COMBAT RATION NETWORK

FOR

TECHNOLOGY IMPLEMENTATION

Retortable Laminate/Polymeric Food Tubes for Specialized Feeding

Final Technical Report STP#3010

Results and Accomplishments (June 2010 – June 2012)

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14. ABSTRACT

Food tube rations are a special customer order, limited production item used by U.S. Air Force pilots for through-the-mask feeding on demanding, long range, high altitude reconnaissance, surveillance, and intelligence collection missions. The aluminum tubes currently used for this application are made from extruded aluminum and are both expensive and fragile since the seal is easily compromised. In recent years, the quality and workmanship of these critical aluminum tube blanks has degraded. The proposed transition to retortable laminate/polymeric (L/P) tubes will eliminate the source concerns, as well as provide additional performance advantages. The L/P tube needs to hold 5 ounces of product, be able to fit in the U-2 heating system and be used in-flight by the pilot through the helmet feeding straw. The shelf-life requirements for the product are a minimum of three years at 80 degrees F. The prototype tubes should be based on commercial off-the-shelf materials and not military unique. A market survey of commercially available laminated tubes revealed that they are all based on polyethylene inner and outer layers and not suitable for retort processing. These tubes are commonly used for toothpaste dispensing. There are polypropylene extruded tubes commercially available, but do

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Abstract:

Food tube rations are a special customer order, limited production item used by U.S. Air Force pilots for through-the-mask feeding on demanding, long range, high altitude reconnaissance, surveillance, and intelligence collection missions. The aluminum tubes currently used for this application are made from extruded aluminum and are both expensive and fragile since the seal is easily compromised. In recent years, the quality and workmanship of these critical aluminum tube blanks has degraded. The proposed transition to retortable laminate/polymeric (L/P) tubes will eliminate the source concerns, as well as provide additional performance advantages.

The L/P tube needs to hold 5 ounces of product, be able to fit in the U-2 heating system and be used in-flight by the pilot through the helmet feeding straw. The shelf-life requirements for the product are a minimum of three years at 80 degrees F. The prototype tubes should be based on commercial off-the-shelf materials and not military unique. A market survey of commercially available laminated tubes revealed that they are all based on polyethylene inner and outer layers and not suitable for retort processing. These tubes are commonly used for toothpaste dispensing. There are polypropylene extruded tubes commercially available, but do not meet the shelf-life criteria, unless they are over wrapped in aluminum foil. Also, these tubes are stiff, do not collapse and suck- back on the product.

Commercial liquid foods, such as baby foods and nutrional drinks are sometimes packed in spouted pouches. This project investigated the possibility using this type container for the U-2 program. Two prototype containers were developed, one based on pillow type pouch that is filled from the opposite side of the spout and one based on a gusseted pouch that is filled through the spout. The size limitation of the U-2 heating system eliminated the first prototype due to its longer length. The second prototype is still under evaluation. The advantage of the spouted pouch is that it uses the same material as MRE retort pouches, a supply that is domestic and commercial available.

To use the domestic supply of L/P tubes, such as the tooth paste tubes that use polyethylene as inner and outer layer, requires the use of acidified (pH<4.6) product so that it can either be hot filled or pasteurized after it is filled in the tube. Because of the lower melting point of polyethylene, it needs to be confirmed that these type tubes can be used in the U-2 heating system.

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1 Results and Accomplishments

1.1 Introduction and Background

Food tube rations are a special customer order, limited production item used by U.S. Air Force pilots for through-the-mask feeding on demanding, long range, high altitude reconnaissance, surveillance, and intelligence collection missions. Tube foods provide the only means of feeding pilots during in-flight operations with missions lasting up to 12 hours. Recent product innovation involving caffeine enhanced tube foods has been extremely successful and is now required for enhanced cognition and performance during critical phases of these difficult missions. Each individual squeezable aluminum tube holds approximately 5 ounces (141.7 grams) of food containing 150 - 300 calories. The tube foods are fully cooked, retort products which are hermetically sealed and can be opened by a spike on the reverse side of the tube cap which is used to puncture the seal. Each tube contains a ready-to-eat food item and has a shelf life of 3 years at 80°F and 6 months at 100°F. There are presently 15 menu items available including entrées, fruits, desserts and puddings. The tubes utilized for this application are specialized extruded aluminum tubes configured to allow for ease of use by the pilot or storage in the aircraft cockpit. Each tube is 1.5 inches in diameter and 6.75 inches in length and double coated on the inside with a phenolic resin to prevent food particles from reacting with the aluminum tube resulting in spoilage or degradation. The bottom end of the tubes has a 5/16" Darex band sealant that enhances the integrity of the hermetic seal and aids in the crimping process during production after the tube has been filled and sealed, prior to retorting.

Tube foods are a uniquely military item, produced in small quantities annually, exclusively at NSRDEC (Natick Soldier Research Development and Engineering Center) for the U.S. Air Force to support through- the- mask, in-flight feeding. The tubes are both expensive and fragile, since the seal is easily compromised. These aluminum tube blanks are currently sole-sourced, manufactured outside the US, and present a possible Diminishing Manufacturing Source which, if interrupted, would have a significantly adverse impact to USAF operational mission readiness. In recent years, the quality and workmanship of these critical aluminum tube blanks has degraded. These identified source, production, and quality issues have elevated concerns over the future availability and viability of this critically important item. Quality, erosion, and availability issues or production delays leading to loss of this tube supply source are of extreme concern to the military, as the missions which they support are closely aligned with National security interests. The U2 program is essential for US manned military reconnaissance gathering. The proposed transition to retortable laminate/polymeric (L/P) tubes will eliminate the source concerns, as well as provide additional performance advantages. L/P tubes are not fragile like the aluminum counterparts, and can easily be carried without fear of compromising product quality or safety due to pin-holing or related package damage associated with package durability and seal integrity. Transition to an L/P tube will aid in the introduction of new products, expand the production base from sole-source, reduce material costs, and lower associated production costs.

1.2 Objectives

The objective of this request is to replace the current diminishing and sole- sourced metallic tubes used for the U.S. Air Force U2 Program with the more common laminate/polymeric tubes.

1.3 Results and Conclusions

The switch over to a laminated polymeric food tube for specialized feeding experienced several hurdles. While there is a vast supply available of laminated polymeric tubes in the USA, none of

these tubes are suitable for retorting. Acidification of the product, followed by hot fill or pasteurization appears to be the only solution to use this supply of available domestic tubes. While switching to a tube that uses materials that can withstand retort conditions is technical feasible, a supply of commercial off-the-shelf laminated materials does not exist. The Air Force's limited demand for these tubes does not warrant the development of these laminated materials. Even if R&D funds would be made available for such development, it would not guarantee that the a consistent supply of this material be available. Only the creation of additional commercial demand for this laminate will guarantee a consistent supply.
The Industry appears to gravitate to spouted pouches for this liquid food systems, such as baby food. Initially, these products were hot filled or pasteurized and used polyethylene laminated films. However, several products are now being introduced that require retorting. These pouches use commercially available retort film and spouts that are molded from polypropylene. The main concern in retortable spouted pouches was the assurance of hermetically sealed containers. This issue seems to be resolved as systems are being deployed by various companies.

2 Program Management

The project was awarded on June 7, 2010, under SP4701-08-0004, delivery order 0005, with a partial obligation ($64,884) of the total requested amount of $264,495. Performance period for this delivery order was initially set at 24 months from June 7, 2010 through June 6, 2012.

