~~Dete~~gent Processing:

1- Surfactant: most common surfactant linear alkyl benzene sulfonate (LAS)

adv. of LAS:
- avalable in large vol.
- relatively cheap
- good safly & biodegradability profile.
- solid @ room temp.

2- Product forms:

Powders:
- main process to form a concentrated aquaces slurry of raw material & spray dry (countercurrent) tower.

Compact Powders:
agglomeration used to compact powders to the right density

Tablets:
liq detergents
liq pauches
synder bars

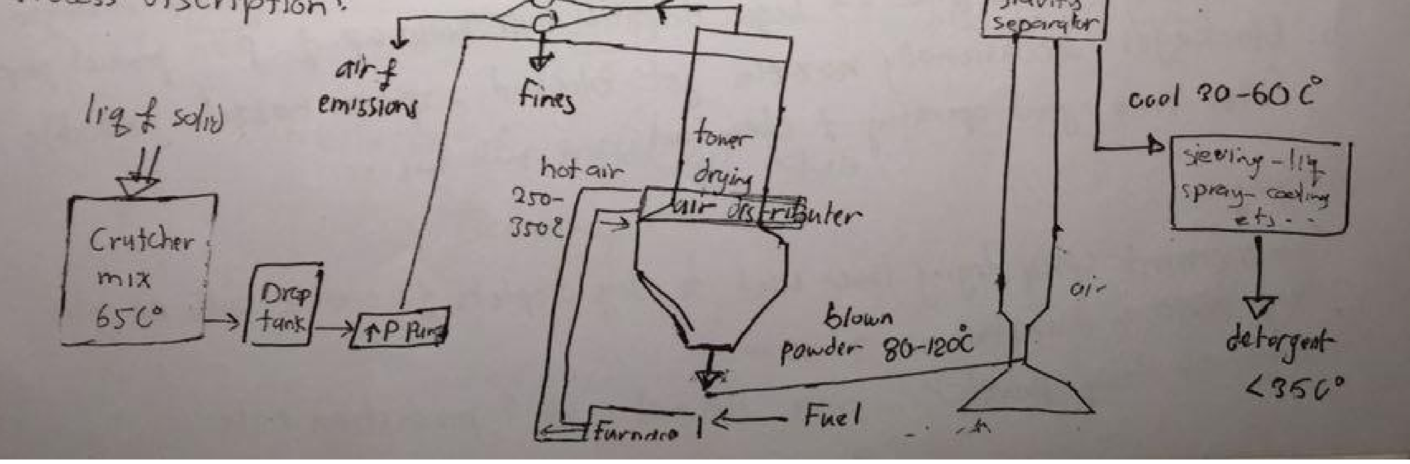
⇒ Sachets have an adv. of providing good moisture barrier protection when. compared to cartons; alot of cartons made with an internal polymer layer. to provide some resistance to moisture ingress.

Detergent Powder processing:

Spray Drying

the spray dried granules are often known as blown powder, the core compounds:
1. anionic surfactant - most often (LAS)
2. builder - Zeolite or STPP
3. inorganic salts - sodium sulfate - sodium carbonate - sodium silicate.
4. Polymers - polyarcylate - carboxy methyl cellulose.

Process discription:



Slurry making → Pumping → Atomization → Drying → Cooling & Clasfication

Slurry making:

obj: make homogeneous slurry of consistant composition & aeration with min. moisture.

1. <u>Crusher</u> (cont. or batch mixer) → incorporate powder & liq raw material @ $T = 65C°$ transfer to

2. <u>drop tank</u>: further mixing, slurry ageo & crystallization take place. filtration to achive homogenization & ensure spray nozzle don't block

Sodium Tripolyphosphate Products:

STTP: good @ controlling water hardness & provide buffer capacity. it hydrates hexahydrate during slurry making & after making process.

hydration have a big impact on vescosity:

too much hydration → extreamly high vescosity

too little hydration → poorly hydrated blown powder that tend to pick up moisture & hydrate on storage.

Pumping:

as a result of low moisture content & short mixing time, slurry may have inorganic lumps (block atomization nozzles) to reducing this is to pump mix into filter & provide disintegrator to break up before passing to main slurry pump.

