

# Ekstrusi & Produk Pangan Esktrudat

Program Studi Teknologi Pangan  
Fakultas Teknik  
Universitas PGRI Semarang

# Contoh Produk Ekstrusi yang Dijumpai di Pasar

## Sereal Sarapan



# Contoh Produk Ekstrusi yang Dijumpai di Pasar

## Produk Pasta





# Contoh Produk Ekstrusi yang Dijumpai di Pasar

Produk Makanan Ringan yang Mengembang  
*Expanded Snack*



# Contoh Produk Ekstrusi yang Dijumpai di Pasar

Produk Makanan Ternak (pakan)



# SELAIN ITU?

## Aplikasi pada produk pangan (dan pakan)

- Makanan ringan, sereal sarapan
- pasta
- pakan
- Produk sosis
- Protein : suplemen, daging tiruan (*meat analogs*)
- *breeding*

# EKSTRUSI

- Arti kata (Yunani) : mendorong keluar (*push out*).
- Sistem pompa yang secara kontinu memasukan, mencampurkan, mengaduk, (**kadang-kadang memasak**), dan akhirnya memaksakan mendorong keluar melalui alat pembentuk tertentu.
- Pertama digunakan pada tahun 1930-an untuk proses pengolahan plastik.
- Proses ekstrusi pangan pertama : 1935 (pasta).

# EKSTRUSI

## PERUBAHAN PENTING SELAMA PRODUKSI EKSTRUDAT

- Peranan Karbohidrat
  - Gelatinisasi pati
    - Input energi (panas) dan air → granula pati membesar ukurannya (*swelling*) → amilosa mulai mengalami difusi keluar → struktur granula pecah → molekul amilosa dan amilopektin terlepas keluar granula.
    - Amilosa dan amilopektin bebas ini akan membentuk suatu jaringan (matriks) yang kental yang dinyatakan dengan meningkatnya kekentalan.



# EKSTRUSI

## PERUBAHAN PENTING SELAMA PRODUKSI EKSTRUDAT

- Peranan Karbohidrat
  - Gelatinisasi pati
    - Peningkatan daya cerna pati produk ekstrudat
    - Membentuk matriks khas
      - → daya kembang produk ekstrudat.
      - → sifat menahan gas dan ekstensibilitas / elastisitas.

# EKSTRUSI

## PERUBAHAN PENTING SELAMA PRODUKSI EKSTRUDAT

- Peranan protein
  - Denaturasi Protein
  - Mempengaruhi elastisitas dan daya tahan gas matriks,
    - rasio pengembangan pada proses ekstrus
    - terlalu banyak protein?
      - tekstur renyah berkurang.
      - denaturasi protein → matriks terlalu elastis dan teksturnya menjadi chewy.

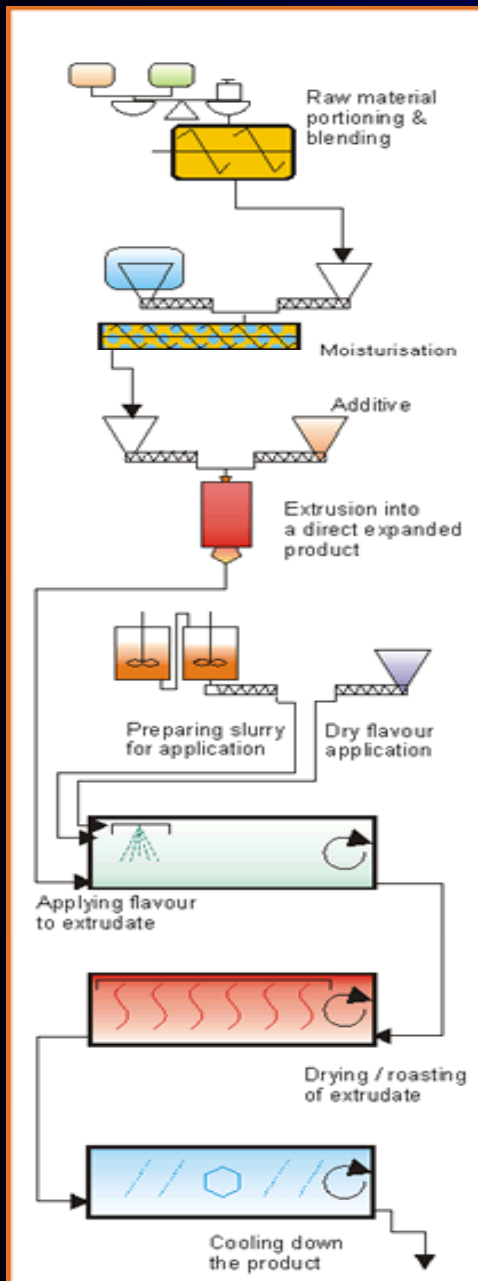
# EKSTRUSI

## PERUBAHAN PENTING SELAMA PRODUKSI EKSTRUDAT

- Peranan Lemak
  - berpengaruh pada mutu produk ekstrudat → berpengaruh pada proses gelatinisasi pati.
  - Lemak : meningkatkan suhu gelatinisasi pati.
  - Pada kondisi proses ekstrusi tertentu : menurunkan rasio pengembangan.
  - Karena itulah : penambahan lemak / minyak untuk citarasa dilakukan setelah proses ekstrusi (dimana minyak / lemak digunakan sebagai medium / pembawa komponen flavor atau citarasa).

# Tipikal Sistem Ekstrusi

1. Pra-ekstrusi
2. Ekstrusi
3. Pasca ekstrusi



# Sistem Pra-ekstrusi

- Mutu produk ekstrusi sangat dipengaruhi oleh mutu bahan mentahnya.
- Umumnya perlu dilakukan pencampuran (*blending*) dan penambahan air (*moisturizing*).



# Sistem Pra-ekstrusi

## Pencampuran (Blending)

- Formula (resep) untuk suatu produk ekstrusi umumnya terdiri dari berbagai macam bahan mentah.
- Umumnya, bahan mentah yang digunakan dalam bentuk meniran (grit), dan bisa juga dalam bentuk tepung.
- Pencampuran bahan mentah secara baik, terutama jika terdaat komponen minor, merupakan prasyarat proses dan produk ekstrusi.
- Tipe pencampur umum : *Ribbon blender type of horizontal mixers.*

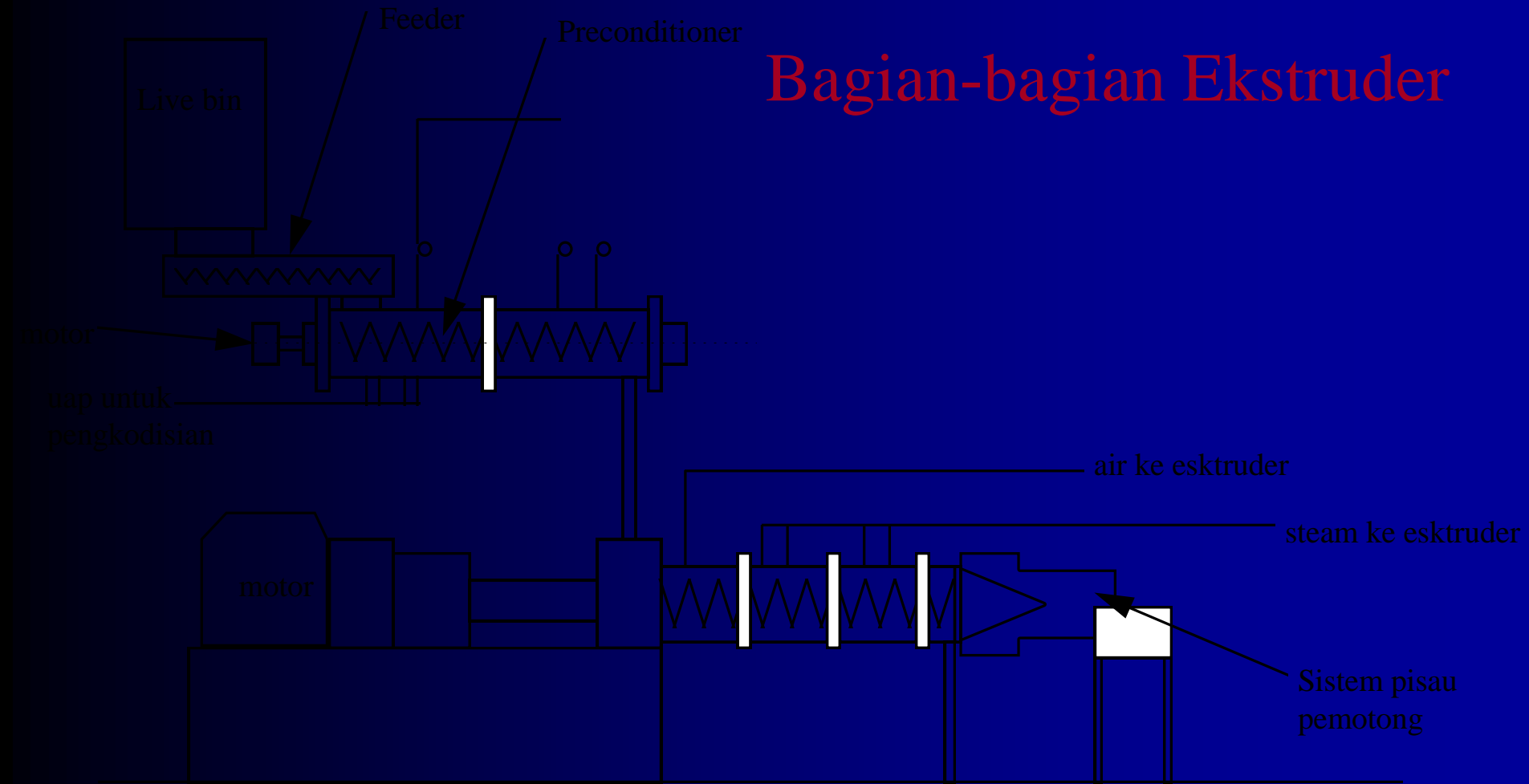
# Sistem Pra-ekstrusi

## **Penambahan (pengaturan) kadar air (*moisturizing*)**

- Kisaran kadar air bahan yang akan diekstrusi umumnya berkisar antara 4% - 8%, tergantung dari jenis bahan, dan karakteristik produk yang diinginkan.
- Pengaturan kadar air : memastikan distribusi air yang seragam.
- Kadar air yang tidak seragam → inkonsistensi kondisi ekstrusi → inkonsistensi produk yang dihasilkan.

