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Research on the structure and function of the extruder And determine the parameters affecting the properties of polymers

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Abstract

Using extruder as batch reactors, for processes such as polymerization, polymer adjustment or polymeric alloy adaptation is among the technologies which are getting more favorable day to day and they can challenge traditional ways through their economical efficiency. In the present paper, technical advantages, disadvantages and characteristics of reactor extruder and the state of flow mechanism performance in extruder have been investigated and studied, and the effective parameters on the process condition have been surveyed. The results indicate that the extruder is appropriate for reactor processes because of its capability in performing the processes step by step, supreme transmit and distributing integration, and temperature controllability. The investigations also indicate that effective parameters on performing proximate polymeric processes in reactor extruders include tarriance time, distribution state, and rate and type of energy, that it is required to be informed about the characteristics and nature of process and needed and special equipments to perform it, before choosing these instruments for extruder activities, besides, it is required to consider effective parameters such as tarriance time, extruder volume, variants and specification of the starter type in choosing extrusion process in order to improve the product quality by controlling these parameterMost results are according to investigation on existence extruder model ZSK .

Keywords: extruder¸ polymerization¸reactor

Introduction:

in recent years, interest in reflexive extruders has been increased considerably. About 25 years ago, in Exson Company, Coaleski investigated the global interest in reflexive extruders' rate through issued papers and invention registration during 1983-1966. The results demonstrated the high range of issued papers in the field of reflexive extruders (almost 150 companies were active in this field). This rate of interest is due to their ability in using high viscose polymers. These devices can melt, pump and mix the mentioned polymers and make them compound. In fact these issues are the required specifications for a chemical reactor. Previously, chemical reaction to form polymers, except the problem of high viscosity, is performed in thin systems. But as the reflexive extruders' technology improved in recent years, the usage of reflexive extruders, and the function of these extruders were increased. In addition, during last three years, protecting energy and environment became one of the important global aims. The industry growth is correlated with these issues; so it is obvious that the advance technology of reflexive extruders in this field is cooperated with industry and optimized the industry growth. If the performed reaction in an extruder compared with a similar reaction in a solvent or thinner, the advantages of reflexive extruder is as follow:

1. Eliminating required energy to retrieval the thinner in case of using extruders;
2.Not distributing solvent or thinner (since they are not used in these extruders)
3.Long term maintenance and protection of most equipments if extruders were utilized;
By considering the fact that solvent or thinner comprised 20-5 weight parts of final polymer product, the significance of above benefits would be determined more.

The usages of reflexive extruders

Reflexive extruders have important usages; the most important ones are as follow:

1-Continuum fracture

This position is applied to control polymers Rheology such as poly propylene. Elasticity poly propylene is high and on the other hand the loss rate of this situation is slow. So this position would make problem when the process rate is high. (Such as film extrusion and fiber), because of high range inflation and creating remain stresses in product that caused reduction in production specifications. So it is the main factor in processing in this situation of elasticity. Since high molecular weigh make a product with high elasticity, the process of continuum fracture is performed reverse temperature profile (the input temperature was 800/700 F and the cylinder temperature was reduced toward rise without adding peroxide of continuum fracture). But later this action was performed with peroxide in order to control the process and non destruction better. In this situation, by moving toward rise, the temperature profile would increase.

2- Modifying

To modify the polymers, poly volfine is performed. The sample of this position is linking poly ethylene with Maleic anhydride. This caused better tenacity with glass fibers which is effective in optimizing specifications. If the linking percent is high, it can be used as a Sirloin average in layers tenacity (poly ethylene and poly amid).

3-Networking

In this situation, poly ethylene flux cooking can be mentioned. So the material which produced in high temperature of water is used. The produced water caused poly ethylene networking.

4-Polymerization

Here we can mention caprolactom polymerization and preparing nylon6.

The advantages of using extruders

The extruder usage in reactions has many advantages.

1-The ability of working with high viscosity polymer without requiring solvent to thin.

Occasionally, in solvable polymerization, the solvent exists by 5 to 20 times of polymer weigh. This situation besides having high cost, it caused environment pollution; so applying extruder lead to more economical material.

2-Saving in location, primary cost and production cost
It has been perceived that in production cost even 15 dollar/kg was saved.

3-Process continuity
This caused to compose a product with steady specification; unlike the discontinuous reactor which the product may not be steady and same.

4-The ability of direct material process
Poly propylene, which the continuum fracture was occurred in there, can be processed directly with that extruder.

