Mixing

There are 3 processed involved in the mixing of pasta. Mixing, kneading and extruding are the 3 essential parts of the mixing of the pasta (1). During the mixing stage, water must be added to the semolina flour so that the moisture content reached approximately 30% (1). The flows of the inputs into the mixer are regulated by one of two types of dosers (volumetric or gravimetric),which have precise and constant outputs that are measured by the dosers.

The semolina flour absorbs the water until it forms a homogenous mixture. If yellow pasta is desired, then whole egg can also be added to the dough mixture (3).The importance of the homogeneity of the mixture is so that there are no imperfections in the final, dried product like white spots. To ensure that the semolina flour particles absorbs the water equally, the flour is sifted, often by a 0180mm mesh sleeve, so that a maximum of 25% of the particles pass through the mesh sleeve.

The temperature of the water used is dependant on the type of the pasta and its shape, so 40-65 degree Celsius water is generally used. For spaghetti, which is a long pasta, the dough which has homogenously absorbed the water will be mixed in a twin shaft mixing chamber for 16-18 minutes. To ensure that the dough does not ball up, each of the shafts will turn in opposite directions. This type of movement is non-centric which will ensure that the dough does not form a ball.

Many modern pasta mixture plants have moved from using the traditional dual shaft mixers to using a new type of continuous pasta-press technology. The Bühler Brothers, in Switzerland, engineered the press in 1934 (2). Using a press reduces the mixing time from 16-18 minutes to about 2-3 minutes, which reflects the other durations of the pre-drying and drying pasta production cycles. The continuous pasta press is capable of producing 3500kg/h of spaghetti and up to 8000 kg/h of macaroni (5).

While the pasta is in the mixing process there are several things to consider. One of the most important aspects to consider while mixing is determining an adequate speed to ensure that the mixture has achieved particle suspension (6 – P205). $N_{js} = Sv^{0.1}\ d_p^{0.2}\ (g\Delta p/pL)^{0.45}\ D^{-0.85}\ X^{0.13}$ (6 – P205). Where “s” is for shape factor which is a dimensionless value that accounts for shape of mixer, type of paddle, distance from paddle to outside of mixer and paddle to tank ratio. “d_p” refers to particle diameter, “D” is a value for the paddle diameter. “p_L” refers to liquid density, “g” is the constant for gravitational acceleration, “Δp” is the solid-liquid density difference . “X” is the solid concentration by weight (X100) and “v” refers to the liquid kinematic viscosity (6 – P205).

Another important aspect to consider is the energy balance around the mixer. All energy from the energy inputs to determining the final temperature of the pasta dough can be determined and adjusted by using the energy balance equation (7).

$\sum_{\text{Ingredients}} M_i \cdot \Delta h_i = M_{flour} \cdot \Delta h_w + M \cdot E_m - Q_j$ where Δh_w=15.1kj/kg(7 #12.1,12.2)

Where "Mi" is the mass of the ingredients and "Δhi" is the change in enthalpy of the ingredients. "M_{flour}" is the mass of the flour, Δh_w is the heat of flour wetting, "M" is the mass of the dough, "E_m" is the energy input per unit mass and "O_j" is the heat transferred through the mixers exterior (7).

The semolina and water is mixed in the pre-mixer until the dough is adequately hydrated, this mixture is then passed onto the mixer which is used with a vacuum to remove air bubbles from the dough, during the initial mixing process (5). The adequate hydration of the dough makes it so the gluten/protein matrix can develop within the pasta once it is at the extrusion stage of production as it does not occur during the mixing stage (5). Once in the mixer warm water is added to the dough to bring the moisture content of the dough to 28-32% (5). For this type of mixer, it is necessary to use finely granulated semolina flour. The press technology makes use of vacuum equipment to remove any small air bubbles within the pasta dough, because air bubbles can result in a pale and unattractive pasta and can weaken the dried product. While the conventional dual shaft mixer uses the length of time and magnitude of mixing to remove the air bubbles from the dough. After the mixing stage the pasta is fed to the extruder after, in some cases, being given time to rest on a "stabilization belt" which feeds the pasts to the extruder (4).

