CONTINUOUS STERILIZATION OF FRESH FRUIT BUNCHES - PART 1

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INTRODUCTION

For years, the palm oil industry has cherished a dream for continuous sterilization. All the fundamental operations in a mill can be carried out in a continuous manner except sterilization. The batch nature of the sterilization process introduces fluctuations not only in the quantity of material processed but also in the overall steam demand. The situation is made worse by the fact that about one-third of the steam generated in the mill is used for sterilization. Operations related to batch sterilization also absorb much of the process labour force in a mill. The use of steam at high pressure and intermittent pressure releases to achieve good sterilization complicates the problem of achieving continuous processing. In spite of the complications, a number of methods have been examined in the past, which will be reviewed in Part 1 of this paper.

SEMI-CONTINUOUS STERILIZATION

Several designs for this type of continuous sterilizer have been proposed (Olie and Tjeng, 1974). A common feature is double-door sluices that can be steam pressurized. The designs can be divided into two categories, *i.e.*, semi-continuous sterilizers with or without the utilization of sterilizer cages.

In the first category of semi-continuous sterilizers, the bunches remain in the usual fruit cages of 1.5 or 2.5 t capacity. The sluices must then be able to hold one fruit cage and, consequently, the mechanically operated sluice doors must have a diameter of about 2 m. Next to the very big technical problems still to be solved for achieving foolproof mechanical movement and locking of the inner sluice doors (separating the sluice compartment from the sterilizer proper), another disadvantage of this design is that pressurizing the sluice compartment will take a long time. Even if suitable technical solutions can be found, investment and maintenance costs are expected to be quite high.

In the other category of semi-continuous sterilizers with mechanical sluices, neither fruit cages nor any other container are used for the fruit bunches. The sluice compartments are considerably smaller and capable of holding several bunches only. The sluice doors are therefore also much smaller in diameter. After passing through the inlet sluice, bunches enter the sterilizing compartment proper. To attain the necessary retention time, the bunches are moved several times forward and backward using scraper conveyors inside this compartment.

COMBINED STERILIZATION-STRIPPING PROCESS

Considerable retention time will be needed in the semi-continuous sterilizer because the process used is quite similar to the single-peak sterilization cycle. The size of the sterilizer must therefore be quite big, making them impractical. The combined sterilization-stripping process proposed by Sivasothy *et al.* (1993) also uses the concept of pressurized compartments, but minimizes the overall processing time through a number of innovations. Sterilization is carried out in two stages. The first stage involves simply heating the bunches in a pre-sterilizer. By using a multiple peak pre-sterilization cycle, it is possible to achieve good deaeration and partial heating of the bunches. The heating is continued in a sterilizer-cum-stripper operated at a pressure of 3 bar. The total retention time needed in both the pre-sterilizer and the sterilizer-cum-stripper to completely strip the bunches is about 20 min. This is a significant reduction in the sterilization cycle time which is typically about 120 min for a triple peak cycle (an even longer time is needed for a single peak cycle) if the time for loading and unloading the sterilizers is included. Studies have shown that a shorter sterilization cycle will lead to better oil quality (Sivasothy, 1989).

Figure 1 shows how the combined sterilization-stripping process concept is incorporated into the prototype automated palm oil mill. At the entrance and exit of the pre-sterilizer are specially designed piston-like valves. Steam for the pre-sterilizer comes from the sterilizer-cum-stripper. The capacity of the pre-sterilizer is less than that of the sterilizer-cum-stripper; hence, there is no significant drawdown in steam pressure. By sequencing the opening and

