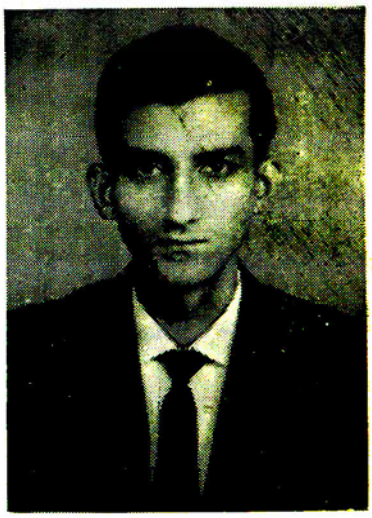
ARTIFICIAL DEHYDRATION IN SEAFOOD INDUSTRY



P. K. Chakraborthy
Central Institute of Fisheries Technology,
Ernakulam, Cochin-682011.

Sun drying has been a traditional process of fish preservation in most of the countries of the world. Inspite of the development of most sophisticated processes of fish preservation such as canning and freezing, sun drying retains its significance in fish processing industry. Large quantites of fish are being sundried in various countries for human consumption. The process, however, is inordinately slow and gives a product lower in nutritional value with a high percentage of moisture which decreases its storage life. The product may also get contaminated with pathogenic bacteria due to the attack of flies and insects and often get mixed up with sand and dirt. Moreover, sundrying is entirely dependant on weather conditions.

In our country it has been estimated that about 40% of fish landing is still preserved by either sundrying or salt curing and drying or converted into fish meal. A major part of dried fish so produced is consumed internally and a part is exported to Ceylon, Burma, Singapore and African countries. It has been observed that better quality of product can be achieved under controlled conditions of air in an artificial drier. The process of production is complex and expensive but dehydrated fish has got more monetary value than sun dried one. Unlike other methods of fish preservation it requires less complicated machinery and the product can be stored and distributed at much reduced costs.

Hot Air Driers

The most important group of driers widely used for dehydration of fish are hot air driers. In the hot air drier air is heated by steam or electric heater which is blown

over the fish surface by an air blower and the evaporated moisture is carried away by the same air. The moisture carrying capacity is more if the air is hot and dry (low humidity) and is moved at faster rate. If the three parameters (temperature, humidity & air velocity) are properly controlled, quality dried product can be produced in quickest possible time.

1) Cabinet Drier

The first development of hot air drier is cabinet drier. It essentially consists of a rectangular wooden or asbestos cabinet in which trays of fish are placed on shelves which may be fixed on the chamber walls or on movable trolleys. Air is blown by a fan past a heater across the fish. It is usually the least oxpensive, easy to install and flexible in operation. The main draw back of this type is non-uniform drying.

2) Tunnel Drier

It is basically a cabinet drier operated in a programmed series as semi-continuous manner. This type of drier is more commonly used for dehydration of fish on mass scale. Commercial tunnel drier consists of a long concrete tunnel divided into upper and lower chambers. In the upper chamber, two steam heaters, one air blower, several instruments for controlling air temperature and humidity are fitted and in the lower chamber five trolleys of mild steel construction are moved on rails. On the trolleys several layers of aluminium trays containing fish are arranged in the form of shelves. Production is so scheduled that when a trolley of finished product is moved out from one end of the tunnel, a trolley of fresh fish is put in the line. Air is moved counter current to the direction of trolley movement for maximum efficiency, rate and quality product. An optimum air temperature of 45–50°C and 55–65% relative humidity is found to be satisfactory for drying of fish in such drier having an average air velocity of 100–120 meter/min. and takes about 12–16 hours to dry a batch of fish. Air temperature is controlled by controlling heaters by bi-metallic thermostats and humidity is controlled by recirculation of drying air. For drying of fish in hot air tunnel drier, the raw moterial is first washed to remove dirt, slime and then cut opened from the dorsal side, intestine and gills are removed and again washed to remove dirt, blood and slime. This is then salted in 1:5 (salt:fish) ratio for 18–24 hours, lightly washed off excess salt and dried in the tunnel drier on perforated aluminium trays with flesh side upwards. Air conditions are properly controlled to the optimum level to get aquality product. In case of big fishes like shark, the flesh is first cut in the form of fillets which are salted in 1:2 ratio for 24 to 36 hours before drying. Small fishes like Sprats, White Baits etc. are dried without salt treatment while Bombay Ducks are dried by hanging on ropes in a current of hot air to a certain moisture level, then laminated and dried on trays. In the case of prawns, the meat is cooked in 10% brine for 15-20 minutes and dried on trays in mechanical drier. It is very important to

note that for most of the fishes except prawns, care should be taken to see that meat does not get cooked up during drying. Generally, unsalted fish and prawns are dried to 10-15% moisture level and salted fish to 25-30% moisture level in the product. Properly dried and packed product can be stored for 3-6 months depending on storage condition.