Atomization:

obj: to create drops small enough to dry in spray drying tower

done with # of high P nozzels distributed @ 1 or more levels within tower.

2 major problem in spray nozzles:

1. nozzle wear: abrasive slurry cause tips of nozzles to become enlarged & rounded with time → biger drops - wall build up & poor product prop.
2. blockages: accasionally nozzles get blocked ∴ spare nozzels. suitable filter size, good operating & clean-out. can min this.

Drying:

Countercurrent spray drying tower used to dry droplets & operate with an inlet temp 300C°, diameter is 3–10 m

high air temp. provide / improve thermal η & ↑ production rate

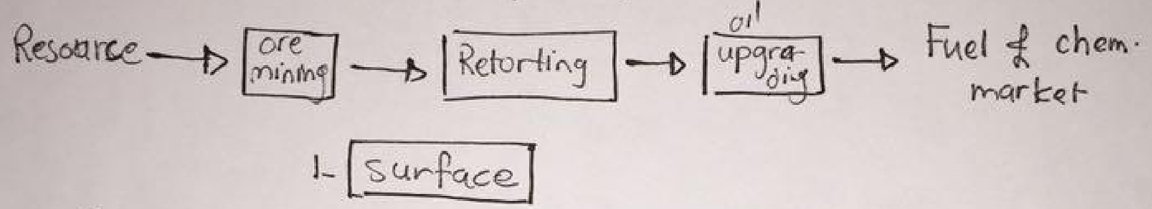
Oil Shale :-

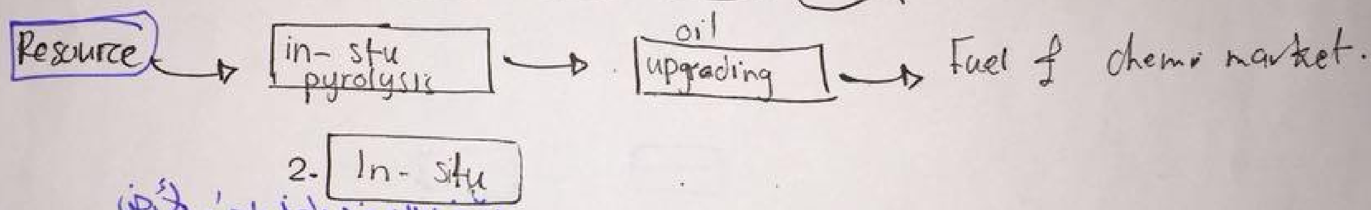
Major Facol Points of Current oil shail RD & D :

1- Improving Recovery Efficiency.
2- Improving process energy Efficiency.
3- Reducing external energy requirements.
4- Reducing net water requirements.
5- Protecting ground water from surface operations
6- Integrating oil shale development with other energy economic development activity.