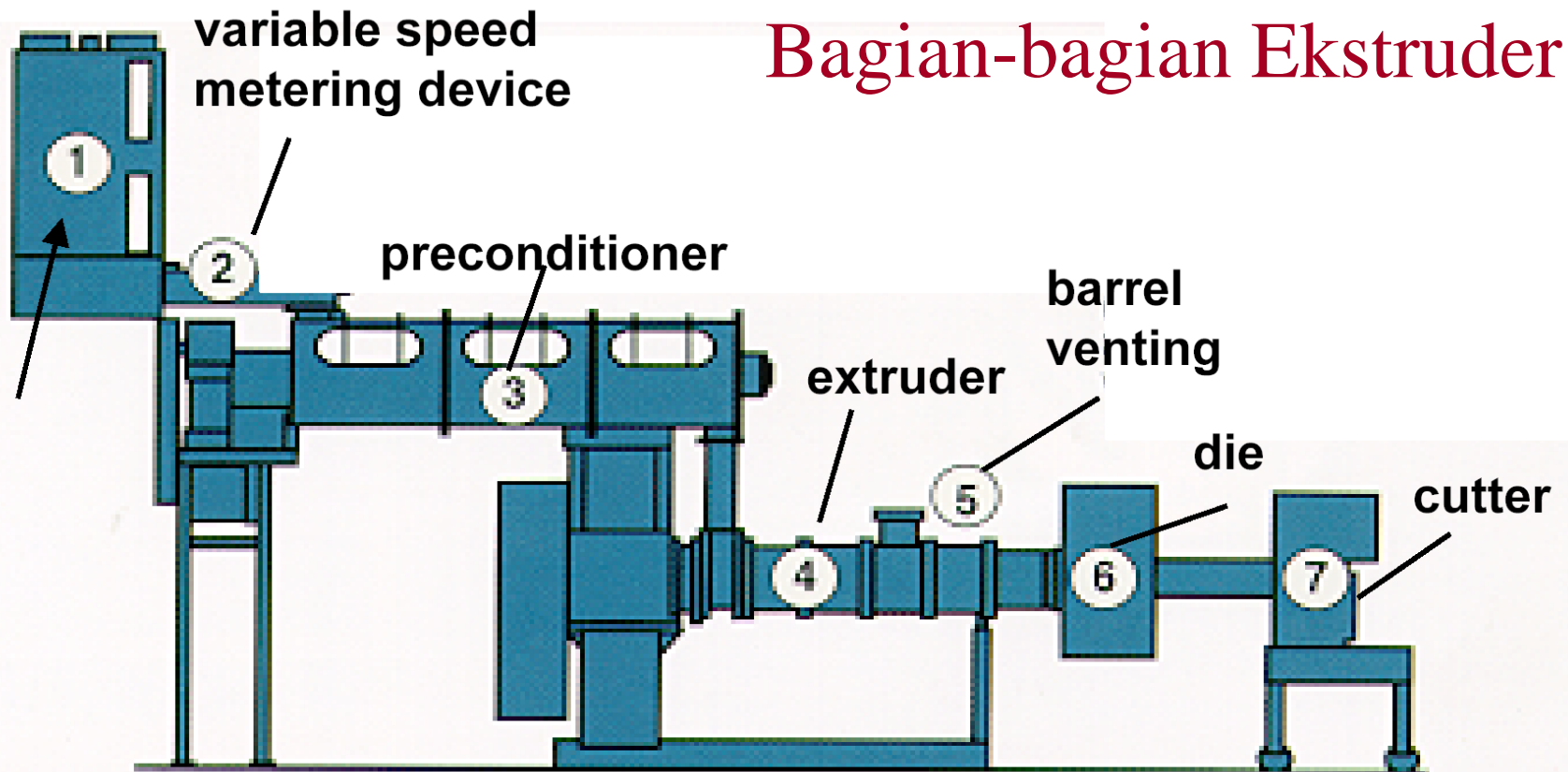
# Sistem Ekstrusi

## Bagian-bagian Ekstruder



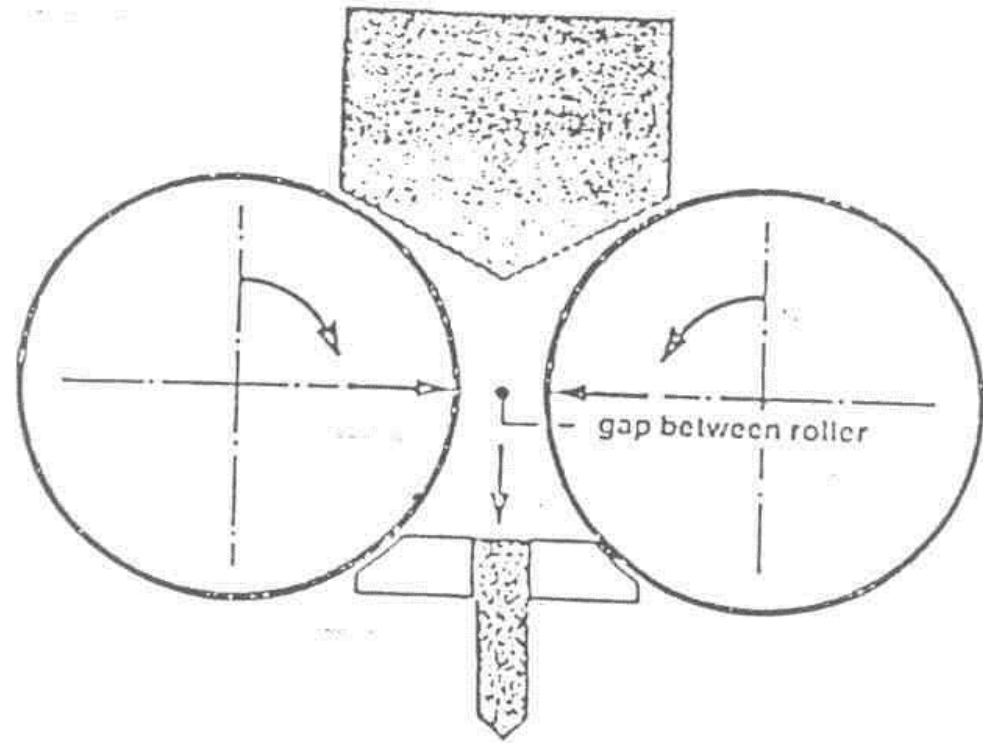
# Sistem Ekstrusi

## Bagian-bagian Ekstruder



# Sistem Ekstrusi

## Jenis-Jenis Extruder

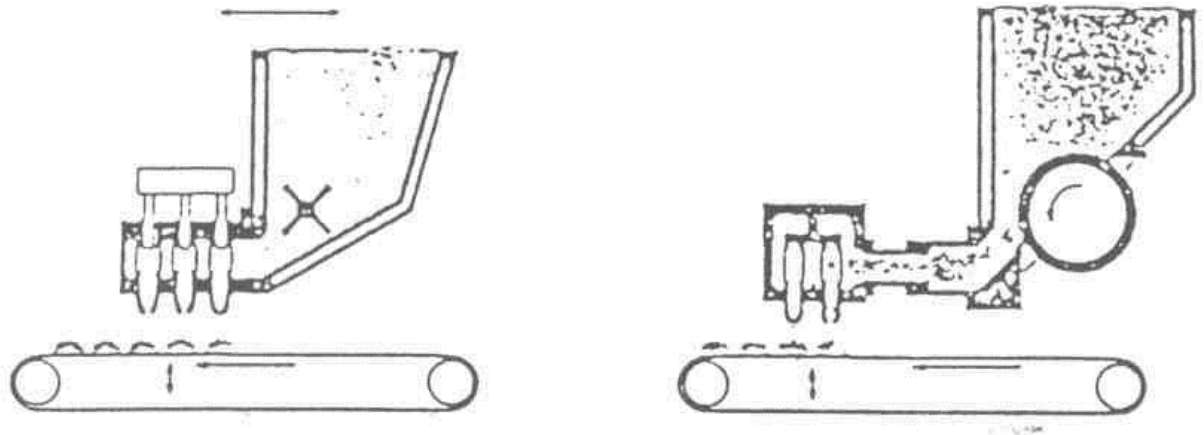


Tipe Roller



# Sistem Ekstrusi

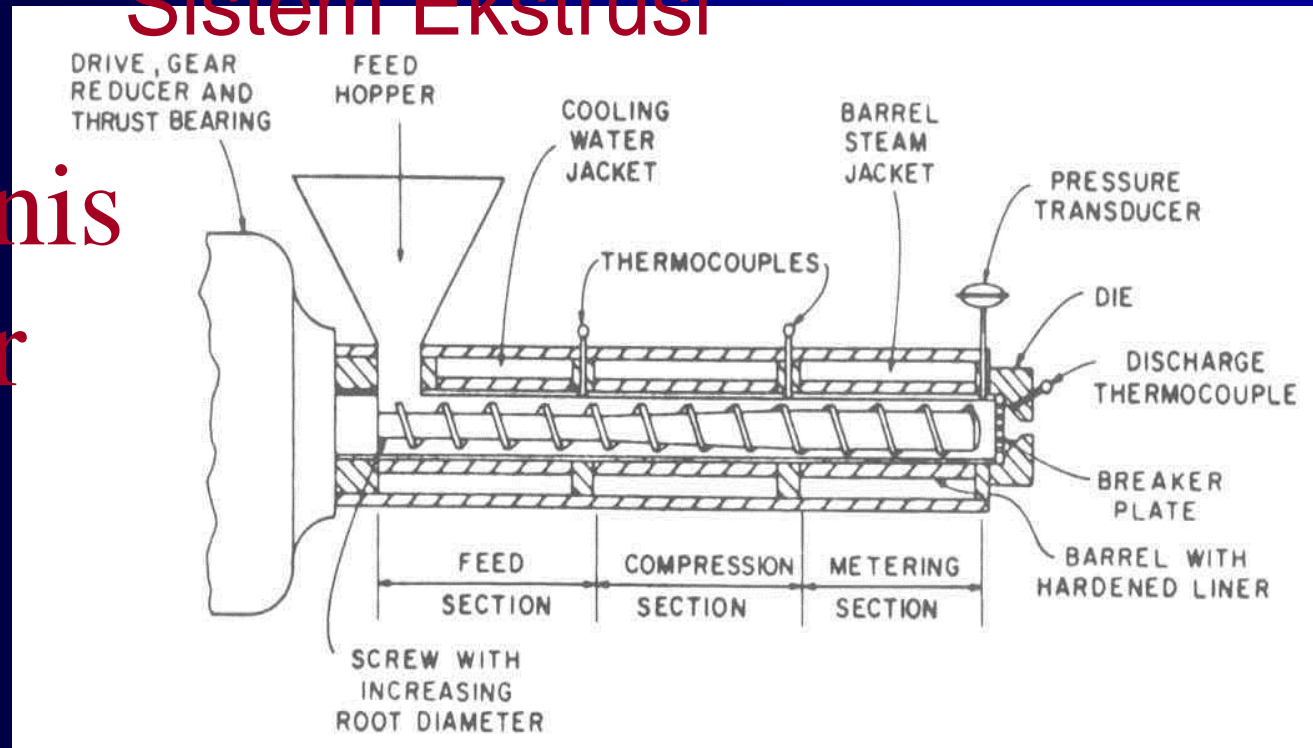
## Jenis-Jenis Extruder



Tipe Piston

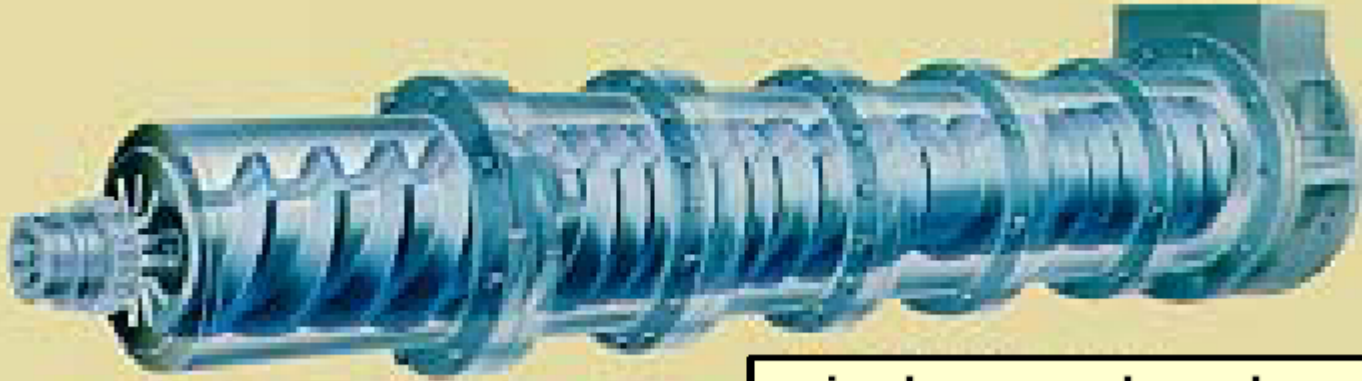
# Sistem Ekstrusi

## Jenis-Jenis Extruder

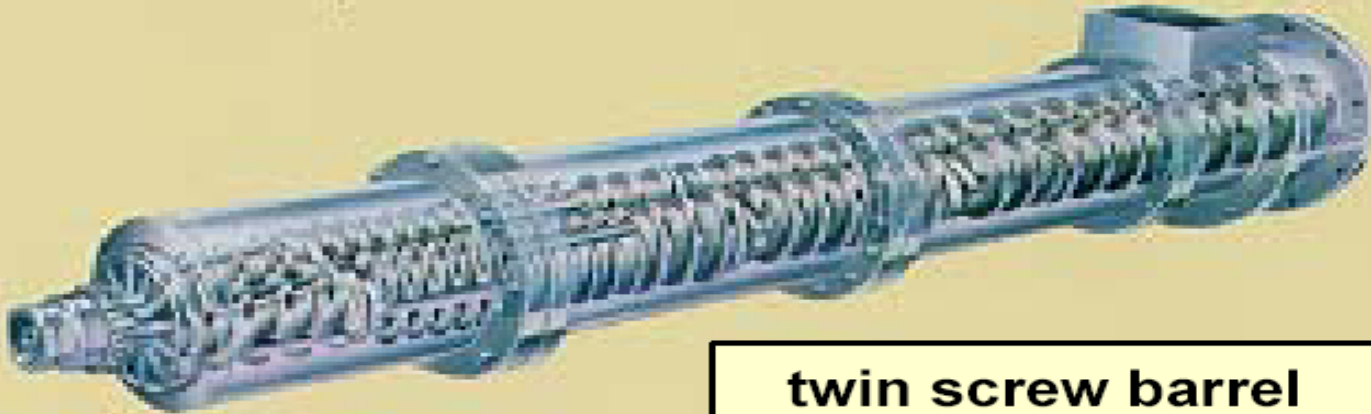


Tipe Ulir

# Jenis-Jenis Ekstruder Ulir



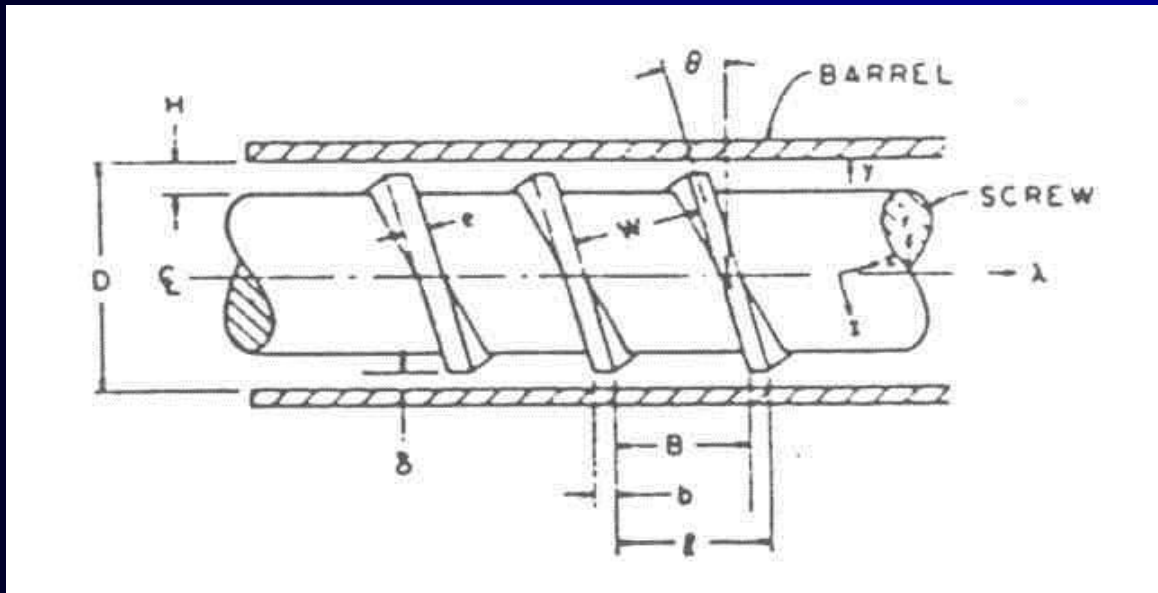
single screw barrel



twin screw barrel

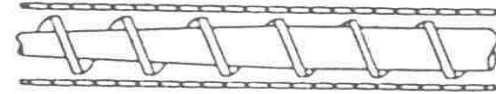
# Jenis-Jenis Ekstruder Ulir

- Ulir Tunggal (*Single screw*)
  - Paling umum
  - Ulir berputar dalam barel (silinder) yang akan memberikan aksi pemompaan.

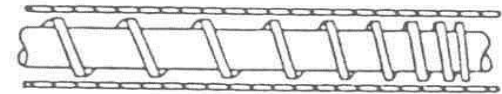


# Jenis-Jenis Ekstruder Ulir

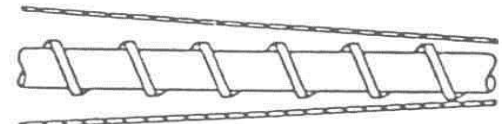
- Ulir Tunggal (*Single screw*)



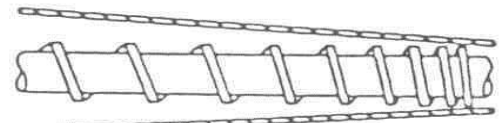
1. INCREASING ROOT DIAMETER



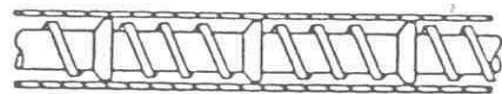
2. DECREASING PITCH, CONSTANT ROOT DIAMETER



3. CONSTANT ROOT DIAMETER SCREW IN BARREL WITH DECREASING DIAMETER



4. CONSTANT ROOT DIAMETER, DECREASING PITCH SCREW IN BARREL WITH DECREASING DIAMETER



5. CONSTANT ROOT DIAMETER, CONSTANT PITCH SCREW WITH RESTRICTIONS IN CONSTANT DIAMETER BARREL

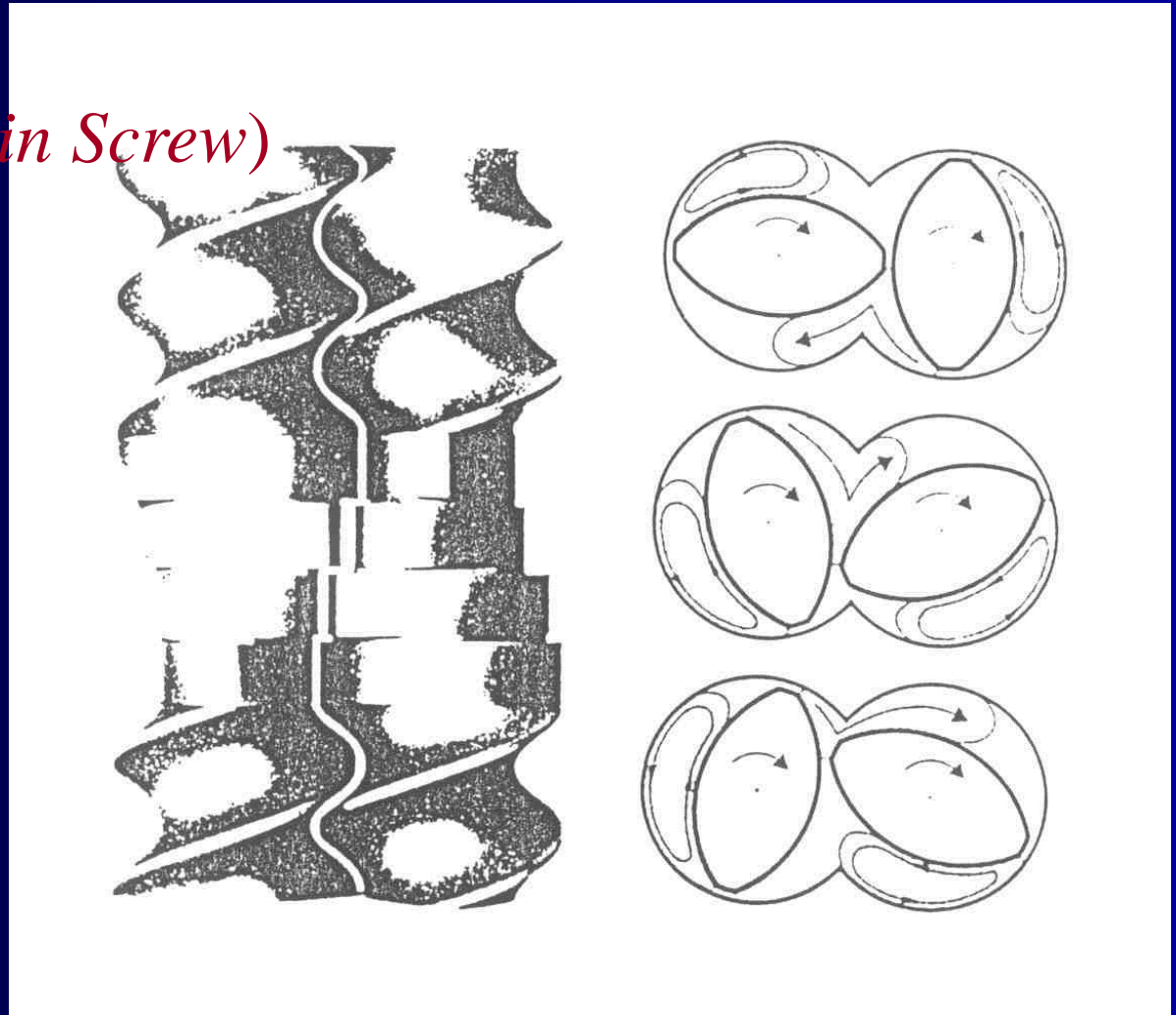


# Jenis-Jenis Ekstruder Ulir

- Ulir Ganda (*Twin Screw*)
  - Ulir ganda mempunyai aksi pompa positif lebih baik
  - Kapasitas lebih besar
  - *Co-Rotating Twin Screw Extruders*
  - *Counter- rotating Twin Screw Extruders*

