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FISH PROTEIN CONCENTRATE PROCESS 1/

by

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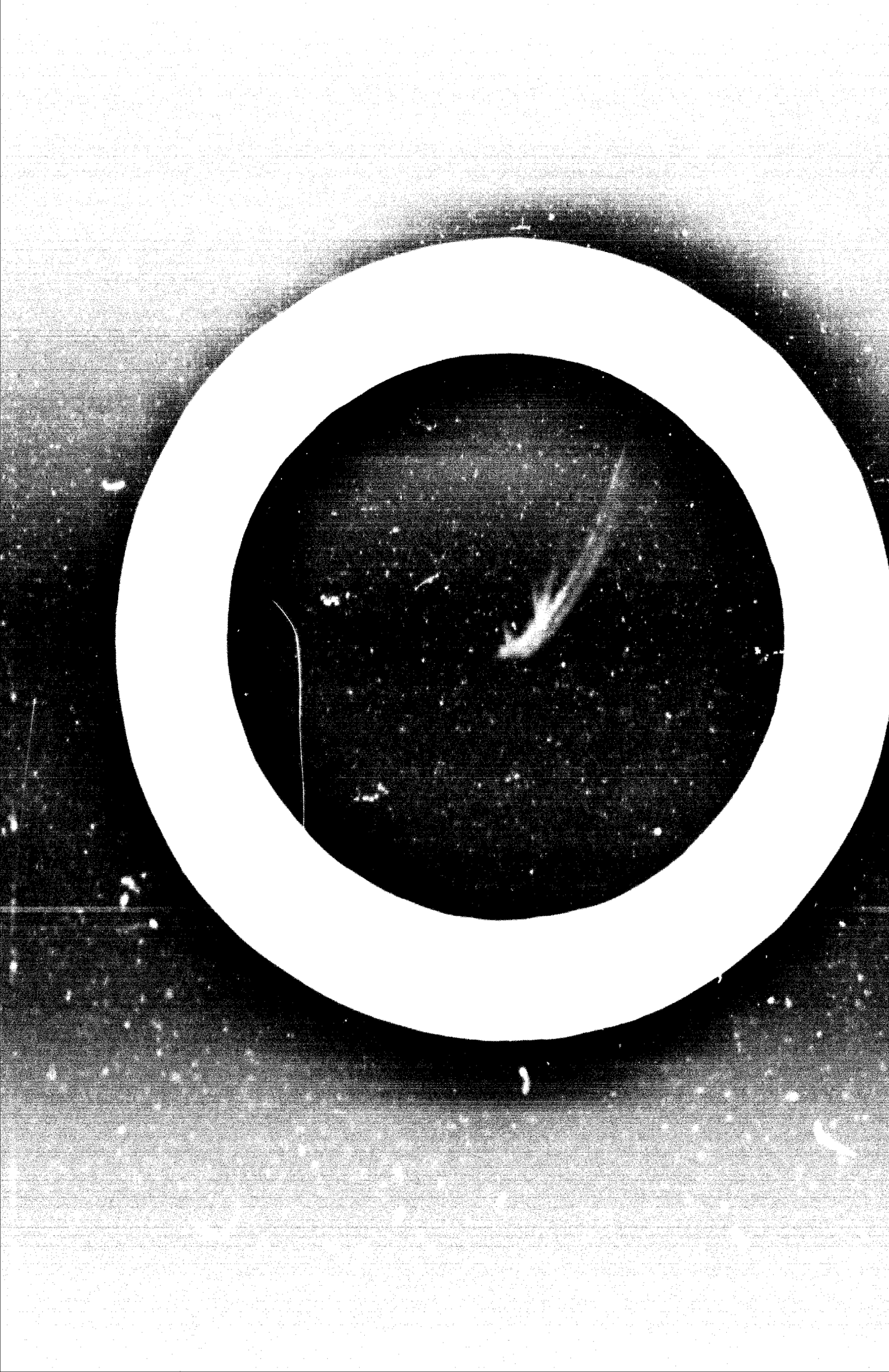

FPC PROCESS

General Description

The Carver process combines solvent extraction and azeotropic distillation for the effective separation of water and oil from proteinaceous fish tissues. The solvent is ethylene dichloride. The extraction temperature occurs at 150°F and does not destroy the high quality amino acids of animal protein. Product yield is much higher than conventional methods of fish reduction because there is no loss of water soluble proteins. This process is shown in Figure 1 and described below.

