UNION CARBIDE

NEW PRODUCT DATA

UNION CARBIDE CORPORATION · PLASTICS DIVISION · 270 PARK AVENUE, NEW YORK, N. Y. 10017

BAKELITE Rigid Vinyl Powder Blend for Pipe

PRODUCT DESIGNATION
QGPB-9311
Gray 5775
White 5135

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INTRODUCTION

BAKELITE rigid vinyl compound QGPB-9311 is a powder blend designed for rigid pipe applications. QGPB-9311 is a normal impact product whose versatile properties meet both PVC 1120 (Type I, Grade 1) and PVC 1120 (Type I, Grade 2) requirements of the Plastics Pipe Institute of the S.P.I. This compound is approved by National Sanitation Foundation for use in potable water systems and also qualifies under Commercial Standards CS-256-63 (Pressure Pipe) and CS-272-65 (Drain Waste & Vent Pipe)

QGPB-9311 is available as an easy handling, free flowing powder that offers better consistency, greater latitude in the use of regrind, and at the same time, permits higher output rates than pellet compounds. The excellent properties of this rigid vinyl powder suggests its use for water, gas, chemical and petroleum piping systems. Other areas of application include irrigation and sprinkler systems.

PROPERTIES

Powder Blend

The physical properties of QGPB-9311 are listed in Table I which compares the properties of this material with the minimum requirements of ASTM Specification D1784-60T for Type I Grade 1 rigid PVC and a competitive rigid vinyl compound. QGPB-9311 offer advantages in both strength and heat distortion characteristics.

Table I

Property	ASTM Method	Type I Grade 1	QGPB-9311	Competitive Product
Specific Gravity	D1505	-	1.386	1.390
Tensile Strength, psi	D638	7000	8200	7900
Tensile Modulus, psi	D628	400,000	418,000	396,000

- Continued -

Table I (Cont'd.)

Property	ASTM METHOD	Type I Grade 1	QGPB-9311	Competitive Product
Heat Distortion Temp. @ 264 psi °C.	D648	70	75	72
Izod Impact Strength ft.lbs./in. notch	D256	0.65	1.5	1.5
Flexural Strength, psi	D790	11,000	14,530	14,049
Flammability		SE	SE	SE
Chemical Resistance, Sulfuric Acid 93% 14 days floatation at 55°C.	D543			
Change in Weight max.%		+5.0/-0.1	+0.104	+3.4
Change in Flexural Str. max.%		+5.0/-25.0	+1.17	-3.44
ASTM Oil #3 30 days immersion @ 23°C.	D471			
Change in Weight max.%		+1.0/-1.0	+0.0345	+0.0240

Pipe

Instantaneous burst strength of 1" (SDR 13.5) pipe produced from QGPB-9311 is 1450 psi (9100 psi Iso hoop stress). The performance of QGPB-9311 pipe under sustained pressure is excellent. As indicated in Figure 1, the hoop stress is 5200 psi at 2000 hours of testing. Extrapolation of this data by computer indicates the ability of the pipe to withstand 4200 psi (670 psi in 1" SDR 13.5 pipe) for 11-1/2 years (100,000 hours), well above the PPI requirements of 3840 psi for Type 1120 pipe.

Powder vs Pellets

Production of rigid PVC pipe from powder blend has gained widespread acceptance over pellet extrusion in recent years for several reasons. Because of the limited heat history powder blends have received, they possess much greater residual heat stability than hot processed pellets. The better stability permits 30-40°F. higher stock temperature, resulting in substantially higher production rates and better physical properties. The better stability of the powder permits greater regrind percentages without impairing pipe properties.

The higher extruding temperature and the inherently more uniform quality of powder blend give greater assurance of producing pipe of superior quality, providing years of dependable service.

EQUIPMENT

Since the extruder must be depended upon not only to melt the compound as with pellets, but to compact and fuse it before forming the pipe, somewhat different equipment is required to assure successful production from powder.