The following modifications were issued:

- June 18, 2010 0005/01 Change in Block 15
- June 23, 2010 0005/02 Change in Block 15
- July 22, 2010 0005/03 Increased obligated funds to $87,412
- Nov 24, 2010 0005/04 Increased obligated funds to $139,268
- Nov 30, 2010 0005/05 Increased obligated funds to $145,268
- June 1, 2012 0005/06 No cost extension to August 30, 2012

3 Short Term Project Activities

A kick-off meeting for this project was held on August 10, 2010 in Natick. A copy of the presentation and meeting notes are attached as appendix 4.1.

3.1 Phase I: "Prototype Development"

The purpose of this project phase was to identify one or more retortable laminate film candidates that could be used for the fabrication of food tubes. Selected materials should be capable of withstanding conditions associated with the thermal processing conditions required for food products, be safe for food contact (21 Code of Federal Regulations, Part 170-190) and not impart any sensory off notes, nor degrade the physical or chemical composition of the food itself. Prototype, filled, sealed and retorted tubes would be supplied to the Natick Soldier Research, Development and Engineering Center for evaluation and testing.

3.1.1 Prototype

The prototype tube needs to hold 5 ounces of product, be able to fit in the U-2 heating system and be used in-flight by the pilot through the helmet feeding straw. The shelf-life requirements for the product are a minimum of three years at 80 degrees F. The prototype tubes should be based on commercially available materials and not be uniquely military.

We surveyed the market for laminated retortable tubes and were not able to find any application that uses a material that can be retorted. All laminated tubes on the market are based on

polyethylene inner and outer layers with an aluminum barrier in between. These tubes are commonly used for toothpaste dispensing. Food products that need to be retorted and need to be dispensed in tubes, are packed in aluminum tubes similar to what the military is currently using for their U-2 feeding program. Current development shows a surge in spouted pouch for liquid food applications, initially only as hot packed foods, but more recently also as retortable food products. We will discuss in the following sections the various prototype solutions.

3.1.1.1 Laminated Tube

After an extensive search and discussion with numerous suppliers of tubes, we concluded that there is no domestic commercial supply of polypropylene based tubes with an aluminum barrier, a configuration that is required to make the tube retortable for low acid products and give it the three year shelf- life.
We did identify one company (Berry Plastic) which manufacturers extruded polypropylene tubes w/o a barrier layer. We will discuss this prototype solution in one of the following sections.

We did request a sample from NSRDEC of a laminated plastic tubes that was supplied to them by an unknown source. Upon retorting these tubes, at 275 degrees F for 60 minutes, severe shrinkage was observed to the cap of the tube and the body of the tube wrinkled. This indicated that the materials used for these tubes were based on polyethylene and not polypropylene, making it not suitable for retort applications.

We also contacted the major manufacturers of laminated films to determine if they had films available that are retortable and can be used for tube manufacturing. Laminated tubes are made with a lap seal, therefore, both the inside and the outside laminates need to be constructed of similar material eg polypropylene. To obtain a three year shelf-life, a barrier layer, preferably aluminum, should be sandwiched between these two outer layers. In addition, also a nylon layer is preferred, to give the tube puncture resistance. Alcan has such film structure available that was developed for the Horizontal Form Fill Seal Technology. It is used in the MRE program as the formable bottom film. Samples of this material were obtained from Wornick and Ameriqual and forwarded to Montebello, one of the major tube manufacturers, for their evaluation. Montebello indicated that the film was too thin for tube manufacturing and that they were pursuing their own contacts to determine if one of their own suppliers could supply a retortable film.

A major problem in developing a new laminated film is the commercial demand for such product. The demand for the U-2 feeding program is limited to 20,000 tubes/year. Even if the Government bought a supply for multiple years, that quantity would not be sufficient to create commercial interest in developing this film at a reasonable cost. However, some progress was being made in the second quarter of 2012, as one food company inquired for a similar retortable laminated tube creating some commercial interest to pursue this application. If this demand would materialize, a laminated retortable food tube might be on the horizon as a new packaging system and could become available to the Government for their U-2 feeding program.

3.1.1.2 Spouted Pouch

During our market survey and discussions with various industry resources, we determined that the spouted pouch is being used for liquid feeding such as baby food. The products packaged in this type of pouches are predominantly acidified and hot filled in polyethylene laminated pouches. Low acid products require the product to either be aseptically packaged or retorted after the product is sealed into the package. This would require a polypropylene spout with a retortable, polypropylene based film structure like the ones used for retortable pouch products.

Existing spouted pouches have a gusseted bottom and are filled through the

spout and then hermetically sealed by the screw cap. While it is feasible to fill a retortable spouted pouch through the spout, concern exists that the integrity of the seal in the cap is not maintained during the retort process, as plastic tends to soften and closing torque diminishes. An alternative would be to use a pre-seal spout and fill the pouch through the opposite side. The pouch can then be sealed after filling with conventional heat seal equipment. This would result in a pillow pouch, like the current MRE Zapplesauce and water pouch, but now with a "hard spout" on one side that can be connected to a drinking straw and be consumed by the U-2 pilot. Our project partner, "Master Packaging", identified a source for polypropylene spouts and manufactured two prototypes pouches using MRE film.

For sizing purposes, we looked at two pouch geometries.

- Option #1: Existing spec for the 5 oz. MRE pouch: 4.75" x 6.25". This is a standard MRE pouch that would run on regular MRE sealing equipment. The U-2 heater would require a slotted opening rather than a round hole in which the tube is heated.

- Option #2: A narrow pouch that is 3.00" wide x 9"00 long. This pouch is longer than the current tube (6.75") and would require a deeper opening in the U-2 heater.

Depending on the order quantities, the estimated cost for this spouted pouch is approximately $0.80/pouch. Sealing of the pouch requires a physical constraint on the side of the pouch, similar to regular MRE pouches which applies a physical constraint to the bottom of the pouch. This assures that the volume of the pouch is maximized and the risk of getting product in the seal surface area is minimized. In spite of this only 70% of the volume can be filled and the pouch had to be made longer than the current tube size. After filling and sealing, the pouches were retorted at 275 degrees F for 60 minutes. No delamination or shrinkage was observed to any part of the pouch and/or spout. Samples of the narrow, retorted spouted pouch were sent to NSRDEC for evaluation by the Air Force. During the review of this concept, it was pointed out that the U-2 heating system cannot accommodate this increased length.

Because the U-2 heating system cannot accommodate the longer spouted pouch, we developed a gusseted pouch. By using a 20 mm gusset, we were able to reduce the pouch length from 9" to 6.5", approximately the same length as the current aluminum tube. Because of the gusset, these pouches need to be filled through the nozzle. The spout would now need to be sealed after filling with an optional security seal and cap. We contacted several packaging companies and

learned that some progress is being made in developing this packaging technology, while assuring a hermetical seal during the life cycle of the pouch. Toyo Jidoki Co, LTD, a leading manufacturer of pouch packaging equipment has several systems specifically designed for spouted pouches. Their information can be found in the Appendix. For demo purposes, we filled and retorted several gusseted tubes for evaluation by NSRDEC in a U-2 heating system.

