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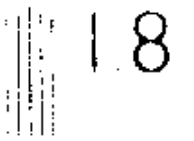
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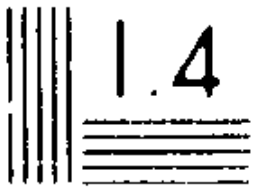
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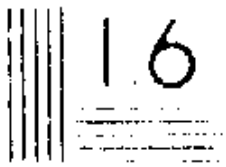
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KOREA DESIGN AND PACKAGING CENTER

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REPUBLIC OF KOREA

Technical report: Testing of Packaging Materials *

Prepared for the Government of the Republic of Kor[illegible]
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of P.V. Narayanan,
consultant in the testing of packaging materials

United Nations Industrial Development Organization
Vienna

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1. INTRODUCTION

1.1 BACK GROUND:

The main objective of the project is the establishment of "package testing and research laboratories" in KDPC (Korea Design and Packaging Center) with the aim of development of packaging techniques. The project is implemented in two phases. Phase-I was completed during the period 1975-1978. Phase-II commenced in the year 1979 is scheduled to be completed by 1981.

1.2 JOB DESCRIPTION:

Considering the needs of the laboratory a job decription is drawn-up and the activities are outlined in Annexure-1.

1.3 OFFICIAL ARRANGEMENT:

The mission was assigned through UNIDO correspondance PRU/81/PPRS/APP/Es, post DP/ROK/78/008/11-58/31.7E, dated 25th May 1981.

The expert entered the field on 7th September 1981.

The work plan was discussed with Kurt W. Jenkner, Co-ordinating Industrial Adviser, UNIDO, SEOUL.

1.4 COUNTERPART STAFF:

The counterpart staff nominated is Mr. Dong Il Lee, Researcher, Packaging Research and Development Department.

1.5 OBJECTIVES OF THE PROJECT:

The immediate objectives and the development objectives remain the same as outlined in the original document.

2. SUMMARY

The expert entered the field on 7th Sept. 1981.

A series of factory visits were undertaken to conduct technical discussions. The factories visited included packaging material manufacturers, converters and user industries. Discussions were held on testing, quality control, materials specification and selection, shelf life studies, package development, mechanical design and performance of package, graphics and packaging economics.(Annexure-II)

Technical sessions were conducted on various aspects of packaging for the benefit of the counterpart staff. These mainly covered packaging concepts, significance of testing, barrier properties and determination of barrier properties and specific case studies.

A detailed write-up on "corrosion in packaging" has been prepared (Annexure-V) and the salient points discussed. Use of available corrosion testing equipment was also highlighted.

A new test procedure to study the effectiveness of V.P.I. paper was introduced. The test equipment was set-up and experiment conducted to acquaint the counterpart staff of all details of the apparatus, sample preparation, observation, recording of results and interpretation of data. A detailed write-up was prepared (Annexure-VI)

A drop impact tester, accelerometer, strain amplifier and rapicorder were already procured by the KDPC earlier for studying the cushioning charecteristics of cushioning materials. These equipment were checked for their working and put in operation and the procedural details provided. Some experiments were conducted and methodology of recording of data and interpretation provided. A write-up on cushioning system and meterials was prepared (Annexure-VII). Other available technical literatures on the subject were also given.

A number of tests on paper and paperboard materials were carried out using Burst tester, Tensile tester, dial micrometer, compression tester etc.

A series of properties of plastics films and laminates were studied. These include tensile, yield point, elongation, barrier properties (GTR & WVTR), tear and calculation of yield. The test procedures, calculation of results, sample preparation, experimental variations etc were specifically discussed with regard to barrier properties. Data collected on GTR and WVTR values for various barrier materials from technical literatures and laboratory experiments were tabulated and provided. Important technical literatures describing different methods available to determine barrier properties, principle underlining each, pros and cons of each method, method of representing results etc. were also provided.

The WVTR tester available was checked and put-in operation.

The Williams oil penetration tester was checked for its working and put-in operation. Some samples were tested. Sample preparation, experimental set-up, recording of results and interpretation of results alongwith usefulness of this test in actual packaging application were explained.

