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FOOD PACKAGING AT THE KOREA DESIGN AND PACKAGING CENTER

DP/ROK/78/008

REPUBLIC OF KOREA

Terminal report*

Prepared for the Government of the Republic of Korea
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Bor S. Luh, food packaging consultant

United Nations Industrial Development Organization
Vienna

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SUMMARY

1. As the first part of the phase II of the UNIDO sponsored KDPC project concerning packaging, the consultant was appointed to spend three months in Korea (May - July, 1980) to advise the KDPC staff and the food industries on improved food packaging technology.

2. The Republic of Korea has made rapid progress during the past 20 years in industrial expansion, especially in textiles, electronics, industrial products and food processing. The total value of packaging materials produced in Korea was about 2.6% of the gross national production. Paper, plastics, metal containers and glass bottles are the major packaging materials used by the industry.

3. KDPC plays an important role in establishing quality standards of packaging materials, and testing the performance of packaged products.

4. The consultant visited more than 20 industrial plants in Korea, and discussed with them problems concerning packaging and food processing. In general, the food industres in Korea, including the bakery, brewery, confectionery, dairy, fruit and vegetables processors are reasonably well in packaging thechnology.

5. Films made of aluminium-metallized polyester, high-density polyethylene (HDPE), oriented polypropylene (OPP) and laminates are finding more applications by the food industry in Korea.

6. The packaging machinery industry in Korea starts to supply automatic form-filling-sealing machines for both local and foreign markets.

7. Technical consultation and discussions were made with the counterpart and the staff of the packaging department. The subject matters discussed were:

   a. Good manufacturing practices.

   b. Principles involved in deterioration of packaged foods.

   c. Effect of packaging materials and storage conditions on quality retention in processed foods.

   d. Food packaging with flexible laminates.

   e. Properties of plastic films for food packaging.

   f. Reliability of closure seals for flexible retort pouches.

   g. New packaging information about aluminium-metallized polyester films and high density polyethelene films for snack food packaging.

8. Some characteristics of the aluminum-metallized polyester and high density polyethylene films for food packaging are presented.

9. Some laboratory instruments, namely the polax polarimeter, refractometer, oxygen indicator and Keiki viscosimeter were used as tools for laboratory tests and for teaching. Emphasis was on the principles involved, maintenance, calibration, calculation of results, and interpretation of data.

10. Some recommendations are presented for future advancement of KDPC.

THE ASSIGNMENT

As a part of the UNIDO "Programme to Strengthen the Korea Design and Packaging Center (KDPC)," a food packaging consultant was assigned to fulfil the following objectives.

1. To advise the KDPC staff, and the food processing industries on appropriate food packaging technology for the local market, specially for dried foods.

2. To advise the KDPC staff and food exporting industries on improved packaging methodology suitable for specific markets abroad.

3. To assist KDPC in planning and organizing its food packaging research and development programme.

4. To arrange training courses on food packaging and related areas, for participants of technical and managerial levels.

INTRODUCTION

The Republic of Korea has made rapid progress in industrial expansion during the past 20 years. The 37 million inhabitants of the country are highly industrious and dilligent. Because of the lack of petroleum, and shortage of natural resources, the country is dependent largely upon foreign raw materials which are converted into industrial products for export.
The more important items for export are textiles, electronic materials, television sets, plastic products, electrical appliances, machineris, pumps, motors, agricultural machineries, chemicals, frozen and dried sea foods, etc.

The rapidly growing industrialization process alters the pattern of living of the Korean people, and also the methods by which goods are distributed and displayed to the customers. The packaging industry is of great importance to the Korean industrial expansion plan.

The total value of the packaging materials produced in 1975 was US$488.5 million, or 2.6% of the GNP.

The values of the more important packaging materials are shown in Table A.

Table A. Values of Packaging Materials Produced in Korea in 1975*

Items	Value in dollars (millions)	%
Paper & paper products	216.4	44.3
Plastics	126.2	25.6
Metal containers	74.8	15.3
Glass	34.2	7.0
Others	38.2	7.8

From: 1976 Packaging Industries in Korea
Korea Design and packaging Center

The Government of the Republic of Korea has stressed the need for better quality control of Korean products.
The Korea Design and Packaging Center (KDPC) is playing an important role in establishing quality standards of packaging materials, and testing the performance of the packaged products.

The United Nations Industrial Development Organization has assisted the KDPC in providing necessary facilities for testing packaging materials and packaged products.

In addition, UNIDO provides experts for acquiring new technology, and also an overseas training program of the selected staff members. KDPC is providing Korea with a complete system of testing facilities in the packaging field.

The Packaging Material Testing Laboratory at KDPC would provide the manufacturers with information on newer and better packaging technology. It will also build up the confidence of the consumers on Korean industrial products.

ACTIVITIES

A. Consultation to the Food Processing Industries. During the period May 16-30, 1980. I visited about 20 industrial plants in the Seoul, Anyang and Busan Areas. Some of them are manufacturing packaging materials such as corrugated paper boxes, laminated plastic materials, aluminium-foil, glass containers, etc. These plants are producing various kinds of packaging materials for the food industries.

The more important packaging industries in Korea are:

1. Lotte Aluminum Co.
   561-2, Docksan-dong, Youndungpo-ku,
   Seoul, Korea

   The plant employs 500 persons, and has facilities for converting aluminium strips into foil of 7 μm thickness. In 1979, it used 4,700tons of aluminum for foil manufacture. It supplies a good portion of the aluminum foil and plastic laminates for the Korean packaging industry. Their products are both for the Korean industry and for export to many Asiatic countries.
   They have three aluminum milling machines, three extruders and 5 printing lines.
   The quality control program of the Lotte Aluminum Co. is very good. Their products carry a very good name in Korea.

2. Daerim Fishery Co., in Busan

   The company has good facilities for freezing. It can process 80-100tons of marine foods daily, both for export and for the local market. They hire 800 people.

Their products are frozen eels for Japan, frozen Hake fish for U.S., smocked oysters in cans for export, and frozen mutton for Japan. They have 8000 tons floor space for frozen foods.
The packaging equipment of the plant is quite good, although a good portion of the work is still done by hand labor. They have a good research and development program. The research laboratory and microbiological laboratory are contributing greatly to their good name. The plant manager, Mr. Soon Chun Lee, is a mechanical engineer with very good experience in frozen food processing and packaging.
I discussed broadly with him and his associates about their research and development program.

3. Hai Tae Confectionery Co., Ltd. in Seoul.
This company is the 2nd largest processor of dairy products, confectionery, canned juices, nectars, chocolate bars, snack foods, biscuits, cookies, pies, beverages, wines, etc. It hires 4,500 employees, and is a multiple operation company. Their packaging equipments are modern and up-to-date. The annual business turn over is US$180 million. I discussed with Mr. Yun Ho Chang, the packaging manager, about their production and their food packaging problems.

4. Tong Yang Confectionery Co., Ltd. This company is the third largest confectionery in Korea.
They have a variety of packaging machines for chewing gum,

candies, backery products, instant snack foods, etc. Some packaging equipment are from Italy, Japan, and England and a good portion from the U.S.A. Its annual business was about US$180 millions in 1979.

5. Shin Han Heavy Cargo Packaging Co., Seoul.
This company specializes in packaging of heavy industrial equipment for export. It needs help for packaging technology. Most of its work is by hand labor. The company has some machanical devices for cutting wood materials for making shipping containers. The phase II of the packaging project would expect a packaging expert for heavy equipment packaging. This company needs help badly.

