

Bob

A

To: PVC Overview Participants

From: J. L. Irvine
Date: March 19, 1992

Subject: Agenda for the March 24 Training in Aberdeen

Interoffice
Communication

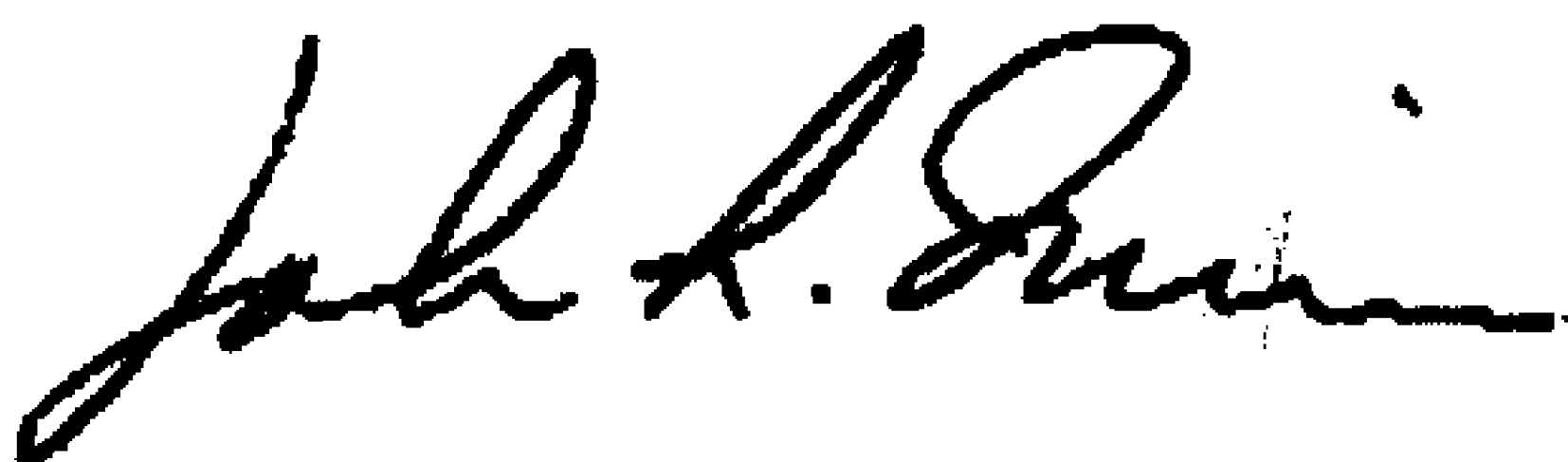
VISTA

Attached is the Agenda for the PVC overview training next week in Aberdeen. We have you scheduled for this session. If you are supposed to be in the in-depth training the latter part of the week, let me or Harold Coleman know and we will get you the correct agenda.

The times are approximate, except for the starting time. Class will be held in the training room of the plant. Lunch will be provided. Dress casually and comfortably. If you want to go on the plant tour bring your safety glasses if you have them. If you don't, they will be provided.

Be prepared in the introduction to tell us what you expect from the class. We can make small changes on the fly to make sure the class is a benefit to everyone. At the end we will see if we were able to meet everyone's expressed need for the class.

We look forward to seeing you there.



John L. Irvine

RESIN/COMPOUND OVERVIEW AGENDA

8:00	Introduction	Harold Coleman
8:15	Resin Overview	Harold Coleman
9:15	Break	
9:30	Resin Overview	Harold Coleman
11:00	Plant Tour	
11:30	Lunch	
12:30	Flexible Compound	John Irvine
2:00	Break	
2:30	Rigid Compound	Randell Jackson
4:00	Summary, Questions, Comments	HGC, JLI, RDJ

A

To: PVC In-Depth Participants

From: J. L. Irvine
Date: March 19, 1992

Subject: Agenda for the March 25-27 Training in Aberdeen

Interoffice
Communication

VISTA

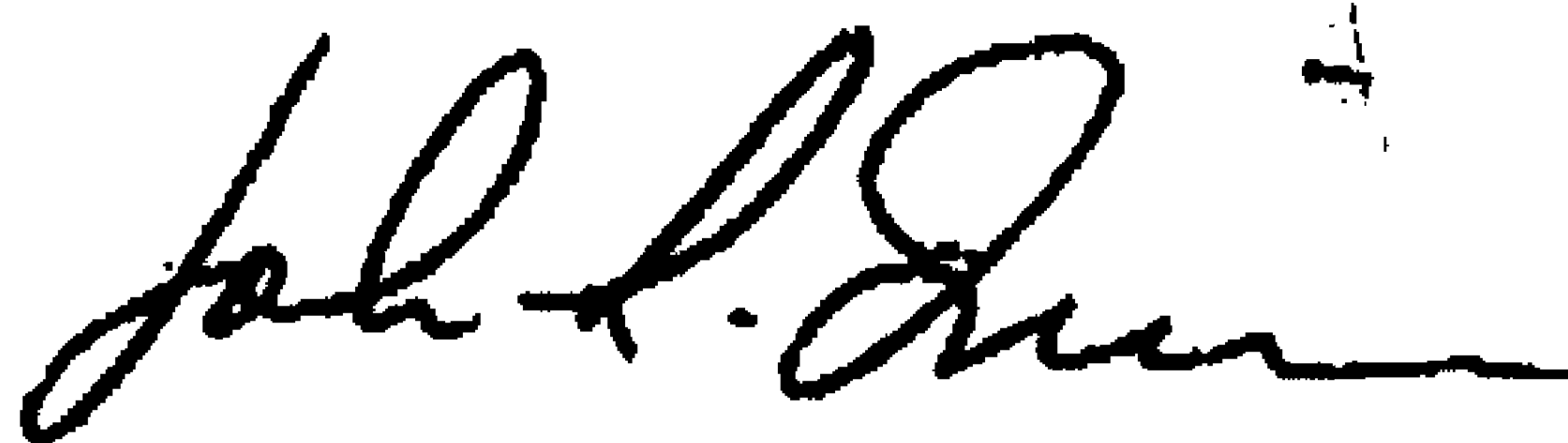
Attached is the Agenda for the PVC In-depth training next week in Aberdeen. We have you scheduled for this session. If you are not supposed to be in the in-depth training, let me or Harold Coleman know. Also let us know if we have you on the wrong day or days. Come to the sessions you are supposed to attend, not necessarily the ones where we have you listed.

The times are approximate, except for the starting time. Class will be held in the training room of the plant. Lunch will be provided. Dress casually and comfortably. If you want to go on the plant tour bring your safety glasses if you have them. If you don't, they will be provided.

Be prepared in the introduction to tell us what you expect from the class. We can make small changes on the fly to make sure the class is a benefit to everyone. At the end we will see if we were able to meet everyone's expressed need for the class.

There will be a group dinner on wednesday night, location still to be decided. If you are not in wednesdays class and want to join us, let me or Harold know so we can include you in the head count.

We look forward to seeing you there.



John L. Irvine

RESIN/COMPOUND IN-DEPTH AGENDA

Wednesday, March 25

8:00	Introduction	Harold Coleman
8:15	Resin Production	Harold Coleman
9:30	Break	
10:00	Resin Production Continued	Harold Coleman
11:30	Lunch	
12:30	Resin Properties	John Irvine
2:00	Break	
2:30	Resin Properties Continued	John Irvine
4:00	Resin Business and Marketing	Mike Clark
5:00	Break	
6:00	Dinner "	

Thursday, March 26

8:00	Resin and Compound Applications	Harold Coleman
8:45	Break	
9:00	Resin and Compound Applications	John Irvine
9:45	Break	
10:00	Resin Competitive Situation	John Irvine
11:00	Plant Tour	
11:30	Lunch	
12:30	Flexible Formulation Technology	Randell Jackson
1:30	Break	
1:45	Flexible Formulation Technology	Randell Jackson

2:45 Break

3:00 Flexible Formulation Technology Randell Jackson

Friday, March 27

8:00 Rigid Formulation Technology Randell Jackson

9:45 Break

10:00 Compounding and Blending Randell Jackson

11:30 Lunch

12:30 Compound Market and Business Fred Williams

1:30 Adios

Tuesday

- 1 Sherry Truitt ✓
- 2 Jim White ✓
- 3 Greg Norman ✓
- 4 Andy Wilson ✓
- 5 Jimmy Autrey ✓
- 6 Don Barclay ✓
- Mike Williams ✓
- Debbie Botkin ✓
- Steve Verner ✓
- 7 Joe Beall ✓
- 8 Bob Seymour ✓
- 9 Steve Hillman
- 10 Linda Michels ✓

Wednesday

- 1 Ted Nickerson
- 2 Doug Skokna
- 3 Amy Bagwell
- 4 Erik Smith
- 5 Reed Mackay
- 6 Tim Arbeiter
- 7 Joe Ganc
- 8 Rory Sneed
- Steve Vincent ?
- Duane Heaton
- Steve Kahara
- Mark Wolverton
- Charlie Muncy
- Carla Foshay
- Jill Wallace
- Ed Marshall
- 9 Kenny Akins
- 10 Mike McCollum
- 11 Roger Crain
- Steve Goodman
- Carol Cooper
- 12 Dan Miller
- 13 Joseph Hegwood
- 14 Craig English
- 15 Mike Swierc
- 16 Gary Wolf
- 17 Richard Williams
- 18 Doug Knittig
- 19 Mike Clark

Thursday

- Doug Skokna
Amy Bagwell
Erik Smith
Reed Mackay
Tim Arbeiter
Joe Ganc
Rory Sneed
Steve Vincent ?
Duane Heaton
Steve Kahara
Mark Wolverton
Charlie Muncy
Carla Foshay
Jill Wallace
Ed Marshall
Kenny Akins
Charles Worlow
Mike McCollum
Roger Crain
Gary Wolf
Debbie Lemmons
Steve Goodman
Carol Cooper
Dan Miller
Joseph Hegwood
Craig English
Mike Swierc
Doug Knittig
Mike Clark

Friday

- Amy Bagwell
Erik Smith
Tim Arbeiter
Joe Ganc
Rory Sneed
Duane Heaton
Mark Wolverton
Charlie Muncy
Carla Foshay
Jill Wallace
Ed Marshall
Charles Worlow
Mike McCollum
Roger Crain
Gary Wolf
Debbie Lemmons
Steve Goodman
Steve Hillman
Dan Miller
Joseph Hegwood
Craig English
Doug Skokna
Mike Swierc
Kenny Akins
Doug Knittig
Mike Clark

WELCOME TO PVC OVERVIEW

VISTA RESEARCH & DEVELOPMENT

Code of Conduct

- ✓ Start on time**
- ✓ Handle business during breaks**
- ✓ No side conversations**
- ✓ Ask questions**
- ✓ Give feedback**
- ✓ Have fun**

PVC OVERVIEW

Objective:

Basic Understanding of PVC

- ✓ Chemistry**
- ✓ Manufacturing**
- ✓ Customers & Markets**
- ✓ Testing**
- ✓ Research & Development**

PVC OVERVIEW

PVC OVERVIEW

AGENDA

Introduction

- Definitions
- PVC Market

Resin

- Markets
- VCM Technology
- Polymerization Chemistry
- Polymerization Processes
- Vista PVC Activities
- Resin Properties

Compound

- Flexible
- Markets
- Formulation
- Manufacturing
- Testing
- What's New

Rigid

- Markets
- Formulation
- Manufacturing
- Testing
- What's New

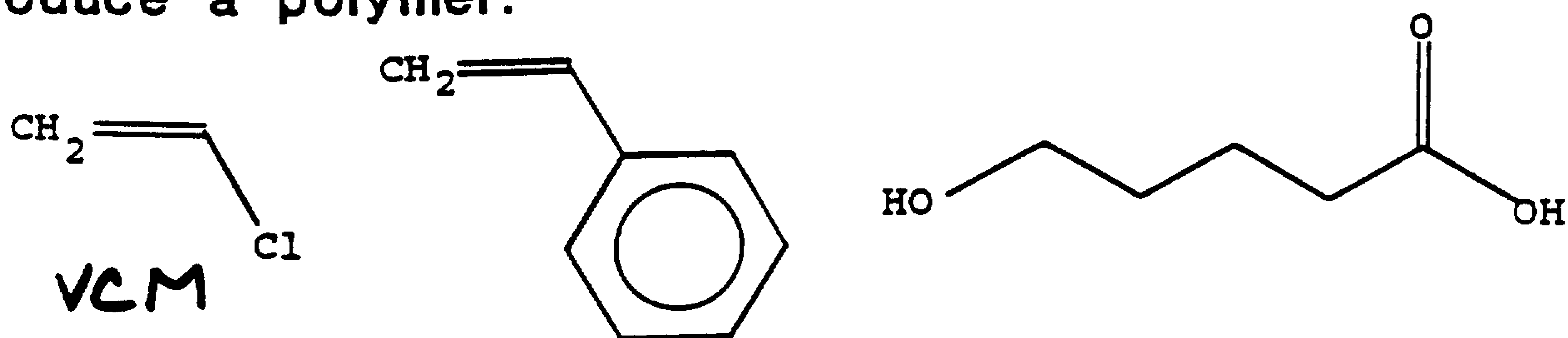
Vista Polymers Research

Summary

Definitions

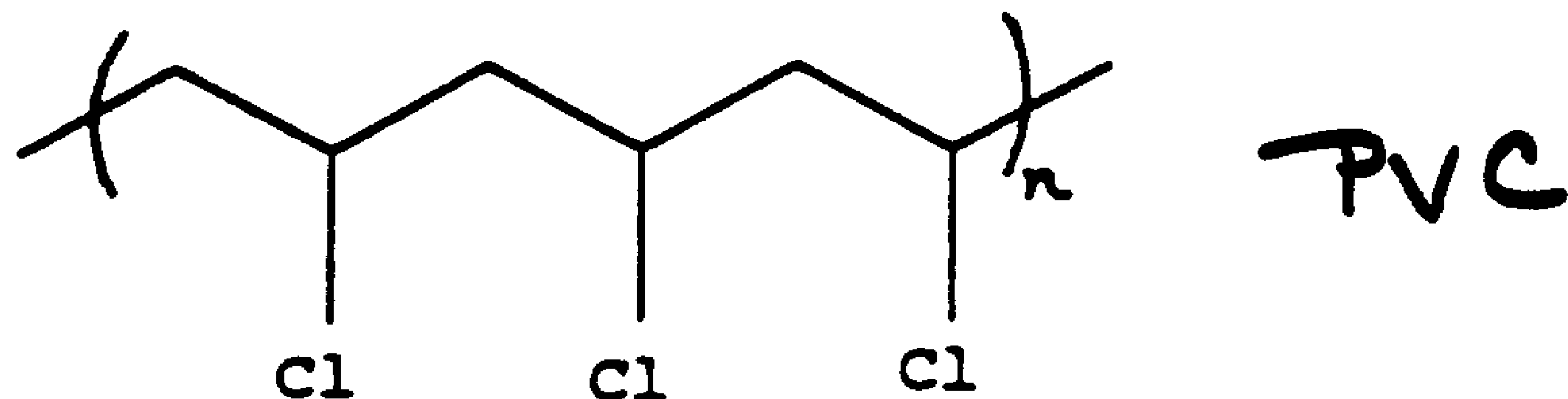
1. Monomer

- A low molecular weight molecule capable of being combined with itself or other similar molecules to produce a polymer.



2. Polymer

- A macromolecule consisting of 5 or more identical combining units called monomers.



3. Polymerization

- A chemical reaction, usually carried out with a catalyst, heat or light, and often under high pressure, in which a number of relatively simple molecules combine to form a chain-like macromolecule.

Definitions (cont.)

4. Vinyl

- Refers to all PVC-containing substances (e.g. copolymers containing VCM or floor tiles containing as little as 15% PVC are called vinyl).

5. PVC

- Polymer produced from vinyl chloride monomer.

6. Resin

- Generally used for non-rubberlike polymers. Refers to the initial form of PVC. Never really pure. PVC resin always contaminated to some extent with initiator, stabilizer, suspending agents, and kill agents. combining units called monomers.

7. Compound

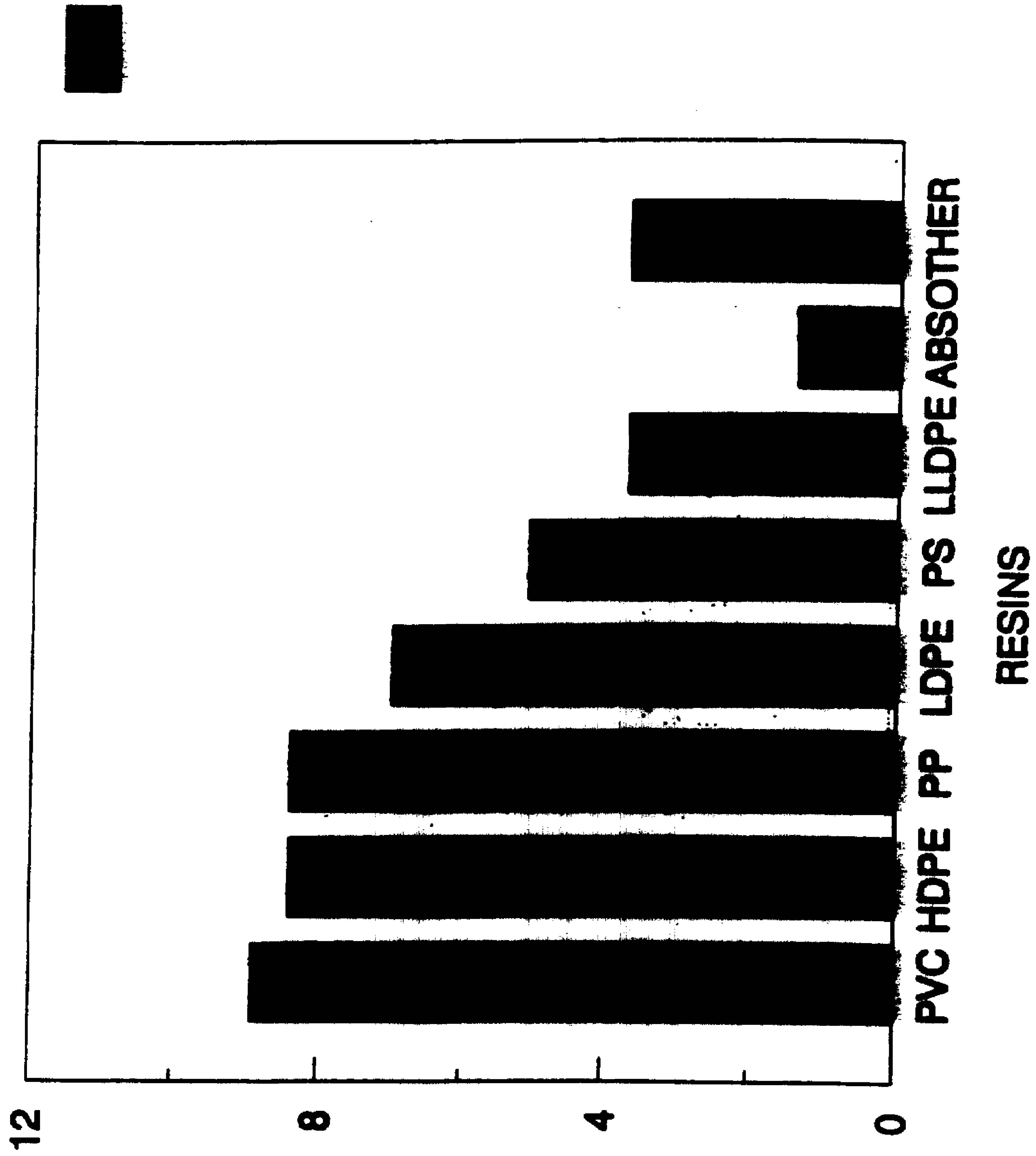
RIGID

Dryblend - Dry free flowing powders containing all the appropriate additives (e.g. stabilizers, plasticizers, etc.).

