PLASTIC STRETCH WRAP

vs

THE LOCK n'POP SYSTEM

A comparison of waste,
environmental and energy
impacts for unitizing pallets.

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Summary

The Lock n'Pop pallet unitizing system has proven to be an efficient low-cost method of packing pallet loads of corrugated boxes or multiwall bags in most industrial applications. The main competitor to the Lock n'Pop unitizing system is the higher-cost polyethylene stretch film. Comparing the two systems from an environmental basis, Lock n'Pop is shown to be the clear favorite.

Comparing the total materials used to unitize pallets, Lock n'Pop is almost 28 times as environmentally desirable to use for shipping pallets as is polyethylene stretch film. Comparing the waste materials going to land fill, polyethylene stretch film is over 100 times more damaging than Lock n'Pop.

A drum of Lock n'Pop chemical product weighs 470 pounds and will unitize 1,625 pallets. It requires only 24.1 pounds of resins in the 470 pounds of finished product. To unitize a comparable number of pallets with stretch film, 883.6 pounds of polyethylene stretch film will be required.

Summarizing this data gives the following:

Comparison of Environmental Usage Of Barrels of Oil Equivalents and Carbon Dioxide Produced from Packaging Pallets With Stretch Wrap and Lock n'Pop				
Basis: 1,625 Pallets	Barrels of Oil Equivalents		Carbon Dioxide Produced	
	Stretch Wrap	Lock n'Pop	Stretch Wrap	Lock n'Pop
Raw Materials Used	2.8	0.08		
Incineration Products from Burning Wastes			361.0	4.0
Losses During Polyethylene Manufacture	0.6		560.0	
Film and Lock n'Pop Manufacture, Shipping and Use	1.82	0.1	1,776.0	1.0
Energy Gains from Incinerating Waste	-0.30		-302.4	
Total	4.92	0.18	2,394.6	5.0

Summary (continued)

When unitizing the number of pallets possible with one barrel of Lock n'Pop:

Stretch film requires the use of almost 5 barrels of oil, and

Creates over one ton of carbon dioxide, as well as small amounts of carbon monoxide, aldehydes, and hydrocarbons, and

Leaves 714.6 pounds of plastic film in land fills.

Lock n'Pop requires the use of less than 0.2 barrels of oil, and

Will produce only 5 pounds of carbon dioxide, and

Will leave only 7 pounds of material in land fills.

Lock n'Pop is clearly the preferred environmental alternative!

Introduction

The Lock n'Pop liquid pallet unitizing system has been successfully introduced and developed by Key Tech Corporation. This system has proven to be an efficient low-cost method of assembling pallet loads of corrugated cartons or multiwall bags in most industrial applications. The main competitive system for pallet unitizing, plastic stretch film is higher in cost and also uses a considerably greater quantity of materials. A decision was made to explore the environmental implications of the two systems, Lock n'Pop vs. plastic stretch film, particularly as to the use of oil reserves and energy and to the recyclability of the two material systems.

This study summarizes the results of the evaluation of these two palletizing systems from the point of view of materials used and recycled, energy required for the systems, and waste products generated. Any study of this nature is, of course, based on certain assumptions which may, or may not, apply in any particular instance. Dumbleton Consulting has endeavored to research the various assumptions in this report so that solid country-wide average values could be used. Nevertheless, comparisons of this nature are basically macro analyses and conclusions drawn from the results should be based on significant differences of at least 20% between the two alternatives. Fortunately, such significant differences have developed in this case.

Objectives

A. Profile and characterize the environmental impact of the Key Tech Lock n'Pop system of pallet unitizing compared to stretch film.

B. Analyze the material usages and the environmental implications of the two systems, including impact on land fills or on public air quality and water systems during disposal of these materials after their use.

C. Analyze the energy usages required for the two systems including raw materials production through shipping to assumed average locations.