A series of new tests were introduced using soxhlet extraction method. The apparatus was set-up and experiments conducted to appraise the counterpart staff of all details. Use of this set-up to estimate some of the properties/materials was shown. Other new tests covered were internal pH, chloride and sulfate content estimation.

Procedures for separation of substrates in a laminate and identification of plastics films by simple solubility and flame tests were drawn-up and introduced (Annexure-VIII & IX). The methods/procedures drawn-up were demonstrated using some of the commonly used laminates and plastics films. List of chemicals, solvents required was prepared and procured.

As a beginning simple laboratory equipment based but industry application oriented research projects were planned and conducted. Projects completed were moisture isotherm of kraft liner, relationship between caliper, grammage and moisture, effect of relative humidity levels on the physical properties of kraft liner. Plotting of graph, inter-pretation of test results and their significance in end use application were explained.

For better understanding of the equipment, test procedures and the significance of the test and property a detailed write-up was prepared (Annexure - X). Discussions were also held in this area.

A brief write-up was also prepared on each of the equipment installed, their use and application (Annexure - XI). A quick identification chart prepared appear at Annexure - XII .

With a view to identifying the significant properties of packaging materials, the materials were grouped and properties drawn-up and given in Annexure - XIII. This could be used to select new areas to expand the testing facilities available at the packaging laboratory.

A comprehensive guide of reference standard for testing of properties of packaging materials was drawn-up (Annexure - XIV). This would help for cross reference, comparison of equipment and procedures followed in other parts of the world and for effective discussion on regional and international meetings on standardisation.

With a view to expanding the testing facilities at the packaging laboratory recommendations were made to conduct frequent technical seminars, undertake more factory visits and follow-up on some of the new procedures and tests introduced. The research projects started should be continued to generate technical data on packaging materials used by the industry. Migration and compatibility studies for plastics materials, additives, lacquers and coatings were also recommended as new area of testing and research. The other recommendation made was on the calibration and maintenance of equipment and maintaining a register for this purpose as well as utilisation of equipment.

Introduction of quality assurance certificate and quality marking scheme for packaging materials and packages could be considered.

3. SUBSTANTIVE SECTIONS

(ACTIVITIES AND FINDINGS)

3.1 GENERAL:

Initial week was spent in introduction to various personnel in the packaging section, Directors and the president of KDPC.Discussions were held on the set-up of KDPC and particularly the packaging section, equipment installed, types of work carried out, conditions maintained in the laboratories, standards fellowed for testing etc. Activities identified under the job description was also discussed.

3.2 FACTORY VISITS:

Visits to packaging material manufacturers, converters and user industries were planned to hold technical discussions. The counterpart staff was also present during these discussions. The other objective of the visits was to appraise the industries of the facilities available at KDPC and to identify the additional facilities required to be established at KDPC, particularly in the field of testing to cater to the needs of the industries.

As many as nine factories were visited during the period. These include five industries engaged in packaging material manufacturing/converting, and four user industries comprising of processed foods, textiles, textile and leather garments and one heavy engineering.

Brief report prepared on each of the factory visits appear at Annexure - II .

Discussions were held with the technical personnel in the factories on properties of raw materials and converted materials. Emphasis was laid on testing and quality control of incoming materials and finished goods as well as in process quality control. Specific discussion was held at Lotte Confectionery Co.,Ltd. with respect to surface emballishment (graphics), colour selection, brand identity, house colour, material selection, shelf life, mechanical design versus strength properties,

and cost reduction techniques. Specific suggestions were given at Tae Kwang Industrial Company Ltd. for packaging of cones, and on box construction to get better performance. Adoption of reuseable collapsible boxes was recommended for movement of products among the Tae Kwang Group of industries which would give long-term benefits. The approach to package development, drawing-up of specification for packaging materials and packages, advantages of some packaging systems like shrink packaging and effective waterproofing methods were the other areas, discussed in detail.