5-Self-cleaning property
Often in discontinuous extruders up to 1200 g/m^2 the material hold the wall and even by using silicone materials the amount of tenacity is $700g/m^2$, While there is almost no tenacity of material to extruder body in reflexive extruders. This is useful especially in bi-bolt extruders which caused the sequel continuum removed with long term settlement and completely equal product is obtained.

6-Proper mixture in extruder
Due to high viscosity in polymers, penetration is very slow. So in pipe reactor which there is only penetration, the mixture is weak; but in diagonal, width and leak extruder fluid caused proper mixture. Based on strip thickness discussion, it is obvious that even in mono-bolt extruder, which the mixture is improper; the mixture is more than pipe position. (If the proportion in extruder is assumed h/D = 0.1 , mixture in extruder with ʃ/D = 25 is equivalent to mixture in pipe position ʃ/D = 1000).

7-Controlling and distribution settlement time
Changing the overlapping amount in bi-bolt extruder, the bolts Homogenization and Non-Homogenization can control the settlement time distribution. Settlement time in bi-bolt extruder, in hungry situation is defined as follow:

$\Theta = 2\int / ZN$

Where z is bolt step, n bolt round and I is extruder length. So by changing these positions the settlement time can be controlled that this time should be longer than required time for reaction.

8-Snap ability
Here, in order to remove remain and not react monomers completely from product, the system should be equipped with strong sucking pump, so special technology should be applied in order to not block the polymer and monomers exiting way.

9-The ability of adding various material in proper locations
In reflexive extruders, the adding of various materials in determined locations is available. Even sometimes, injecting such materials is occurred with low weighing.
In material injection the point which is important is that the materials with low melting point, if added in primary zone with polymer, they would be melted and acted as lubricator. So transferring polymer toward became challenging. So they would added further than polymer injection place where the polymer melt(if the variety of this materials was high, due to limitation of extruder length, several materials should be injected, otherwise the injections points increased and caused excessive length of extruder).

10-Creating proper and ideal temperature profile and better control of temperature
In this situation the temperature of each zone can be adjusted separately and in aspect of temperature create the best situation in order to have the best result (unlike discontinuous rectors that chose unit

temperature). Also in discontinuous extruders, due to large volume of reaction, the temperature in borders to middle of extruder has differences, unless strong mixture used until the polymer was viscose, this performed hardly. In a sample of this situation, the zone temperature was adjusted in six zones. (180-190-200-210-210-200)°CIt's worth to mention that if the temperature in peroxide adding zone was high, it caused rapid fracture of peroxide and considerable increase that this lead to peroxide radicals react with themselves, and their efficiency decreased; but if peroxide is injected in lower density and some points, this problem would solved.

The disadvantages of using extruder

1-Requiring to special geometry for each specific reaction

In spite of the fact that in solvability polymerization a reactor can be used for various reactions. In reflexive extrusion process, to be successful in each reaction, a specific reaction should be designed for that reaction that this geometry may not be proper for another reaction. One of these situations is designing specific geometry to halogenated Elastomeric butyl.

2-Difficulty of thermal transferring to out of system

In extruder due to thermal waste resulted from shear viscosity, monotonous thermal can be created in polymer; so making heat and transferring it in system is challenging. But heat transferring to out of system and cooling the system is difficult because of the following reasons:

Heat transferring coefficient of polymer is low and so cooling the polymer is hard;

Exceeding cooling of polymer in this situation caused creating a layer of viscose from polymer in cylinder surface, and the thermal waste due to shear viscosity increased. So the cooling is not useful and inactivated with created thermal. Hence this situation is not effective. To better transfer of heat with wall, the bolt depth reduced, since γ and produced heat increased; the depth can not be reduced in ideal size:

$\gamma = \pi DN / h$

Increasing the cylinder diagonal the problem would not solved because in this situation the reactant volume would raise more then the surface and caused more heat and negative effect;

By increasing the round, this problem would solve:

Heat transfer to system outside: in $10^{-3} \leq Re \leq 10$

Heat producing in system $Q \infty N^{0.28}$

Total heat in system that exit $G \infty N^{2}$

$S = -G + Q$

In above equation G is input power, q exiting heat transfer and S is pure exiting energy.

However, increasing the round is partly proper and after that caused temperature increase and creating more problems.

3- Undefined situation and amount of mixture

Investigating mixture in bi-bolt extruder is too hard especially in a case of considering temperature exchanges. This situation is also on investigating and particularly, the mixture and amount of penetration will change with changing viscosity in polymers and affect the reactions.