Assumptions

A. All calculations will be based on the unit of one barrel of Lock n'Pop unitizing product. The following assumptions were made:

1. Pallets average 50 cases each
2. Each case requires 2.6 grams of Lock n'Pop chemical product
3. Each pallet requires 130 grams of Lock n'Pop chemical product
4. One percent of the chemical product is lost in pot drying and clean up
5. Therefore, each pallet requires 131.3 grams of Lock n'Pop chemical product
6. Each barrel of Lock n'Pop has 470 pounds of product, or 213,380 grams
7. Therefore, each barrel of Lock n'Pop product will make 1,625 pallets ready for shipment

B. It is assumed that all pallets are recycled for both systems.

C. For the purposes of this report an oil-equivalent BBL is considered to be 42 gallons of oil or oil–derived products. While it is not possible to convert a barrel of oil totally into diesel fuel or polyethylene, on a macro basis, it is possible to consider and calculate the amount of oil needed to make these products.

Raw Material Usages

Stretch Film:

Stretch film is made from high-grade polyethylene resin that is extruded into a very strong thin film. The film is then slit into specific widths and wound onto thick cores for shipping to the customers. Originally manufacturing waste values were much larger for this process, but as volume has grown, manufacturers have developed special lines that run only one product and run with much smaller average wastes.

Total Materials Usage	
	Pounds
Wrapping used on each pallet	0.5
Total wrapping materials for 1,625 pallets	812.5
Shipping and storage losses to customers = 3.0% 812.5 x 0.03 = 24.4 lbs Total polyethylene	836.9
Packaging materials (polyethylene film) = 0.5% 836.9 x 0.005 = 4.2 lbs Total polyethylene	841.1
Losses on the extruder and rewinder = 3.5% 841.1 x 0.035 = 29.4 lbs Total polyethylene	870.5
Losses during shipping, storage, and usage, including roll-end waste = 1.5% 870.5 x 0.015 = 13.1 lbs Total polyethylene	883.6
Therefore, the total amount of polyethylene needed to make stretch film for 1,625 pallets	883.6
Paperboard cores used = 2% of total weight 883.6 x 0.02 = 17.0 lbs	17.0
Total materials usage for 1,625 pallets	**900.6**

Lock n'Pop Pallet Unitizing System:

Lock n'Pop is a family of chemical products with formulas for unitizing a wide variety of surfaces. The unitizing agent is in a liquid form that is sprayed onto individual shipping containers (such as corrugated boxes or multiwall bags) immediately prior to palletizing. Manufacturing is primarily a chemical process in a liquid state and waste levels tend to be smaller. The active resins that do the unitizing are so efficient that they represent only about 5% of the total liquid material. The balance is water that evaporates during use. Therefore, the total 470 pounds of Lock n'Pop in a barrel represents only 23.5 pounds of dry solids. The product is packaged in blowmolded plastic bottles shipped in metal cages and also in plastic lined fiber drums. About 25% of Lock n'Pop is shipped in bottles that are recycled and reused. Of the remaining volume (75%), about one half of the fiber drums are recycled and reused. Therefore, roughly 37.5% of the containers are lost to land fills or incineration.

Total Materials Usage	
	Pounds of Material
Total liquid chemical product needed for unitizing 1,625 pallets	470.0
Total dry solid resins used per barrel = 5% 0.05 x 470 = 23.5 lbs	23.5
Losses during shipping and storage = ½% 0.005 x 23.5 = 0.1 lbs	23.6
Losses during mixing and packaging = 2% 0.02 x 23.6 = 0.5 lbs	24.1
Total dry chemical products	24.1
Therefore, the total amount of dry chemical products to make unitizing materials for 1,625 pallets	24.1
Packaging materials = 50% of fiber drums 0.375 x 22 lbs/drum = 8.3 lbs	8.3
Total materials used for 1,625 pallets	**32.4**

Total Materials Comparison of
Stretch Film vs. Lock n'Pop

Total materials usage to pack 1,625 pallets of product:

Lock n'Pop	32.4 pounds
Stretch Film	900.6 pounds

Therefore, the Lock n'Pop unitizing system, as shipped, uses only 3.6% as much material as does the stretch film for assembling pallets.

The Lock n'Pop unitizing system, as shipped, is almost 28 times as environmentally desirable to use for shipping pallets as is stretch film on the basis of materials usage.