6. Korea Design and Packaging Center (KDPC) plant in Seoul.
This plant is specialized in making water-proof corrugated paper and paper board boxes. It has been one of the income sources for the KDPC operation. The Seoul plant has two corrugating machines (1.7m width) with a maximum speed of 70m/min, and is one of the largest corrugated plants in Korea. The floor space of the plant is 13,500m^2. They use water-resistant kraft-paper liner (186gm/m^2). Thirty percent of the product are as sheets, and 70% as corrugated boxes. The corrugated board blanks are delivered directly from the corrugator to the customer, and the corrugated boxes are converted in the plant.
The plant employs 160 workers. The production per day is 90,000m^2.

7. Dai Han Color Ind. Co., Ltd. in Busan

This company manufactures and exports synthetic dyes to foreign countries. They are having a packaging problem. The powdered dyes are packaged in heavy duty plastic bags (50lbs capacity). The packaged dye tends to shrink to half its original volume one week after package, with evolution of gases.

I discussed the problem with the plant manager, Mr. Seung Phal Ju, and suggested a number of changes, including vacuum treatment of the dyes before packaging, and removal of adsorbed gas in the dye under controlled temperature and humidy. Hopefully, they will solved the problem after changing the operation.

It is possible that some changes have occured in the organic dye during the grinding process. A thorough study of the chemical and physical properties of the dye in each step must be checked to make sure that no side reactions occur. It is extremely important that the product to be packed must be stable and resistant to changes during storage and transportation.

8. Pacific Chemical Ind. Co., Ltd. Seoul.

This company is one of the largest plants making cosmetics in Korea. It employs 900 people.

They have some problems concerning packaging of their cosmetic products. More important problems are how to select a better container, avoidance of dust contamination in the container, and quality standards of their cosmetics. Important products of the company are lip sticks, shampoo, after-shaving lotion, cold cream, etc. It was felt that the plant could cut down the labor cost greatly if they can install more automatic filling, sealing, and packaging machines.

9. Doosan Glass Bottle Co., Anyang, Korea

This company has its head quarter in Yongdung-po, Seoul. The newest plant is in Anyang near Seoul. It employs 2000 people. They make more than 200 kinds of glass bottles for beer, cosmetics, pharmaceuticals, fruit juices, mushrooms, etc. The facilities of the plant for glass bottle making and labelling are good. They cooperate technically with the Owens - Illinois glass Company of U.S.A.

The plant produces 33,400 tons glass bottle per year. It has ten glass furnaces.

The quality control laboratory tests thermal resistance by the shock test (70°C water), internal pressure test (hydraulic 400-500 psi), deviation test, deformation test, crystallization test (polarized light), light transmission (spectrophotometric), softening test (735°C), etc. Annealing was done at 560-580°C. There are 16 annealing lines in the plant.

The plant also do color labelling of the glass bottles.

The plant exports glass bottles to Hong Kong and Japan.

For the time beeing they have more orders than they can fill.

10. Korea Ginseng Research Institute

The Korea Ginseng Research Institute is a very important research organization in Seoul, Korea. Genseng is one of the most famous agricultural products of Korea. It has certain pharmacological values. Various Ginseng products such as instant ginseng powder, tablets, extracts, beverage, and dehydrated Ginseng, are available in Korea. Ginseng powder is prepared by spray drying the concentrated extract. Ginseng powder is hygroscopic. It tends to absorb moisture from the air during packaging. The shelf life of ginseng powder may be shortened when its moisture content is increased. It would be desirable to use aluminium foil as the container, and to pack the powder in an air-conditioned room under controlled temperature and relative humidity.

B. Technical Consultation with the Counterpart

Several discussion sessions were held with the counterpart, Jae Hong Kong and also with Dae Sung Lee, Sea Bong Chang, Myung Hun Lee, Jong Koo Han and other staff members. The subject matters cover the following:

1. Good manufacturing practices
2. Principles involved in deterioation of packaged foods.
3. Effect of packaging materials and storage conditions on quality retention in processed foods.
4. Food packaging with flexible laminates.
5. Properties of plastic films for food packaging.

6. Reliability of closure seals for flexible retort pouches. (appendix 1)

7. New packaging information about Al metallized polyester film (12 μ) for snack foods, ice cream, chewing gum, etc.

C. Seminars

I will present a seminar on "Tomato processing and packaging" to the Food Research Institute in Suweon, on July 29th. On August 2nd, I will present a seminar to the Tokyo University Agriculutral College in Japan. On the same day, I will present a speech to the Japanese Institute of Food Technologists in Tokyo concerning recent trends in food packaging.

D. Participation in Research Projects.

1. Characterization of Skyrol Polyester Film.

In Korea, there is a new packaging film called Skyrol made of 12 μ polyester (polymer from dimethyl terephthalate and ethyleneglycol) and vaporized aluminum (.03 μ) is available. It is formed by coating the polyester film with aluminum in a high vacuum chamber. The film looks like the aluminium foil of 7 thickness, but is much reduced in aluminum thickness (.03 μ). It prevents light penetration. When laminated with low density polyethylene an excellent packaging material is abtained. The physical properties of the SR-300 Aluminium-metallized polyester film and SR-30 polyester film are presented in Table 1.

Table 1. Physical Properties of a new polyester film (Skyrol).

	(SR) SR30	SR300
Aluminum,	None	0.03 μ
Thickness,	12 μ	12 μ
Tensil strength, kg/cm^2* (Speed 100mm/min)		
MD (Machine Direction)	1,992	2.500
TD (Cross Direction)	2,357	2,417
Elongation rate, %*		
MD	37.8	56.5
TD	61.6	57.0
Tearing test, kg-cm* (speed : 20mm/min)		
MD	252	251
TD	208	231
Busting test, kg/cm^2*	3.68	5.46
Haze test, % **	1.64	100
Light transmission %	98.36	0
Pin hole test (1Kv)		
# Pin holes/m^2	2	0
WVTR $gm/24hr/m^2$ @40°C 90% R.H.	46.3	1.5

* Average of 9 determinations

** Average of 5 determination

Results indicate the aluminium metallized polyester film can prevent light penetration as shown by the haze test .

It appears that the aluminum-metallized polyester film (SR-300), when laminated with polyethylene of 30μ thickness may be used as a packaging materialfor snack foods, candies, ice cream, and others.

2. High Density Polyethylene Films.

The physical properties of domestic and imported high density polyethylene films were studied. The HDPE films are used for different purposes. The 10μ HDPE film is for food wrapping, the 30μ HDPE (made in Korea) film is for packaging of clothes, and the 60μ HDPE film is for packaging of snack foods.

The inquiry from the industry was what's the difference in properties of these films. The results are presented in Table 2.

It appears that the imported HDPE of 60μ thickness is superior because of its lower number of pin holes, and lower WVTR (Water Vaper Transmission rate).

Table 2. Physical Properties of High Density Polyethylene Films (HDPE)

Test items	Domestic		Imported from U.S.A.
Thickness, μ	10	30	60
Tensile strength, Kg/cm^2 at 200mm/min (Instron 1125)			
MD	1300	487	307
TD	483	453	332
Elongation, %			
MD	22.6	524	4.91
TD	598	335	408
WVTR, $gm/24hr/m^2$ $40 \pm 1^{o}C$ & 90% R.H.	46.1	11.8	4.5
Haze meter reading %	54	48.3	30.8
Tearing test kg.cm			
MD	360	250	268
TD	195	162	197
Pinbole test, holes (1.5 KV)	75/2000 cm^2	4/3000 cm^2	4/5000cm^2
pin holes/5000cm^2	188	7	4

The imported HDPE 60 film, can be sealed readily without formation of wrinkles.

E. Calibration of Laboratory Instruments.

The following instruments of the Packaging Test Laboratory were calibrated.