Pellets - Melt processed material which has been diced

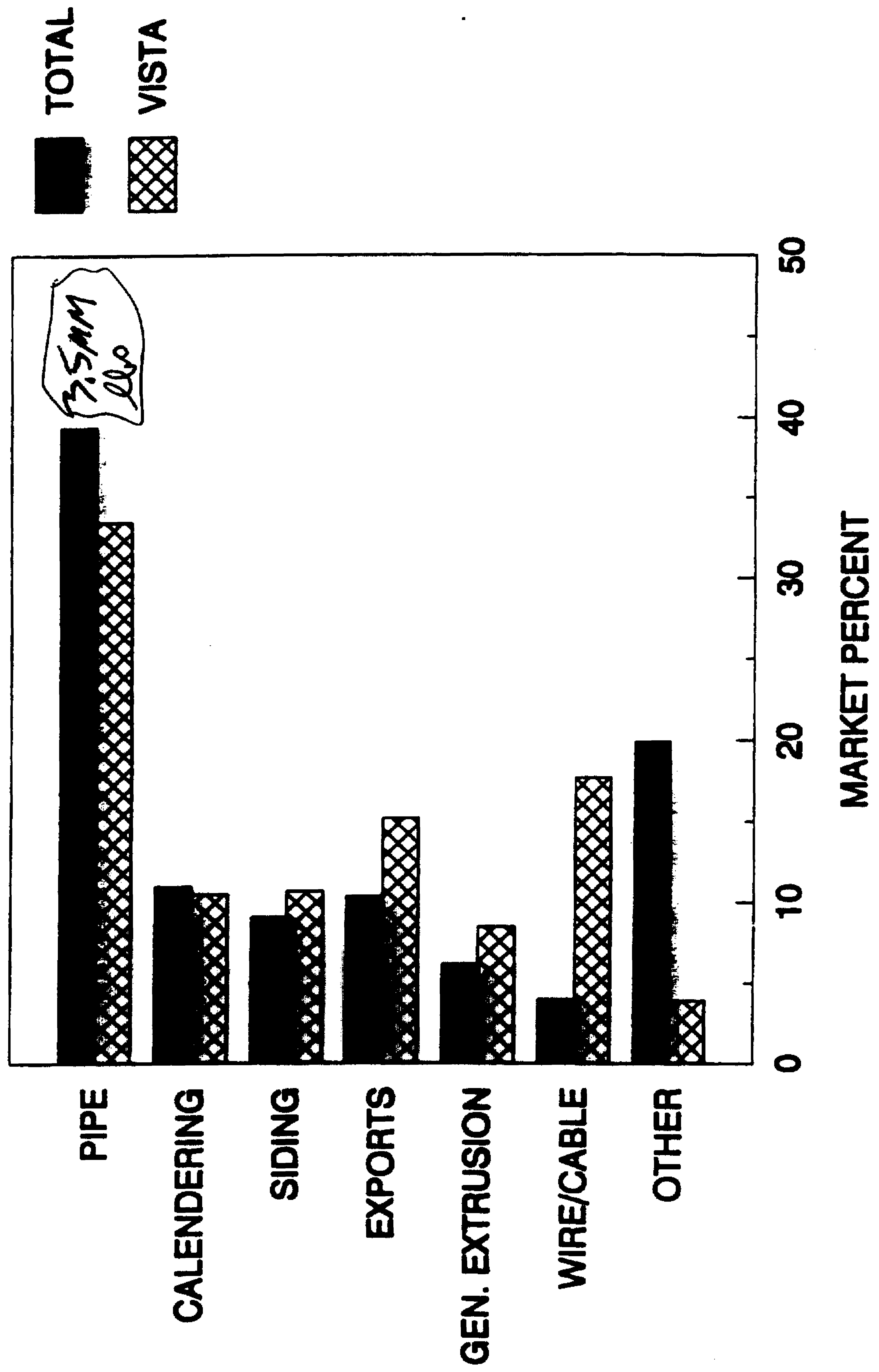
- Both dryblends and pellets can be rigid or flexible compounds.

US COMMERCIAL THERMOPLASTICS PRODUCTION 1990
TOTAL PRODUCTION - 46.8 BILLION POUNDS
BILLION POUNDS

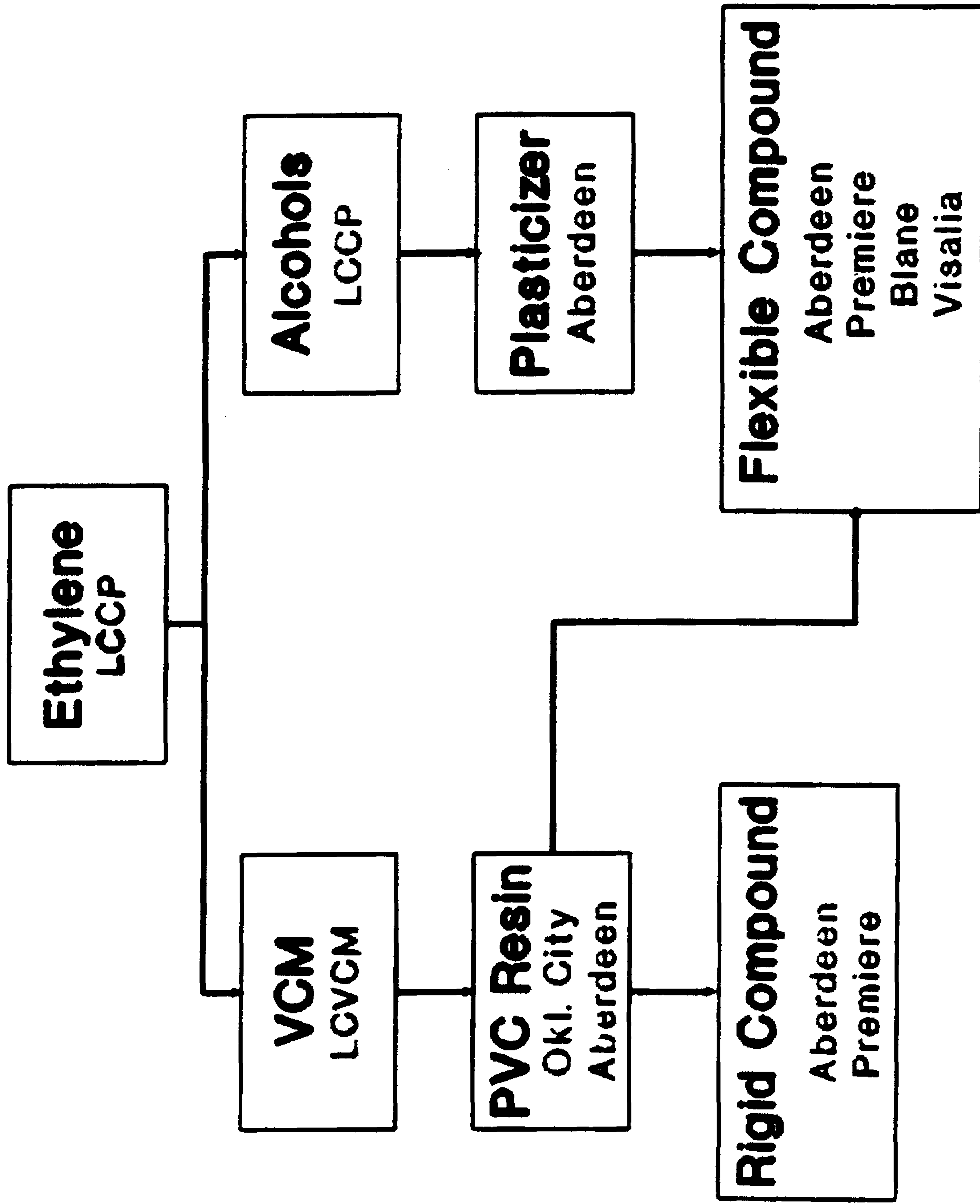


POLYVINYLCHLORIDE - END USE INDUSTRY VS VISTA

APPLICATION

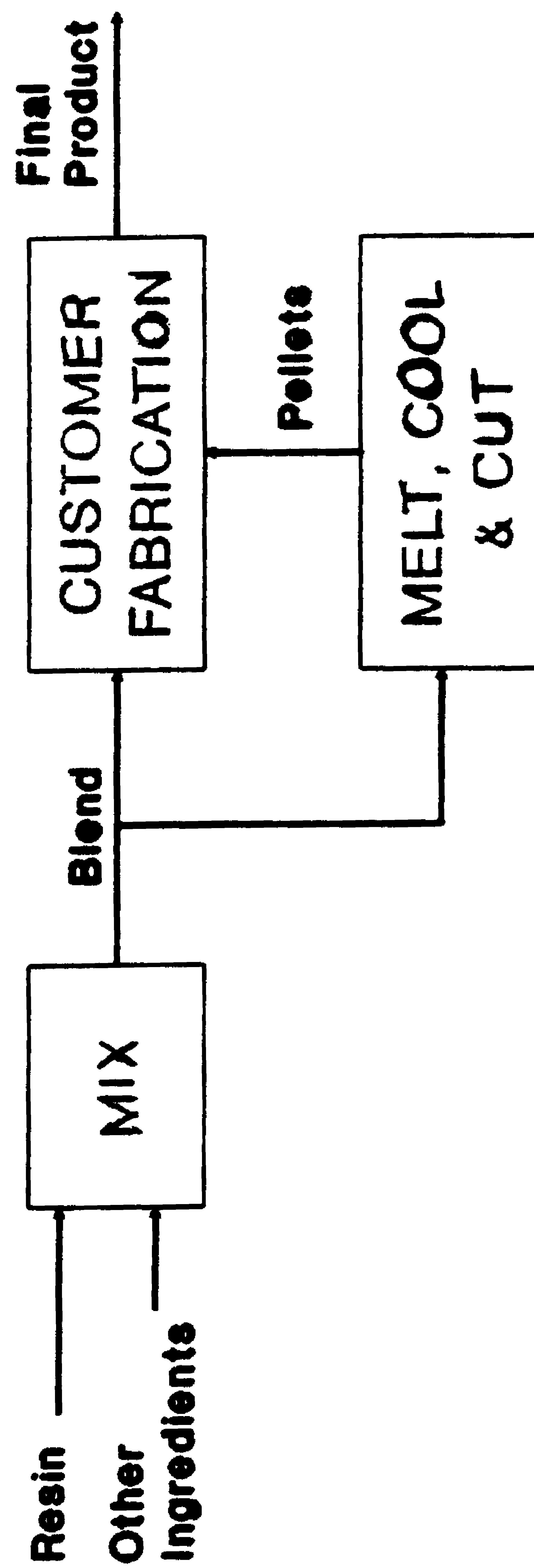


Integrated Product Flow



PVC Compound

Flow Diagram



PVC Manufacturing Plants

Oklahoma City

Resin (5385 only)

Aberdeen

Resin (All MW's)

Flexible Pellets (incl. Plenex™)

Rigid Blend (dryblend)

Plasticizer

Blane Polymers

Flexible Pellets

Premiere Polymers

Flexible Pellets

Flexible Blend (Rotoflex™)

Rigid Blend (dryblend)

Rigid Pellets (Vistel™, Suprel™)

Visalia

Flexible Pellets

PVC MAJOR MARKETS - 1990

Source: Modern Plastics, Jan. 1991

<u>CALENDERING</u>	<u>MM</u>	<u>LBS</u>
Building & Construction	348	
Transportation	90	
Packaging - Sheet	115	
Electrical - Tape	13	
Consumer/Institutional	287	
Furniture/Furnishings	200	
SUB-TOTAL		1053
<u>EXTRUSION</u>		
Pipe & Conduit	3610	
Siding & Accessories	860	
Window Profiles	401	
Transportation	20	
Packaging - Film & Sheet	365	
Electrical - Wire & Cable	410	
Consumer/Institutional	307	
SUB-TOTAL		5973
<u>INJECTION MOLDING</u>		
Building & Construction	182	
Transportation	10	
Electrical/Electronics	135	
Consumer/Institutional	73	
Other	20	
SUB-TOTAL		420
BLOW MOLDING (BOTTLES)		223
COMPRESSION MOLDING (RECORDS)		20
DISPERSION MOLDING		225
DISPERSION COATING		381
LATEXES		65
EXPORT		937

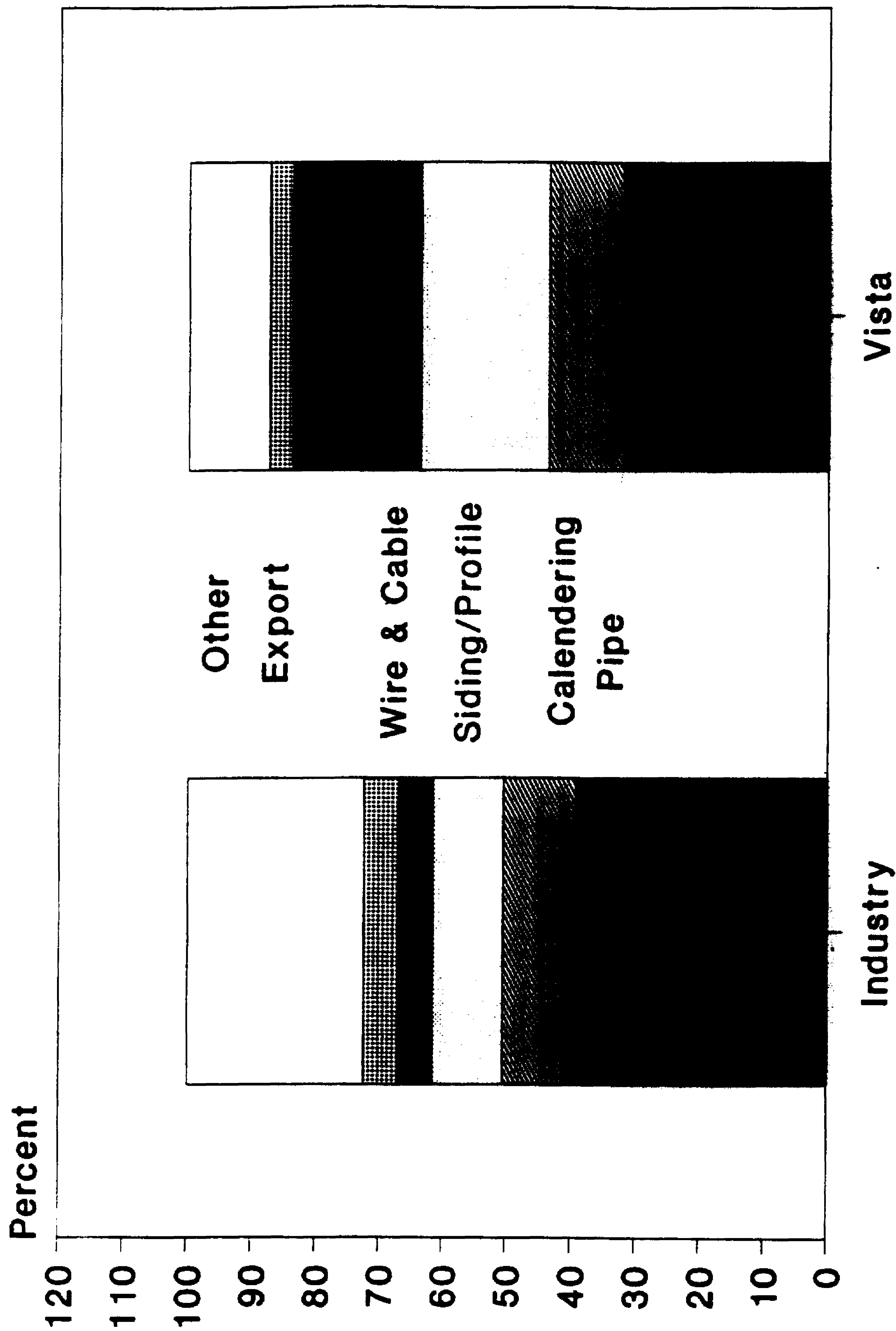
GRAND TOTAL		9297

VISTA POLYMERS

RESIN SALES FY86-FY90

<u>MARKET</u>	<u>FY86</u>	<u>FY88</u>	<u>FY90</u>
PIPE	53 %	35 %	33 %
SIDING	14	23	9
CALENDERING	12	14	13
WIRE & CABLE	7	13	12
FITTINGS	4	2	2
GEM	2	7	7
COMPOUNDERS	2	<1	<1
EXPORT	6	5	24
TOTAL SALES (MM LBS)	588	611	658

PVC END-USE PROFILE 1988



DOMESTIC PVC NAMEPLATE CAPACITY

<u>SUPPLIER</u>	1981 CAPACITY		1990 CAPACITY*	
	<u>MM</u>	<u>LBS</u> <u>%</u>	<u>MM</u> <u>LBS</u>	<u>%</u> (DISP)
OCCIDENTAL	650	9	2100	19
TENNECO	890	12	-	-
SHINTECH	730	10	2000	18
FORMOSA	180	2	1855	16
BF GOODRICH	1280	18	1750	15
DIAMOND SHAMROCK	620	9	-	-
GEORGIA GULF	705	10	860	8
VISTA	715	10	850	7
BORDEN	450	6	800	7
PW RESINS (APCI)	360	5	500	4
OTHERS	650	9	630	6
	-----		-----	
TOTAL	7230	-	11345	-

Modern Plastics, Jan. 1991

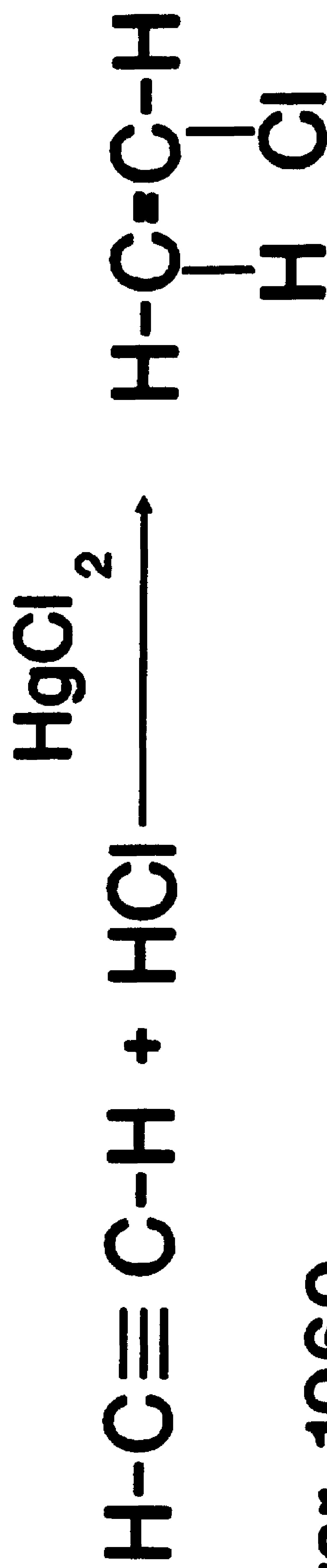
* INCLUDES ALL PLANNED EXPANSIONS

NAMEPLATE CAPACITY 1/1/92*

SUPPLIER	SUSPENSION	DISPERSION
SHINTECH	2000	
OXYCHEM	1900	200
FORMOSA	1789	96
BFGOODRICH	1600	150
BFG 1993	1100	150
VISTA	840	
GEORGIA GULF	810	48
BORDEN	795	55
WESTLAKE	500	
CERTAINTEED	265	
VYGEN	125	

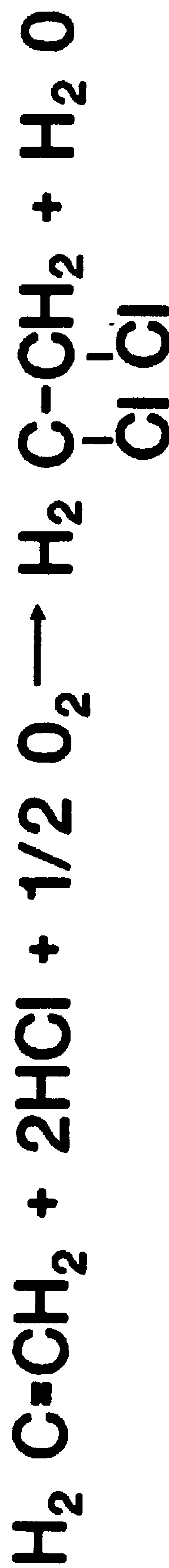
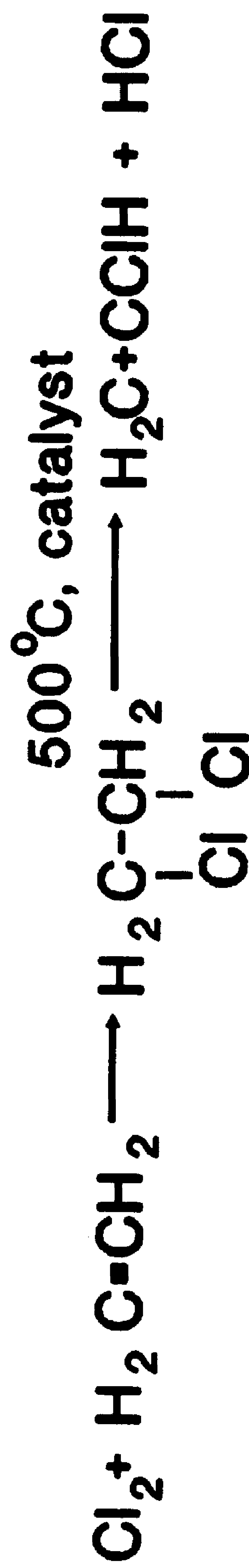
PREPARATION OF VINYL CHLORIDE