3.3 TECHNICAL SESSIONS AND STUDIES:

3.3.1. PRINCIPLES AND TECHNIQUES OF PACKAGING:

A series of seminars - technical discussion sessions were conducted for the benefit of the counterpart staff. These mainly covered

a. packaging concepts
b. objectives and significance of testing
c. WVTR & GTR tests
d. testing of physical properties
e. case studies

A detailed write-up covering all major aspects of packaging is prepared (Annexure III) and given to counterpart. All these points were covered during the technical discussion sessions. The points covered under testing are listed in Annexure - IV. WVTR and GTR tests, and testing of physical properties are dealt with separately.

A few actual case studies were discussed to highlight the importance of properties of materials, testing for compatibility requirement with particular reference to end use applications. These included discolouration of labels, curling of labels, adhesion of labels to different surfaces, leakage in glass bottles, continuous rotation of caps etc.

In addition to the above, brief discussions were also held at various stages of testing, preparation of reports and on observations during factory visits.

3.3.2. BARRIER MATERIALS

(Waterproofing and Water vapour proofing)

The significance of barrier materials and the essential difference between waterproofing and watervapour-proofing were explained. A brief write-up alongwith examples was prepared and given. Details of work done in the areas of watervapour and gas barrier properties are enumerated later in the report.

3.3.3. ANTI CORROSION TECHNIQUES:

3.3.3.1. CORROSION IN PACKAGING:

A detailed write-up on the subject was prepared (Annexure - V) and the salient points explained. In this context the equipment available and their usefulness was also discussed.

3.3.3.2. TESTING OF V.P.I (V.C.I) PAPER:

A new test procedure to study the effectiveness of vapour phase (corrosion) inhibitor paper was suggested. The complete details worked out are in Annexure - VI.

The required components for the test equipment were procured and the equipment assembly was made in the laboratory.

With the above set-up experiment was conducted in the laboratory to study the corrosion protectiveness of an indigenously produced V.P.I. paper, for ferrous metal. This practical demonstration was used to explain the experimental details, methodology, sample preparation and observation and interpretation of results.

3.3.4. STUDY ON CHARACTERISTICS OF PACKAGING MATERIALS:

3.3.4.1. CUSHIONING:

A background material on the subject was prepared for discussion. The details are given in Annexure - VII.

The KDPC had already procured a Drop impact tester, Rapicorder and Strain Amplifier and Accelerometers. All these were checked for their operation and found working satisfactorily. Installation, calibration and operation of these are individually explained and recording of data observed. Interpretation of the print-out from the recorder in relation to the accelerometer used was also explained.

In the next stage use of the above equipment and recorder for studying the cushioning characterics of different cushioning materials was undertaken. The experimental set-up of connecting the drop impact tester, accelerometer. Strain amplifier and recorder was explained. The working was explained through practical demonstration. The practical application of the 'g' values of the cushioning materials, calculation of stress/strain relationship, cushion factor and determination of cushion thickness and cushion area were also explained. A few readily available technical papers on the subject were provided for future use and reference.

3.3.4.2. PAPER AND PAPERBOARD:

Paper and paperboards - mainly kraft liner, corrugating medium paper and corrugated boards were tested in the laboratory. Samples from the regular inflow of materials received for testing were used for this purpose. This involved operation of quite a few equipment like tensile tester, Burst tester, compression tester, dial micrometer etc.

While conducting the tests and recording data, procedures outlined in other standards were also discussed. The other aspect emphasised is on calibration of the equipment against standard material.

Samples of kraft liners and corrugating medium collected during factory visits were used for laboratory research projects to study the behaviour of these materials in respect of their physical properties under different environmental conditions. The studies carried out are detailed separately.

3.3.4.3. PLASTICS FILMS AND LAMINATES

A series of properties were studied for plastics films and laminates. Noteably these were tensile strength, yield strength, yield, percentage elongation, tearing strength, watervapour transmission rate and gas transmission rate. The studies carried out and discussions held are briefed in the following paragraphs.