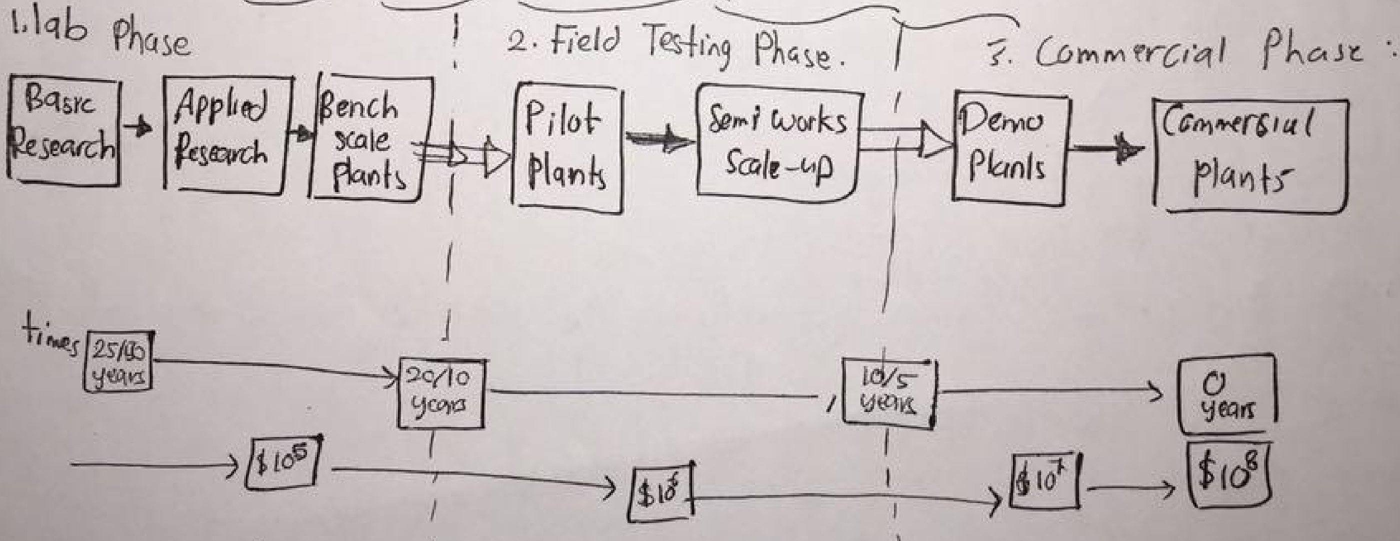
* للأردن سابع أكبر دولة احتياط صخر زيتي في العالم

* Conversion of oil shale to products.





تسخين الصخر داخل باطن الأرض

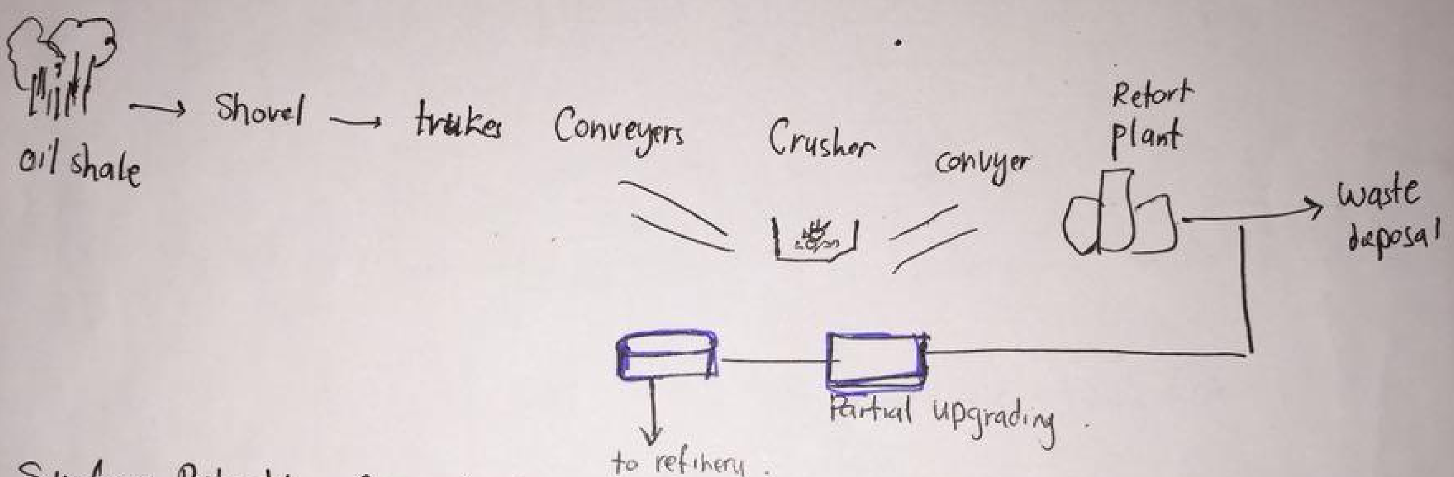


Evolution of Major oil shale Technology.

