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A Study of replacing PVC with PEGT plastic bottles due to recycling concers for PVC

Manpreet Soch

A STUDY OF REPLACING PVC WITH PETG PLASTIC BOTTLES DUE TO RECYCLING CONCERNS FOR PVC

By

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Due to Recycling Concerns for PVC

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ABSTRACT

Environmental concerns in European countries caused a US cosmetics company to evaluate plastic materials to replace PVC bottles for fragrances. PVC bottles and PETG bottles were measured and tested for several attributes, including finished dimensions following molding, leak testing, ink adhesion, drop testing, and product compatibility. Testing results indicate that PETG bottles make an acceptable replacement material for PVC bottles for a fragrance package.

(Abstract not prepared by author)

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TABLE OF CONTENTS

INTRODUCTION

The debate over the environment is not a single debate. Rather, it is several ongoing, parallel debates, each having its own central theme. Environmental debates are linked to each other, but sometimes conflict. For example, the controversy over paper bags versus plastic bags in supermarkets. It can be argued that each is environmentally sound over the other. Each debate is centered on a particular cause of concern. The importance perceived by the legislators for each is in direct relationship to the strength of public pressure at a given time. Topics not only go up and down in importance, they can and do reverse their direction as is happening with polyvinyl chloride (PVC). Social pressures tend to be expressed by individuals in black and white terms of being for or against certain items or activities. For example, Greenpeace, an environmental group, is against the use of PVC packaging because they claim that "PVC reduces the value of other materials in recycling and causes dangerous emissions in incineration" (Leaversuch 61). Greenpeace also referred to PVC as "the poison plastic". On the other hand, the Vinyl Institute calls PVC "a highly environmentally friendly material" (Heller 1999.).

To deal with issues like these the European Committee for Standardization (CEN) formed a Technical Committee to deal with packaging. All aspects of technical importance are studied including environmental impact and recycling.

In 1992, Packaging Waste Directive proposed to harmonize national measures on the management of packaging and packaging waste in order to reduce their impact on the environment. This was to be accomplished by reducing packaging at the source, eliminating any harmful materials in packaging waste, maximizing the recovery of packaging waste and minimizing the quantity going for final disposal.

In Europe, many products could be banned because of their current packaging under new European Union (EU) regulations. Each country has its own recycling laws, which must be obeyed by companies that are selling their products in that country. Calvin Klein, being a global company, sells products all over the world. It is important that the packaging meets each country's recycling laws. As a result, packaging needs to be universal. In Europe, there is a ban against the use of PVC packaging. In light of this, Calvin Klein had to change its PVC bottles to an alternate material. The EU is finalizing what is called the **ESSENTIAL REQUIREMENTS.** This will establish standards for how packaging must meet environmental demands such as source reduction, reuse, recycling and the use of heavy metals. These standards are expected to be finalized by the year 2000.

ESSENTIAL REQUIREMENTS

Under the new requirements, packaged products could be banned if:

a) they interfere with the recycling program of the country in which the product is sold

b) their packaging is not easily recovered

c) they could be packaged with less material, without interfering with the package's performance (Bell 58)

Examples of packaging that could be banned include blue glass bottles, polyvinyl chloride (PVC) packaging, pigmented high-density polyethylene (HDPE) milk containers, some software packages and ink jet cartridge packaging.

The **ESSENTIAL REQUIREMENTS** include six individual standards for packaging and one standard that links all the elements together. They are:

1. source reduction
2. limiting heavy metals and other hazardous substances
3. material recovery
4. energy recovery through incineration
5. organic recovery (composting and biodegradation)
6. reusability (Bell 58)

The standard that links these elements is titled "Packaging and the Environment" and it specifies how to comply with the six individual standards as a whole. Manufacturers will be required to demonstrate that their packaging does not interfere with existing recovery programs. For example, blue glass could contaminate a specific country's glass recycling program and PVC could contaminate a country's polyethylene terephthalate (PET) recovery program.

In recent years, Greenpeace International, an umbrella group representing National Greenpeace Organizations, has launched anti-chlorine drives in Germany, Austria, Switzerland, and Australia. Greenpeace states that PVC items are products of "a dangerous and toxic industry" (Leaversuch 43). When PVC is incinerated, its high chlorine content makes it a potential source of dioxin emissions. Greenpeace blames a number of ills on PVC manufacturing such as "toxic byproducts, use of heavy metals containing additives and plasticizers that are viewed as carcinogens, and deficiencies in incineration and disposal safety" (Leaversuch 43). The upcoming global convention on Persistent Organic Pollutants has targeted dioxin as one of the 12 priority pollutants for further reduction and/or elimination, making PVC a focus of concern.

CASE AGAINST PVC

There is much controversy concerning the recycling and reuse of PVC due to health and safety issues. "Some environmentalists criticize rigid PVC packaging as a detriment to recycling and incineration" (Leaversuch 58). "PVC softeners like phthalates are linked to cancer and oestrogenic properties that may be contributing to the incrase in reproductive problems in men" (Homepage of the Chlorophiles 5). PVC is accused to be the origin of sudden children's deaths. It is also accused of giving irritations and allergic reactions.

The Federal Food and Drug Administration (FDA) has ordered its staff to prepare environmental impact statements covering PVC's role in landfills and incineration. Landfilling is not a viable option because additives such as phthalates and heavy metals in PVC can migrate into the environment. Phthalates are plasticizers that help make PVC flexible especially for children's toys.

When PVC is burned, the effects on the incinerator and quality of the air are often questioned. The burning of PVC releases toxic dioxins, furans, and hydrogen chloride. These fumes are carcinogenic.

PVC can be recycled; however, the costs associated with this are very high. Independent research shows that by the year 2005, "it will only be possible to mechanically recycle 15-30% of PVC consumed at a very high cost" (Web Site

Greenpeace - PVC Plastic: a Looming Waste Crisis, May 10, 1998 page 2). PVC requires separation from other plastics and sorting before mechanical recycling. Greenpeace sees PVC recycling as particularly problematic because of high separation and collection costs, and the loss of material quality after recycling. PVC has the lowest recycling rate compared to other plastics like PET and PE. According to the Association of Post Consumer Recyclers, "PVC bottles are a contaminant to the recycling of PET and HDPE bottles" (press release 15 April 1998).

ACTIONS TO PHASE OUT PVC IN EUROPE

A large number of communities and states have restricted the use of PVC, showing that it is possible to use alternative materials. In addition, some national Governments have also taken action for a wider ban on PVC.

In Western Europe, campaigns against PVC have been most intense in Scandinavia and in Germany. The first PVC free community was Bielefeld, in 1987. Since then campaigns against PVC have also taken place in the U.K. In 1992 the Federal Government in Germany proposed a ban on PVC packaging and also set targets and goals to avoid, reduce, and recycle waste. Packages were to reduce in volume and weight to the minimum necessary for protection. In Norway, the Ministry of Environmental Protection asked for a phase out of PVC in all packaging and to look at the drawbacks of PVC and alternatives in long life applications.

A report released in Brussels in 1998 states that more and more PVC is entering the waste stream with no safe disposal option. Greenpeace has urged the European Commission to live up to its commitment of July 1997 and propose measures to tackle PVC waste. "The PVC industry has had 10 years to demonstrate that PVC can be recycled, but failed" (press release 15 April 1998) said Wytze van der Naald of Greenpeace International.

The county of Aarhus in Denmark has introduced a policy of buying PVC free alternatives for all public purchases. In 1992 Denmark announced its intention to phase out PVC wherever practical. The Environment Minister encouraged voluntary delisting of PVC by the retailers. Denmark has now also proposed restrictions on the use of softeners; lead and other additives used in PVC plastic and is questioning the recycling potential of PVC.

In Australia, the Sydney 2000 Olympics is committed to environmental criteria based on the concept of ecologically sustainable development. This includes a commitment to minimize the use of PVC. In particular, no PVC is to be used in plumbing and drainage pipes or flooring material.

The Czech Republic agreed to phase out production, imports, and use of PVC packaging from 2001 onwards. In 1992 Finland placed a ban on packaging from PVC.

In Netherlands a declaration was signed to avoid PVC. In 1990 the Dutch retailers stated that they wished for their suppliers to stop using PVC by September 1990. The Environment Minister stated that if the retailers were not successful in getting PVC out of their stores within two years, he would ban it. Actions were taken to eliminate chlorine-bleached materials and to replace PVC with other more favorable plastics for specific package types and applications.

128 communities in Sweden agreed to avoid PVC. In 1991 Swedish industry agreed to phase out PVC packaging by the middle of that year. The proposal stated "choice of packaging material should be aimed at reducing environmental load, specifically by eliminating PVC and heavy metals" (Packaging and the Environment Review 24). In 1995, SNV, the Swedish Environmental Protection Agency, denounced a proposal by the Swedish Parliament to phase out the use of plasticized PVC by 2000. SNV wanted stabilizers based on heavy metals to be phased out and the abolition of PVC recycling. The North Sea Ministers Conference agreed in 1995 to stop environmental emission of hazardous substances within one generation. According to the Swedish Chemical Committee, "PVC has no place in a sustainable society and should by completely phased out for all uses by the year 2007" (Greenpeace Web Site - PVC Plastic: a Looming Waste Crisis, May 10, 1998 page 4).

ACTIONS TO PHASE OUT PVC IN UNITED STATES

In 1992 certain states in the U.S. proposed bans on all except "environmentally acceptable packaging". In New Jersey, Bill A 2218 would ban the sale or distribution of any single use package that is made from PVC.

In New York, legislators banned Polystyrene (PS) foam and plastics that yield dioxins when burned. This includes polyvinyl chloride.

PVC bottles have lost significant market share in recent years due to environmental attacks. In Europe, PET has already replaced a large number of PVC bottles. In the United States, the demand for PVC bottles has also declined significantly. The large packaging companies often refuse to consider PVC in new applications. PVC replacement is underway. The consensus among several consultants and other industry sources is that 50% or more conversion within 5 years is feasible for rigid food bottles, PVC blister packs, water distribution pipes as well as flexible flooring, food wraps, intravenous medical bags and tubing. Since 1994, there has been a 15% decrease in PVC packaging in the U.S. Stretch blow molders are also speeding the switch to PET in cosmetic bottles, which were once a PVC stronghold.

PHASE OUT ACTIONS WITH RESPECT TO PVC

Recommendation is to systematically eliminate PVC in Europe, North America and high profile environment countries such as Australia and New Zealand. Elsewhere, the real arguments against PVC are related to its mode of disposal and some governments support its use due to local availability. In this case the recommendations apply:

1. Companies must decide on the use of PVC in bottles in light of their local situations reflecting consumer, retailer and governmental attitudes.

2. Companies that continue to use PVC must have clear, rapid contingency plans to move to replacement materials.

3. Companies that continue to use PVC are strongly advised to develop good contacts with their local environmental opinion leaders. Their objectives are to influence attitudes favorably to PVC and to obtain an early warning of any negative shift in opinion (Legislation: Packaging and the Environment Review 101-102).

IMMEDIATE ACTIONS WITH RESPECT TO PVC

1. Replace all PVC labels with an alternate material in Europe.
2. Replace all PVC vacuum forms to alternate materials.
3. Replace all PVC bottles with PETG in Europe and Domestic markets.

This project focuses on the process involved in replacing PVC with PETG bottles used to package after-shave balm, body moisturizer, and shower gel. This study includes an understanding of extrusion blow molding process for plastic bottles, material characteristics and mechanical properties of PVC and PETG. A number of tests including decoration test, leakage test, vibration and drop test, stability and weight loss test are performed to qualify the new material. A capability study for the dimensions is also conducted to make sure the parts are within specified tolerances.

EXTRUSION BLOW MOLDING PROCESS

PROCESS:

Blow molding is a means of forming hollow thermoplastic objects. Air pressure is applied inside a small hollow and heated plastic piece called a parison. The parison expands against the walls of the mold cavity and takes it shape. The part cools and hardens. The mold opens and the part is ejected. Figure 1 illustrates the blow molding process. Figure 2 illustrates the extrusion blow molding process.

Obsession for men plastic bottles are manufactured using the extrusion blow molding process. In extrusion blow molding, the parison is extruded as a tube. This is inserted in the blow-molding die with one end engaging a blow pin or a needle. As the die is closed, the tube is pinched at both ends. After the pinched off tube is expanded and the bottle is formed, the die opens and the bottle is ejected. Extrusion blow molding leaves extraneous material after molding, which requires a trimming operation. Figure 2 illustrates the extrusion blow molding process. PVC and PET are the most suitable materials for manufacturing with this process. PETG can be processed using the same equipment that is used to process PVC. The reason is that both of these materials behave similarly when melted. The processing temperature for PETG is slightly higher than PVC, but the viscosity and melt strength are similar.

TYPICAL APPLICATIONS:

Containers of various sizes and shapes are the predominant blow molded products. Another large market is in blow-molded toys, ranging from simple balls to elaborate dolls. Specialized containers like carrying cases for instruments and tools; vehicle fuel tanks, etc. are made by blow molding. Containers for liquids and other items used in the household are the most common application. Bottles for laundry detergent and bleach, cooking oil, shampoo, various cosmetic and medicines are typical examples.

Extrusion blow molding and injection blow molding have somewhat different capabilities when it comes to the size and shape of the containers. Injection blow molding is more suitable for small containers, with fairly regular shapes. It can also produce more accurate dimensions around the neck of a container. The wall thickness in the neck area of a container is normally greater than in the body to provide secure sealing surfaces for caps. Walls can thin out considerably below nominal values in area where the material stretches to fill the mold. Extrusion blow molding is better for larger containers and those with irregular shapes. This process is capable of producing containers with integral handles, which is not feasible with injection blow molding process. Extrusion blow molds are lower in cost than injection blow molds by about one-third for the same part.

DESIGN RECOMMENDATIONS:

Following is a list of recommendations when designing parts using blow-molding process (Bralla, James G. 6-59):

Wall thickness:

The wall thickness should be as uniform as possible to ensure more rapid molding cycles, conserve material, and avoid distortion due to uneven cooling.

Draft:

The part design should permit portions of the blow mold, which are perpendicular to the parting plane to have a draft to ensure that the molded part can be easily removed from the mold.

Corners:

Rounded corners are necessary to ensure uniform wall thickness and ensure easy molding and maximum strength of the part.

Shapes:

Regular, well-rounded shapes are more easily molded. Examples of such shapes are soda bottles, cosmetic bottles, oil bottles, and shampoo/conditioner bottles.

Dimensional Factors:

Blow-molded parts are subject to the following factors that cause dimensional variation in plastic parts (Bralla, James G. 6-61):

1. There is shrinkage in material as it sets.
2. Time, temperature, and pressure variations during molding.
3. Variations in material from batch to batch.
4. Low molding pressure can also result in dimensional variation.

Close dimensional tolerances can greatly increase the cost of injection molded parts. Tight tolerance molds are more costly than loose tolerance molds. The processing cost increases for extra-tight dimensional control.

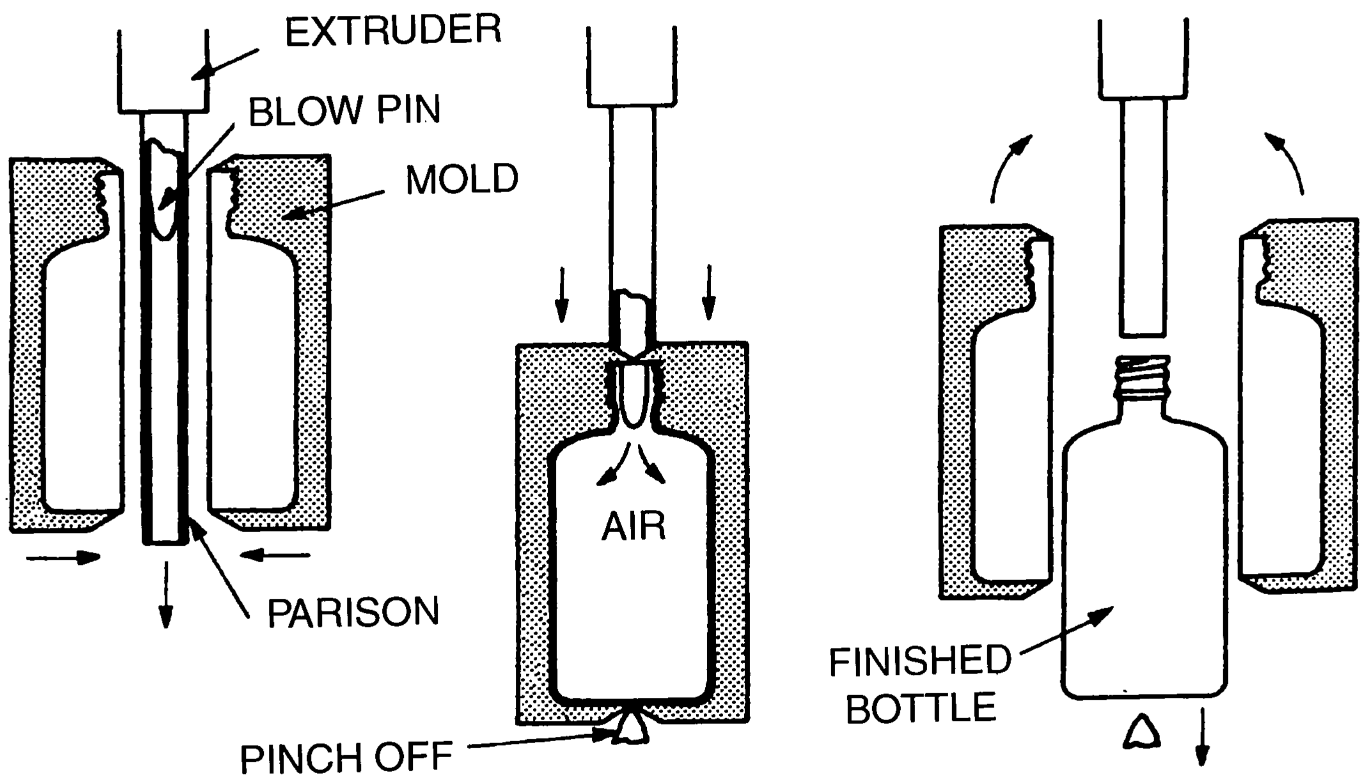

FIG. 1 Blow molding.