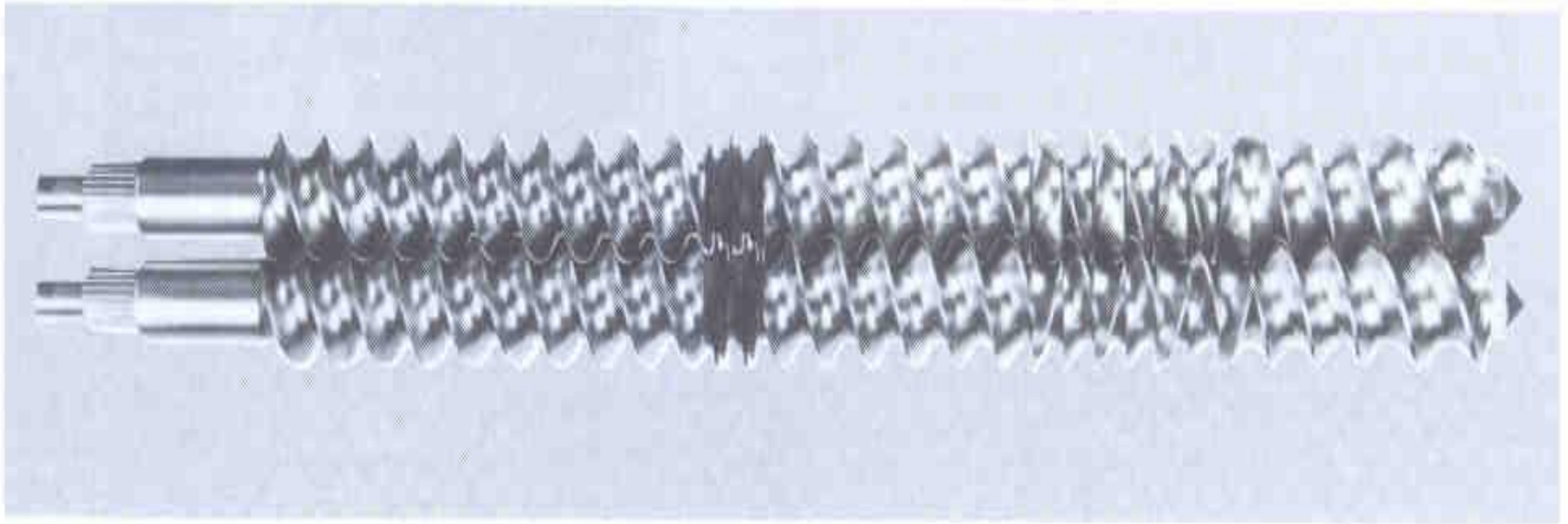
# Jenis-Jenis Ekstruder Ulir

- Ulir Ganda (*Twin Screw*)



# Jenis-Jenis Ekstruder Ulir

- Ulir Ganda (*Twin Screw*)

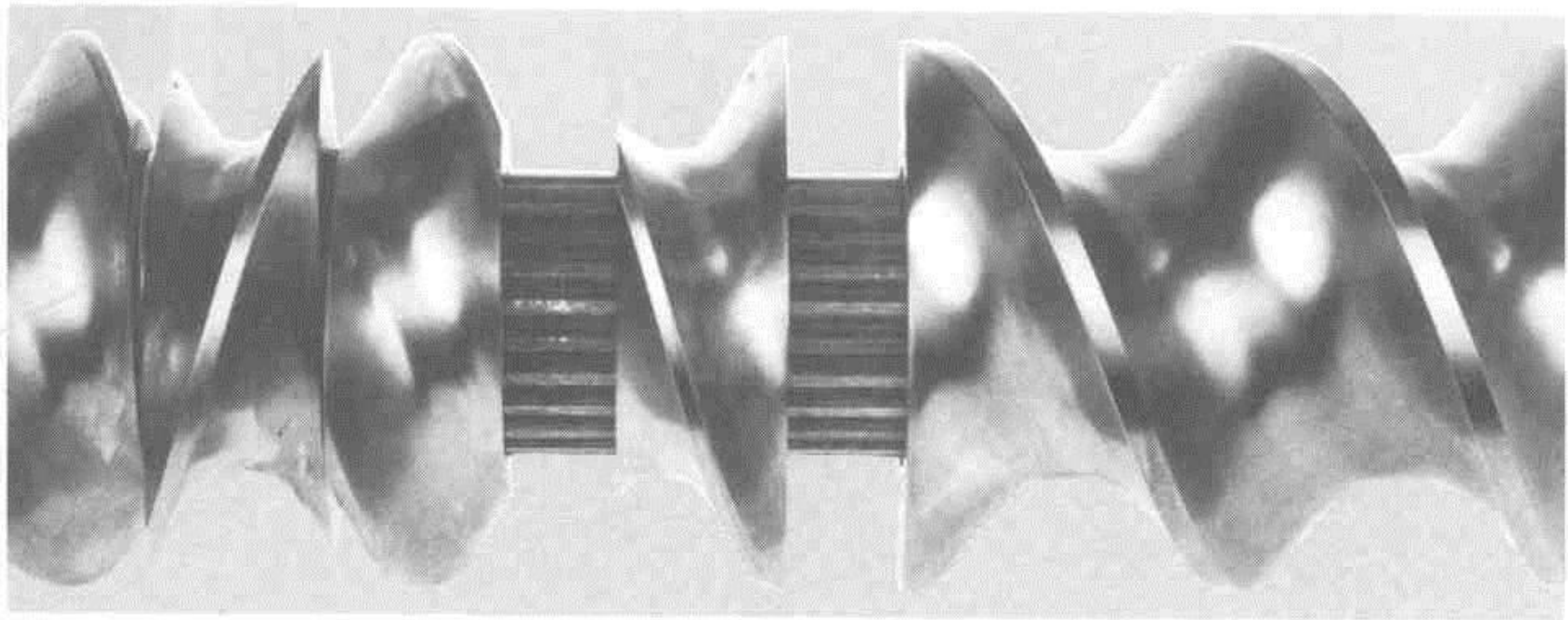


*Spline shaft with screw elements*

77935

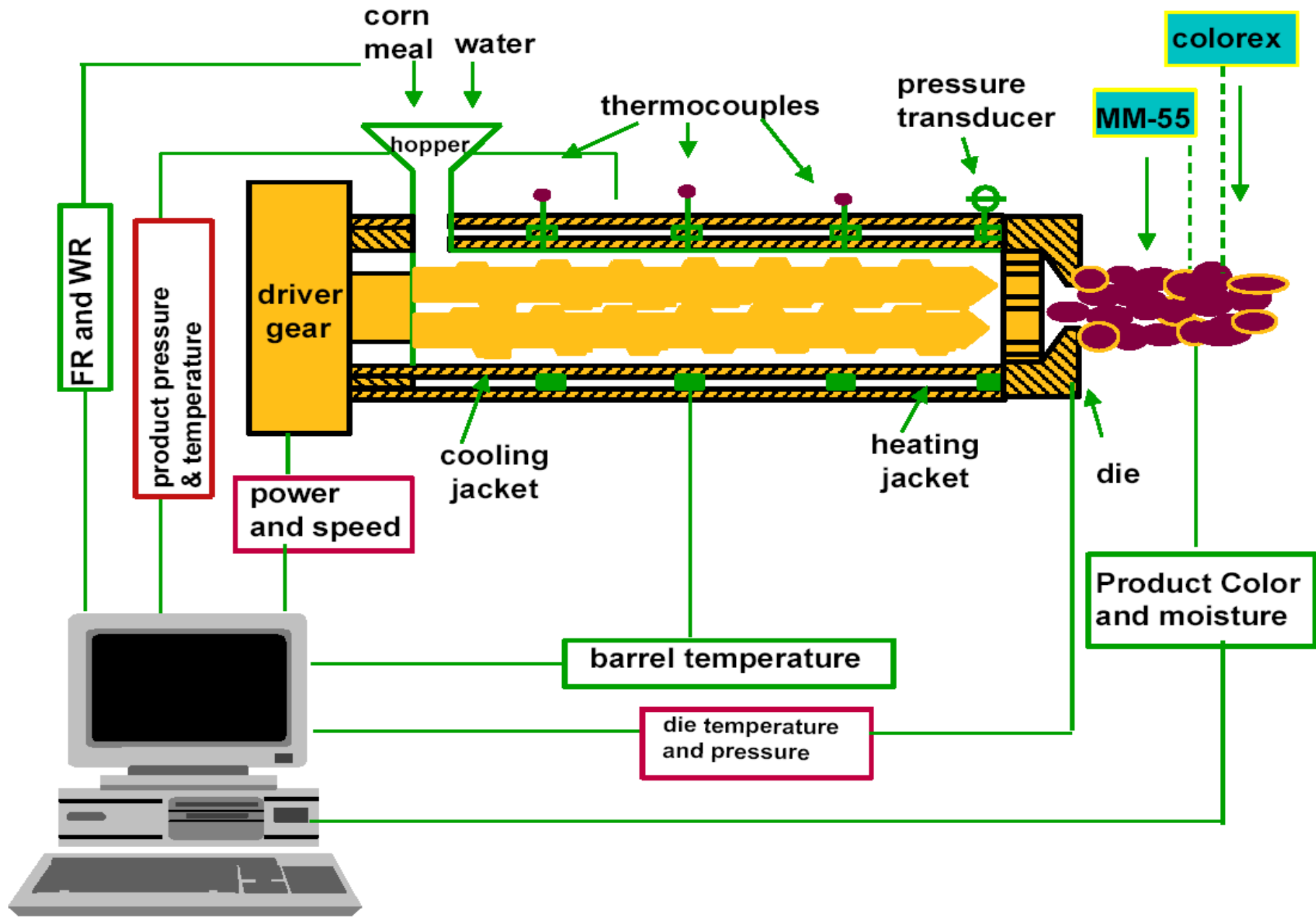
# Jenis-Jenis Ekstruder Ulir

- Ulir Ganda (*Twin Screw*)



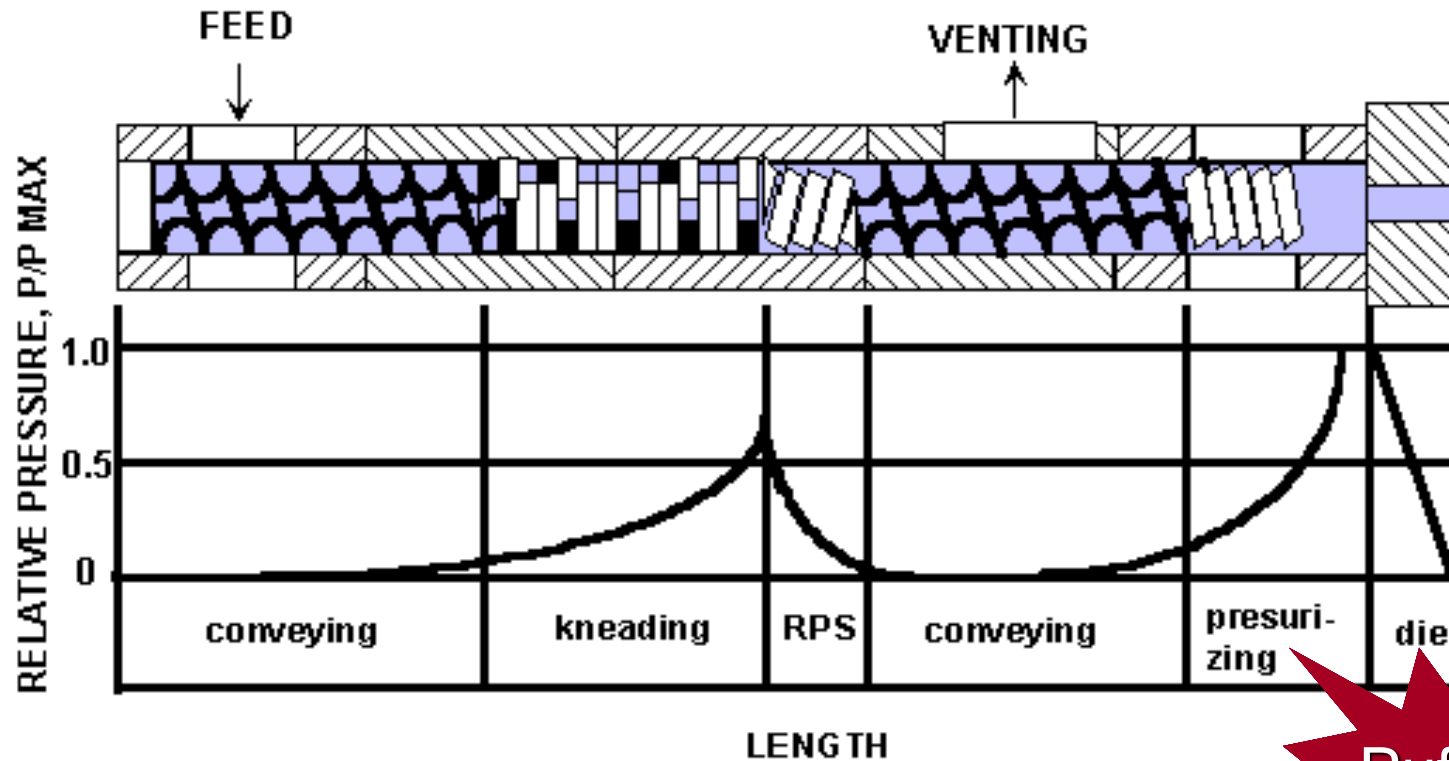
Spline shaft with screw elements

77937-5





# Screw & Pressure Profile

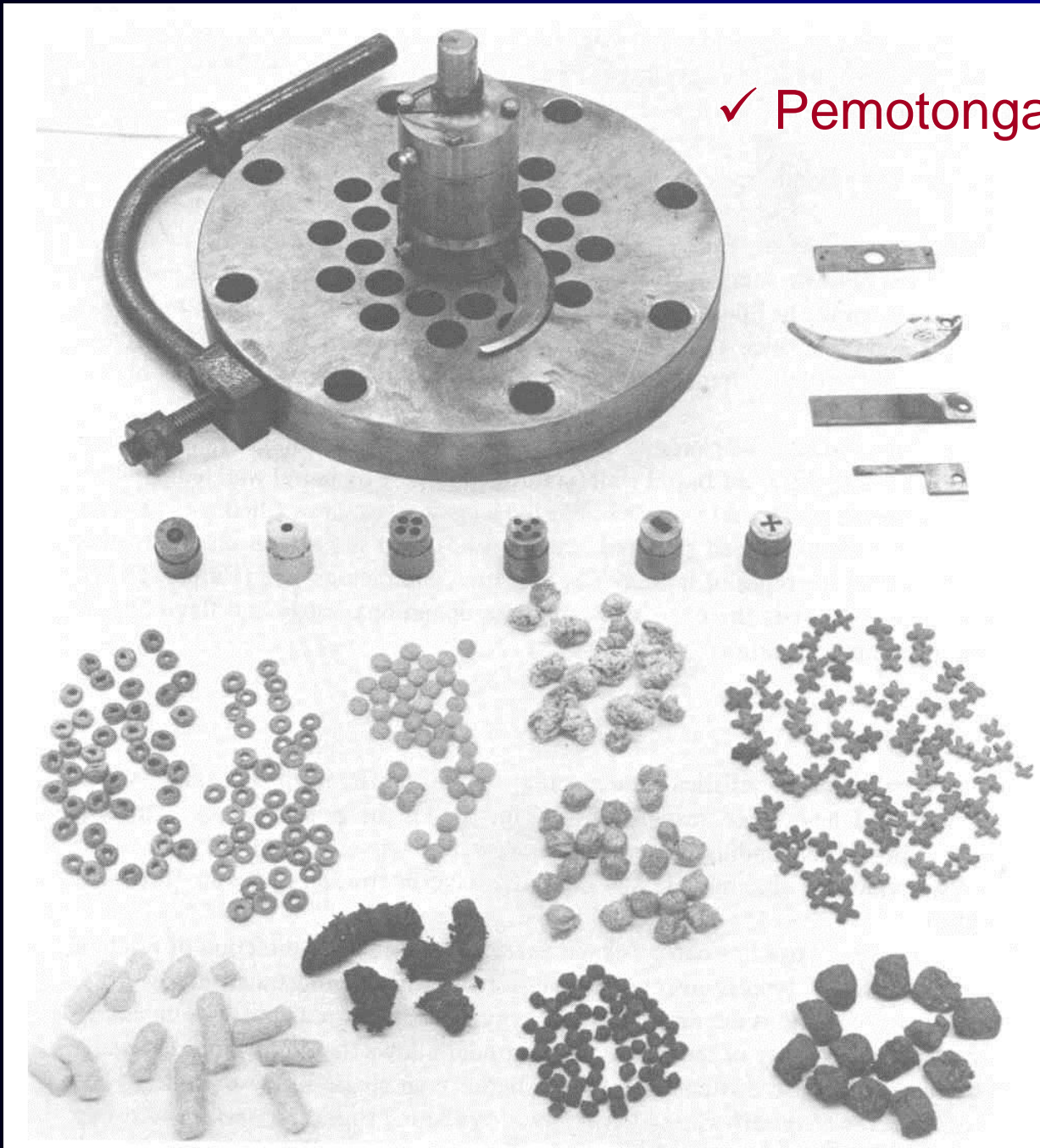


Puffing

# Sistem pasca-ekstrusi

- Hasil dari proses ekstrusi = ekstrudat (*extrudate*)
- Belum merupakan produk akhir
- Masih memerlukan pengolahan lanjut, pasca ekstrusi; yaitu :
  - ✓ Pemotongan / pembentukan
  - ✓ pengeringan
  - ✓ penambahan flavor (flavoring)
  - ✓ pendinginan
  - ✓ pengemasan