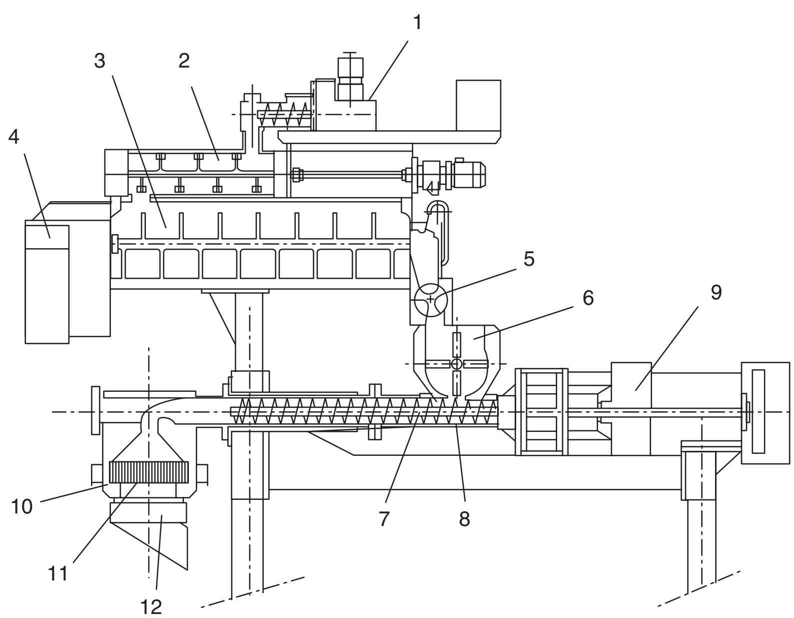

Figure 3 Layout of a modern continuous press: (1) doser; (2) premixer; (3) mixer; (4) control gear box for mixers; (5) capsulism device; (6) vacuum mixer; (7) extrusion worm; (8) cylinder; (9) worm control gear box; (10) extrusion head; (11) die; and (12) cutter. (Reproduced with permission from Kruger JE, Matsuo RB, and Dick JW (eds.) (1996) *Pasta and Noodle Technology*, p. 15. St. Paul, MN: American Association of Cereal Chemists.)

(8)


8000Kg/H pasta press (4)


Close up of pasta press(4)

(1)http://www.sciencedirect.com.login.ezproxy.library.ualberta.ca/science?_ob=ArticleURL&_udi=B782R-4B4YJ1Y-VY&_user=1067472&_coverDate=12%2F03%2F2003&_alid=1217306361&_rdoc=1&_fmt=high&_orig=search&_cdi=15117&_sort=r&_docanchor=&view=c&_ct=6&_acct=C000051251&_version=1&_urlVersion=0&_userid=1067472&md5=3c41e38920681aeff11d32b38357622c
(2) Owens, G. (2001). Cereals Processing Technology. (pp: 110-127). Woodhead Publishing.
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(3) Ranken, M.D.; Kill, R.C.; Baker, C.G.J. Food Industries Manual (24th Edition).. Springer - Verlag.
Online version available at:
http://knovel.com.login.ezproxy.library.ualberta.ca/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=943&VerticalID=0
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(4) http://www.foodprocessing-technology.com/projects/aipc/
(5) http://www.ag.ndsu.nodak.edu/plantsci/breeding/durum/pasta_products.htm
(6) Cullen, P.J. Food Mixing: Principles and Applications. Iowa: Blackwell Publishing Ltd, 2009. Print.

(7) Levine, Leon., and Boehmer, Ed. “Dough Processing Systems.” Handbook of Food Engineering. Ed. Kenneth J. Valentas , R. Paul Singh , and Enrique Rotstein. CRC Press, 1997. <http://www.crcnetbase.com.login.ezproxy.library.ualberta.ca/doi/abs/10.1201/9781420049077.ch12?prevSearch=%2528%255Bfulltext%253A%2BDough%2BProcessing%2BSystems%255D%2529%2BAND%2B%255Bpublisher%253A%2Bcrc%255D%2BAND%2B%255Blanguage%253A%2Ben%255D%2BAND%2B%255BpubType%253A%2B109%255D&searchHistoryKey=>

(8)<http://www.sciencedirect.com.login.ezproxy.library.ualberta.ca/science?_ob=MiamiImageURL&_imagekey=B7GGJ-4DP5M0M-G-F&_cdi=20152&_user=1067472&_pii=B0127654909001233&_check=y&_orig=search&_coverDate=11%2F01%2F2004&view=c&wchp=dGLbVzz-zSkWz&md5=57222ea9bd987deb4e41cb4b075ba5dc&ie=/sdarticle.pdf>