Surface Mining:

Despite the economical & technical adv of varies surface mining approaches; they have been generally dimissed for oil shale activities in sensitive areas due to associated enviromental impacts that many include:

1- Surface area disturbance of associated habitats @ mine & storage sites.
2- over burden, spent shale management requirement & cost (transport - handle - storage)
3. Risk to surface & ground water quality associated with potential run-off.
4. Air quality impact from fugitive dust & equipment
5. Habitat disturbance due to noise from mining & transport & crushing.



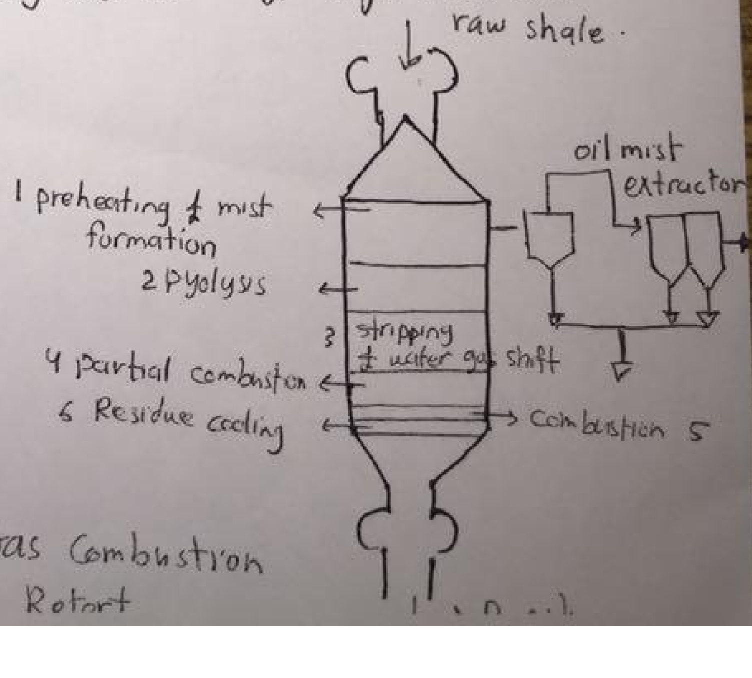
Surface Retorting Approach & technology:

3 major steps:

1. oil shale mining & preparation.
2. Pyolysis of oil shale to produce Kerogen oil.
3. upgrading Kerogen oil to produce refinery feed stock & high value chem.

The principal obj of retort process:

1. high product yield
2. high thermal eff.
3. short residence time in retort (< 1hr)
4. high process / operational relability.
5. low enviromental impact.



Gas Combustion Retort

Recent Innovation:

→ more recent direct gas heat → fluidized bed heating Process
injection of sys-gas from coal gasifier
Hydrogen doner solvent Technology

In-Situ Technology:

adv: 1- Potential surface & ground water impacts of leachates from over burden. shale & spent shale.

2- water requirement for mining, reclamation, dust control & spent shale dispossal are largly eleminated.

3- Emmissions of criteria air pollutant can be significantly reduced.

4- Depending on the surce of heating energy, life cycle, carbon emissions could be reduced.

New Approaches to In-Situ: Variation of traditional ↑

1- Reduction in energy use
2- Reduction in net water use
3- Higher production yield
4- Effective carbone management
5- Improvement in thermal efficiences.

disadvantages:-

1- require greater heating tim
2- Product recovery / heterogenous.
3- heating leave residual carbon
4- Combustion use some of the shale itself as feul for heating the rest of formation
4- production η relatively law
5- inefficien heating & creashion of unwanted stream

New Approach Classified:

1. Down hole heaters
2. Direct Current heating
3. Hot gas Injection

In-Situ Combustion Approach:-

→ True in-situ (TIS): there is minimal or no disturbance of the ore bed.

→ Modified in-situ (MIS): ore bed is rubblized either through direct blasting or after partial mining to create void space.

both → Forced major challanges related

1. Sustaining & controlling subsurface combustion 2. generation of subsurface pollutents
3. direct & communicating heat through target shale formation.
4. degredation of subsarface enviroment.