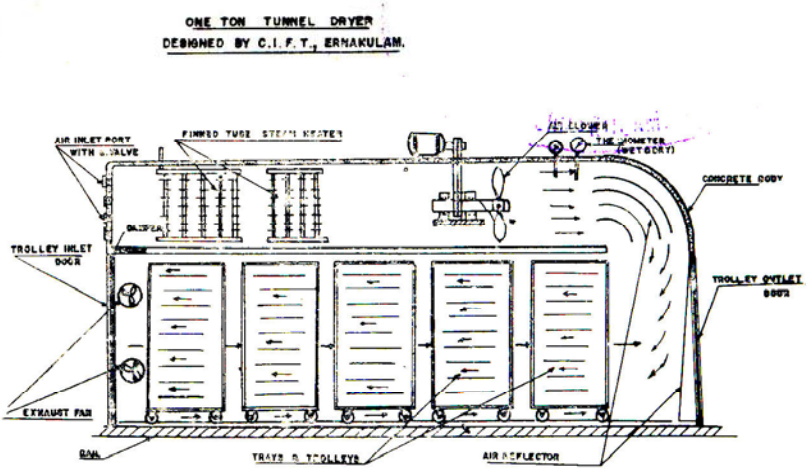
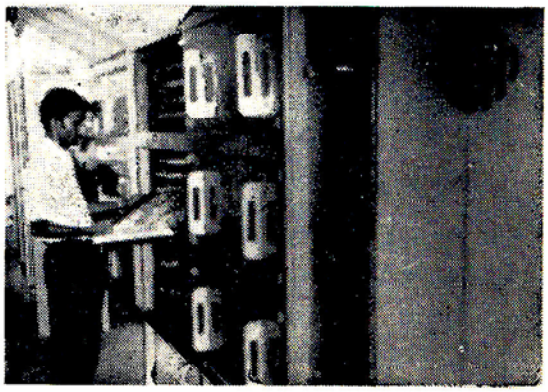


Fig. 1

Tunnel drier has got several advantages. It can be designed for any capacity and all types of fish and fishery products can be dried easily. Cost of production is comparatively low and more or less uniform drying takes place under controlled conditions giving a quality product within short time.

3) Multideck Tunnel Drier

Tnis is the most recent concept in tunnel drier design. In place of a single tunnel, several such are placed one above the other and air is blown in a zigzag fashion three times before it is exhausted. All controls, heaters, air blower and exhaust fan are placed on the sides. In the multideck tunnel drier, better control of drying parameters and greater thermal eifficiency can be achieved. By moving the fish from one deck to the other mechanically, it is possible to design continuous drier fish and fishery products. This drier has got more capacity per unit volume, occupies less floor area per unit capacity and cost of production is less per unit of product compared to tunnel drier particularly for smaller unit.



4) Fluidised Bed Drier

This is another recent development in hot air design of driers. When air is passed over a bed of solid, air flows between and around the particle without disturbing them but as the pressure is gradually increased a stage is reached when the air pressure lifts the bed and entire bed is suspended in a state of constant agitation and as such

solid particle can be blown to any place like a fluid. In this case, drying takes place in quickest possibl time. This type of drier is used for drying granular material like fish meal, fish powder etc. In case of fish which is difficult to suspend in air, fish is supported on a wire mesh conveyor belt which is moved inside a drier and hot air is passed through the fish. This type of driers have got high thermal efficiency.

Rotary Drier

All types of rotary driers consist of cylindrical shell mounted on horizontal or at slight angle on rollers or bearings so that they can be rotated by suitable drive mechanism. The source of heat is generally hot air which circulates through the shell or it can be suplied from the steam heated jacket. This type of driers are generally used for fish meal production.