A barrel of oil weighs about 321 pounds. Therefore, converting the resins to barrels of oil equivalents gives the following data:

Comparison of Environmental Usage Of Barrels of Oil Equivalents and Carbon Dioxide Produced from Packaging Pallets With Stretch Wrap and Lock n'Pop				
Basis: 1,625 Pallets	Barrels of Oil Equivalents		Carbon Dioxide Produced	
	Stretch Wrap	Lock n'Pop	Stretch Wrap	Lock n'Pop
Raw Materials Used	2.8	0.08		

Recycling

Stretch Film:

The polyethylene used in stretch film is of the highest quality and would normally be considered desirable for recycling. As the thickness of the stretch film has dropped over the years for economic reasons, the quality of the resin has been kept at the very highest levels. However, only marginal amounts of resin are recycled at this time. The reasons for this anomaly are:

1. Only small amounts of stretch film, roughly eight ounces, are used on each pallet of product. Therefore, the film is difficult to collect in quantities sufficient for recycling.

2. The shipping process is often a dirty operation, exposing the loaded pallet to small rocks, dirt, paper and other adulterants. In addition, pallet film has high friction, or "tackiness", so the various layers of film will stick to each other and hold together to help strengthen the pallet load. These tacky films also tend to hold onto the rocks and dirt easily, and these extraneous materials make the film hard to use during recycling.

3. There are limited recycling facilities that can handle polyethylene films of this type. Stretch film would be in the class-4 group of SPI recycling, or the low-density polyethylenes. Only a few installations can handle low-density films at this time. Mobil has built such a facility for stretch film, but it now handles only one million pounds a year. Anticipated full volume of three million pounds per year is still less than one percent of annual stretch film usage.

4. Discussions with the proprietors of these recycling facilities indicate a lack of interest in stretch film due to the dirt and other problem materials. In addition, these facilities need a supply of recyclable films in reasonably large quantities. Collecting the small amounts of stretch films from so many diverse locations is apparently difficult and uncommon.

As a result of these problems, we have assumed a recycling rate of 5%, primarily from controlled internal shipping operations, although this estimate may be somewhat generous.

The polyethylene lost during the film manufacturing step can also be recycled, although often it is diverted into garbage bags or the like.

On a nationwide basis about 15% of solid waste, including paper board, is burned each year. Since most of the stretch wrap goes to land fill or to incineration, the 15% figure has been used. In the Northeast the percent burned would be higher and in other parts of the country it would be lower.

Stretch Film Recycling Data		
		Pounds of Material
The total amount of polyethylene needed by customers to stretch wrap 1,625 pallets, including shipping waste		836.9
Polyethylene recycled as No. 4 SPI group = 5% 0.05 x 836.9 = 41.8 lbs	41.8	
Polyethylene recycled in the stretch film manufacturing plant (see p. 6)	29.4	
Total polyethylene recycled		71.2
Total polyethylene disposed of after use		765.7
Polyethylene stretch film burned in incinerators = 15% 765.7 x 0.15 = 114.8 lbs		114.8
Incinerating this polyethylene gives off the equivalent of <u>361.0 pounds of carbon dioxide</u>, including small amounts of carbon monoxide, aldehydes, nitrogen oxides, hydrocarbons, and very small amounts of some metals such as chromium.		
Polyethylene stretch film sent to land fills:		
Total polyethylene and cores	900.6	
Recycled polyethylene	71.2	
Incinerated polyethylene	114.8	
Net polyethylene to land fills		714.6
Therefore, enough stretch film to unitize 1,625 pallets leaves the following after recycling and disposal:		
Land fill		**714.6**
Carbon dioxide or equivalents		**361.0**

Lock n'Pop Pallet Unitizing System:

The Lock n'Pop product is sprayed on the corrugated boxes or multiwall bags during the stacking of pallet loads. At the time of removal of the boxes or bags from the pallet, the small amount of dried Lock n'Pop product remains on the surface of the paper or corrugated board. A thorough repulping study was conducted by Weyerhaeuser company in 1990. this study showed no difference in recyclability of paper products, either with Lock n'Pop treatment or without.

The current recycling rate for corrugated paper board and similar materials is 57%. The great majority of non-recycled corrugate is represented by in-home uses such as toy boxes and the like. Most authorities agree that the recycling rate in industrial organizations is significantly higher. Estimates range up to 80%, but these values probably represent local situations. An overall country-wide estimate of 65% is reasonable. Corrugated paper board recycling continues to grow each year because the fiber is of much higher quality.

