

An Experimental Analysis on the Effect of Filler Material (CaCO_3) On PVC Pipes

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Abstract: The Filler Reinforced composite material as an alternative to traditional material is becoming widespread. The Major technical advantages of these materials are low weight, High specific strength and stiffness, Environmental Resistance and long life when compared to metals, wood & Glass. PVC is one of the composite material to manufacturing structural components such as House pipes, Bottle , Tanks, Automobile and Aerospace Parts etc. The main objective of this work is to determine the PVC Pipe lifespan. By adding CaCO_3 filler in different compositions such as 12kg, 10kg, 8kg the specimens were fabricated and various tests like Tensile test, Impact test, Pressure test have been carried out. Finally Results are concluded by comparing actual composition filler material to varying composition filler material of PVC Pipe.

Keywords: Extruder Machine, Cooling section, Automatic Cutter.

I. INTRODUCTION

Although plastic pipes were in use in Europe as early as 1930s, in India, use of PVC pipes can be traced to 1960s especially for water transportation. Nearly two-thirds of PVC production in the world is consumed in the construction and building industry. Pipes are the largest single articles, consuming about one third of PVC production. With the increase in popularity, the BIS (then ISI) standardized PVC pipes and thus the first issue of IS 4985 was brought out in 1968 covering pipes from 16 to 315 mm. The standard has since undergone three revisions and the current revision in 2000. The standard is greatly in line with ISO 4422 keeping in view the requirements of the global market.

UPVC pipes are now in increased use as an alternate to cast iron, ductile iron and steel pipes. UPVC pipes are highly Economical in comparison to pipes made from other materials. Plastic pipes offer high corrosion resistance to aggressive chemical media. Moreover, due to very smooth surfaces, the pipes are not prone to crust formation on the internal surface, which can have a detrimental effect on the water carrying capacity of the pipe. Ease of handling due to light weight, and ease of lying and Installation are other advantages. Plastic lends itself to extrusion, which has made possible uninterrupted production of pipes in continuous lengths. But, UPVC pipes having a fair amount of rigidity cannot take undue bends. Therefore, although made in continuous lengths, the pipe has to be cut into convenient lengths before they can be joined and laid into a pipeline.

II. EXPERIENTIAL DETAILS

A. Materials:

The essential ingredients in a UPVC formulation are:

- PVC Resin
- Primary Plasticizer

- Secondary Plasticizer
- Stabilizers
 - Heat Stabilizers
 - Light Stabilizers
- Lubricants
- Fillers
- Pigments
- Special Additives

UPVC PIPE COMPOSITION (100 kg)

✓ 8Kg FILLERS

- 80 kg PVC Resin
- 8 kg Filler (CaCO_3)
- 6 kg one pack stabilizer
- 3 kg TiO_2
- 3 kg Wax and carbon black

✓ 10Kg FILLERS

- 78 kg PVC Resin
- 10 kg Filler (CaCO_3)
- 6 kg one pack stabilizer
- 3 kg TiO_2
- 3 kg Wax and carbon black

✓ 12Kg FILLERS

- 76 kg PVC Resin
- 12 kg Filler (CaCO_3)
- 6 kg one pack stabilizer
- 3 kg TiO_2
- 3 kg Wax and carbon black

Manufacturing process:

Several steps during the manufacturing process that are closely monitored to ensure that the product complies with these rigorous standards. Some of these steps are discussed in the section of this chapter on quality control and assurance.

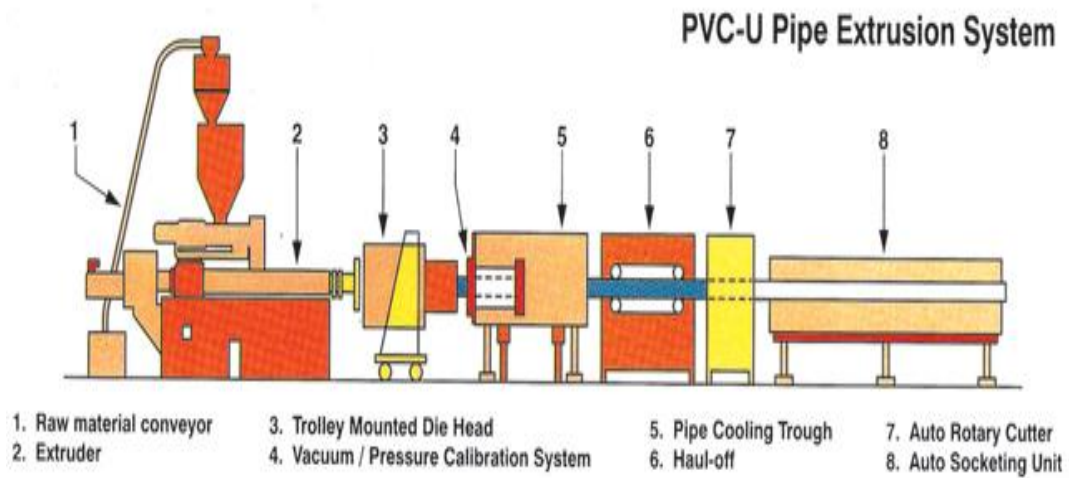
Pipe Extrusion:

