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B. F. Goodrich Chemical Company
A DIVISION OF THE B. F. GOODRICH COMPANY
DEVELOPMENT CENTER

**BRABENDER DYNAMIC THERMAL STABILITY TESTS
ON
EUROPEAN C-PVC RESINS FROM WACKER AND ICI**

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INTRODUCTION

Samples of five European C-PVC resins were acquired for comparison with our current Geon hi-temp resin production. Two Wacker and three ICI C-PVC resins have been evaluated along with three Geon hi-temp materials via Brabender Plastograph to establish comparative relationships regarding Dynamic Thermal Stability, melt viscosity, and the nature of the changes which take place in the melt as processing progresses. This report discusses the results of these tests.

CONCLUSIONS

1. ICI Corvic C60/97 and Wacker VN40/60 are similar to Geon hi-temp 603X560 in density, Brabender D.T.S., and viscosity.
2. ICI Corvic C50/98 is similar to Geon hi-temp 605X560 in density, Brabender D.T.S., and viscosity.
3. Wacker VN50/60 is a high level chlorination of a PVC resin having a molecular weight considerably lower than Geon 105.
4. None of the foreign C-PVC resins were similar to Geon hi-temp 601X560.

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DISCUSSION

The quantities of European resin which were available for this evaluation were very small, in all but one case sufficient for only one Brabender run. Each batch was separately compounded as follows:

		(Parts)
C-PVC Resin	70 grams	100
Thermolite 31 Stabilizer	2.1 grams	3
Allied AC-629H Lubricant	0.35 grams	0.5

Each batch was weighed into a 6 oz. bottle having a screw lid. The bottles were then packed in a 1 gal. paint can, (carefully padded), and mixed by agitating for 10 minutes on a Red Devil paint shaker. The entire contents of each bottle constituted one Brabender charge.

The Brabender procedure employed in this study paralleled as closely as possible the procedure developed during a recent evaluation of Dynamit Nobel C-PVC resin*. The differences were (1) the use of the paint shaker to mix a 72.45 gram batch as opposed to the previous use of a Waring blender in which 225 gram batches were mixed, and (2) the use of a 72.45 gram Brabender charge rather than a 70 gram charge. The following standard conditions were used in this evaluation:

C.M. Brabender Plastograph
72.45 gram Batch
190° Cavity Temperature
30 rpm Rotor Speed
3' Loading and Preheat Time

The Brabender test results are presented in Table I. No individual value taken singly can adequately describe the results of this test, but several observations do convey more fully than others the character of the various polymer melts under shear. Differential torque (Δ Torque) taken as the difference between fusion torque and some other point along the Brabender curve, is especially meaningful. In this study Δ Torque represents the difference between fusion torque and decomposition torque.

Chlorinated high molecular weight PVC resins which result in products such as Geon hi-temp 601X560 have high fusion torques, (~8000 wt. gm. depending upon compounding), and maintain relatively high torque to decomposition and thus have low Δ Torque. Geon 60 is produced by the chlorination of a lower molecular weight resin, and has been observed to have a high fusion torque, it does have a low Δ Torque. Geon 60 is produced by the chlorination of a low molecular weight resin, and has both lower fusion torque and high Δ Torque.

* Brabender Dynamic Thermal Stability Tests on Dynamit Nobel and Geon hi-temp resins, by H.J. Meyer, D.V. Pappas, May 22, 1958.

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The manner in which Δ Torque can be used to draw conclusions upon the nature of viscosity of the original resin is suggested from the following:

C-PVC Resin	Original Resin	Original Inherent Viscosity	Fusion Torque	Decomposition Torque	Δ Torque
601X560	101EP F-24	1.10	8150	6600	1500
603X560	103EP F-10	0.95	8350	6000	2350
605X560	110X236	0.77	7350	4300	2950

Using fusion torque, decomposition torque, and Δ Torque we can roughly rank the Wacker and ICI C-PVC resins into groups with the comparable Geon hi-temp resins. In examining the data we find that none of the resins tested are similar to hi-temp Geon 601X560. Hi-temp 601X560 appears to be of higher molecular weight than any other tested in this study, has a Brabender DTS time of 9.5 minutes, and a Δ Torque of 1500 mt. gas. Upon decomposition it becomes dry and crumbly- apparently highly crosslinked.

Geon hi-temp 603X560 had a higher fusion torque than the 601X560 sample tested but had a lower decomposition torque, and thus a larger Δ Torque. D.T.S. time for this 603X560 resin was 8.5 minutes. Based upon the several torque measurements we find that ICI's Corvic C60/97 and Wacker's Vinnol VM40/60 are similar to 603X560. Corvic C60/97 was found to be equally as stable as 603X560 while Vinnol VM40/60 was marginally less so.

Geon hi-temp 605X560 had a 7300 mtr. gm. fusion torque and a 2950 mtr. gm. Δ Torque. The two ICI Corvic C90/98 resins compare quite well with 605X560 in viscosity and both are slightly more stable than our 605X560 control.

The Wacker Vinnol VM50/50 resin produced exceptionally low torque values- both fusion and decomposition torque. A density measurement of 1.58 gm/cm³ suggests that it is a highly chlorinated very low molecular weight resin. The long D.T.S. time (13 min.) resulted from the fact that very little shear heating occurred during the processing. The maximum stock temperature generated with Vinnol VM50/50 was 410°F., compared with 430°F. for our lowest molecular weight product hi-temp 605X560.

SUMMARY

It has been indicated that while the European C-PVC resins tested are not quite as stable as Geon hi-temp products, they are certainly equivalent in terms of processing capability. Additional samples of C-PVC resin from these sources should be secured for further testing, as well as samples from Solvay, Dynalene, Mobay, Bannan, and from the Japanese producers of C-PVC resins. This particular test can be run with a sample as small as 70 grams and anyone in possession of this quantity of a European C-PVC resin is encouraged to forward it to the Development Center for possible evaluation.

Reference: 108-175-32

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Table I

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Brabender Plastograph Test Results

	Resins							
	hi-temp 601X560	hi-temp 603X560	Corvic C60/97	Wacker VN40/60	hi-temp 605X560	Corvic C50/98	Corvic C50/98	Wacker VN50/50
Density, gms/cm ³	1.56*	1.56*	1.56	1.55	1.56*	1.57	1.57	1.58
<u>Brabender Observations:</u>								
D.T.S. Time, Min.	9.5	8.5	8.5	7.5	8.5	10	10	13
Torque at Fusion	8150	8350	8200	7700	7350	7650	7600	4850
at 2'	6800	7100	7250	6700	6100	6050	5750	3600
at 4'	6550	7100	6450	6200	5200	4600	4750	3050
at 6'	6500	6250	5850	5950	4650	4300	4400	2850
at 8'	6550	6050	5550		4350	4100	4200	2750
at 10'						4000	3950	2700
at Decomposition	6600	6000	5550	5800	4300	3900	3950	2650
Δ Torque	1500	2350	2700	1900	2950	3750	3750	2200
Stock Temperature, °F.								
at 2'	415	414	410	405	412	412	413	395
at 4'	430	430	426	415	420	422	421	408
at 6'	435	441	436	424	426	425	425	406
at 8'	435	445	441	427	428	428	427	409
at 10'	438	446	442		430	428	427	410
at 12'								410
Δ Temp (Decomp.-Cylinder)	35	43	39	24	26	26	25	8

* Estimated

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