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GLASS FRAGMENT CONTROL

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Summary: *In this article a digital system for glass fragment control is discussed. The possible decisions are analyzed. Methods for detection of glass breakdown and broken glass flushing are discussed. Based on this analysis and particular technological requirements of the manufacturer a microprocessor-based system for glass fragment control is proposed. Also a system for cleaning from type CIP (clean in place) is designed and is connected with the pyramidal rejection scheme. System software of the controller allows full statistical and diagnostical real time monitoring, which can be achieved both on-line – using the control panel and remote control – through the industrial network.*

I. INTRODUCTION

When glass bottles are used in beverage industry it is necessary to control the glass fragments content in the beverage. They appear after bottle breakage during the filling process.

Many companies provide different technologies for glass fragment control.

The presented decisions differ mainly in the types of flushing system used and the methods for detection of the broken bottles.

The flushing systems differ in type and number of spray systems, which are separated in one or two spraying zones. The jets in each zone are aimed at different angles in order to remove glass from filling valves, centering tulips and lifting cylinders.

Methods for broken bottle detection are direct and indirect.

The direct ones allow finding the exact place of the broken bottle. This is done with the help of sensor, place in the particular position.

Indirect methods allow detecting where the breakage occurs but it is not possible to locate the exact place. Hence, this method is mainly auxiliary. In this case acoustic detectors, placed near the filler, are used.

II. SOLUTION

In order to achieve maximal efficiency of the broken glass flushing with minimal water consumption and manual operations, a microprocessor control is implied. The control algorithm includes detection of the valve position, where the bottle is broken and all subsequent operations.

The operations are:

1) the spraying system is activated from valve *n* to valve *m*;

2) the filler is stopped after *k* positions in such a way that the cylinder with the broken bottle to be in a position to allow manual operation;

3) removal of the bottles from the valve where breakage have occurred for *l* subsequent operations.

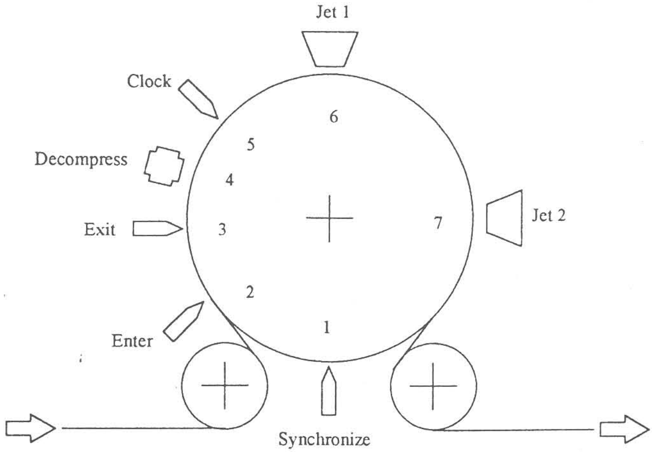

Fig. 1. The kinematic scheme

The kinematic scheme of the filler is presented in fig. 1. Bottle breakage zones is detected between positions 2 and 3. The two independent spraying systems flush the valves in positions 6 and 7. The position where the valve with the broken bottle is handled manually is denoted in the figure with 1. In order to remove the bottles from the valve in position 4 decompression is performed and subsequently the filling process is stopped.

III. ANALYSIS

Thus described method is characterized with high efficiency. Parameter *m*, *n*, *k* and *l* are determined experimentally and depend on the external dimensions of the filler. The most important operation is the removal of the bottles from the valve where breakage has occurred for *l* subsequent operations.

This can be performed for the particular valve (reduction method) and for the valves in the area as shown in table 1.

Table 1

	POSITION						
Revolution	$n-3$	$n-2$	$n-1$	n	$n+1$	$n+2$	$n+3$
I				⊗			
II		X	X	X	X	X	
III			X	X	X		
IV				X			

⊗ — broken bottle
X — decompressed bottle

After this operation glass fragments introduced in the infeed are flushed. The main advantage, compared to water jet flushing, is that air pockets are not generated. Thus optimal flushing of the glass fragments and maximal reliability is provided. This is particularly valid for infeed tube, which are in close contact with the bottles.

IV. APPLICATION

The method for glass fragment control is realized with the help of programmable microprocessor based controller created for this specific purpose (fig. 2). One-chip microcontroller MC68HC11A1 is used as CPU. It is supported with 32K RAM, where dynamic variables are placed, and 16K ROM, where the system software is located. The state of the filler is monitored through the four inputs where digital data from the sensors is provided (fig. 2). Signals are:

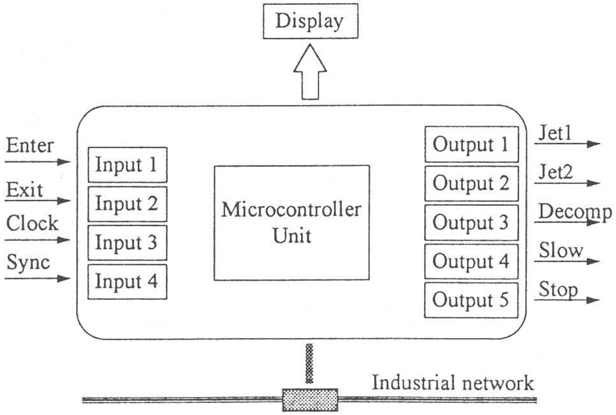

Fig. 2. The controller

— CLOCK — with this signal rest of the sensors are gated;

— SYNCHRONIZE — the signal for the first valve. It is activated on every revolution;

— ENTER and EXIT — indicate that there is a bottle in the valve.