Hydrochlorination of acetylene



After 1960

oxychlorination/cracking of dichloroethane



MORE PROPERTIES OF VCM

A

1. SOLUBLE IN ETHYL ALCOHOL, DIETHYL ETHER,
BUT NOT WATER
2. VOLUME DECREASES WHEN POLYMERIZED BY 35%

SAFETY

1. NARCOTIC
2. CAN CAUSE LOSS OF CONSCIOUSNESS
AT HIGH CONCENTRATION
3. SUSPECTED CARCINOGEN
 - A. ANGIOSARCOMA
 - B. AOL - BONE DISORDER
4. TERATOGEN - FETUS AFFECTS IN PREGNANT WOMEN
5. OSHA LIMITS
 - A. 1 PPM OVER 8 HOURS
 - B. 5 PPM IN 15 MINUTES
6. MONITORS (BADGES) RECOMMENDED
7. FRESH AIR MASKS REQUIRED

HANDLING AND STORAGE

1. ORDINARY STEEL CONTAINERS
2. ONLY MILDLY CORROSIVE
3. MUST BE KEPT ACIDIC AND OXYGEN-FREE

Lead Chloride Regulations

0.5 ppm

1.0 ppm

5.0 ppm

Vinyl Chloride Regulations (Cont'd)

400 ppm

20 Lbs

Vinyl Chloride Per Million Lbs. PVC Produced

10 ppm

POLYMERIZATION CHEMISTRY

POLYMERIZATION STEPS

1) Initiation

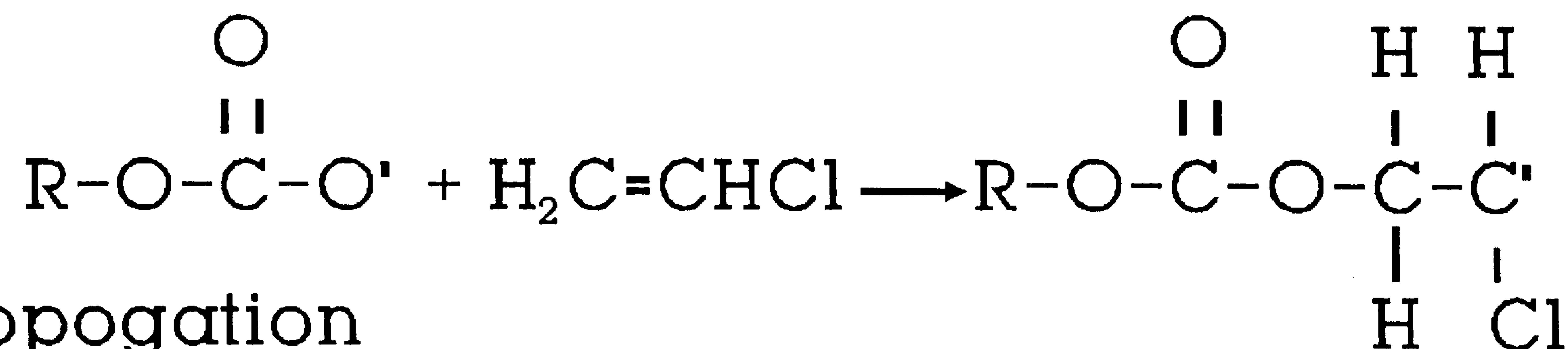
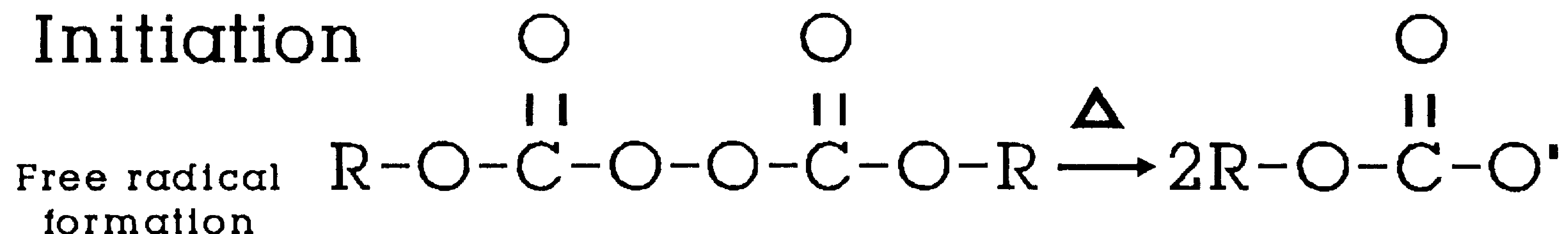
2) Propagation

3) Chain Transfer

4) Termination

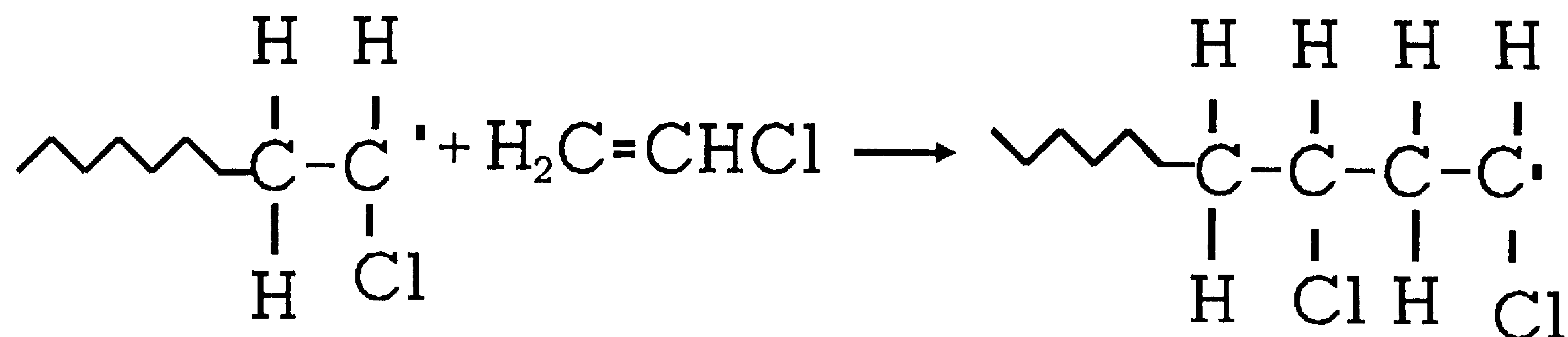
MECHANISM OF POLYMERIZATION

1. Initiation

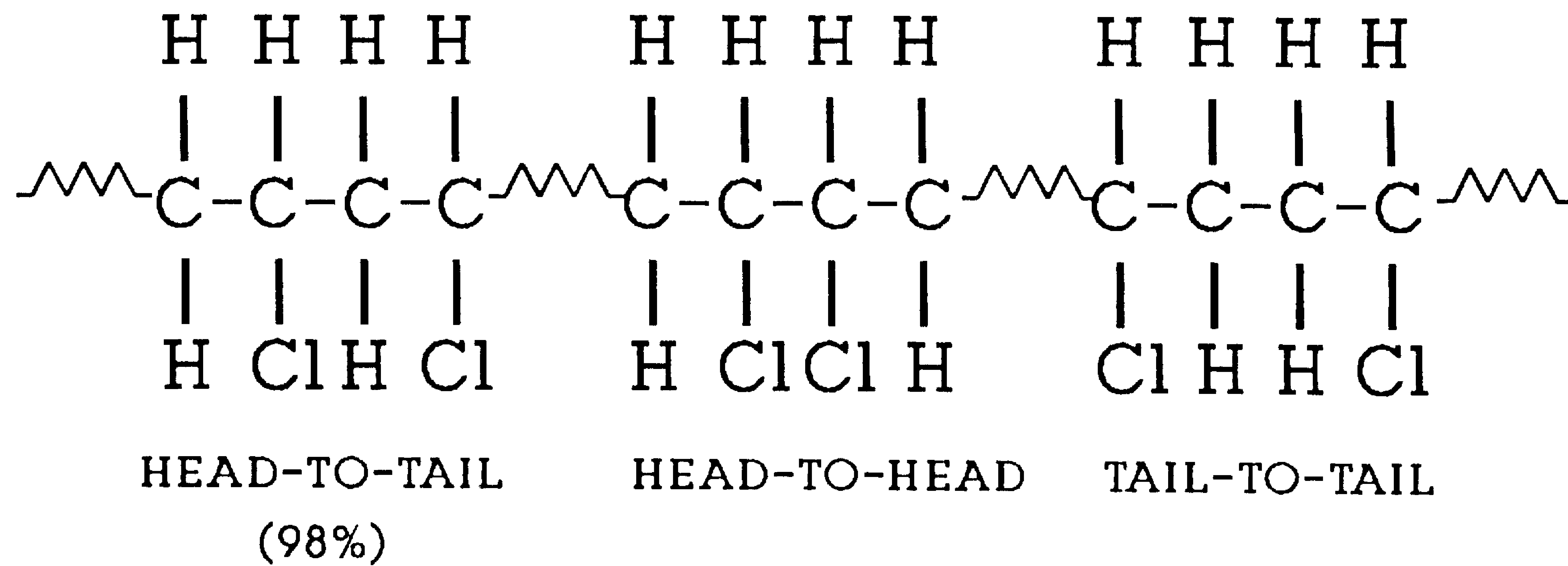


2. Propagation

note head to
tail addition



STRUCTURE OF PVC

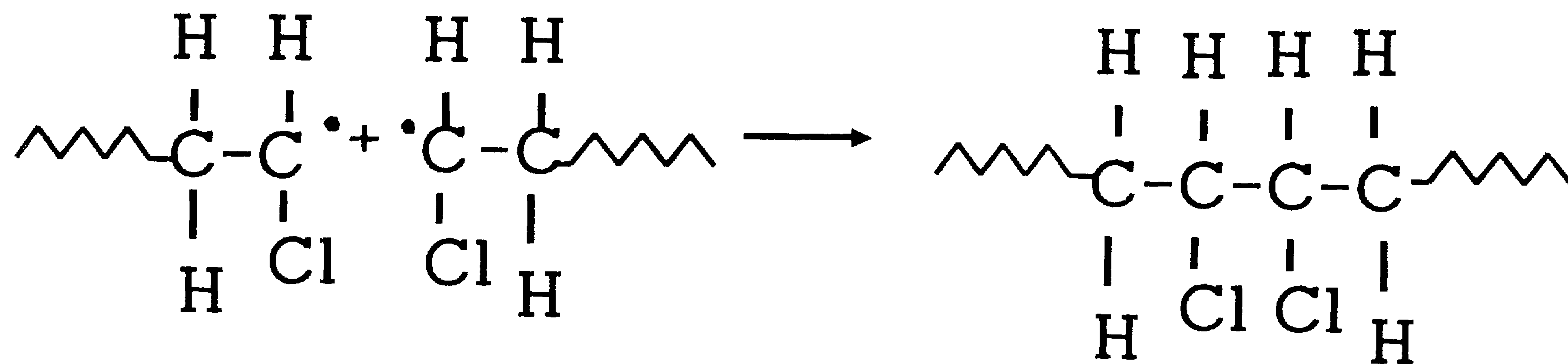


MECHANISM OF POLYMERIZATION

3. Chain Transfer



4. Termination Recombination



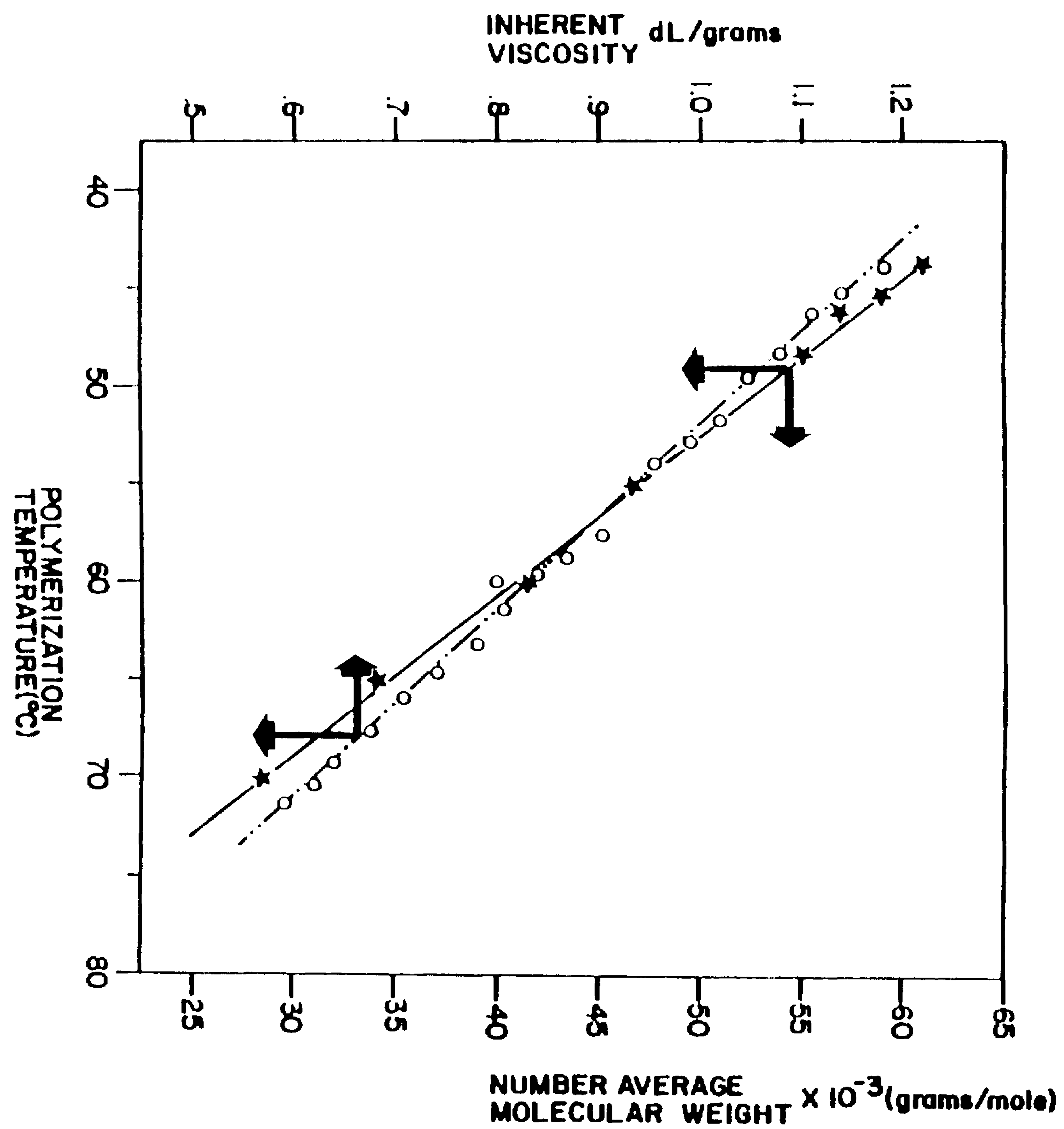
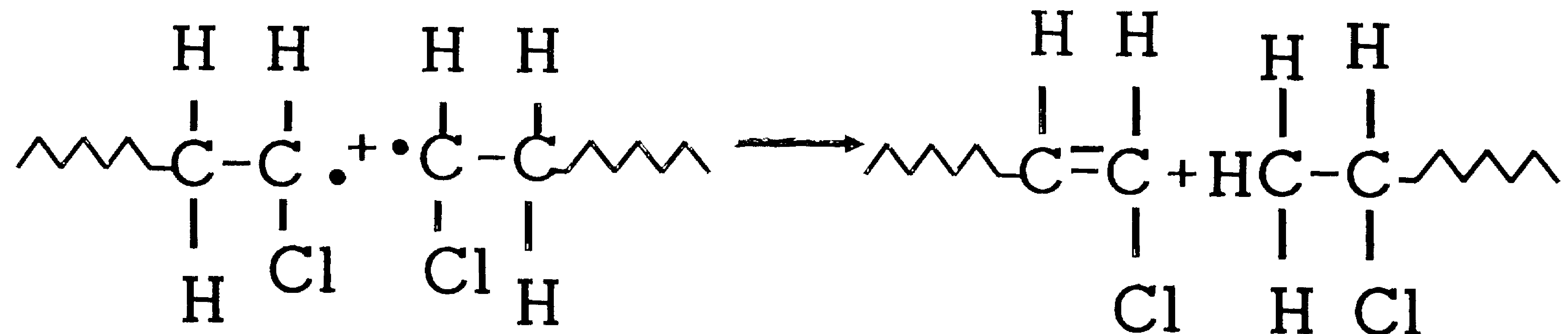


FIGURE 2 - INHERENT VISCOSITY AND NUMBER AVERAGE MOLECULAR WEIGHT VS POLYMERIZATION TEMPERATURE.

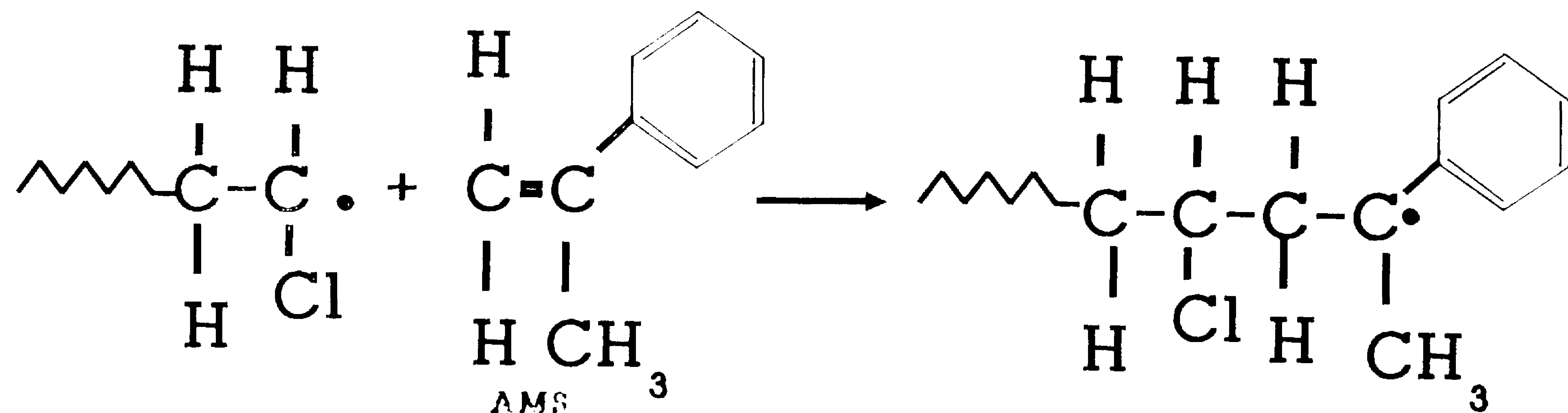
MECHANISM OF POLYMERIZATION

4. Termination

Disproportionation



K111



POLYMERIZATION PROCESSES

MASS (BULK)

EMULSION

SOLUTION

SUSPENSION

MASS (BULK) POLYMERIZATION

Manufacturers: Pechiney St. Gobain
BFG - Plaquemine, LA
Occi - Burlington, NJ
(closing down)

Two-stage batch process

Polymerization starts in VCM phase, then precipitates.

Advantages:

1. Very uniform, porous particles.
2. High bulk density.
3. Free of suspending agent and water contaminants.

Disadvantages:

1. Difficult to control temperature (mol wt).
2. More expensive than suspension.
3. Difficult to strip residual VCM.

Markets: Same as suspension except for molding.

EMULSION POLYMERIZATION

Manufacturers: Borden
BFG
Occi
Formosa
Georgia Gulf

Process:

1. Soaps used to form "micelles" in water.
2. Water-soluble initiator encounters VCM in micelles.
3. Diffusion from monomer droplets to micelles replaces polymerized VCM.

Advantages:

1. Very uniform, small, nonporous particles.
2. Processes easily (plastisols) without much heat.

Disadvantages:

1. High contamination level of soap.
2. Poor heat stability.
3. High cost - energy intensive drying.

Markets: Plastisols - used for coatings and molding.

