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PASTA PRODUCTION USING SCREW EXTRUDERS

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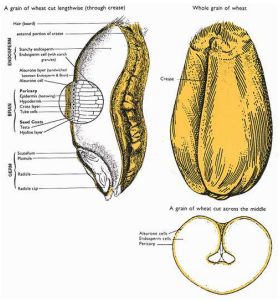
Pasta is a favorite food around the world: Italian spaghetti with meatballs, Asian curried noodles and good old American macaroni and cheese, just to name a few. Available in a multitude of shapes made from wheat, rice, corn, beans, and a host of lesser known grains and vegetables, this simple, basic food (flour and water is all that's required) has been a staple in almost every major cuisine for millennia.

The aim of pasta production is to convert the milled flour of the durum wheat into an edible product. Pasta is made from coarse flour called semolina. Semolina is composed of a collection of cells from the starchy endosperm of the wheat plant. These cells are composed of;

- Cell walls (bran)
- Starch (endosperm)
- Protein
- Enzymes



Structure of Wheat Grain

Pasta production includes Noodle, Macaroni and Spaghetti products. It was produced very early in Italy and most production was done manually, but it is only since 20th century that automatic machinery has been made available to produce such product in bulk capacities for uniform quality. Following products are just few examples of various pasta which is commonly consumed:

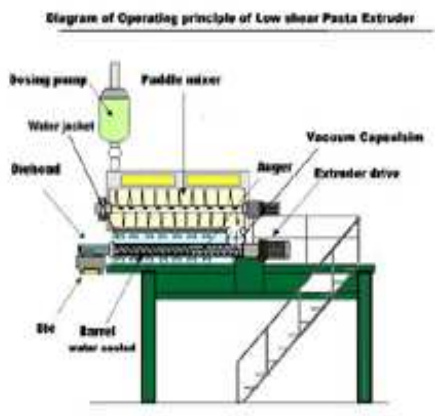
Basically, producing pasta involves three basic steps:

1) **Mixing.**
2) **Kneading & Extrusion.**
3) **Cutting.**
4) **Drying.**
5) **Cooling & Packing**.

Mixing:
The mixing stage will mix the semolina flour with desired proportion of moisture (water) properly and evenly. It is important that water is sprayed evenly over the semolina so that the proteins and starch in semolina absorb water uniformly and form a soft, crumb structure with no lumps.

The Pre mixer for mixing the semolina with water is a double/single shaft paddle mixer to mix the semolina flour (milled durum wheat) and water (optional ingredients like egg, or other flour in small amounts like rice, bran may also be added along with salt, etc.). The water is continuously added in the mixer in required proportion via the dosing pump and injection nozzles. It is important to use only pure, drinking water with low bacterial count, since the processing is not at very high temperature inside the extruder. Moisture can be added upto 30% on wet basis. The Pre mixer discharges into Vacuum Mixer which is also a paddle mixer with "Capsulsim" which provides vacuum in the chamber to remove any entrapped air bubble in the hydrated flour. This is important since any air present in the raw-materials will eventually appear as bubble inside the extruded product giving it a "chalky" or whitish appearance and a weak product.

Kneading & Extrusion:
The raw-materials then fall inside Single screw Low shear Extruder which continuously pushes & compacts (compress) the pre-mixed materials at low temperature < 50 deg. C along with suitably shaped die opening (shape could be round, rectangular or tubular or any other decided by die orifice). In the Extruder, the particles of premixed raw-materials are fused together due to compaction and kneading and it results in formation of homogenous plastic mass. A pasta Extruder technically falls under LSHT (**L**ow **S**hear **H**igh Residence **T**ime). It means, the Extruder develops less shear required for extrusion, to prevent excess temperature rise, but greater residence time in the barrel to provide adequeate mixing and temperature control of dough. Inside the extruder, due to mechanically working of raw-materials by the action of rotating helical screw, products are partially cooked due to mechanical frictional heat and it is important to limit this temperature rise, otherwise it results in sticky/gummy product..



Principle of Pasta Production with Single screw Extruder.

Pasta Extruder or Press

Inside the Extruder, the material is compacted, compressed as it moves forward towards the die. This occurs because the material is picked by rotating screw inside a stationery barrel which has grooves on its internal surface. The grooves enables the sticky, plastic mass to move forward and mix thoroughly under controlled shear and temperature. The auger screw has helical grooves cut on its surface which thoroughly mix, knead as well as transport the material forward. The screw flights are deep so that shear is minimal and the rotational speed is also low which minimizes friction and temperature rise. The processing temperature is not allowed to exceed > 50 degree Centigrade for preserving the taste and quality of product. The temperature tends to rise inside the machine due to mechanical working of material inside the extruder, but cooling jackets which are placed around the barrel constantly circulate cool water to remove the extra heat from the material. The extruder is fitted with vertically downward die head unit having Teflon (for smooth extrusion) die inserts of suitable shape through which the extrudate emerges continuously, vertically downward. It can be round, oval, tubular rectangular or spiral shape. While deciding for choice between two available materials for die inserts, it should be borne in mind, that, brass or bronze inserts with their relative rough surface ideally produce porous or "rough" pasta to which sauces are adhered readily which is appreciated and good to consume. As against this, Teflon dies tend to have too smooth surface and produce slippery pasta with too smooth surface and sauces do not adhere easily to such product.
As the product emerges out of die openings, it is cut into small lengths by rotating knives working against the die face. The length of pasta depends on the no. of knives as well as the speed of their rotation, since fast rotating knives produce short length of product and vice-versa.
The cutting apparatus is modified to produce long lengths of pasta or "long goods" as they are commonly called.
3D shapes have become common now with many producers. Such shapes are produced by special rotary roll cutters which have required shape embossed as 3d figure on periphery and which accept flat sheet product from the Extruder

Drying:
The cut pasta (also termed as "short goods" because it is cut into short lengths), which still has excess moisture, is then passed through Pre-dryer which removes some moisture making the product tough for subsequent handling, as well as to prevent sticking in the main drier further. The Pre-dryer is also called Shaker-Dryer because it constantly shakes the product and moves it further in heated air to remove some moisture.

Main Dryer for drying pasta

In the Main Drier, the product is dried under controlled humidity so that drying is neither too slow or too fast. Too slow drying of product will damage the product as the product is rendered sticky or moldy. Too fast drying will crack the pasta. It might be necessary to ascertain and control different drying times for different product to get optimal results. Drier is continuously fed from the Pre-Drier, and has multiple steel belts, usually from 3-5 belts (passes) are used which moves the wet product from top to bottom of the Drier in controlled temperature and humidity to remove the excess moisture from the wet product. Pasta producing plants use long. A properly extruded and dried pasta product would be firm, but flexible enough to be bent to considerable degree before cracking. In general, product retains about 10% moisture after drying.

Cooling & Packing:
Before packing, it might be essential to cool the pasta coming out from the Main Dryer. This is generally done by belt conveyors and cooling fans to remove the excess heat before final packing. Ideally, pasta should have no more than 10% moisture before packing to prevent mould growth.

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