Initially, fresh raw fish is reduced in a grinder, conveyed to the extractor, and contacted with ethylene dichloride (EDC) solvent. The extractor is the primary vessel in the system and maintains the proper temperature for separating liquids from most proteins. Water removed from fish tissue forms a heterogenous azeotrope with the solvent. Distillation of this azeotrope at 150°F separates water from fish oil so effectively that no water-oil emulsion is formed. Several other methods being developed to produce fish protein in a similar manner tend to form these notoriously difficult emulsions. The remaining liquid is called MISCELLA and contains a solvent oil solution. This is separated by evaporation, filtering and finally steam stripping. Losses are indicated at less than one percent of solvent in process. The residue oil may be of tremendous value if considered for use in ethical drugs.

As water and oil are continuously removed in the extractor, the density of EDC is reduced. Droppage to the bottom of the primary, proteinaceous fish solids are then conveyed to an agitated washer for a similar operation with fresh solvent. After this washing process, the wet meal is conveyed to rotary steam jacketed vacuum dryers. This process removes residual EDC solvent by several applications of purge steam and evaporation. The FPC is then either milled, screened and stored, or conveyed to the 2nd stage process, an isopropyl extraction unit for further deodorizing to meet FDA specifications.

Solvent vapors (EDC or IPA and steam) from the dryers, evaporates and extractors are condensed on their way to the decanter, which discharges the water and recycles the solvent for further use. Vented vapors from the vacuum pump and from various process vessels are sent to a solvent recovery system for further recovery of small amounts of solvent that would otherwise be lost.

A detailed description of each of the stages of the process is included below.

VioBin - First Stage Process Description

The basis of the VioBin process, particularly the continuous separation of fat from wet tissue and the apparatus utilizing such continuous process results in the following premise:

Many substances, particularly of animal origin, contain relatively high proportions of water which are present either in the form of intracellular fluid, or are present in the cell tissue as intercellular fluid. The presence of a moisture content in tissue in excess of 20 percent greatly impairs or prevents use of a conventional solvent extraction process for the removal of fat from the tissue.