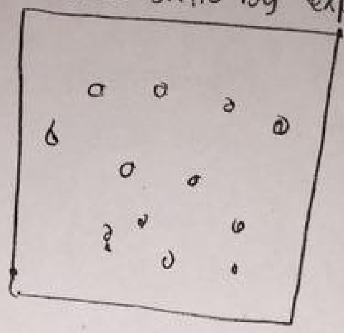
True In-situ: Resource → pyrolysis → oil upgrade → Fuel & chem. market.

Modified In-situ:

step ①
Create void mining

mined shale to surface retorts

step ②
Reblize shale by explosions



step ③
Combustion.

Shale oil to refinery

Oil shale:

sedimentary rock embedded with organic material called Kerogen 20% bitumen, 80% kerogen.

3 major categories: for origin of organic material: terrestrial - lacustrine - marine

- terrestrial → organic material plant-animal live in land
- lacustrine → fish brackish water algae remains
- marine → salt water algae

Deposits of oil shale generally found @ shallow depth < 900m

⇒ Quality factors:-

1. richness/grade (L/ton)
2. organic material content
3. hydrogen content
4. moisture content
5. conc. of contaminants: N, S & metals.

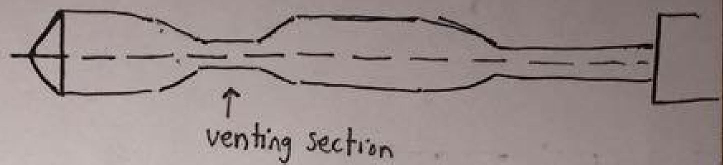
Commercially attractive richness/grades of oil shale contain 100 L/ton or more.
Percentage of organic carbon in ore.

$$\text{yield} = \frac{\text{vol. of shale oil}}{\text{vol. of oil shale}}$$

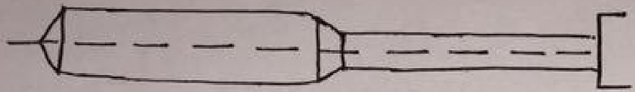
Screw Configurations

traditional ; 3 zone screw.

PVC type for amorphous polymers



3 zone screw with venting.



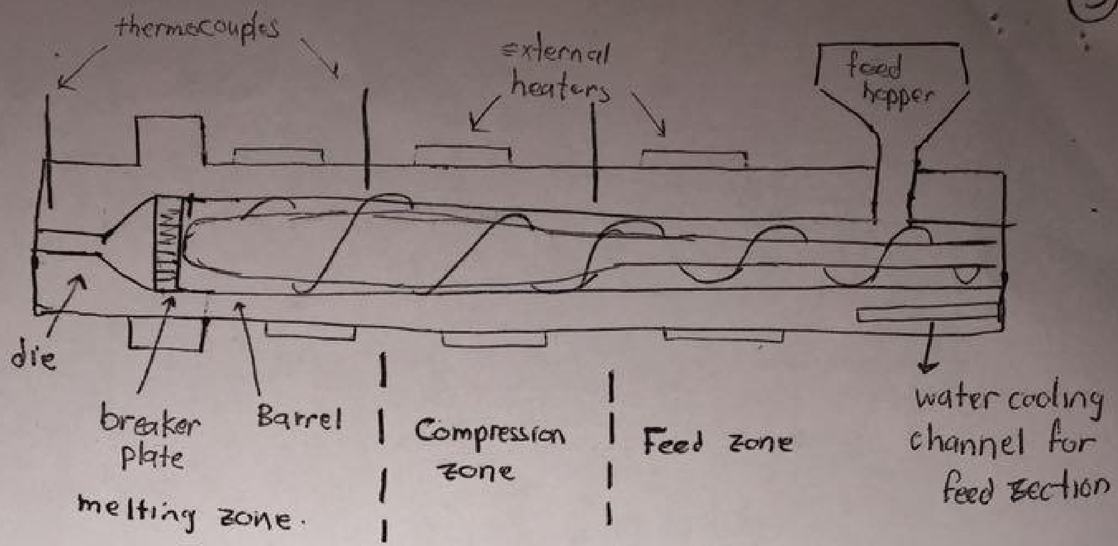
Nylon type for crystalline polymers with sharp melting point

Differant types ⟹ for different materials.

