DESIGN & FABRICATION OF A DRAUGHT CONTROL MECHANISM FOR THE CHORKOR SMOKER

A Project Report Submitted under the Ghana/Netherlands Artisanal Fish Processing and Applied Research Project

By

DANIEL BLAY

Food Research Institute
P. O. Box M.20
Accra.

December 1992

ACKNOWLEDGEMENT

This work was supported by the Ghana/Netherlands Artisanal Fish Processing and Applied Research Project. The author acknowledges the contributions of Messrs Sampare S.A. and Okine R.O. of the Food Research Institute Engineering Division during the construction of the Draught Control Mechanism(DCM) and of Lawrence Abbey of the Processing Division, during the trial stages of the work. The author also acknowledges the assistance given by the Research Coordinator, Dr. W.A. Plahar during the write up.

TABLE OF CONTENT

LIST OF ILLUSTRATIONS

LIST OF TABLES

DESIGN AND FABRICATION OF A DRAUGHT CONTROL MECHANISM FOR THE CHORKOR SMOKER

Daniel Blay

ABSTRACT

Attempts being made by the Ghana/Netherlands Artisanal Fish Processing and Applied Research Project at the Food Research Institute to enhance the removal of moisture from fish smoked with the Chorkor Smoking Oven have resulted in the development of a device called the Draught Control Mechanism (DCM). The design is based on an idea suggested by J. Bon of the Regional Training Project on Artisanal Fish Processing of the Netherlands. The design employs a wooden frame with flat steel bars welded in such a way as to carry nine lower stationary and nine upper movable specially designed ceramic slabs. With the DCM it was envisaged that even though smoking time and fuel consumption would increase, the moisture content of the final product would be so low that re-smoking and its attendant high cost would be eliminated, thus making processing with the DCM more economical. The results obtained from test runs however showed a decrease in moisture content of less than 2%. This is far less than the expected; thus making the DCM unsuitable for the improvement of draught in the system.

DESIGN AND FABRICATION OF A DRAUGHT CONTROL MECHANISM FOR THE CHORKOR SMOKER

1.0 INTRODUCTION

The Draught Control Mechanism (DCM) is a device which is supposed to enhance the removal of moisture from fish during smoking with the Chorkor Smoking Oven. The Chorkor Smoking Oven is one of the most widely used ovens in Ghana and other parts of the continent by fish processors for smoking fish. This is because of its high fuel efficiency and consistency of product quality.

However fish smoked with the Chorkor Smoking Oven usually have rather high moisture content. For example, tuna chunks lose about only 20% weight during smoking to give a final moisture content of about 60% (Wood & Tariq, 1990). Such products have shelf life of two to three days at ambient temperatures of 29 - 35°C, at which time moulds often start to grow with the head and gills contaminated with insect larvae (Stroud, 1990). In order to increase the shelf life at ambient temperatures, the smoked fish is often re-smoked and redried after two to three days to prevent mould growth and spoilage. This practice increases processing cost in terms of firewood and time. The DCM is supposed to enhance moisture removal from fish during smoking to give final products with low moisture content to eliminate re-smoking.

The DCM concept was first suggested by J. Bon of the Netherlands. It consists of a wooden frame which holds two

horizontal metal plates with rectangular holes, one sliding on top of the other which is stationary. The DCM is positioned on the wall of the oven before the trays containing the fish to be smoked are stacked on it. It is supposed to cause an increase in pressure drop across it, thus resulting in the improvement of draught in the system. Realizing that the cost of the DCM could be halved by using ceramic slabs on flat steel bars instead of the metallic plates, a design based on ceramic slabs was developed.

2.0 DRAUGHT CONTROL MECHANISM : DESIGN OF PROTOTYPE

A prototype Draught Control Mechanism (DCM) was designed and constructed for one half of one of the Chorkor Smoking Ovens at the smoking shed of the Food Research Institute at Okponglo, near Accra.

2.1 Design

The design consists of nine lower stationary and nine upper movable ceramic slabs positioned on a frame made with wood and flat steel bars. The dimensions of the slabs which are dictated by the size of the oven are presented in Fig 1. A slab (290 x 340 x 15 mm) has two rectangular openings (240 x 85 x 15 mm) and two 8 mm-diameter holes which accommodate linking rods which link up three upper slabs in three separate rows.

