Instrument for Determining Depth of Dehydration of Frozen Fish

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Introduction

United States Standards for grades of various frozen seafood products include as a quality defect the presence of dehydration. It is considered a quality defect both because product weight is lost and because the surface and thin parts of the fish become irreversibly dry and porous, often making the product unpalatable and unacceptable. This quality defect is exhibited by a white porous appearance and by affected areas that feel relatively dry to the touch.

Most USDC (United States Department of Commerce) voluntary standards for frozen fish products evaluate the degree of the defect by the depth of the dehydration and the area affected. To date, the depth of dehydration has been determined by scraping the dehydrated area with the thumbnail. While this method is as useful as many tests used for determining seafood quality, an investigation to arrive at a more quantitative and more precise method has been made.

This report describes the design, construction, and operation of a dehydration depth gauge to measure the degree of dehydration in frozen seafoods.

Design

The dehydration depth gauge adopts the principle of a hand-operated wood plane (Fig. 1). A small, inexpensive plane was modified by using a heavier gauge blade having a narrow cutting edge extending 1 mm below the plane's flat surface. The extension is $^3/_{16}$ inch (4.76 mm) wide at the lower end and ¼ inch (6.25 mm) wide at the top (Fig. 2A).

The depth of cut of this blade is set accurately by a gauge block. The block has a wide groove 1 mm deep milled across its top surface so that when the plane is set on top of the block and the blade is loosened and moved down to rest on the bottom of the groove, the cutting edge of the blade extension is exactly 1 mm below the bottom of the plane. Tightening the screw on the blade lock holds it in position at a constant depth of 1 mm.

The resistance of the frozen fish to being grooved by the plane blade required a force such that it was necessary to attach a push knob to the plane which permitted a firm grip and effective control facilitating the test procedure.

The parts of the plane that were modified were held to close manufacturing tolerances (Fig. 3). The guides for holding the plane blade from canting were modified to provide a closer tolerance and still allow it to slide freely when the blade locking screw is loosened. This makes it easy to set the blade extension accurately and still keep its position when the locking screw is tightened. The maintenance of close tolerances between the blade guides and the blade, along with the gauge block for depth control, make it possible to remove the blade for cleaning and replacement without any loss of accuracy in the setting. By these modifications, a small plane was transformed into an accurate depth measuring device.

Essentially, the thumbnail method for determining dehydration was designed to determine only whether the dehydration was deep enough to be considered a defect. There was no attempt to obtain a measure of the depth; thus there is no indication as to what the threshold that established the presence of dehydration should be. The best available estimate is that the value of the threshold is about 1 mm. Accordingly, the depth gauge was designed to yield a go/no-go decision with the threshold at 1 mm.

In an intermediate design, the planer blade was left at full width, but the cutting edge was set to cut a path of varied depth from 0 to 2 mm (Fig. 2B). This was done by cutting one side of the edge of the blade back 2 mm while leaving the other side alone. By extending the blade so that its cut side was flush with the flat bed of the plane, the uncut side was extended a full 2 mm. The cutting edge of the blade was uniformly marked so that an accurate measure of the depth of dehydration could be made up to twice the threshold depth. However, this was not possible for several reasons: 1) It required too much force to cut wide strips of frozen fish tissue; 2) the V-notches in the plane blade produced an irregular surface which distorted the light being reflected from the clean frozen fish flesh and from the dehydrated flesh fibers; and 3) sharpening the plane blade must be done in a holding jig to maintain some of the parameters that must not be changed. The results of this part of the study forced the decision to reduce the width of the cutting edge and