(i) TENSILE RENGTH AND ELONGATION:

The primary observation made was with regard to sample preparation. The system followed differed from other popular methods described in ASTM, B.S, ISO and others. Taking ASTM standards as guideline the sample preparation for testing of plastics films and sheets was explained alongwith suggested speed of separation, jaw distance in the Instron, which is the main equipment used for testing of these properties. In order to study the effect of the different sample preparation on the results, samples were cut following the currently practiced procedure which is also as per J.I.S and as per ASTM and were tested. Although the initial tests and results indicated no significant deviation in the results, it was recommended to carry out an intensive study.

The methodology to calculate the yield strength from the graph was also explained and a few examples worked out.

Samples of plastics films, woven plastics, and plastics twine were used in the above tests.

(ii) TEARING STRENGTH:

Tearing strength of the plastics films also is tested using Instron. Two important aspects were explained in this particular area.

The first one was with regard to the accuracy of the sample dimension mainly because of the intrigate shape in which it is cut. The two methods of sample preparation and testing were also explained. One type of samples use Instron for testing, while Elmendorf Tear Tester is used for the second lot of samples. It was emphasised that the results obtained by the above two methods are not comparable.

The second aspect was with regard to presentation of data of tear property and thickness of film tested. It was clarified and explained that the tear property value is to be expressed in force for the specific thickness of the film and the value obtained cannot be converted for unit thickness of the material. This was made clear particularly in the context of a query received for giving result of tear for unit thickness.

(iii) YIELD:

Primarily the difference between yield and yield strength (point) was clarified. The method of calculation of yield of a given film of a particular specific gravity was explained. Specific example was worked out using a sample material received for testing. The method of expressing yield value both in metric and F.P.S. systems were shown, and conversion factors prvided.

(iv) WATER VAPOUR TRANSMISSION RATE:

Currently the conventional and more popular dish method is followed.

Technical literature giving details of various methods of determining WVTR properties, the sensitivity, pros and cons of each method, method of expression of the results were given (not annexed to this report). However, detailed discussions were held on the dish method. Some salient guidelines given include the advantage of using a shallow dish, need for testing a larger number of samples from each lot, exposure to longer duration of time for obtaining a better plot (graph), use of the specific grade and seive of calcium chloride (desiccant) and the method of reactivation of calcium chloride.

Charts giving values of WVTR for different plastics films cellulosics and laminate from published literatures and obtained through laboratory experiments were furnished. A graphical illustration of the water vapour permeability of some plastics films and aluminium foil was also provided (not annexed to this report). This graph explains the behaviour of the foil & plastics films at different thicknesses to water vapour permeability, and clearly explains that there is no linear relationship between these properties.

One of the methods of expressing the WVTR property is by "Perms". The method of calculation was explained with example.

The other important points emphasised in the preparation of sample for studying this property were marking of the side exposed, wrinkleless clean surface, creased and uncreased samples and relavance of values for creased and uncreased samples in the end use application.

(iv-a) WVTR TESTER:

KDPC had earlier procured a WVTR tester based on the T.N.O design The principle of working is different from the dish method. In this method the loss of weight is determined due to egress of moisture from the dish through the barrier.

The tester was checked and found to be in working condition. The preparation of sample, working principle, experimental set-up, methodology and calculation of and interpretation of test results were elaborated.

(v) GAS TRANSMISSION RATE (PERMEABILITY)

Technical literature giving details of various methods of determining GTR properties, the sensitivity, pros and cons of each method, method of expression of the results were furnished (Not annexed to this report). Values of G.T.R. for various plastics films, cellulosics, and laminates collected from different sources were also furnished.

Detailed discussions were held on preparation of sample, marking of sides of exposure, wrinklefree and clean sample, creased and uncreased samples' testing and usefulness of tests GTR results in end use application.

A series of experiments were carried out in the laboratory to determine the GTR values of plastics films, coated films and laminates.

The possible reasons for fluctuations in the results for the same lot material were explained. It was emphasised that since many factors influence the permeability, a number of samples should be studied before finalising the permeability data. Test conditions should also be uniform.

