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"Experimental Of Controlling Heat Losses Process On Twin-Screw Extruders With Hdpe Material Using Regression Method"

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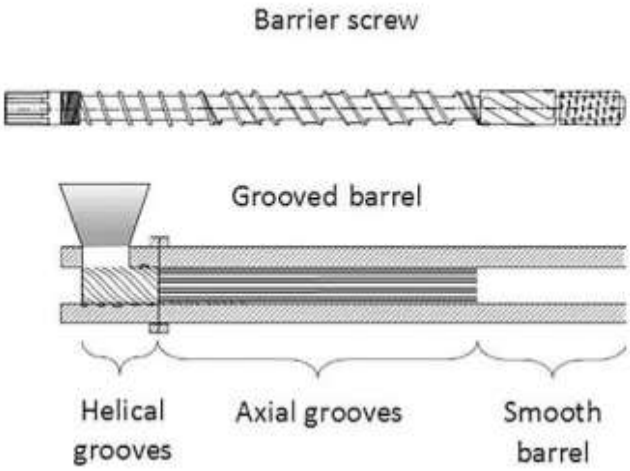
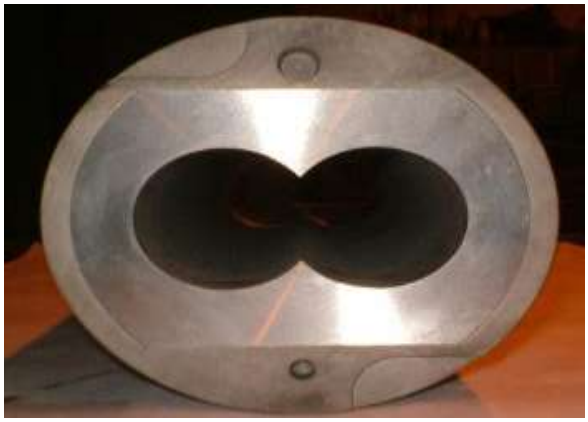
Abstract: The Twin screw extruder machining process (TSE) is a one of the plastic extrusion technology. The quality of parts produced by the TSE machining is significantly affected by various parameters used in the process. In this present research, Three different levels of screw speed, barrel temperature and die zone temperature were selected. The response parameters were tensile strength and impact strength of the High Density Polyethelene (HDPE) polymer material. Investigation of the statistical-mathematical analysis results perform by the ANOVA and Regression analysis in MINITAB software that the optimum processing conditions for the HDPE polymer material,

Keyword: The Twin screw extruder machining process (TSE) is a one of the plastic extrusion orthogonal array, optimize process parameter signal-to-noise ratio, tensile and impact strength. Using taguchi analysis with ANOVA Method and Regression analysis

Introduction: A twin screw extruder is a machine with two Archimedean screws. Twin screw extruders function similarly like a single screw extruders, apart from the fact that they are more effective due to the presence of two screws that generate and mixed, Today, twin-screw extrusion is accepted worldwide for plastic manufacturing. The advanced equipment offers up tothree times the throughput from extruders with similar screw diameters, while at the same time significantly improving feed quality and variety





✓ **Literature**:

Vikash Agarwal, Jyoti Vimal. et al have been found out optimization of extrusion blow molding process parameters by grey relational analysis and Taguchi method. This research work based on extrusion blow molding process for making plastic container of high density polyethylene grade B6401 (HDPE) and experimental runs based on an L9 orthogonal array of Taguchi method. The Taguchi method was performed on plastic material and the process parameters were blowing temperature, blowing time and exhaust/cooling time. They also used an optimal parameter combination of the extrusion blow molding process. Extrusion blow molding process was obtained by grey relational analysis and ANOVA analysis from the response table of the average grey relational grade. **[1]**

Imran Nazir Unar & shaheen Aziz et al. had been found the effect of various additives on the physical properties of polyvinylchloride resin in polyvinyl chloride (PVC) material. They used the different additives for Experimental investigation that was carried out on based PVC

material for analyzing the mechanical properties like tensile strength, elongation at break, hardness and physical property.

✓ **Design of Experiments**

DOE is an experimental strategy in which effects of multiple factors are studied simultaneously by running tests at various levels of the factors. What levels should we take, how to combine them, and how many experiments should we run, are subjects of discussions in DOE.

- **Selection of process parameter**

In this researcher suggests that major part of quality output of TSE machine processed part primarily depends on input factors. Based on these exhaustive literature reviews, selected three important factors such as screw speed, temperature of barrel zone and temperature of die zone are considered to study their influence on Tensile strength and Izod impact strength of TSE machine processed component.