Currently, there is a lot of commercial interest in spouted pouches, both for hot filled product as well as for retorted products. Commercially there are quite a few products sold in this type of pouch and the packaging equipment is evolving. In the past year, there were two pouch conferences that spent quite a bit of time on the spouted pouch concept, confirming the interest in this concept by the industry:

- Spout-Pac 2011 by the Packaging Group Inc. on February 16, 2011: http://www.packaginggroup.com/conference2.html
- Global Pouch Forum on June 7-9, 2011: http://www.globalpouchforum.com/index.php/agenda/currentagenda

3.1.1.3 Extruded Tube

We did identify one company (Berry Plastic, Evansville, IN.) that is able to supply an extruded polypropylene tube w/o a barrier layer. Samples of these tubes were obtained, filled and retorted at 275 degrees F for 60 minutes. The tubes showed no shrinkage or deformation. The screw threads of the tube were, however, not compatible with the adapter screw threads (M-8) nor did the cap have a safety seal under the cap. The company indicated that these options can be added. However, in order to achieve 3 year shelf-life, these extruded tubes would need to be over-wrapped in a high barrier pouch with optional oxygen scavenger. An additional disadvantage is that this tube is stiff, making it not collapsible and creating a certain amount of suck-back as the product is eaten.

3.1.1.4 Acidified Food

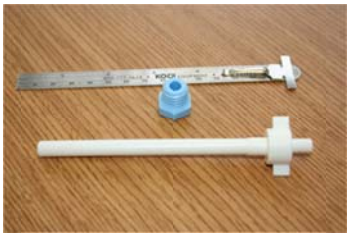
As retortability of the food tube appears to be a major stumbling block in identifying commercially available tubes, one can consider acidifying the products (pH<4.6) via appropriate formulation changes. This would allow the use of polyethylene laminated tubes. Baby food manufacturers who pack their products in polyethylene spouted pouches have used this approach. Acidification would make laminated tubes, such as toothpaste tubes available for use by the Air Force, eliminating their concern of domestic sourcing. While this solution would be viable, the cockpit heating system needs to be checked out to determine what temperature the tubes will be exposed to. This heating system could cause melting of these tubes as polyethylene has a rather low melting point.

3.1.2 Compatibility Study

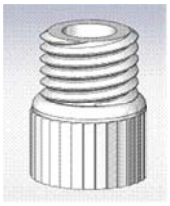
3.1.2.1 Adapter

An adapter piece is used by the Air Force to interface the food tube and the feeding straw. It is screwed onto the tubes when the tubes are given to the U-2 pilot. After the tube is heated, the

pilot will screw the tube onto the straw, at which time, the straw will break the security seal on the tube, therefore avoiding any spills in the cockpit.

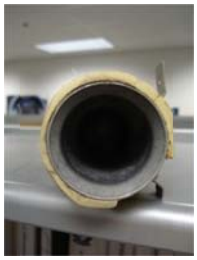


The screw threads that screw onto the tube appear to be metric (M-8) in design. The screw threads for the straw are nonstandard and have a double helix. The Air force still has many of these adapters in storage and prefers that the new tube design matches this adapter. The spouted pouches use a universally designed spout. It would be cost prohibitive to develop a uniquely military spout.



Our Partner, Master Food Packaging, did obtain a quote for a new adapter design that interfaces the spouted pouch to the straw. The cost of an injection mold would be $57K and the cost of the parts would be $51.93/1,000 pieces.

3.1.2.2 U-2 Heating System



The U-2 heating system is an integral part of the cockpit and has a tube in which the pilot inserts the food tube up-side-down. The opening in which the tube is heated is 6" deep and 1.6" in diameter. According to the manual, the oven can reach temperatures of 320 degrees F. It is not clear what temperature the actual food tube will realize. Neither polypropylene nor polyethylene materials can be exposed to 320 degrees F. It is, however, possible that 320 degrees F is measured in the heating coil section and not at the surface of the tube. NSRDEC is awaiting an U-2 heating system to confirm this.

4 Appendix:

4.1 Kickoff Meeting

4.2 Interim Project Review #1

4.3 Spouted Pouch Packaging Equipment.

Kickoff Meeting

Laminate/Polymeric Food Tubes for Specialized Feeding
STP#3010
Project Kick-Off Meeting
Natick Soldier Center
Natick MA

August 10, 2010 8:00 am – 10:00 am

Agenda:

- **Welcome and Introductions**
- **Project Outline and Management**
- **Prototype Tube Samples and Fitment**
- **Compatibility with U2 helmet**
- **Compatibility with the U2 Heater System**
- **Memory Characteristics**
- **Commercial Filler Sealers**
- **Selected Demonstration Products**

Attendees:

Name	Title/Co	Email
Peter Sherman	Natick	Peter.Sherman@us.army.mil
Bob Trottier	Natick	Robert.Trottier@us.army.mil
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Rieks Bruins	Rutgers University	Bruins@aesop.rutgers.edu
Jeff Canavan	Rutgers University	jscanavan@yahoo.com

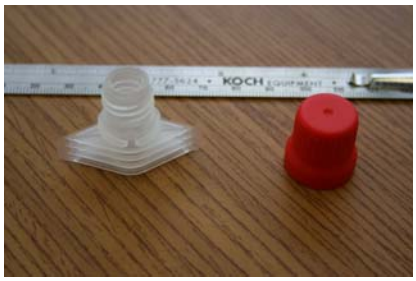
Note: Glen Douset from Natick could not attend the kick-off meeting, but he is a key contact on any technical issues related to the U2-heating system.

Meeting Notes:

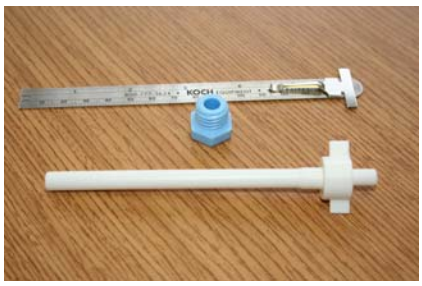
Rieks Bruins started the meeting by reviewing the technical scope of the project (presentation is attached). Master Packaging is a sub-contractor to Rutgers University under this contract and the technical expert as far as packaging materials and prototype development. Phil Nader is the technical contact at Master packaging.
The original tube that is used by Natick is an aluminum tube that is custom made by a non domestic source. This tube is fragile and the supply is uncertain. Attempts to identify a domestic source for a retortable laminated tube have failed so far due to the non-retortable end cap that is being used on these tubes. Their main resource for the aluminum and laminated polymeric tubes has been Montebello in Quebec, Ontario
http://www.montebellopkg.com/about_index.html

As Demonstration products for feasibility testing, we will use an apple sauce (natural acid) and a pudding (low acid). Both products require a fill weight of 5 oz. Natick will provide the formulation for the pudding at some time in the future once the project progresses to phase II.

Master Packaging showed an alternative packaging system that is retortable and uses existing components. This packaging system is based on a MRE film that is formed into an elongated sleeve. A fitment is then sealed into one end of the sleeve. The bottom of the sleeve can be open for filling or a gusset can be sealed into the bottom at which time the sleeve needs to be sealed through the fitment. Master Packaging has identified two fitments that can be used for this system, a 9 mm fitment and a 20 mm fitment.



Natick showed the actual Helmet that is being used by the U2 pilot and the drinking straw that fits into a helmet through which the pilot squeezes the food into his mouth. Because the current used tube doesn't fit onto the drinking straw, an adapter piece is being used to convert the screw threads of the tube to the screw threads of the straw. This adapter piece is applied to the tube before the mission by the ground crew. The tube is heated during the mission by inserting it into the heater with the cap down. Once the food is heated the pilot pierces the seal of the tube by screwing the straw onto this adapter.



Note: Natick will inquire the geometry of the U-2 heater, specifically the diameter and depth of the cavity in which the tube is placed.

Upon testing the 9 mm spout of the proposed package system did not have the correct screw threads to either fit on the straw directly of fit on the adapter. Therefore, either the screw threads of the spout have to be changed, a new adapter would need to be developed or a new straw would need to be developed. It is assumed the drinking straw is used for other items as well and less likely to be a candidate for replacement.