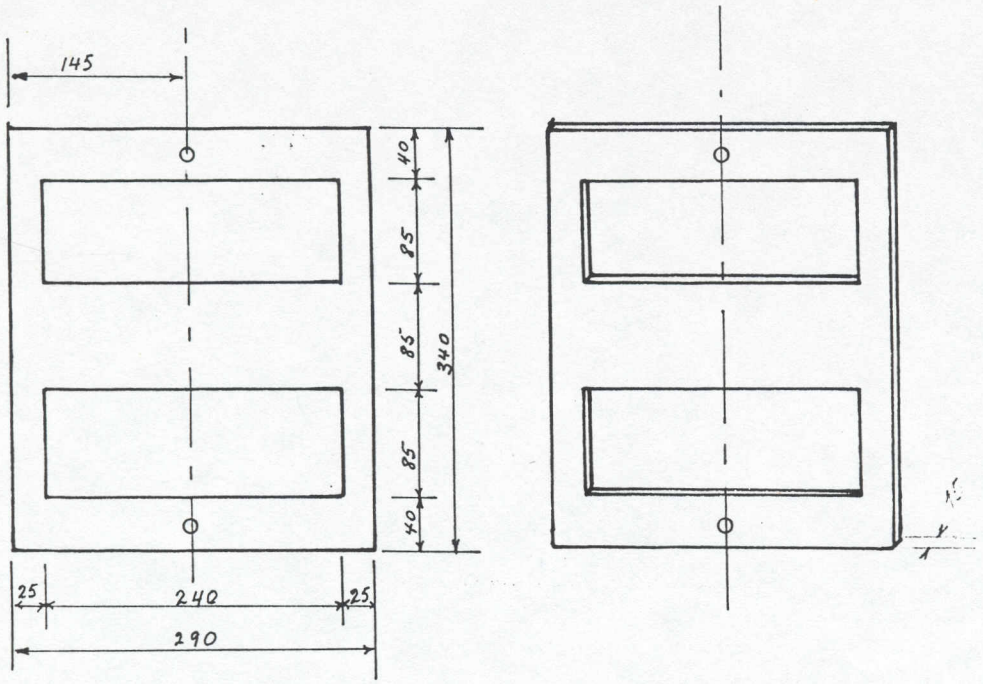
Figure 2 shows the frame positioned on the wall of the oven. The flat steel bars are welded according to the design in Fig 2, and screwed onto the wooden part of the frame to ensure comfortable seating of the nine lower stationary slabs and smooth to and fro movement of the nine upper movable slabs.

2.2 Fabrication

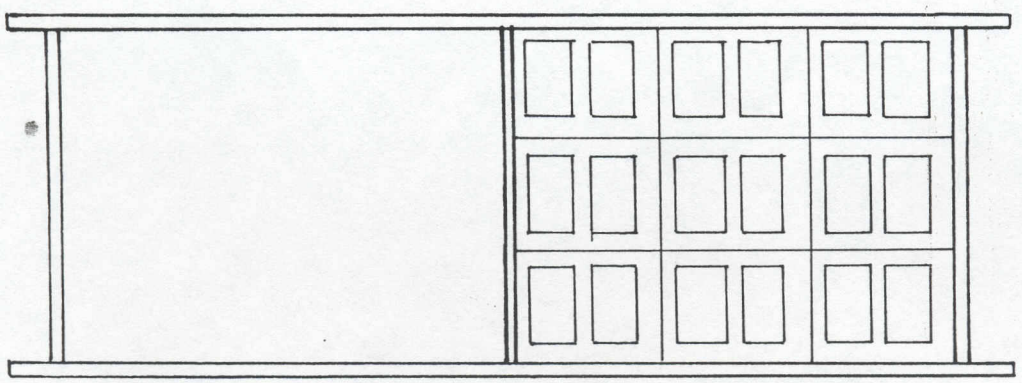
The fabrication of the slabs was done by a ceramic firm, Ofori-Duodu Ceramics Ltd. of Accra. The frame and the linking rods were fabricated by the staff of the Engineering Division of the Food Research Institute.