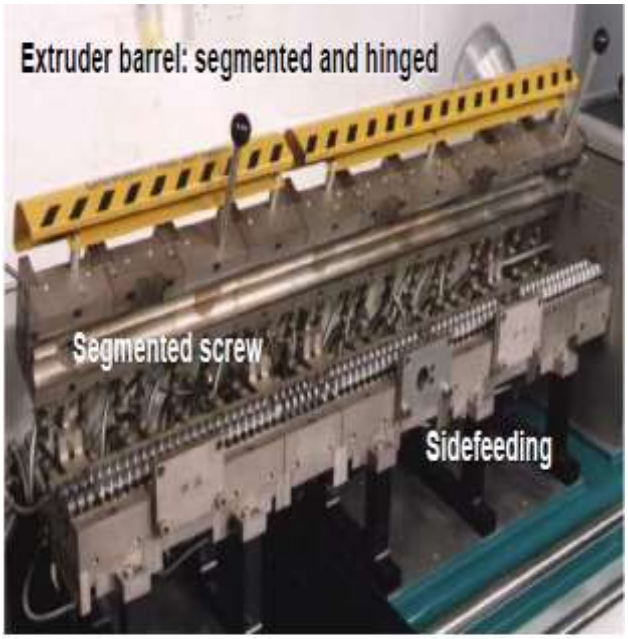
Input parameter	Output parameter
Screw speed (RPM).	Tensile test
Temperature of barrel (C°)	Izod impact test
Temperature of die zone (C°)	

✓ **Factors and their levels in Extruder machine**

Process parameter	Level 1	Level 2	Level 3
Screw speed (rpm)	35	40	45
Barrel Temp. (C°)	175	180	185
Die zone Temp. (C°)	190	195	200

Experimental machine setup

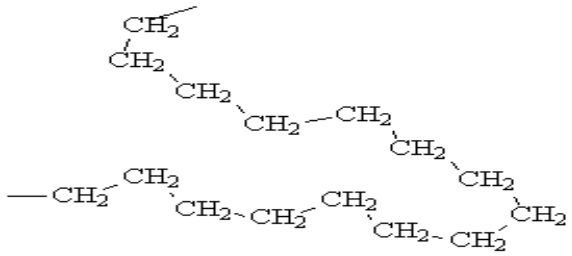
Twin screw extrusion is a continuous processing operation in which a material is extruded by means of the action of two Archimedean screws. The generic term for the devices achieving such an operation is “twin screw extruders”. In this study tensile strength and Izod impact strength is considered as measure of part quality in accordance to industrial requirements. This machine is setup in **Duke Plasto India Pvt. Ltd**



Crush motor	55 kw	**Barrel heating power**	33 kw
Main extruder	90 kw	**Screw effective length**	3300 mm
hree phase induction motor	1000 r/min	**Barrel centre height**	715 mm
DC motor	1000 r/min	**Capacity**	300 kg/h
Screw diameter	100 mm	**Total installed power**	234 kw
Screw speed	120 r/min	**Dimensions**	9132 mm x 4554 mm x 2850 mm

Material

HDPE has a unique amorphous structure with polar chlorine atoms in the molecular structure having chlorine atoms and the amorphous molecular structure are inseparably related. HDPE has completely different features in terms of performance and functions as compared with olefin plastics which have only carbon and hydrogen atoms in their molecular structures. HDPE has molecular formula.



High Density Polyethylene (HDPE)

Testing material

Test specimen for Tensile strength

Tensile properties of HDPE test specimen using SAUMYA universal testing machine (DP-0002) with a load capacity of up to 100 KN, a test speed of 0.01 mm/min to 500 mm/min. The dimension of specimens at Length of 150 mm, width of 10 mm, and thickness are vary

Test specimen for Izod impact strength

Izod test experiment carried out on the Izod impact tester machine KI-042 has pendulum drop angle of 240º, Pendulum weight of 1.3725 kg to 6.575 kg, striking velocity of pendulum is 2.45 m/sec. The dimension of the specimen is length of 63.5 mm, width of 12 mm and notch of 2.5 mm in middle of the specimen.