Rutgers and Master Packaging took samples of the adapter and drinking straw to ascertain the screw threads of these units.
Note: The screw threads are neither metric nor English and appear to be custom made.

Next, we visited the Natick pilot plant and saw the two filling systems that they have for the tube feeding program.

- The first machine, an Nordenmatic 400 is setup for aluminum tubes and is rated for 40 tubes/min. The machine steam flushes the headspace before it is crimped close in a three stage process.
- The second machine is a Nordenmatic 250 which is setup for laminate polymeric tubes and rated for 25 tubes/min. It uses hot air to heat up the inside of the tube to its melting point and is then crimped by cold jaws for form a hermetic seal. To minimize the residual air inside the tube, the tube is mechanically squeezed at the same time as when it is crimped. The hot air process works well according to Natick, as long as the roundness of the tube is not compromised.
- In a production process, the batch is prepared in a 40 gal kettle that is then pumped over to the fill hopper of the Nordenmatic. On an annual basis, Natick fills about 20,000 tubes

Appendix:
Presentation

RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

Retortable Laminate/Polymeric Food Tubes for Specialized Feeding

Rutgers University
&
Master Packaging

Introduction/Background

- Each individual squeezable aluminum tube holds about 5 ounces (141.7 grams) of food containing 150 - 300 calories. The tube foods are fully cooked, retort products which are hermetically sealed and can be opened by a spike on the reverse side of the tube cap which is used to puncture the seal. Each tube contains a ready-to-eat food item and has a shelf life of 3 years at 80°F and 6 months at 100°F.
- These aluminum tube blanks are currently sole-sourced, manufactured outside the US.
- The aluminum tubes currently used for this application are made from extruded aluminum and are both expensive and fragile since the seal is easily compromised.
- The proposed transition to retortable laminate/polymeric (L/P) tubes will eliminate the source concerns as well as provide additional performance advantages.
- It is further expected that transition to an L/P tube will aid in introduction of new products, expand production base from sole source, reduce material costs, and lower associated production costs.

Objective

- The objective of this project is to replace the current diminishing and sole sourced metallic tubes used for the U.S. Air Force U2 Program with the more common laminate/polymeric tubes.

Scope

- This project will identify and recommend one or more candidate retortable laminate films to be used for fabricating food tubes. Selected materials will be capable of withstanding conditions associated with specified retort thermal processing required for tube food products, be safe for food contact (21 Code of Federal Regulations (CFR, Parts 170-189), and not impart any sensory off-notes, or degrade the physical or chemical composition of the food itself. Prototype filled, sealed and retorted tubes will be supplied to the Natick Soldier Research, Development and Engineering Center for further evaluation and testing. If the prototype tubes are acceptable, the project will proceed to phase III and perform the necessary work to develop/update specification for this new package.

Phase I

- Prototype Development
  - Prototype Selection
    - Target dimensions for the tube configuration will be 1.5-inches diameter and 6.75-inches length
  - Compatibility Study
    - evaluation regarding the compatibility of the fitment to the existing feeding interface on the U2 pilot helmet and the memory characteristics of the system
    - Performance of the tube in the U2 heater system
  - **Producibility**
    - commercial fillers/sealers that are capable of filling the experimental tubes with tube foods

Phase II

- Manufacturability
  - Tube Fabrication
    - A total of 500 to 1,000 tubes will be fabricated and outfitted with sealed fitments, and a screw cap that can be applied after the retort process.
  - Processing Studies
    - Sealing conditions will be developed to yield maximum strength.
    - compliance to 21 CFR Part 170.1390
    - 500 tubes will be filled with a variety of food products
    - visual inspected and tested after the retort process
    - demonstrate effective producibility
    - accelerated storage (6 month at 100 F) and sensory evaluations of selected products conducted by NSRDEC

Phase III

- Technology Transfer
  - Assessment regarding expected production capabilities for L/P tube design
  - Determination optimal tube design/ material based on performance, producibility, and cost
  - Final engineering drawing of tube configuration and specification requirements

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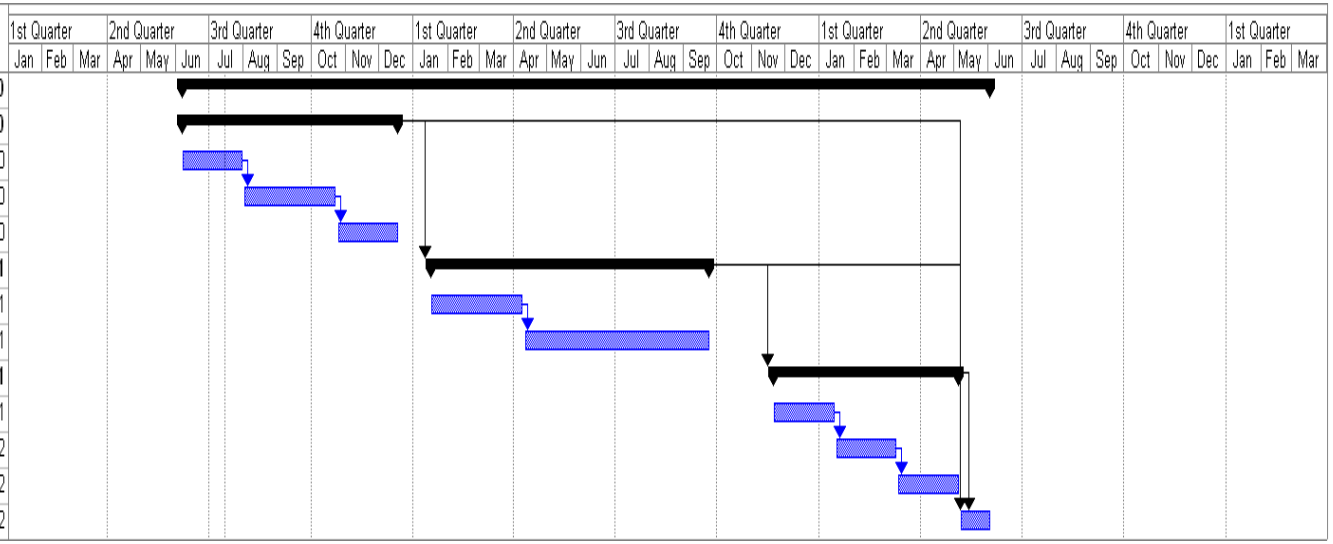
13	Final Report	1 mon	Mon 5/7/12



Interim Project Review #1

CORANET IPR Meetings
June 1, 2011

Natick Research Development and Engineering Center
Building 36, Conference Room E110

Agenda

1:00 pm - 4:00 pm	STP#3010	Retortable Laminate/Polymeric Food Tubes for Specialized Feeding

Invitees:

Name	Title/Co	Email
LTC Mark Bohannon	DLA, CORANET program director	mark.bohannon@dla.mil
Robert Coger	DLA, CORANET program manager	Robert.Coger@dla.mil
Bob Trottier	Natick, CORANET Liaison	Robert.Trottier@us.army.mil
Peter Sherman	Natick, CORANET Liaison	Peter.Sherman@us.army.mil
Dan Nattress	Natick	Daniel.Nattress@us.army.mil
Rieks Bruins	Rutgers University	Bruins@aesop.rutgers.edu
Jeff Canavan	Rutgers University	jscanavan@yahoo.com
Phil Nader	Master Packaging	pnader@masterpackaging.com

RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

Retortable Laminate/Polymeric Food Tubes for Specialized Feeding

IPR Meeting 6/1/2011

Rutgers University
&
Master Packaging

CORANET Liaison: Peter Sherman

Objective

- The objective of this project is to replace the current diminishing and sole sourced metallic tubes used for the U.S. Air Force U2 Program with the more common laminate/polymeric tubes.