4- Hard determination of proper feeding

In order to optimize the reaction, densities and feeding fluid rate had to be determined that is too hard and also feeding situation that affect reaction, is determined hardly.

5- Not specific location of polymer melting

Polymer melting theories in EXTROGEN need more work, so the exact location of polymer can be denoted and system modeling face to challenge.

6- Important factors in reaction extrogen process choosing

In order to choose a proper extrogen process, it had to consider the all aspects, nonetheless some parameters have determining role in reaction that the most important issues of them are as bellow:

1-6 Settlement duration

Long duration remain (it means long period of reaction) has no economical description because it decreases production rate hence reaction duration must be in a way that it would be possible to perform the reaction process in the extruder in other wise it had to be leaved. The significant issue is that, duration of reaction in extruder and discontinuous reactor is different. For instance a reaction that longs 4 hours in discontinuous reactor may be performed in 10 minutes in extruder because of the following reasons.

a) Hard mixture circle in extruder: this causes proper arranging the materials and at the result, reaction will perform fast and properly.

b)Better heat transferring in extruder: in discontinuous reactor, for not burning the materials beside the walls and proper heat transferring in large volume of reaction mixture, firstly temperature is low and secondly, because of improper mixing, heating is performed slowly that make the reaction slower.

c)In extruder, evasive materials emit not reacted monomers through air purging and reuse them again, but in reactor, since not performing this, it needs more time to reach high amount of exchange.

2-6 energy issues

The reaction of **RCH = CH2 ®-RCH -CH2** creates heat almost equals to 16-20 $^{kcal/\ mol}$ that causes continuum polymerization of monomer and phenyl with increase some proportion of temperature degrees that causes products burning therefore, continuum polymerization of vinyl monomers can not be performed in reaction extruders. But temperature difference made by opening of the circle and polymerizing of them is so low so, the increasing polymerization of the decoder circle is performed almost successfully. (such as caprolactam polymerization and forming nylon No.6) because in modifying reactions a little amount of monomer is linked, the produced heat is low and these reactions and polymerizations is capable to perform in reaction extruders.

3-6 extruders' volume

Extruders' volume can be calculated through the following equation:

$V=Q\Ø/f$

In which, Q is external fluid rate, f is the amount of canal filling-in and is required time for reaction.

4-6 the available variations for optimizing processes

Bolt velocity

Products amount

Wall temperature

Raw resistance

Radica density

The rest variables, viscosity and etc are capable to exchange through controlling of these variables but not directly.

5-6 determining starter type

*The affective factors in determining the starter type are as bellow:

The half life: have to be in a type that peroxide must be consumed in existence duration in extruder completely;

**The solubility of starter in polymer: better solubility caused better mixture and better distribution then at the result increasing the proficiency of starter operations.

***Consistency of the starter or the other material that were in polymer before: as already mentioned if commercial poly ethylene was used, peroxide may cause the darkness of the product because of the reaction with luminous stabilizer reaction, so in these cases peroxide type election is important.

Conclusion

There are so many profits in applying extrudes because they can be made in a way that have a reactor role with molding current or even better than that with returning current. Multi processes reaction is also the other benefits of the current in the extruders. The base of the all these mechanisms are the extruder current that the simplest form of them is declared as follow:

A) $Q = Qd+Qp = \acute{\alpha}N-\beta\Delta P/Hl$

B) $Qd = \frac{1}{2}\, n^2D^2NH.Sin\acute{o}Cos\acute{o}$

C) $Qd = (Ndh^3\sin^2\acute{o}) /12n (\Delta P/L)$

D) $\Gamma=NDn/H$

E) $\acute{\alpha} = n^2D^2H(1-ne/t)sin\acute{o}cos\acute{o}/2$

F) $\beta = Ndh^3(1-ne/t)\sin^2\acute{o}/2$

In above equation N, thee velocity of bolt, a and b device parameters design, Q external volume fluid rate, Q_d tensional current volume fluid rate , Qp pressure current volume fluid rate. ή average viscosity, L the length of testing zone, Δp required pressure depression, D the bolt size, H the canal depth, helix angle, n the number of canals, e the unsteady degree and t is the canal width.

Meanwhile, as it already said, there are some restrictions in wider usage of reaction extruders that included the following issues:

a)Hard transfer of reaction heat (in the case of being a lot)

b)High amount of cost for long time reactions

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