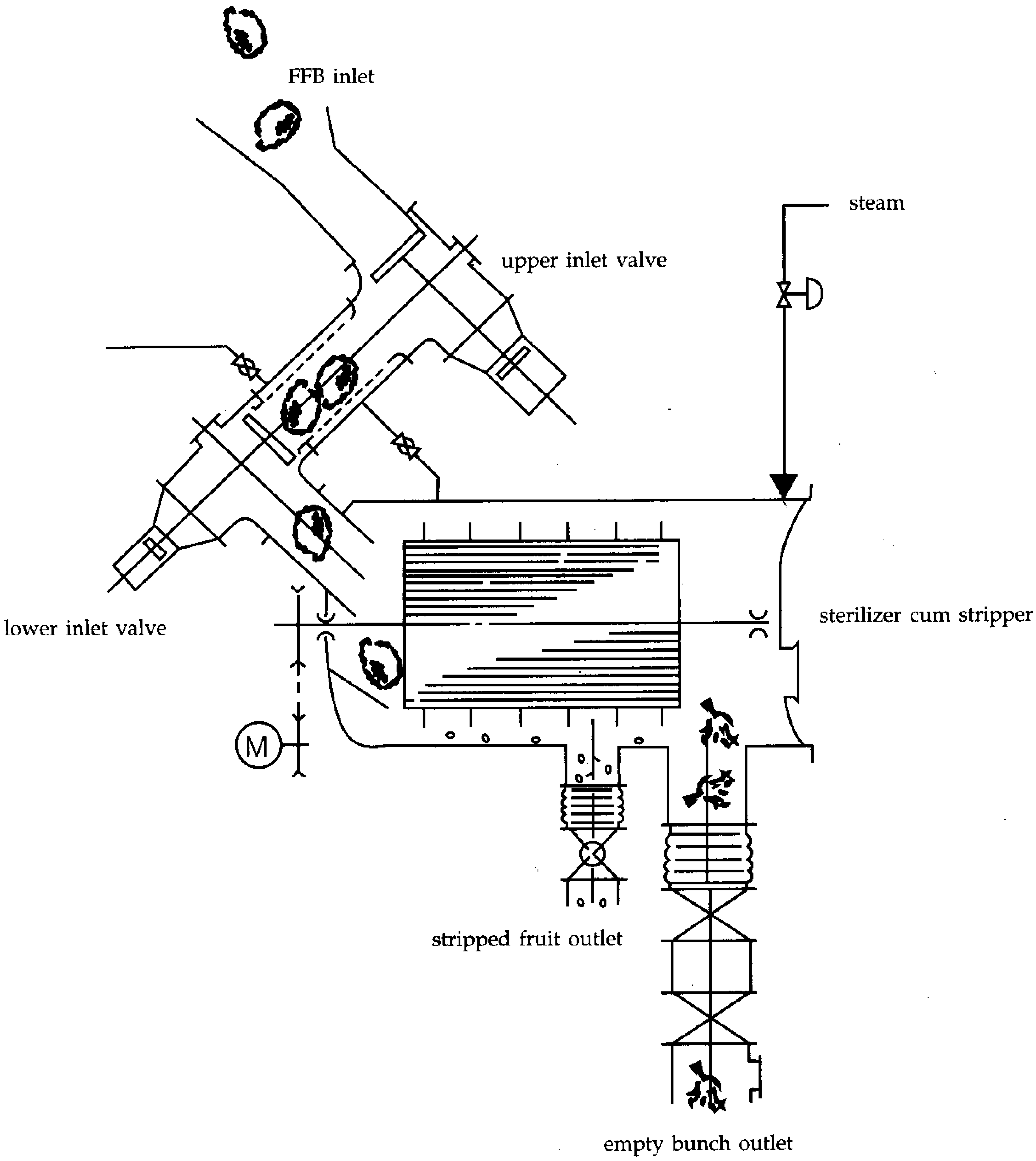


Figure 1. Combined sterilization-stripping process.

closing of the upper and lower inlet valves, it is possible to achieve a semi-continuous flow of bunches through the system.

The main limitation of this process is the small throughput that can be handled by the pre-sterilizer. Further research is needed to make the process viable on an industrial scale.