The filler is controlled with five digital outputs i.e. JET1, JET2, DECOMPRESS, LOW SPEED and STOP.

The current condition of the controller is displayed on the terminal. It also has interface for local network, which provides the statistical information for the filler productivity.

The algorithm for solving is followed.

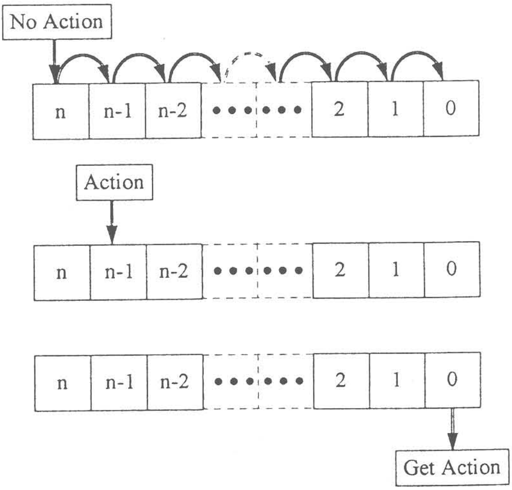

Fig. 3. Operations with the array

In order to perform the control specially created data structure is implemented. This is an array that dynamically changes its content in accordance with the state of the filler (fig. 3). There is one array for each output. The array content is of Boolean type and determines the type of the operation (NO –ACTION; DO-ACTION). Array size *n*, is determined from the maximal number of clocks between the stimuli and reaction. Usually the size *n* is multiple to the number of the valves in the filler, due to the cyclic kind of the control algorithm.

There are three operations with this array. The first operation is named transition to the next state. It is realized through the shifting of elements to the right. During this operation the zero element is lost and the highest-order element is new and is loaded as NO-ACTION. The second operation is loading of reactions. In the elements with the order equal with the necessary delay is loaded with the value DO-ACTION. This is done with the help of a pattern responding to the necessary reactions. The last operation is extracting the current reaction. Setting each output with the zero element value of the corresponding array does this.

The program operates in cyclic mode. The CLOCK signal activates the program cycle. It starts with the consequent execution of the operations that extract the current reaction for every output. This is the third operation. Then the input signals are monitored. On this basis and on the current state the following situations are recognized (see table 2):

Table 2

ENTER	EXIT	Event	Reaction
Empty	Empty	No load	No reaction
Empty	Full	Fault	Send message
Full	Empty	Breakage	Add pattern
Full	Full	Normal load	No reaction

It is obvious that if the detected event is breakage then the second operation is performed (fig. 3), for each of the outputs. Then, in all cases, a transition to the next state, for each of the outputs, is performed.

The next step is to increment the counter showing the number of the current valve. During this operation the state of the signal SYNCRONIZE is monitored. When activated the counter must check the number of the last valve. If this is not true a message for incorrect synchronization is send. Then, in both cases the counter is set to zero. This ends the control cycle.

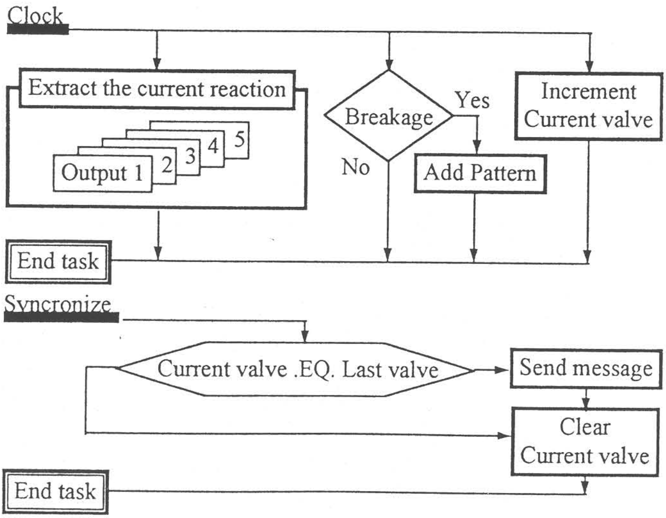

Fig. 4. Diagram of tasks.

The diagram of tasks is shown on fig. 4.

Furthermore the system software provides several background processes. They serve the network communication and send data to the terminal.

Statistical information that consists of the number of the prepared bottles, number of the broken bottles for each valve and the total amount of broken bottles is preserved in the controller. All parameters of the controller can be changed during the working process. This can be done directly through the terminal or by using the network.

V. CONCLUSIONS

Analysis of all existing methods for detection of glass breakdown and broken glass flushing is made.

Based on this analysis a microprocessor-based system for control of glass fragments is performed. The proposed system for flushing, of the type CIP (cleaning in place), is connected with the pyramidal rejection scheme. A dynamic control and diagnostics of the input information are applied. The incorrect situation "enter empty, exit full filler valve" and the loss of synchronization is trailed. This improves the efficiency of the system. Efficient removal of breakage is achieved. Water consumption is minimized and operating costs are kept down.

The basic advantages of the here proposed solution be:

— Allows discovering and memorizing the position where the breakage of the bottle occurs for the purposes of statistics and diagnostics;

— Flexible programming of the work of the flushing system;

— Flexible setting of the number of consequently removed bottles from the breakage position;

— Possibility for transmission of statistical information through the local network;

— Thus described system is successfully introduced in the manufacturing of soft beverages.

VI. REFERENCES

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