Fig 1. Draught Control Mechanism (DCM) Ceramic Slabs showing two rectangular openings and two rod linking holes

Figure1 : Draught control mechanism (DCM) ceramic slab



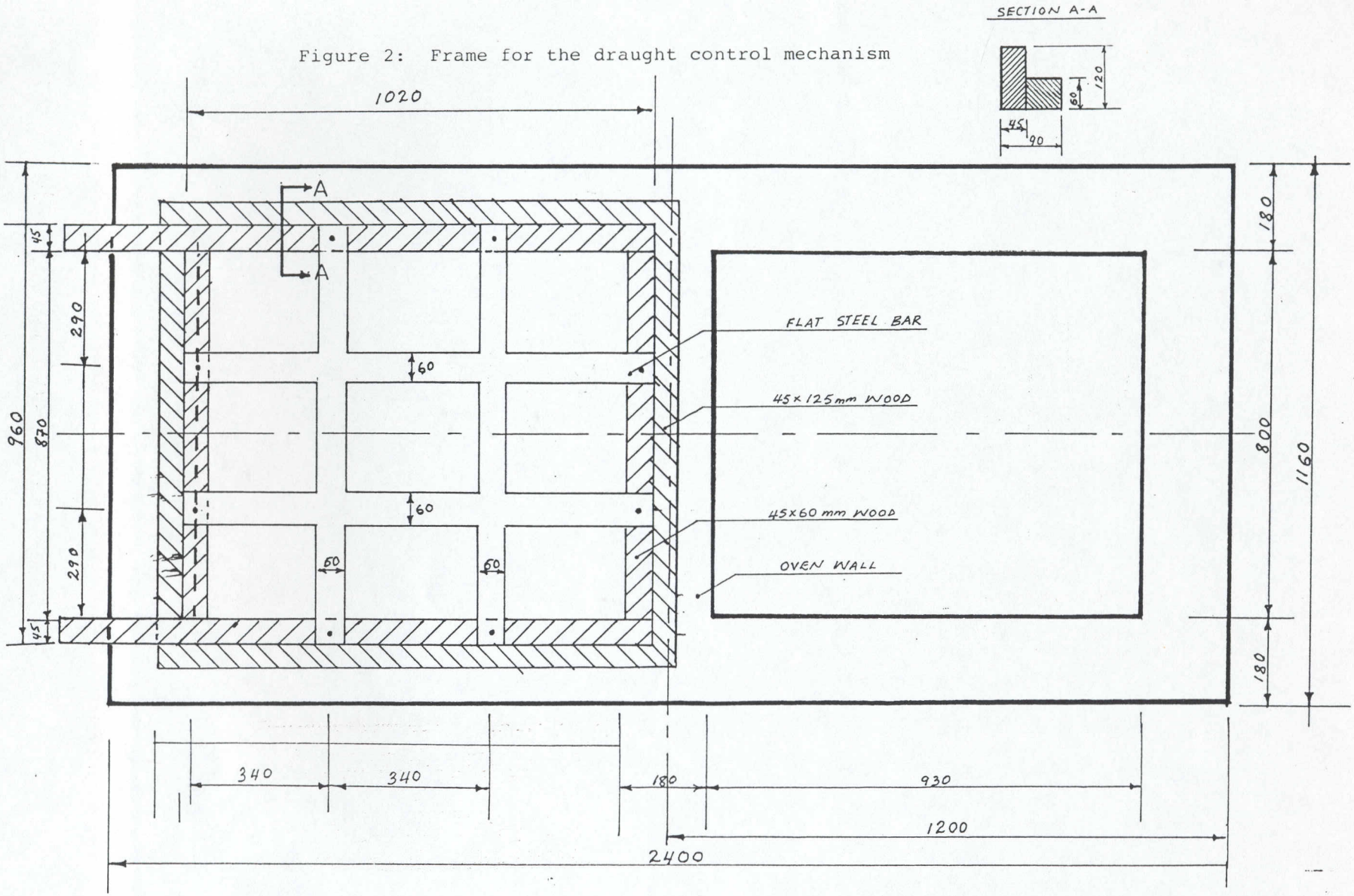
a) DCM ceramic slab



b) DCM slabs positioned on frame

Fig 2. Sketch showing DCM frame positioned on the wall of Chorkor Oven

Figure 2: Frame for the draught control mechanism



3.0 PRINCIPLE OF OPERATION OF THE DCM

The DCM is positioned on the wall of the chorkor smoking oven such that the slabs are pulled out and pushed in towards one side of the oven. The trays with fish are then stacked on it. With firewood burning, the flow rate of flue gas is regulated and the draught in the system controlled by moving the three upper outermost slabs in and out to open and close the openings of the slabs respectively. In this way, the effect of fire on the fish can also be controlled. It is expected that with the uppermost tray left uncovered throughout the heating and smoking period, draught in the system could be improved thereby increasing the rate of moisture removal from the fish.