DISPERSION POLYMERIZATION

Manufacturers: Occi (others?)

Similar to emulsion, except:

1. Monomer soluble initiators.
2. No micelles are formed; instead, high mechanical shear is used in a preliminary step to form droplets.

Advantages:

1. Same as emulsion.

Disadvantages:

1. Same as emulsion.

Markets: Same as emulsion. The terms "emulsion resins" and "dispersion resins" are used interchangeably in the industry. Resins used in plastisols can be made by either emulsion or dispersion processes.

SOLUTION POLYMERIZATION

Manufacturers: Union Carbide

Process:

1. Mostly PVC/polyvinyl acetate copolymers.
2. Polymerized in a solvent (n-butane), then precipitates.
3. Not much is known about UC's process.

Advantages:

1. Similar physical properties as bulk.

Disadvantages:

1. High cost.
2. Solvent recovery/environmental.
3. Limited market.

Markets: Can liners.

SUSPENSION POLYMERIZATION

Manufacturers: Vista and many others

Process:

1. Mostly homopolymer, but some PVC/polyvinyl acetate copolymers.
2. VCM droplets suspended in water.
3. Initiator is monomer soluble.

Advantages:

1. Easily controlled temperature.
2. Easily filtered and dried.
3. Low cost.

Disadvantages:

1. Small change in conditions alters properties.
2. Not as pure as mass or solution.

Markets: Extrusion, molding, calendering...

Virtually unlimited.

THE SUSPENSION PROCESS

THE ROLE OF WATER

1. **ACT AS A CONTINUOUS PHASE AND ENABLE VCM TO BE DISPERSED**
2. **ACT AS A HEAT TRANSFER MEDIUM**
3. **CARRIER FOR PROTECTIVE COLLOID (SUSPENDING AGENT)**

THE ROLE OF SUSPENDING AGENT

1. **CONTROLS PARTICLE-SIZE DISTRIBUTION**
2. **KEEPS VCM DROPLETS DISPERSED**
3. **FACILITATES HEAT TRANSFER AND AGITATION**

THE ROLE OF THE AGITATOR

1. **PRODUCES DESIRED PARTICLE SIZE**
2. **MAINTAINS SUSPENSION DROPLETS AND PVC GRAIN**
3. **ENSURES GOOD HEAT TRANSFER**

THE ROLE OF THE INITIATORS

1. CONTROLS RATE OF POLYMERIZATION
2. CONTROLS RATE OF HEAT EVOLUTION
3. AFFECTS NUMBER OF GELS IN RESIN

CHAIN TRANSFER AGENTS

FUNCTION: TERMINATE MACRORADICAL CHAIN AND INITIATE NEW CHAIN.

EFFECT: TERMINATE CHAINS AT SHORTER LENGTH THAN NORMAL FOR A GIVEN TEMPERATURE.

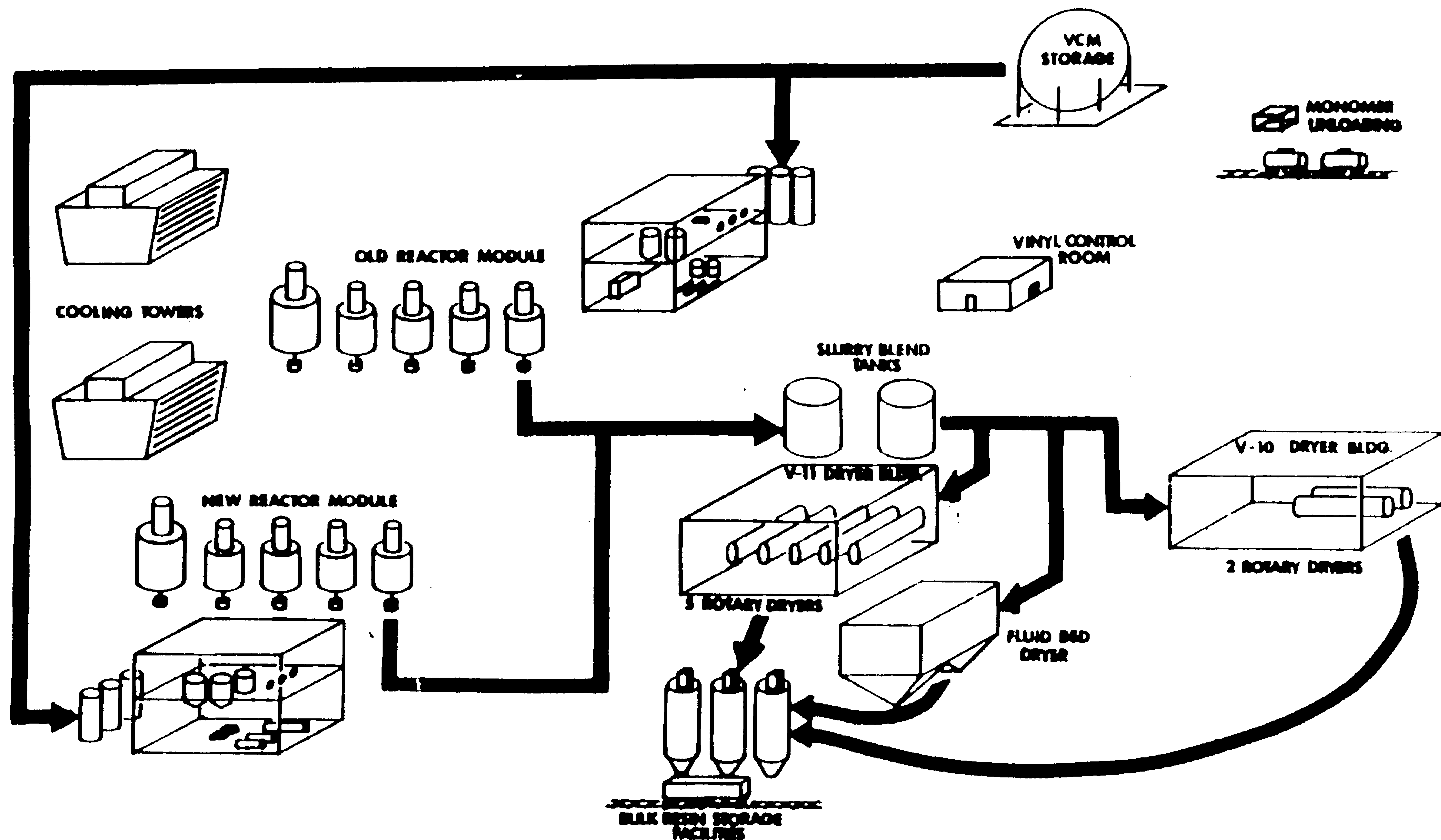
PURPOSE: ALLOWS PRODUCTION OF LOW MOLECULAR WEIGHT PVC AT LOWER TEMPERATURE (AND PRESSURES).

CHARACTERISTICS OF PVC POLYMERIZATION PROCESSES

	Resin Polymerization Type			
	<u>Suspension PVC</u>	<u>Emulsion PVC</u>	<u>Mass or Bulk PVC</u>	<u>Solution PVC</u>
Ingredients:				
Monomer(s)	VCM	VCM	VCM	VCM/Vinyl Acetate
Initiator Solubility	VCM	Water	VCM	VCM
Suspending Agent	Protective Colloid	Soap	None	None
Reactor Agitation	High Shear	Low Shear	High then Low	Low
Market Rank (Lb. Basis)	1st	2nd	3rd	Distant 4th
Mean Particle Diameter	150 μ m	10 μ m	150 μ m	Solution
End Use	Rigid Flexible Extrusion Film Blown Calender Molding	Pastes Latex Dispersions Creams	Rigid Flexible Extrusion Film Blown Calender	Beer Can Liners

VISTA POLYMERIZATION PROCESS TECHNOLOGY

ABERDEEN PVC OPERATIONS



POLYMERIZATION CYCLE

CHARGE

POLYMERIZATION

RECOVERY & STRIPPING

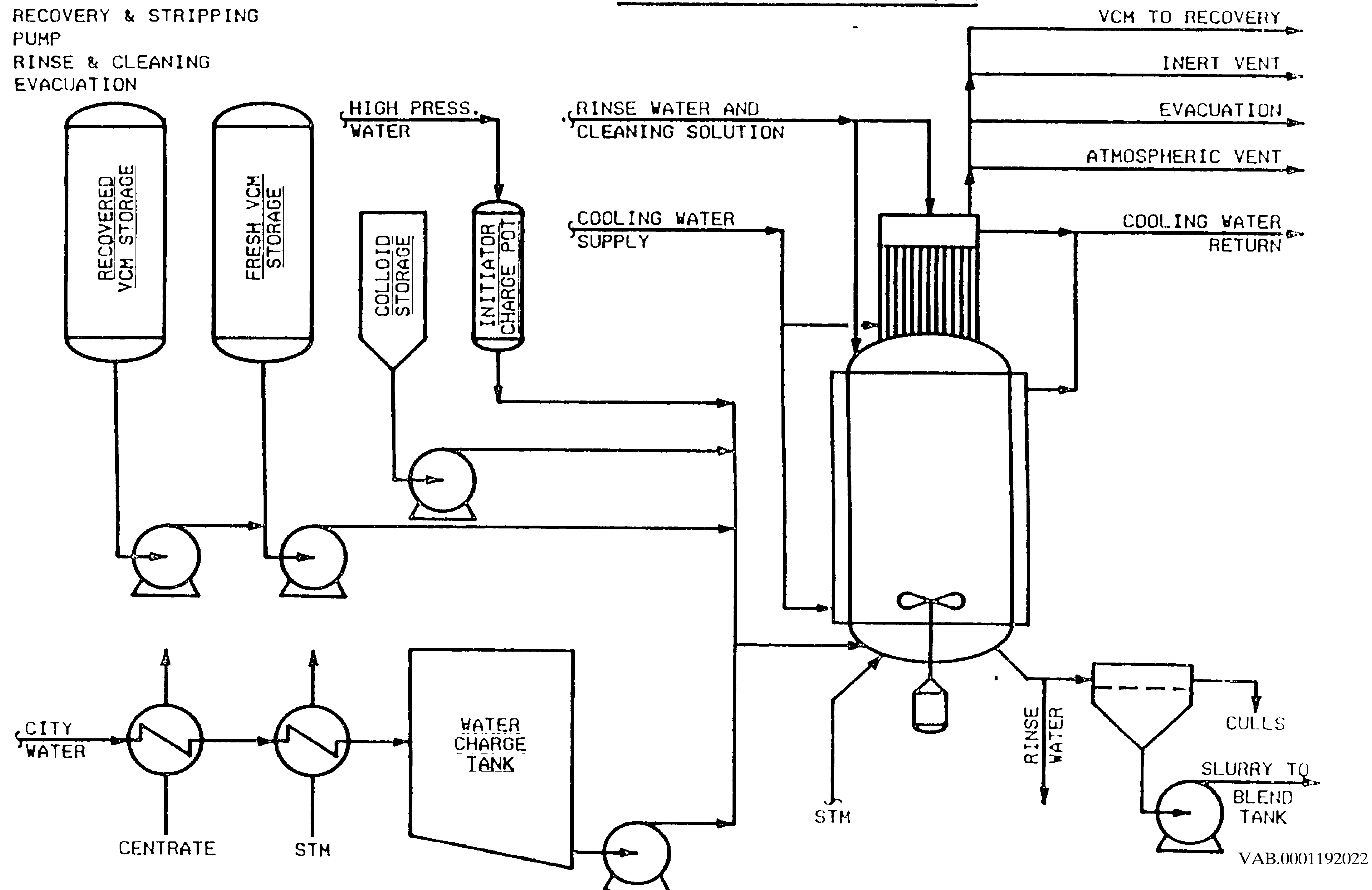
PUMP

RINSE & CLEANING

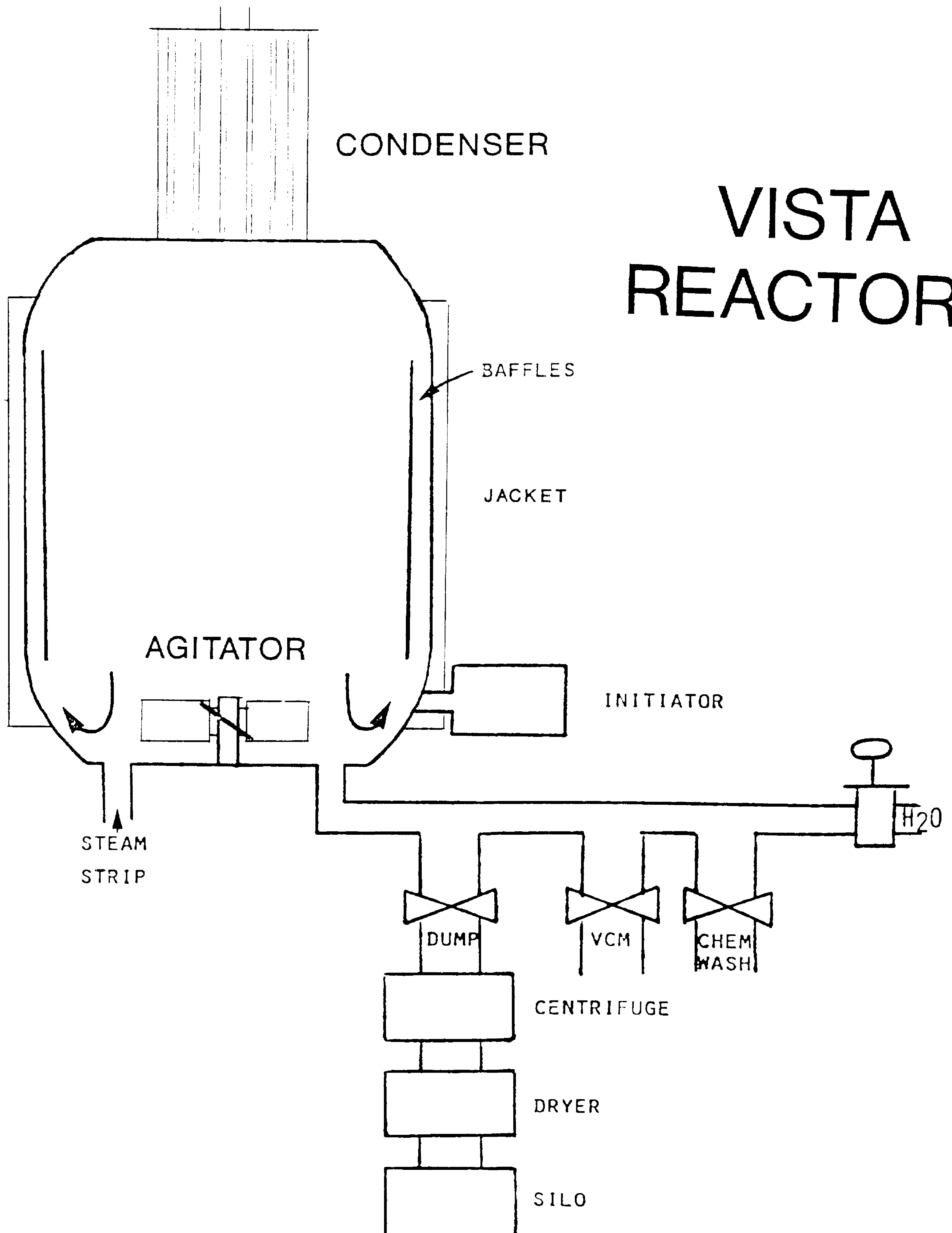
EVACUATION

POLYMERIZATION SECTION

PVC MANUFACTURE

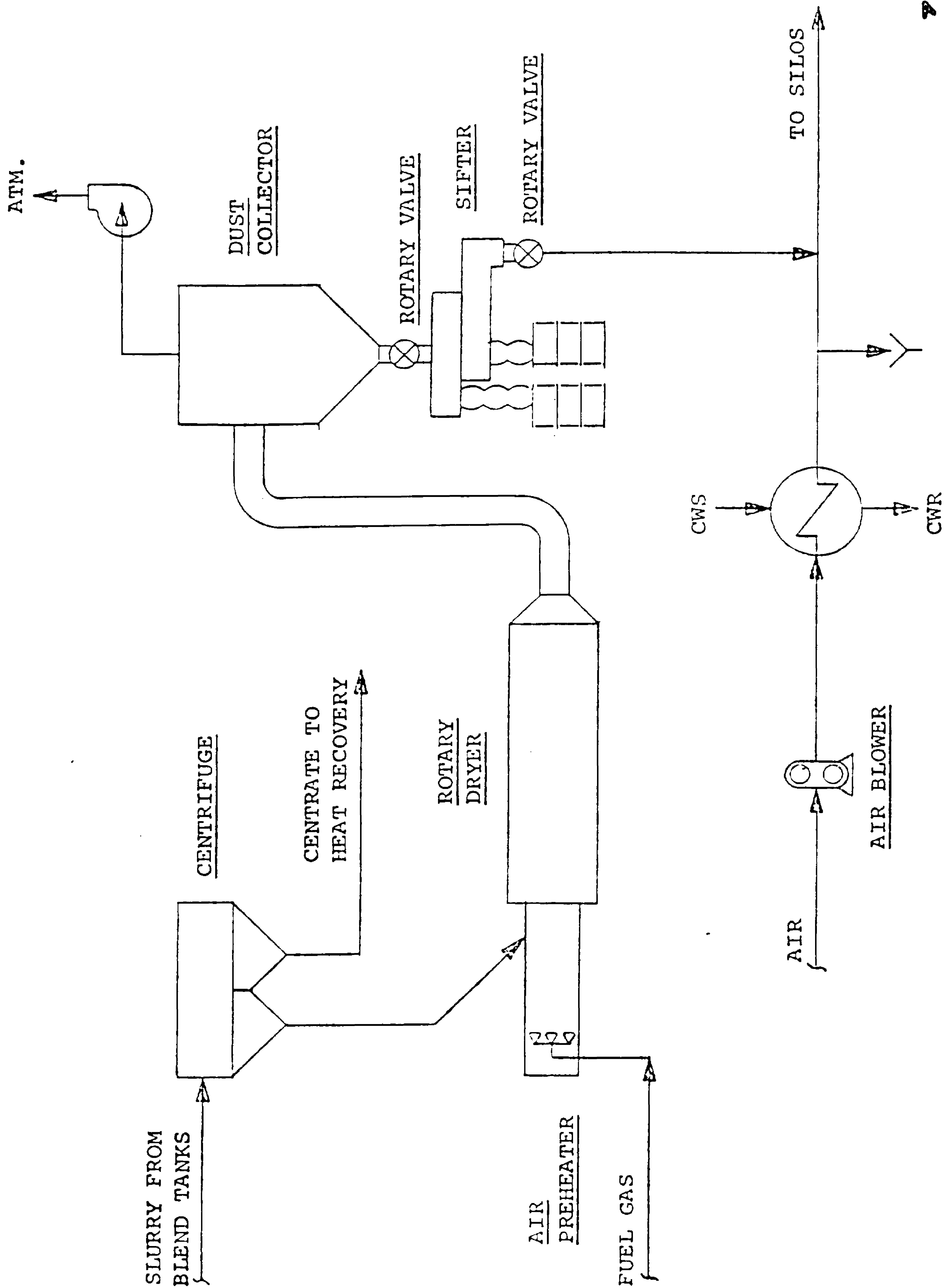


VISTA REACTORS



RESIN DRYING SECTION

PVC MANUFACTURE



VISTA RESIN GRADES

(MOLECULAR WEIGHTS)

Grade	Monomer Units	Poly Temp (F)	Inherent Viscosity	Average Molecular Weight
5225	730	152*	0.50	46,600
5265	975	152*	0.66	62,000
5305	1200	152	0.72	76,300
5325	1400	145	0.80	88,700
5385	1630	134	0.92	103,800
5395	1750	131	0.96	110,000
5415	1900	127	1.02	120,600
5465	2130	119	1.10	135,200