Extruder

QGPB-9311 can be extruded easily on 2-1/2", 3-1/2" and 4-1/2" machines designed for rigid PVC powder blend materials. To compact the powder from a bulk density of 35 lbs./ft.^{3} to a melt density of 88 lbs./ft.^{3} air must be removed while compacting and fluxing it. This may be accomplished through the use of either a typical vented extruder or a vacuum hopper. QGPB-9311 has been extruded successfully in both ways.

A low shear auger type vertical screw (stuffer) in the hopper is desirable to assure uniform flow of powder to the extruder screw regardless of free flowing qualities of the powder. In addition, the use of the stuffer will increase significantly the output rate; about 30-50 lb./hr. in a 2-1/2" extruder.

The extruder barrel should have provisions for cooling in order to control a rise in stock temperature as screw speed is increased to increase production.

Screw

Because the screw has the greatest influence on the performance of an extruder, careful attention must be given to its design to assure maximum mixing at screw speeds which optimize output rate while limiting stock temperature to 400-410°F.

Any screw handling powder blend should be hard chrome plated to increase its life. A two-stage screw having a length to diameter ratio of 24 to 1 and constant pitch equal to the diameter is recommended. The compression ratio in the first stage where fluxing, compacting and fusing occurs should be 3.0 -3.5/1. Since a fluxed homogeneous stock is delivered to the second stage, less compression is required; approximately 2/1.

The flight depth at the end of the first stage and at the discharge section have an important influence on the shear developed and, therefore, will influence the output rate at given screw speeds as well as the rate of stock temperature rise as the screw speed is increased. The screw should be cored for cooling, preferably with circulating oil, so that the stock temperature can be controlled to achieve optimum performance at various speeds.

A screw design offering flexibility for rigid PVC compositions in a 2-1/2" extruder and well suited for QGPB-9311 will have the dimensions shown in Figure 2. The sections are labelled with the number of flights in

that section shown. The flight depth in the fed, decompression and two metering sections are also indicated.

Dies

Dies should be carefully streamlined to eliminate any potential stagnation areas which could result in material decomposition. All interior surfaces of the die should be polished and chrome plated. Land lengths should be in the range of 10-15 times the average wall thickness of the pipe to assure good welding of the stock past the spiders supporting the pin and to develop gloss. It will be noted the inherently high gloss of QGPB-9311 makes it unnecessary to induce surface gloss by special die and pin temperatures.

No attempt will be made to recommend pin and die sizes since head pressure, stock temperature, output rate, will all influence the swelling that occurs as the stock leaves the extruder and the subsequent shrinkage as the pipe is cooled to room temperature.

Sizing

Because higher stock temperatures are required for good quality pipe from powder blend compared to pellets, handling the less viscous melt is more difficult and may require different sizing arrangements than those used for same size pipe made from pellets.

Sizing with a vacuum has been found to be ideally suited for rigid pipe extruded from QGPB-9311. The vacuum could be applied to a box containing several sizing plates or directly to a water cooled sleeve of about 2" length. Using negative pressure in this way to size the outside diameter of the pipe not only results in saving pipe quickly after start up but avoids the need of maintaining a seal and uniform air pressure on the inside of the pipe. Sizing the inside diameter with a water cooled mandrel can be very difficult. The taper of the mandrel must be exactly right to maintain good contact for rapidly cooling the shrinking pipe without the pipe sizing or dragging excessively on the mandrel. The amount of dimensional change occurring in the pipe over the length of the mandrel is dependent upon stock temperature and extrusion rate which tends to make the taper requirements more critical.