✓ Pemotongan / pembentukan



✓ Pemotongan / pembentukan

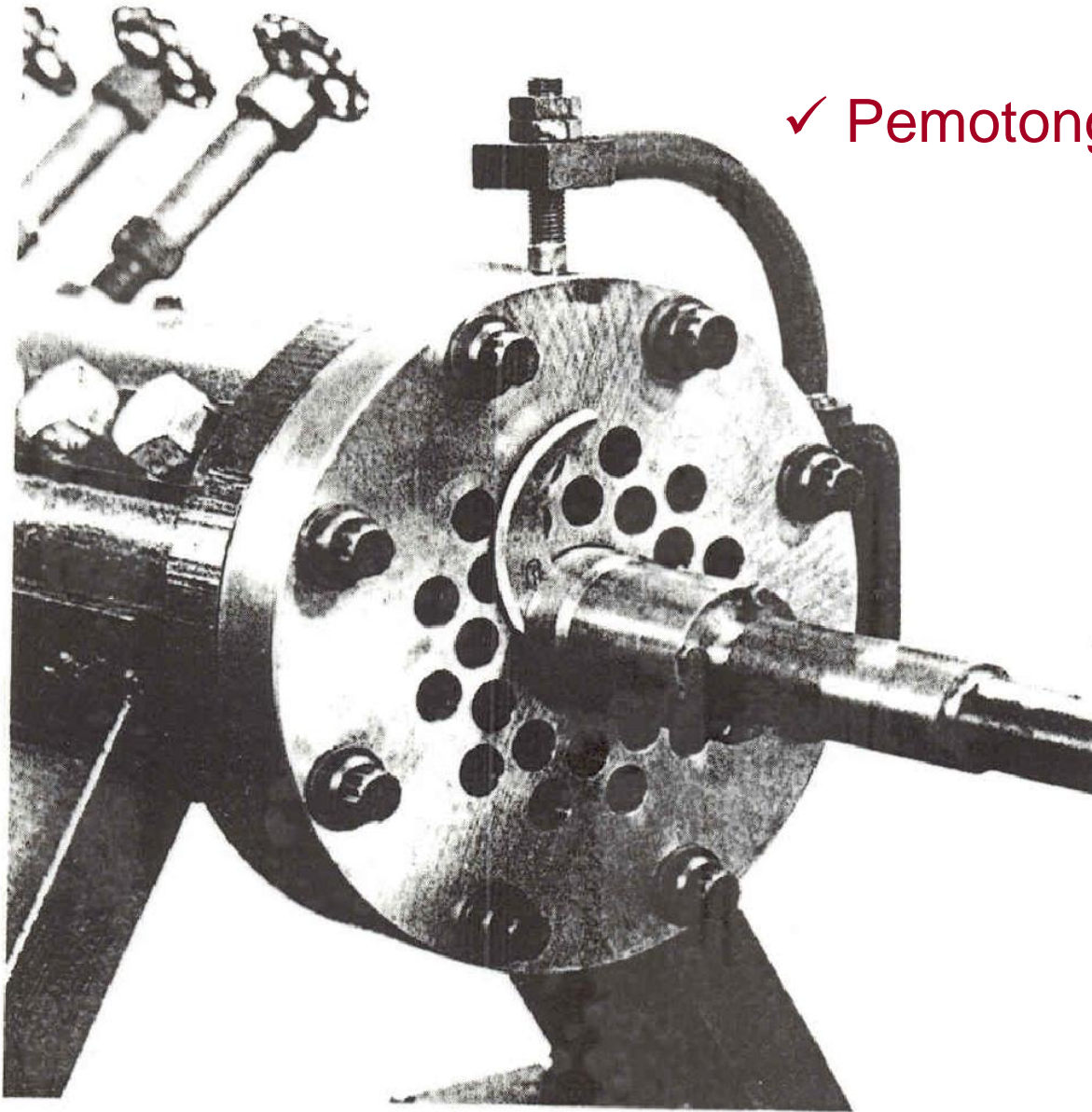
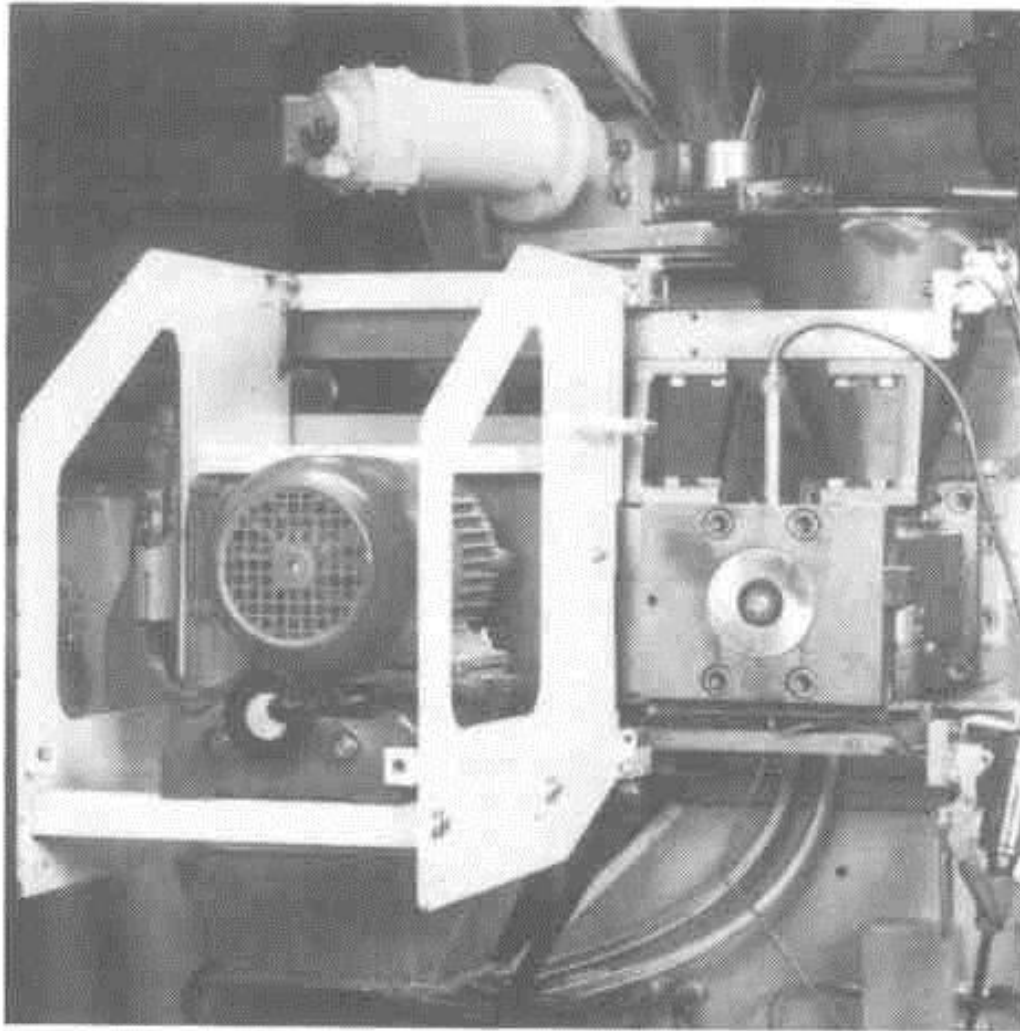


Figure 15. Coaxial die-face cutter with curved blade. Holes in the die plate are for die inserts containing the actual die orifices. (Courtesy Anderson International Corp., Cleveland, OH)

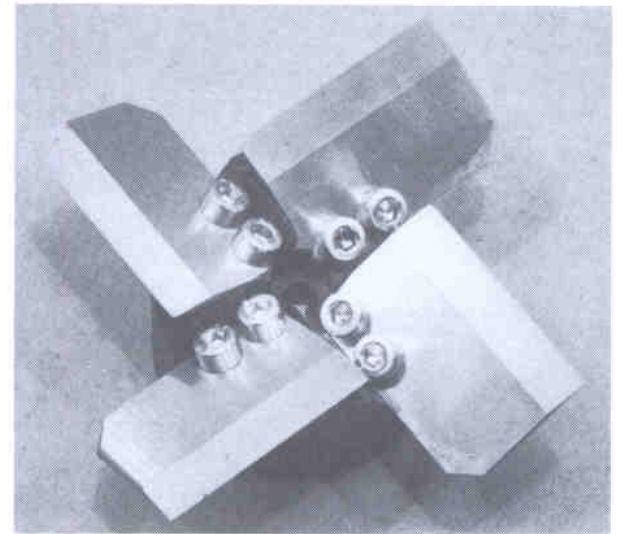


## ✓ Pemotongan / pembentukan



*Movable cutter*

82346-4



*Cutter head, 4 parts*

81811-16

✓ Pemotongan / pembentukan

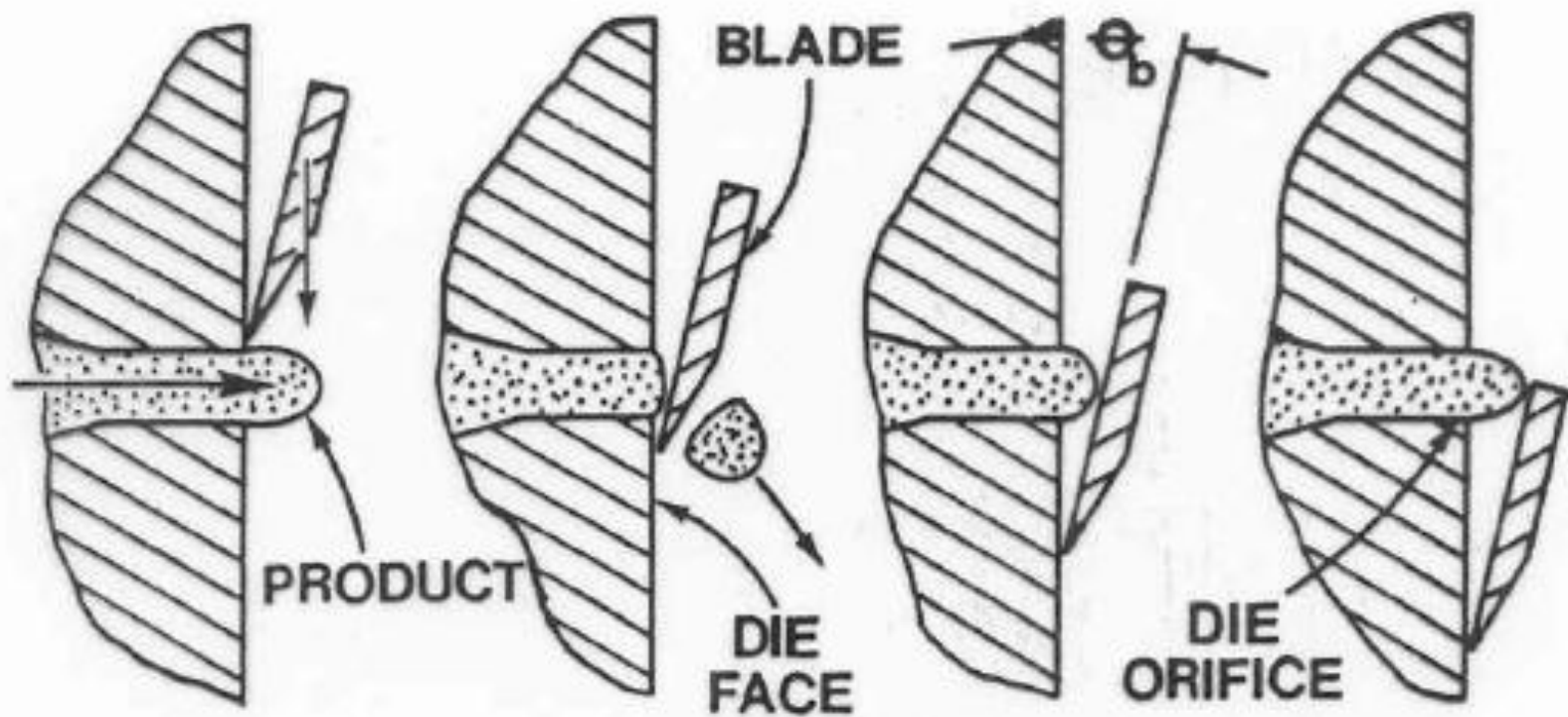


Figure 14. Die-face cutting.  
 $\theta_b$  = blade angle.

(left to right), cutter sequence at die face.