* With CTA

PVC RESIN APPLICATIONS

5225

Rigid Injection Molding

5265

Pipe Fittings

5305

Rigid Pipe Fittings

Rigid Calendering

Powder Slush Molding

5325

Powder Slush Molding

5385

Pipe

Siding

Profile extrusion

5395

General Flexible Applications

• Calendering

• Molding

5415

Building Wire

Communications Wire

General Purpose Calendaring

Flexible Automotive Molded Parts

5465

Automotive Wire

Vinyl Car Tops

Toys

Electrical Tape

Molecular Weight Measures of PVC Resin

From W. V. Titow, PVC Technology, 4th Edition

Inherent viscosity ASTM D1243-58T (Method A)	Relative Viscosity 1% cyclohexanone @25°C	Specific viscosity ASTM D1243-58T (Method D)	K value 0.5 g/100 ml cyclohexanone at 25°C (Fikentscher: DIN 53 726)	Polymerization degree JIS K6721	Weight Average Molecular Weight (Vista Analytical)
0.42		0.155	45.3	275	
0.44		0.165	46.2	310	
0.47		0.175	47.1	350	
0.49	1.54	0.185	48.4	380	46,600
0.52	1.58	0.195	49.3	415	
0.55	1.62	0.206	50.1	450	
0.57	1.66	0.217	51.3	495	
0.60	1.70	0.228	52.4	525	
0.62	1.74	0.239	53.6	560	
0.65	1.78	0.25	54.7	600	
0.67	1.83	0.264	56.1	640	62,000
0.70	1.87	0.275	57.2	680	
0.73	1.90	0.285	58.2	720	76,300
0.75	1.96	0.3	59.5	760	
0.78	1.99	0.31	60.5	800	
0.80	2.03	0.32	61.7	840	88,700
0.83	2.07	0.33	62.9	885	
0.85	2.10	0.34	64.1	930	
0.88	2.17	0.36	64.9	975	
0.91	2.21	0.37	66.1	1025	
0.92	2.25	0.38	67.1	1070	103,800
0.95	2.28	0.39	68.2	1120	
0.98	2.32	0.40	69.2	1175	
1.01	2.36	0.41	70.2	1230	120,600
1.03	2.43	0.43	71.5	1300	
1.06	2.46	0.44	72.4	1350	
1.08	2.50	0.45	73.3	1420	
1.11	2.54	0.46	74.3	1490	135,200
1.13	2.57	0.47	74.9	1570	
1.16	2.64	0.49	75.8	1650	
1.18	2.68	0.50	76.6	1720	
1.21	2.72	0.51	77.5	1810	
1.23	2.79	0.53	78.3	1900	
1.26	2.83	0.54	79.1	1980	
1.28	2.90	0.56	79.9	2070	
1.30	2.93	0.57	80.7	2170	
1.33	2.97	0.58	81.5	2260	
1.35	3.04	0.6	82.2	2360	
1.38	3.08	0.61	83.0	2460	

VISTA

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VAB.0001192027



REACTOR SIZE

ABERDEEN

OKC

FOUR 18,000 GAL SIX 18,000 GAL
FOUR 22,000 GAL
TWO 33,500 GAL

CAPACITY

ABERDEEN - 450 MM LBS/YR

5465	0	(0%)
5415	160	(35%)
5395	20	(4%)
5385	190	(42%)
5325	1-2	(<1%)
5305	50	(11%)
5265	30	(7%)
5225	1-2	(<1%)

OKC - 350 MM LBS/YR

5385	350	(100%)
------	-----	--------

TYPICAL CHARGE SIZE

ABERDEEN

INGREDIENT	18,000 GAL	22,000 GAL	33,500 GAL
VCM (LBS)	50,000	55,000	71,000
WATER (GAL)	7,200	8,000	12,300
PVC YIELD (LBS)	40,000	44,000	57,000

POLYMERIZATION RECIPES

4

INGREDIENT	5225	5265	5305	5325	ABD 5385	OKC 5385	5395	5415	5465
VCM	*	*	*	*	*	*	*	*	*
WATER	*	*	*	*	*	*	*	*	*
SUSPENDING AGENT • Methocel F-50 • Cuminal MHPC-25 • PVA GH-20 • PVA ALCOTEX 72.5 • Post-Add ALC 72.5	*	*	*	*	*	*	*	*	*
POROSITY ENHANCER • POLYVIC S-202	*	*	*	*					
INITIATOR • L-554 • L-223 • L-10 • L-288	*	*	*	*	*	*	*	*	*
Chain Transfer Agent • 2-Mercaptoethanol	**	*							
KILL AGENT • AMS						*			
ANTIOXIDANT • Isonox 132	*	*	*	*	*	*	*	*	*
ANTISTAT • Lubrical 48N • Dry CaSt • GMS	*	*	*	*	*	*	*	*	*
POLY TEMP (F)	152	152	152	145	134	134	131	127	119

VISTA ADVANCES

LARGE REACTOR TECHNOLOGY

STATISTICAL PROCESS CONTROL

ADVANCED SUSPENDING AGENTS (RQIP)

- LICENSED FROM BASF

FLUID BED DRYING

ENHANCED COMPUTER CONTROL

EXTENSION OF RESIN TECHNOLOGY

- 5225
- 5325
- 5395
- 5416 (MORE POROUS 5415)

CLEAN WALL TECHNOLOGY

- LICENSED FROM EVC

NEXT: EXTERNAL STRIPPING

IMPROVED GELS/CONTAMINATION

IMPROVED CONSISTENCY

HISTORY OF VISTA'S PVC ACTIVITIES

- 1963 ACQUIRED CARLON PVC PIPE CO.
- 1964 ACQUIRED APEX TIRE AND RUBBER CO. (COMPOUND) AND THOMPSON CHEMICAL CO. (PVC RESIN) FROM FAIN FAMILY.
- 1964 EXPLOSION AND FIRE AT THE HEBRONVILLE MASS. PVC PLANT.
- 1964 ABERDEEN MISS. PLANT STARTED-UP AND THE ASSONET MASS. PLANT BUILT.
- 1967 R&D MOVED FROM PONCA CITY TO ASSONET MASS.
- 1968 VINATEX (ENGLAND) CAME INTO EXISTENCE.
- 1968 FTC MADE CONOCO DIVEST OF ITS ASSONET MASS. PLANT (SOLD TO OLIN INDUSTRIES), COMPOUNDING FACILITIES IN RHODE ISLAND (SOLD BACK TO THE FAIN FAMILY <TECKNOR-APEX>), AND BUY OUT STAUFFER PORTION OF THE VCM PLANT.
- 1968 CONOCO PLASTICS FORMED FROM CARLON PIPE AND PVC PLANT IN ABERDEEN AND HEADQUARTERED IN WILTON, CONN., INCLUDING R&D.
- 1970 LARGE REACTOR PLANT STARTED-UP IN OKLAHOMA CITY.
- 1972 SOLD CARLON TO INDIAN HEAD INDUSTRIES, SHUT DOWN THE WILTON FACILITIES, MOVED R & D TO PONCA CITY, AND FORMED CONOCO CHEMICALS.
- 1975 ALL SMALL REACTORS SHUT DOWN.
- 1976 DIVESTED OF OUR HOLDINGS IN VINATEX.
- 1978 PVC RESIN, DRY BLEND, AND COMPOUND CAPACITIES INCREASED.
to
1981
- 1984 VISTA POLYMERS INC. FORMED.
- 1986 VISTA POLYMERS COMBINED INTO VISTA CHEMICALS.
- 1986 PREMIERE POLYMERS ACQUIRED.
- 1987 BLANE POLYMERS ACQUIRED.
- 1988 VYCOM STARTED
- 1989 R & D MOVED TO AUSTIN/ABERDEEN.

EFFECT OF PROCESS VARIABLES ON RESIN PROPERTIES

<u>PROPERTY</u>	<u>PROCESS VARIABLE</u>
A. MOLECULAR WEIGHT (INHERENT VISCOSITY)	1. POLYMERIZATION TEMPERATURE 2. CHAIN TRANSFER AGENTS 3. CHAIN COUPLING AGENTS
B. PARTICLE SIZE DISTRIBUTION	1. SUSPENDING AGENT CONCENTRATION 2. AGITATION
C. BULK DENSITY	1. STATIC 2. RESIN PARTICLE SHAPE 3. ADDITIVES
D. POROSITY (BRABENDER DRY TIME, COLD PLASTICIZER ABSORPTION, RESIDUAL VCM)	1. DEGREE OF CONVERSION OF VCM TO PVC 2. POLYMERIZATION TEMPERATURE 3. ADDITIVES
E. GELS	1. CLEANLINESS OF REACTOR 2. AGITATION 3. ADDITIVES
F. RESIN COLOR	1. HEAT HISTORY 2. ANTIOXIDANT
G. HEAT STABILITY	1. HEAT HISTORY 2. KILLING AGENT 3. ANTIOXIDANT
H. MOISTURE	1. DRYING EFFICIENCY
I. ELECTRICAL PROPERTIES	1. TYPE INITIATOR 2. ADDITIVES 3. TYPE POLY WATER

PVC PROPERTIES--REACTOR RELATED

<u>Resin Property</u>	<u>Process Variable</u>	<u>Process Change</u>
• Molecular Weight (MW) • (Inherent Viscosity)	• Polymerization Temperature • Chain Transfer Agent (CTA)	• Higher Temperature; Lower MW • Lower Polymerization Temp with Increased Amounts of CTA
• Particle Size Distribution (Average Particle Size [μ] and Coefficient of Variation)	• Suspending Agent (SA) (Methocel^R)	• More SA; Finer the Resins
• Bulk Density (gms/cc)	• Conversion	• Kill Polymerization After Pressure Drop
• Plasticizer Absorption (Brabender Dry Time [min])	• Conversion • Additives	• Higher Kill Pressure; Faster Dry Time • Addition of OMS
• Gels (Fish Eyes)	• Clean Reactor • Charging and Killing Procedures	• Adequate Cleaning and Rinsing of Reactor • Proper Charge Sequence and Initiator Addition Along with Proper Killing

PVC PROPERTIES--DRYER RELATED

Resin Property

- | | | |
|---|-------------------|------------------------------------|
| ● Moisture | ● Dryer | ● Better Control of Dryer |
| ● Contamination | ● Dryer | ● Clean Dryer |
| | ● Chem Wash | ● Clean Chem Wash Filter/Tank |
| ● Static Flow | ● Dryer | ● Add Additional CaSt |
| ● Residual VCM | ● Steam Stripping | ● Proper Steam Stripping Procedure |
| ● Gardner "b" Color and Heat Stability (Static Oven, Dynamic Mill, and Brabender) | ● Dryer | ● Proper Dryer Conditions |
| | ● Steam Stripping | ● Proper Steam Stripping Procedure |
| | ● Antioxidant | ● Increase Level |

FORMULATE

FLEXIBLE - FORMULATE FOR FINISHED
PROPERTIES

RIGID - FORMULATE FOR PROCEEDING

Flexible Compound

- ✓ **Markets**
- ✓ **Formulation (Ingredients)**
- ✓ **Manufacturing**
- ✓ **Testing**
- ✓ **What's New?**

PVC OVERVIEW

Market: Wire & Cable

Applications:

- insulation, jacketing, conduit**
- power, communications, computer**

Vista lbs:

**108MM lbs/yr
(70% of Vista Flexible)**

Major Customers:

**Times Fiber, AT&T, Northwire,
Tandy, General Cable, Allflex**

FLEXIBLE COMPOUND

Market: Automotive Windows

Application:

Window encapsulations

Vista lbs:

7MM lbs/yr

(5% of Vista Flexible)

Major Customers:

Donnelley, Deckerville

FLEXIBLE COMPOUND

Market: Weatherstripping

Vista lbs:
15MM lbs/yr
(10% of Vista Flexible)

Major Customers:
**Central Plastics, Betterbuilt,
Vytron, Macklanburg Duncan**

FLEXIBLE COMPOUND

Other Uses/Markets

Flexible Hose and Duct

Heating Pads

Coated Fence

Coated Yarn

Shoe Soles

Furniture Trim

Many Others

FLEXIBLE COMPOUND

Formulation

- ✓ **Flexible Compound =
PVC Resin + Plasticizer + Other Ingreds.**
- ✓ **Other ingredients added to improve**
 - **performance properties**
 - **processibility**
- ✓ **Customize formulation to end-use,
processing needs, and economics**

FLEXIBLE COMPOUND

Ingredients

ingredient	PRO	CON
PVC Resin	low cost & low flammability	low stability
Plasticizer	flexibility	flammability
Stabilizer	prevents heat degradation	cost
Fillers	lowers cost	inc. hardness dec. flex.

*CaCO₃ ~ \$4/lb.
Clay more expensive than CaCO₃
(use for elect. formulation)*

FLEXIBLE COMPOUND

Ingredients

Ingredient	PRO	CON
Lubricants	better processibility	--
Flame Retardants <i>(antimony oxide)</i>	flame resist. & lower smoke	cost
Antifungals/ Antimicrobials <i>(arsenic yd)</i>	reduce fungus & bacteria	toxicity
Pigments	color	can affect other properties

ESQ loved by microbes

FLEXIBLE COMPOUND

Plasticizer

- ✓ Gives PVC flexibility & rubbery feel**
- ✓ Vista makes & purchases plasticizer**
- ✓ 108P & 610P made at Aberdeen from alcohols shipped from LCCP**
- ✓ Vista also sells & trades plasticizer**

FLEXIBLE COMPOUND

Typical Formulation

Product: Wire Jacketing

Ingredient	PHR	Weight %
Resin	100	46
Plasticizer	70	32
Filler	40	18
Stabilizer	5	2
Flame Retardant	5	2
Lubricant	0.5	< 1

Stearic Acid

FLEXIBLE COMPOUND

Typical Formulation

Product: Wire Jacketing

Ingredient	Cost ¢/lb	Cost %
Resin	38	48
Plasticizer	42	38
Filler	5	3
Stabilizer	62	3
Flame Retardant	135	8
Lubricant	40	< 1

FLEXIBLE COMPOUND

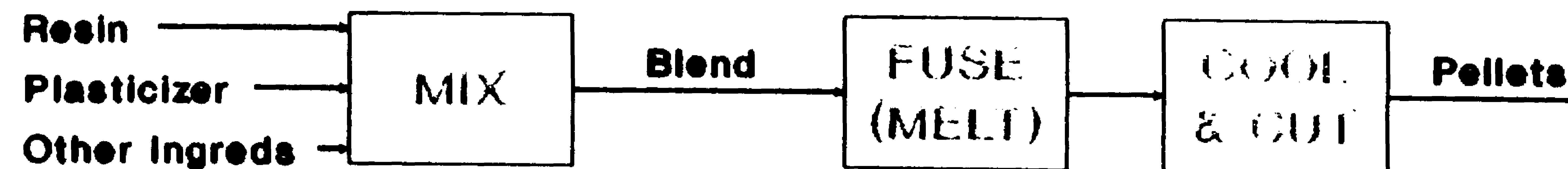
Typical Formulation

Product: Wire Jacketing

ingredient	Cost ¢/lb	¢/lb Diff.
Original Formulation	35.3	
w/o Flame Retardant	33.7	1.6
w/o Filler	42.4	7.1

FLEXIBLE COMPOUND

Manufacturing Flow Diagram

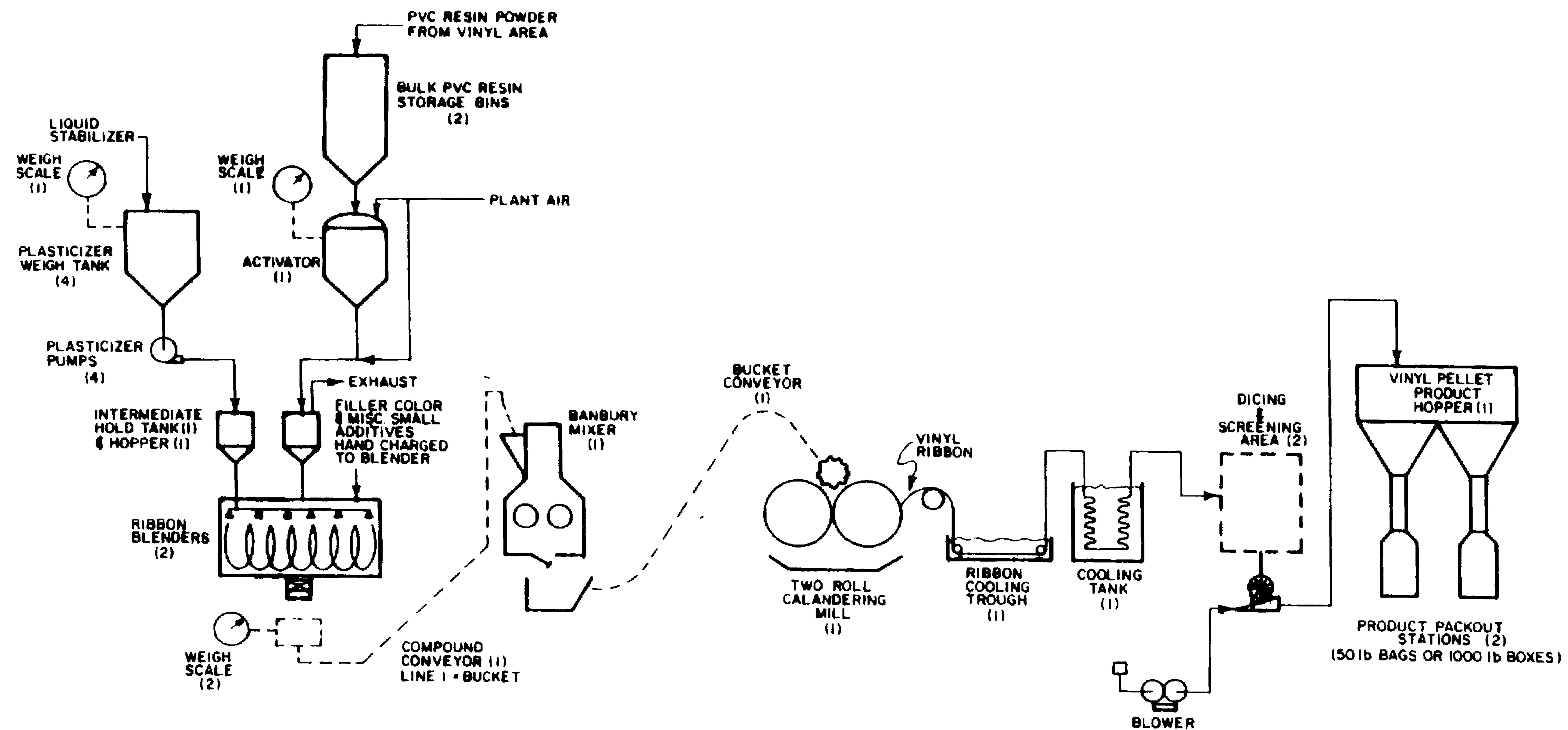


FLEXIBLE COMPOUND

Vista Plants

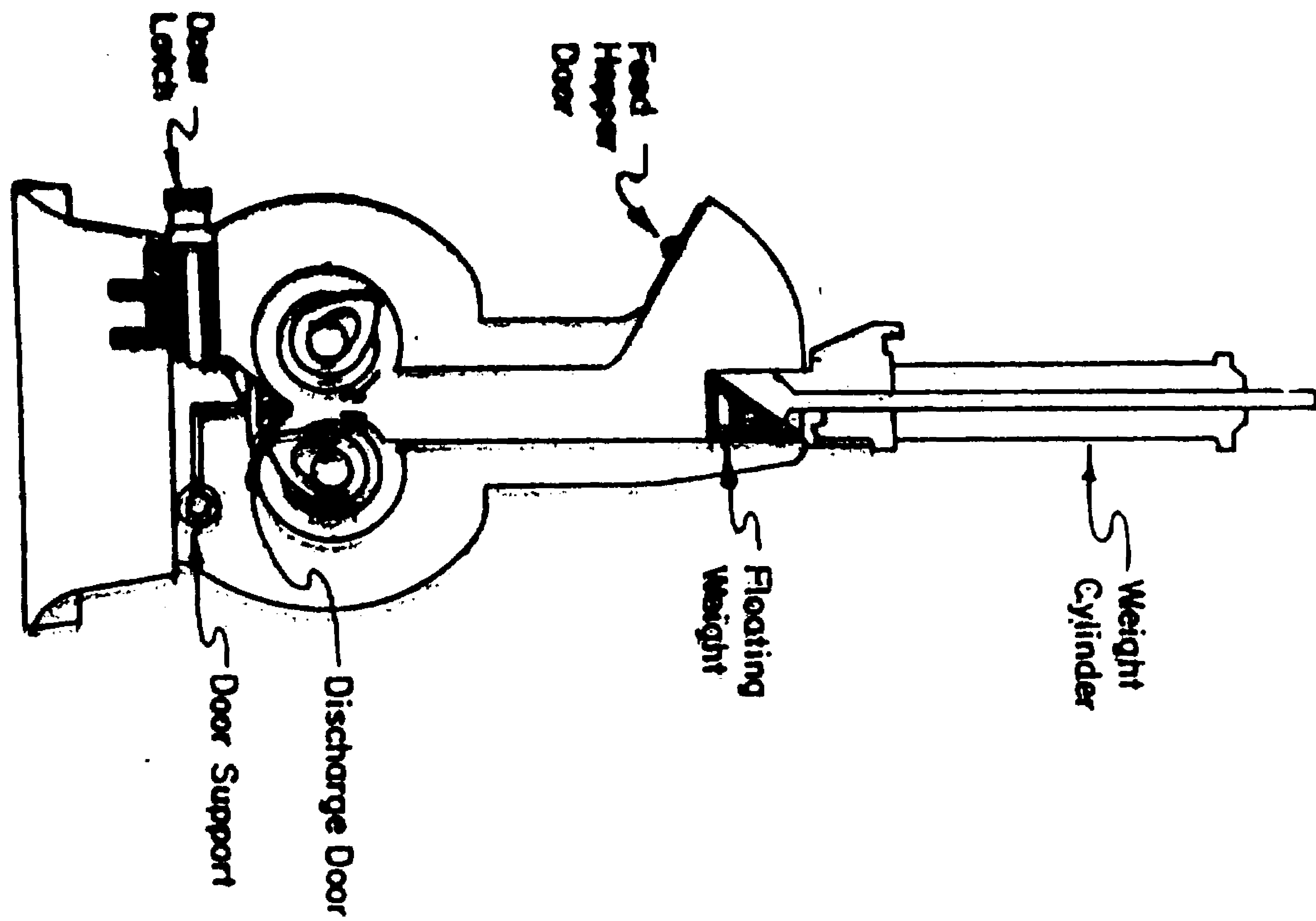
Plant	# Lines	Capacity (MM lbs/yr)
Aberdeen	3	95
Blane	4	100
Premiere	3	25
Visalia	1	36
		256

FLEXIBLE COMPOUND



ABERDEEN LINE I SCHEMATIC

FIGURE 11.