The incineration rate of about 15% applies to solid waste for Lock n'Pop as well.

Lock n'Pop Unitizing System Recycling Data		
		Pounds of Material
The total amount of dry solids Lock n'Pop needed by customers to unitize 1,625 pallets, including shipping waste		24.1
Lock n'Pop recycled with corrugated paperboard and similar materials = 65% 24.1 x .65 = 15.7 lbs		15.7
Lock n'Pop disposed of after use		8.4
Lock n'Pop burned in incinerators = 15% 8.4 x 0.15 = 1.3 lbs		1.3
Incinerating this amount of Lock n'Pop gives off the equivalent of 4.0 pounds of carbon dioxide, including small amounts of carbon monoxide, aldehydes, and nitrogen oxides.		
Lock n'Pop chemical product sent to land fills:		
Total Lock n'Pop dry solids	24.1	
Recycled Lock n'Pop dry solids	15.7	
Total Lock n'Pop disposed of after use	8.4	
Incinerated lock n'Pop dry solids	1.3	
Net Lock n'Pop product to land fills	7.1	
Therefore, enough Lock n'Pop to unitize 1,625 pallets leaves the following after recycling and disposal:		
Land fill		**7.1**
Carbon dioxide or equivalents		**4.0**

Total Recycling Comparison of
Stretch Film vs. Lock n'Pop

Total Usage to Pack 1,625 Pallets of Product		
	To Landfill	Carbon Dioxide
Lock n'Pop	7.0 lbs	4.0 lbs
Stretch Film	714.6 lbs	361.0 lbs

Therefore, Lock n'Pop sends about one hundredth as much waste to land fill as does plastic stretch film.

Converting the resins to barrels of oil equivalents and adding the carbon dioxide produced gives the following data:

Comparison of Environmental Usage Of Barrels of Oil Equivalents and Carbon Dioxide Produced from Packaging Pallets With Stretch Wrap and Lock n'Pop				
Basis: 1,625 Pallets	Barrels of Oil Equivalents		Carbon Dioxide Produced	
	Stretch Wrap	Lock n'Pop	Stretch Wrap	Lock n'Pop
Raw Materials Used	2.8	0.08		
Incineration Products from Burning Waste			361.0	4.0

Energy Requirements

Stretch Film:

Not only does stretch film use more material than Lock n'Pop, it is also more energy intensive. The manufacture of polyethylene resin is a high-energy process itself, and the following extrusion and roll-winding steps to make the film ready for consumer use are also large users of energy.

The film is shipped to wholesalers who, in turn, ship the film in smaller quantities to individual customers. The wrapping of stretch films around the pallets also uses some energy. After the film is used and the pallets disassembled, the waste film must be transported to land fills or incinerators. No estimates of these last transportation steps are included, since they vary widely and often must be made by users anyway for other products in the customer's plant. The reclaimed energy from the portion that is burned is included.

Energy Use Calculations:

The manufacture of polyethylene requires the following production steps:

Crude oil extraction
Transportation
Refining of naphtha
Cracking and separation
Polymerization (low pressure) and pelletization
Transportation

In the actual manufacture of the polyethylene, both thermal and electrical energy are required. The thermal energy is calculated at actual process requirements since the losses in generating this energy are small. The electrical energy, on the other hand, involves considerable losses in efficiency from burning oil through to electricity delivered at the manufacturing facility. The best average efficiency of electrical companies is about 31%. Therefore, electrical process energy totals are divided by 0.31 to obtain the true energy required.

The manufacturing steps require, on average, the following amounts of energy:

Thermal energy	6,265.7 BTU/lb
Electrical energy	4,847.7 BTU/lb
Total energy	11,113.4 BTU/lb