(Hanlon, Joseph F. 8-56)

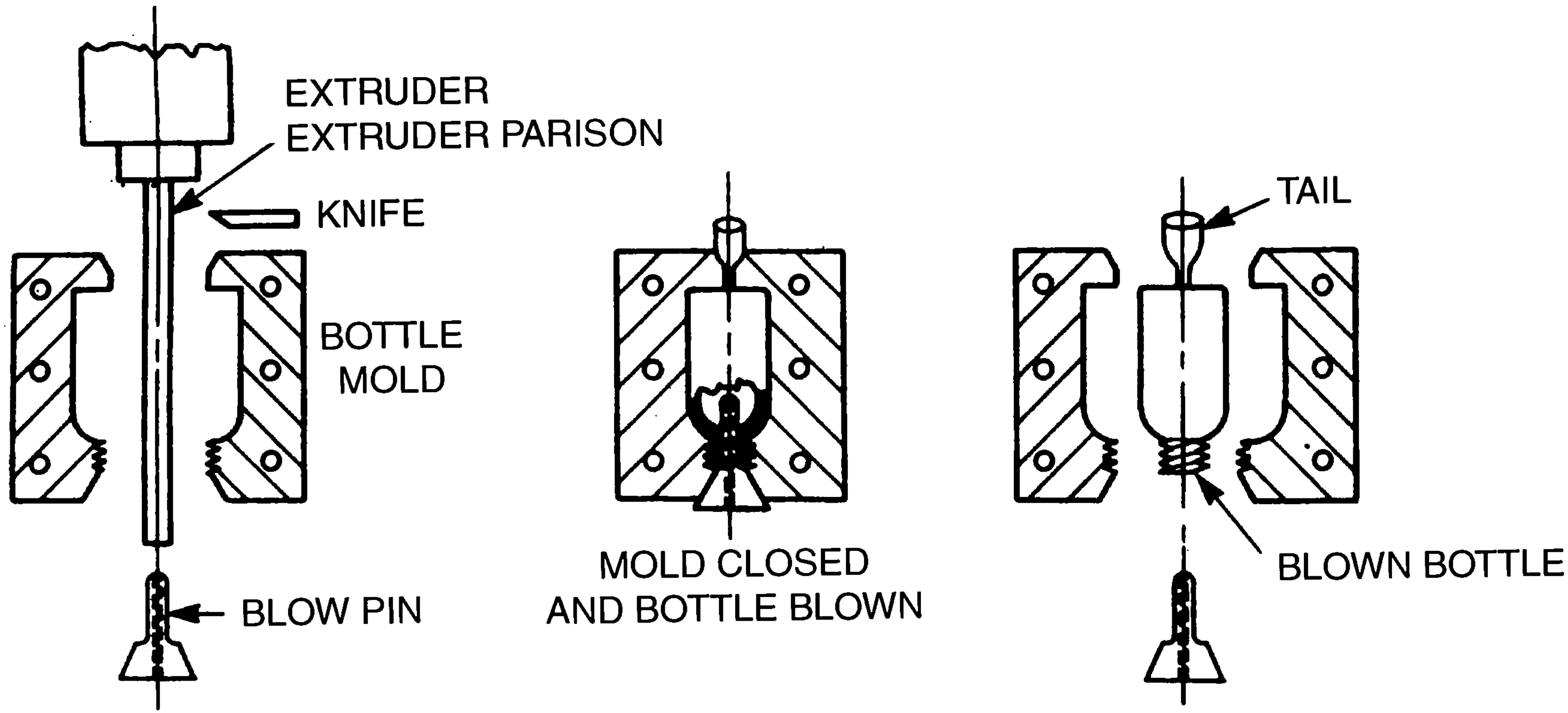

FIG. 2 Schematic diagram of the extrusion-blow-molding process.

(Bralla, James G. 6-57)

PVC AND PETG ATTRIBUTES

PVC – POLYVINLY CHLORIDE

Polyvinyl chloride (PVC) is a thermoplastic. Thermoplastics do not set under heat. They soften when heated to a liquid state. As a liquid it can be forced or transferred from a heated cavity into a cool mold. It can be remelted and rehardened by cooling many times. Eventually, the material will degrade, thus limiting the number of heat cycles.

Description:

PVC, commonly called a vinyl, has been used commercially for more than 50 years. Flexible PVC was introduced in the mid-1930s. A rigid engineering grade of PVC became useful in the early 1950s for piping on naval vessels. It is now used for packaging for food and cosmetic bottles, shrink wraps, children's toys, window frames, pipes and vinyl floors.

Chemistry:

PVC is the largest member of a group of polymers commonly referred to as vinyls. It is manufactured from sodium chloride (NaCl) and natural gas. "PVC is polymerized from vinyl chloride monomer (CH_2=CHCL) to produce [-CH_2CHCL-] $_n$" (Summers 209).

Characteristics:

In its natural state, PVC is hard and rigid but the addition of phthalate esters as plasticizers makes it soft and pliable. PVC is generally transparent with a bluish tint. Precise properties depend on formulation. Selection of type and proportion of plasticizer can make plasticised PVC flexible. It is obtainable in the form of granules, solutions, lattices, and pastes. PVC is self-extinguishing. It burns with a yellow flame and a green tip. It gives off the odor of hydrochloric acid and white smoke. PVC can be easily identified by the copper wire test, which indicates the presence of chlorine, by a bright green flame. The specific gravity ranges from 1.2 to 1.7.

Advantages:

PVC is an excellent barrier for oils, alcohol, and petroleum solvents. PVC has a very good resistance to water, concentrated acids and alkalis. It has a low permeability to gases. It has very low oxygen transmission. It is also very chemically resistant. It is relatively unaffected by hypochlorite solutions and aliphatic hydrocarbons. Since it provides a good oxygen barrier, PVC is an excellent choice for salad oil, mineral oil, and vinegar. It is also commonly used for shampoos and cosmetic products.

Disadvantages:

PVC in its pure form has very poor impact resistance. This is generally improved by the addition of plasticizers. PVC is seldom used in its pure form. It is vulnerable to solvents. It is not recommended for use above 70 Deg. C. although it can be taken to 80 Deg. C. for short periods. General Purpose PVC exhibits poor resistance to high temperatures and will distort at 160° F, making it incompatible with hot filled products. PVC yellows when it is exposed to heat or ultraviolet light, unless there is a stabilizer added by the resin supplier. Heat and light degrade all PVC polymers. As a result, hydrogen chloride is eliminated and oxidation occurs. PVC scratches very easily if handled roughly during production or distribution.

Properties:

PVC is available in different grades depending on its application. These grades include general-purpose grade, food grade, and fragrance-guard perfume grade. Controlling the toner levels in each of these grades can modify the occurrence of the blue tint in clear PVC. PVC is also available in a rigid injection blow-molding grade. New PVC grades are able to withstand temperatures up to 190° F and can be hot filled.

PVC offers a number of unique features:

1. *Combustibility:* PVC offers low combustibility without additives that can sometimes cause problems due to migration.

2. *Toughness:* PVC compounds are usually ductile and tough. They can be designed to be virtually unbreakable.

3. *Weatherability:* PVC compounds have outstanding weatherability including good color and impact retention, good tensile and flexural strength retention, and no loss in modulas stiffness.

4. *Dimensional Control:* PVC compounds can be designed to have either high or low melt viscosity to meet processing and property requirements.

PVC has become one of the most versatile polymers. PVC is readily modified to attain enhanced properties using compounding additives that are available. PVC is usually compounded with stabilizers to minimize its thermal dehydrogenation, or with plasticizers to reduce its melt viscosity and increase compliance of certain shaped containers. A rigid PVC bottle can be blow molded with proper additives.

Dissolved by: tetrahydrofuran, cyclohexanone, methyl ethyl ketone, and dymethylformamide, also by mixture of acetone/ (carbon disulphide, carbon tetrachloride, or benzene).

Plasticized by: primary plasticizers (phtalates, phosphates, sebacates and fatty acid derivatives) and polymeric plasticizers (adipates, sebacates or azelates of propylene glycol).

Combustion: burns but is self-extinguishing.

PVC Processing:

PVC processing includes calendering, extrusion, injection molding, rotational molding, powder coating, and roller coating.

Packaging Applications:

PVC packaging applications fall into three general categories: food, non-food, and medical. PVC bottles are being used for edible oils, honey, etc. PVC bottles are also used extensively to package items such as toiletries, cosmetics, and household detergents.

PETG - POLYETHYLENE TEREPHTHALATE GLYCOL

PETG is a thermoplastic. It was first developed in 1941 for use in synthetic fibers. The second principal application of PET was film. In 1966 PET became available for the manufacturing of injection molded parts. In 1976, the first 2-liter PET beverage bottle was introduced.

Description:

PETG is also known as glycolised polyester. The "G" represents glycol modifiers, which are incorporated to minimize brittleness. PETG is a very durable material. It has excellent gloss, clarity and sparkle, which are desired for clear bottles. PETG can be processed via conventional extrusion blow molding methods, generally on machines designed to process PVC.

Chemistry:

PETG is a medium-viscosity polymer. This polymer is prepared by condensing ethylene glycol and terephthalic acid.

Characteristics:

PETG is extremely hard, wear resistant, and dimensionally stable. Like PVC, it is very resistant to chemicals. PETG continues to burn without dripping even after the removal of the ignition source. It burns with a yellow flame with blue edges and produces black smoke with soot in the air. It gives off a sour cinnamon odor. The specific gravity ranges from 1.30 to 1.50.

Advantages:

Polyethylene Terephthalate Glycol is an excellent material for use in extrusion blow molding. PETG exhibits good impact strength. It is a good gas barrier. The chemical resistance of PETG is fair and compatibility testing is recommended, especially with products that contain alcohol. PETG has many features similar to PVC with similar temperature resistance and durability.

Disadvantages:

This material does not provide resistance to high temperature applications (max. temp. 160° F). However, heat-set PET creates a container which will accept a 195° F hot fill and exhibit the clarity of other PET containers. This process provides an alternative to glass for products such as juice.

PETG Processing:

To attain optimum part performance, PETG must be dried before processing by injection molding and maintained at a moisture level of less than 0.02% to prevent hydrolysis. For optimum surface appearance, dimensional stability, and part performance, mold surface temperatures of 100 °C to 110 °C are preferred.

Packaging Applications:

Amorphous unoriented copolyesters are used to make blow-molded, crystal clear bottles for applications such as bottles for cosmetic toiletries. These bottles can be produced on conventional blow-molding equipment. Applications include shampoos, soaps, and detergents.

CHART # 1: PVC AND PETG DATA SHEET

PROPERTIES	PVC	PETG
Specific Gravity	1.34	1.27
Tensile Strength at Break	39 N/mm^2	28 N/mm^2
Elongation at Break	190% (ISO)	110% (ASTM)
Izod Impact Strength (Notched specimen 73°F)	18 KJ/m^2 (ISO)	101 J/m (ASTM)
Temperature Stability	65°C max	60-70°C
Printability	Can be easily printed, medium quality print	Can be printed very well

TESTING OF PACKAGING MATERIALS

In order to predict the ultimate performance of a package in the marketplace, a wide array of test procedures can be performed. The procedures and results for the tests performed on the Obsession for Men plastic bottles are described below.

DIMENSIONING

Overview:

It is important to measure critical dimensions of the package to ensure that they are satisfactory for the end use and meet the required specifications.

Objective:

Various dimensions are recorded to check to see if the part is within specified limits.

Test apparatus:

Calipers .001 inch

Test material:

Thirty plastic bottles in PETG

Test procedure:

Measure all critical dimensions on the bottles. Record the T, E, ID, overall height, and side to side and front to back dimensions of the bottles. Most importantly, check the fill capacity of the bottles to make sure that the weight claim is met for legal requirements.

Description:

T dimension is also referred to as the major/largest diameter of the thread.

E dimension is also referred to as the minor/smallest diameter of the thread.

ID dimension is the measurement of the inside diameter of the bottle opening.

Figure 3 shows a diagram of the dimensions measured.

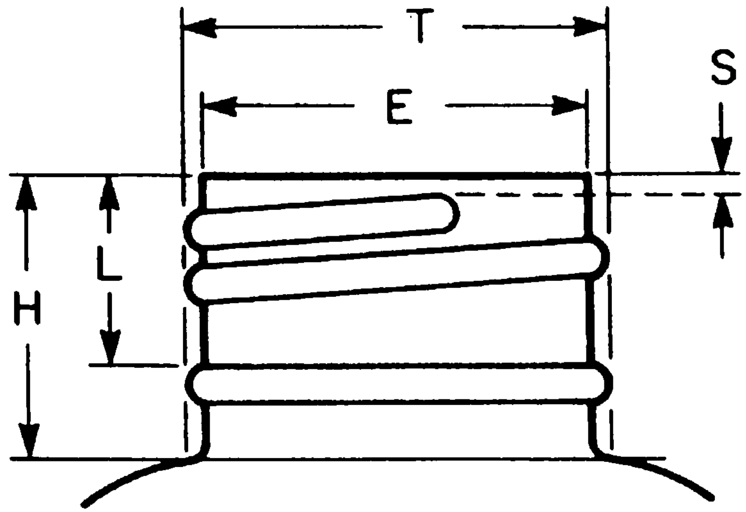

FIG. 3 : Illustration of a thread finish on a plastic bottle

(Bralla, James G. 6-60)

Chart 2: Dimensional Analysis

Capability Study for Critical Dimensions of PETG Bottles

	ID (mm)	E (mm)	T (mm)	Front to Back (mm)	Side to Side (mm)	Overall Height (mm)	Bottle Weight (g)	Overflow Capacity (ml)
	8.06	14.14	15.81	28.10	75.77	106.55	18.04	122.74
	7.85	14.13	15.78	28.01	75.77	106.58	18.02	122.71
	8.01	14.10	15.78	28.02	75.82	106.64	17.99	123.16
	8.04	14.13	15.81	28.02	75.77	106.53	18.06	122.96
	8.02	14.13	15.78	27.94	75.72	106.59	17.99	123.02
	8.04	14.13	15.84	28.00	75.91	106.50	18.00	122.90
	8.06	14.14	15.82	27.95	75.81	106.63	18.02	122.90
	8.08	14.13	15.81	27.83	75.81	106.67	17.94	122.95
	8.04	14.17	15.82	27.97	75.74	106.60	17.98	123.05
	8.00	14.13	15.85	27.81	75.83	106.60	18.06	122.92
	8.02	14.13	15.84	27.98	75.77	106.68	17.99	123.22
	8.07	14.11	15.79	27.73	75.73	107.02	18.00	123.25
	8.02	14.13	15.89	27.72	75.80	106.67	17.99	122.72
	8.04	14.11	15.81	27.77	75.85	106.72	18.06	122.72
	8.01	14.16	15.87	27.88	75.89	106.69	17.95	123.11
	8.06	14.11	15.95	27.98	75.82	106.62	17.98	123.09
	8.07	14.18	15.86	27.89	75.75	106.68	18.07	122.61
	8.05	14.12	15.83	27.85	75.82	106.55	17.90	123.27
	8.07	14.11	15.76	27.93	75.82	106.68	17.97	122.97
	8.03	14.14	15.79	27.84	75.80	106.69	17.99	122.88
	8.05	14.12	15.77	28.00	75.84	106.62	18.19	122.45
	8.06	14.11	15.87	27.99	75.81	106.62	17.97	123.09
	8.07	14.15	15.81	28.00	75.82	106.72	18.13	122.71
	8.06	14.12	15.81	28.06	75.83	106.63	17.90	123.22
	8.02	14.12	15.81	27.88	75.81	106.68	18.05	122.72
	8.00	14.15	15.81	28.01	75.94	106.78	18.03	122.83
	8.04	14.12	15.81	27.93	75.81	106.63	17.98	123.23
	8.06	14.14	15.80	28.04	75.86	106.68	18.07	122.95
	8.01	14.15	15.84	27.91	75.82	106.70	17.97	123.02
	8.04	14.13	15.81	27.90	75.85	106.65	18.01	122.89
Average	8.04	14.13	15.82	27.93	75.81	106.65	18.01	122.94
std dev	0.04	0.02	0.04	0.10	0.05	0.09	0.06	0.21
-3 sigma	7.87	14.06	15.66	27.55	75.62	106.28	17.77	122.11
+3 sigma	8.20	14.21	15.98	28.32	76.01	107.02	18.25	123.77
Lsl	7.80	14.00	16.00	26.90	75.20	106.60	14.50	122.00
Usl	8.20	14.40	16.40	27.50	75.80	108.20	17.50	128.00

RESULTS:

The inside diameter performed well in the dimensional analysis. The mean was within 0.04 mm of nominal and the standard deviation was 0.04 mm. At ± 3 sigma, it fell within both the upper and the lower specification limits.