1) Rotary Drum Drier

It is a batch drier with steam jacket and is made out of mild steel. The drum is mounted on ball bearing and is rotated at 15-20 r. p. m. The internal baffles lift the material and the evolved moisture is drawn out by an exhaust fan. The material in the form of pressed cake or whole fish is charged inside the drier, the drum is rotated while drying and steam is passed inside the jacket. For the production of prawn pulp, the whole prawn as such or after beheading, is charged in the drier and the drier is operated at slow r. p. m. at the begining and high at the end when the product gets dried and deshelled in one operation within 4-6 hours.

2. Direct Rotary Drier/Flame Drier

This type of drier is widely used all over the world for the continuous production of fish meal. It consists of a long steel shell having length about ten times the diameter depending on the drying time of the material and the shell is set with its axis slightly inclined to the horizon and is mounted on rollers. The drier is rotated at slow speed of about 1–3 r. p. m. by a drive mechanism. Material to be dried is fed at high end of the drier which travels towards the low end due to the rotation of the drier and the slope of the drier assisted by the longitudinal flights fixed inside the shell. The material comes in direct contact with the hot air passing through the shell countercurrent to the flow of material and intimate contact of material with the hot air takes place due to the agitation of material

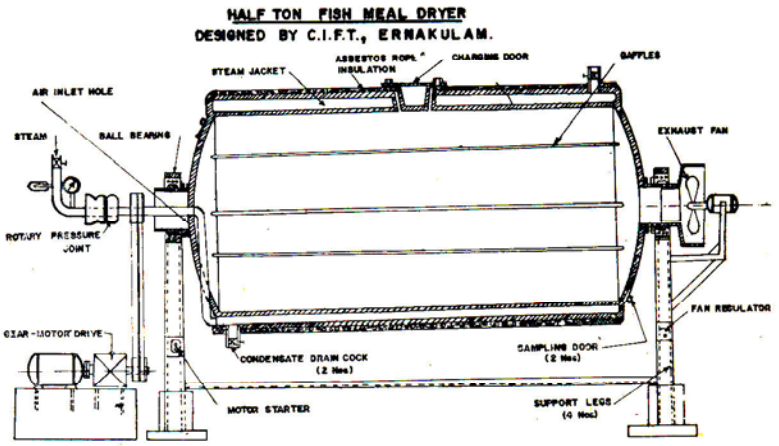


Fig. 8

by the baffles. High temperature air is generally used (flue gas of combustion of fuel) in this type of drier. Disadvantages of so called flame drier are the contamination of fish meal with products of combustion, blackening of colour of meal and thereby decreasing the quality of the meal. In some modern design, in order to remove this drawback, air is heated by passing through a bunch of finned tube steam heater at low end or products of combustion heat the finned tube heater in place of steam. The dried products from this type of drier is continuously collected from low end by a suitable mechanism. Part of fish meal which is carried away by the drying air is collected by a dust collector.

3. Indirect or Steam Tube Drier

This is more or less the same except the heating arrangement. Here, heat is supplied from steam jacket along the entire length of the shell or a row of steam tubes are fitted inside the full length of the shell. This has got the advantage of more heat transfer than the jacketted one. Material cannot come in contact with the products of combustion, and hence this type of drier gives a better quality product. In some design, both these principles are combined. In more recent fish meal plant, two driers are put in series, one for preliminary drying of pressed cake and the other for final drying, depending on moisture content. This type of rotary fish meal driers are already in operation in fish meal plants at Malpe, (Karnataka), Azhikode and Calicut (Kerala), Zafrabad (Gujarat) and Mandapam (Tamil Nadu).

In continuous fish meal plant of 1000 to 1500 tonnes capacity/day, the process of production of fish meal is somewhat different. Raw material is first disintegrated; cooked in a continuous cooker, pressed in continuous screw press to produce pressed cake which is again disintegrated and charged continuously at the high end of the flame drier where it is partly dried to 30–40% moisture level. At this stage, it is mixed with concentrated spent liquor recovered from screw press through another indirect drier. In this way high quality whole meal is produced without any difficulity. In some old plant, fish meal is produced without admixture of spent liquot which is of lower quality. Fish meal is generally dried to a moisture content of 10%, pulverised, packed and stored.