BUNCH DOWN-SIZING

Table 1 shows the relationship between sterilization temperature and time of sterilization for achieving 100% strippability of fruits from spikelets. The sterilization conditions needed to strip fruits from spikelets are generally much milder than for bunches. The difference is due to occluded air in bunches which slows down considerably the transfer of heat. Various proposals for cutting bunches to spikelets using knives have therefore been proposed. Due consideration must, however, be given to the variation in bunch size and the problem of cutting blades becoming blunt very quickly. A system proposed recently makes use of a robotic arm to grab and drop the bunch onto a gripper, while the cutting is achieved using a programmable logic controller (PLC) to enable following the tapering contour of the bunch.

Loh (1994) proposed a method of bunch decoring (*Figure 2*). A conveyor feeds bunches to the edge of a knife where they tilt with the stalk facing downwards as it is the heavier end. Two decoring machines are used, one on each side of the knife edge.

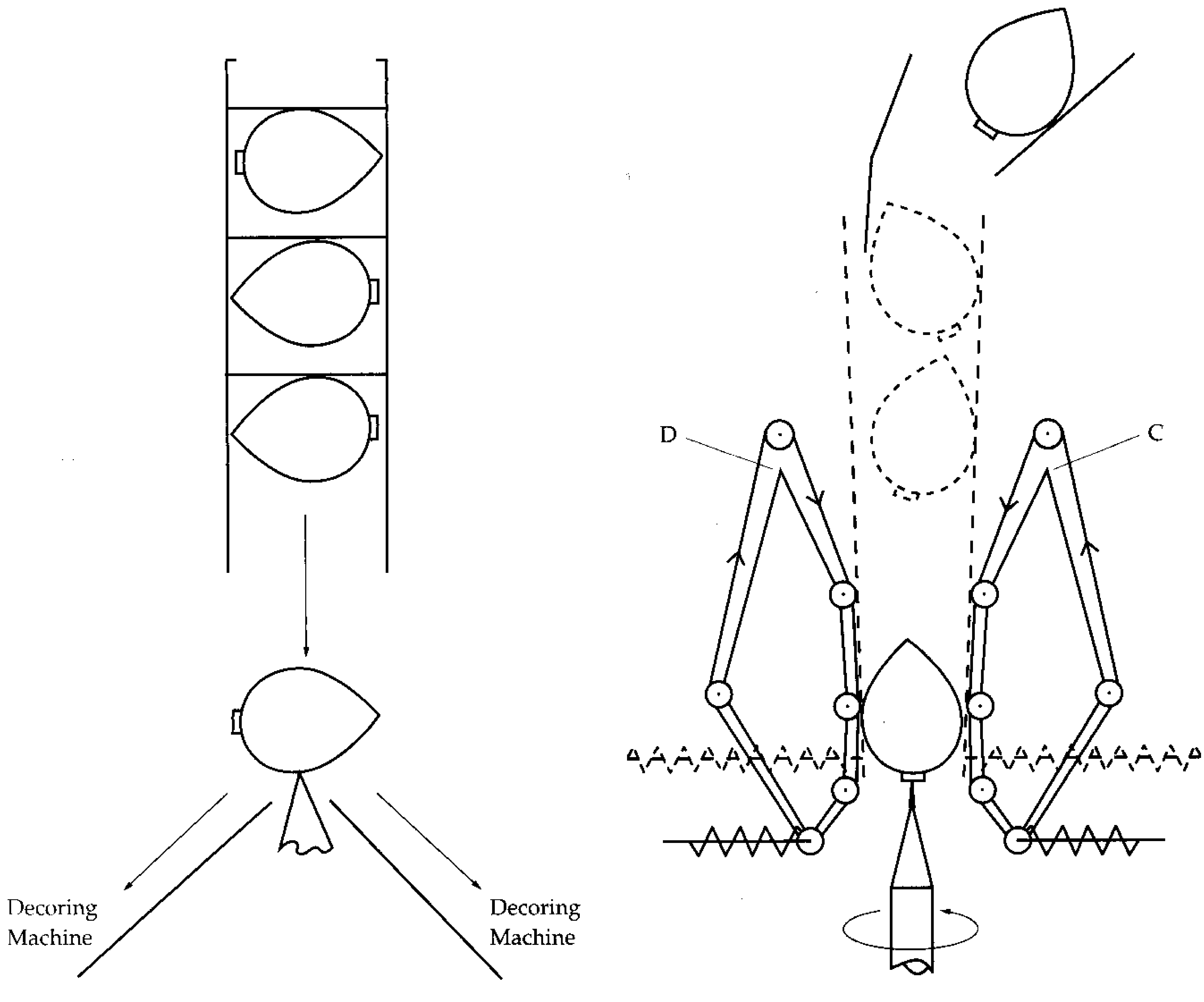
TABLE 1. THEORETICAL RELATIONSHIP BETWEEN STERILIZATION TEMPERATURE AND STERILIZATION TIME FOR COMPLETE STRIPPING OF SPIKELETS