1. Polax Polarimeter.

This instrument is a good tool for determination of optical rotation of compounds containing assymetric carbon atoms. It was used to determine the optical rotation of a sucrose solution. The operation of the instrument, the principle invc involved, the calibration process, and determination of the concentrations in an unknown mixture were discussed. The instrument can be used to determine purity of sugars, L-ascorbic acid, L-asparagine, limnene, etc.

2. Abbe '60' Refractometer.

This instrument is useful for rapid determination of soluble solids in food systems. Proper calibration of the instrument, control of temperature of the prism and the sample, and correction of results to standard conditions at 20°C were discussed. Experiments were carried out to determine soluble solid contents of sugar solutions, beverages, cider, nectars and other products. The importance of light source, the protection of the prism from damage, removal of insoluble solids from the sample, and correction of results to standard condition were discuss.

3. Bacharach Oxygen Indicator—Model K.

This instrument was usually used for detection of oxygen levels in places where oxygen might be too low for normal respiration. It was observed that the instrument was not sensitive enough for analyzing head space gases in processed foods. There are better and more accurate methods, available such as gas liquid chromatography of gases on a molecular sieve 13 column, or the Orsat gas analysis instrument. The Bacharach Model K oxygen indicator did not give useful results for the packaging laboratory.

4. Viscosimeter Model B (Tokyo Keiki Co.)

The Keiki Viscosimeter is basically same as the Brookfield Viscosimeter. It is a useful apparatus to measure the viscosity of solutions in a short time.

Important parameters to be considered are the temperature of the sample and the size and speed of the spindle.

The consistency of fluids, juices, purees, and many other liquid foods can be determined with the Keiki viscosimeter.

F. The Korea Packaging Show'80

During the period 6/26 to 7/10, the KDPC sponsored a packaging show at the Exhibition Building of the Center. This gives me a good opportunity to meet the technical people serving the packaging industry.

There were 57 companies participated in the packaging exhibition.

There were 287 types, and 1034 entries.

The more impressive ones are the packaging machine companies demonstrating their various packaging machines for snack foods, bakery product, and cosmetic products.

A new packaging material made of aluminum-metallized polyester film, various kinds of laminates and polyester bottles for vegrtable oil were exhibited.

The food industry in Korea will use more plastic materials for packaging because of its convenience and light weight.

The first prize went to Ginseng package made by the IL HWA GINSENG CO., Seoul, Korea.

RECOMMENDATIONS

Besides the design laboratory, KDPC has the following laboratories;

1. Material testing laboratory
2. Package performance laboratory
3. Chemical laboratory

The Material Testing, and Package Performance laboratories are reasonably well equipped to solve industrial problems related to packaging materials and package performance.

A. Instruments for Research.

The facilities of the chemical laboratory is very weak. It is recommended that the following instruments be installed to meet the minimum requirements for chemicial work:

a. Beckman DB Spectrophotometer with recorder.

This equipment will help to answer many problems related to product purity and stability. When the samples of organic dyes were delivered by Dae Han Pigment Company to KDPC for study of the gas evolution problem, we don't have a spectrophotometer to identify the light absorption characteristics of the dyes. The unit may cost US$60000 - $8000, but it will be of great value to KDPC for research and for identification of compounds involved in quality changes in foods.

b. Infrared Spectrophotometer.

For identification of polymers in packaging materials the Infrared spectrophotometer with recording device is needed.

When available, we can characterize the absorption peaks of the polymer in the infrared region. It will help answer many problems that came from the industry. The unit may cost US$20,000 or so Either the Perkin-Elmer Co. or Beckman Instruments Co., U.S.A. sells such instruments.

B. Scientific Journals in the Library

In general, KDPC is reasonably equipped with scientific journals on design and packaging. The library need the following journals to keep the Center up-to-date with the new development. It is recommended that the library should make efforts to purchase some of the Journals listed below:

a. Food and Drug Packaging (U.S.A.)

b. Food Engineering (U.S.A.)

c. Food Processing (U.S.A.)

d. Food Product Development (U.S.A.)

e. Food Technology (Institute of Food Technologists, Chicago, U.S.A.)

f. J. Agriculture and Food Chemistry (American Chemical Soc., U.S.A.)

g. J. Food Science
Institute of Food Technologists,
Chicago, Ill. U.S.A.

h. J. Food Science and Technology, Mysore, India

i. J. Science Food and Agriculture (England)

j. Journal Stored Products Research (England)

k. Package Development (U.S.A.)

l. Package Engineering (U.S.A.)

m. Packaging India

n. Packaging Review (England)

o. Packaging (London, England)

p. Plastics and Polymers (England)

C. Book.

a. Paines, F.A. Latest Edition
Fundamentals of packaging
Blackie and Son. London

b. Luh, B.S. and Woodroof J. G 1975
Commercial Vegetable Processing
Avi Publishing Co.
Westport, Conn. U.S.A.

c. Sacharow, S. and Griffin, R.C. gr. 1972
Principles of packaging Development
Avi Pulbishing Co.
Westport, CONN. U.S.A.

D. Advanced Training

The personnels now working at the materials testing laboratory have received adequate training and are doing a good job.

The food packaging industries in Korea will face more problems as time goes by. It is recommended that KDPC select one or two of its packaging staff members in the coming years to receive advanced training for a year or so concerning food processing and packaging. This will strengthen the capability of the Center to solve problems and to answer questions facing the food packaging industry.

E. Technical Seminars and Exhibition

KDPC devotes its effort in design, packaging and management studies. It is recommended that the Center will continue to sponsor seminars and exhibitions whenever experienced people are available.

F. New Packaging Technology

The Center should continue its close contact with the various research insitutes in Korea, and the packaging research centers in other countries. Participation in international packaging meetings and exhibition will be most beneficial. It is recommended that KDPC will actively engaged in packaging research, and create new knowledge for the packaging industry.

G. Service to the Packaging Industry.

KDPC has done very well in serving the packaging industry. It is recommended that the Center will continue its contact with the food industry and render its service to them. The staff will serve the industry through continued learning.

H. Up-dating the Equipment

The Center has quite good facilities for packging research at the present time. But, new developments in the field never end. The Center must make effort to keep up with new development in equipment as time goes by. This is very important for the Center to be abreast with others in the packaging field.

I. Research on Food Packaging

There are always new ideas to be developed and tested.

The center should make good use of its staff and facility for new technology and development either on packaging of foods, or on new uses of packaging materials. For example, Kimchee, a fermented and pickled vegetable, is one of the most popular side dishes in Korea. The Center may mobilize some of its staff members and equipment to develope a packaged Kimchee which will facilitate the consumers in Korea. At the present time, a good portion of the time of the Korean house wives are spent in making Kimchee. There are problems in continuing it because of the lack of space in the new apartment house to do the Kimchee preparation. The product is obtained by a lactic acid fermentation process. There is a shortage of equipment to study preservation of Kimchee at KDPC, perhaps the facilities of the Food Research Institute in Suweon may be utilized.

Kimchee may be packaged in certain plastic pouches under refrigerated storage to retain its attractive taste and texture. The product would give convenience to the consumer.

J. Utilization of Packaging Waste

The plastic material after usage became a waste.

It will worth the KDPC to think about how to handle and utilize the waste packaging materials. Since most of the packaging materials ar are not bio-degradable, it will create a waste disposal problems. Perhaps KDPC can start look for methods on utilization of plastic wastes, or to convert the package wastes into some form that will not pollute the environment.

RELIABILITY OF CLOSURE SEALS FOR FLEXIBLE RETORT POUCHES

CONTENT

I. INTRODUCTION

During the past decade, many investigations have been carried out in various research institutes to develop a aluminium-foil laminated retortable pouch which can be used to replace the can or jar (Chen et al, 1975). It must undergo heat processing to render its contents sterile (Corning, 1973). Due to its rectangular rather than cylindrical geometry, the retort pouch can be brought to the sterilization temperature more rapidly. A shorter "cook" time in the retort means less degradation of the food. Most retort puches contain a polyester as the outer component, aluminium foil, and an inner heat sealable poly-olefin. They may differ in thickness, type of laminating adhesives, and in the inner food contacting polyolefin. Modified high density polyethylene and polypropylenes are used as the inner layer for retort pouches.