Venting :- necessary to allow moisture to escape which affect the quality of outp[ut]
Filter :- fine gauze to remove inhomogeneuos material & any contaminations
Breaker Plate :- plate with large holes to prevents dead spots ; straightens the spiralling melt & assists the build up of back Pressure in order to remove mixing to break twist fenomina of molecules.
Extruder die :- determining the desired shape of the extrudate. (subsequant shape downstreams) its externally heated & ensures that flow channel changes shape smoothly from the barrel shape → product shape.
→ the latter type ensures constant melt velocity @ the die exit

Main Problem with a die is Material Swell : Polymers are long chains save thermomechan[ical] stresses.
* arises from the elastic prop. of the melt, together with draw down of the material → necessary 4 ensuring straight product.
* determination of product dimensions usually trial & error proces.
* in some cases ; shapping plate (template) is necessary to define the shape
⟹ opening of the die is a high resistance to the flow, so we need high pressure to force flow toward the die ⇝ Screw pump
to match screw & die designs to obtain an optimum output :
* Cooling needs to be rapid to maintain shape & water bath is used.
* its better to extrude @ law temp → reduced production & necessary for higher pressures.
* output rate (Q) depends on pressure drop (proportional relation).

Single Screw Extruder



temp range: 200 - 300 °C
: screw speed: 50 - 150 rpm.
output rate: 10 - 1000 Kg/hr.
: Pressure: 40 MPa → controlled by a transducer in metering zone & valve before die.
& screw diameter: 20 - 150 mm
: length/diameter ratio: 25 - 30

⇒ Feed zone :-

: Preheating - supplying the correct quantity of material to the next zone.
& important to avoid overfeeding or starving this zone.
* Operation is influenced by the shape & fractional Prop. of feedstock & screw geometry

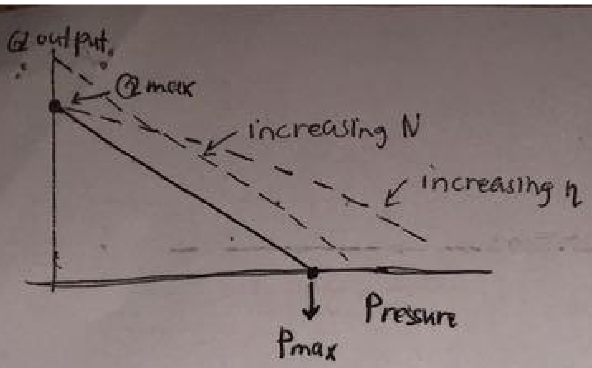
⇒ Compression zone :-

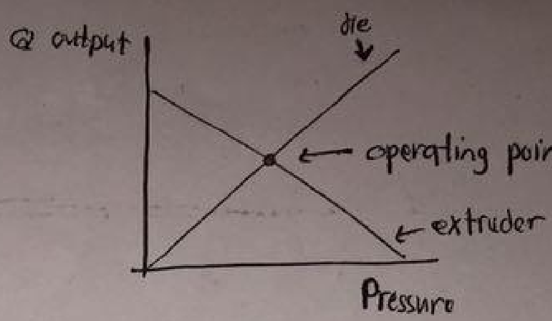
& moving air (compaction) & melting polymer.
* melting achived by friction & conductive heating : aided by reduction in material thickness.

⇒ Melting Zone :-

* Producing a homogenuous melt (distributive mixing) & maintaining a constant temp & Pressure @ die.

twin screw ⇒ required for some materials (PVC) to produce adequte mixing





* Injection Molding Process :-

→ thermoplastic ; in form of granules or powder passed through feed hopper into the barrel where it's heated & become soft.
→ then forced through nozzle into relatively cold mould.
→ after sufficient time to become solid ; the mould is open.
→ the article is ejected & the cycle is repeated.

major adv.
* wide range of products * the ease with which automotion can be introduced.
* high production rates & the manufacture of articles with close tolerances.

injection machine → Plunger type. its Problems:
1. little mixing (homogenization) of molten plastic.
2. diffecult to meter accurately the shot size because its on vol. basis [because diff. pro of materials.
3. prussure @ nozzle can vary quite considerably from cycle to cycle
4. presence of the torpedo causes a significant pressure loss.
5. flow prop. of the melt are pressure sensitive ; varing in mould filling

Stages during injection molding :—
Pause → Clamp → inject → Holding pressure → screw back → complication cooling
opening → ejection

* screw rotate backward to collect material in the front.
* when shot size fill ; stope rotate & use the screw as a piston to inject material to the molding part.