The essential aspects of a solid wall PVC pipe manufacturing facility are presented in Figure 1. This section will describe the production of solid wall pipe from raw material handling, extrusion, sizing, cooling, printing, and cutting, through finished product handling. Details concerning profile wall pipe are also discussed in the appropriate sections.

Raw Materials Description:

The quality of the starting resin material is closely monitored at the resin manufacturing site. As discussed in the chapter on test methods and codes in this handbook, a battery of tests is used to ensure that the resin is of prime quality. A certification sheet is sent to the pipe and fitting manufacturer documenting important physical properties such as melt

index, density, ESCR (environmental stress crack resistance), SCG (slow crack growth), stabilizer tests, amongst others. The resin supplier and pipe manufacturer may agree upon additional tests to be Conducted.



Typical Conventional Extrusion Line

III. PERFORMANCE TESTS

IMPACT TEST:

- Impact test is a sudden applied load
- Taking sample piece i.e. 100mm length x 180mm dia
- Kept in refrigeration at 0°C for one hour
- Test pieces are subjected to blows from a falling striker, of specified mass and shape
- Dropped from 2m height on to specified positions around the circumference of the test pieces
- Each sample piece 25 strokes are striking , in that case anyone breaking total batch will be rejected



Tensile test:

- ✓ The ability of the material to resist a force that tends to pull it apart. It is usually expressed as the measure of the largest force that can be applied in this way before material breaks apart
- ✓ Tensile test is to place sample of material between two fixtures called grip's , which clamp the material.
- ✓ The material as known dimensions like length and cross sectional area, we then begin to apply weight to material gripped at one end while the other end is fixed.

- ✓ We keep increasing the weight (often called load are force) while at the same time measuring the change in length of the sample



Reversion Test:

The lot, having satisfied visual and dimensional requirements, shall be tested for reversion.

- First of all we Take 200mm length pipe sample piece then mark 100 mm length at middle at the two corners 50 mm length
- On both sides making holes inserted electrodes and kept in oil bath
- Maintain 150°C in 15 min
- And we will remove sample piece to check the shrinkage of pipe
- It is less than the 5mm shrinkage so it's safe in hot places



12 kg of filler material :

(Shall not alter in length by more than 5% (Max))

Sample No.	Initial Length	Final Length		Average Final Length	Difference in Length (ie) % of Difference	Remarks
		Place -1	Place -2			
1	100	97.66	96.96	97.31	2.69	Satisfactory
2	100	96.1	97.84	96.97	3.03	"
3	100	97.52	96.6	97.06	2.94	"

Size/Class of Pipe : 180mm/6kg/sqcm Nandi
 Batch No : A3.1561
 Quantity : 10 Meters

PHYSICAL PARAMETERS:

AS per IS 4985 : 2000

SL. No.	Out Side Diameter		Wall Thickness		Effective Length	Socket Length	Socket ID
	Min	Max	Min	Max			
1	180.30	180.36	6.15	6.40	6006	124	180.58
2	180.25	180.29	6.20	6.35	6006	125	180.56
3	180.30	180.36	6.28	6.40	6005	127	180.57
4	180.32	180.38	6.18	6.38	6006	124	180.59
5	180.26	180.30	6.21	6.39	6005	126	180.55
6	180.25	180.32	6.25	6.41	6006	122	180.59
7	180.38	180.34	6.27	6.42	6006	115	180.60
8	180.36	180.42	6.17	6.39	6007	115	180.60
9	180.30	180.36	6.16	6.29	6006	115	180.59
10	180.34	180.38	6.18	6.32	6006	122	180.59
11	180.36	180.40	6.19	6.39	6006	124	180.60
12	180.27	180.32	6.20	6.40	6006	126	180.50
13	180.20	180.44	6.19	6.31	6006	124	180.55

Reversion Test : At 150^o C :

(Shall not alter in length by more than 5% (Max))