Sealing of retort pouches is accomplished by fusion weld of two compatible polymeric film surfaces. The reliability of flexible package seal is discussed here for consideration of processing foods in retort pouches.

II. TESTS FOR RELIABILITY OF CLOSURE SEALS

The seals for retort pouches have to perform in accordance with strict and definitive criteria for the seals of cans and bottles. The requirements are as follows:

a. Defective pouches be as low as the metal cans.

b. Seals must stand 120°C or higher heat processing temperatures.

c. The pouch must be durable through the entire distribution system.

According to Burke and Schulz (1972) and Schulz (1973), retort pouch must survive the rough handling cycle representative of the military distribution system. Basically the cycle consists of vibration in case lots at 1G for one hour, a series of ten drops from 46cm (18 inches) according to the ASTMD-775-68, Obj. B, followed by visual examination and biotesting (Maunder et al., 1968). They presented a tentative performance criterion of 2% maximum leakers after the vibration, drop, and biotesting.

Dux-bury et al (1970) and Lampi and Rubinate (1973) reported that retort pouches could be reliably formed, filled, sealed, handled and processed.

The definition for a good flexible package seal may be delineated as follows:

1. Fusion

Fusion is considered necessary when the opposing seal surfaces form a total weld. Such a weld is characterized by the inability to visually distinguish either opposing seal surface at the inner seal junction or afte seal tensioning beyond point of failure. On tensile failure shown by manual pulling, fusion exists when fracture of one inner ply at the seal junction occurs and there is delamination of one lamina. If the seal peels or fails so that the inner seal surfaces are identifiable, such seals should be rejected (Figure 1).

2. Visual examination

Visual examination beyond that required to establish the presence or absence of fusion is necessary to assure the absence of heat creep, significant wrinkles (over one-half the seal width), surface irregularities and occluded matter in the seal area.

3. Internal burst test

The internal burst test for seal integrity appears to be a good overall measure of the ability of a package to withstand transportation and handling (Schulz, 1973). It measures the internal air pressure needed to burst the pouch seal or the time to burst at a constant air pressure. In making the test, an unsealed or cut and emptied pouch is placed over the air source. The jaws are clamped and the internal pressure increased to the predetermined level. Either the pressure to burst, or time to burst at a constant pressure-time cycle is recorded.

A schematic diagram illustrating the pouch static load test is shown in Fig. 2.

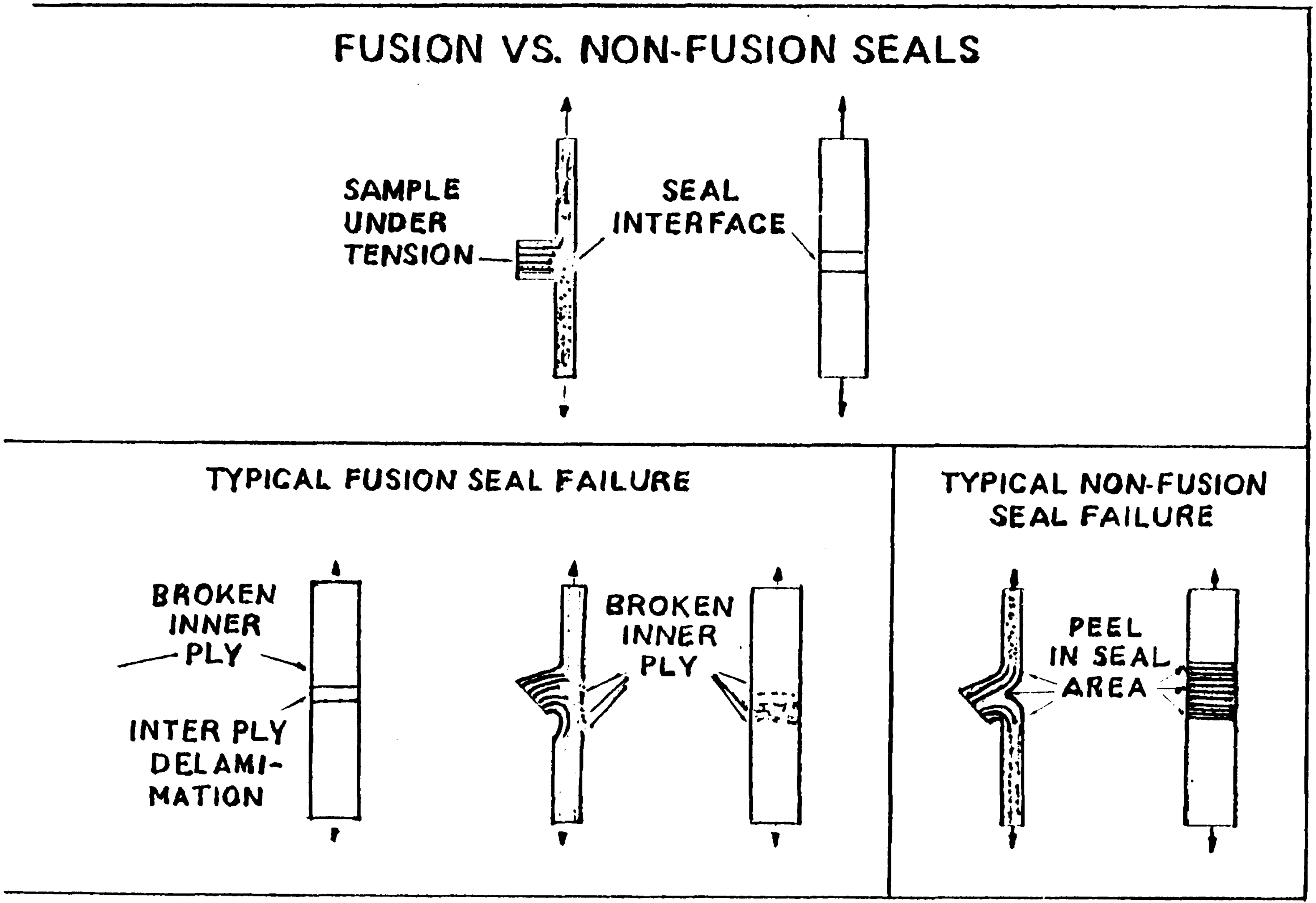

Figure 1. Fusion Vs. Non-Fusion Seals

A heavy metal plate restrains the pouch thickness to 13mm (one half inch). The seal junction yield should be no more than 1.6mm (1/16"); A greater yield generally indicates lack of fusion or material inadequacies.

Retorting and storage (time after sealing) may affect achievable burst levels. The following relationships are typical of a polyester - foil - modified polyolefin laminate pouch :

(a) Immediately after sealing, it passes 35 psig test with a 30-sec holding time.

(b) 24 hours after sealing, it passes the 30 psig test with a 30-sec holding time.

(c) Retorted with indefinite storage, it passes the 20 psig test with a 30-sec holding time.

Materials and pouches passing the above criteria have shown a correlation with acceptable tensile strengths.

The advantage of the internal burst test is its ability to measure the weakest part of the seal.

4. Tensile test

Seal tensile strengths are currently measured dynamically on Instron or similar equipment: The test is used for surveillance on materials sealability and as a spot check on sealing conditions and equipment operation.