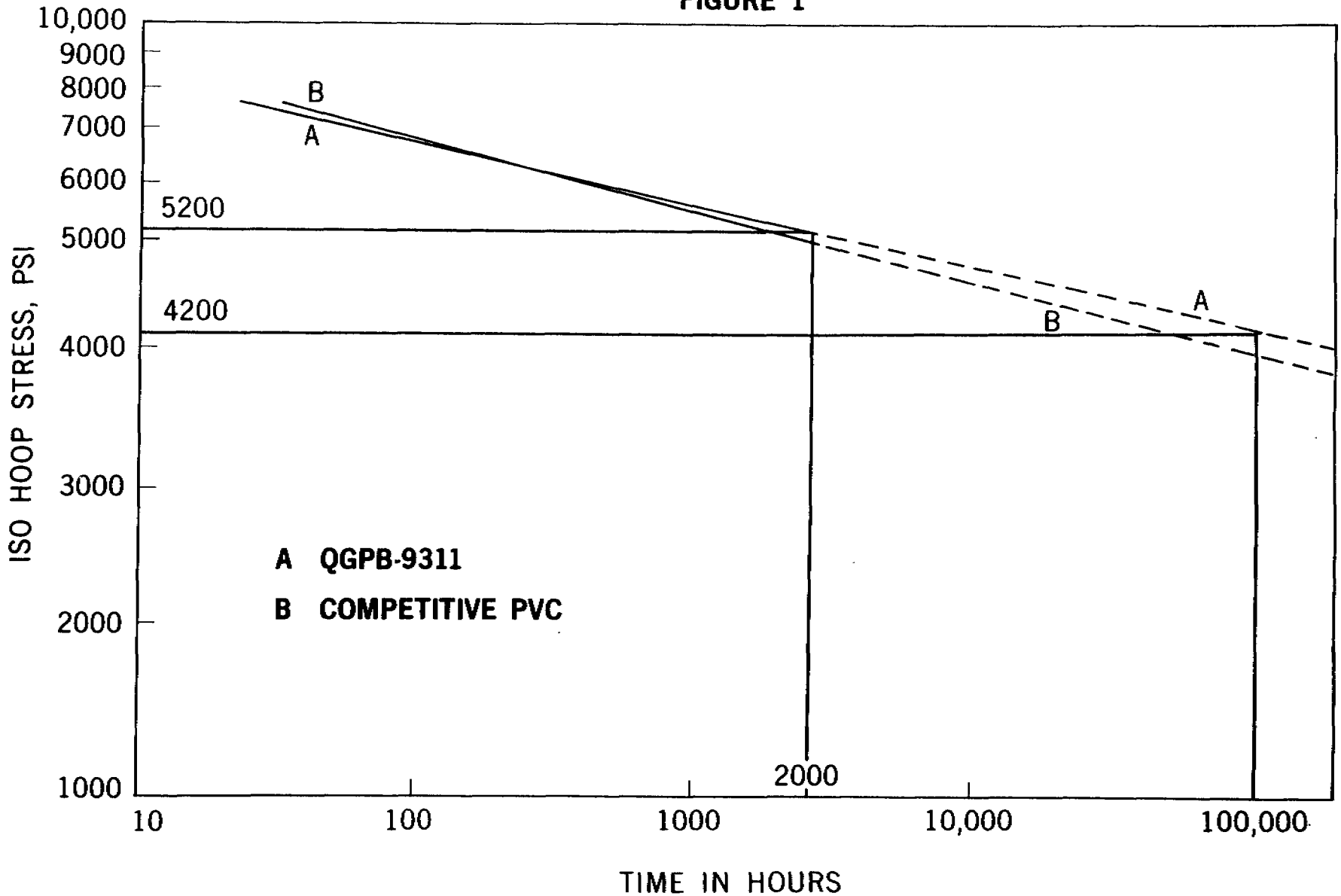
EXTRUSION

A 2-1/2" Davis Standard extruder with a vacuum hopper and hopper stuffer were used to develop QGPB-9311 at Union Carbide Plastics' Application Development Center at Bound Brook, New Jersey. The conditions outlined in Table II resulted in an excellent balance between quality and production rate.

Table II

Temperature		
	Barrel Zones	
1	Feed section	340°F.
2	Transition	360
3	Metering	370
4	Decompression	370
5	Metering	370
	Die Zones	
1	Adapter	350
2	Transition	350
3	Die lands	370
Screen		1-40 mesh
Head Pressure		3000-4000 psi
Screw Speed		65 rpm
	Temperature	180 - 210°F.
Stock Temperature		390 - 410°F.
Rate		180 lbs./hr.
Sizing		
Die		1.420"
Pin		1.226"
Vacuum Sizing Box		
	Sleeve diameter	1.314"
	Distance from die	1.5"
Water Bath		40°F.
Pipe	OD	1.320"
	wall thickness	0.097"