## ✓ Pemotongan / pembentukan

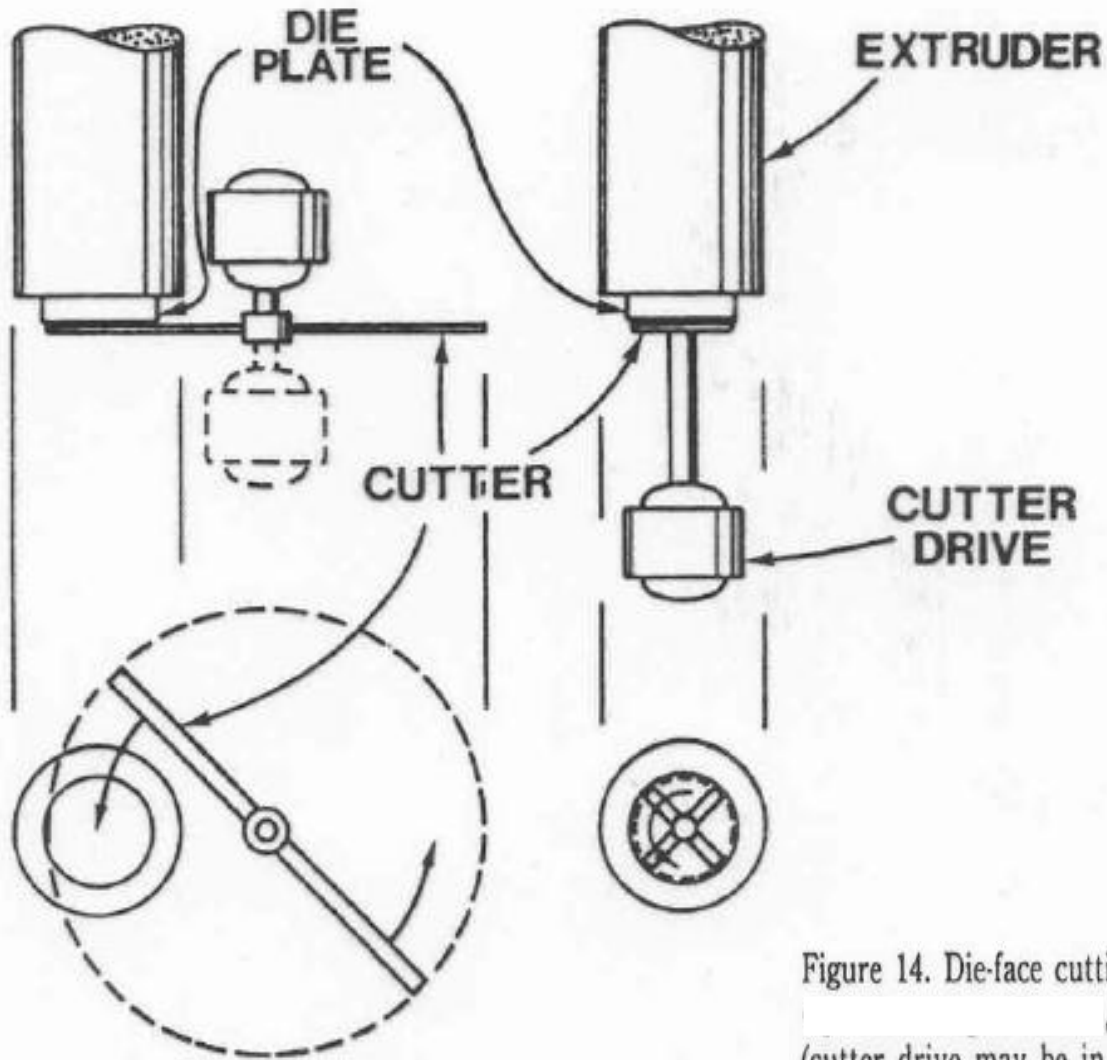


Figure 14. Die-face cutting.

, various cutter layouts: left, parallel axis arrangement (cutter drive may be in either inboard or outboard position); right, coaxial position.

# Flavouring systems

*Umum digunakan sistim penambahan flavor dengan sistim drum (horizontal) berputar dan/atau konveyor.*

Sistim drum lebih fleksibel, cocok untuk ekstradar berukuran kecil yang sulit ditangani menggunakan sistim konveyor (bocor).



# Flavouring systems

Keuntungan menggunakan sistim drum berputar :

- Memberikan “gentle yet regular movement” → distribusi flavor lebih seragam, meminimisasi produk rusak.
- Konstruksi baja *stainless* dan akses yang mudah → memudahkan pembersihan → proses lebih higienis
- Sistim kecepatan putar drum yang bervariasi/bisa diatur → memungkinkan digunakan untuk aplikasi berbagai jenis flavor untuk berbagai jenis produk pada satu sistim.

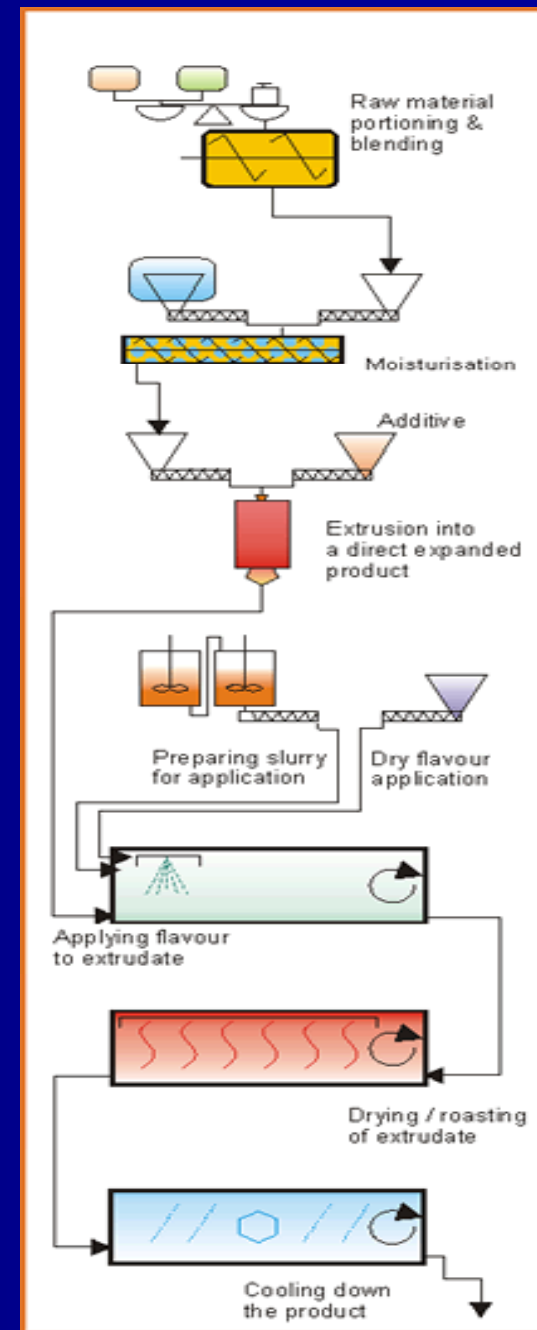
# Beberapa Contoh Proses Esktrusi untuk Berbagai Jenis Produk Pangan

# Sweet snacks and cereals

Trend :

Dengan meningkatnya kesadaran konsumen ttg kesehatan dan perubahan “lifestyles” :

sereal, khususnya sereal ekstrusi, telah menjadi menu sarapan banyak rumah tangga.

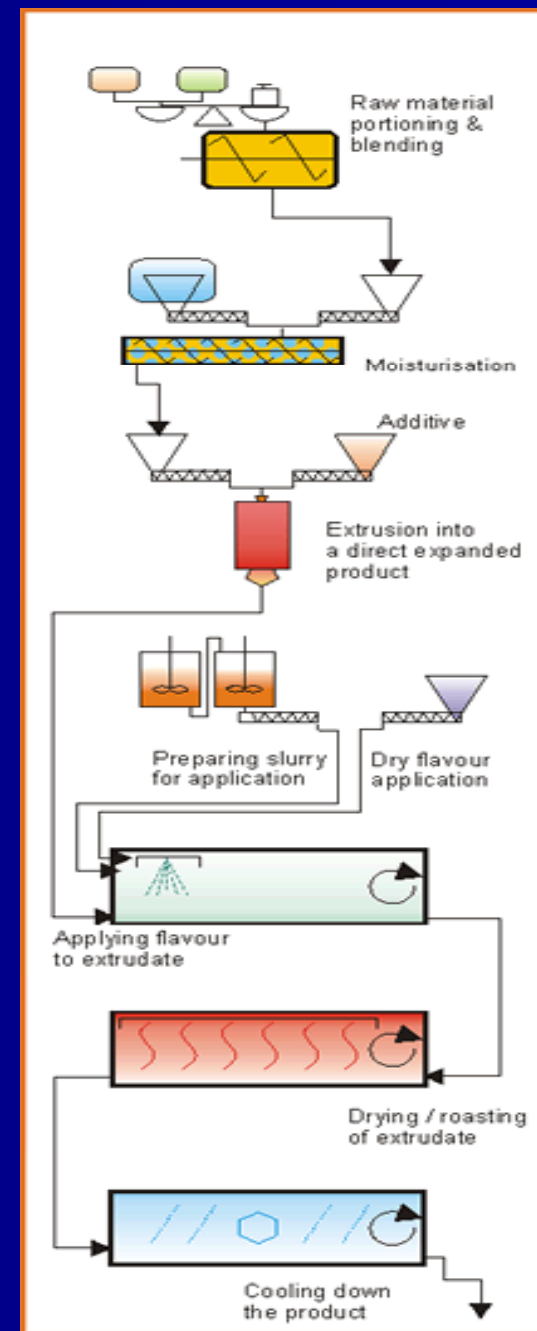


# Sweet snacks and cereals

## Bahan Mentah

Aneka/multi bahan : jagung, beras, ubi, dll

- *multi-cereal products*
- Persyaratan gizi khusus → kelompok konsumen khusus



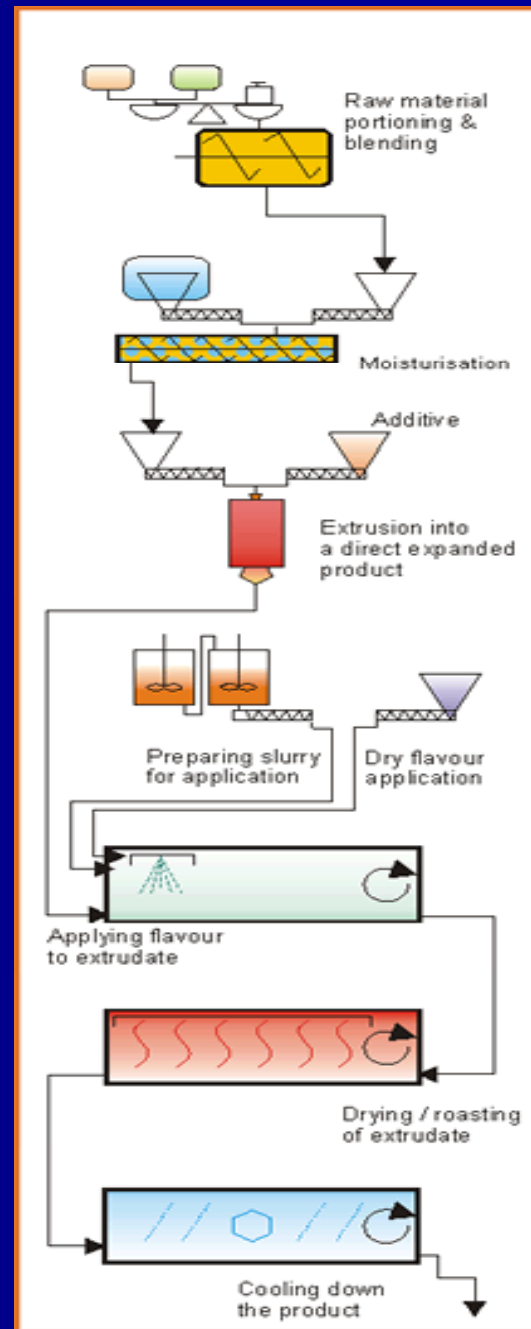
# Sweet snacks and cereals

## Pra-ekstrusi

Umumnya terdiri dari beberapa bahan mentah yang perlu dikondisikan dengan air atau pasta yang mengandung air sampai pada tingkat kadar air tertentu yang diinginkan.

Komponen tambahan umum : susu bubuk, gula, coklat bubuk.

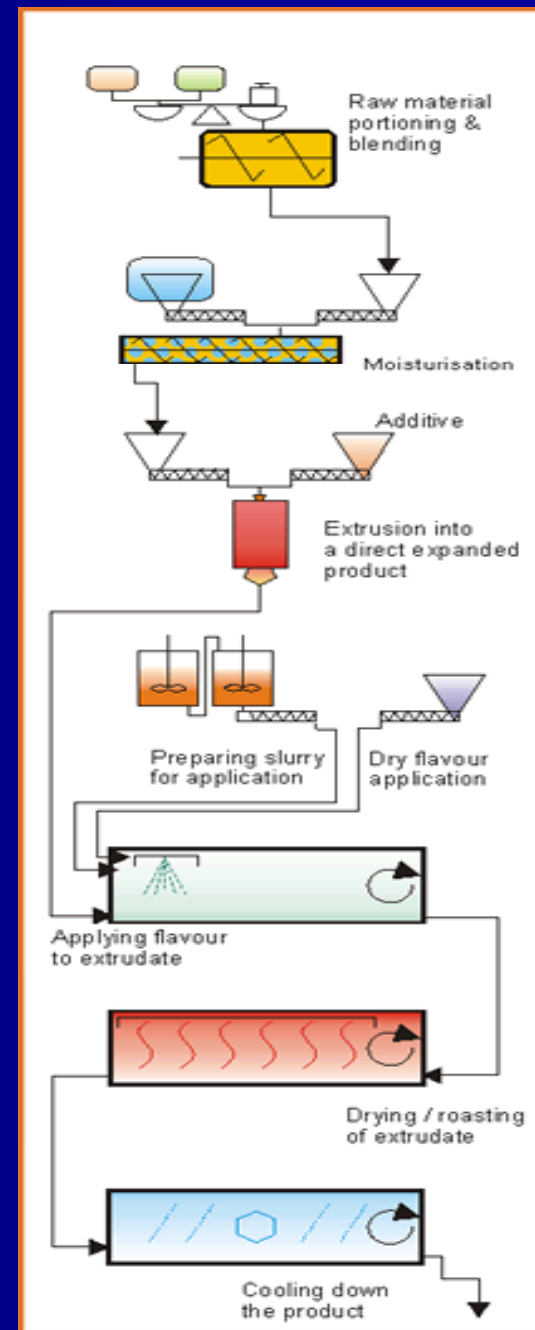
Bahan yang telah dikondisikan tetap bersifat “free-flowing” dan dimasukkan ke dalam ekstruder dengan menggunakan *screw dosing units*.



# Sweet snacks and cereals

## Ekstrusi

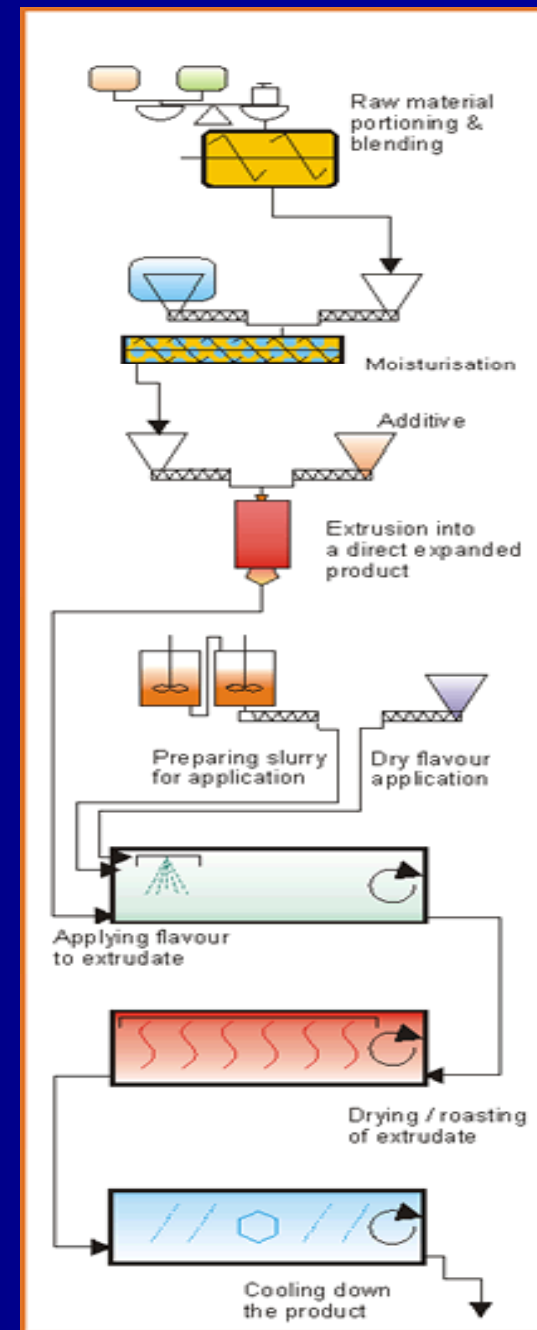
- The dosed raw-materials are extruded and formed into an expanded and shaped base extrudate.
- Most cereals are in small sizes, sometimes requiring special cutting systems.
- The texture of the cereals are controlled in the extruders from soft to crunchy, depending on the method in which the product is expected to be consumed.
- Products to be consumed in milk have denser textures so that they can remain crunchy for a longer period of time.