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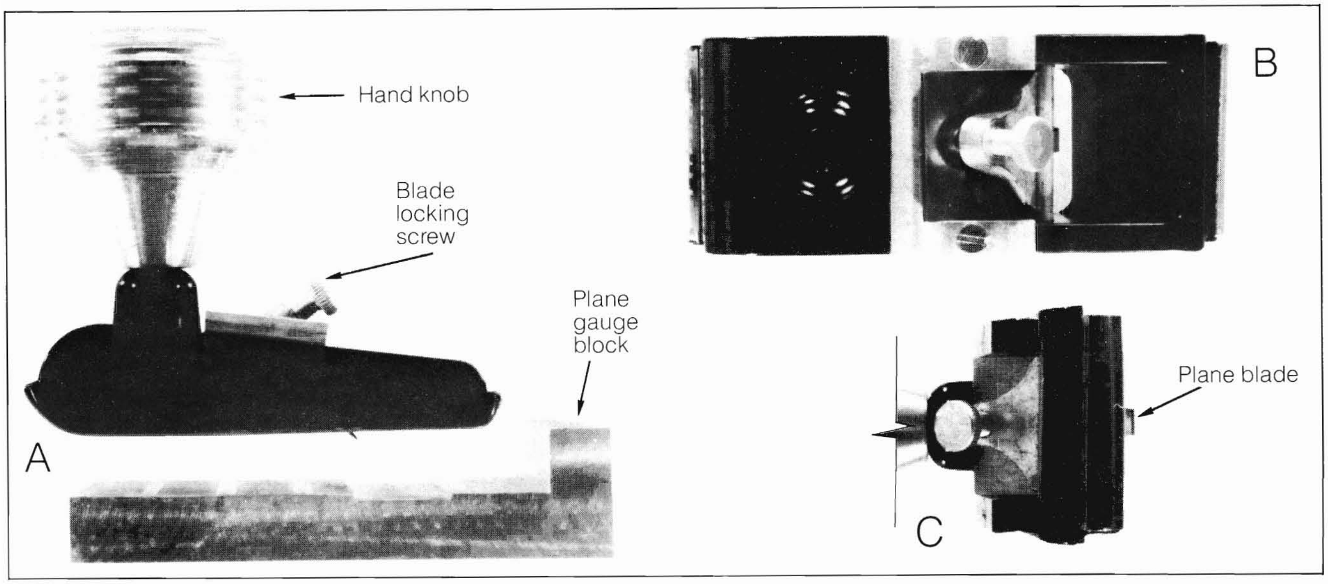

Figure 1.—The dehydration depth gauge: A) Side elevation shows hand knob, blade locking screw, and plane gauge block for setting blade extension to 1 mm; B) plan view of plane gauge with hand knob removed; C) end view of plane blade.