FIGURE 1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6000
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2000
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ISO HOOP STRESS, PSI
B
A
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B COMPETITIVE PVC
10
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TIME IN HOURS

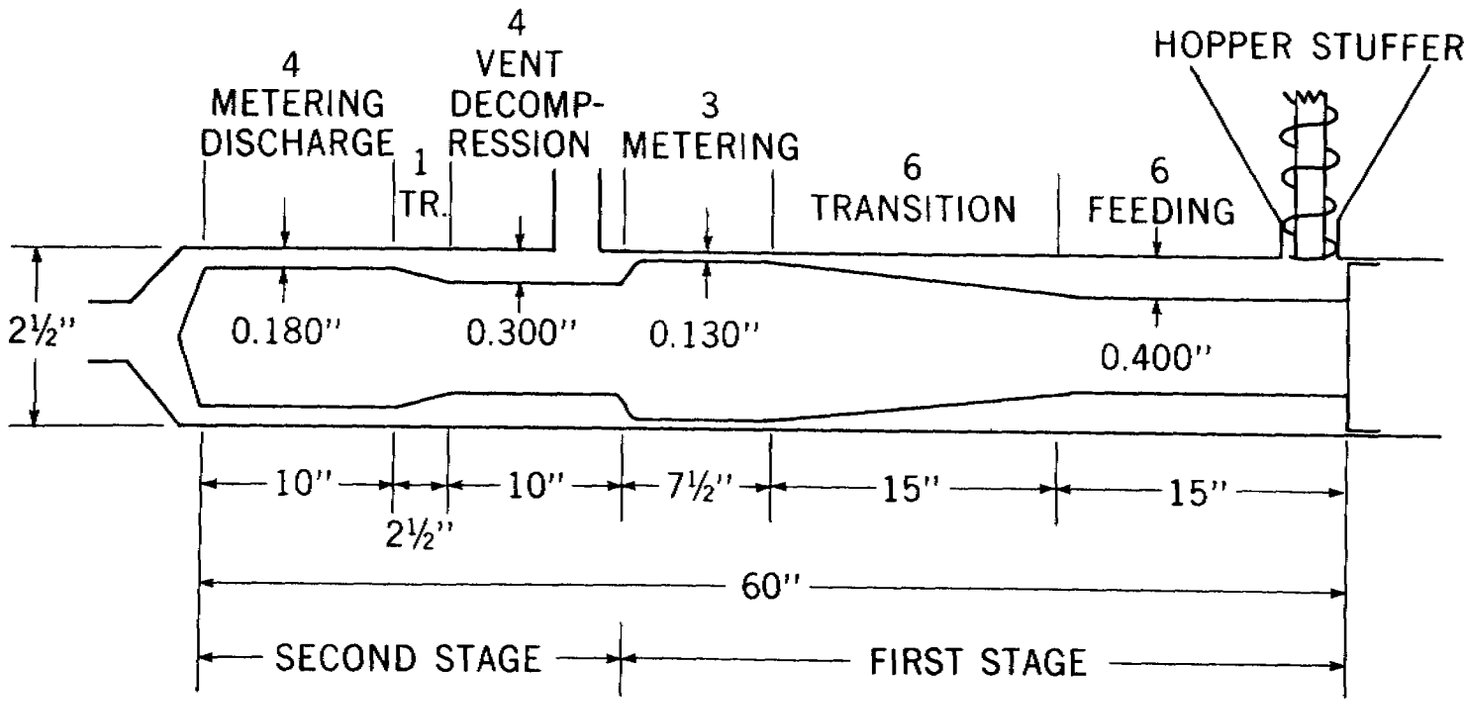
4
METERING
DISCHARGE
1
TR.
4
VENT
DECOMP-
RESSION
3
METERING
6
TRANSITION
6
FEEDING
HOPPER STUFFER
2½"
0.180"
0.300"
0.130"
0.400"
10"
10"
7½"
15"
15"
2½"
60"
SECOND STAGE
FIRST STAGE

FIGURE 2