The manufacture of enough polyethylene to wrap 1,625 pallets requires	883.6 x 11,113.4 = 9,819,800 BTU
During the cracking step, a significant amount of carbon dioxide is released into the atmosphere. This amount is 0.634 pounds per pound of polyethylene manufactured. Therefore, enough polyethylene to unitize 1,625 pallets requires:	883.6 x 0.634 lbs = 560 pounds of carbon dioxide
This cracking step requires the use of 0.6 BBL of extra oil that is lost during manufacture.	
The blending, film extrusion, and rewinding steps require, on average:	1,096 BTU/lb
The extrusion of enough film for wrapping 1,625 pallets requires	870.5 x 1,096 = 954,068 BTU
The stretch wrapping of one pallet in a customer's plant requires a 1-horsepower motor running for about 1.5 minutes. Higher horsepower motors will wrap pallets more quickly with a similar net energy usage. Therefore, the total energy needed to wrap 1,625 pallets requires:	339,912 BTU
The total BTU's required to prepare and use stretch film for wrapping 1,625 pallets:	
Polyethylene resin manufacture	9,819,800 BTU
Stretch film extrusion and rewinding	954,068 BTU
Pallet wrapping in customer's plant	339,912 BTU
Total BTU's	11,113,780 BTU
A barrel of oil has 6,368,000 BTU of energy. Therefore, the oil required to manufacture and use enough polyethylene stretch film for 1,625 pallets is	11,113,780 / 6,368,000 = 1.75 BBL of oil or 73.3 gallons
The shipping of enough stretch film to the warehouses for wrapping 1,625 pallets requires, on average, 2.7 gallons of diesel fuel	
The shipping of the finished films to the final customer plants requires, on average, 0.4 gallons of diesel fuel	
Therefore, the amount of oil needed to make and ship stretch film to customers is, on average:	
Manufacturing film	73.3 gallons
Shipping to warehouse	2.7 gallons
Shipping to customers	0.4 gallons
Total oil needed	76.4 gallons or 1.82 BBL
All the oil needed to manufacture, ship and use the polyethylene stretch film must be burned to release the energy. This volume of oil will release the following amount of carbon dioxide:	1,776 lb of carbon dioxide
Approximately 15% of the stretch film is incinerated, and this operation saves some oil that would otherwise be used for generating electricity. Incineration of polyethylene gives 16,659 BTU/lb. Therefore, the incinerated portion of the waste stretch film saves:	114.8 x 16,659 = 1,912,453 BTU
Or, in barrels of oil:	1,912,453 / 6,368,000 = 0.3 BBL
The incineration of the waste polyethylene also saves a commensurate amount of carbon dioxide that would be released on normal electricity generation. This amount of carbon dioxide would be:	302.4 lb of carbon dioxide

Lock n'Pop Pallet Unitizing System:

The Lock n'Pop chemical products contain resin chemicals, some of which are derived from oil. Assuming all of the 24.1 pounds of chemical products are oil derived, enough Lock n'Pop product to unitize 1,625 pallets would require less than 0.08 BBL of oil equivalents.

The processing and shipping requirements are also considerably smaller for Lock n'Pop and, in total, represent 0.032 BBL of oil equivalents. This quantity of oil will produce just under one pound of carbon dioxide on burning.

The usage of Lock n'Pop in the customer's plants requires a small pump to spray on the material. A total of 0.15 KWH is needed for this operation to unitize 1,625 pallets. The oil equivalent needed for this step is less than 0.01 BBL of oil.

The incineration rebates are virtually negligible since so much of the product leaves only water vapor. Therefore, no measurable fuel value can be found in the incinerated Lock n'Pop products.

The net result of this analysis is that Lock n'Pop would require less than 0.1 BBL of oil equivalents.

Total Energy Comparison of
Stretch Film vs. Lock n'Pop

Summarizing the energy data along with the materials and recycling data gives the following:

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Energy Gains from Incinerating Energy	-0.30		-302.4	
Total	4.92	0.18	2,394.6	5.0

Polyethylene stretch film uses 27 times more oil equivalent barrels than does Lock n'Pop and also adds over one ton more carbon dioxide to the atmosphere than does Lock n'Pop for the same 1,625 pallets.

Sources of Information

Dumbleton Consulting used the knowledge and backgrounds of its associates to develop this report as well as information from:

1. Resin producers
2. Unpublished book on garbage in the United States
3. Published reports of Grocery Manufacturers Institute
4. Plastic recyclers
5. Flexible film manufacturers
6. Presentations at Environmentally Responsible Packaging conference, September 1991
7. Weyerhaeuser Company Physical Testing Services report, September 1990
8. Reports in Plastics Focus News Reports
9. Design engineering firms
10. Swedish National Commission on Packaging report of December 1991
11. Council for Solid Waste Solutions report June 1990