Sterilization temperature (°C)	Sterilization time (min)
80	250
90	100
100	40
110	16
120	8
130	2
140	1

Source: Mongana Report (1955).

Spring-loaded deflectors and vee-chutes are used to position bunches with the stalk end vertically downwards before feeding to the decoring tool. The speed of the feeding mechanisms is synchronized with the decoring capacity of the machine. The use of spring-loaded feed mechanisms allows a decorer to handle a range of bunch sizes. It is reckoned that about five decorers would be needed to handle the whole range of bunch sizes encountered in a mill. A method of grading bunches according to size has also been proposed. The spikelets and loose fruits are then sterilized in a continuous fashion using steam at 5 to 8 psig. One or two rotary steam locking devices are used at each end of the sterilizer. The conveyor inside the sterilizer agitates the spikelets so that the fruitlets are loosened from the spikelets. Separation of the sterilized fruits and the spikelet stalks is achieved using a vibrating perforated plate.

Another method studied is cutting bunches using shredders in a manner that minimizes nut breakage. The shredder is based on two parallel inward rotating shafts, each fitted with intermeshing cutting teeth. The shafts rotate at different speeds, so that as well as a 'nip in' by the teeth, there is tearing and shearing action between the opposing teeth. The cutting teeth are spaced far enough apart to



Source: Loh (1994).

Figure 2. Decoring of oil palm fresh fruit bunches.

allow the majority of fruitlets to pass through without being cut. The shredded material, which consists of fruitlets and bunch stalks, is steam-steamed, homogenized and screw-pressed.

MICROWAVE STERILIZATION

The use of microwaves and radiowaves for heating bunches has been suggested (Olie and Tjeng, 1974; Cheah, 1991). Less than 5 min of heating of spikelets using microwave ovens is sufficient for stripping. However, when bigger portions of the bunch are heated, dehydration occurs and very little stripping is possible. Further studies are needed using microwave systems that allow changing the wavelength and power output. It may be necessary to cut and soak bunches in water before microwave heating or supplement microwave heating with steam heating. The possibility of combining microwave heating with stripping or carrying out heating and stripping in several stages also warrants consideration.

Microwave heating equipment must be effectively safeguarded to prevent leakage of microwaves. Also, the high cost and complexity of microwave technology can only be justified if it offers clear advantages over more orthodox methods. Because microwave technology enables heating to temperatures above 100 °C quickly without the use of pressurized steam, it may provide a simple and elegant solution to the problem of continuous sterilization. Nevertheless, the probability of oil quality deterioration due to over-heating must be carefully considered.

CONCLUSION

In spite of the many efforts made in the past, the technical and economic difficulties have not been entirely overcome yet to make continuous sterilization viable on an industrial-scale. Part 2 of this paper, which will appear in the next issue of Engineering News, will examine a promising new approach based on crushing and sterilization of fresh fruit bunches.

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