By definition, the tensile test measures the total force or weight required to cause failure over the total width of each sample strip. The detection of any channels, stress point and the effect of

POUCH STATIC LOAD TEST SCHEMATIC

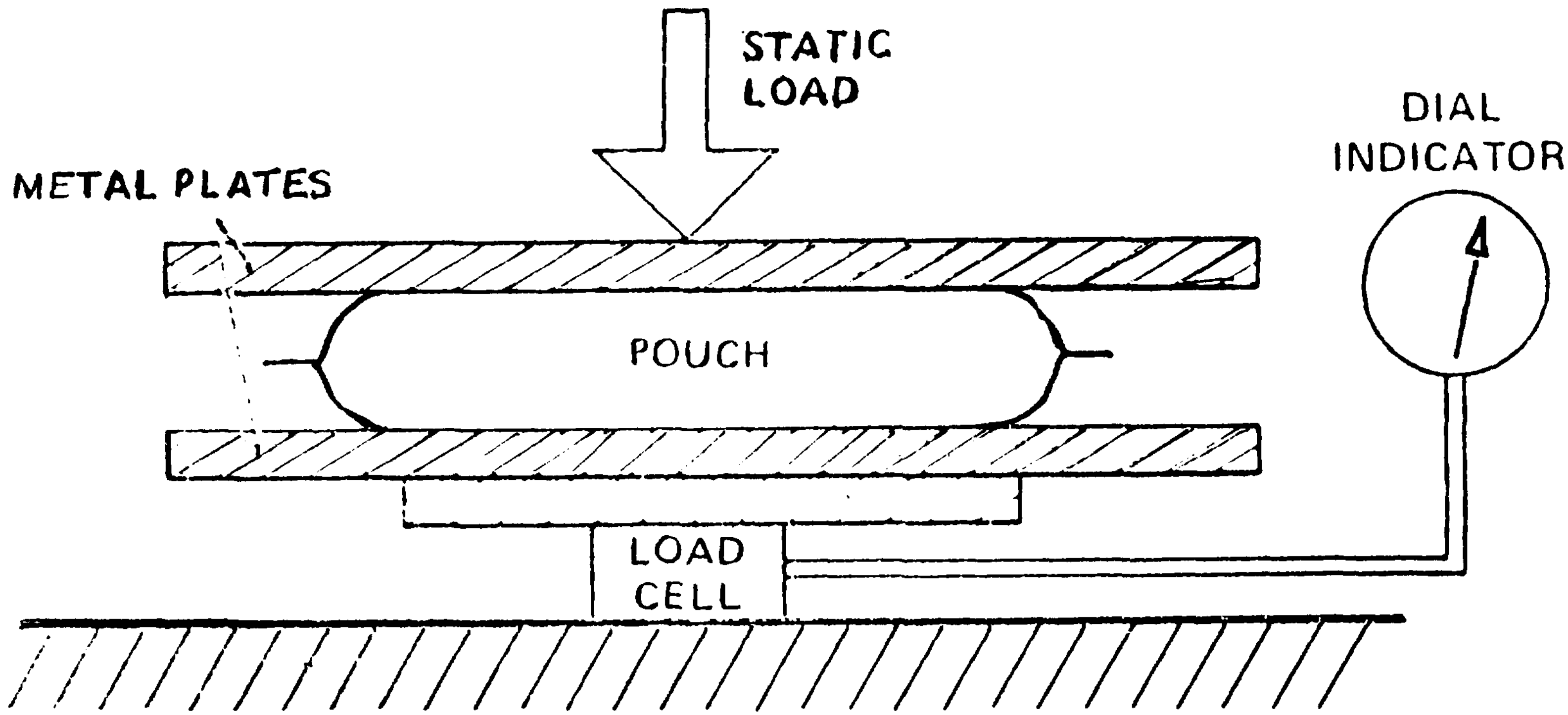

Figure 2. Pouch Static Load Test Schematic

occluded particles within the dimension is obscured by the adjoining high value area. Therefore, the tensile test should be supplemented by the burst test.

The tensile test is used as a quality control tool for assessing the inherent sealing qualities of flexible package films and should be a mandatory test.

The tensile strengths for materials specifications range (laboratory sealing) from 11 to 19 lbs/in. For example, the tensile strength of an aluminium foil (12μ mylar/ 9μ foil/ 75μ modified polyolefin) was 16 lbs/in (Duxbury et al., 1970).

These same levels should be achieved by the production equipment. The criteria fer each film should be related to the performance standards.

The behavior of a seal under retort conditions cannot be completely predicted by room temperature tensile tests. (Pflug and Long, 1966). They affirmed the value of fusion test above the tensile strengths test.

III. EFFECT OF OCCLUDED PARTICLES IN CLOSURE SEALS

Lampi (1975) conducted a series of tests at the Natick Development Center on flexible retort pouches with pieces of rubber 0.16 x 0.16 x 0.08cm entrapped in the seals. These tests included two seal widths, 0.32cm and 0.64cm, both made with hot bar sealers. The performance of contaminated and clean seals were compared on the basis of internal burst tests, failures during retorting, and failures during rough handling and storage. Figure 3 shows that there was no significant difference in the number of pouches passing burst levels between the two seal widths when no contaimination was present. There were no significant differences between the burst levels of the two seal widths when contaminated with a piece of rubber.

Despite the similarity in resistance to internal pressure at standard conditions, the packages with 0.32cm wide seals with particles in the closure seals showed a failure rate of 11% during retorting and a failure rate of 3.3% during rough handling (cycle used by Burke and Schultz, 1972). The pouches with 0.64cm seals had no failure during retorting and rough handling.

The samples of retort pouches with occluded rubber particles in the seals were placed in storage and examined after 6 and 12 months of alternating 3 month storage at 38°C and 95% relative humidity, and at 29°C to determine if any changes had occurred.

Table I shows the changes in internal bursting strength that occured after retorting and storage for 6 and 12 months. All seals with defects

EFFECTS OF OCCLUDED PARTICLES ON BURST LEVELS

BURST TEST LEVEL, Pa (PSIG)	0.32 cm SEALS				0.64 cm SEALS			
	BEFORE RETORTING		AFTER RETORTING		BEFORE RETORTING		AFTER RETORTING	
	CONTROL	DEFECT	CONTROL	DEFECT	CONTROL	DEFECT	CONTROL	DEFECT
3.4×10^5 (50)					9			
		2			1	10		
2.8×10^5 (40)	10	5						
		3						
2.1×10^5 (30)			7	9			7	8
				1			1	2
			1				1	
1.4×10^5 (20)			1				1	
			1					
6.9×10^4 (10)								

Figure 3. Effects of Occluded Particles on Burst Levels.

decreased in internal bursting strength after storage. The greatest decrease in all instances occurred during the first 6 months.

Based on failure rates noted after retorting and during rough handling, it appears that a minimum seal width should be 0.64cm and that occluded particles in such a seal cannot be tolerated.

Table 1. EFFECTS OF STORAGE ON BURST LEVELS OF SEALS WITH OCCLUDED PARTICLES, Pa (PSIG)

	0.32 cm		0.64 cm	
	CONTROL	DEFECT	CONTROL	DEFECT
BEFORE RETORT	2.76×10^5 (40.0)	2.72×10^5 (39.5)	3.41×10^5 (49.5)	3.10×10^5 (45.0)
AFTER RETORT	1.95×10^5 (28.3)	2.05×10^5 (29.8)	1.77×10^5 (25.6)	2.05×10^5 (29.8)
6 MONTHS	1.61×10^5 (23.4)	8.83×10^4 (12.8)	1.77×10^5 (25.6)	1.52×10^5 (22.0)
12 MONTHS	1.45×10^5 (21.0)	8.96×10^4 (13.0)	1.97×10^5 (26.0)	1.45×10^5 (21.0)

IV. RELIABLE SEALS UNDER PRODUCTION CONDITIONS

The definition of a good seal as discussed earlier applicable to retort pouches sets the basic criteria for production purposes. To achieve that the following points should be followed:

1. The inherent equipment designs and performance characteristics should give the recuired seals under ideal conditions, i.e. good film and clean unwrinkled surfaces.