* Blown Film Process :-

one of the most significant polymer processing method.
several billion pounds of polymer (polyethylene) are processed annually by this technique.

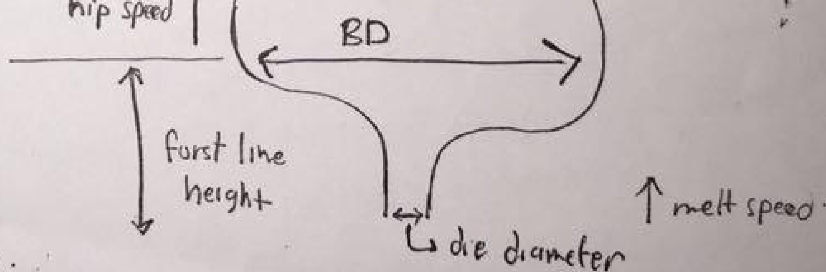
Product used with low profit margins :
grocery sacks - grabage bags - flexible packaging.

*Polymer chem. & molecular structure :-
1. vital in establishing film prop.
2. bubble geometry resulting from process conditions also segnificant.
3. molecular oriantation & crystalline structure. controlled by bubble dimensions -
4. affect prop. such ; tensile - strength - impact toughess - clarity.

:molten polymer : exit the die vertically as freely extruded bubble (50 feet / 15 m) hight
:process variable :
[screw speed - nip speed - internal bubble air vol. - cooling rate (frost-line hight)]
& bubble geometry :
not specifically hardware because hardware directly affected the bubbles geometry.
shape depends on combined influence of several process parameters.
usually has a small diameter & thickness as it moves upward toward solidification.
. frozen-in remains vertually constant.

.Parameters discripe bubbles geometry :
[die diameter - die gap - frost line height - stalk - bubble diameter (BD) (initial)
film thickness - layflat width (LF)] :
→ the die face in molten state is cooled & reaches temp when it becomes a solid.
→ forst line height : the destance between die face & where solidification takes place

:Process variable :
[melt speed - nip speed
internal bubble vol. - cooling rate]



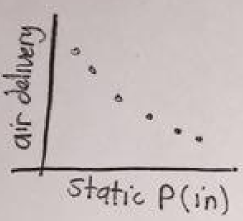
melt speed :-
upward velocity as it exit the die gap.
Controlled by screw speed (not same) because its linear & screw speed is rotational.
nip speed :-
velocity of polymer as it travels through nip roller. (film speed - line speed - take off)
internal bubble vol :- alternative of (P)
amount of air contained inside bubble between die face & nip rollers :
cooling rate :
by speed @ rate impinges on Bubble & the temp. of air.

bubble cooling:-

* by blowing large vol of air on film as it exits the die.
* bubble kipt inflated to remove more heat from film as it travel up in tower.
* deserves much attention.
* in many blown film, it's the limiting factor to max. throughput.
* improve the efficiency of this process (removal of heat)

Process variable responsible for η :

1. air speed : as volumitric flow rate (ft^3/min) ↑, more heat removed - capillary
2. air temp : 3. air humidity



[as static P on blower ↑, blower η ↓]

Factors affect static P:

the number - length - diameter of cooling hoses - flow restrictions within

* the importance of insulater between air ring & die
often underestimated but missing, damaged or poorly chosen insulator will;
→ allow die transfer large amount of heat thru. air ring & into cooling air.
so ↓ production η

line control:

to maintain min. variation in all measurable film quantities (position & time)

variable control process:

melt quality - film thickness (gauge) - vescosity of material - frost line hight
layflat width - BD (measured using laser micrometer)

⇒ blow molding (batch & continuous)