Current Tubes in use at NSRDEC

Introduction/Background

- Each individual squeezable aluminum tube holds about 5 ounces (141.7 grams) of food containing 150 - 300 calories. The tube foods are fully cooked, retort products which are hermetically sealed and can be opened by a spike on the reverse side of the tube cap which is used to puncture the seal. Each tube contains a ready-to-eat food item and has a shelf life of 3 years at 80°F and 6 months at 100°F.
- These aluminum tube blanks are currently sole-sourced, manufactured outside the US.
- The aluminum tubes currently used for this application are made from extruded aluminum and are both expensive and fragile since the seal is easily compromised.
- The proposed transition to retortable laminate/polymeric (L/P) tubes will eliminate the source concerns as well as provide additional performance advantages.
- It is further expected that transition to an L/P tube will aid in introduction of new products, expand production base from sole source, reduce material costs, and lower associated production costs.

Scope

- This project will identify and recommend one or more candidate retortable laminate films to be used for fabricating food tubes. Selected materials will be capable of withstanding conditions associated with specified retort thermal processing required for tube food products, be safe for food contact (21 Code of Federal Regulations (CFR, Parts 170-189), and not impart any sensory off-notes, or degrade the physical or chemical composition of the food itself. Prototype filled, sealed and retorted tubes will be supplied to the Natick Soldier Research, Development and Engineering Center for further evaluation and testing. If the prototype tubes are acceptable, the project will proceed to phase III and perform the necessary work to develop/update specification for this new package.

Phase I

- Prototype Development
  - Prototype Selection
    - Target dimensions for the tube configuration will be 1.5-inches diameter and 6.75-inches length
  - Compatibility Study
    - evaluation regarding the compatibility of the fitment to the existing feeding interface on the U2 pilot helmet and the memory characteristics of the system
    - Performance of the tube in the U2 heater system
  - **Producibility**
    - commercial fillers/sealers that are capable of filling the experimental tubes with tube foods

Market Survey: Liquid Food in Plastic Bottles

Market Survey Laminated or Extruded Tubes

CCL Packaging

Impact Tubes

Market Survey: Pouches

MRE Spouted Pouches

- Zapplesauce
- Water

Capri-Sun Fruit Juice Pouches

- **"WILD FLAVORS, INC. BRINGS HIGH SPEED FILLING LINES TO NORTH AMERICA"**
  Roy Anderson, Director Pouch & Packaging Technology, Wild Flavors Inc.

Recently, WILD and INDAG, have begun building and operating high speed spouted pouch filling lines for the Capri Sonne and Capri Sun business in Germany and the United Kingdom. These high speed filling lines draw from their heritage of dominating the straw pouch market, but leapfrog current linear technology, being continuous rotary fillers which offer the same smooth reliability as continuous rotary bottle fillers. Until now, they have been closely held for internal use only. A movie of one of these units in full commercial operation will be shown publicly for the first time at this conference.

AMPAC spouted pouches

Baby Food in Spouted Pouches

- Plum
- Homemade Harvey
- Peter Rabbit
- Revolution Foods
- Happy Baby Food
- Earth Best
- Ella’s Kitchen

Tube Manufactures Contacted

- Albea group (Tubes are all PE based)
- Berry Plastics, (most are PE based, but has some PP tubes)
- Express Tubes, (PE based)
- JSN Packaging (PE based)
- Montebello Packaging, (PE based)
- Plastube North America (PE based)
- Top Tubes (PE based)
- Vista Packaging (PE based)
- Amber International (PE based)

Prototype Tube Solution

- No existing domestic supply could be identified for high barrier polypropylene tubes.
- Found supplier of plain polypropylene tubes and polyethylene/EVOH or Alum (non retortable tubes)
- While feasible to develop a high barrier polypropylene tube, economics/demand are such that it is not a high priority development item and supply would be unreliable.
- Using a plain polypropylene tube would require that the tubes are refrigerated/frozen or overwrapped with O2 scavenger to achieve 3 years shelf life.
- Polypropylene Tube is stiff material with memory causing “suck back”

Polypropylene Tube w/o barrier

Tube Fillers and Sealers

- ProSys (http://www.prosysfill.com/)
- Norden (http://www.nordenmachinery.se)
- Kalix (http://www.kalix.fr)
- Oystar IWK (http://www.oystar.iwk.de)
- ……

Material Comparison

- Typical Material Structure for Laminated Tooth Paste Tubes:
  - Polyethylene (only good for acidified foods, none retortable)
  - Aluminum or EVOH
  - Polyethylene

  - Polypropylene with EVOH or Aluminum barrier tubes are primarily foreign based

- Typical Material Requirements for Retort Application (inside to outside)
  - Polypropylene, food grade (sealant layer)
  - Aluminum (3 year shelf life)
  - Nylon (puncture resistant)
  - Polyester
  - Adhesive layers that are “retort proof”

Pouch Prototypes

MRE Tube

MRE Pouch

Spouted MRE Pouch Solution

- All materials used in this construction are commercial off the shelf materials.
- The laminate structure is exactly the same as the MRE quad laminate
- The seals are fusion seals and can be made by conventional heat seal bars, impulse seal bars or ultrasonic sealing.
- The fitment has a security seal under the cap
- Pouch material meets the FDA requirements for retortable materials (21 CFR Part 170.1390: Laminate structures for use at temperatures of 250 deg. F and above).
- Pouch material has barrier properties that yield a 3 year shelf life,
- Pouch is fully collapsible, allowing the pilot to drink the food without creating a suck back
- Pouch material excellent puncture resistance (similar to an MRE quad laminate pouch)
- The tube withstands the internal pressure test standard designed for MRE pouches
- Spouted pouch is not a military unique concept, there are examples of beverage and foods packed in laminated pouches (ex: Baby Food)

MRE Tube in U2-Tube-Heater

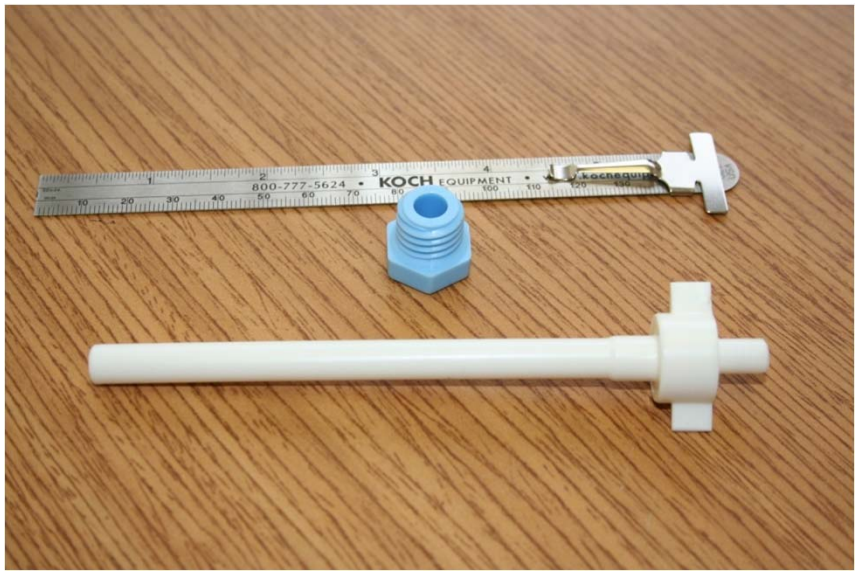
Filler & Sealer Equipment for Spouted Pouches