A SCHEMATIC OF THE EMERGENCY

Vista's Competition

Company	Capacity (MM lbs/yr)	% PVC, Plz
Vista	260	100,50
BF Goodrich	220	100,0
Teknor-Apex	150	0,100
Cary	110	0,0
Gary	80	0,0
North American	75	0,0
Many others (small)		

FLEXIBLE COMPOUND

Testing

- ✓ **Why do we test?**
 - **quality control**
 - **product development**
 - **certification**
- ✓ **Used to predict performance**
- ✓ **Comparative tests**
- ✓ **Test methodology - ASTM**

FLEXIBLE COMPOUND

Tests

Property Tested

Test

Hardness
(resistance to indentation)

Durometer Hardness

Flexibility

Tensile (elongation)

Strength

Tensile (strength)

Resistance to Tearing

Tear strength

Electrical Properties

Resistance

FLEXIBLE COMPOUND

Tests

Property Tested	Test
Flammability	Limiting Oxygen Index (LOI)
Smoke Generation	Arapahoe Smoke
Low Temperature	Brittle Point
High Temperature	Oven aging (retention of elongation)

FLEXIBLE COMPOUND

What's New?

✓ Rotoflex™

✓ Plenex™

FLEXIBLE COMPOUND

What's New? Rotoflex™

- ✓ **"Dry" Flexible Blend**
- ✓ **Made with special ingredient that absorbs excess plasticizer**
- ✓ **Made at Premiere on dryblend unit**

FLEXIBLE COMPOUND

What's New? Rotoflex™

- ✓ Used to make automotive interior "skins"**
- ✓ Current customer: Toyota (Camry instrument panel)**
- ✓ Market potential:
5 MM lbs/yr in 5 years**
- ✓ Powder Slush Molding**

FLEXIBLE COMPOUND

What's New? PlenexTM

- ✓ **Low smoke & flame wire & cable compound for plenum applications**
- ✓ **Plenum space:**
 - **area between false ceiling and floor in commercial buildings**
 - **very strict smoke & flame requirements**
- ✓ **competition is flouropolymers**

FLEXIBLE COMPOUND

What's New? Plenex™

- ✓ **Higher profit margin market**
- ✓ **Applications:**
fire alarm, telephone,
computer networks
- ✓ **Market potential:**
5 MM lbs/yr in 5 years

FLEXIBLE COMPOUND

RIGID PVC

- **MARKETS**
- **FORMULATION**
- **MANUFACTURING**
- **TESTING**
- **WHATS NEW?**

MAJOR END USES PVC

PIPE

PIPE FITTINGS

SHEET

SIDING

PROFILES

PVC PIPE

PRODUCTION PROCESS

-EXTRUSION

FINAL PRODUCTS

-POTABLE WATER (PW)

-SEWER

-DRAIN, WASTE AND VENT
(DWV)

-IRRIGATION

-ELECTRICAL

-COMMUNICATIONS CONDUIT

-CORRUGATED DRAINAGE

VISTA PRODUCTS

-5385

-80273

-80174

IMPORTANT CONSIDERATIONS

-COST

-OUTPUT RATES

PVC PIPE FITTINGS

PRODUCTION PROCESS

-INJECTION MOLDING

FINAL PRODUCTS

-COUPLING FITTINGS

-“TEE” FITTINGS

-“ELBOW” FITTINGS

VISTA DRYBLENDS

-90171

-90172

IMPORTANT CONSIDERATIONS

-HEAT STABILITY

-MELT FLOW

PVC SHEET

PRODUCTION PROCESS

THIN SHEET

THICK SHEET

-CALENDARING

-EXTRUSION

FINAL PRODUCTS

CALENDAR SHEET

-BLISTER PACKAGING

-CREDIT CARD STOCK

-FLOPPY DISKS

EXTRUDED SHEET

-WALL COVERINGS

-SANITARY WARE

-ACID TANKS

VISTA DRYBLENDS

-RP 421

-RP 442

-RP 461

IMPORTANT CONSIDERATIONS

-SURFACE APPEARANCE

-IMPACT STRENGTH

VINYL SIDING

PRODUCTION PROCESS

-EXTRUSION

FINAL PRODUCTS

-HORIZONTAL SIDING

-SIDING TRIM

-CORNERS

-SOFFIT

-INDUSTRIAL SIDING

-MOBILE HOME
SKIRTING

VISTA PRODUCT

-5385

IMPORTANT CONSIDERATIONS

-WEATHERABILITY

-IMPACT STRENGTH

-OUTPUT RATES

-COST

PVC PROFILES

PRODUCTION PROCESS

-EXTRUSION

FINAL PRODUCTS

INTERIOR PROFILES
("CUSTOM")

-APPLIANCES
-INTERIOR CONSTRUCTION
-AUTOMOTIVE

EXTERIOR PROFILES

-WINDOW FRAMES
-DOORS
-FURNITURE
-MOBILE HOME SKIRTING
-GUTTERS

VISTA PRODUCT

-RP 200T

IMPORTANT CONSIDERATIONS

-SURFACE APPEARANCE
-WEATHERABILITY
-IMPACT STRENGTH

RIGID PVC FORMULATION CRITERIA

**GOOD PROCESSING (EASE OF
FABRICATION)**

**GOOD PROPERTIES IN FINISHED
PART**

OTHER (SECONDARY)

TYPICAL PVC FORMULATION INGREDIENTS

ALWAYS: RESIN

STABILIZER

LUBRICANT

USUALLY: PROCESSING AID

IMPACT MODIFIER

PIGMENT

FILLER

Terminology Page 3

Phr: Parts per Hundred Parts Resin

Reason: Convenience for formulation development

Simple example:

	<u>Percent</u>	<u>phr</u>
5385	86	100.0
Stabilizer	2	2.3
Lubricant	2	2.3
Impact modifier	6	7.0
Filler	4	5.8
Total	<u>100</u>	<u>117.4</u>

CRITERIA FOR FINISHED PRODUCT PROPERTIES

TOUGHNESS (IMPACT STRENGTH)

APPROPRIATE STIFFNESS

WEATHERABILITY AS NEEDED

APPEARANCE: SMOOTHNESS, GLOSS, AND COLOR

OTHER: CHEMICAL RESISTANCE, ETC.

Selecting PVC Resin Grade

Decision - which MW?

Limitations - Aberdeen ~~incapable~~ *not equipped to be* of using
5415 in dryblend *(more than 2 products)*

Criteria - Processing vs Physical properties

Generally use 5385.

Use lower MW resins where low
melt viscosity essential.

Example: Injection molding

RPVC Stabilizer Selection

Can use salts, soaps, or esters of metals:

Pb
BaCd
Sn
CaZn
Sb

Antimony

*We use
all
Sn*

Pb & BaCd used extensively in Europe.
Use in RPVC declining due to toxicity.

CaZn weak stabilizer. In past used only
where very low toxicity & odor needed. May
replace much Pb and BaCd in European RPVC.

Vast majority of RPVC in USA is Sn stabilized.
Good balance of properties.

Sb generally similar to Sn but less effective.
Minor.

RPVC THERMAL STABILIZERS

Function - Prevent PVC degradation due to heat or UV light.

PVC Degradation Causes:

HCl generation

Color Change

**Melt viscosity increases
(cross-linking)**

Physical properties change

**Therefore, stabilizers affect processing
and end-use properties.**

Essential additive

RPVC Lubricants

"Black art" of RPVC formulating

Function- Assist processing:

**Reduce melt viscosity and shear
Boost thermal stability (often
indirectly).
Provide metal release
Control fusion**

Use is mandatory.

**Types (theoretical) - Internal
External
Calcium Stearate**

**Generally use 2 or more lubricants
in combination.**

SUMMARY - LUBRICANTS

Internal lubricants

- not frequently used
- reduce melt viscosity only

External lubricants

- generally retard fusion
- provide metal release
- reduce melt viscosity
- "wax"

Calcium stearate

- promote fusion
- reduce melt viscosity
- costabilizer

Processing Aids

Function - Promote fusion

Increase melt strength

**Smoother melt flow, can
affect appearance**

Composition - Acrylic Copolymers

IMPACT MODIFIERS

FUNCTION

IMPROVE IMPACT STRENGTH
MORE DUCTILE
LESS BRITTLE

RUBBERY COPOLYMERS

MAJOR TYPES

INTERIOR - MBS
EXTERIOR - ABS

COLORING RIGID PVC

Color Concentrate: Pigment "Dispersed" In Carrier

Carrier Can Be: **Wax**
 Liquid (E.G., Plasticizer)
 PVC
 Other Compatible Polymer
 (E.G., EVA)

Raw Pigment	<u>VERSUS</u>	Color Concentrate
Dispersion Problems		"Some" Predispersion
Messy		Less Cross-Contamination
Pigment Color Variations		Uniform Color
Cheap		Expensive
Flexible		Inflexible
Multi-Component		Single Component
Requires Intensive Mixer		Can Add On - Line
Fast Response		Slower Matching

Fillers for RPVC

Functions

Major -

Reduce cost (lb/volume?)

Increase modulus

Improve powder flow (B.D.)

Make melt stiffer & less tacky

Aid TiO_2 dispersion

Scrubbing action - clean tooling

Increase impact strength?

Control gloss

stiffer

Mechanism

Physical. Chemically inert re: PVC

Chemical Types

Calcium carbonate (almost exclusively)

TYPICAL RIGID COMPOUND

INGREDIENT	AMOUNT (PHR)	MAIN FUNCTION
PVC RESIN	100	BASIS OF COMPOUND
STABILIZER	0.4 - 2.0	THERMAL STABILITY
LUBRICANTS	2.0 - 4.0	PROCESSING EASE
PROCESSING AID	0 - 3.0	PROCESSING EASE
IMPACT MODIFIER	0 - 8.0	IMPACT STRENGTH
FILLER	0 - 10.0	COST REDUCTION
PIGMENT	1.0 - 15.0	COLORING

BALANCING PROPERTIES IS KEY

- ✓ **MECHANICAL PROPERTIES**
 - **STIFFNESS / FLEXIBILITY**
 - **TOUGHNESS**
 - **USE TEMPERATURE RANGE**
- ✓ **APPEARANCE**
- ✓ **FIRE RETARDANCY**
- ✓ **PROCESSABILITY**
- ✓ **CHEMICAL RESISTANCE**
- ✓ **INTERFACIAL PROPERTIES**
- ✓ **WEATHERABILITY**

MANUFACTURE OF RIGID PVC

OTHER FORMULATING CRITERIA

DRYBLEND OR PELLET?

OFTEN DETERMINED BY EQUIPMENT.
SINGLE SCREWS FAVOR PELLETS,
ESPECIALLY NON-VENTED SINGLES.

PELLETS ARE ALSO CLEANER:
LESS DUST & LEAKAGE.

DRYBLEND ADVANTAGES:

LOWER MANUFACTURING COST
ONE LESS HEAT HISTORY (LOWER STABILIZER
COST OR HIGHER STABILITY)

