k	8k / 8k
No. of Digital Channel I/O	256 / 256	1024 /1024	16384 /16384	65536 /65536
No. of Analog Channel I/O	64 /64	256 /256	1024 /1024	4096 /4096
Operable FMs	8	8	8	8
Operable CPs (LAN)	4	10	10	10
Communication Interfaces	X1: MPI	X1: MPI	X1: MPI X2: DP X2: PN	X1: MPI /DP X2: DP X2: PN

The Function modules in the table 1 above are intelligent modules that independently execute the technological tasks like counting, measuring, cam control, PID control and motion control. Thus they reduce the load on the CPU. They are used when a high level of accuracy and dynamic response is required.

Communication processors are used for connecting S7-300 to the different bus systems / communication networks as well as for point-to-point link. According to application case and module different protocols and different bus systems are available like PROFIBUS, DP or Industrial Ethernet [9]. Most Ethernet connections are CAT 5 and CAT 6 based and run at the speed of 10,100 and 1000 Mbps input have Ethernet connection built onto their motherboard and these allow you to connect to make use of your other personal computer.

The software used during the experimentation is PRTG network monitor software.

3.0 CAPABILITIES OF THE PRTG SOFTWARE IN REAL TIME SYSTEM

PRTG means Paessler Router Traffic Grapher. It is a network monitoring software from Paessler AG. PRTG runs on window and monitor network availability and network usage using SNMP packet sniffing, WMI, IPSLASH and net flow and various other protocols

METHOD OF COLLECTION OF RESULT THROUGH PRTG

The report at the top menu bar was clicked and the summary reported for all system was displayed as well as the period you want the report to be investigated

Therefore, the data collected showed the day to day activities going on in the real time network system. It will also show the time to time, seconds, minutes, hours, months, years and most importantly the downtime and uptime that occurred in the real time control system in this environment. However in the analysis of this data, table and graph shows the operational hourly reports of daily

production and the beverage industry reports of every day in real time system, you don't need to spend time on capturing data and making reports. What you need to do is click on the customized menu for viewing necessary report; the system will show you report as requested.

Operator Status: List present operators, absent operator and operator performance.

Crate Conveyor Line: Visual display of line balancing

Hourly production report: Hourly output report of each operator.

Style Status: Percentage of work completed, work remaining and manpower required to complete remaining work.

Line Performance: Efficiency and lost time

With such report, system helps the managers to monitor operators and other plant employees. Everything is transparent to them. Moreover, when you know the line performance and individual operators with low performance, you can find ways to improve their performance.

To improve production, you don't need to collect production information from each operator and write on the display board, the system keeps this report ready for you.

HIGH COST OF MAINTENANCE OF REAL TIME SYSTEM

The cost of maintaining the equipment that failed are very high. The power surge is the most common cause of equipment failure. If router and switches are not supported with surge and UPS, the fluctuation in voltage can affect the equipments

4.0 PRECAUTION CARRIED OUT WHEN WORKING ON REAL TIME SYSTEM

1. Avoid operator error. Duplicating IP address plugging wires into the wrong jack and setting bad firewall rules in order to avoid data transfer blockage.
2. Backup all the equipment's with power surges and UPS to avoid losing any data.
3. Always make use of bandwidth control or always increase the size

of your bandwidth link to reduce network congestion.

HMI (Human Machine Interface) is also a good concept in the field of automation. An HMI is another software application that can present information to the operator or user about the process and displayed it in the graphical format too.

KRONE in operator panel meets all the requirements of modern and complex operation because it is very advanced machine in a bottling or packaging line into a functional unit. Its high-tech sensor, intelligent controller and frequency controlled drives significant contribution to a continuous product flow, for example, downtimes of individual machines is to be bridged effectively through the system's buffer function. It operates with gently product treatment, low noise and minimum energy consumption and provides easy gaining and role-based access to all KRONE machines. RFID access control enables the machine operator to easily log in at a machine simply by logging in his/her ID number in the control panel. This system

automatically identifies the user, the user's role (machine operator, maintenance staff and administrator) displays the data and menus relevant for the particular user. An outstanding key advantage of the HMI is that the different graphical user interfaces of individual machines have been combined to form a uniform system for entire production line.

Major features of these innovative clear line HMI concepts are:

- **Alignment of conveyor crate:**

Considering an assembling of conveyor chain line if the line is not balanced well, you will lose productive time of many operators. This system provides clear information of conveyor chain in each work station of a line. System can identify bottlenecks and shows the crate conveyor comes out empty without bottles inside. The supervisors can act quickly and focus on specific operators to balance line using breakdown analysis compensation

technique. Result is improved production.

- **Non- Productive Time (Lost Time):** Capturing non-productive time in a line was never an easy task. So, majority of factories don't bother tracking non-productive time. Time lost once is gone forever. "No Cutting", 'Hold for quality issue' and crate conveyor machine breakdown are few example of lost time. Do you know how many hours in a week you are losing due to lost time? You couldn't even believe that lost time may be up to 233 minutes of your total production (based on my study). Real time system provides detailed lost time. You can improve your production by reducing lost time using breakdown analysis compensation technique.
- **Quality of Data Tracking:** Existing practice of quality data capturing, quality report making, analyzing and reporting takes longer time.

When you get to know quality issues the line, style get over. This system can provide information of quality issues on real time and quality control person is informed. Quality can be improved when operators improve high first time quality stitching using breakdown analysis compensation technique.

- **Improved Reporting System:** The operators make hourly report, daily production reports and product reports everyday. With real time system, you don't need to spend time on capturing data and making report. What you need to do is to click on the customized menu for viewing necessary report. System will show you report as you requested.

5.0 CONCLUSIONS

At this stage, it is pertinent to articulate the gains of automation in production industries as well as the milestones achieved in this paper. Apart from the ever re-occurring

benefit of optimization in production and cost effectiveness, this work has led to the appreciation of the some what new/novel system breakdown analysis compensation technique. This technique is unique and has proved quite handy in solving problems arising from system breakdown in real time production processes. Having tested this technique personally during the process of making this research, it has become clearer that downtime during production processes, even in the best automated environment or industry, can be reduced considerably.

Combining the above with the possibility of reducing human errors and in consistencies, automation in industries has indeed proved to be innovation which should be embraced to enhance a technology driven economy. At the national level, this process will help in no small way to grow our economy. At this time when our national economy is nose-diving, automation processes hold the needed key to bring about a reversal in the economic system and hence overturn our country's economy for the better.

Apart from our country's economy, the global economy at large will ultimately benefit from the overall benefit of automation.

Finally, life is lived in real time mode. As a result, since automation also performs real time processes, it is one technique which has arrived to adequately perform the work of man but more efficiently. Hence, automation holds the key in all spheres of human endeavour. It should not be limited to production industries such as breweries as treated in this work.

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