- Sealer Types
  - Seal in spout and fill through open end of pouch
  - Fill pouch and seal in spout
  - Seal in spout, fill through spout and seal off spout
- Equipment/Pouch Companies
  - Cheer Pack
  - Toyo Jidoki
  - The pouchcompany
  - Pouchsmart
  - Wild Flavors

Compatibility Issues

- Fit in U2 Heating System
- The screw thread of the spout are different than that of current tube
- How do the U2-pilots consume water/juice during their flight. Do they use the same tubes or do they some other container which might have screw threads similar to our spout?
- Unless an adapter exist a new adapter piece would need to be designed and manufactured

Fitment Compatibility



drinking straw with adapter
adapts to M8 tube fitment

9 mm pouch fitment with
security seal and cap

Prototype Comparison Matrix

Criteria	MRE Tube	MRE Pouch	PE-Alum Tube	PP-Tube	PP-Alum Tube	Alum-Tube
Commercially Available	+	+	+	+	-	+
Domestic Source	+	+	+	+	-	-
Retort T >250 F	+	+	-	+	+	?
3 Year Shelf Life	+	+	+	-	+	+
Final Seal Quality	+	+	+	+	+	-
Memory Characteristic	+	+	+	-	+	+
Compatability Heater	+	-	+	+	+	+
Compatibility Straw	-	-	?	+	?	+

Summary

- Tube:
  - Laminated Tubes are made from polyethylene and not suited for low acid food sterilization
  - Extruded polypropylene don't have the barrier properties and would need to be over wrapped in MRE type pouch with O2 scavenger.
- Spouted Pouches:
  - Gaining popularity for the larger fruit juice and water filled pouches because of re-closability
  - Being used for baby food products instead of glass jar because of ease of use
  - Materials available for retort application (<275 F)
- Compatability:
  - U2 Heating System
  - Adaptaion to the U2 drinking straw

Next Steps

- Pouch vs Tube decision
- Start with Phase II tasks

Phase II

- Manufacturability
  - Tube Fabrication
    - A total of 500 to 1,000 tubes will be fabricated and outfitted with sealed fitments, and a screw cap that can be applied after the retort process.
  - Processing Studies
    - Sealing conditions will be developed to yield maximum strength.
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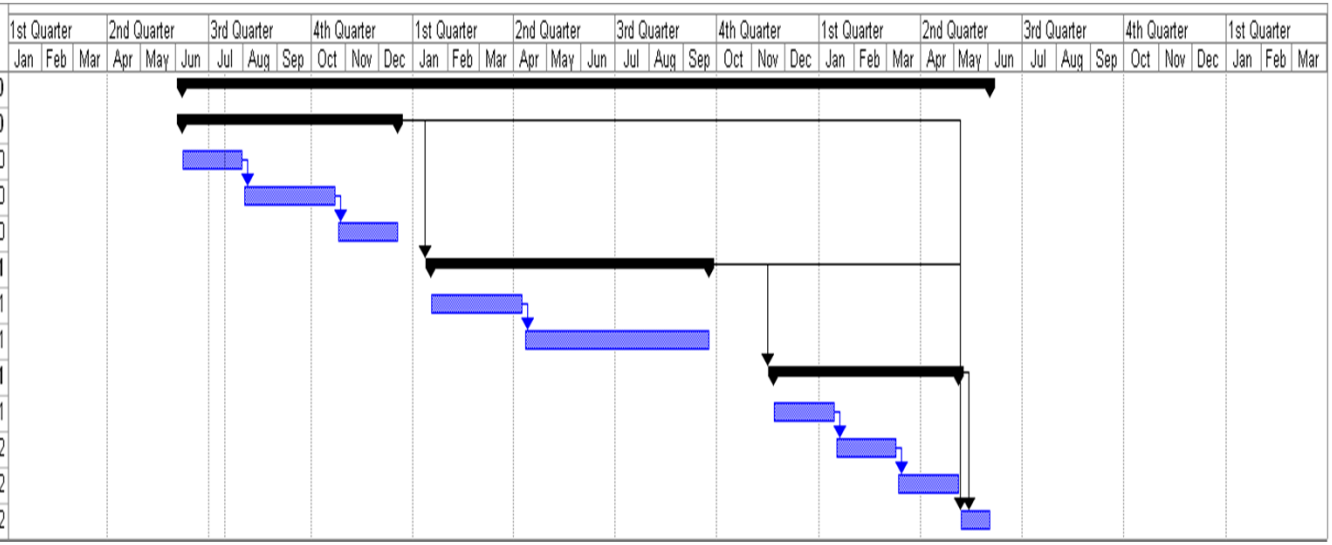


Spouted Pouch Packaging Equipment

Model TT-15CW

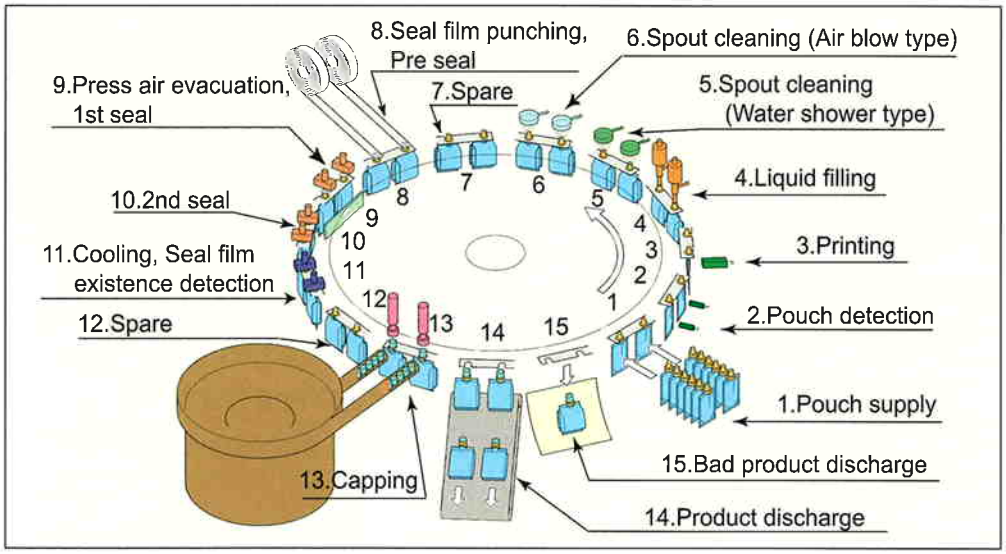
SPOUTED POUCH AUTOMATIC PACKAGING MACHINE

- High speed duplex type spouted pouch filling machine developed for retorted pouch food and drinks.
- By simply snapping on the pouch stock rail the pouch is supplied.
- Two times seal, one time cooling for reliable inner seal.
- Spout cleaning nozzle method for hygienic and better sealing.
- Equipped with vacuum type nozzles for high speed filling through the spout.

TOYO JIDOKI CO.,LTD.