TWIN SCREWS WORK BETTER WITH DRYBLEND
LESS OPPORTUNITY FOR COMPOUNDING VARIATIONS

BLENDING

HOMOGENEOUS MIXTURE

HIGH INTENSITY MIXING

HIGH SPEED

HIGH SHEAR

HEATING

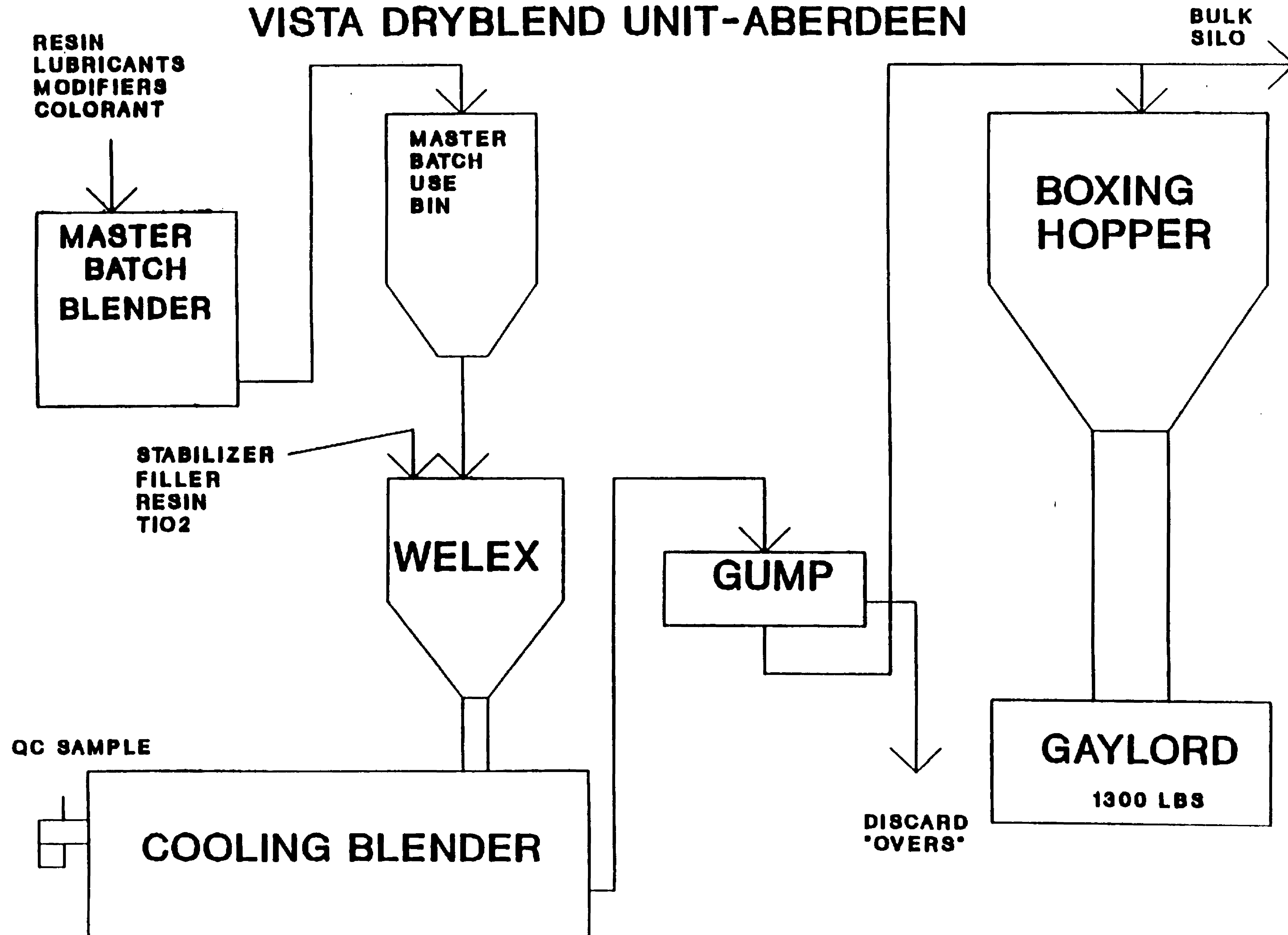
LOW INTENSITY MIXING

LOW SPEED

LOW SHEAR

COOLING

VISTA DRYBLEND UNIT-ABERDEEN



COMMON TESTS

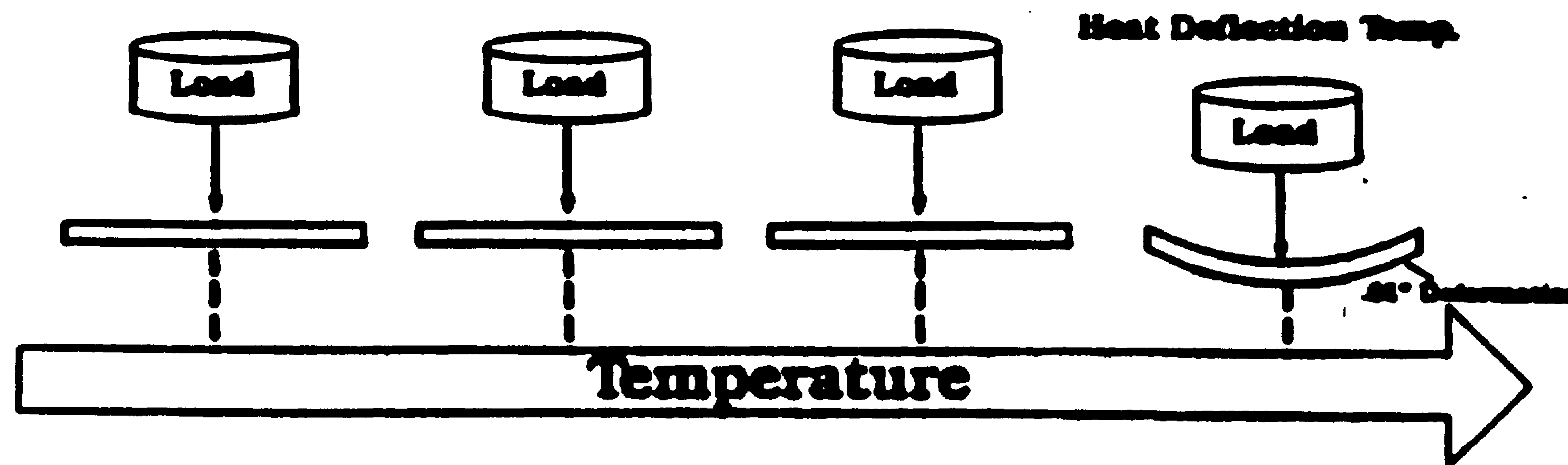
RIGID PVC COMPOUNDS

IZOD IMPACT

HEAT DISTORTION TEST

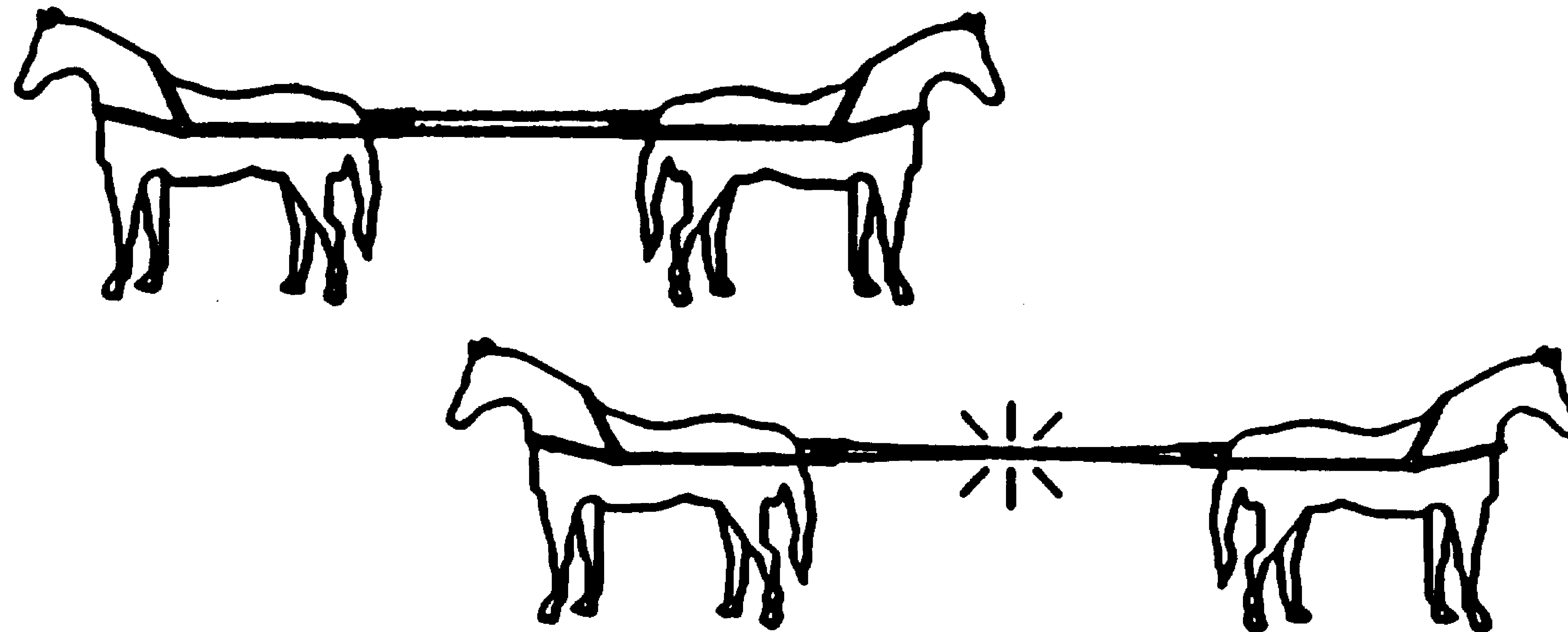
TENSILE TEST

Heat Deflection Temperature



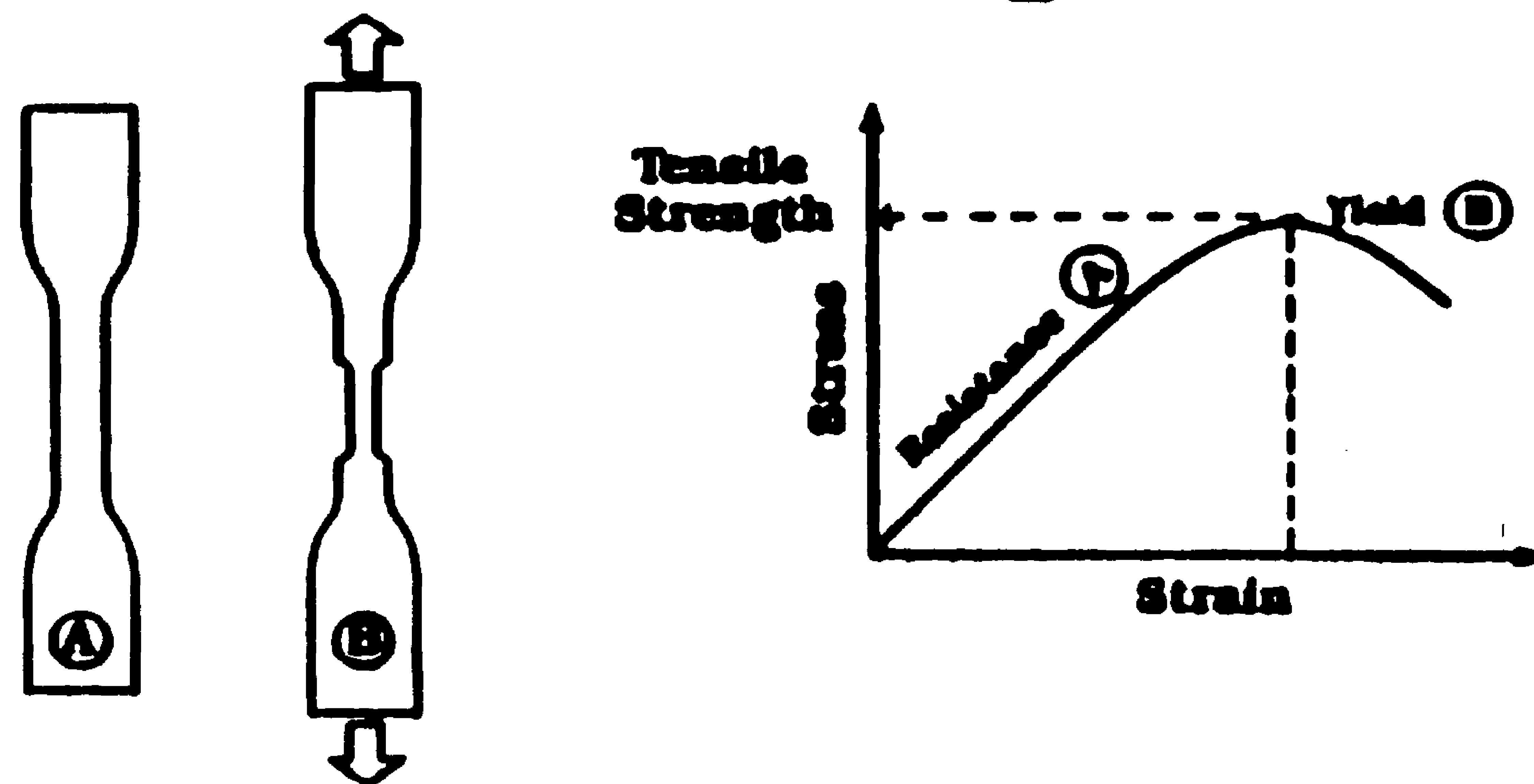
- The heat deflection temperature reports the temperature at which a material shows .01 inches deformation under load
- It is reported in °F or °C at loads of both 66psi and 264psi

Tensile Strength



Tensile strength is the maximum pulling load a material can support before yielding or breaking.

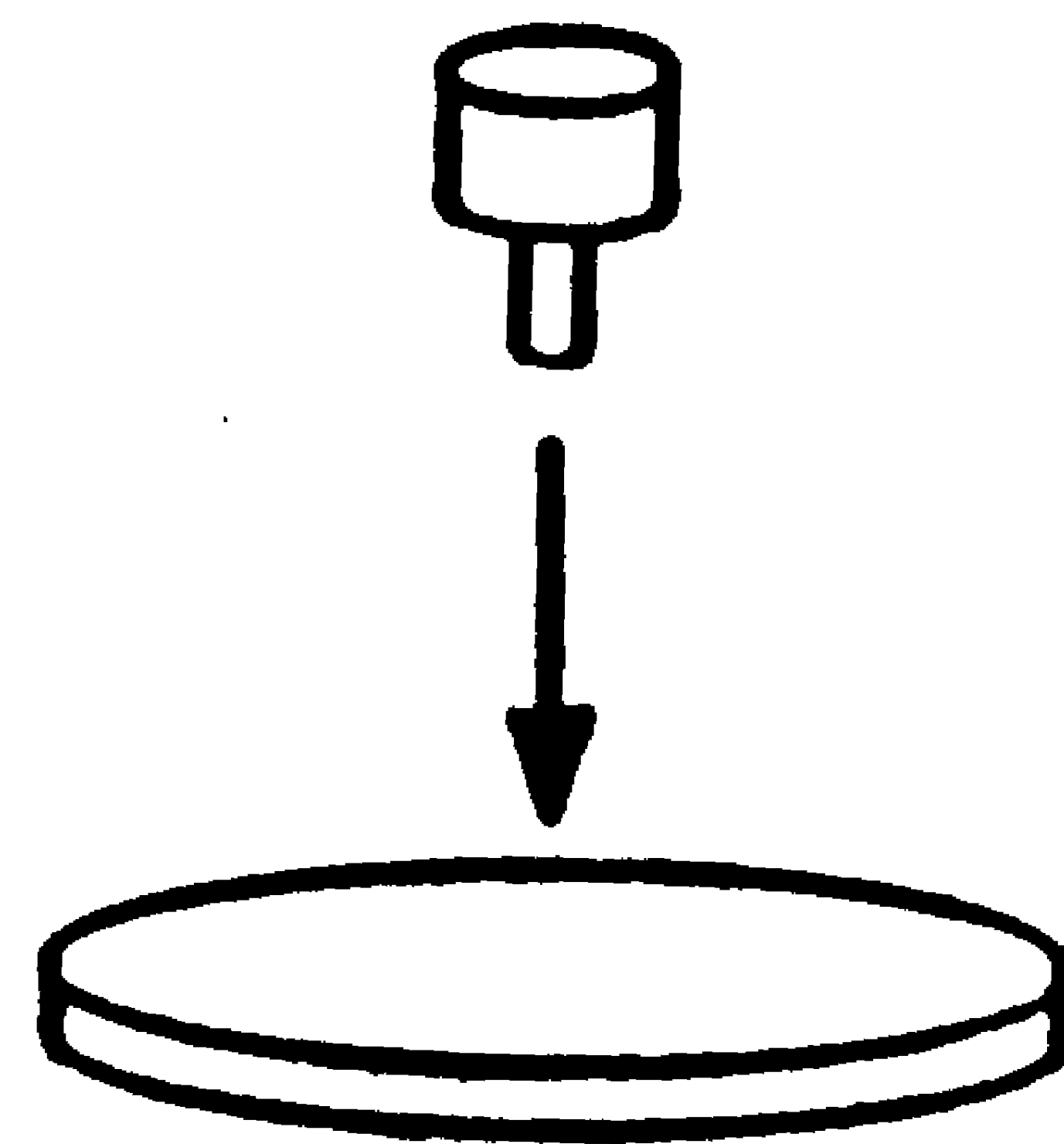
Tensile Strength



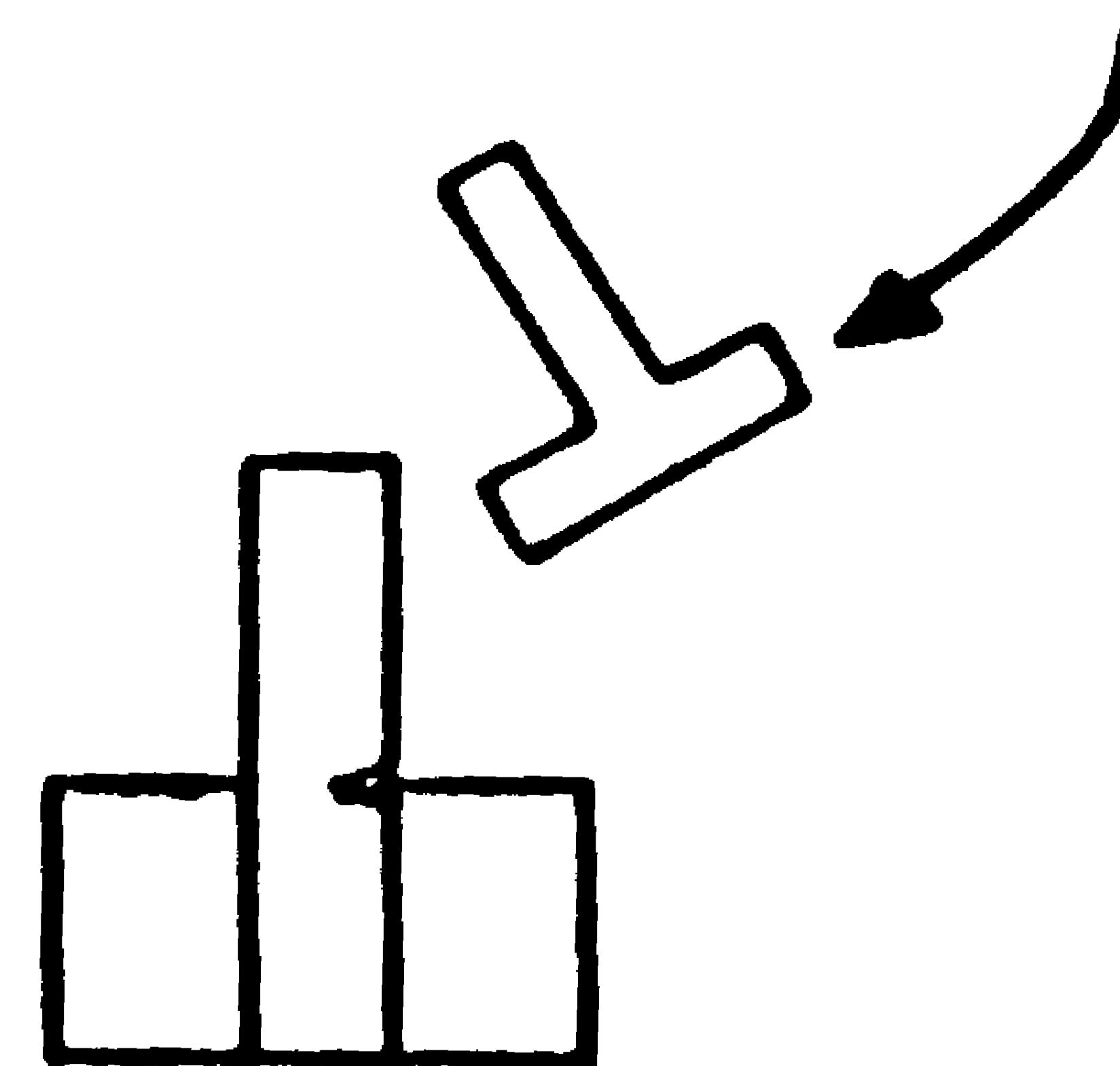
Tensile strength is tested using a tensile bar.

Impact Strength

Impact strength is the energy required to break a material.



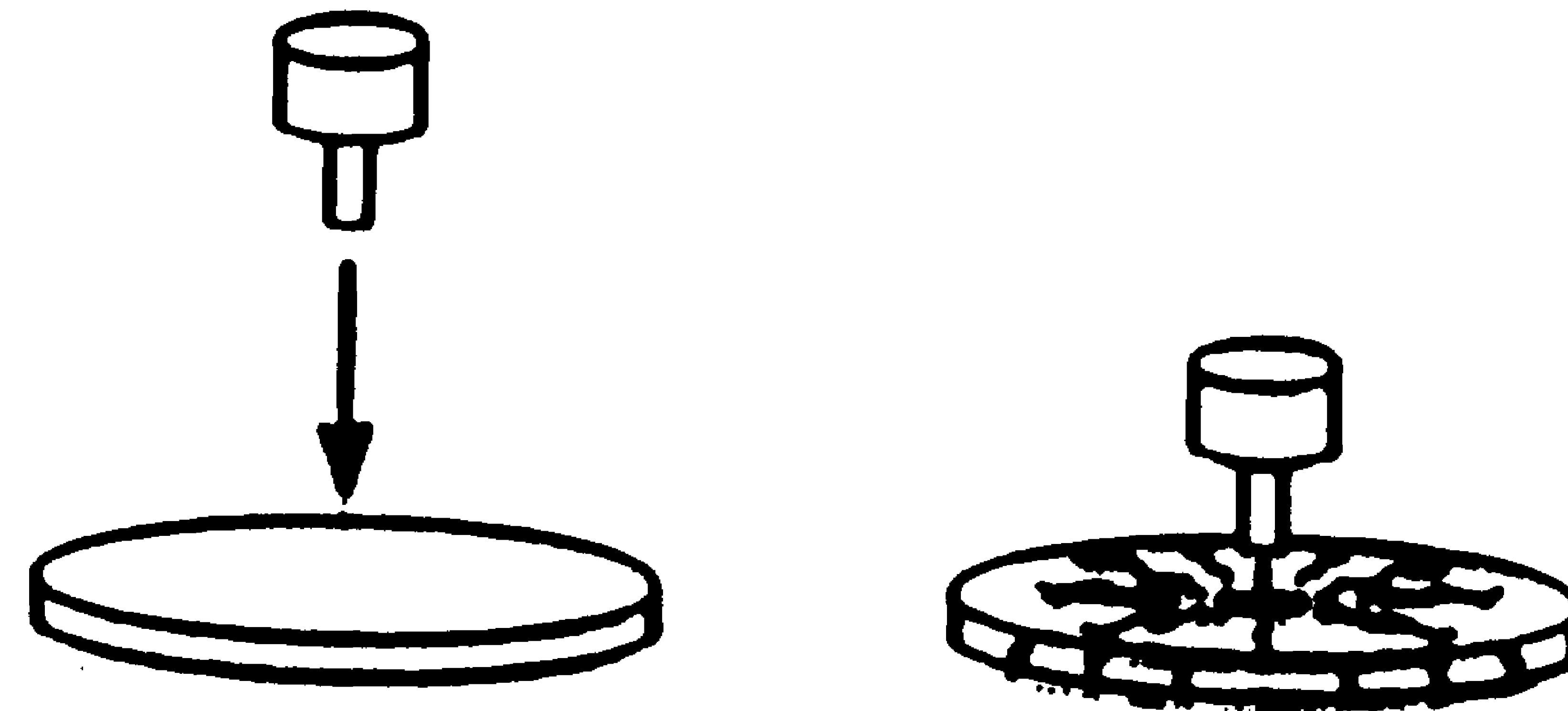
Falling Dart Test



Izod Impact Test

Falling Dart Impact

Typical names for this test are Gardner Impact
& Dynatup[®] Impact.