The results for the E dimension were similar. The mean was within 0.02 mm of nominal and the standard deviation was 0.02 mm. At ± 3 sigma, the dimensions fell within both the upper and the lower specification limits.

The T dimension was more problematic with the mean falling 0.38 mm below nominal, 0.18-mm below the lower specification limit. The standard deviation of .04 mm was acceptable, but at +3 sigma it did not meet the lower specification limit. Because of the critical nature of this dimension, mold changes were required.

The front to back dimension was 0.73 mm over nominal with a standard deviation of 0.10mm, much higher than expected. The high variation was indicative of a high degree of subjectivity in the measurement. This is due to the flexibility of the bottle. Since this was not a critical dimension, the print was changed to reflect the part.

The side to side dimension had a mean of 75.81 mm, exceeding the upper tolerance by 0.01 mm. The variation was .05 mm. Again the print was changed to reflect the actual part.

The mean of the overall height was 106.65 mm, 0.05 mm within the lower tolerance. However, at –3 sigma it was out of tolerance. The print was changed to reflect the part.

The average weight for the bottle was 18.01 grams. The standard deviation was 0.06 grams. The weight was 2 grams over nominal and 0.51 grams over the upper specification limit. The bottles weighed more than what is specified on the blueprint.

The overflow capacity was found to average 122.94 ml. The standard deviation was 0.21 ml. The 3-sigma limit fell within the tolerance of 122.00 ml – 128.00 ml. What is significant about this is that the average is so close to the lower end of the tolerance. Because –3 sigma is still within specification, the legal requirements for the weight claim are met and less product is used than if it were at the higher end of the tolerance.

LEAKAGE TESTING

Calvin Klein Cosmetics Company Testing Manual 18.

Overview:

Leakage is the passage of gases and vapors through discontinuities in the material, such as cracks, pinholes, and microscopic gaps between the closure and the bottle neck finish. Leakage test is performed by creating a partial vacuum around the package.

Objective:

This test detects leakage and it can also locate leakage pathways. Detection is visual observation for air bubbles or dye solutions emanating from the package.

Test apparatus:

Vacuum chamber

Test materials:

Twelve samples
Water with coloring dye

Test procedure:

1. Fill twelve samples with colored water, making sure that nothing spilled on the threads or the neck of the bottle.

2. Close bottle with cap.
3. Place samples laying horizontally into vacuum for 30 minutes at 25" of mercury.
4. Check samples visually for leakage. Check packages for defects at points of leakage.

Results:

At the end of the test, the samples were visually inspected for leakage. This was done by checking the white tissue that the bottles were laying on for any wet marks. Since the tissue was completely dry, there was no evidence of water leaking through the mouth of the bottle. Failure would have resulted if the bottles had leaked. Leakage would have resulted if there were a gap between the neck of the bottle and the cap. Wet tissue would have been evident. This test was done for both PVC and PETG bottles and they both performed equally well. Neither sample had any water leak out from around the bottle finish. As a result, both PVC and PETG passed the leakage test.

DECORATION COMPATIBILITY/SCOTCH TAPE TEST

Calvin Klein Cosmetics Company Testing Manual 2-3.

Overview:

Various printing processes are used to decorate plastic bottles. The most common printing methods are hot stamping, offset printing, heat transfer, and silk screening. Screen-printing is the most common method of decorating plastic bottles. It provides a thick, even print by forcing ink through a photographically treated screen. Screen-printing is low in initial cost and offers versatility of decorating effects. Flame treatment is often required prior to decoration. Epoxy ink can be used for protection against scratching and for use with products that may attack standard enamel inks. Ultra violet (UV) ink is also very resistant to scratches and dries very quickly.

Objective:

Scotch tape test is performed on all graphics decorated by silk screening to evaluate the adhesive properties of the decoration on various surfaces.

Test Materials:

1. Minimum of six test samples free of dirt
2. 3" long pieces of '3M' brand #600 ¾" wide tape
3. Work sheet

Test Procedure:

1. Test should be performed at room temperature.
2. Place tape over decoration from side to side, pressing firmly and evenly.
3. Quickly remove tape perpendicular to test surface.
4. Note removal of any lettering or decoration.
5. Place tape onto work sheet.
6. Repeat procedure on the same test sample, placing tape top to bottom over decoration.
7. Repeat test on the remaining samples.

Pass/Fail Criteria:

Removal of any lettering or decoration is unacceptable.

Results:

The 3" long pieces of scotch tape were placed on a blank white sheet to inspect for any ink that might have transferred from the bottle onto the tape. After carefully checking the tape, there was no evidence of any ink transfer or removal from the test samples. The test would have been considered failed if any of the lettering on the test samples was not legible. Both the PVC and PETG bottles passed the decoration test.

PACKAGE SYSTEM TEST

Vibration and drop test is used to verify package performance and integrity. Performance refers to the ability of the package system to protect the product from shock and vibration. Package integrity refers to the ability of the package system itself to withstand the rigors involved during a normal distribution cycle.

VIBRATION TESTING OF SHIPPING CONTAINERS

Overview:

Vibrations to a packaged product can cause physical damage such as scuffing. Vibration tests are intended for determining the response of products to vibration. This test helps to determine the naturally occurring vibrations during the transit of packaged goods. The results from this test are also helpful for product design purposes. Vibration effects can be simulated by using a vibration tester.

Objective:

The objective of vibration test is to determine the effects of transportation vibration on a complete shipping unit including the product and the components.

Test results can help in the design and modification of a package that will minimize transportation damage.

Test Apparatus:

The vibration machine has a flat horizontal table, which operates in a rotary motion. The vibration table consists of a bed driven by two wheels connected in phase with one another. A platform is attached to the top of the vibrating bed and a circular, harmonic type of vibration occurs when the table is operational. The overall frequency may be varied from about 120 cycles/min to 360 cycles/min. Vibration tests can run between 15 minutes and an hour. One hour on the vibration table equals to a 1,000-mile trip by rail.

Test Procedure:

1. Take 24 filled bottles and place inside the shipper.
2. Close and tape shipper.
3. Place shipper on the vibration table in its normal shipping orientation.
4. Vibrate shipper on three sides (bottom, top, and one long side) for 20 minutes on each panel. Total vibration time is one hour.
5. At the end of the test, open shipper and examine contents for scuffing.
6. Observe for any damages such as scuffing of folding cartons, bottles, and caps.

Results:

There was evidence of minor scuffing on both PVC and PETG bottles. The marketing group deemed the damage acceptable. It is important to note that the bottles were in their upright position when the shipper was being vibrated on its bottom panel. The bottles were upside down when the shipper was vibrating on its top panel. The bottles were resting on their narrow side when the shipper was vibrating on its long side. The scuffing was acceptable because it was minor and barely noticeable.

DROP TEST ASTM 775-80

Overview:

Test method ASTM 775-80 "Drop Test for Loaded Boxes" indicates hazards present in the distribution environment. As containers move throughout the environment, they usually encounter several hazards in various sequences. This test helps identify the weak points of the container.

Objective:

The objective of drop test is to measure the ability of shipping containers to withstand damage caused by the sudden shock induced by dropping a package. Test method D775-80 "Drop Test for Loaded Boxes" simulates those shocks that are likely to occur in the handling of packages through a variety of distribution cycles and the ability of the box to protect the contents against these shocks. Drop tests are performed with either of the two following objectives:

Objective A – To measure the ability of the shipping container to withstand the rough handling.

Objective B – To measure the ability of the package (shipping container and interior packaging materials) to protect its contents (ASTM Standard test Method for Drop Test For Loaded Boxes 27).

Test Apparatus:

The apparatus used in drop testing allows for the box to be positioned accurately, controls the height of the drop, and provides a release mechanism that does not impart rotational or sidewise forces to the test package. Gaynes Drop Tester was used to perform drop testing.

Test Procedure:

1. Take one complete shipping unit (consisting of 24 bottles filled with product).
2. Determine the drop height of the shipper by weighing the complete shipping unit.
3. Record the weight.

Use the following chart to determine the drop height:

Weight (lbs.)	*Drop height (in.)*
0-15	36
16-20	30
21-30	24
31-40	18
41-50	15

4. Assemble shipper and place it on the drop tester leaves centered.
5. Release the drop tester leaves by pressing on the foot paddle.

6. Drop shipper on all of its sides from a height of 36" as follows:

Drop A - bottom and top panel of the shipper

Drop B – two long sides of the shipper

Drop C – two short sides of the shipper

7. Complete drop A and examine the contents of the shipper.
8. Complete drop B and examine the contents of the shipper.
9. Complete drop C and examine the contents of the shipper.
10. Mark damaged contents at point of deterioration (A, B, or C drop).
11. Inspect and record all packages for damage such as scuffing, cracking and breaking.

Results:

There were no broken bottles. The shipper was dropped from a height of 36" During drop A, the bottles were oriented in their upright and upside down position. For drop B, the bottles were dropped on their front and backside. For drop C, the bottles were dropped on their left and right sides. The bottles were checked for any stress marks, cracks and breaks. There was no damage noted on the 24 bottles in the shipper. This test was done for both PVC and PETG bottles containing body moisturizer, shower gel, and after-shave balm. Both PVC and PETG bottles passed the drop test.

PRODUCT PACKAGE COMPATIBILITY TESTING

Calvin Klein Cosmetics Company Testing Manual 14-15

Overview:

Product compatibility is determined by measuring critical package properties immediately after packaging and periodically thereafter until the end of the normal product life cycle. Product package compatibility tests help determine a package's compatibility with the product, its permeability rate and also its organoleptic behavior. This allows one to test for weight change, odor, taste, and headspace analysis. If the resulting weight change is too severe, then the package may not be suitable for long-term storage of the product. Bottles are examined for bulging, collapsing, stress cracking, discoloration and staining.

Objective:

The objective of package compatibility and weight loss test is to determine the effects on packaging materials filled with product under the influence of elevated temperature, to evaluate compatibility of products and their associated packaging components, to make predictions on weight loss, and to make any visual observations. Weight loss from an aqueous product packaged in plastic bottle results from permeation through the walls as well as from leakage around the closure. One of the simplest ways of measuring transmission rates it to package a liquid product and to store the sample in an environment containing none of the volatile ingredients, which could escape from the product. The sample is weighed periodically. The steady state transmission rate can be found from the slope of a weight versus time plot.

Test Materials:

1. Forty empty packages (which include bottles and caps) to test each product.
2. Five gallons of the most current formulation of product being tested accompanied by Research and Development "certificate of analysis".

Test Procedure:

1. Label all bottles from #1 - #40 with brand name, product name and batch # for reference purposes.
2. Weigh an empty bottle and a cap. Record the tare weight.
3. Fill bottle with the product to label claim.
4. Record the complete filled weight of the package.
5. Repeat process for the remaining test samples.
6. Fill sixteen 1 oz. glass standards and label as mentioned above.
7. Place samples #1 - #12 and four glass controls in 45° environmental chamber.
8. Place samples #13 - #24 and four glass controls in 40° environmental chamber.
9. Place samples #25 - #32 and four glass controls in 25° environmental chamber.

10. Place samples #33 - #40 and four glass controls in –15° environmental chamber.
11. Evaluate samples at every two weeks during an eight-week period.
12. Allow samples to achieve equilibrium.
13. Record weights of all forty samples.
14. Record any visual observations such as material discoloring stress cracking along the parting lines and bulging of sidewalls.
15. Record any differences in product changes such as discoloring, product separation, change of texture, and change in fragrance.
16. Compare test samples to the glass controls for visual observations.
17. At the end of every two weeks, provide one sample along with one glass control from each environmental chamber to Research and Development for product evaluation.
18. Test is complete at the end of eight weeks.
19. Complete data evaluation by providing weight loss results and Research & Development evaluations.

Pass/Fail Criteria:

Average percent weight loss over 1% at the two-week period is unacceptable. Maximum average percent weight loss acceptable over eight weeks is 3%. Changes in product color or consistency are unacceptable.

Results:

At the end of the eight-week general package and product compatibility testing, weight loss in PETG bottles was almost twice as much as in PVC bottles for all bottles. Both PVC and PETG bottles passed the product compatibility test. It is important to note that the PVC bottles consistently gained weight at –15°C. For samples that gained weight, a possible theory is that there was condensation on the bottles. It is also possible the PVC absorbed more moisture from the air than product lost. This could attribute to the better performance of PVC in this test. Some of the PETG bottles also gained weight at -15°C.

All samples had average percent weight loss less than 1% at two weeks and less than 2% after eight weeks. The maximum allowable loss is 1% at two weeks and 3% at eight weeks. Therefore, the results were acceptable. For individual test results, refer to graphs 1-9.

The samples were also compared to glass controls for odor, appearance and color. At the end of each two-week test period, one glass control along with one bottle from each environmental chamber was given to the Research and Development group for product evaluation of body moisturizer, shower gel, and after shave balm. For comments on stability for each product, refer to the Research and Development section.

LR# 1997 WEIGHT LOSS - Obsession For Men Body Moisturizer in PVC Bottle

				Initial	Week 2		Week 4		Week 6		Week 8	
Sample #	Temp.	Package Wt.	Fill Level	03/15/99	03/29/99	% Wt.Loss	04/12/99	% Wt.Loss	04/26/99	% Wt.Loss	05/10/99	% Wt.Loss
1	45°C	34.83	80.53	115.35	115.03	0.2774	to R & D		to R & D		to R & D	
2	45°C	34.95	80.88	115.82	115.48	0.2936	115.27	0.4749	to R & D		to R & D	
3	45°C	35.02	80.08	115.09	114.79	0.2607	114.56	0.4605	114.30	0.6864	to R & D	
4	45°C	34.95	80.22	115.16	114.85	0.2692	114.62	0.4689	114.34	0.7121	114.08	0.9378
5	45°C	34.85	81.18	116.04	115.71	0.2844	115.45	0.5084	115.15	0.7670	114.87	1.0083
6	45°C	35.10	80.08	115.17	114.85	0.2779	114.64	0.4602	114.34	0.7207	114.06	0.9638
7	45°C	34.63	80.10	114.71	114.36	0.3051	114.11	0.5231	113.80	0.7933	113.49	1.0636
8	45°C	35.07	80.24	115.31	114.98	0.2862	114.74	0.4943	114.44	0.7545	114.17	0.9886
9	45°C	34.75	80.17	114.94	114.60	0.2958	114.37	0.4959	114.08	0.7482	113.79	1.0005
10	45°C	35.13	82.21	117.33	117.02	0.2642	116.80	0.4517	116.52	0.6904	116.27	0.9034
11	45°C	34.95	80.73	115.67	115.33	0.2939	115.09	0.5014	114.79	0.7608	114.51	1.0029
12	45°C	35.10	80.75	115.86	115.56	0.2589	115.33	0.4574	115.05	0.6991	114.77	0.9408
13	40°C	34.92	80.04	114.97	114.73	0.2088	to R & D		to R & D		to R & D	
14	40°C	34.78	81.55	116.35	116.11	0.2063	115.88	0.4040	to R & D		to R & D	
15	40°C	35.11	80.52	115.62	115.40	0.1903	115.18	0.3806	114.96	0.5708	to R & D	
16	40°C	35.00	80.23	115.22	114.99	0.1996	114.77	0.3906	114.56	0.5728	114.35	0.7551
17	40°C	34.94	80.61	115.55	115.31	0.2077	115.10	0.3894	114.86	0.5971	114.65	0.7789
18	40°C	34.56	81.18	115.76	115.49	0.2332	115.27	0.4233	115.04	0.6220	114.80	0.8293
19	40°C	35.05	80.60	115.65	115.38	0.2335	115.15	0.4323	114.92	0.6312	114.68	0.8387
20	40°C	34.73	80.09	114.83	114.58	0.2177	114.36	0.4093	114.13	0.6096	113.90	0.8099
21	40°C	35.05	81.07	116.11	115.85	0.2239	115.55	0.4823	115.32	0.6804	115.10	0.8699
22	40°C	34.62	80.41	115.04	114.73	0.2695	114.50	0.4694	114.27	0.6693	114.04	0.8693
23	40°C	34.93	80.31	115.22	114.96	0.2274	114.72	0.4357	114.50	0.6266	114.26	0.8349
24	40°C	34.63	80.07	114.71	114.46	0.2179	114.19	0.4533	113.96	0.6538	113.74	0.8456
25	25°C	35.11	80.04	115.15	115.01	0.1216	to R & D		to R & D		to R & D	
26	25°C	34.85	80.07	114.93	114.78	0.1305	114.68	0.2175	to R & D		to R & D	
27	25°C	35.12	80.14	115.26	115.13	0.1128	115.04	0.1909	114.95	0.2690	to R & D	
28	25°C	35.12	80.39	115.50	115.37	0.1126	115.27	0.1991	115.18	0.2771	115.08	0.3636
29	25°C	35.04	80.73	115.77	115.64	0.1123	115.55	0.1900	115.46	0.2678	115.37	0.3455
30	25°C	34.77	80.27	115.04	114.90	0.1217	114.81	0.1999	114.73	0.2695	114.62	0.3651
31	25°C	34.93	80.60	115.54	115.39	0.1298	115.29	0.2164	115.21	0.2856	115.10	0.3808
32	25°C	34.85	80.16	115.04	114.88	0.1391	114.77	0.2347	114.68	0.3129	114.58	0.3999
33	-15°C	34.74	80.04	114.78	114.80	-0.0174	to R & D		to R & D		to R & D	
34	-15°C	34.92	80.09	115.01	115.09	-0.0696	115.07	-0.0522	to R & D		to R & D	
35	-15°C	35.07	80.45	115.53	115.57	-0.0346	115.57	-0.0346	115.55	-0.0173	to R & D	
36	-15°C	34.90	80.23	115.14	115.19	-0.0434	115.19	-0.0434	115.16	-0.0174	115.20	-0.0521
37	-15°C	35.20	80.90	116.09	116.17	-0.0689	116.17	-0.0689	116.13	-0.0345	116.17	-0.0689
38	-15°C	35.03	80.92	115.94	116.00	-0.0518	115.99	-0.0431	115.99	-0.0431	116.01	-0.0604
39	-15°C	34.71	80.13	114.86	114.91	-0.0435	114.88	-0.0174	114.88	-0.0174	114.92	-0.0522
40	-15°C	34.80	80.50	115.26	115.29	-0.0260	114.98	0.2429	114.47	0.6854	114.33	0.8069