# Sweet snacks and cereals

## Flavouring

- Most cereals are flavoured using a flavouring mass, which has been prepared in a water base.
- Usually components like, sugar, milk powder and flavours are suspended in a water base and sprayed on to the extrudate in a coating drum.
- The coating mass is prepared in a 2 vessel system.
- After the product has been coated uniformly with the flavouring mass, it may be also sprinkled with dried powder sugar or similar materials.
- Then the product is dried to remove the moisture in the extruded base as well as in the coating mass.



# Sweet snacks and cereals

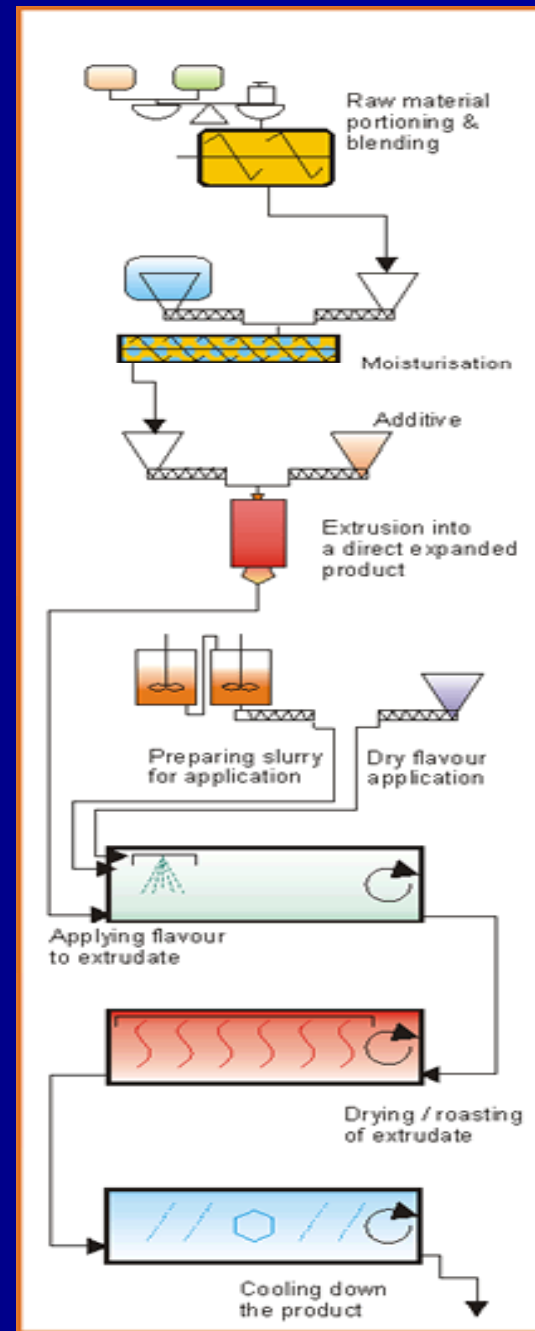
## Pengeringan

Proper drying of the product while minimising the sticking of the product to the walls of the drum.

## Cooling

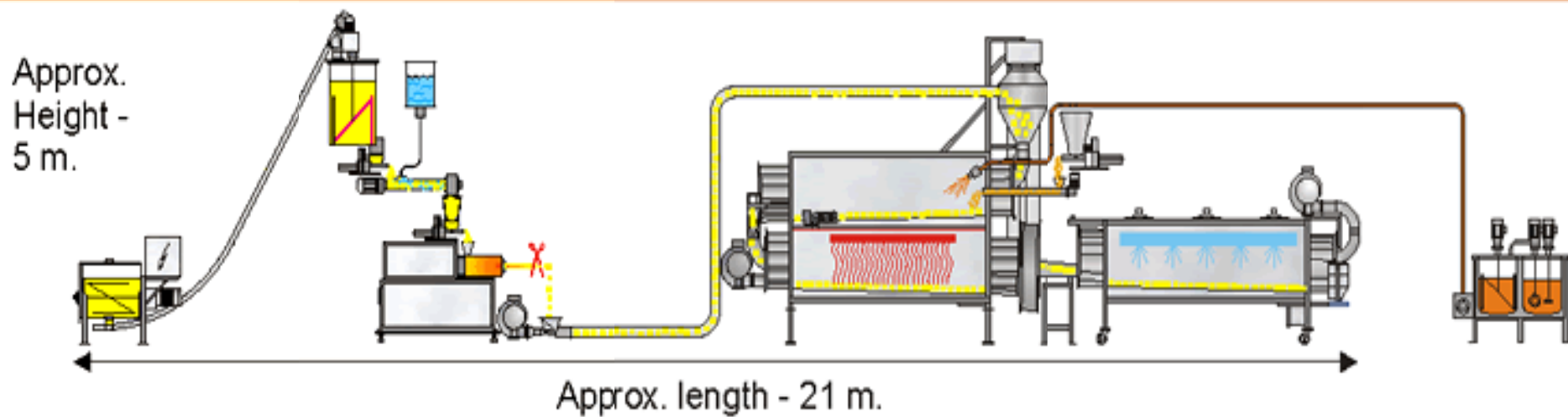
After the product has gone through the drier, the product is lumpy and difficult to handle. The product is hence passed through a cooling drum, where ambient cool air is used to cool the product and break down the product lumps before it is sent for buffering or packing.

*Catatan :* Sometimes it may be necessary to carry out the drying in 2 stages i.e. dry the raw-extrudate first and redry the product again after coating.



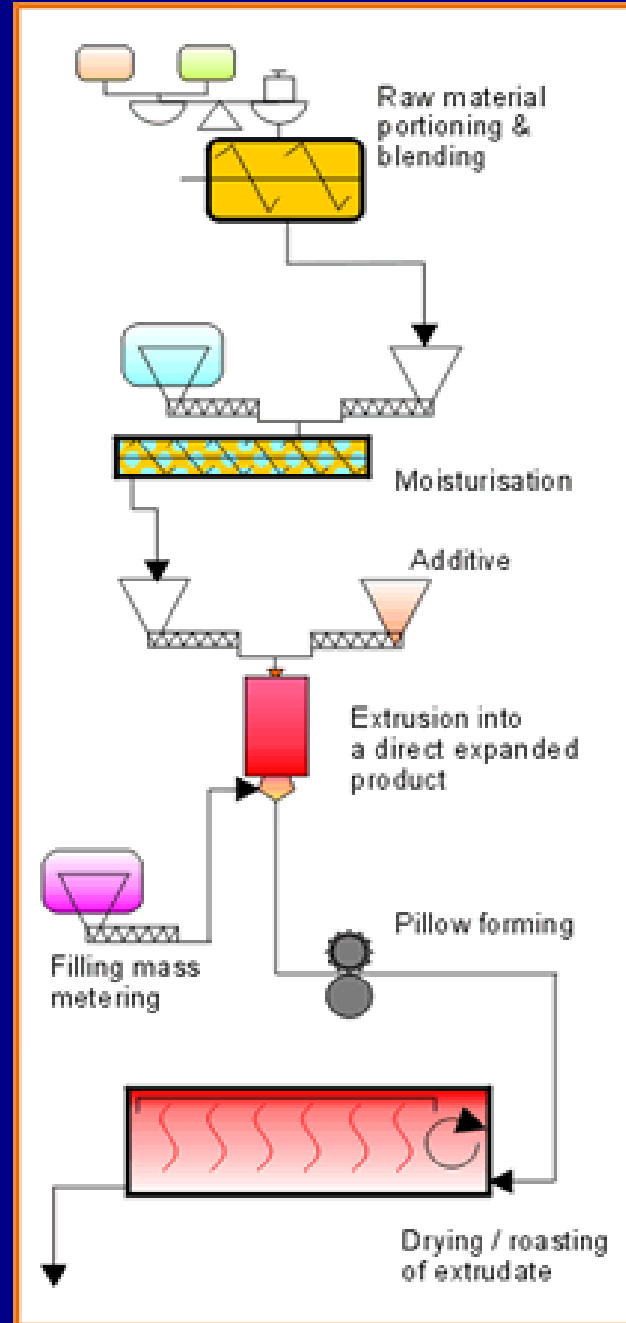


# Sweet snacks and cereals

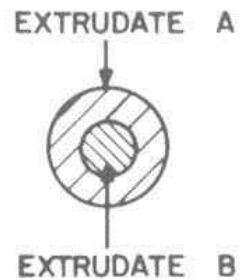
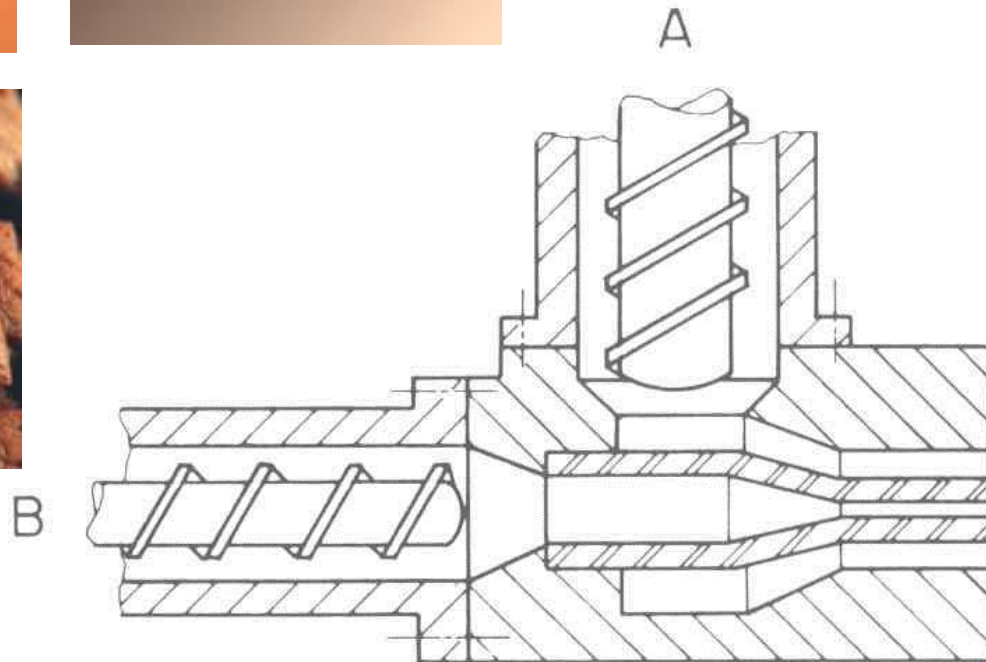


Schematic view of a possible plant configurations for making sweet snacks & breakfast-cereals

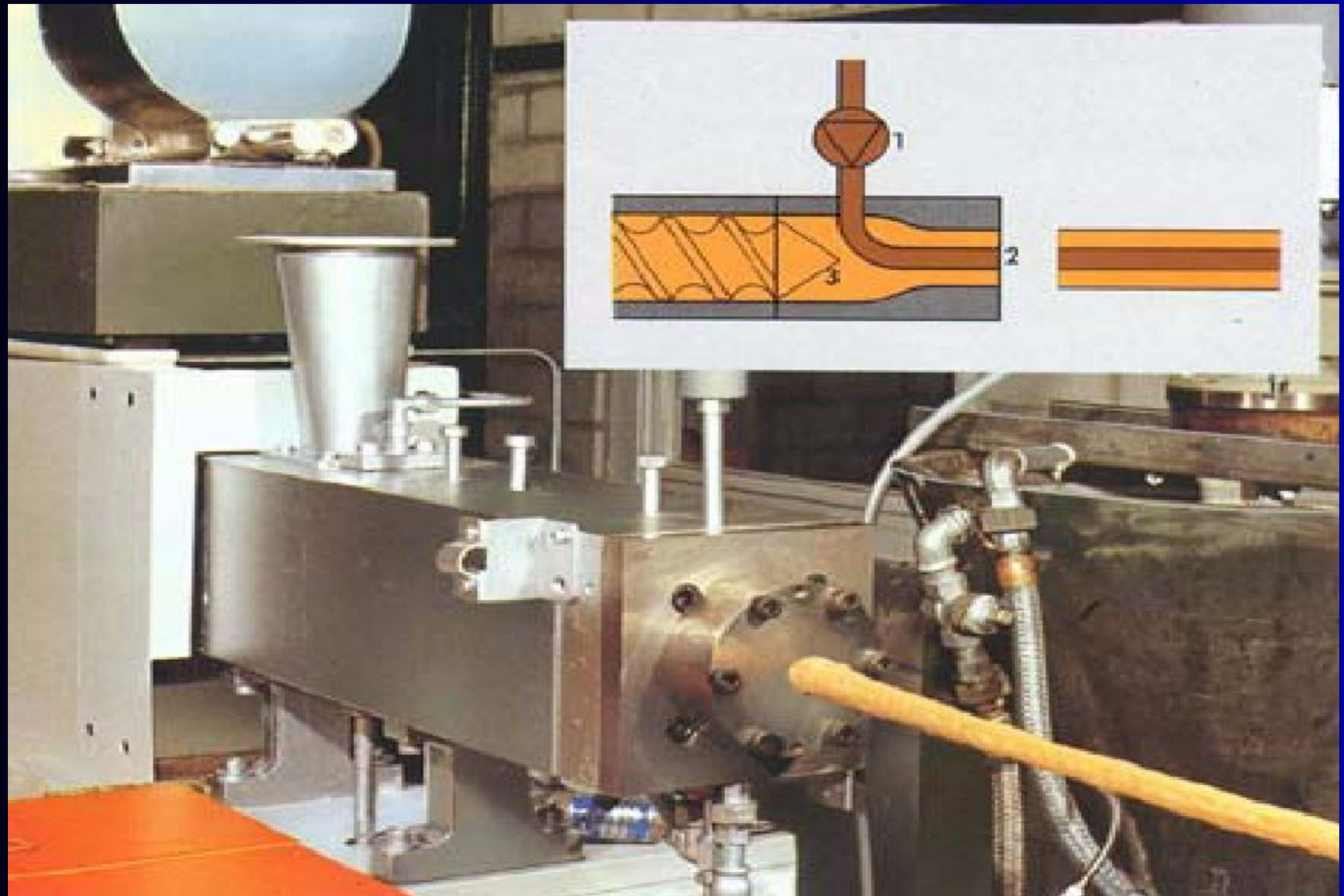
# Co-extruded centre-filled pillows



# Co-extruded centre-filled pillows



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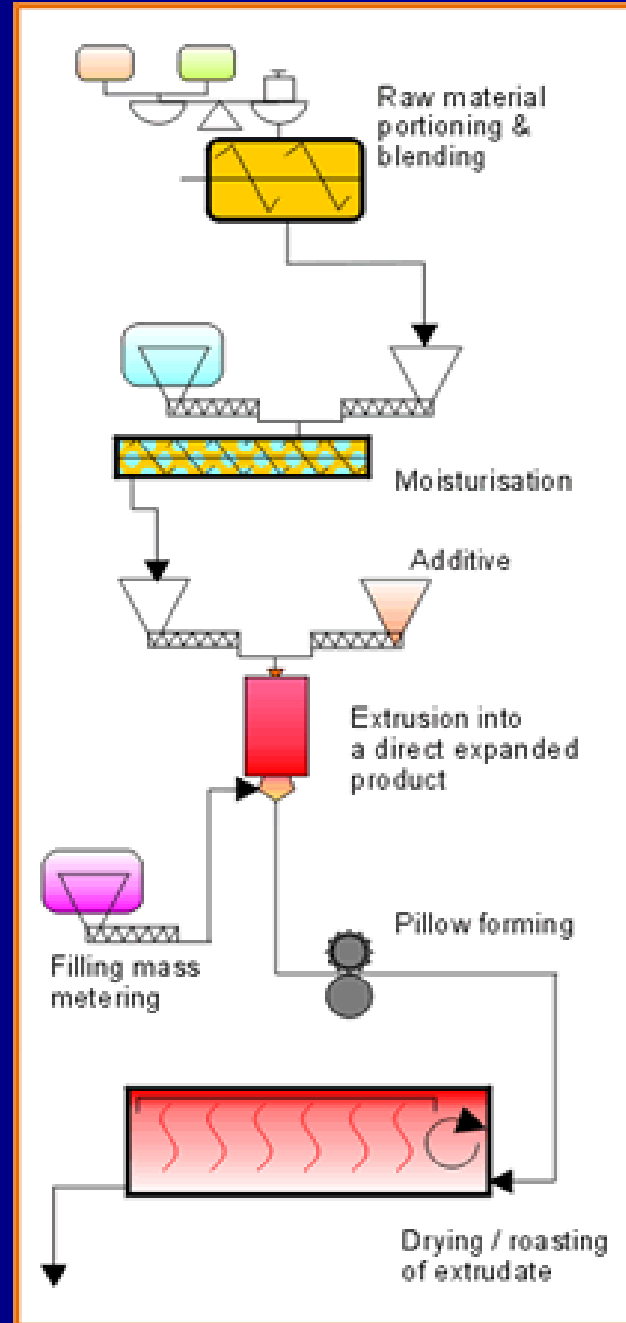
# Co-extruded centre-filled pillows

*The dual textured sweet and savoury delights*

## Bahan

The outer shell of the co-extruded products are generally made from a blend of cereals, after considering the taste and other characteristic of the filling mass proposed to be used.