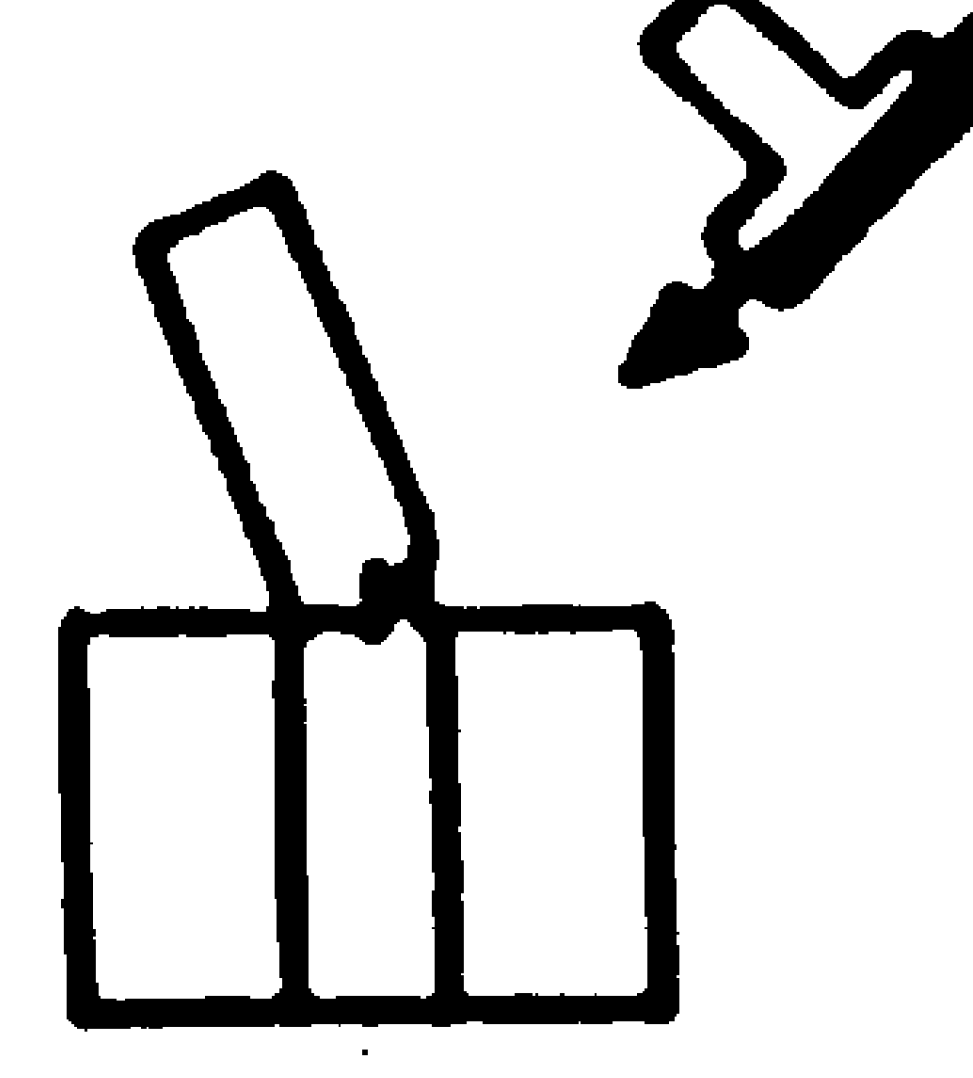
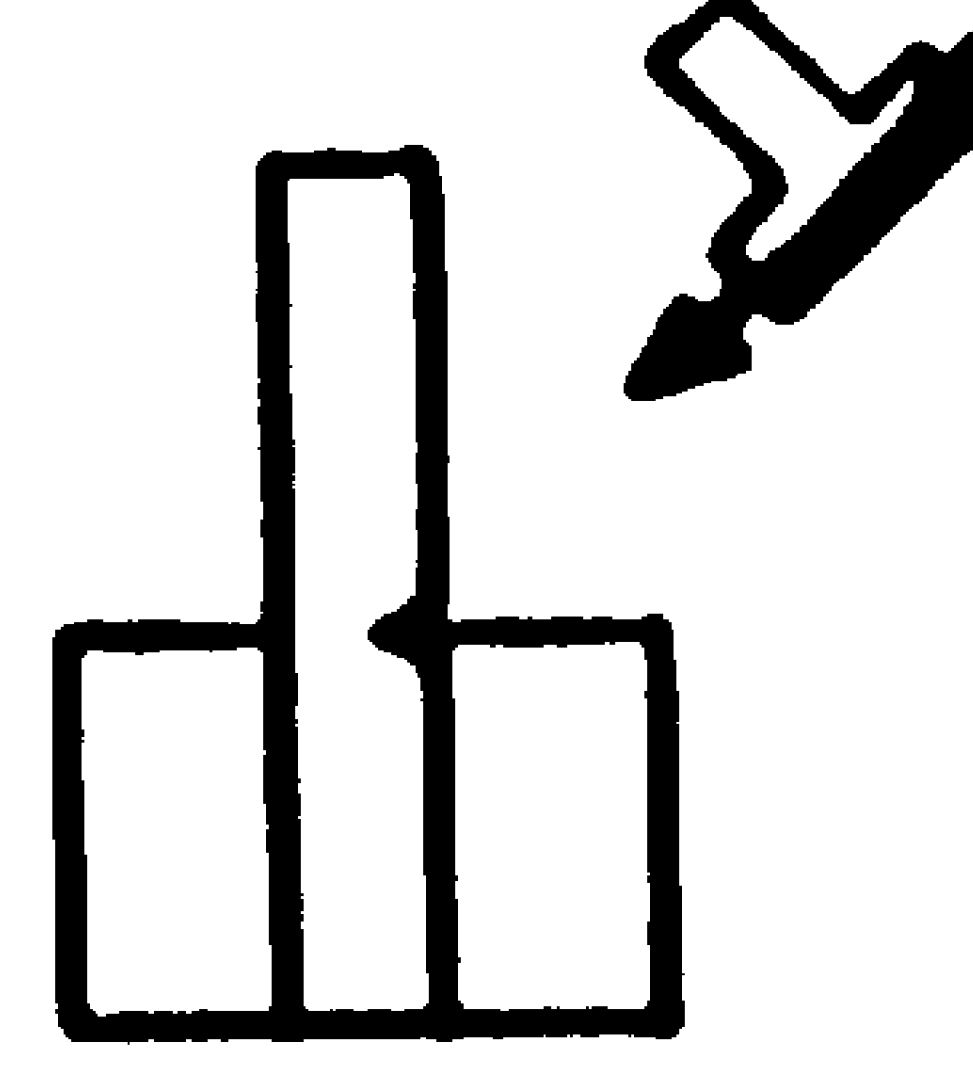
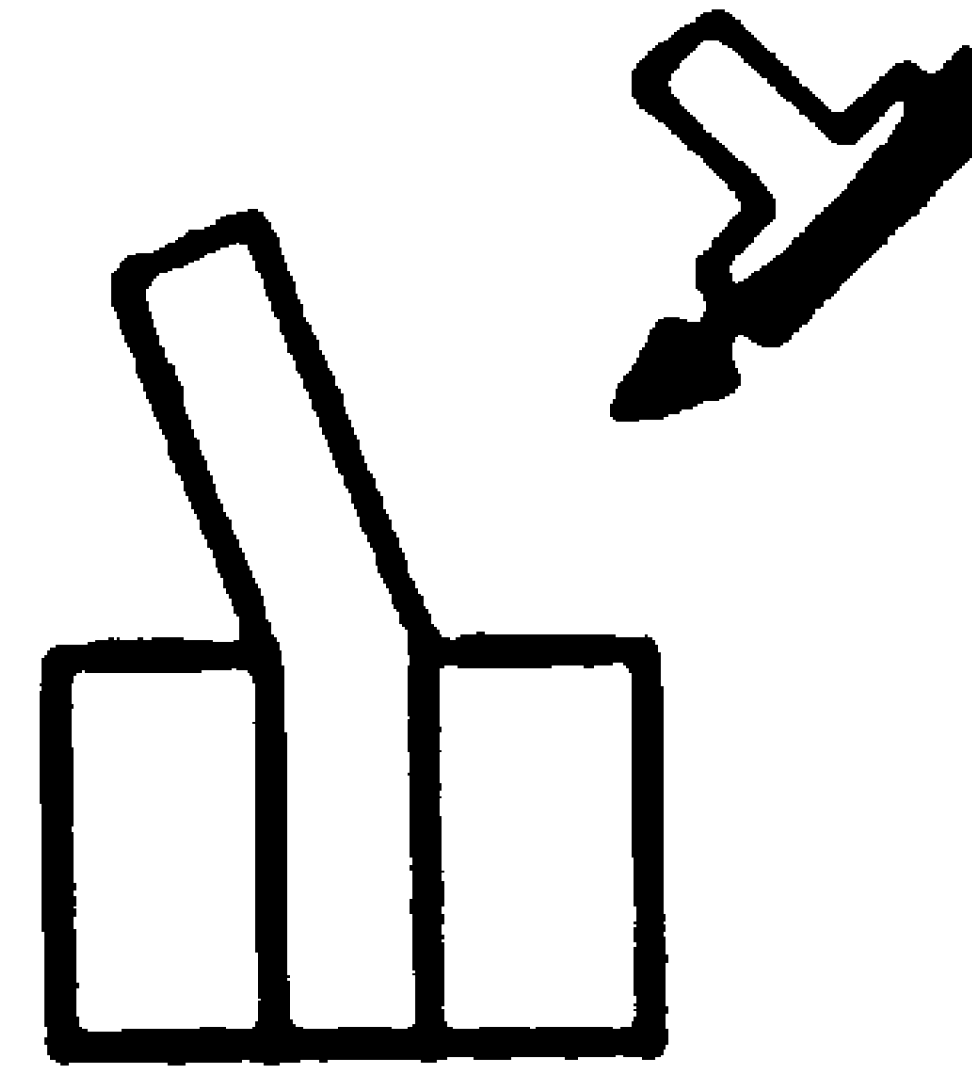
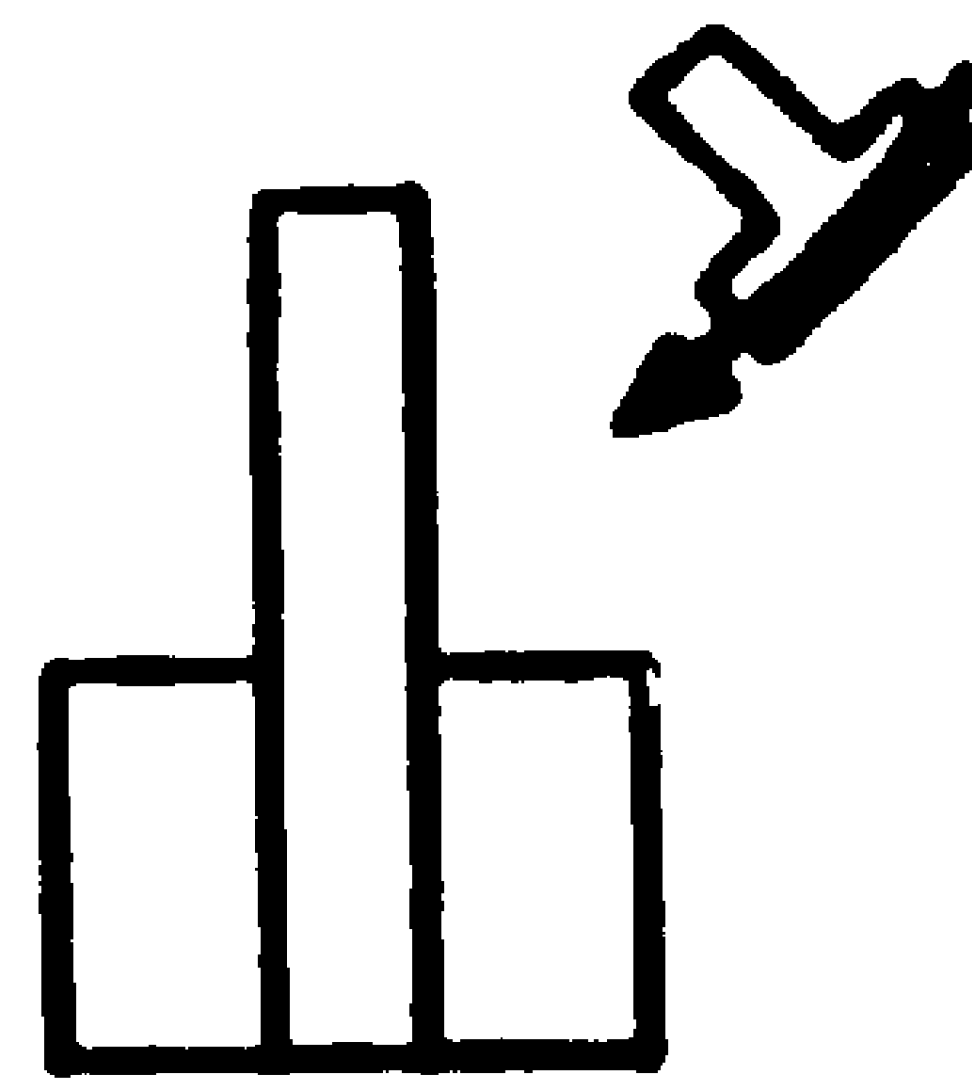


Falling Dart tests measure the ability of a material
to resist breaking when struck on a surface.

Izod Impact Test

Unnotched Izod

Notched Izod



Izod impact is reported in ft/lbs per inch.

INTRODUCING

VISTEL™

AND

SUPREL™

VISTEL™ RIGID PVC PELLETS

PVC PELLETS

CUSTOM FORMULATED

COST EFFECTIVE

ALTERNATIVES TO ENGINEERING RESINS

FOR INJECTION MOLDING

APPLICATIONS

VISTEL™

SPECIALTY PLUMBING
FITTINGS
VALVES
TANK HOUSINGS

OUTDOOR PRODUCTS
ELECTRICAL OUTLET BOXES
RAIN GUTTER FITTINGS
PATIO FURNITURE

GENERAL PURPOSE
ELECTRIC BLANKET CONTROLS
TELEPHONE JUNCTION BOXES

OTHER

END USE BENEFITS VISTEL™

INHERENT FLAME RETARDENT CHARACTERISTICS

**EXCEPTIONAL PHYSICAL STRENGTH AND IMPACT
RESISTANCE**

GOOD STIFFNESS AND CREEP RESISTANCE

**RELIABLE UV COLOR STABILITY AND
WEATHERABILITY**

EXCELLENT SURFACE APPEARANCE AND GLOSS

OUTSTANDING CHEMICAL RESISTANCE

SUPREL™ ENGINEERED THERMOPLASTIC POLYMERS

SUPREL™--

FAMILY OF COMPOUNDS

INCORPORATES PVC AS AN INGREDIENT

COMBINATION OF POLYMERS

VERY UNIQUE PROPERTIES

HDT

IMPACT

COLD TEMPERATURE

PROCESSING LATITUDE

CUSTOM FORMULATED

APPLICATIONS

SUPREL™

HOUSINGS (ELECTRICAL WIRING)

COMPUTER SCREEN

KEYBOARD

TYPEWRITER

CALCULATOR

CARD READER

APPLIANCE (HAIR DRYER)

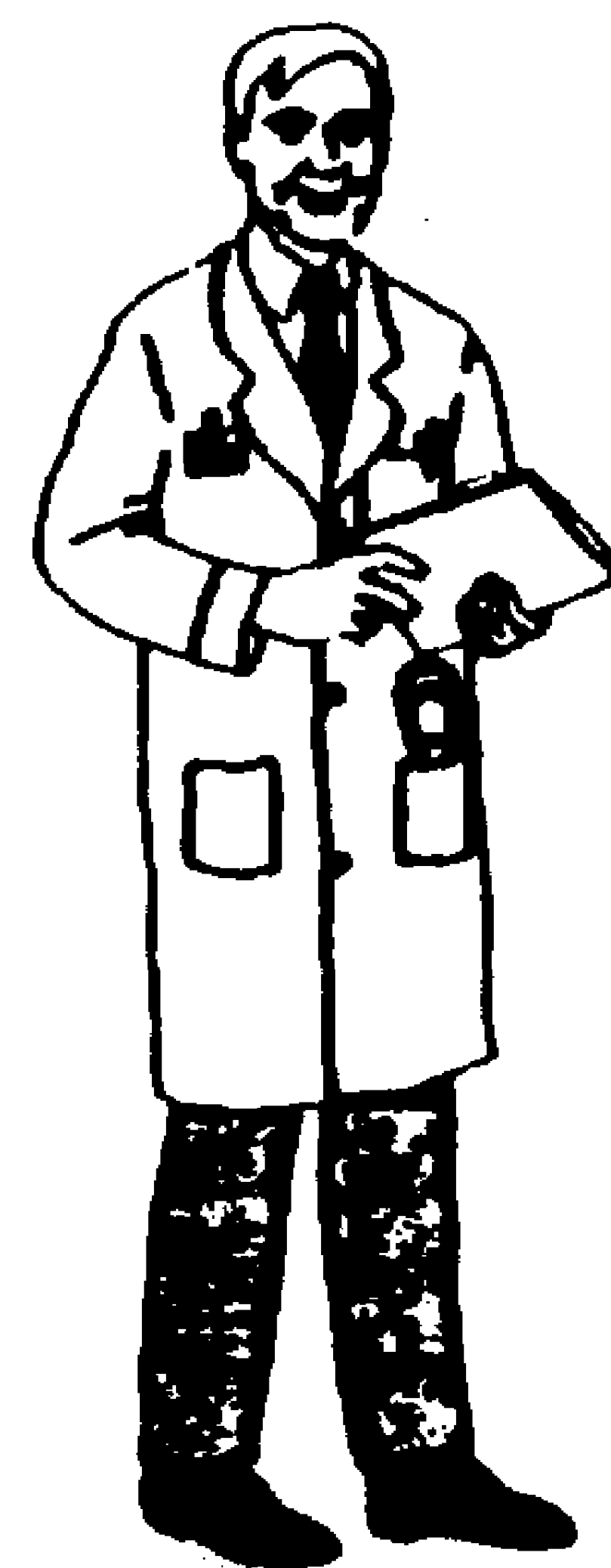
SPEAKER

OTHER

IRRIGATION VALVES

WINDOW TRIM COMPONENTS

VISTA POLYMERS RESEARCH



PVC OVERVIEW

Vista Research & Development

Located in Austin, Tx

Moved from Ponca City, OK in 1989

Approx. 135 people in R&D center

PVC OVERVIEW

Polymers Research Group

- ✓ **Purpose of Polymers Research:**
 - **develop new products**
 - **improve existing products**
 - **troubleshoot customer problems**
- ✓ **Approx. 35 in Austin R&D**
- ✓ **6 in Aberdeen plant
(Tech Service Lab)**

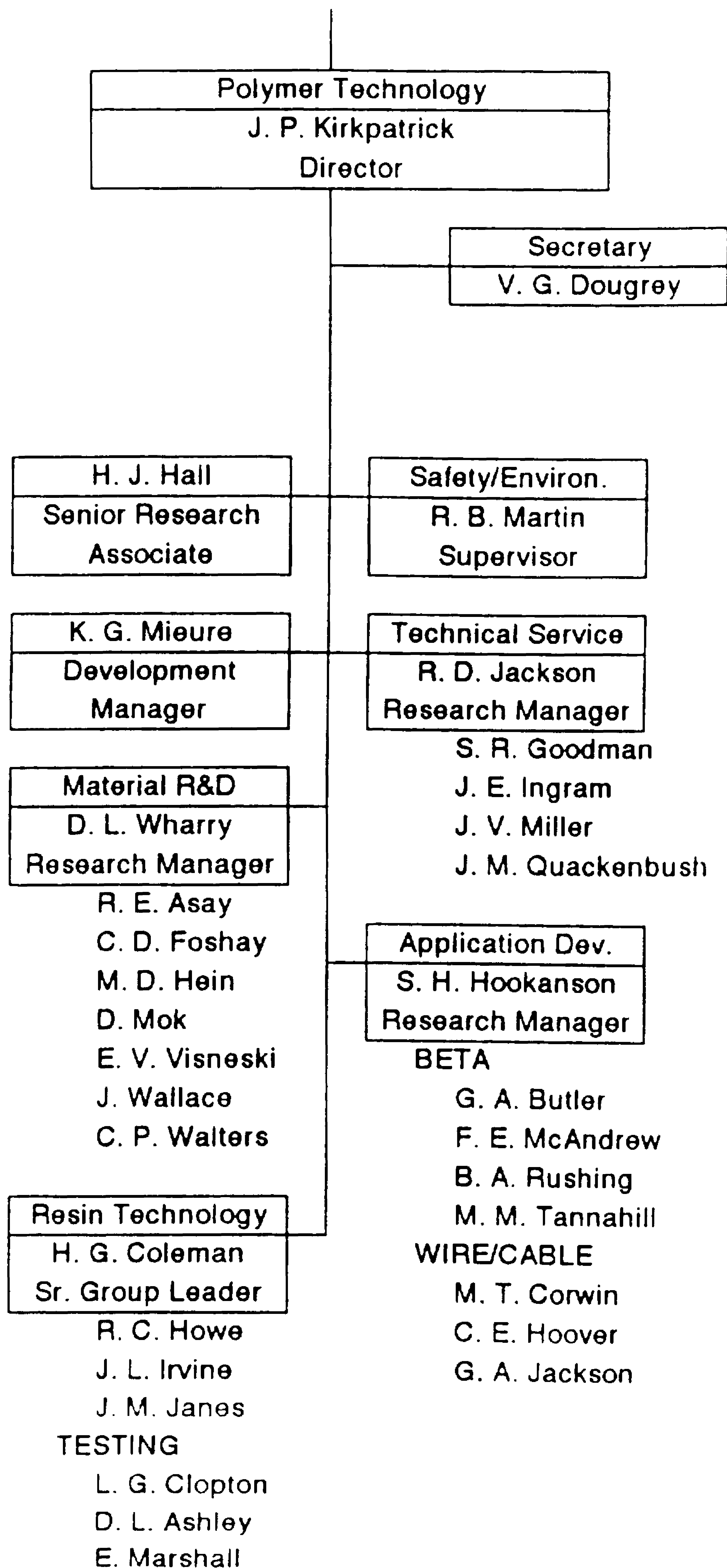
PVC OVERVIEW

Polymers Research Group

Current Research

- ✓ **PVC based polymeric blends & alloys
(e.g. Suprel™)**
- ✓ **Recycling & waste minimization**
- ✓ **Alternatives for heavy metal additives**
- ✓ **Lower molecular weight resins**

PVC OVERVIEW



Summary

✓ Why PVC?

- low cost
- good physical, chemical, weathering properties
- variety of processing techniques

✓ PVC resin is not useable by itself

✓ PVC Compound =

PVC Resin + Other Ingredients

- Rigid Compound
- Flexible Compound
(has plasticizer)

✓ Vista sells PVC Resin, Rigid & Flexible Compound

✓ Customers who buy resin make compound themselves

PVC OVERVIEW

Summary

✓ PVC Compound - two physical forms:

- Blend (powder)
 - Rigid (dryblend)
 - Flexible (Rotoflex™)
- Pellet
 - Rigid (Vistel™)
 - Flexible

✓ Customers process Compound into final product:

- Extrusion
- Injection Molding
- Calendering

✓ Vista is...

- 6th largest Resin
 - Largest Flexible Compound
 - 4th largest Rigid Compound
- ...producer (by capacity, domestic)

PVC OVERVIEW