At the initial position (zero position), it is expected that the heat generated is reduced by an amount AH, which can be determined by the relation:

$$AH = H \times As/A$$

where
H = heat generated by firewood
As = Area of solid part of slabs
A = Area of entire slabs

Here, it is assumed that the slabs are perfect insulators and that there are no heat losses.

Useful heat, Hu, at this position is defined as:

$$Hu/A_o = H \times Ah,$$

where H = heat generated by firewood
Ah = area of holes in slabs
A_o = area of oven

Useful heat that passes through the DCM,

$$Hu = 0.40H$$

As the movable slabs are slided on the stationary ones from the zero position to final position (fully closed) the heat supply decreases proportionally to the area of holes being covered by the movable slabs.

3.0 TEST RESULTS & DISCUSSION

The DCM was tested by smoking some known quantity of fresh herrings on an oven with the prototype DCM. The herrings were weighed and spread as evenly as possible on five trays and stacked on the DCM. Temperature distribution in fish on three trays (lowest, middle and uppermost at start of smoking) were recorded at 20 min intervals by means of three Type K (Chromel-Alumel) thermocouple whose probes were buried in the fish and the other ends connected to the rear of a recording thermometer (model KM 1242).

Weight of firewood consumed was noted as well as the time taken to smoke the fish. Moisture content determinations of both the fresh and smoked fish were undertaken. The results of the smoking trial are given in Table 1. The temperature distribution curves during smoking are also shown in Figure 3 for the three trays.

The results showed that:

i. As expected, the fuel consumption was high, about 57% higher than what it normally takes the oven to process the fish without the DCM.

ii. The processing time was also about 20% longer than it usually takes the oven without the DCM.

iii. Relatively low temperatures were recorded during most of the smoking period giving an average temperature of 72.3°C.

iv. A moisture content value of 48.7% obtained for the test smoked fish samples (with DCM on oven) is less than that for the control samples (no DCM on oven) by about only 2%. This is not worth the extra fuel input and processing time on smoking with the DCM.

v. The unfavourable results obtained could be attributed to the fact that the driving force from the fire source was not strong enough to creat a substantial pressure drop across the DCM to improve the draught in the system.