Sample No.	Intial Length	Final Length		Average Final Length	Difference in Length (ie) % of Difference	Remarks
		Place - 1	Place -2			
1	100	97.66	96.96	97.31	2.69	Satisfactory
2	100	96.10	97.84	96.97	3.03	"
3	100	97.52	96.60	97.06	2.94	"

INTERNAL HYDROSTATIC PRESSURE TEST :

(Shall not fail with in pressure of 4.19 times the class of pipe for 1 hour at 27^o C water temperature)

Sample 1 :: Passed for 26.00 Kgf/cm² at 27^o C for one hour

Sample 2 :: Passed for 26.00 Kgf/cm² at 27^o C for one hour

Remarks :: Test result is Satisfactory

IMPACT TEST : At 0° C :

(External Blows, 1-50)

strokes:: 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,
 26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,
 43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,
 61,62,63,64,65,66,67,68,69,70,71,72,73,74,75.

10KG'S OF FILLER MATERIAL :

Size/Class of Pipe : 180mm/6kg/sqcm Nandi
 BatchNo : A3.1561
 Quantity : 1438 Metres

PHYSICAL PARAMETERS

AS per IS 4985 : 2000

All Dimensions are In mm.

SL. No.	Out Side Diameter		Wall Thickness		Effective Length	Socket Length	Socket ID	REMARKS
	Min	Max	Min	Max				
1	180.30	180.36	6.15	6.40	6006	124	180.58	Satisfactory
2	180.25	180.29	6.20	6.35	6006	125	180.56	"
3	180.30	180.36	6.28	6.40	6005	127	180.57	"
4	180.32	180.38	6.18	6.38	6006	124	180.59	"
5	180.26	180.30	6.21	6.39	6005	126	180.55	"
6	180.25	180.32	6.25	6.41	6006	122	180.59	"
7	180.38	180.34	6.27	6.42	6006	115	180.60	"
8	180.36	180.42	6.17	6.39	6007	115	180.60	"
9	180.30	180.36	6.16	6.29	6006	115	180.59	"
10	180.34	180.38	6.18	6.32	6006	122	180.59	"
11	180.36	180.40	6.19	6.39	6006	124	180.60	"
12	180.27	180.32	6.20	6.40	6006	126	180.50	"
13	180.20	180.44	6.19	6.31	6006	124	180.55	"

OTHER TESTS

Reversion Test : At 150° C

(Shall not alter in length by more than 5% (Max))

Sample No.	Initial Length	Final Length		Average Final Length	Difference in Length (ie) % of	Remarks
		Place -1	Place -2			
1	100	97.98	97.02	97.50	2.50	Satisfactory
2	100	98.10	97.02	97.34	2.67	"
3	100	98.40	98.10	98.25	1.75	"

Remarks :: Test result is Satisfactory

INTERNAL HYDROSTATIC PRESSURE TEST :

(Shall not fail with in pressure of 4.19 times the class of pipe for 1 hour at 27⁰C water temperature)

Sample 1 :: Passed for 26.00 Kgf/cm² at 27⁰ C for one hour
 Sample 2 :: Passed for 26.00 Kgf/cm² at 27⁰ C for one hour
 Remarks :: Test result is Satisfactory

IMPACT TEST : At 0⁰ C

(External Blows, 1-50)

Strokes :: 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,
 26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,
 43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,
 61,62,63,64,65,66,67,68,69,70,71,72,73,74,75.

Samples	NO OF External Blows	Result
1	0/25	Passed
2	0/25	Passed
3	0/25	Passed

Remarks :: Test result is Satisfactory

DENSITY TEST :

(1.40 to 1.46 gm/cc)

Samples Specification	W1 (Grams	W2 (Grams	W1 - W2 = W3	w1/ w3 x 1	Result
1	4.15	1.4312	2.7188	1.53	Pass
2	3.92	1.2220	2.6980	1.45	Pass
3	4.012	1.173	2.8390	1.41	Pass

Remarks :: Test result is Satisfactory

IV. CONCLUSION

- From series of performance tests conducted on the PVC pipes by varying filler material percentage, The following conclusion were drawn
- The strength & lifespan of PVC pipe is increasing with Increase of filler material (CaCo₃) up to 10kg.
- Addition of filler material also reduces the cost per unit.
- Combination of 8 kg filler material with 80 kg PVC resin gives maximum lifespan of above 50 years and cost will be increases of PVC pipes.
- Adding 12 kg filler material and 76 kg of PVC decrease strength and lifespan of PVC pipe
- Finally we concluded that by adding 10 kg filler material (CaCo₃) and 78 kg PVC resin gives good strength, lifespan and cost also reduces.

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