3.4 OTHERS:

3.4.1. OIL PENETRATION TESTER:

The williams oil penetration tester was examined and found in working condition. The principle of working, preparation and mounting of sample, experimental methodology, and determination of test result value were explained.

The equipment was put-in operation and a few samples were tested to give a prac ical demonstration. The interpretation of test values to field application was also explained. From packaging point of view the usefulness of this equipment and test data in the printing and varnishing industry, for packaging of fatty acid products and semisolids were cited.

The type of oil to be used, level of oil to be maintained, temperature control, and assessment of oil penetration for desired surface area were some of the salient points emphasised. The need to express the side of exposure, thickness of material sample while recording test results were also explained.

3.4.2. SOXHLET EXTRACTION:

Presently the laboratory uses very little of chamical analysis for studying the properties of packaging materials. The usefulness of introducing few qualitative and quantitative chemical analysis methods was explained. One among these is the soxhlet extraction.

The set-up of this extraction procedure was elaborated. The requirements of laboratorywares, glasswares and chemicals were listed out and procured.

The soxhlet extraction assembly was prepared in the laboratory and principle underlining the working explained. Two experiments were conducted using the following two packaging materials.

(i) Kraft liner coated with polyethylene

(ii) Millboard laminated to kraft with asphalt

The objective was to identify/assess the quantity of individual materials in the combined materials like basis weight and caliper/coating quantity of kraft liner and polyethylene. In the second case to determine in quantitative terms the material of millboard, kraft and asphalt.

Complete procedure from sample preparation, experimental set-up, quantitative assessment of samples, and calculations were explained and demonstrated through the above experiments. Guidelines were also provided in the selection of the solvent, in respect of the packaging material to be tested and recovery and purification of the solvent for reuse. The possible areas of application of soxhlet extraction method in the field of packaging were also elaborated. These include determination of wax content and basis weight of base paper used in waxed paper, PVA based adhesives used in laminated, PE content in polyethylene laminates, asphalt content in asphalt bonded materials, and asphalt impregnated materials, solvent soluble materials in paper and other packaging materials.

3.4.3. pH, CHLORIDE AND SULFATE:

The importance of these properties particulerly of paperbased materials was outlined. This was also linked to the case study examples. The difference between surface pH and total pH was explained and method of determination was shown.

The procedures for determination of these properties were also provided.

3.5 LAMINATES - DELAMINATION OF SUBSTRATES:

- IDENTIFICATION OF PLASTICS FILMS:

The packaging industry uses a number of laminated flexible packaging materials and the KDPC often is called upon to find out the substrates. This primarily calls for separation of each layer and then identification of the individual materials by simple methods. This could be achieved by using laboratory methods with different solvents and by solubility and burning tests(flame tests). The analysis and identification of plastics films and coatings could also be done more accurately through sophisticated instrument, but not considered at this juncture here.

Simple laboratory procedures using different chemicals, laboratory and glassware were recommended for detemination of substrates in laminates. Procedure for these were prepared and provided. Details given in Annexure-VIII. The chemicals and other requirements were listed and arrangements made for procuring these.

Samples of various laminates produced indigenously were collected and techniques of separation demonstrated in the laboratory. The samples used included different types of laminates - two plies, triple laminates and multiple laminates. Some typical laminates used for study are:

Kraft/Polyethylene
Cellophane/Polyethylene
Polypropylene/Polyethylene
Aluminium foil/Polyethylene
Aluminium foil/Tissue
Aluminium foil/Paper
Polyester/Aluminium foil/Polyethylene
Cellophane/Aluminium foil/Polyethlene
Cellophane/Polypropylene/Polyethylene

Method of determination of individual substrates quantitatively for their caliper and weight was explained and working details provided.

Simple laboratory procedure for identification of the substrates (plastics films) in the laminates (after separation) and plastics films received individually were prepared and details given at Annexure-IX. These are mainly based on the solubility and flame charecteristics of the film material. To help the staff acquainted a few materials were tested for practical demonstration.

A list of solvents required was prepared and these were procured. A few samples were used for practical demonstration of the tests in the laboratory.