The filling mass is usually a fat based mass like chocolate or similar cream mass with other flavours.

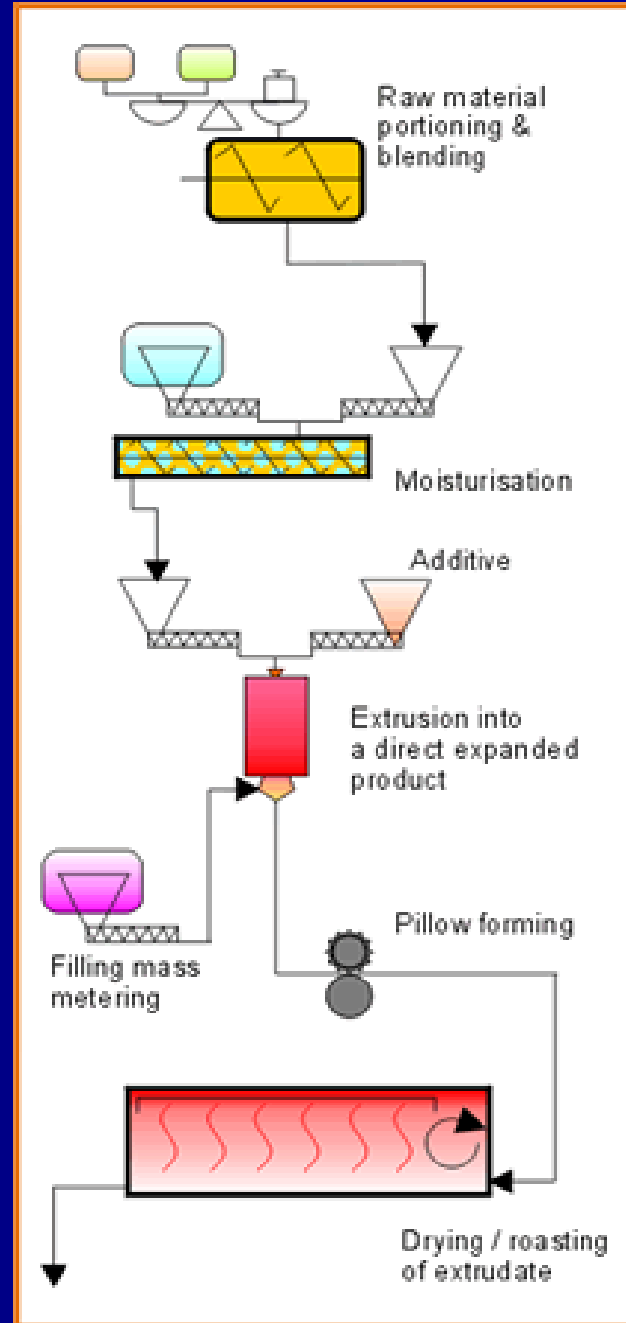


# Co-extruded centre-filled pillows

*The dual textured sweet and savoury delights*

## Pre-extrusion

- The extrusion mix for the shell undergoes mixing and moisturisation as for other products.
- The filling mass must be well homogenised and refined. The moisturised raw-material for the shell is metered into the extruder with screw dosing units.



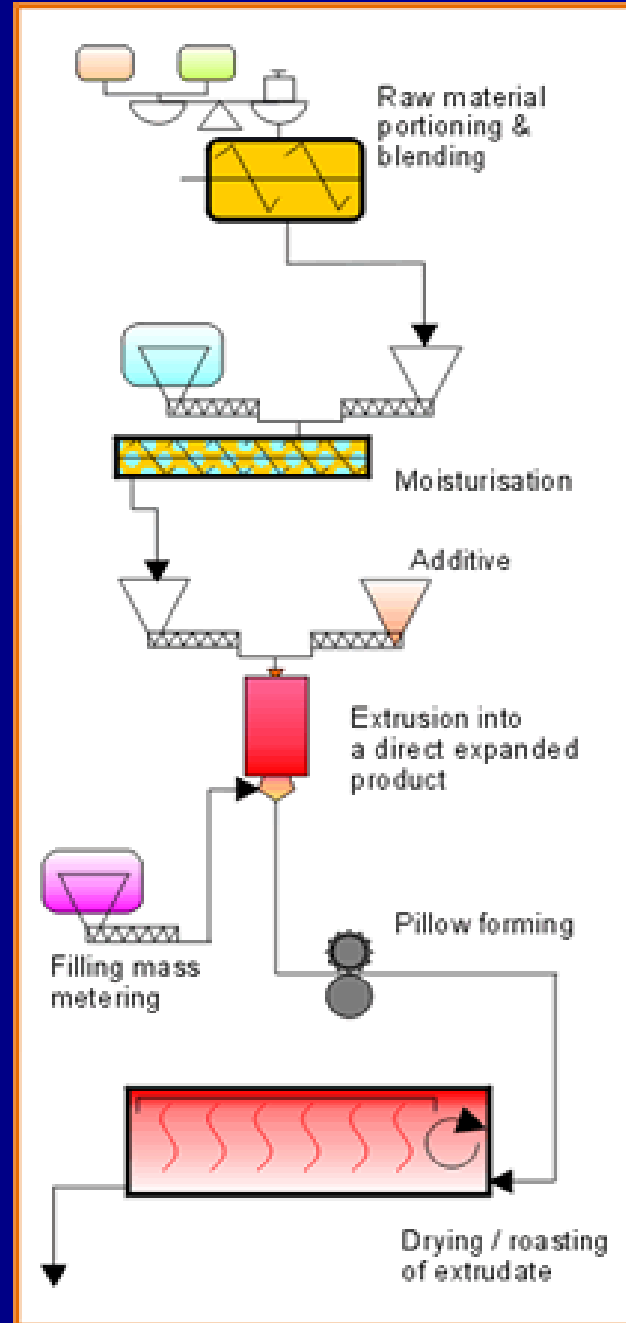


# Co-extruded centre-filled pillows

*The dual textured sweet and savoury delights*

## Ekstrusi

- The dosed raw-materials are extruded and formed into an expanded crispy hollow tube.
- While being extruded using a special co-extrusion die, the tube is also filled simultaneously and continuously with the filling mass being metered by variable speed eccentric screw pumps.



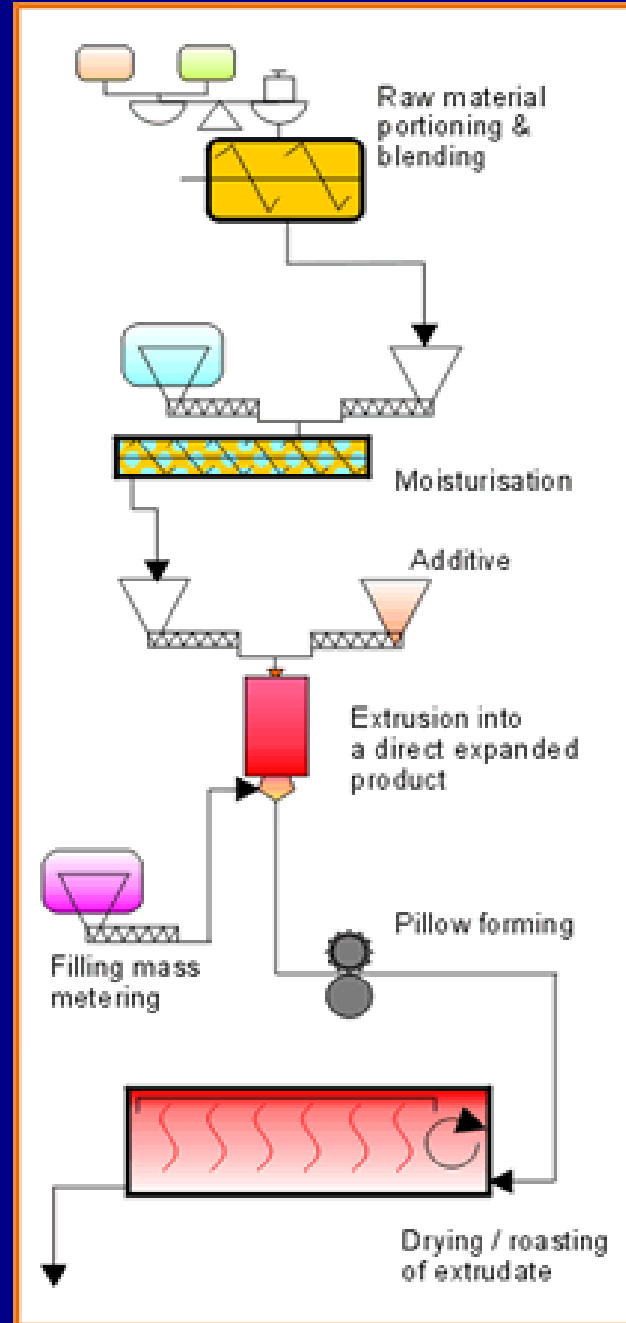
# Co-extruded centre-filled pillows

*The dual textured sweet and savoury delights*

## Pembentukan (*Pillow forming*)

The filled co-extruded tube is pulled into a pillow former and there crimped and cut into pillows using special rollers.

The crimping prevents the filling mass from leaking out of the pillow pieces.



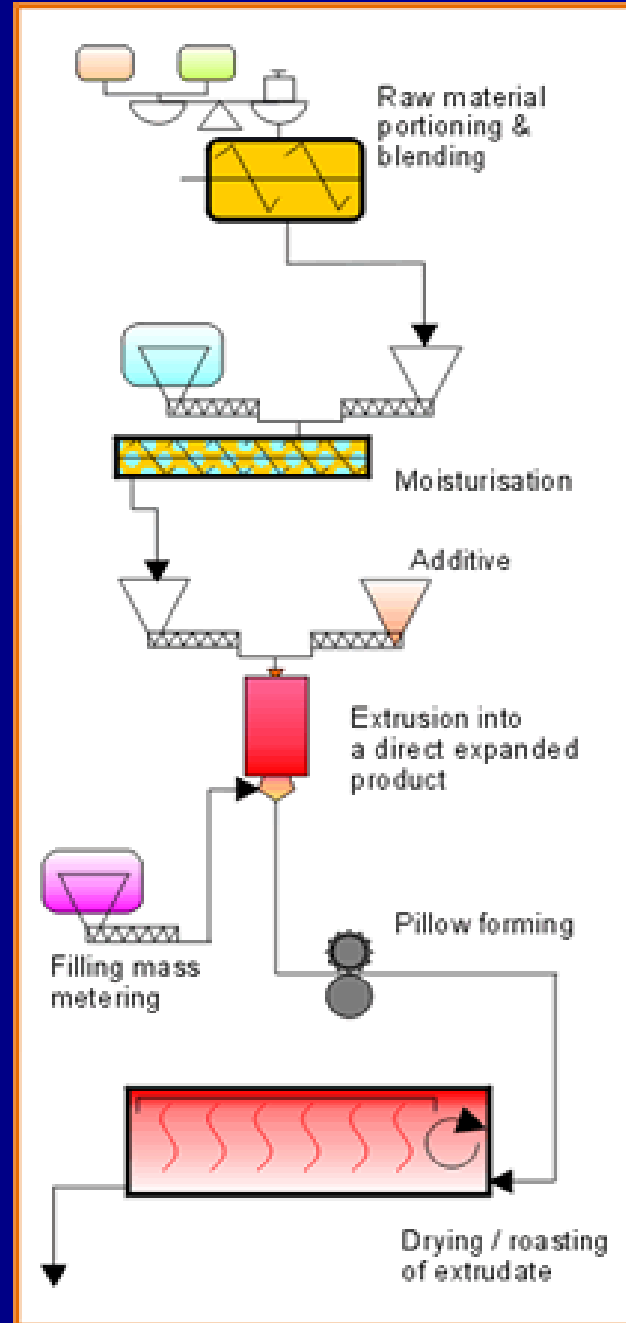


# Co-extruded centre-filled pillows

*The dual textured sweet and savoury delights*

## Drying

- For short pillows, drying can be done in Infra-red drums operating at slow speed to minimise product damage.
- Other long-cut products are dried in other suitable drying systems.



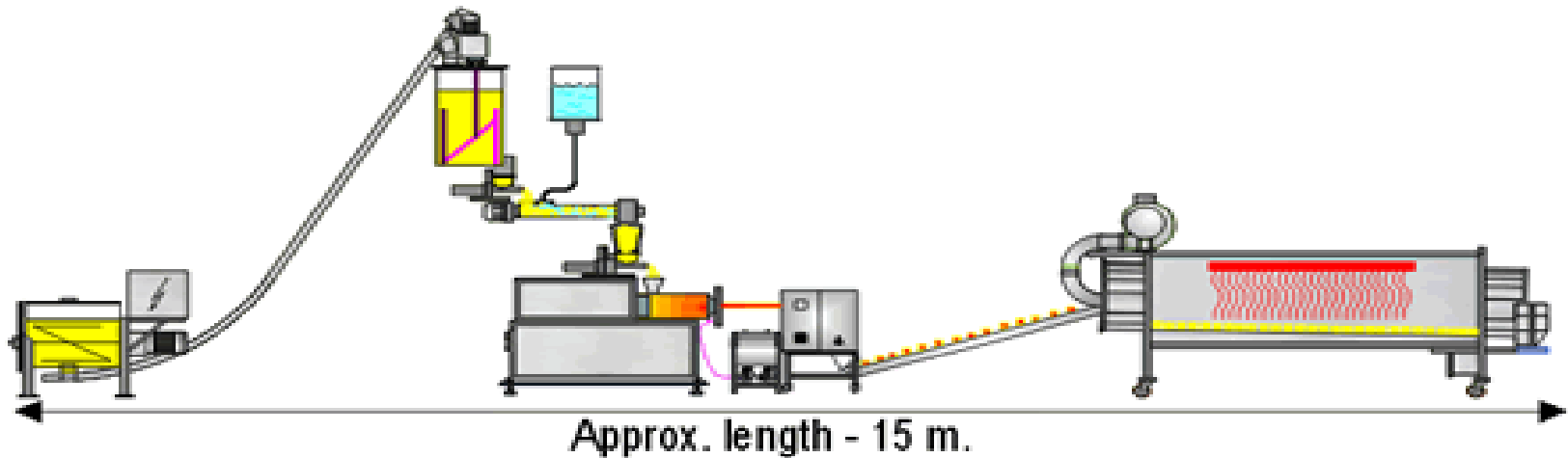
# Co-extruded centre-filled pillows

*The dual textured sweet and savoury delights*

## ***Catatan***

Co-extruded products can be produced in different lengths and also in a wide variety of cross-sections, though this then needs specialised forming, filling and cutting systems.

Approx.  
Height -  
5 m.