Model TT-15CW
SPOUTED POUCH AUTOMATIC PACKAGING MACHINE

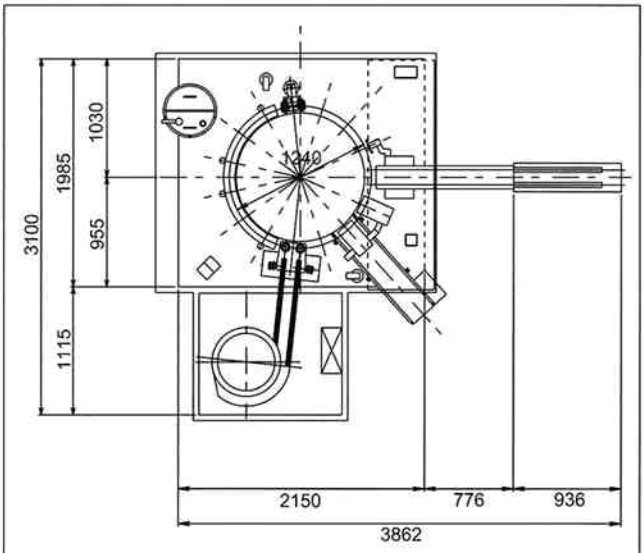
Functions of each station

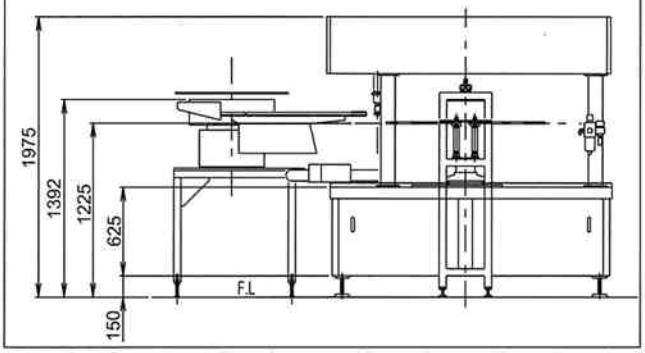


Capping

Cap supplied by handling device.
Controlled by a torque sensor a constant capping can be obtained.

Machine Dimensions





Specifications and dimensions are subject to change without prior notice, due to continuous efforts made for product improvement.

Machine Specifications

Capacity	70pouches/min (Filling water 300cc)
Pouch size	Width 60 ~ 110mm Length 100 ~ 250mm
Pouch type	Center spouted pouches
Spout mouth dimension	Inner dimension 8.5mm
Liquid filling range	100~500cc
Inner sealing method	2times heat seal, 1time seal cooling
Capping method	Torque detection type servo motor driven
Electric power	Approx.8kw
Air consumption	0.5Mpa, 500Nl/min (Standard)
Machine dimension	W 3,352 x L 4,507x H 1,900mm
Machine weight	3,000kg
Accessories	Spout cleaning device,Seal cooling device, Seal film punching & pre seal device,Seal device, Seal film existence detection device, Capping device,Cap supply device, Discharge conveyor,Bad pouch discharge device
Options	Date printer,Various inspection devices, Various pouch stocker

Applications

Drinks, mineral water, tea, juice, retorted pouch food, soup

TOYO JIDOKI CO.,LTD. http://www.tyj.co.jp/

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0407.1000(gr@/sai)

Model TT-15CW-10

SPOUTED POUCH AUTOMATIC PACKAGING MACHINE

- High speed duplex type spouted pouch filling machine developed for drinks, marmalade, liquid detergent and etc.
- By simply snapping on the pouch stock rail the pouch is supplied. Optional pouch stockers are also available.
- Equipped with a special type nozzle, high speed filling through the spout is possible.

TOYO JIDOKI CO.,LTD.

Model TT-15CW-10
SPOUTED POUCH AUTOMATIC PACKAGING MACHINE

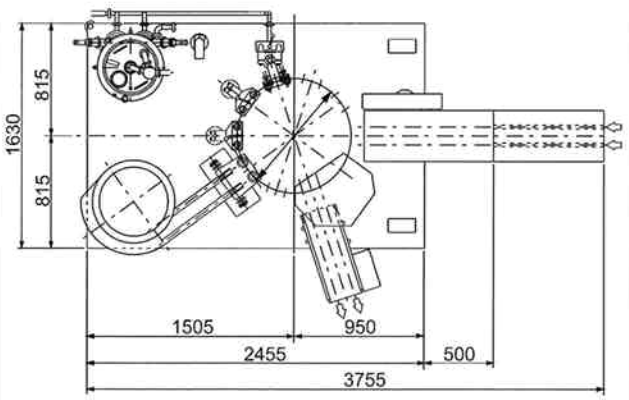
Liquid fill

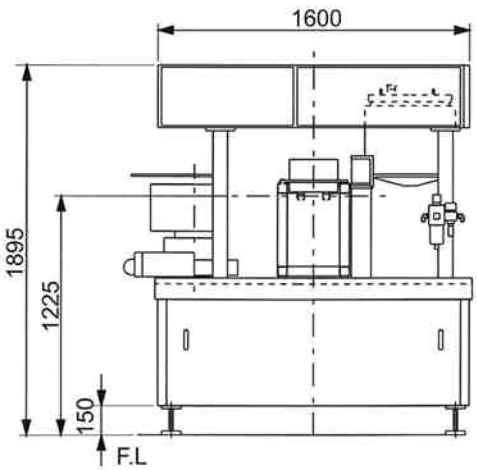
With special filling nozzle the liquid will be filled with few forming.

Capping

Cap supplied by handling device. Using a servo type capper, the torque can be controlled to obtain a constant capping.

Machine Dimensions





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Machine Specifications

Capacity	70-90pouches/min (Depending on products)
Pouch size	Width 60 ~ 110mm Length 110 ~ 250mm
Pouch type	Center spout stand up pouch Center spout gusset pouch Center spout flat pouch
Electric power	Approx.7kw
Air consumption	0.5Mpa, 500Nl/min (Standard)
Cleaning water	0.2Mpa, 5L/min
Machine dimension	W 1,630 x L 3,755 x H1,900mm
Machine weight	3,800kg
Accessories	Discharge conveyor, Product counter, Heater disconnection alarm, Pouch opening detection device
Options	Date printer,Various inspection devices, Various pouch stocker, Compressor

Applications

Dedicated to center spout pouches
Drinks, marmalade, shampoo, liquid detergent, sauce etc.