	at 2 weeks	at 4 weeks	at 6 weeks	at 8 weeks
Average 45°	0.2806	0.4815	0.7332	0.9789
Average 40°	0.2196	0.4246	0.6234	0.8257
Average 25°	0.1225	0.2069	0.2803	0.3710
Average -15°	-0.0444	-0.0024	0.0926	0.1146

<u>Lab Request # 1997: Percent Weight Loss Over Eight Weeks for Body Moisturizer in PVC Bottles:</u>

Conclusion: At the end of 8-week general compatibility testing in the environmental chambers, the results of average weight loss are as follows:

General compatibility and weight loss test for Body Moisturizer (lot # K06051-1) in PVC Bottle.

Weight Loss

	2 weeks	4 weeks	6 weeks	8 weeks
Average % Weight loss at 45°C	0.28%	0.48%	0.73%	0.98%
Average % Weight loss at 40°C	0.22%	0.42%	0.62%	0.83%
Average % Weight loss at 25°C	0.12%	0.21%	0.28%	0.37%
Average % Weight loss at -15°C	-0.04%	0.00%	0.09%	0.11%

Research and Development Evaluation for Body Moisturizer in PVC Bottles

8 WEEK TEST EVALUATION

Product #: 1997

Description: BODY MOISTURIZER K06051-1

Package: API - PVC plastic bottles

Summary of package test procedure. Samples evaluated by Research and Development at 8 weeks for color, odor and appearance.

EVALUATION COMMENTS:

	Color:	Slightly creamier than glass control.
45°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Slightly creamier than glass control.
40°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Slightly creamier than glass control.
25°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Slightly creamier than glass control.
-15°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

General Comments: [x] Approved [] Not Approved

Average Cumulative % Weight Loss
PVC - OBM Moisturizer

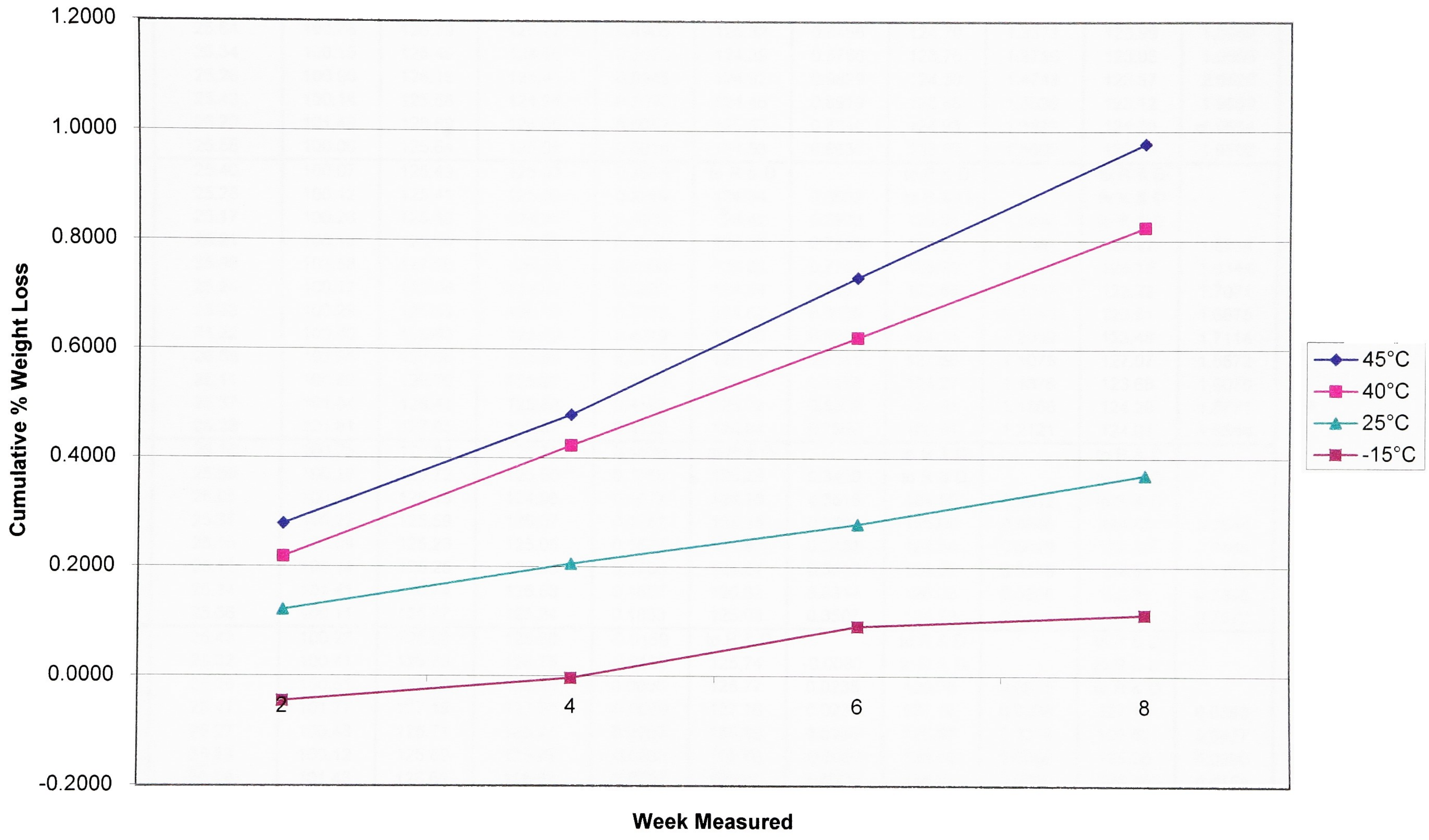

Figure 4

LR# 1996 WEIGHT LOSS - Obsession For Men Body Moisturizer in Qualipac PETG Bottle

				Initial	Week 2		Week 4		Week 6		Week 8	
Sample #	Temp.	Package Wt.	Fill Level	03/15/99	03/29/99	% Wt.Loss	04/12/99	% Wt.Loss	04/26/99	% Wt.Loss	05/10/99	% Wt.Loss
1	45°C	25.39	100.59	125.97	125.35	0.4922	to R & D		to R & D		to R & D	
2	45°C	25.39	100.38	125.72	125.10	0.4932	124.62	0.8750	to R & D		to R & D	
3	45°C	25.37	100.32	125.68	125.05	0.5013	124.57	0.8832	123.96	1.3686	to R & D	
4	45°C	25.34	100.30	125.65	125.02	0.5014	124.54	0.8834	123.92	1.3768	123.18	1.9658
5	45°C	25.22	100.18	125.40	124.77	0.5024	124.30	0.8772	123.68	1.3716	122.93	1.9697
6	45°C	25.34	100.24	125.57	124.96	0.4858	124.50	0.8521	123.90	1.3299	123.17	1.9113
7	45°C	25.64	100.76	126.39	125.77	0.4905	125.32	0.8466	124.70	1.3371	123.99	1.8989
8	45°C	25.34	100.15	125.49	124.86	0.5020	124.39	0.8766	123.76	1.3786	123.03	1.9603
9	45°C	25.26	100.90	126.16	125.41	0.5945	124.92	0.9829	124.30	1.4743	123.57	2.0529
10	45°C	25.43	100.14	125.58	124.94	0.5096	124.46	0.8919	123.86	1.3696	123.12	1.9589
11	45°C	25.20	101.49	126.69	126.05	0.5052	125.57	0.8840	124.93	1.3892	124.20	1.9654
12	45°C	25.58	100.06	125.64	125.01	0.5014	124.53	0.8835	123.92	1.3690	123.19	1.9500
13	40°C	25.40	100.07	125.49	125.03	0.3666	to R & D		to R & D		to R & D	
14	40°C	25.28	100.12	125.41	125.00	0.3269	124.34	0.8532	to R & D		to R & D	
15	40°C	25.17	100.26	125.42	124.91	0.4066	124.42	0.7973	123.91	1.2040	to R & D	
16	40°C	25.21	100.13	125.34	124.83	0.4069	124.35	0.7899	123.84	1.1967	123.22	1.6914
17	40°C	25.68	101.58	127.26	126.75	0.4008	126.28	0.7701	125.79	1.1551	125.18	1.6344
18	40°C	25.24	100.12	125.36	124.86	0.3989	124.34	0.8137	123.85	1.2045	123.22	1.7071
19	40°C	25.33	100.29	125.63	125.13	0.3980	124.62	0.8039	124.13	1.1940	123.51	1.6875
20	40°C	25.22	100.40	125.63	125.10	0.4219	124.59	0.8278	124.11	1.2099	123.48	1.7114
21	40°C	26.55	102.55	129.08	128.60	0.3719	128.11	0.7515	127.65	1.1078	127.07	1.5572
22	40°C	25.11	100.60	125.70	125.21	0.3898	124.76	0.7478	124.27	1.1376	123.68	1.6070
23	40°C	25.37	101.04	126.41	125.88	0.4193	125.39	0.8069	124.91	1.1866	124.29	1.6771
24	40°C	25.22	101.81	127.05	126.52	0.4172	126.04	0.7950	125.51	1.2121	124.91	1.6844
25	25°C	25.18	100.75	125.94	125.71	0.1826	to R & D		to R & D		to R & D	
26	25°C	25.59	100.12	125.72	125.50	0.1750	125.29	0.3420	to R & D		to R & D	
27	25°C	25.05	100.14	125.19	124.98	0.1677	124.75	0.3515	124.50	0.5512	to R & D	
28	25°C	25.37	100.22	125.59	125.37	0.1752	125.15	0.3503	125.00	0.4698	124.63	0.7644
29	25°C	25.16	100.09	125.26	125.05	0.1677	124.83	0.3433	124.58	0.5429	124.30	0.7664
30	25°C	25.11	100.14	125.25	125.03	0.1756	124.81	0.3513	124.58	0.5349	124.31	0.7505
31	25°C	25.34	101.41	126.74	126.53	0.1657	126.32	0.3314	126.08	0.5208	125.81	0.7338
32	25°C	25.36	100.11	125.47	125.24	0.1833	125.03	0.3507	124.79	0.5420	124.52	0.7572
33	-15°C	25.43	100.23	125.66	125.68	-0.0159	to R & D		to R & D		to R & D	
34	-15°C	25.32	100.41	125.73	125.75	-0.0159	125.74	-0.0080	to R & D		to R & D	
35	-15°C	25.28	100.51	125.80	125.80	0.0000	125.77	0.0238	125.76	0.0318	to R & D	
36	-15°C	25.41	101.77	127.19	127.20	-0.0079	127.16	0.0236	127.16	0.0236	127.14	0.0393
37	-15°C	25.27	100.43	125.71	125.71	0.0000	125.66	0.0398	125.67	0.0318	125.65	0.0477
38	-15°C	25.59	100.12	125.69	125.72	-0.0239	125.70	-0.0080	125.69	0.0000	125.68	0.0080
39	-15°C	25.19	101.43	126.61	126.64	-0.0237	126.61	0.0000	126.61	0.0000	126.59	0.0158
40	-15°C	25.28	101.50	126.77	126.79	-0.0158	126.76	0.0079	126.76	0.0079	126.74	0.0237

	at 2 weeks	at 4 weeks	at 6 weeks	at 8 weeks
Average 45°	0.5066	0.8851	1.3765	1.9593
Average 40°	0.3937	0.7961	1.1808	1.6619
Average 25°	0.1741	0.3458	0.5269	0.7544
Average -15°	-0.0129	0.0113	0.0158	0.0269

Lab Request # 1996: Percent Weight Loss Over Eight Weeks for Body Moisturizer in PETG Bottles

Conclusion: At the end of 8-week general compatibility testing in the environmental chambers, the results of average weight loss are as follows:

General compatibility and weight loss test for Body Moisturizer (lot # K06051-1) in PETG Bottle.

WEIGHT LOSS

	2 weeks	4 weeks	6 weeks	8 weeks
Average % Weight loss At 45°C	0.50%	0.88%	1.38%	1.96%
Average % Weight loss at 40°C	0.39%	0.80%	1.18%	1.66%
Average % Weight loss at 25°C	0.17%	0.35%	0.53%	0.75%
Average % Weight loss at -15°C	-0.01%	0.01%	0.02%	0.03%

Research and Development Evaluation for Body Moisturizer in PETG

8 WEEK TEST EVALUATION

Product #: 1996

Description: BODY MOISTURIZER K06051-1

Package: Qualipac PETG plastic bottles

Summary of package test procedure. Samples evaluated by Research and Development at 8 weeks for color, odor and appearance.

EVALUATION COMMENTS:

	Color:	Compares to glass control.
45°C	Appearance:	Compares to glass control.
	Odor:	Slightly less spicy, slightly fatty but acceptable.

	Color:	Compares to glass control.
40°C	Appearance:	Compares to glass control.
	Odor:	Slightly less spicy, slightly fatty but acceptable.