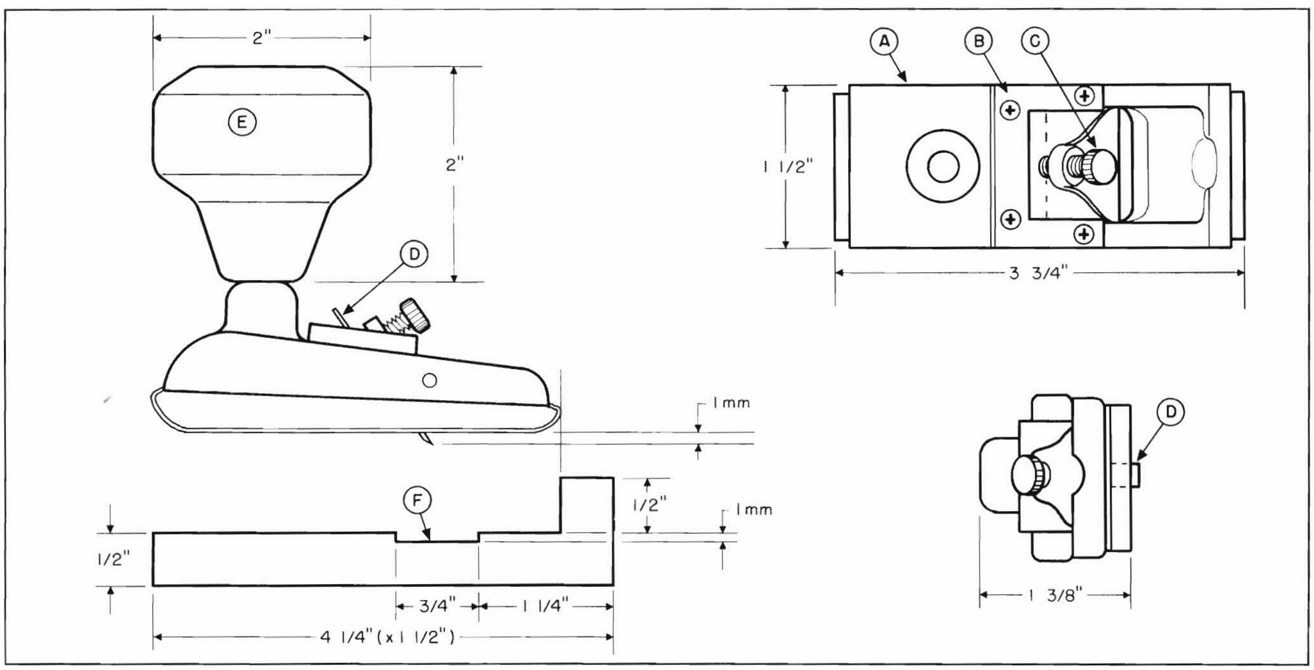

Figure 2.—Plane gauge construction and accessories: A) Plan view of plane, B) blade guide to keep blade from canting, C) blade locking screw, D) blade ($^{3}/_{16}$ inch wide) which extends 1 mm beyond bottom, E) hand knob for pushing and guiding the plane, F) gauge block for setting blade extension exactly to 1 mm.

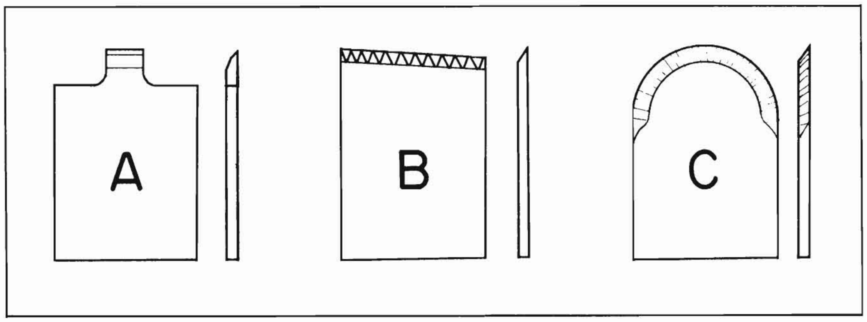

Figure 3.—Three experimental blade designs. All had the same body width, length, thickness, tolerances, and tempered tool steel. Only the shape and width of the cutting end has been altered to obtain a path that is clear and readable without having to exert excessive pressure to cut the path. Blade A is narrow, $^3/_{16}$ inch, and set to protrude 1 mm. Blade B was angled and notched to cut a 1-inch track varying from 0 to 2 mm deep in the frozen flesh. Blade C was shaped to simulate an inspector's thumbnail.

to attempt to obtain only a go/no-go decision.

In another intermediate design (Fig. 3C), a planer blade was shaped nearly semicircular to duplicate the shape of a thumbnail. This design was not practical because it required too much force to use. This raised the question as to the ability to push a thumbnail through dehydrated flesh, and it was concluded that the thumbnail did not cut a uniform path of 1 mm depth but that it cut at an uneven depth, most of the times at less than 1 mm.

Operation

The dehydration depth gauge tells whether the surface of the frozen fish has developed a layer of dehydration which is less than 1 mm or more than 1 mm in depth. If the dehydrated fish flesh is less than 1 mm deep, the end of the plane blade will cut through the dehydrated layer and enter the acceptable clear flesh which has not been dehydrated. The "go" criterion has been met and the frozen block is acceptable for shipping. If, on the other hand, the blade does not cut all the way through the dehydrated layer then the bottom of the groove will appear white and spongy. The plane blade cuts a path in the frozen product 1 mm deep. Examination of the bottom of the path will disclose three different conditions:

1) A clear, semitransparent product with no spongy dehydrated material included. This condition is "go", meaning that the frozen product has passed the test, and requires no decision by the inspector other than cutting three or four more confirmatory test paths.

2) A mixture of sections of clear, semitransparent product along with white, spongy spots occurring regularly. This indicates that the depth of the dehydration has progressed to the 1 mm limit. This requires an estimation to be made to determine the percent of the surface area of the product affected by this depth of dehydration. Several paths, three or four inches long should be cut to confirm the depth of the dehydration and the extent of the surface area affected. If that area exceeds the allowable limit described in the standard, then the product fails the test.

3) A white spongy appearance at the bottom of all paths cut for inspection after making confirmatory checks. Again, there should be no question of what decision should be made. This is a "no-go" condition and the product fails the test.

In tests conducted at the Gloucester Laboratory, the depth gauge performed so well and was such an improvement over the thumbnail method that it will be the recommended procedure for the dehydration test in all future standards and Inspectors' Instructions.

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