**Schematic view of the basic plant configuration for making short, co-extruded pillows**

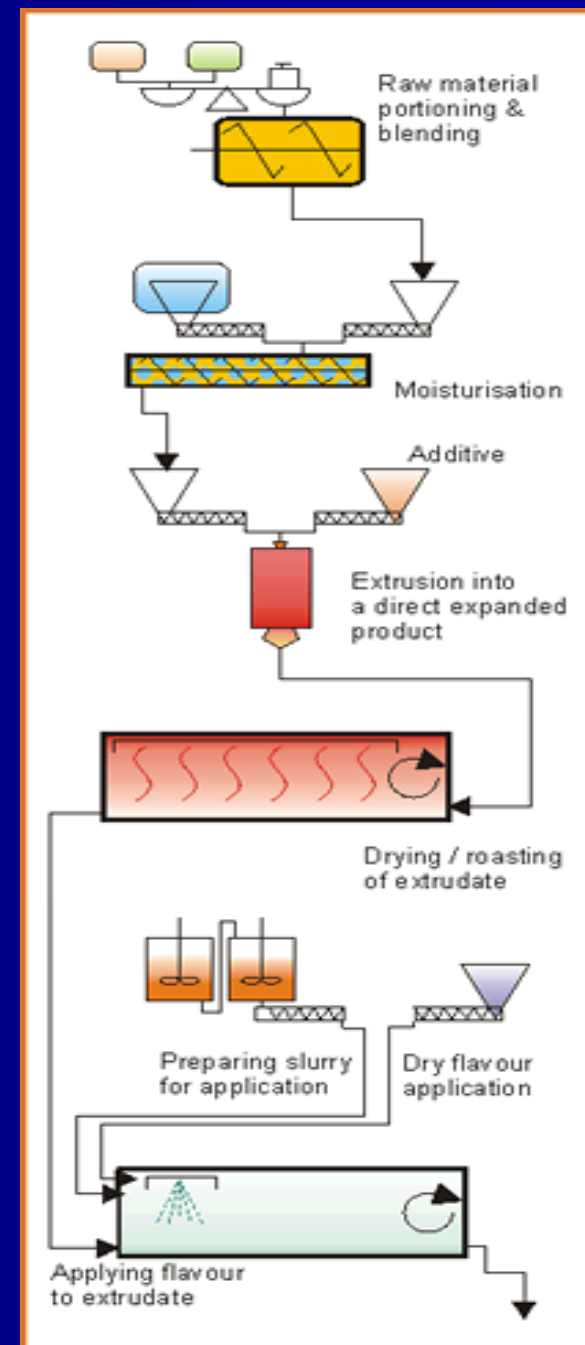
# Savoury Snacks



## Raw-materials

Most savoury snacks are made from corn. Sometimes other raw-materials like potato powder or rice grits are used to impart an identifiable and attractive taste to the base product.

In some markets pulses or beans are also added to cater to distinctive local tastes.

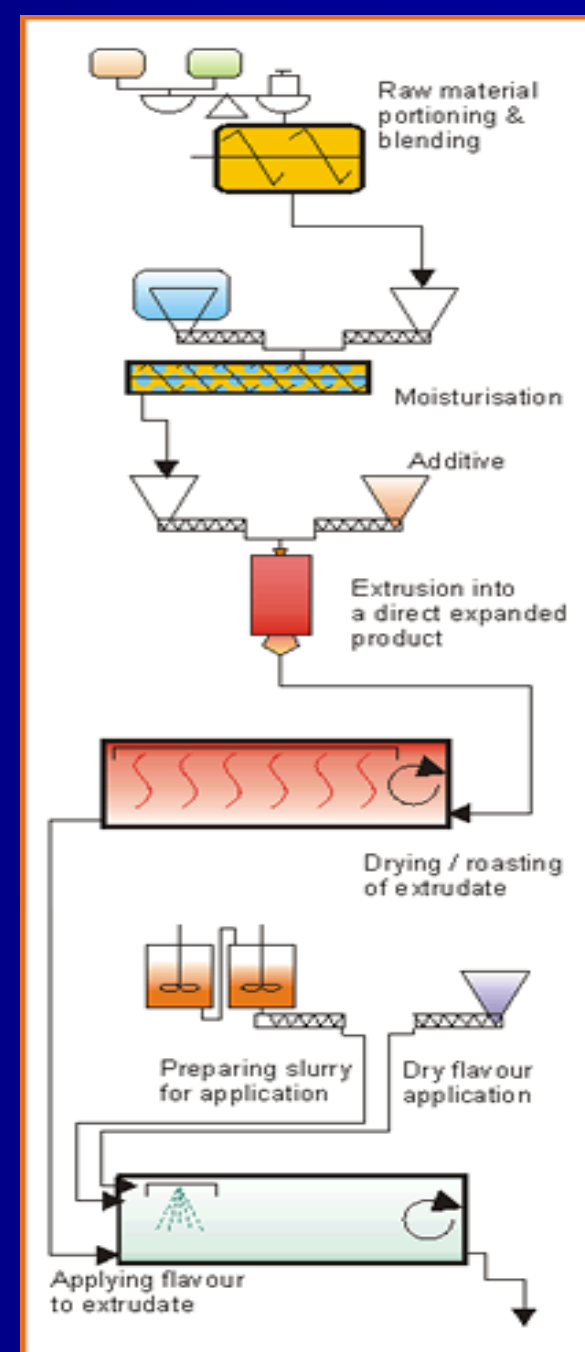


# Savoury Snacks

## Pre-extrusion

The single raw-material or blend of more than one raw-materials is moisturised with water or water containing pastes to a pre-determined level prior to extrusion.

The moisturised raw-material is still free-flowing and is metered into the extruder with the help of screw dosing units.

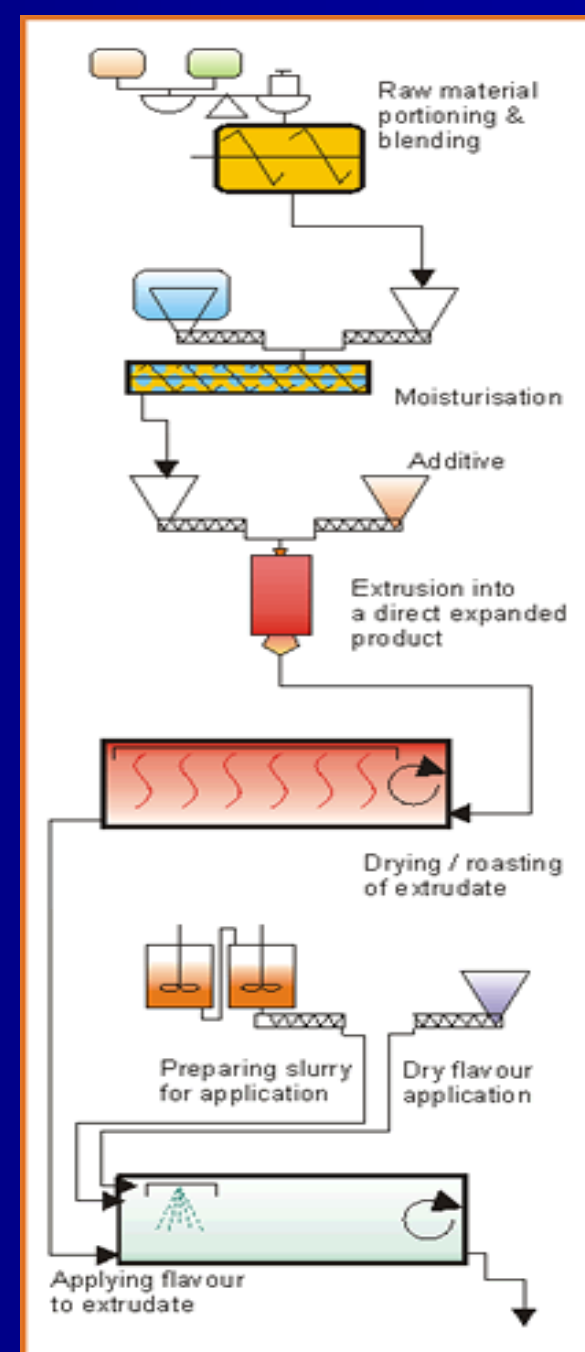


# Savoury Snacks

## Extrusion

The dosed raw-materials, so long as their major component is starch or protein, are extruded and formed into an expanded and shaped base extrudate.

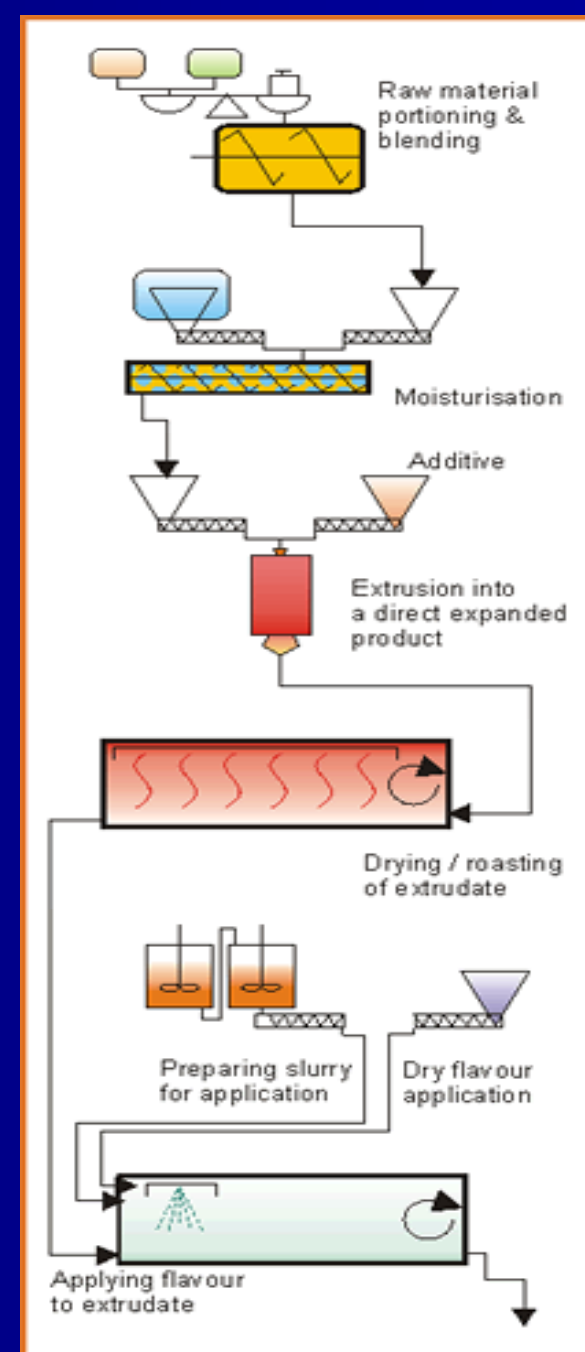
Extruders offer the possibility to control the expansion of the extrudate through various means in order to control the texture and bite of the extrudate.



# Savoury Snacks

## Drying

- Though fully cooked, when it comes out of the extruder, the extrudate must be dried to reduce its moisture level to allow it to be preserved for a longer time.
- Infra-red drum driers for drying, is also able to impart special effects like roasting or toasting of the product to enhance the taste of some components in the base extrudate favourably.



# Savoury Snacks

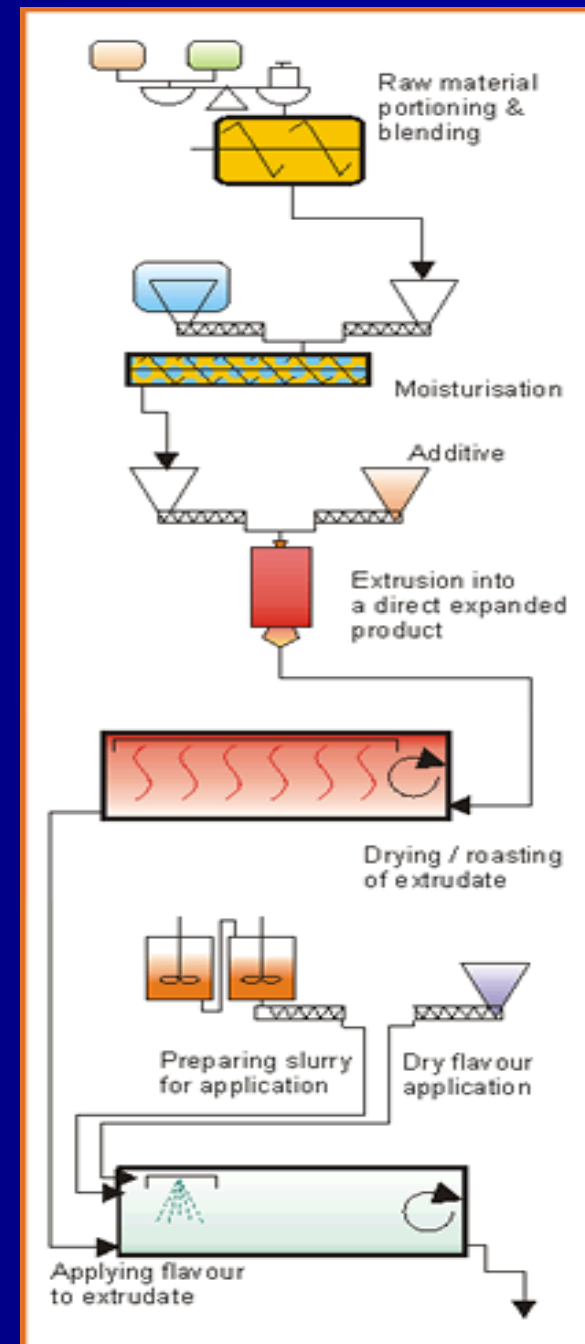
## Flavouring

After the extrudate is dried it is crispy in bite, but most often still lacks an attractive taste.

The taste giving materials are applied on to the extrudate in a coating drum.

While the product rolls and moves along the drum, either fat or a slurry of fat with flavouring materials is sprayed on to the product with the help of compressed air.

The slurry to be sprayed is prepared in a system with 2 vessels.



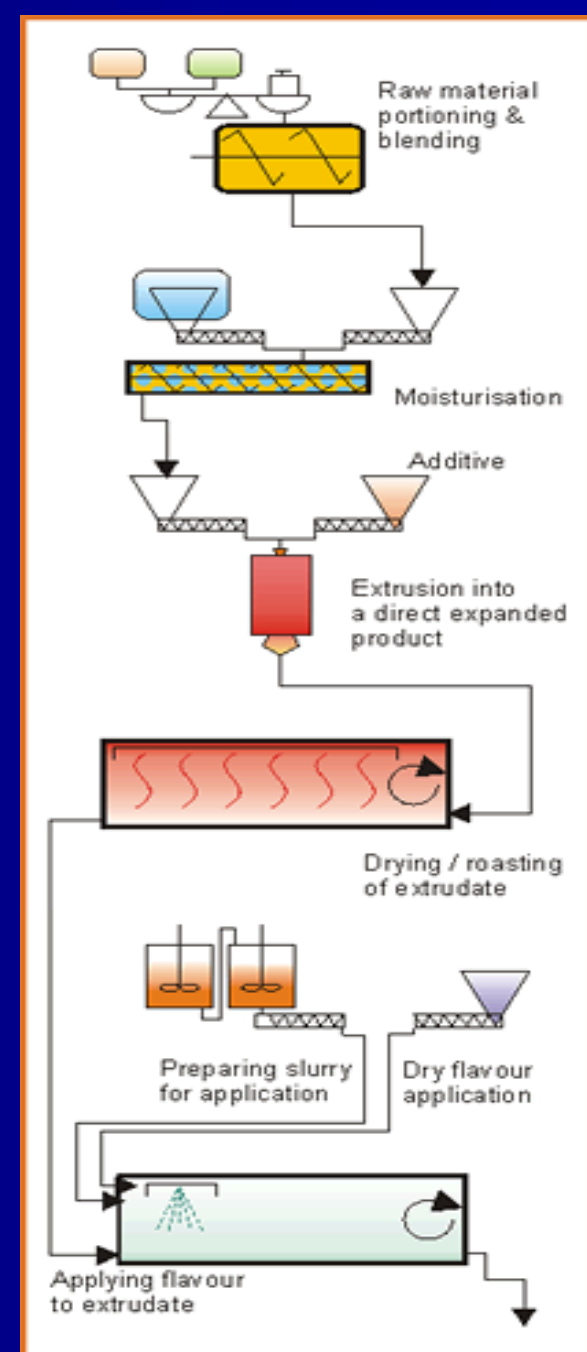
# Savoury Snacks

## Flavouring

The fat and the flavour are vigorously mixed in one vessel and then pumped to another holding vessel, which ensures uninterrupted supply of the slurry, while another batch is being prepared in the first.

If only fat is sprayed on the product, then the dry flavouring material is sprinkled on to the product, immediately after the fat spray, using a suitable device.

After getting uniformly applied with fat and flavour as the product rolls and moves along the length of the drum, the product is ready and must be suitably buffered, protected from atmospheric moisture, or sent for suitable packaging immediately.





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