	Color:	Compares to glass control.
25°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Compares to glass control.
-15°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

General Comments: [X] Approved [] Not Approved

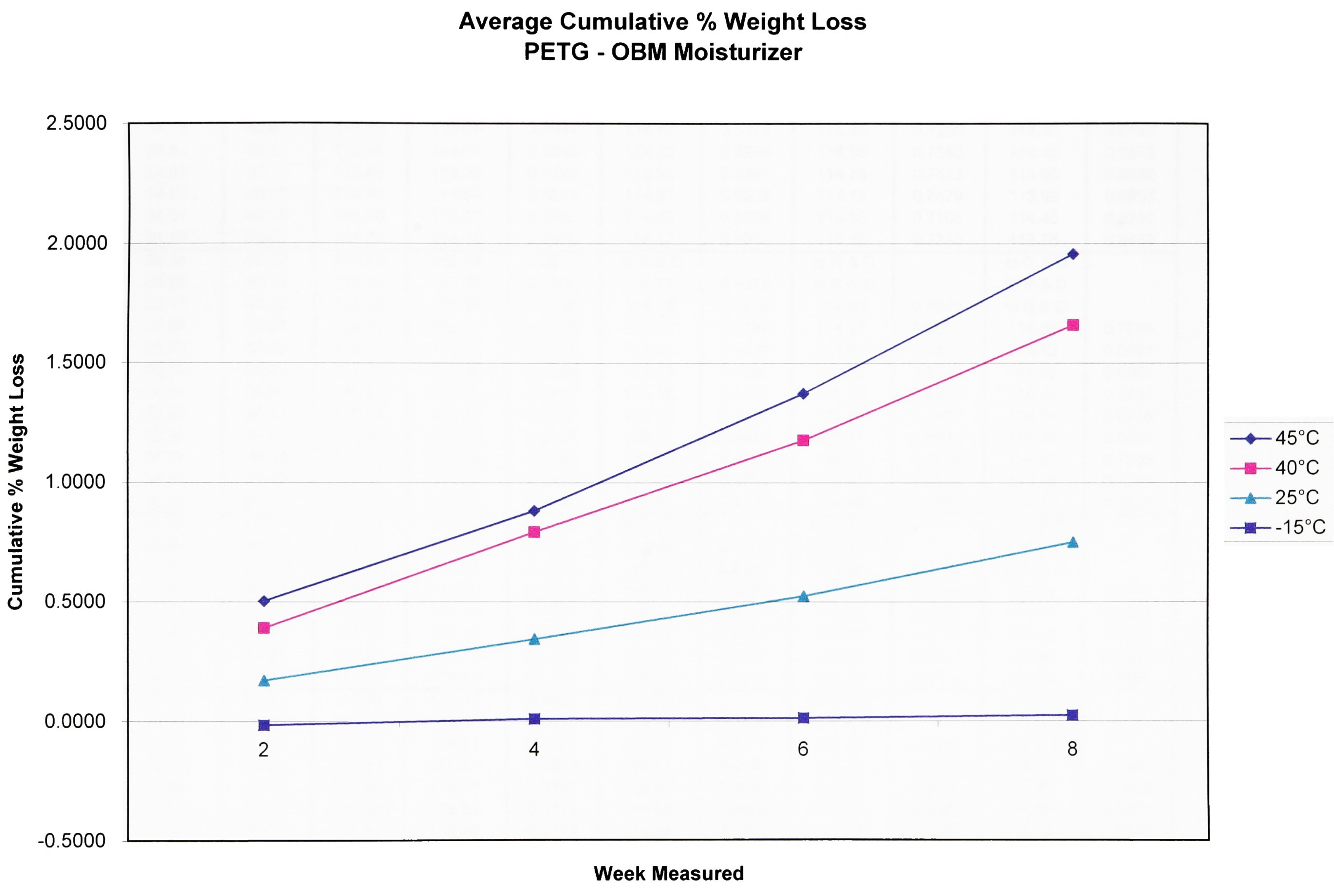
Average Cumulative % Weight Loss
PETG - OBM Moisturizer
Cumulative % Weight Loss
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
-0.5000
2
4
6
8
Week Measured
45°C
40°C
25°C
-15°C

Figure 5

LR# 2009 WEIGHT LOSS - Obsession For Men Shower Gel in PVC Bottle

				Initial	Week 2		Week 4		Week 6		Week 8	
Sample #	Temp.	Package Wt.	Fill Level	03/15/99	03/29/99	% Wt.Loss	04/12/99	% Wt.Loss	04/26/99	% Wt.Loss	05/10/99	% Wt.Loss
1	45°C	35.09	80.63	115.72	115.39	0.2852	to R & D		to R & D		to R & D	
2	45°C	35.22	80.34	115.56	115.23	0.2856	to R & D		to R & D		to R & D	
3	45°C	35.25	80.24	115.49	115.17	0.2771	114.91	0.5022	to R & D		to R & D	
4	45°C	35.49	81.19	116.65	116.33	0.2743	116.06	0.5058	115.85	0.6858	115.72	0.7973
5	45°C	34.99	80.07	115.06	114.74	0.2781	114.45	0.5302	114.24	0.7127	114.12	0.8170
6	45°C	34.91	80.25	115.15	114.80	0.3040	114.52	0.5471	114.29	0.7469	114.14	0.8771
7	45°C	34.79	80.62	115.39	115.05	0.2947	114.77	0.5373	114.55	0.7280	114.40	0.8580
8	45°C	34.88	80.51	115.41	115.07	0.2946	114.80	0.5286	114.56	0.7365	114.42	0.8578
9	45°C	34.92	80.72	115.65	115.28	0.3199	115.03	0.5361	114.78	0.7523	114.66	0.8560
10	45°C	34.96	80.05	114.99	114.64	0.3044	114.37	0.5392	114.13	0.7479	113.99	0.8696
11	45°C	35.01	80.38	115.40	115.07	0.2860	114.82	0.5026	114.58	0.7106	114.45	0.8232
12	45°C	34.73	80.02	114.75	114.42	0.2876	114.17	0.5054	113.92	0.7233	113.78	0.8453
13	40°C	35.34	80.19	115.53	115.24	0.2510	to R & D		to R & D		to R & D	
14	40°C	34.82	80.45	115.24	115.08	0.1388	114.77	0.4078	to R & D		to R & D	
15	40°C	35.12	80.22	115.33	115.08	0.2168	114.88	0.3902	114.69	0.5549	to R & D	
16	40°C	35.34	80.33	115.67	115.06	0.5274	115.07	0.5187	114.97	0.6052	114.85	0.7089
17	40°C	35.09	80.25	115.31	115.00	0.2688	114.84	0.4076	114.64	0.5810	114.52	0.6851
18	40°C	34.99	80.23	115.21	115.36	-0.1302	114.73	0.4166	114.55	0.5729	114.42	0.6857
19	40°C	34.81	80.86	115.64	115.36	0.2421	115.12	0.4497	115.00	0.5534	114.78	0.7437
20	40°C	35.24	80.41	115.64	115.35	0.2508	115.15	0.4237	114.95	0.5967	114.84	0.6918
21	40°C	35.42	81.37	116.79	116.51	0.2397	116.32	0.4024	116.11	0.5822	115.99	0.6850
22	40°C	35.12	80.04	115.15	114.79	0.3126	114.60	0.4776	114.37	0.6774	114.24	0.7903
23	40°C	34.84	81.49	116.32	116.03	0.2493	115.82	0.4298	115.61	0.6104	115.48	0.7221
24	40°C	35.23	80.16	115.38	115.12	0.2253	114.91	0.4073	114.69	0.5980	114.58	0.6934
25	25°C	35.02	81.74	116.73	116.59	0.1199	to R & D		to R & D		to R & D	
26	25°C	34.86	80.03	114.88	114.74	0.1219	114.65	0.2002	to R & D		to R & D	
27	25°C	35.65	80.52	116.18	116.03	0.1291	115.93	0.2152	115.86	0.2754	to R & D	
28	25°C	35.01	80.93	115.94	115.80	0.1208	115.71	0.1984	115.61	0.2846	115.51	0.3709
29	25°C	35.18	81.73	116.89	116.74	0.1283	116.65	0.2053	116.57	0.2738	116.47	0.3593
30	25°C	35.05	80.49	115.52	115.37	0.1298	115.28	0.2078	115.20	0.2770	115.09	0.3722
31	25°C	34.71	81.21	115.91	115.78	0.1122	115.67	0.2071	115.60	0.2674	115.50	0.3537
32	25°C	34.94	80.41	115.35	115.21	0.1214	115.09	0.2254	115.03	0.2774	114.94	0.3554
33	-15°C	35.17	80.31	115.48	115.49	-0.0087	to R & D		to R & D		to R & D	
34	-15°C	34.83	80.46	115.30	115.32	-0.0173	115.30	0.0000	to R & D		to R & D	
35	-15°C	34.70	80.47	115.16	115.13	0.0261	115.12	0.0347	115.12	0.0347	to R & D	
36	-15°C	35.29	80.81	116.11	116.14	-0.0258	116.12	-0.0086	116.13	-0.0172	116.16	-0.0431
37	-15°C	35.68	80.18	115.86	115.86	0.0000	115.85	0.0086	115.86	0.0000	115.89	-0.0259
38	-15°C	35.30	81.24	116.53	116.55	-0.0172	116.54	-0.0086	116.54	-0.0086	116.59	-0.0515
39	-15°C	34.67	80.79	115.47	115.49	-0.0173	115.48	-0.0087	115.48	-0.0087	115.54	-0.0606
40	-15°C	35.12	80.50	115.60	115.64	-0.0346	115.62	-0.0173	115.62	-0.0173	115.66	-0.0519

	at 2 weeks	at 4 weeks	at 6 weeks	at 8 weeks
Average 45°	0.2909	0.5234	0.7271	0.8446
Average 40°	0.2327	0.4301	0.5932	0.7118
Average 25°	0.1229	0.2085	0.2760	0.3623
Average -15°	-0.0119	0.0000	-0.0028	-0.0466

Chart 5

Lab Request # 2009: Percent Weight Loss Over Eight Weeks for Shower Gel in PVC Bottles

Conclusion: At the end of 8-week general compatibility testing in the environmental chambers, the results of average weight loss are as follows:

General compatibility and weight loss test for Shower Gel (lot # 10754) in PVC Bottle.

WEIGHT LOSS

	2 weeks	4 weeks	6 weeks	8 weeks
Average % Weight loss at 45°C	0.29%	0.52%	0.73%	0.84%
Average % Weight loss at 40°C	0.23%	0.43%	0.59%	0.71%
Average % Weight loss at 25°C	0.12%	0.21%	0.28%	0.36%
Average % Weight loss at -15°C	-0.01%	0.00%	0.00%	-0.05%

Research and Development Evaluation for Shower Gel in PVC Bottles

8 WEEK TEST EVALUATION

Product #: 2009

Description: SHOWER GEL # 10754

Package: API - PVC plastic bottles

Summary of package test procedure. Samples evaluated by Research and Development at 8 weeks for color, odor and appearance.

EVALUATION COMMENTS:

45°C	Color:	Compares to glass control.
	Appearance:	Pearl is more mica-like than glass control.
	Odor:	Slightly spicy, less citrus than glass control, but acceptable.

40°C	Color:	Compares to glass control.
	Appearance:	Compares to glass control.
	Odor:	Slightly spicy, less citrus than glass control, but acceptable.

25°C	Color:	Compares to glass control.
	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

-15°C	Color:	Compares to glass control.
	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

General Comments: [X] Approved [] Not Approved

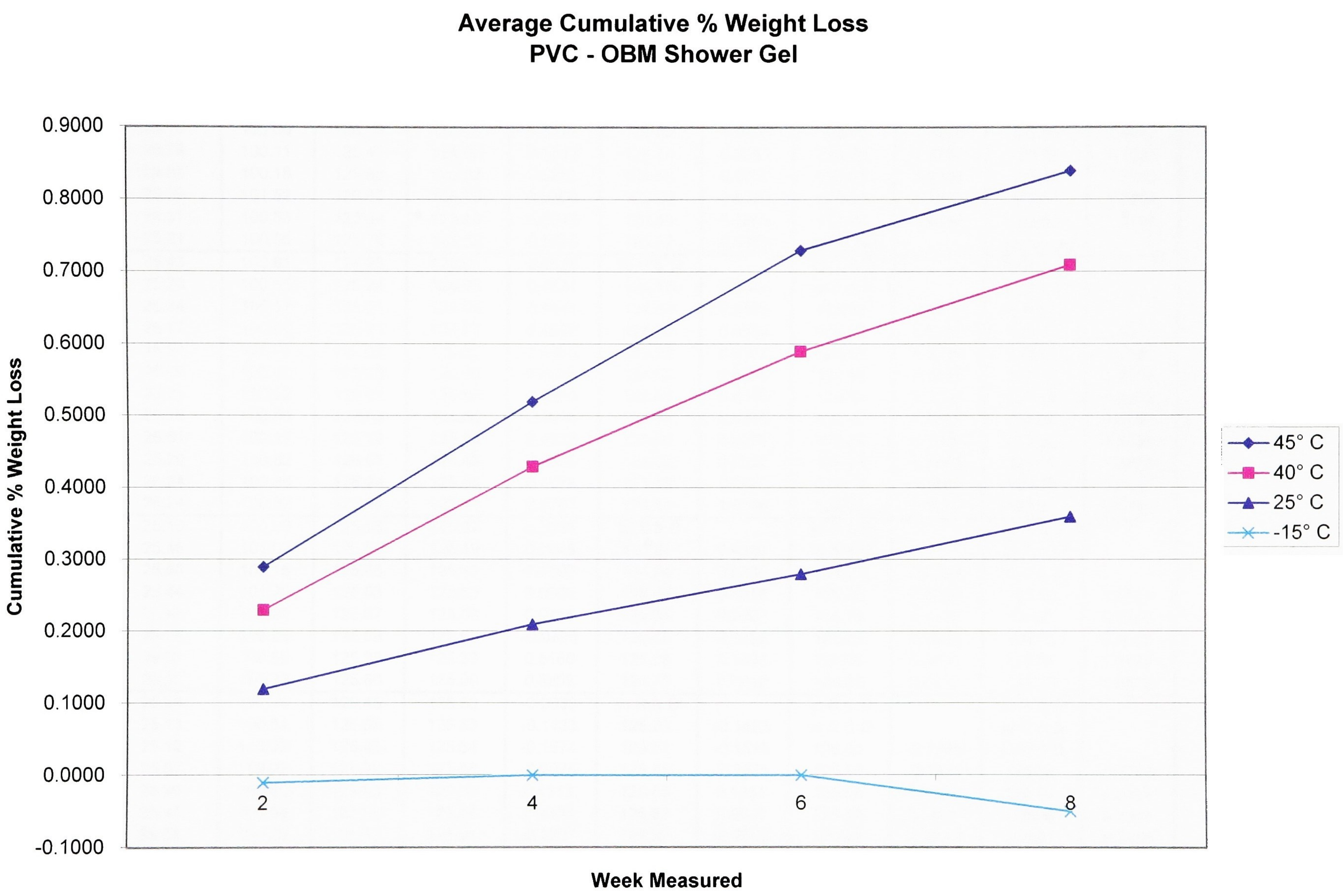
Average Cumulative % Weight Loss
PVC - OBM Shower Gel
0.9000
0.8000
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
-0.1000
Cumulative % Weight Loss
2
4
6
8
Week Measured
45° C
40° C
25° C
-15° C

Figure 6

LR# 2008 WEIGHT LOSS - Obsession For Men Shower Gel in Qualipac PETG Bottle

				Initial	Week 2		Week 4		Week 6		Week 8	
Sample #	Temp.	Package Wt.	Fill Level	03/15/99	03/29/99	% Wt.Loss	04/12/99	% Wt.Loss	04/26/99	% Wt.Loss	05/10/99	% Wt.Loss
1	45°C	25.02	100.00	125.02	124.35	0.5359	to R & D		to R & D		to R & D	
2	45°C	25.32	100.25	125.56	124.89	0.5336	124.33	0.9796	to R & D		to R & D	
3	45°C	25.01	100.22	125.23	124.55	0.5430	123.99	0.9902	123.51	1.3735	123.99	0.9902
4	45°C	25.27	100.47	125.72	125.05	0.5329	124.47	0.9943	123.97	1.3920	123.47	1.7897
5	45°C	24.96	100.13	125.08	124.40	0.5437	123.81	1.0154	123.31	1.4151	122.80	1.8228
6	45°C	25.07	100.14	125.21	124.52	0.5511	123.94	1.0143	123.44	1.4136	122.91	1.8369
7	45°C	25.10	100.08	125.18	124.49	0.5512	123.89	1.0305	123.40	1.4220	122.85	1.8613
8	45°C	25.38	100.11	125.49	124.82	0.5339	124.24	0.9961	123.76	1.3786	123.24	1.7930
9	45°C	25.52	100.18	125.68	125.02	0.5251	124.45	0.9787	123.97	1.3606	123.45	1.7743
10	45°C	25.36	101.52	126.87	126.19	0.5360	125.60	1.0010	125.11	1.3872	124.61	1.7814
11	45°C	25.31	100.53	125.84	125.13	0.5642	124.55	1.0251	124.06	1.4145	123.55	1.8198
12	45°C	25.21	100.56	125.76	125.09	0.5328	124.52	0.9860	dispensed		dispensed	
13	40°C	25.43	100.81	126.26	125.69	0.4514	to R & D		to R & D		to R & D	
14	40°C	25.20	100.05	125.24	124.66	0.4631	124.17	0.8544	to R & D		to R & D	
15	40°C	25.34	100.17	125.51	124.94	0.4541	124.45	0.8446	124.04	1.1712	to R & D	
16	40°C	25.17	100.68	125.84	125.27	0.4530	124.79	0.8344	124.37	1.1682	123.91	1.5337
17	40°C	25.34	101.75	127.08	126.51	0.4485	125.99	0.8577	125.60	1.1646	125.15	1.5187
18	40°C	25.49	100.49	125.98	125.40	0.4604	124.93	0.8335	124.51	1.1669	123.99	1.5796
19	40°C	25.21	100.92	126.12	125.55	0.4520	125.06	0.8405	124.65	1.1656	124.18	1.5382
20	40°C	25.16	100.50	125.66	125.08	0.4616	124.59	0.8515	124.16	1.1937	123.68	1.5757
21	40°C	25.61	100.11	125.70	125.13	0.4535	124.66	0.8274	124.25	1.1535	123.79	1.5195
22	40°C	25.20	100.82	126.01	125.43	0.4603	124.95	0.8412	124.53	1.1745	124.06	1.5475
23	40°C	25.34	100.88	126.24	125.65	0.4674	125.17	0.8476	124.74	1.1882	124.29	1.5447
24	40°C	25.24	100.92	126.14	125.41	0.5787	124.84	1.0306	124.39	1.3873	123.93	1.7520
25	25°C	25.16	100.68	125.86	125.37	0.3893	to R & D		to R & D		to R & D	
26	25°C	25.46	101.09	126.55	126.19	0.2845	125.97	0.4583	to R & D		to R & D	
27	25°C	25.50	100.15	125.66	125.17	0.3899	124.94	0.5730	124.75	0.7242	to R & D	
28	25°C	25.44	101.20	126.63	126.63	0.0000	126.40	0.1816	126.22	0.3238	125.99	0.5054
29	25°C	25.48	100.21	125.67	125.58	0.0716	125.34	0.2626	125.15	0.4138	124.91	0.6048
30	25°C	25.36	100.25	125.58	125.68	-0.0796	125.45	0.1035	125.25	0.2628	125.02	0.4459
31	25°C	25.35	100.60	125.98	125.33	0.5160	125.09	0.7065	124.91	0.8493	124.66	1.0478
32	25°C	25.36	100.33	125.66	125.00	0.5252	124.75	0.7242	124.55	0.8833	124.30	1.0823
33	-15°C	25.31	101.14	126.45	126.53	-0.0633	to R & D		to R & D		to R & D	
34	-15°C	25.13	100.51	125.65	125.83	-0.1433	125.83	-0.1433	to R & D		to R & D	
35	-15°C	25.12	100.32	125.43	125.64	-0.1674	125.62	-0.1515	125.63	-0.1595	to R & D	
36	-15°C	25.07	100.22	125.32	125.58	-0.2075	125.55	-0.1835	125.56	-0.1915	125.54	-0.1756
37	-15°C	25.26	100.60	125.83	125.69	0.1113	125.66	0.1351	125.66	0.1351	125.66	0.1351
38	-15°C	25.41	100.54	125.95	125.66	0.2303	125.63	0.2541	125.64	0.2461	125.66	0.2303
39	-15°C	25.31	100.29	125.60	125.94	-0.2707	125.92	-0.2548	125.92	-0.2548	125.91	-0.2468
40	-15°C	25.38	101.54	126.93	126.64	0.2285	126.61	0.2521	126.61	0.2521	126.60	0.2600