2. All interfacing equipment functions (filling and vacuumizing) functions should operate with minimum interference with those ideal sealing conditions.

3. Apply adequate surveillance tests on various steps of the process.

4. Final inspection

Seal Wrinkles.

Frequently, irregularities in seal surfaces not caused by occluded matter do not constitute a hazard. But, until experience permits otherwise, wrinkles are to be avoided and seals containing excessive wrinkles should be rejected.
True wrinkle can be defined as a material fold on one seal surface, caused when one seal surface is longer than the other at least in a localized area at the moment of seal fusion.

It would also encompass a severe fold over of both seal surfaces at the time of sealing.

Minor wrinkle emanating from the inner seal junction out into the seal width, but generally not over more than half the seal width should not be the cause for rejection. These minor wrinkles occur with hot bar sealing methods and are usually caused by the collapse of a package around its contents on transfer from vacuum to ambient pressure before the polymeric material in the seal area has been adequately cooled. Seal wrinkles do not occur when the opposing seal surfaces are flat and parallel.

To accomplish such a condition, it will be desirable to :

(1) Specify that there will be no filling of the content within 3.3cm of the top of the pouch (see Figure 4).

(2) Use appropriate but not ultra-taut tensioning by means of clamps or grippers, or spring-loaded tensioning devices;

(3) Form a partial cylindrical shape (or round cornered partial fold) across the width of the pouch at or immediately adjacent to the location of seal (see Fig. 4);

(4) Allow a time lag to cool the seal before release of the pouch from vacuum to atmosphere.

By following the guidelines listed above, the incidence of closure seal wrinkle can be reduced to 1 in 500 pouches.

Seal Contamination

Contamination of the closure seal by product may be caused by improper packing operations. They include filling deficiencies, incorrect vacuumization procedures or improper pouch handling prior to sealing. To assure a reliable final seal one must eliminate contamination of the seal by the product in the pouch. It is very important to detect any packages so affected.

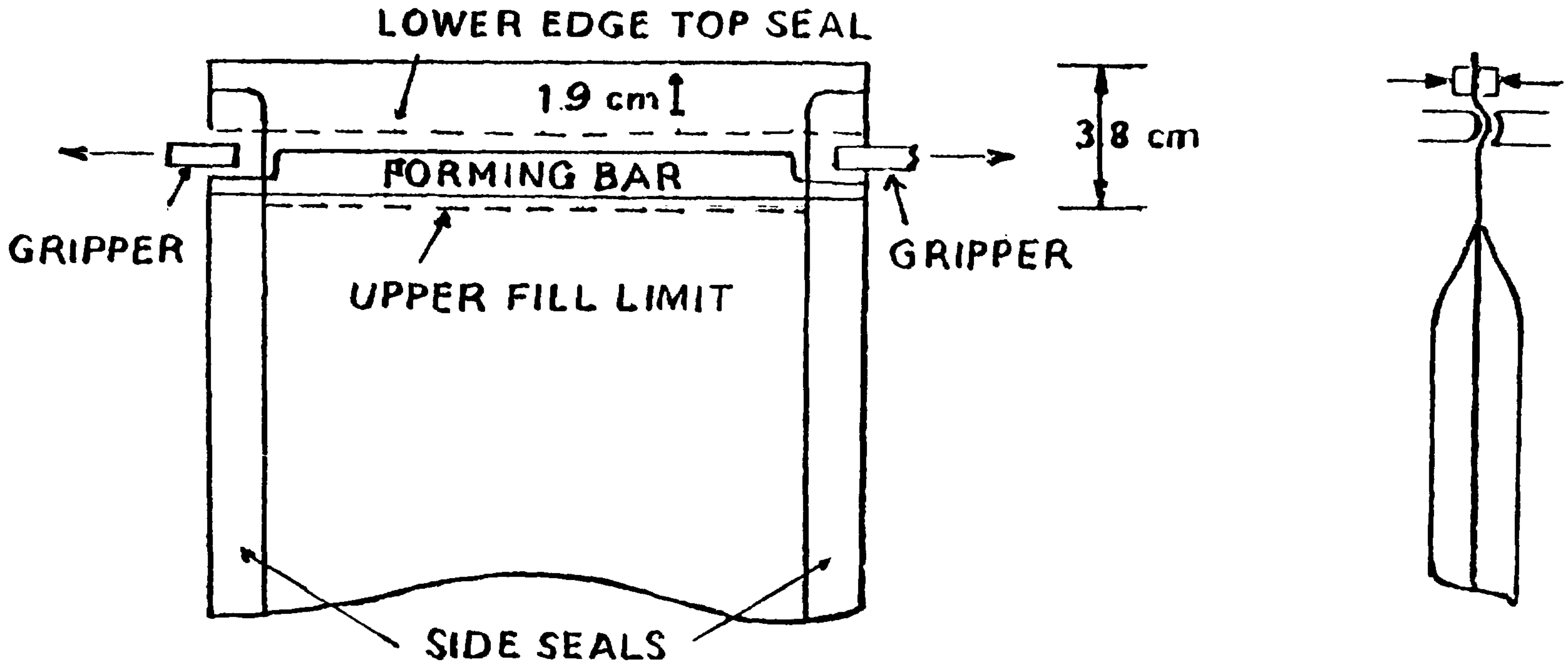

Figure 4. Design and Filling Steps to Eliminate Top Seal Wrinkles.

The following steps, if followed properly, will minimize seal area contamination resulting from the filling operation:

(1) There should be a correct match of filler to product characteristics, preferably established through actual filling tests;

(2) Improved nozzle design features such as circumferential suction holes on nozzle tips to suck back dripping product, external suction rings, or sheet metal synchronized guards to physically prevent drippings from contaminating seal surfaces;

(3) Specification of bottom-to-top filling, and no filling within a specified distance of the top of the pouch; for example, within 3.8cm of the top.

(4) Assurance of close control over the size and shape of the pouch opening by means of conveyor clamps on both leading and rear pouch edges, air jet assistance to initiate opening, and use of suction cups.

(5) Use of winged or formed guards to swing down into the package opening at the moment of filling to physically protect the inner seal surfaces (Figure 5).

(6) Use of a tack or partial seal below the location of the closure seal to prevent splash of product into the seal area.

The process for removal of residual air in the pouch may result in splash, especially with viscous products (sugar syrup, gravey) prone to air occlusion. Precautionary measures include the care to avoid occluded air, control over the programming of the rate of air removal, and control over product fill temperature to prevent flashing.