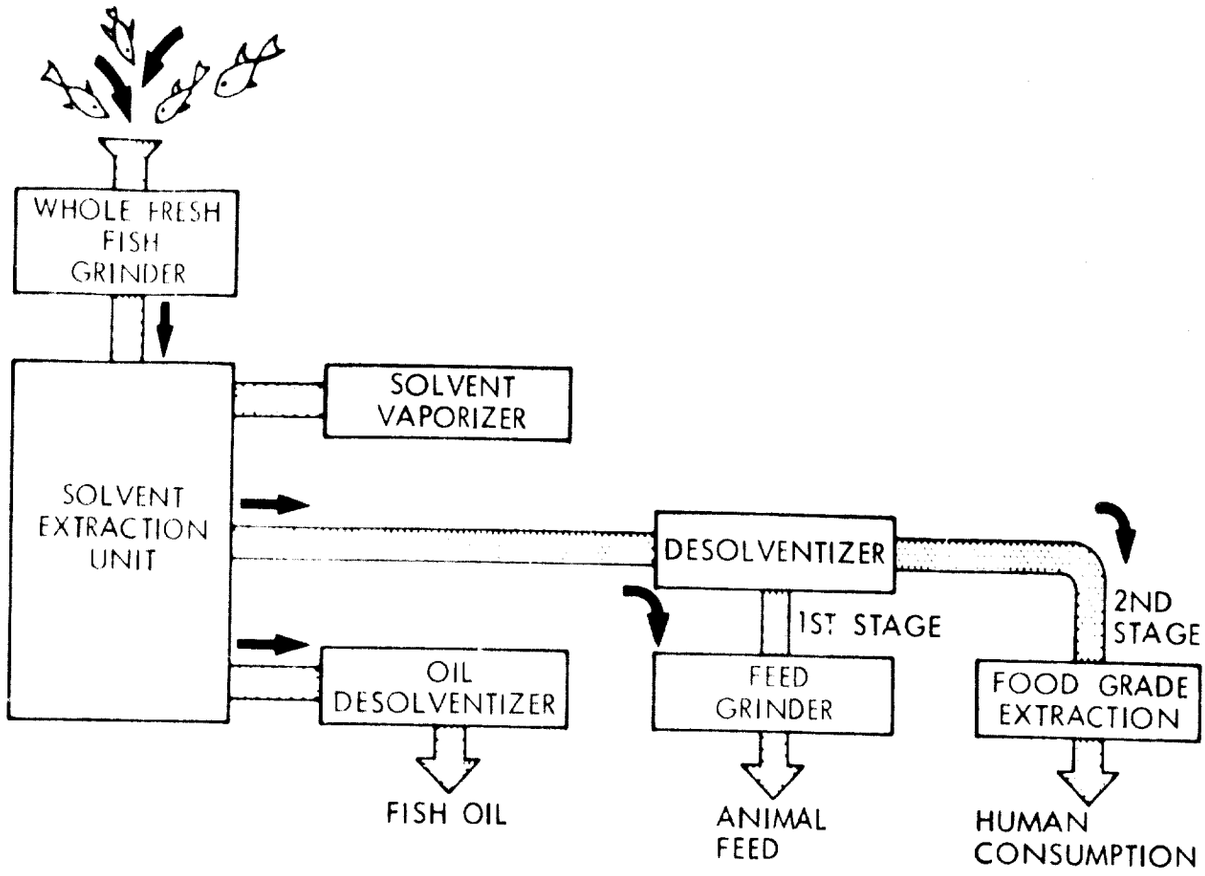

Figure 1. FPC Process Diagram

The basis of the VioBin process is azeotropic distillation. Two liquids form an azeotrope when the conditions of the following formula are met:

$$P_1 + P_2 = P_t \text{ and } \frac{W_2}{W_1} = \frac{P_2}{P_1} \times \frac{M_2}{M_1} = K$$

Where: P_1 = Vapor pressure of first liquid

P_2 = Vapor pressure of second liquid

P_t = Total vapor pressure of combined liquids, equal to pressure of system for boiling of the mixture

W = Vapor weights

M = Molecular weights

An azeotrope has the property of boiling at a lower temperature than the boiling point of either of the liquids which form the azeotrope.

The body of solvent must form an azeotrope with water preferably at atmospheric pressure. The solvent should be selected to form an azeotrope, which will remove substantial portions of water in relation to the amount of solvent distilled at the operating temperature selected. Among the solvents of this class, ethylene dichloride is preferred. Ethylene dichloride has a boiling point at atmospheric pressure of 83.5°C. A water-ethylene dichloride azeotrope boils at 70.5°C.

The solvent must not be reactive with the tissue constituents under operating conditions, and must be capable of being removed by evaporation from the fat without leaving harmful or toxic residues.

The finished product is feed grade (non-deodorized) FPC. The flow process of each plant is designed for 200 tons per day input of whole wet fish. The ratio of input is 5:1 for non-deodorized (feed grade) FPC and 6:1 for a deodorized FPC, meeting standards for human consumption in the USA and abroad.

After drying, the vacuum is released in the desolventizer and the vacuum pump stopped. The desolventizer discharges to a conveyor. The empty desolventizer is then prepared to receive additional drained FPC for the next cycle.

Marine Protein, Inc., will be permitted to modify or combine any of the above operations as may be of advantage to the performance or processing capability.

Module 2 - Second Stage Process Description

The second stage process consists essentially of contacting non-deodorized feed grade FPC with IPA water solvent to extract flavor and aroma producing materials. The extracted meal is then desolventized to give a deodorized food grade FPC and the solvent is distilled to separate the extracted materials and to concentrate the IPA-water solution.

The flow begins with feed grade FPC discharged at a uniform rate provided by feeder systems. The feed grade FPC flows through the seal zone in the feed conveyor and into the extractor. In the extractor, it proceeds from chamber to chamber, countercurrent to the flow of solvent. The extracted FPC is discharged from the extractor over a weir by a lifting flight. The solvent-FPC mixture drops on the drain table by which it is conveyed over a drainage section that separates free liquid from the FPC and returns the solvent to the extractor by means of a pump. The drained FPC then goes into the desolventizer for removal of solvent.

Desolventizing is conducted on a batch operation basis with one desolventizer being in the desolventizing process while the other is inoperative but is accumulating the continuous flow of drained FPC.


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