	at 2 weeks	at 4 weeks	at 6 weeks	at 8 weeks
Average 45°	0.5403	1.0010	1.3952	1.7188
Average 40°	0.4670	0.8603	1.1934	1.5677
Average 25°	0.2621	0.4300	0.5762	0.7372
Average -15°	-0.0353	-0.0131	0.0046	0.0406

Chart 6

Lab Request # 2008: Percent Weight Loss Over eight Weeks for Shower Gel in PETG Bottles

Conclusion: At the end of 8-week general compatibility testing in the environmental chambers, the results of average weight loss are as follows:

General compatibility and weight loss test for Shower Gel (lot # 10754) in PETG Bottle.

WEIGHT LOSS

	2 weeks	**4 weeks**	**6 weeks**	**8 weeks**
Average % Weight loss at 45°C	0.54%	1.00%	1.40%	1.72%
Average % Weight loss at 40°C	0.47%	0.86%	1.19%	1.57%
Average % Weight loss at 25°C	0.26%	0.43%	0.58%	0.74%
Average % Weight loss at -15°C	-0.04%	-0.01%	0.00%	0.04%

Research and Development Evaluation for Shower Gel in PETG Bottles

8 WEEK TEST EVALUATION

Product #: 2008

Description: SHOWER GEL # 10754

Package: Qualipac PETG plastic bottles

Summary of package test procedure. Samples evaluated by Research and Development at 8 weeks for color, odor and appearance.

EVALUATION COMMENTS:

	Color:	Compares to glass control.
45°C	Appearance:	Pearl is more mica-like than glass control.
	Odor:	Slightly spicy, less citrus than glass control, but acceptable.

	Color:	Compares to glass control.
40°C	Appearance:	Compares to glass control.
	Odor:	Slightly spicy, less citrus than glass control, but acceptable.

	Color:	Compares to glass control.
25°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Compares to glass control.
-15°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

General Comments: [X] Approved [] Not Approved

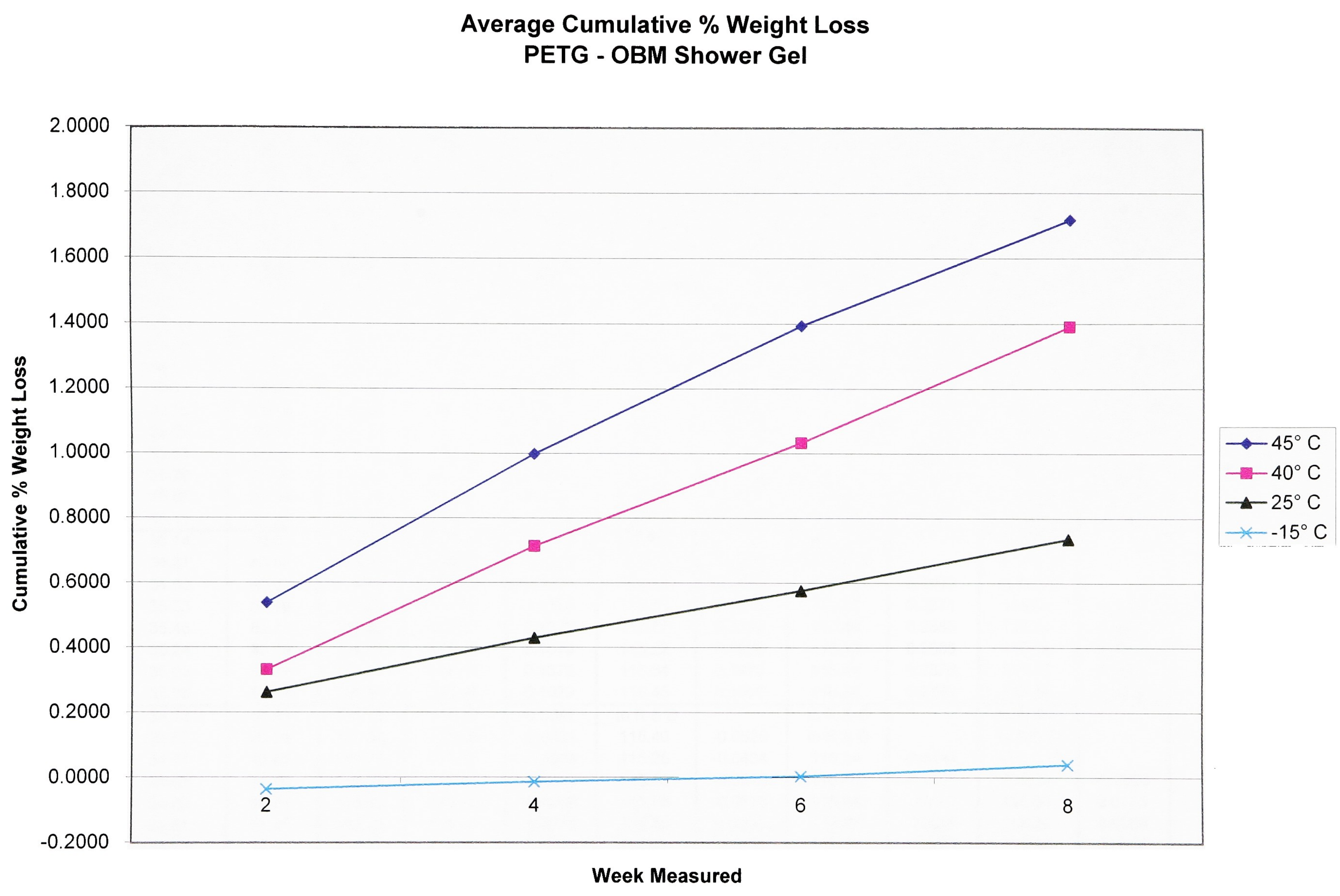
Average Cumulative % Weight Loss
PETG - OBM Shower Gel
Cumulative % Weight Loss
2.0000
1.8000
1.6000
1.4000
1.2000
1.0000
0.8000
0.6000
0.4000
0.2000
0.0000
-0.2000
2
4
6
8
Week Measured
45° C
40° C
25° C
-15° C

Figure 7

LR# 2029 WEIGHT LOSS - Obsession For Men After Shave Balm in PVC Bottle

				Initial	Week 2		Week 4		Week 6		Week 8	
Sample #	Temp.	Package Wt.	Fill Level	03/15/99	03/29/99	% Wt.Loss	04/12/99	% Wt.Loss	04/26/99	% Wt.Loss	05/10/99	% Wt.Loss
1	45°C	34.86	81.62	116.48	116.16	0.2747	to R & D		to R & D		to R & D	
2	45°C	34.87	80.09	114.96	114.68	0.2436	114.43	0.4610	to R & D		to R & D	
3	45°C	34.73	80.11	114.84	114.57	0.2377	114.30	0.4728	114.05	0.6905	to R & D	
4	45°C	35.36	80.43	115.79	115.50	0.2505	115.24	0.4750	114.99	0.6909	114.76	0.8895
5	45°C	35.23	80.69	115.92	115.65	0.2329	115.40	0.4486	115.14	0.6729	114.91	0.8713
6	45°C	34.89	80.54	115.42	115.14	0.2426	114.88	0.4679	114.63	0.6845	114.39	0.8924
7	45°C	35.22	80.37	115.59	115.31	0.2422	115.04	0.4758	114.78	0.7008	114.53	0.9170
8	45°C	34.82	81.17	116.00	115.66	0.2931	115.41	0.5086	115.16	0.7241	114.90	0.9483
9	45°C	35.29	80.24	115.53	115.23	0.2597	114.97	0.4847	114.71	0.7098	114.47	0.9175
10	45°C	34.59	81.79	116.37	116.09	0.2406	115.84	0.4554	115.58	0.6789	115.35	0.8765
11	45°C	34.53	80.85	115.38	115.08	0.2600	114.83	0.4767	114.58	0.6934	114.34	0.9014
12	45°C	34.64	80.06	114.69	114.39	0.2616	114.13	0.4883	113.88	0.7063	113.64	0.9155
13	40°C	34.42	80.74	115.17	114.92	0.2171	to R & D		to R & D		to R & D	
14	40°C	34.73	81.14	115.87	115.61	0.2244	115.39	0.4143	to R & D		to R & D	
15	40°C	34.67	80.55	115.23	114.97	0.2256	114.75	0.4166	114.53	0.6075	to R & D	
16	40°C	34.89	80.05	114.95	114.64	0.2697	114.42	0.4611	114.18	0.6699	113.99	0.8351
17	40°C	34.49	82.36	116.91	116.63	0.2395	116.42	0.4191	116.20	0.6073	115.99	0.7869
18	40°C	34.48	81.99	116.48	116.22	0.2232	116.01	0.4035	115.78	0.6010	115.58	0.7727
19	40°C	35.06	81.39	116.44	116.18	0.2233	115.98	0.3951	115.72	0.6183	115.54	0.7729
20	40°C	35.09	80.47	115.54	115.12	0.3635	114.90	0.5539	114.67	0.7530	114.48	0.9174
21	40°C	35.34	80.87	116.21	115.84	0.3184	115.62	0.5077	115.39	0.7056	115.21	0.8605
22	40°C	35.26	80.37	115.63	115.38	0.2162	115.15	0.4151	114.95	0.5881	114.75	0.7610
23	40°C	35.53	81.80	117.30	117.04	0.2217	116.83	0.4007	116.63	0.5712	116.42	0.7502
24	40°C	35.11	80.32	115.42	115.16	0.2253	114.94	0.4159	114.75	0.5805	114.53	0.7711
25	25°C	35.14	80.05	115.20	115.06	0.1215	to R & D		to R & D		to R & D	
26	25°C	34.81	80.88	115.69	115.58	0.0951	115.48	0.1815	to R & D		to R & D	
27	25°C	34.50	80.22	114.73	114.58	0.1307	114.49	0.2092	114.39	0.2963	to R & D	
28	25°C	35.33	80.76	116.08	115.94	0.1206	115.85	0.1981	115.77	0.2671	115.64	0.3790
29	25°C	35.46	82.35	117.82	117.67	0.1273	117.57	0.2122	117.48	0.2886	117.36	0.3904
30	25°C	35.24	80.19	115.44	115.32	0.1040	115.22	0.1906	115.13	0.2685	115.02	0.3638
31	25°C	35.03	81.74	116.77	116.61	0.1370	116.54	0.1970	116.44	0.2826	116.32	0.3854
32	25°C	35.26	81.41	116.66	116.54	0.1029	116.45	0.1800	116.34	0.2743	116.24	0.3600
33	-15°C	34.72	80.41	115.13	115.17	-0.0347	to R & D		to R & D		to R & D	
34	-15°C	35.07	80.28	115.34	115.39	-0.0434	115.40	-0.0520	to R & D		to R & D	
35	-15°C	34.71	80.49	115.20	115.27	-0.0608	115.25	-0.0434	115.24	-0.0347	to R & D	
36	-15°C	34.57	81.76	116.34	116.40	-0.0516	116.40	-0.0516	116.40	-0.0516	116.35	-0.0086
37	-15°C	34.82	80.74	115.56	115.59	-0.0260	115.58	-0.0173	115.58	-0.0173	115.54	0.0173
38	-15°C	34.81	81.45	116.25	116.27	-0.0172	116.25	0.0000	116.26	-0.0086	116.22	0.0258
39	-15°C	34.93	82.02	116.95	116.99	-0.0342	116.97	-0.0171	116.98	-0.0257	116.94	0.0086
40	-15°C	34.64	81.35	116.01	116.06	-0.0431	116.05	-0.0345	116.05	-0.0345	116.02	-0.0086

	at 2 weeks	at 4 weeks	at 6 weeks	at 8 weeks
Average 45°	0.2533	0.4741	0.6952	0.9033
Average 40°	0.2473	0.4366	0.6302	0.8031
Average 25°	0.1174	0.1955	0.2796	0.3757
Average -15°	-0.0389	-0.0308	-0.0287	0.0069

Lab Request # 2029: Percent Weight Loss Over Eight Weeks for After Shave Balm in PVC Bottles

Conclusion: At the end of 8-week general compatibility testing in the environmental chambers, the results of average weight loss are as follows:

General compatibility and weight loss test for After-Shave Balm (lot # 20057) in PVC Bottle.

WEIGHT LOSS

	2 weeks	4 weeks	6 weeks	8 weeks
Average % Weight loss at 45°C	0.25%	0.47%	0.70%	0.90%
Average % Weight loss at 40°C	0.25%	0.44%	0.63%	0.80%
Average % Weight loss at 25°C	0.12%	0.20%	0.28%	0.38%
Average % Weight loss at -15°C	-0.04%	-0.03%	-0.03%	0.00%

Research and Development Evaluation for After Shave Balm in PVC Bottles

8 WEEK TEST EVALUATION

Product #: 2029

Description: AFTER SHAVE BALM # 20057

Package: API PVC plastic bottles

Summary of package test procedure. Samples evaluated by Research and Development at 8 weeks for color, odor and appearance.