<u>Sealing in Spite of Contamination</u>

In rare occasion, if the seal becomes contaminated with product, the pouch is not necessarily lost. Held (1970) describes the FMC Hydropac

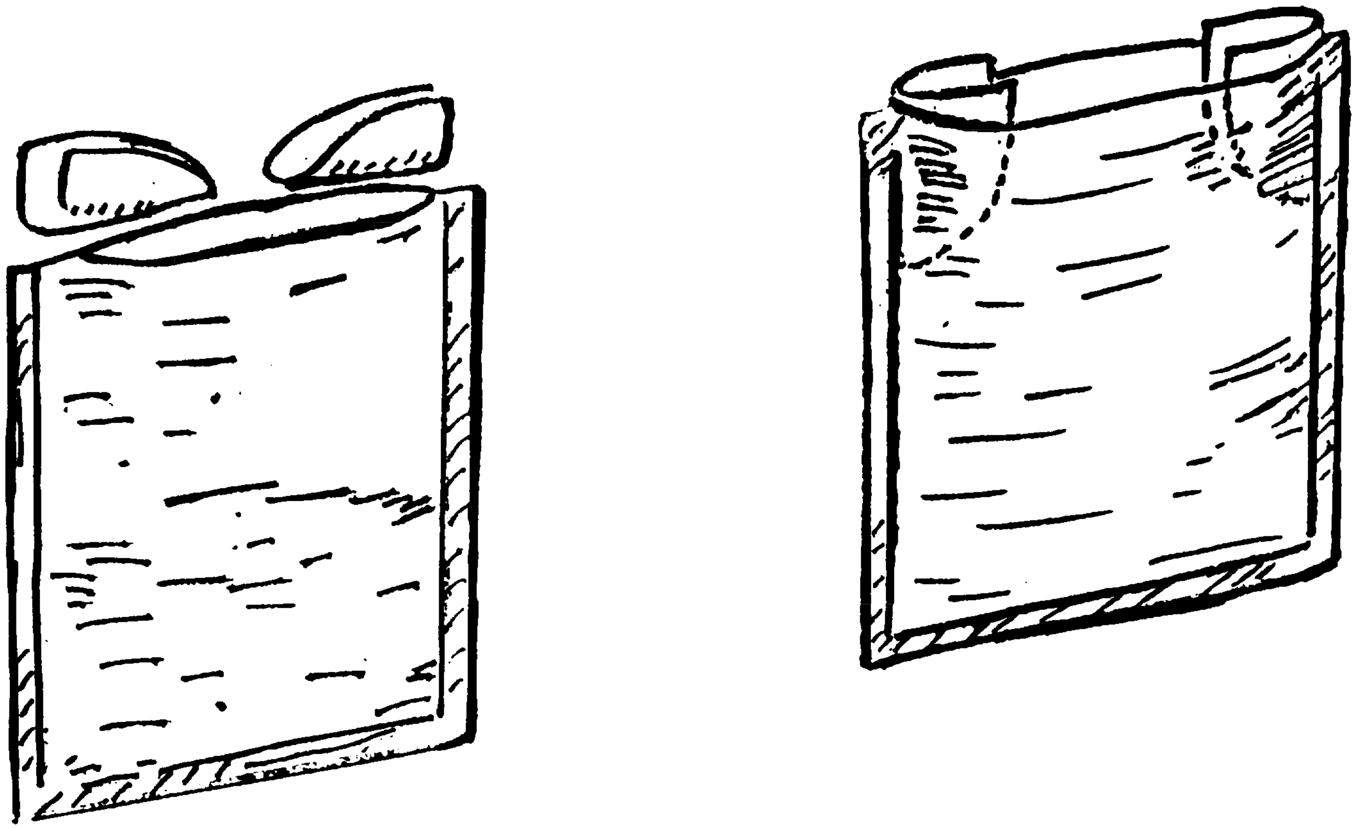

Figure 5. Pouch Opening Guards.

processing system, wherein unsealed pouches with seal areas held taut by tensioning grippers are held immersed to the seal height in a hot water bath to remove residual gases and clean the seal surfaces of product by a reflux action. Schulz and Mansur (1969) indicated the feasibility of using a steam flush to not only clean seal surfaces, but to remove residual air from the pouch prior to sealing. The key to their success was the use of a curved sealing bar against a silicone rubber anvil (Figure 6) which could seal through gross grease or water seal area contamination.

Wilson (1974) provides a variation of the curved bar approach, using first a hot bar to vaporize and then an impulse sealer for the ultimate bonding. Tsutumi (1974) reported a unique, superimposed triple hot bar approach. The initial hot bar effects a seal; a second, slightly lower temperature bar flattens any blister that was caused by vaporization of contaminant during the initial sealing; and a third, ambient temperature bar performs a final flattening action on the still heated polymer. This technique was shown to be effective. It reduces the contaminated closure seals from 10% to 0.2%.

Detection of Contamination

There are no non-destructive methods currently available for assessing seals for fusion, tensile or burst strength. One must rely on periodic sampling during production to keep these variables in control. However, physical abberation and contamination can be detected.

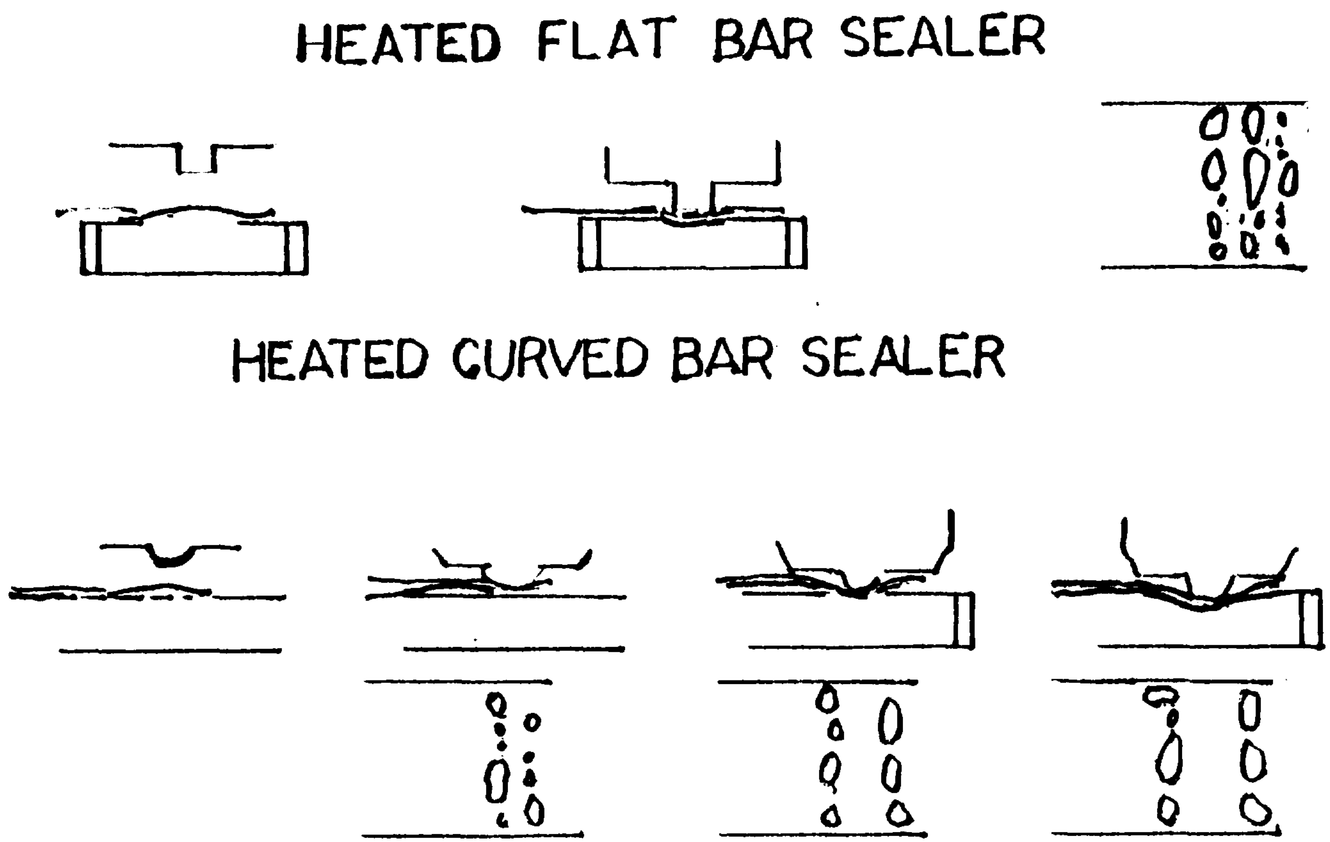

Figure 6. Sealing Thru Contaminants

(1) Visual Inspection

Visual methods are subjective to human error. Usually, visual inspections under ideal conditions are 75% effective. However, for retort pouches, defect rates can be kept at low levels by visual on-line 100% inspection. Tsutsumi (1974) cites the use of visual inspection and final pouch defect rates of 0.02%.