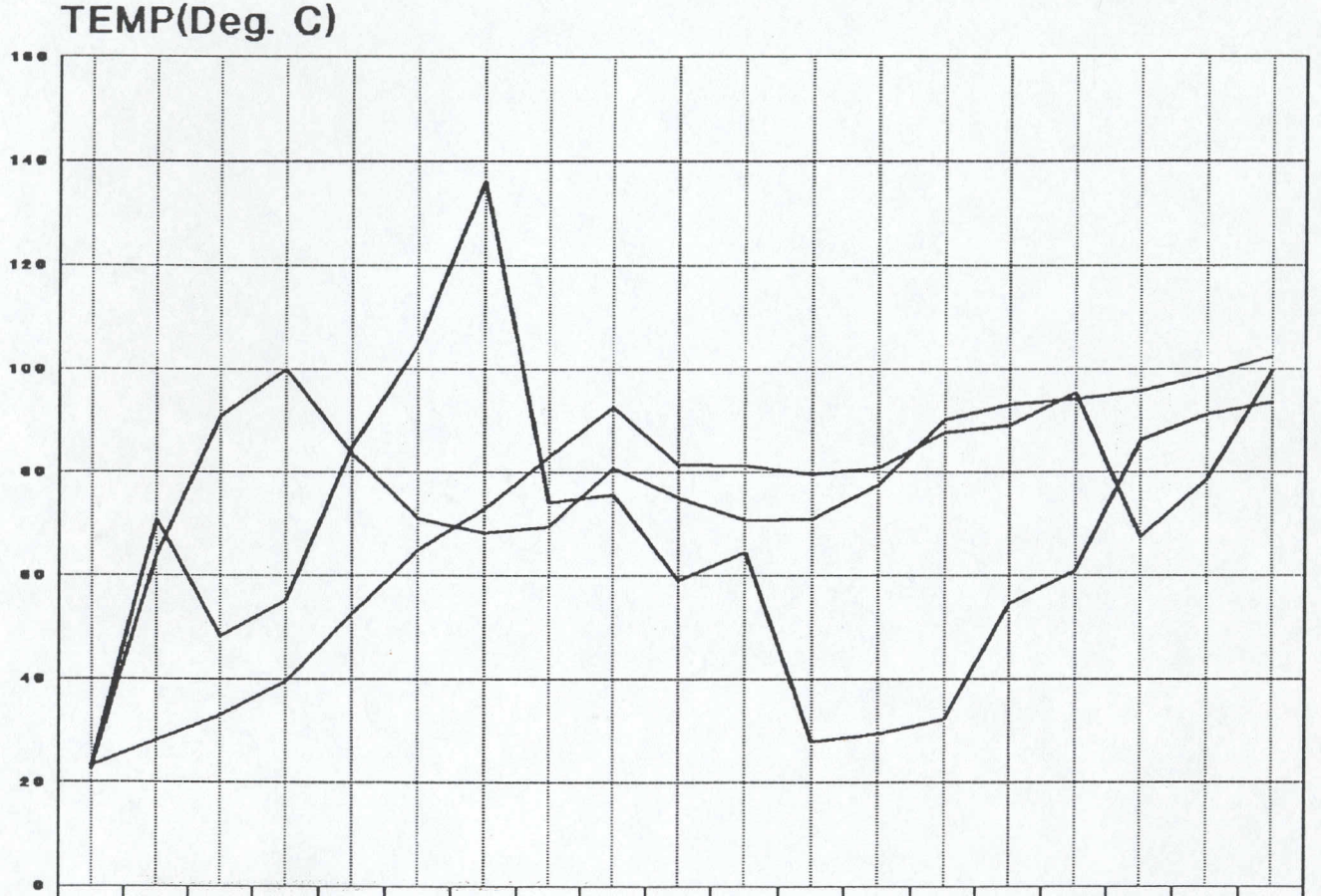
vi. To rectify this situation will require an external source such as fan to improve on the draught in the system. This is more expensive and also not applicable in many fish smoking areas where electrical power is not available.

Table 1. Summary of test results for smoking trials using oven with DCM.

Item	Description	Results
1	Weight of fresh fish (Kg)	34.0
2	Weight of smoked fish (Kg)	16.0
3	Overall loss in weight (Kg)	18.0
4	Percentage loss in weight (%)	53.0
5	Weight of firewood used (Kg)	33.7
6	Weight of firewood per fresh fish	0.99
7	Processing time (Hr)	5.5
8	Overall average drying rate (Kg H_2O per Hr)	3.3
9	Moisture content of fresh fish (%)	71.6
10	Moisture content of smoked fish (%)	48.7

Fig 3. Temperature distribution curves

TEMPERATURE DISTRIBUTION IN FISH



	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360
1st. Tray(start)	23.1	70.8	48.2	56.2	84.9	104.7	136.2	74.2	76.7	59	64.6	27.8	29.3	32.2	64.6	61	86.3	91.2	93.6
3rd. Tray(start)	23.2	28.2	33	39.6	62.6	86	72.8	83	82.7	61.6	61.3	78.5	80.8	87.7	89	95.6	87.6	78.6	88.7
5th. Tray(start)	22.6	63.8	90.7	100	83.6	71.1	68.2	69.6	80.8	76	70.7	70.9	77.6	90.1	93.1	94.1	95.8	98.8	102.4

TIME(MINS)

5.0 CONCLUSIONS AND RECOMMENDATIONS

The DCM constructed with the purpose of enhancing moisture removal from fish when used with the Chorkor Smoking oven was not successful. The reduction in moisture content of its product was less than 2% as compared with increase in fuel consumption and processing time of 53% and 20% respectively.

Nevertheless, it is recommended that search for other methods of improving the draught in the system which would prove technically feasible and economically viable should be pursued.

6.0 REFERENCES

Stroud, G.D. Technical and economic appraisal of Artisanal smoking ovens in Ghana. Project No. TCP/GHA/45.

Wood, C.D. and Tariq, A.S. 1990. Report on a visit to Ghana to investigate the use of the Nygesi fish smoking kiln.