EVALUATION COMMENTS:

	Color:	Compares to glass control.
45°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Compares to glass control.
40°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Compares to glass control.
25°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Compares to glass control.
-15°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

General Comments: [X] Approved [] Not Approved

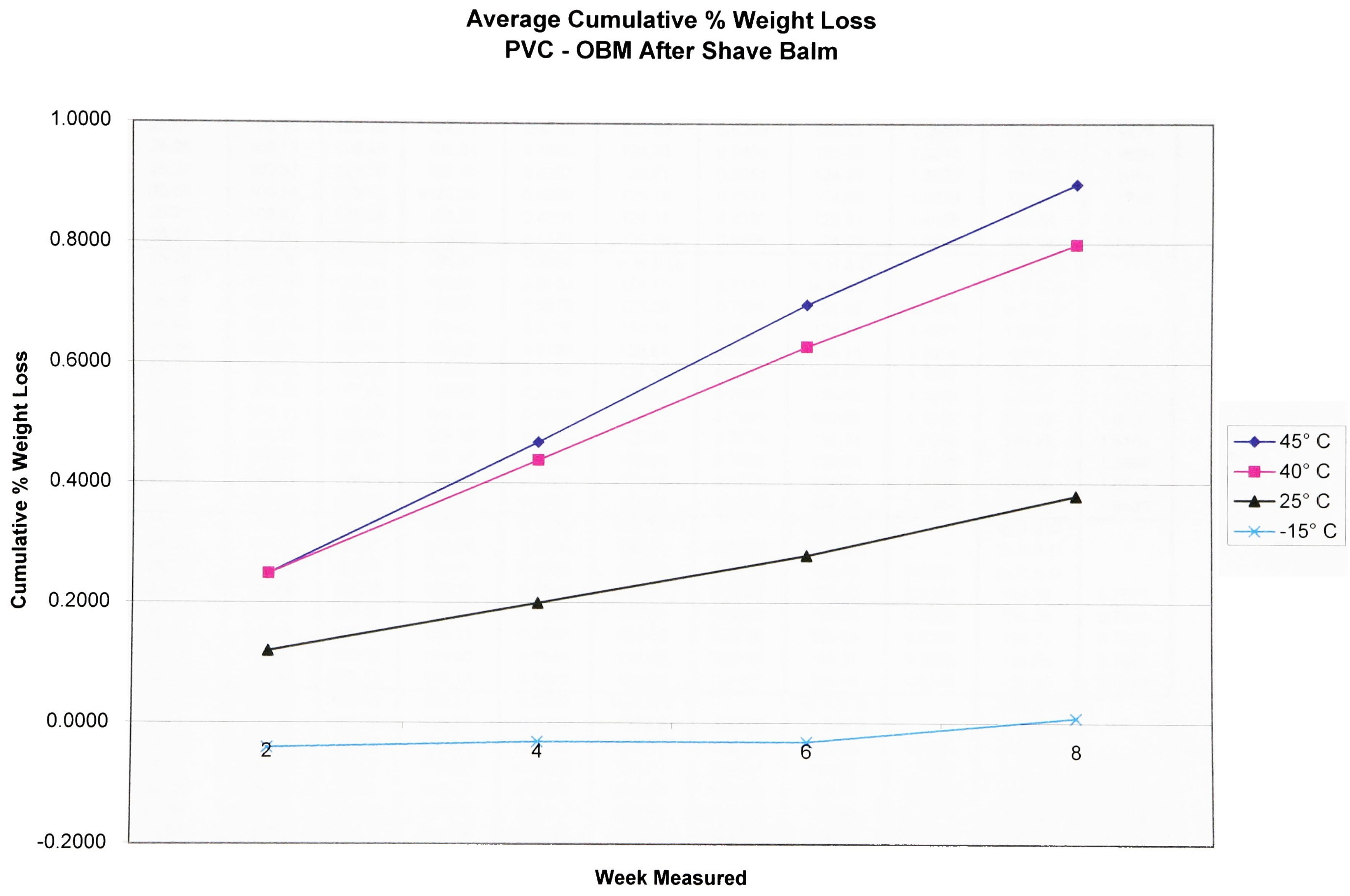
Average Cumulative % Weight Loss
PVC - OBM After Shave Balm
1.0000
0.8000
0.6000
0.4000
0.2000
0.0000
-0.2000
Cumulative % Weight Loss
2
4
6
8
Week Measured
45° C
40° C
25° C
-15° C

Figure 8

LR# 2028 WEIGHT LOSS - Obsession For Men After Shave Balm in Qualipac PETG Bottle

				Initial	Week 2		Week 4		Week 6		Week 8	
Sample #	Temp.	Package Wt.	Fill Level	03/15/99	03/29/99	% Wt.Loss	04/12/99	% Wt.Loss	04/26/99	% Wt.Loss	05/10/99	% Wt.Loss
1	45°C	25.42	100.02	125.44	124.90	0.4305	to R & D		to R & D		to R & D	
2	45°C	25.33	100.07	125.40	124.62	0.4625	124.23	0.9330	to R & D		to R & D	
3	45°C	25.37	100.37	125.74	125.17	0.4533	124.56	0.9364	123.96	1.3997	to R & D	
4	45°C	25.24	100.06	125.30	124.75	0.4369	124.14	0.9256	123.56	1.3667	122.69	1.9234
5	45°C	27.59	100.47	126.06	127.53	0.4139	127.00	0.6277	126.50	1.2162	125.93	1.6633
6	45°C	25.27	101.10	126.37	125.62	0.4352	125.19	0.9336	124.62	1.3646	123.95	1.9150
7	45°C	25.04	100.15	125.15	124.62	0.4235	123.99	0.9269	123.41	1.3903	122.75	1.9177
6	45°C	25.26	100.19	125.45	124.64	0.4662	124.22	0.9605	123.65	1.4346	122.96	1.9669
9	45°C	25.37	100.57	125.95	125.41	0.4267	124.61	0.9051	124.23	1.3656	123.56	1.6976
10	45°C	25.36	100.55	125.92	125.39	0.4209	124.79	0.6974	124.20	1.3659	123.56	1.6742
11	45°C	25.21	100.07	125.26	124.70	0.4630	124.11	0.9339	123.51	1.4126	122.64	1.9476
12	45°C	25.17	101.56	126.73	126.20	0.4162	125.59	0.6996	124.99	1.3730	124.34	1.6659
13	40°C	25.26	101.26	126.56	126.11	0.3556	to R & D		to R & D		to R & D	
14	40°C	25.36	100.56	125.96	125.50	0.3652	124.96	0.7760	to R & D		to R & D	
15	40°C	25.26	100.62	126.06	125.61	0.3570	125.09	0.7695	124.56	1.1740	to R & D	
16	40°C	25.65	100.09	125.73	125.26	0.3736	124.74	0.7674	124.24	1.1651	123.69	1.6225
17	40°C	25.24	101.47	126.71	126.23	0.3766	125.69	0.6050	125.16	1.2075	124.61	1.6573
16	40°C	25.43	100.12	125.55	125.06	0.3744	124.55	0.7965	124.05	1.1947	123.49	1.6406
19	40°C	26.06	101.24	127.33	126.66	0.3534	126.37	0.7539	125.69	1.1309	125.36	1.5472
20	40°C	25.29	100.11	125.40	124.94	0.3666	124.40	0.7974	123.90	1.1962	123.33	1.6507
21	40°C	25.37	101.27	126.64	126.19	0.3553	125.66	0.7736	125.15	1.1766	124.59	1.6166
22	40°C	25.34	102.45	127.77	127.32	0.3522	126.61	0.7514	126.30	1.1505	125.73	1.5966
23	40°C	25.24	100.76	126.01	125.55	0.3651	125.03	0.7777	124.52	1.1624	123.95	1.6346
24	40°C	25.30	100.66	125.95	125.49	0.3652	125.96	-0.0079	124.44	1.1969	123.66	1.6435
25	25°C	25.15	101.93	127.06	126.67	0.1653	to R & D		to R & D		to R & D	
26	25°C	25.36	101.56	126.97	126.76	0.1654	126.54	0.3367	to R & D		to R & D	
27	25°C	25.25	100.42	125.67	125.47	0.1591	125.24	0.3422	125.00	0.5331	to R & D	
26	25°C	25.41	100.06	125.46	125.29	0.1514	125.07	0.3267	124.63	0.5160	124.53	0.7571
29	25°C	26.31	100.16	126.46	126.26	0.1561	126.07	0.3242	125.64	0.5060	125.56	0.7274
30	25°C	25.24	100.26	125.51	125.31	0.1593	125.06	0.3426	124.64	0.5336	124.54	0.7726
31	25°C	25.21	101.02	126.23	126.03	0.1564	125.60	0.3406	125.57	0.5229	125.26	0.7664
32	25°C	25.26	100.05	125.33	125.12	0.1676	124.90	0.3431	124.66	0.5346	124.36	0.7740
33	-15°C	24.66	100.66	125.54	125.51	0.0239	to R & D		to R & D		to R & D	
34	-15°C	25.30	101.45	126.73	126.77	-0.0316	126.75	-0.0156	to R & D		to R & D	
35	-15°C	26.15	100.52	126.67	126.69	-0.0155	126.67	0.0000	126.66	0.0076	to R & D	
36	-15°C	25.15	100.62	125.77	125.60	-0.0239	125.77	0.0000	125.76	0.0060	125.70	0.0557
37	-15°C	25.23	100.02	125.24	125.26	-0.0160	125.24	0.0000	125.22	0.0160	125.16	0.0639
36	-15°C	25.49	102.14	127.64	127.66	-0.0313	127.66	-0.0157	127.65	-0.0076	127.56	0.0470
39	-15°C	25.64	100.70	126.33	126.36	-0.0237	126.36	-0.0237	126.35	-0.0156	126.27	0.0475
40	-15°C	25.05	100.46	125.53	125.55	-0.0159	125.52	0.0060	125.52	0.0060	125.44	0.0717

	at 2 weeks	at 4 weeks	at 6 weeks	at 6 weeks
Average 45°	0.4396	0.9164	1.3734	1.6662
Average 40°	0.3636	0.7075	1.1797	1.6236
Average 25°	0.1606	0.3369	0.5247	0.7599
Average -15°	-0.0166	-0.0067	0.0027	0.0571

<u>Lab Request # 2028: Percent Weight Loss Over Eight Weeks for After Shave Balm in PETG Bottles</u>

Weight Loss Test Results

Conclusion: At the end of 8-week general compatibility testing in the environmental chambers, the results of average weight loss are as follows:

General compatibility and weight loss test for After-Shave Balm (lot # 20057) in PETG Bottle.

WEIGHT LOSS

	2 weeks	4 weeks	6 weeks	8 weeks
Average % Weight loss at 45°C	0.44%	0.92%	1.37%	1.89%
Average % Weight loss at 40°C	0.36%	0.71%	1.18%	1.62%
Average % Weight loss at 25°C	0.16%	0.34%	0.52%	0.76%
Average % Weight loss at -15°C	-0.01%	0.00%	0.00%	0.06%

Research and Development Evaluation for After Shave Balm in PETG Bottles

8 WEEK TEST EVALUATION

Product #: 2028

Description: AFTER-SHAVE BALM # 20057

Package: PETG plastic bottles

Summary of package test procedure. Samples evaluated by Research and Development at 8 weeks for color, odor and appearance.

EVALUATION COMMENTS:

	Color:	Compares to glass control.
45°C	Appearance:	Compares to glass control.
Odor: Less top note, less sweet, less spicy than glass control, but acceptable.		

	Color:	Compares to glass control.
40°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Compares to glass control.
25°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

	Color:	Compares to glass control.
-15°C	Appearance:	Compares to glass control.
	Odor:	Compares to glass control.

General Comments: [X] Approved [] Not Approved

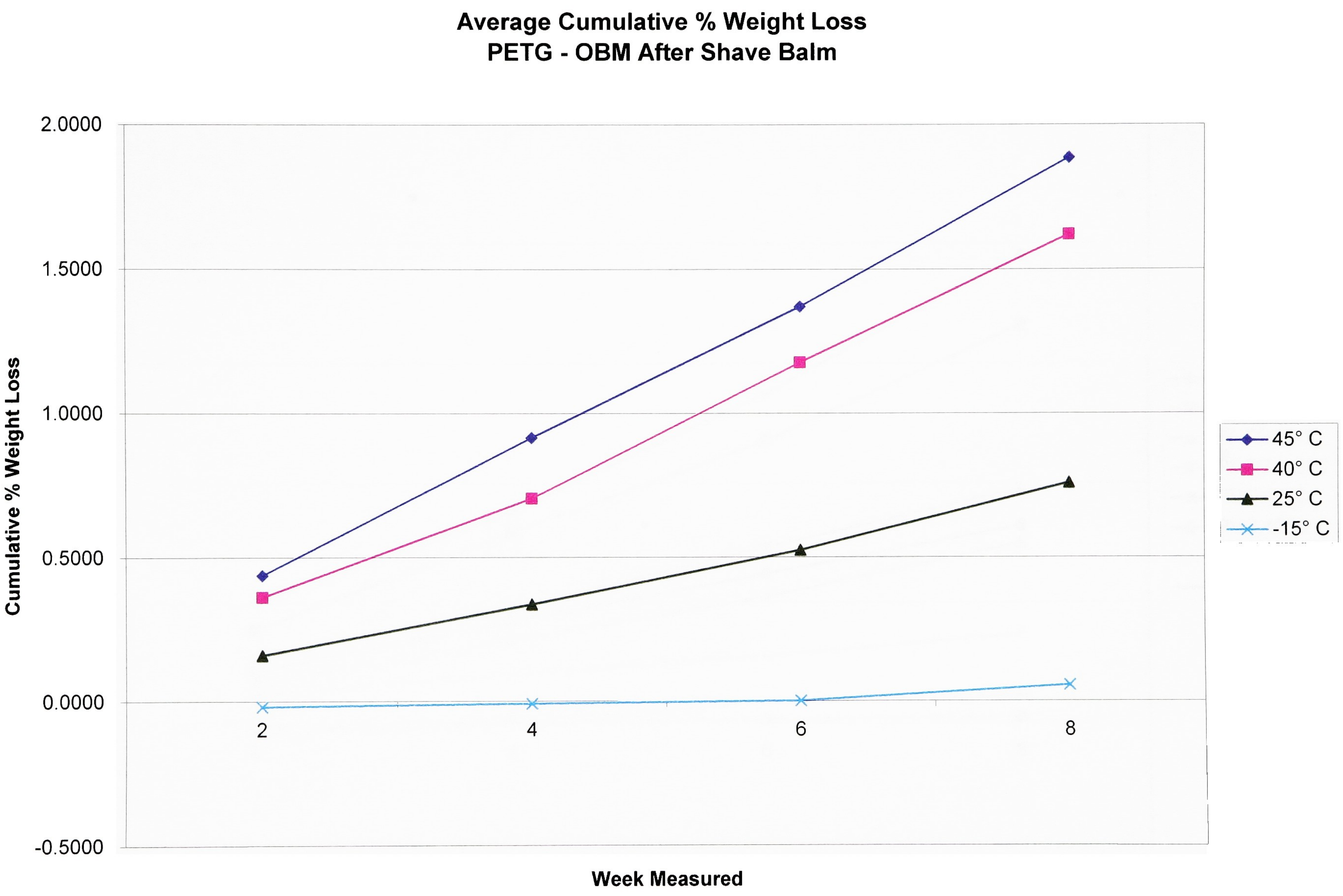
Average Cumulative % Weight Loss
PETG - OBM After Shave Balm
2.0000
1.5000
1.0000
0.5000
0.0000
-0.5000
Cumulative % Weight Loss
2
4
6
8
Week Measured
45° C
40° C
25° C
-15° C

Figure 9

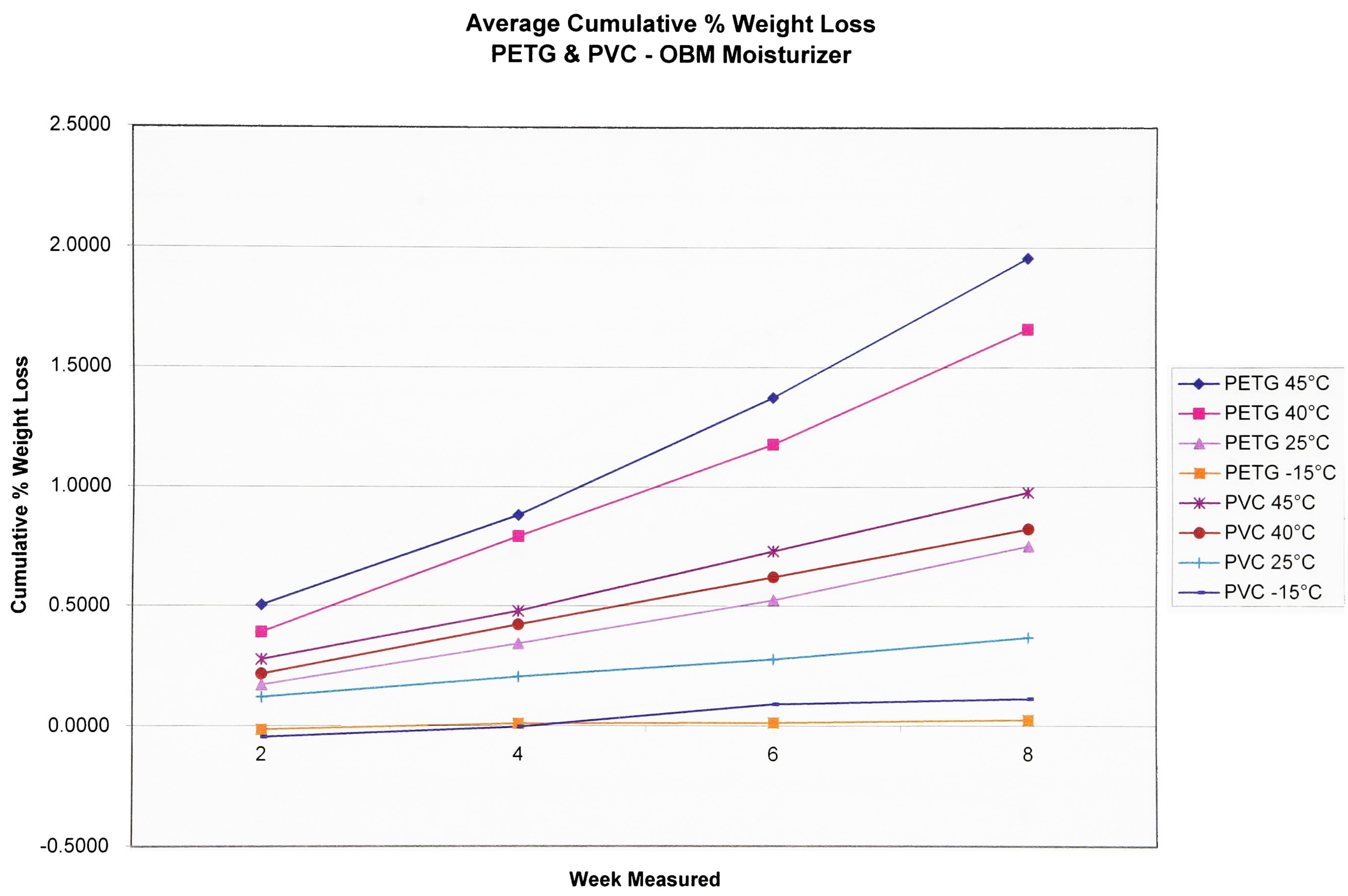
Average Cumulative % Weight Loss
PETG & PVC - OBM Moisturizer
Cumulative % Weight Loss
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
-0.5000
2
4
6
8
Week Measured
PETG 45°C
PETG 40°C
PETG 25°C
PETG -15°C
PVC 45°C
PVC 40°C
PVC 25°C
PVC -15°C