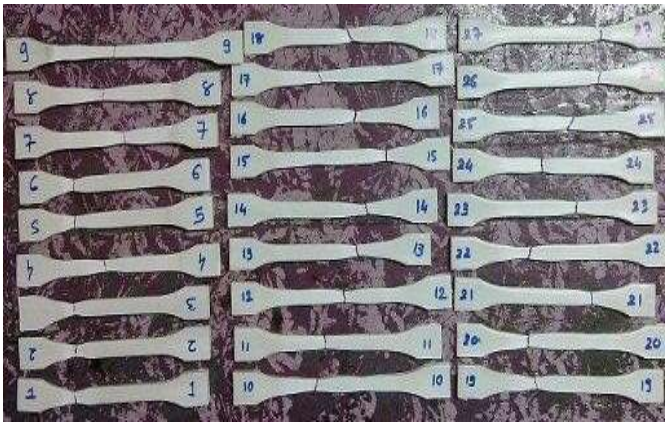


Fig-2 Tensile Testing Method with work-piece

Fig-2 Impact Testing Method with work-piec

Results and Discussion

Exp. No	Screw speed (RPM)	Temp. of barrel (C°)	Temp. of die zone (C°)	Tensile strength (Mpa)	Izod impact strength (Joule)
1	35	175	190	49.38	0.375
2	35	175	195	49.45	0.387
3	35	175	200	49.87	0.429
4	35	180	190	50.69	0.449
5	35	180	195	51.01	0.431
6	35	180	200	50.74	0.476
7	35	185	190	50.12	0.510
8	35	185	195	51.35	0.491
9	35	185	200	51.47	0.479
10	40	175	190	51.33	0.427
11	40	175	195	51.67	0.440
12	40	175	200	51.78	0.447
13	40	180	190	52.72	0.538
14	40	180	195	52.81	0.513
15	40	180	200	52.81	0.489
16	40	185	190	52.88	0.555
17	40	185	195	52.92	0.574
18	40	185	200	52.94	0.579
19	45	175	190	51.16	0.502
20	45	175	195	51.06	0.524
21	45	175	200	51.98	0.517
22	45	180	190	52.37	0.518
23	45	180	195	52.44	0.524
24	45	180	200	52.93	0.540
25	45	185	190	53.74	0.566
26	45	185	195	54.03	0.576
27	45	185	200	54.34	0.602

Regression Analysis: tensile versus screw speed, barrel temp., ...

The regression equation is
tensile = 1.07 + 0.222 screw speed + 0.179 barrel temp. + 0.0497 die zone temp.

Predictor	Coef	SE Coef	T	P
Constant	1.071	7.690	0.14	0.890
screw speed	0.22189	0.02865	7.74	0.000
barrel temp.	0.17900	0.02865	6.25	0.000
die zone temp.	0.04967	0.02865	1.73	0.096

S = 0.607777 R-Sq = 81.6% R-Sq(adj) = 79.2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	37.684	12.561	34.01	0.000
Residual Error	23	8.496	0.369		
Total	26	46.180			

Regression Analysis: izod impact versus screw speed, barrel temp.,

The regression equation is
izod impact = - 1.90 + 0.00936 screw speed + 0.00982 barrel temp.
+ 0.00131 die zone temp.

Predictor	Coef	SE Coef	T	P
Constant	-1.8994	0.2700	-7.03	0.000
screw speed	0.009356	0.001006	9.30	0.000
barrel temp.	0.009822	0.001006	9.76	0.000
die zone temp.	0.001311	0.001006	1.30	0.205

S = 0.0213399 R-Sq = 88.9% R-Sq(adj) = 87.4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	0.083575	0.027858	61.17	0.000
Residual Error	23	0.010474	0.000455		
Total	26	0.094049			

Tensile strength:

- Screw speed, temperature of barrel zone and temperature of die zone significantly effect on tensile strength.
- From the ANOVA results conclude that the screw speed is most influence factor on tensile strength rather than temperature of barrel zone and temperature of die zone
- By the use of the regression analysis for the model confidence level has reached at 95% and the optimum parameter combination for tensile strength is meeting at screw speed of 45 rpm, temperature of barrel zone of 185 C° and temperature of die zone of 200 C°

Izod impact strength:

- Screw speed, temperature of barrel zone and temperature of die zone significantly effect on impact strength.
- From the ANOVA the barrel temperature is most influence parameter on impact strength rather than screw speed and temperature of die zone.
- By the use of the regression analysis to conclude that the optimum parameter combination for impact strength is meeting at screw speed of 45 rpm, temperature of barrel zone of 185 C° and temperature of die zone of 200 C°.

References:

[1] Introduction of extrusion process by "Extrusion process articles".

[2] Visit www.zeusinc.com

[3] Anuj Datar "Micro-extrusion process parameter modeling".

[4] Imran Nazir Unar, Shaheen Aziz, "Effect of various additives on the physical properties of polyvinylchloride resin", Pak. J. Anal. Environ. Chem.-2010,Vol-11(2), PP: 44-55.

[5] Achmat Sarifudin & Alhussein M. Assiry, "Some physicochemical properties of dextrin produced by extrusion process", Journal of Saudi society of agricultural sciences-2013.

[6] Vikash Agarwal, Jyoti Vimal, "Optimization of extrusion blow molding process parameters by grey relational analysis and taguchi method", IJREAS- 2012, Vol. 2(2).

[7] Poostforush M, Al-Mamun M, "Investigation of physical and mechanical properties of High Density Polyethylene/Wood Flour Composite Foams", Research journal of engineering sciences-2013, Vol-2(1), PP: 15-20.

[8] Shao-Yuan Leu, Tsu-Hsien Yang, "Optimized material composition toimprove the physical and mechanical properties of extruded wood-plastic composites (WPCs)", construction and building material-2011, Vol-29, PP: 120-127.

[9] Zhen-Xiu Zhang, Changyun Gao, "Effect of extruder parameters and silica on physico-mechanical and foaming properties of PP/wood fiber composites", Composites: part B 43-2012, PP: 2047-2057.

[10] Yu Dong, Debes Bhattacharyya, "Optimization on property enhancement of polypropylene/organoclay nanocomposites", 16th International conference on composite materials.

[11] M BRNCIC, B TRIPALO, "Effect of twin-screw extrusion parameters on mechanical hardness of direct-expanded extrudates", Sadhana-2006, Vol. 31(5), PP: 527-536