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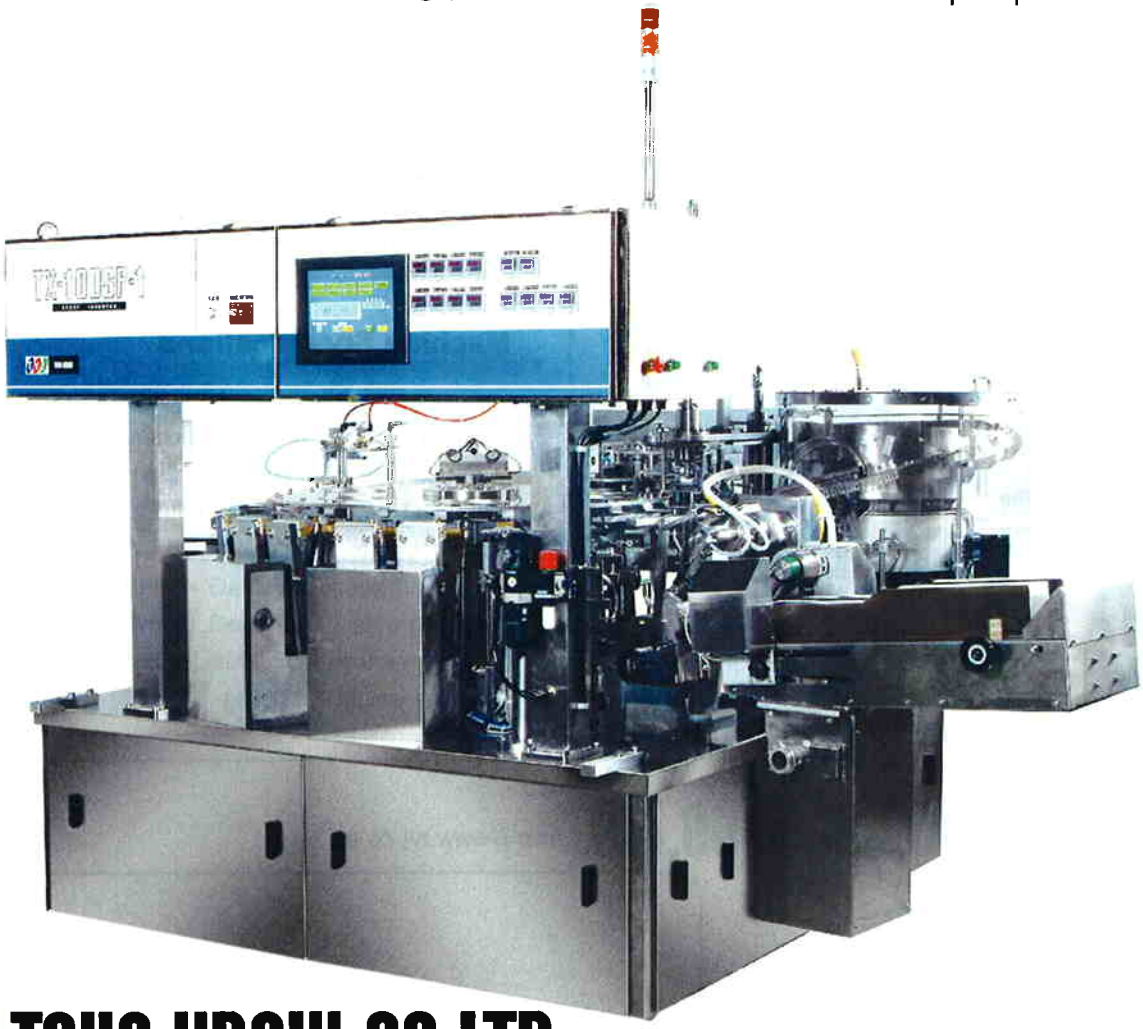
0502.2000(gr@/Sai)

Model TX-100SP1

CENTER SPOUT INSERTING MACHINE

- A duplex type spout inserting machine which automatically supplies spouts and pouches to the intermittent rotary table, opens, apply the spout to the pouch and sends out to the filling machine.
- The precision of the spout applying position to the pouch has elevated due to the spout applying position set system.
- By cam driven 3 times heat seals and 1 time cooling a certain seal can be made.
- As options, seal leak detection device (Non pressure system) and spout position detection device (Machine vision system) is available.
- Contributes to the cost down of center spout pouches.



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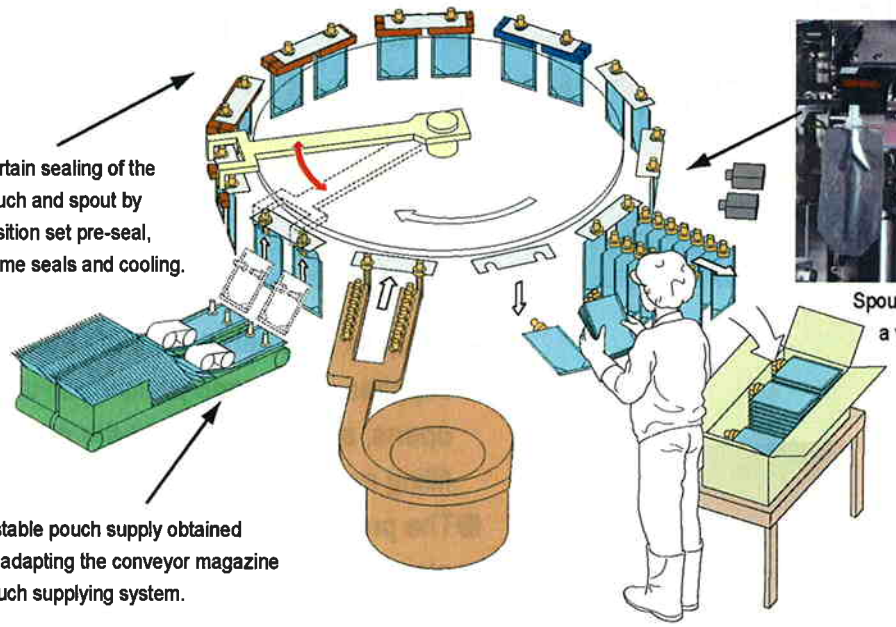
Model TX-100SP1
CENTER SPOUT INSERTING MACHINE

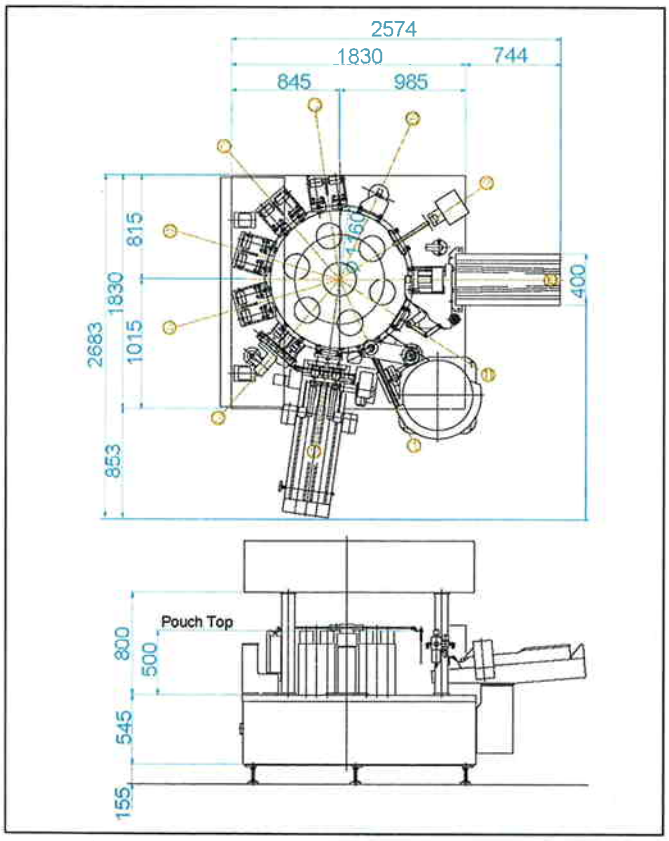
Certain sealing of the pouch and spout by position set pre-seal, 3 time seals and cooling.

Spout position inspected by a vision system.(*Option)

A stable pouch supply obtained by adapting the conveyor magazine pouch supplying system.



Machine Dimensions



Specifications and exterior are subject to change without prior notice, due to continuous efforts made for product improvement.

Stations

1st	station	Spout supply
2nd	station	Pouch supply
3rd	station	Pouch position setting, Pre-seal
4th	station	Spout 1st seal
5th	station	Spout 2nd seal
6th	station	Spout 3rd seal
7th	station	Spout seal cooling
8th	station	Seal leak detection (Option)
9th	station	Spout position detection (Option)
10th	station	Product discharge
11th	station	Rejected product discharge

Machine Specifications

Capacity	Max100pouches/min.(Depending on product specifications)
Pouch Size	Width 70-110mm Length 120-250mm
Pouch type	Stand up pouch, Gusset pouch, Flat pouch
Electric power	Approx.10kw
Air consumption	0.5MpaG, 400Nl/min (Standard)
Cooling water	0.2MpaG, 5L/min
Machine dimension	W2,000xL2,685xH1,900mm
Machine weight	2,500kg

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