Figure 10

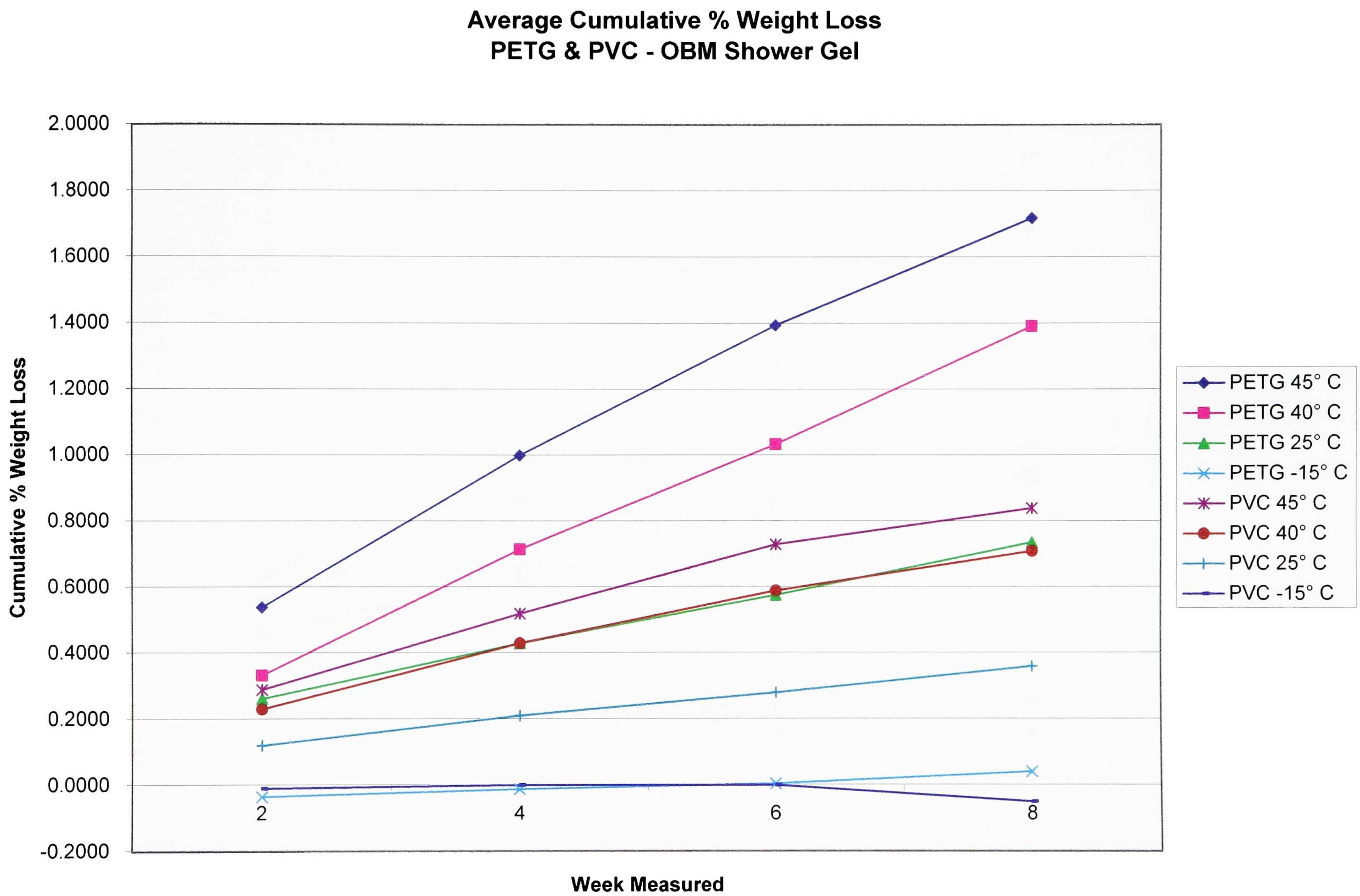
Average Cumulative % Weight Loss
PETG & PVC - OBM Shower Gel
Cumulative % Weight Loss
2.0000
1.8000
1.6000
1.4000
1.2000
1.0000
0.8000
0.6000
0.4000
0.2000
0.0000
-0.2000
2
4
6
8
Week Measured
PETG 45° C
PETG 40° C
PETG 25° C
PETG -15° C
PVC 45° C
PVC 40° C
PVC 25° C
PVC -15° C

Figure 11

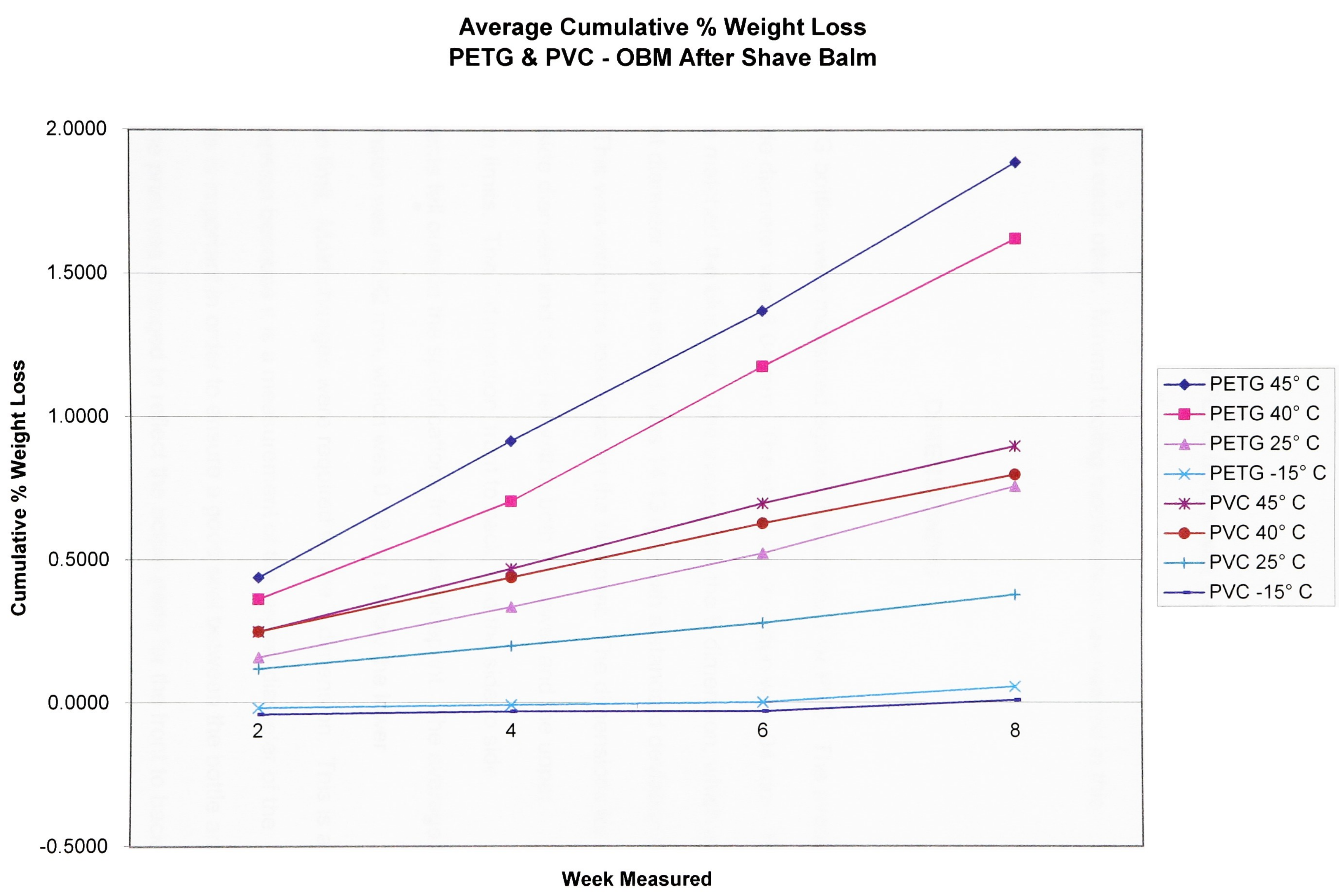
Average Cumulative % Weight Loss
PETG & PVC - OBM After Shave Balm
Cumulative % Weight Loss
2.0000
1.5000
1.0000
0.5000
0.0000
-0.5000
2
4
6
8
Week Measured
PETG 45° C
PETG 40° C
PETG 25° C
PETG -15° C
PVC 45° C
PVC 40° C
PVC 25° C
PVC -15° C

Figure 12

CONCLUSION

The transition from PVC to PETG bottles was a relatively smooth one. As shown in the material data sheets, the physical properties of PVC and PETG are very similar to each other. Minimal tooling modification was needed in this application.

DIMENSIONING

PETG bottles were measured against the blueprint for PVC. The average for the inside diameter was 8.04 mm. The standard deviation was .04 mm. The dimensions matched the blueprint. The average for the E dimension, which is the smallest diameter of the thread, was 14.13 mm with a standard deviation of 0.02 mm. This was within the tolerance on the blueprint. The dimensions for both the inside diameter and the E fell within both the lower and the upper specification limits. The T dimension, front to back, and the side to side measurements fell outside the specifications from the blueprint. The average for the T dimension was 15.82 mm, which was 0.18 mm below the lower specification limit. Mold changes were required for the T dimension. This is a critical dimension because it is a measurement of the largest diameter of the thread. This is important in order to ensure a good seal between the bottle and the cap. The print was changed to reflect the actual parts for the front to back and the side to side dimensions. This was done because it was easier and less costly to change the print rather than the mold.

The average for the overall height was 106.65 mm and it fell within the lower specification limit of 106.60 mm and the upper specification limit of 108.20 mm. The dimensions were within the specified tolerance on the blueprint.

The bottles are heavier than specified on the blueprint. The average weight for the bottles was 18.01 g. This is 0.51 g over the upper specification limit.

The inside diameter performed well in the dimensional analysis. The mean was within 0.04 mm of nominal and the standard deviation was 0.04 mm. At ± 3 sigma, it fell within both the upper and the lower specification limits.

The results for the E dimension were similar. The mean was within 0.02 mm of nominal and the standard deviation was 0.02 mm. At ± 3 sigma, the dimensions fell within both the upper and the lower specification limits.

The T dimension was more problematic with the mean falling 0.38 mm below nominal, 0.18-mm below the lower specification limit. The standard deviation of .04 mm was acceptable, but at +3 sigma it did not meet the lower specification limit. Because of the critical nature of this dimension, mold changes were required.

The front to back dimension was 0.73 mm over nominal with a standard deviation of 0.10mm, much higher than expected. The high variation was indicative of a high degree of subjectivity in the measurement. This is due to the flexibility of the bottle. Since this was not a critical dimension, the print was changed to reflect the part.

The side to side dimension had a mean of 75.81 mm, exceeding the upper tolerance by 0.01 mm. The variation was .05 mm. Again the print was changed to reflect the actual part.

The mean of the overall height was 106.65 mm, 0.05 mm within the lower tolerance. However, at –3 sigma it was out of tolerance. The print was changed to reflect the part.

The average weight for the bottle was 18.01 grams. The standard deviation was 0.06 grams. The weight was 2 grams over nominal and 0.51 grams over the upper specification limit. The bottles weighed more than what is specified on the blueprint.

The overflow capacity was found to average 122.94 ml. The standard deviation was 0.21 ml. The 3-sigma limit fell within the tolerance of 122.00 ml – 128.00 ml. What is significant about this is that the average is so close to the lower end of the tolerance. Because –3 sigma is still within specification, the legal requirements for the weight claim are met and less product is used than if it were at the higher end of the tolerance.

LEAK TEST

At the end of the test, the samples were visually inspected for leakage. This was done by checking the white tissue that the bottles were laying on for any wet marks. Since the tissue was completely dry, there was no evidence of water leaking through the mouth of the bottle. Failure would have resulted if the bottles had leaked. Leakage would have resulted if there were a gap between the neck of the bottle and the cap. Wet tissue would have been evident. This test was done for both PVC and PETG bottles and they both performed equally well. Neither sample had any water leak out from around the bottle finish. As a result, both PVC and PETG passed the leakage test.

DECORATION TEST

The third test was a decoration test to check the screen printing on the bottles. Two different decoration tests were performed. One test involved using a specified '3M' tape to remove any print from the lettering. Samples of scotch tape were adhered to a clean piece of white paper and were examined carefully for any ink removal. The second test used actual product (after-shave balm, body moisturizer, and shower gel) on the lettering to see if any copy came off.

The 3" long pieces of scotch tape were placed on a blank white sheet to inspect for any ink that might have transferred from the bottle onto the tape. After carefully checking the tape, there was no evidence of any ink transfer or removal from the test samples. The test would have been considered failed if any of the lettering on the test samples was not legible. Both the PVC and PETG bottles passed the decoration test.

VIBRATION TEST

A number of additional tests were performed to qualify the new material. One of the tests performed on the PETG bottles was the vibration test. This was to see if any physical damage, such as scuffing, would occur to the bottles during shipping. The results were good and they matched those of PVC. There was minor scuffing to both the PVC and PETG bottles. However, they were deemed acceptable by industry standards. It is important to note that the bottles were in their upright position when the shipper was being vibrated on its bottom panel. The bottles were upside down when the shipper was vibrating on its top panel. The bottles were resting on their narrow side when the shipper was vibrating on its long side. The scuffing was acceptable because it was minor and barely noticeable.

DROP TEST

ASTM 775-80 "Drop Test for Loaded Boxes" was another test performed on the PETG bottles to qualify the material for its durability and strength. A full shipping container was dropped from a specified height to see if any bottles cracked or shattered. PETG has good impact strength and PVC has fair impact strength. Due to this, PETG bottles performed well. These bottles withstood the rigors of the normal distribution cycle. The results were good since there was no damage to the bottles. There were no broken bottles. The shipper was dropped from a height of 36". During drop A, the bottles were oriented in their upright and upside down position. For drop B, the bottles were dropped on their front and backside. For drop C, the bottles were dropped on their left and right sides. The bottles were checked for any stress marks, cracks and breaks. There was no damage noted on the 24 bottles in the shipper. This test was done for both PVC and PETG bottles containing body moisturizer, shower gel, and after-shave balm. Both PVC and PETG bottles passed the drop test.

WEIGHT LOSS TEST

The weight loss test was performed to monitor the weight loss of the products. The results from this test indicated that PETG bottles lost twice as much weight as PVC bottles during the course of eight weeks. The weight loss was still within the acceptable range and so passed this test as well. It was noted that the samples at –15°C exhibited some weight gain instead of weight loss. This could be attributed to the fact that there was condensation on the bottles. Another explanation could be that the product gained some extra moisture from the environment. A third possibility could be that the bottles absorbed moisture from the environment. Weighing empty bottles at –15°C to see if they gain any weight could test this third theory. Perhaps the test procedure should be changed to only use the –15°C samples for Research and Development product evaluations. Regardless, all samples passed the weight loss and product evaluations.

At the end of the eight-week general package and product compatibility testing, weight loss in PETG bottles was almost twice as much as in PVC bottles for all bottles. Both PVC and PETG bottles passed the product compatibility test. It is important to note that the PVC bottles consistently gained weight at –15°C. For samples that gained weight, a possible theory is that there was condensation on the bottles. It is also possible the PVC absorbed more moisture from the air than product lost. This could attribute to the better performance of PVC in this test. Some of the PETG bottles also gained weight at -15°C.

All samples had average percent weight loss less than 1% at two weeks and less than 2% after eight weeks. The maximum allowable loss is 1% at two weeks and 3% at eight weeks. Therefore, the results were acceptable. For individual test results, refer to graphs 1-9.

The samples were also compared to glass controls for odor, appearance and color. At the end of each two-week test period, one glass control along with one bottle from each environmental chamber was given to the Research and Development group for product evaluation of body moisturizer, shower gel, and after shave balm. For comments on stability for each product, refer to the Research and Development section.

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