(2) Infrared Radiometric Scanning

Lampi et al (1973) used infrared radiometric scanning of seal surfaces that have been heated through the seal thickness. Any defect in the seal area momentarily impedes heat flow sufficiently that the detector can measure the temperature drop. In a prototype machine, the heat source and detector are stationery, while the pouch seal area, at rates up to 15cm (6 inches) per second, is passed between. The system has been proven feasible and reliable. However, its cost is higher than the dimensional aberration detector.

(3) Dimensional Aberration Detector

The Dimensional Aberration Detector (DAD) relies on the use of calipers to measure any irregularities in seal thickness (Fig 7). The roller contact points permit frictionless passage of the package seal area through the measurement device.
The dimensional measurement is amplified and converted into an electrical output through a capacitance meansuring technique. A prototype instrument was fabricated by the Lion Research, Inc. This instrument can detect occluded particles and fold - type seal wrinkles, but the sizes had to be larger than those detected by the infrared scanner. The trials also reveal that alignment had to be very accurate and closely controlled. But broad grease and moisture contamination were not as easily detected as the infrared technique.

The caliper technique is less costly than the infrared system.

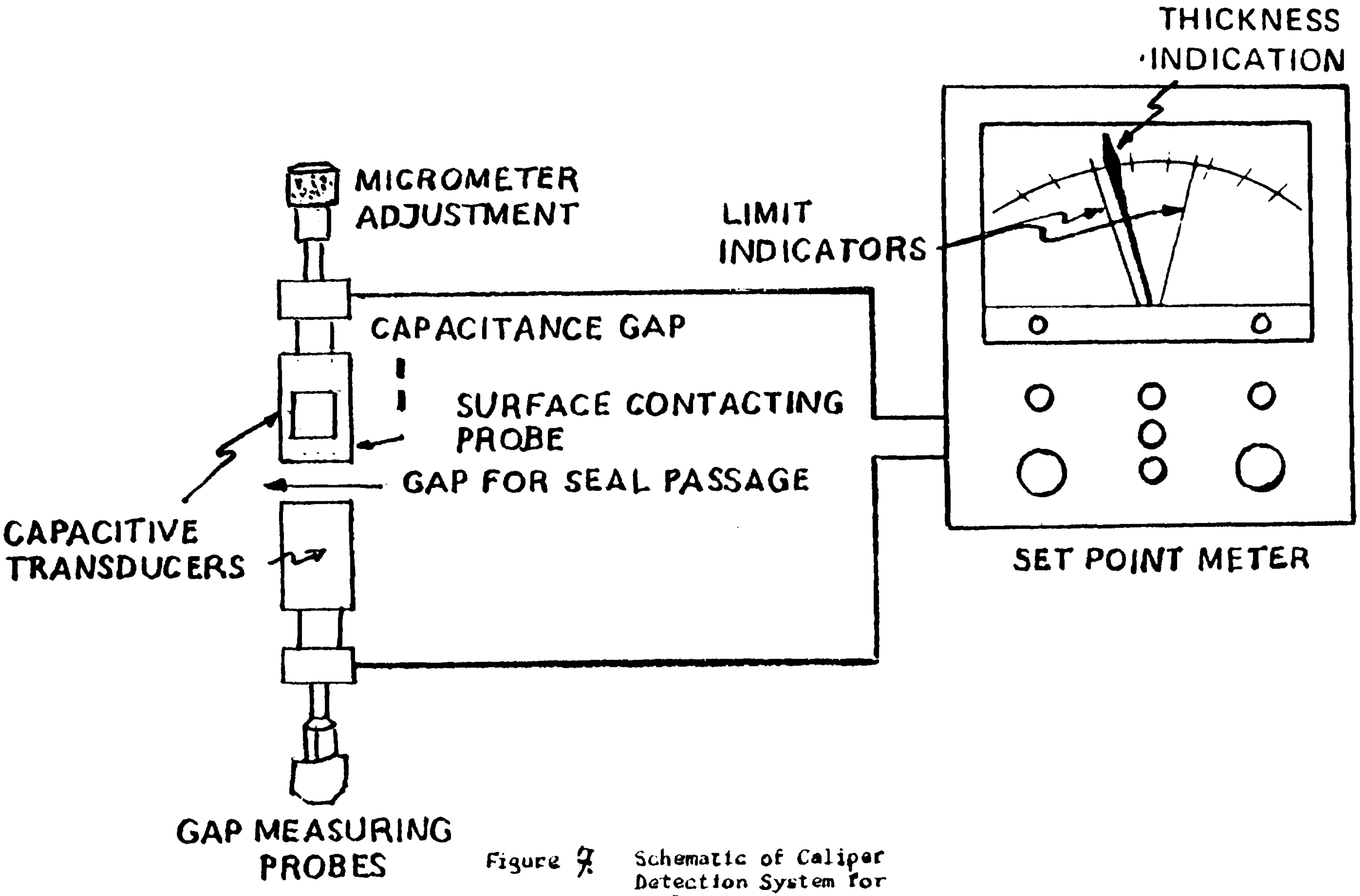

Figure 9 Schematic of Caliper Detection System for Seal Defects

With the advent of curved bar sealing to void concern over grease and moisute contamination, the caliper technique can easily detect occluded matter and large wrinkles.

V. PROCESS SURVEILLANCE

Since many of the applicable tests are destructive (internal pressure, tensile), quality assurance protocols should be established and carried out to maintain control over the entire packing operation.

Table 2 presents those tests measuring the effectiveness of seals and seal formation along with the sample plan.

Such tests were found to be adequate for production reliability program (Lampi, 1973). Utilization of the plan resulted in a low 0.002% seal failure rate and a 0.016% closure seal contamination rate for 298,791 packages. As experience and data accumulate sampling levels m may be reduced.

Table 2.

INSPECTION PLAN FOR ASSURING

HIGH QUALITY SEALS [a]

Prototype Form, Fill, Seal Production System [b]

SAMPLING SITE	TEST	NUMBER OF SAMPLES PER LOT	REJECT CRITERIA
In-Process - After Pouch Formation	Air Burst - Bottom & Side Seals	6 Consecutive Per 30 Minutes [c]	1
In-Process - After Closure Seal	Air Burst - Top Seal	6 Consecutive Per 30 Minutes	1
	Visual for Defects	100%	All Defective pkgs. removed
Final Package - After Retorting	Air Burst	13 Random [d] (6 - bottom & side) (7 - top seal)	1
	Visual for Defects	100%	All Defective pkgs. removed

(a) Utilization of plan resulted in the following low seal defect rates for 298,971 packages of six diverse products.

Seal Failure: 0.002%

Closure Seal Contamination: 0.016%

(b) US Army Natick Development Center: Contract DAAG17-69-C-0160 (Swift & Co.)

(c) Corresponds to 1800 pouches (30/minute).

(d) Lot based on retort load of 2688 pouches; (Sampling level S-3, Normal inspection, AQL of 1.0 - MIL-STD-105D).

VI. SUMMARY

Reliability of closure seals for foods processed in flexible retort pouches is a very important technical matter. A high level of seal integrity both in terms of inherent strength and absence of defects is mandatory. When all the interfering materials, product, and equipment variables are recognized, the act of achieving good seals with confidence becomes a complex task. In this report, an attempt has been made to identify the important characteristics of reliable closure seals and the factors that can effect these characteristics.

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