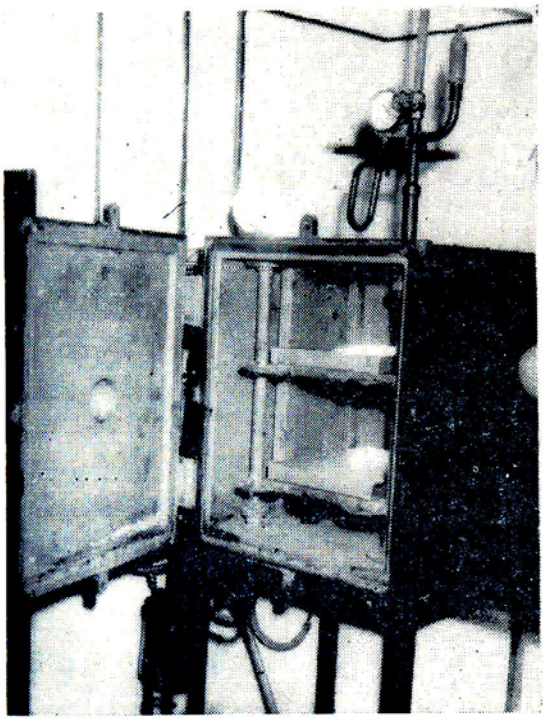
Vaccum Drier

This type of driers are generally used for drying fish at lower temperature by the application of vacuum and the evolved vapour is condensed in a condenser. Heat is applied by conduction or radiation from the steam heated plates.

1. Vacuum Shelf Drier

It consists of a cast iron or mild steel rectangular or cylindrical shell inside of which hollow shelves of steel plates are fitted. These shelves are filled with hot water/steam or hot oil at desired temperature. Raw material as described under hot air drying is spread on trays which are placed on these shelves. The chamber is closed and is connected to a vacuum pump via. a condenser and steam is passed at

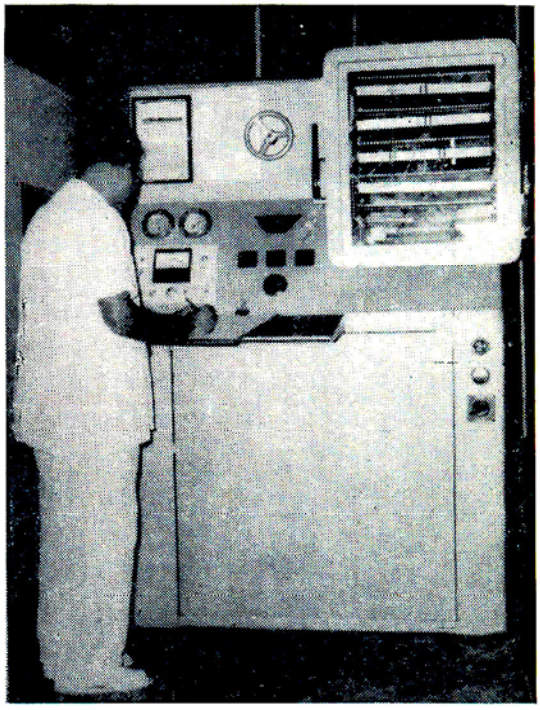
desired temperature inside the shelves which gradually heats up the material and water vapour is evolved at the existing vacuum. Generally, the drier is operated at 25–28" of mercury vacuum. The dried material is removed after removing the vacuum and packed in air tight container.



In vacuum drier, heat sensitive food constituents can be preserved which are otherwise destroyed by heat or oxygen and therefore, quality products can be obtained from such vacuum drier but the cost of production is rather high.

2. *Freeze drier*

This is a modification of vacuum shelf drier. By using high vacuum in the range of 4.7 to 1 mm Hg. and temperature below 0°C, it is possible to establish conditions of temperature and pressure whereby the physical state of food substances can be maintained at critical point for successful dehydration with marked improvement of quality. Under these conditions water molecules pass from solid state



to vapour phase directly without passing through liquid phase. The construction details of the drier are more or less the same as described under vacuum shelf drier except that high vacuum vessel and low temperature condenser using refrigeration are used. Heating may be done by radiation or conduction method.

In case of freeze drying, the thickness of material should not be more than 1 cm. After dressing and washing the raw material,

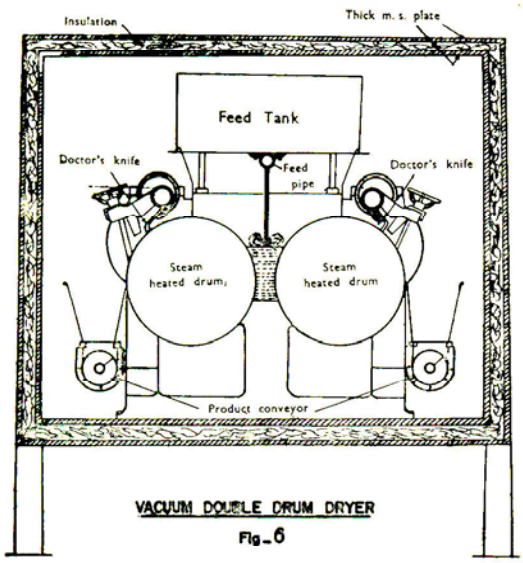
it is spread on trays in single layer and the material is frozen in quick freezer, the frozen fish is inserted in the drier and drier is operated as per operational instruction. Particular attention is paid to see that the material does not get thawed during drying. The material temperature is kept below -20°C and vacuum below 1 mm. of Hg. Generally, if takes about 8—10 hours to dry to 1–2% moisture level in the product. Vacuum chamber is broken by admitting inert gas (nitrogen) and product is packed in cans or suitable air tight container under nitrogen. In case of pre-cooked food, the procedure is somewhat same. Sometimes, if it is not possible to freeze in a freezer, the same can be done in the freeze drier itself by evaporative freezing method.

Freeze dried products have natural colour, flavour, rapid and complete rehydration potential, retain original shape and contain most of the nutrients of the original raw material, good storage life at ordinary temperature but the process is very costly. Ready to serve pre-prepared food can be well preserved by this method for defence personnel and are widely used in space fights. Freeze drying is perhaps the ultimate answer in food dehydration. Several types of freeze driers have been developed from time to time, each differing mainly in their heating arrangement of which accelerated freeze drier is the most efficient. A commercial freeze drying plant is in operation under Defence Ministry at Tundla near Agra.

3. *Vacuum Double Drum Drier*

This type of drier essentially consists of two metallic rolls of stainless steel having

smooth surfaces placed in contact and are rotated towards each other at slow speed by a suitable drive mechanism. These drums are housed inside a vacuum chamber and steam is passed inside these drums through rotary joints. Generally this type of drier is used for drying fish slurry like fish solubles, peptone, fish soup mix etc. Semi-liquid material is fed in the V shaped space between the rolls and as the drum rotate, a coating of material is automatically applied on them, thickness of which depends on the drum clearance. A scraper blade removes the dried material from the surface

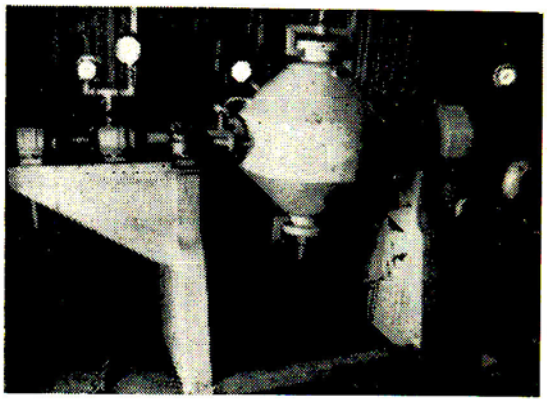


VACUUM DOUBLE DRUM DRYER
Fig.-6

before the drums start next rotation. Dried material may be collected on trays inside the chamber or conveyed by suitable mechanism without breaking vacuum. There are several modifications to this type of drier. Sometimes it is operated at atmospheric pressure also. There may be single, double or triple drums and feeding arrangement may be by spraying on the drums or by immersion in a pool of liquid. The solid content of feed should be 40—50% and the dried product may be obtained in the form of sheet or flakes which may be powdered if necessary.

4. *Rotocone Vacuum Drier*

This is a cone shaped vessel haying a small cylindrical portion and is mounted perpendicular to the axis of this compound vessel on hollow shafts. The vessel is fitted with two doors, steam jacket, vacuum cum steam connections through hollow shafts via rotary pressure joints and is rotated by suitable drive mechanism at medium



speed. This drier is mainly used for final drying and mixing of powder like F. P. C. (fish protein concentrate) and edible fish powder with other starchy ingradients. This drier has got the advantage of vacuum drying while the material is in a state of agitation which helps in removing last traces of moisture or solvent from semi-dried fish powder. ●