3.6. PROJECTS - LABORATORY RESEARCH PROJECTS:

A few research projects were planned and carried out to study the packaging material properties. The projects completed are:

(i) Moisture Isotherm of kraft liner

(ii) Kraft liner caliper (thickness) Vs Basis Weight

(a) for imported liners

(b) for indigenous liners

(iii) Kraft liner Basis Weight Vs. Bursting strength

(iv) Kraft liner Basis Weight Vs Tensile strength

(v) Effect of Humidity on Bursting strength of kraft liner

(vi) Effect of Humidity on Tensile strength of kraft liner

3.6.1. MOISTURE ISOTHERM:

This project was to establish the moisture absorbancy/desorbancy charecteristics of kraft liner used by the corrugated board industry. A commonly used kraft liner was exposed to different relative humidity conditions and after adequate exposure, the moisture content determined by oven dry method. A plot of Relative Humidity to percentage moisutre content was made to obtain a graphical illustration of the moisutre isotherm.

3.6.2. CALIPER-BASIS WEIGHT RELATIONSHIP:

Different samples of kraft liners both imported and produced indigenously were collected and their caliper and basis weight determined. A graph of basis weight to caliper was plotted to establish the linear relationship of these properties. However, the influence of bulk density in this regard was explained.

3.6.3. BASIS WEIGHT - BURSTING STRENGTH:

The direct influence of increasing basis weight on burst values was studied through this project. Values of basis weight to bursting strength of kraft liners were determined and graph plotted.

3.6.4. BASIS WEIGHT - TENSILE BTRENGTH:

This project is similar to 3.6.3 and here the relationship between basis weight and tensile properties were studied.

3.6.5. EFFECT OF HUMIDITY ON BURSTING STRENGTH:

The objective was to study the effect of exposure of kraft liner to different relative humidity conditions, and its bursting strength. The methodology involved exposure of kraft liner to relative humidity conditions between 11 percent and 92 percent, prepared by using saturated salt solutions in desiccators, for adequate time and assessing the bursting strength values. In other words this also gives the effect of moisutre content on bursting strength values. From the test results, a graph of percentage relative humidity to burst values was plotted to illustnate the behaviour of kraft liner with regard to its burst property under different environmental conditions.

3.6.6. EFFECT OF HUMIDITY ON TENSILE STRENGTH:

The methodology adopted was similar to that detailed under 3.6.5. In this project the tensile properties was considered.

In all the projects details of sample selection, sample preparation, expertimental details, methodology of exposure, test details, recording of data and plotting of graph were outlined and explained. All the details alongwith results and graphs furnished to counterpartstaff (Not annexed to this report). The results obtained were diacussed in detail and their practical use in field application of specifying a material, storage conditions, and as a liner in corrugated board, or bag/sack ply or laminate were explained.

In line with the series of projects completed a few more projects to generate useful data on properties of other materials like corrugated boards, paper boards, and plastics films were suggested.

3.7 SIGNIFICANCE OF TESTS

Understanding of the equipment and testing alone would not be enough. The purpose of use of a particular test and the selection of a particular test or property is extremely important. Thus the significance of the various tests and properties of materials are highly relevant. To enable the counterpart staff to equip better, a write-up giving the significance of tests and properties was prepared and given at Annexure - X.

These adpects were also discussed in as detailed a manner as possible while conducting discussion sessions. Practical examples in the field of packaging were cited as cases. These would help the counterpart staff in the understanding of various problems likely to be referred to them by the industry, better utilisation of the equipment and a useful approach to arrive at the solutions.

3.8 EQUIPMENT UTILISATION:

The laboratories are equipped with various testing instruments and machines, meant for studying different charecteristics of packaging materials and forms. A brief write-up was prepared on each of the equipment outlining the function and use. This would help to identify their use and in the introduction of new tests. The details are at Annexure-XI. A chart prepared is also appended Annexure-XII . This chart gives the equipment and tests that could be performed with it.

3.9 PACKAGING MATERIALS AND PROPERTIES:

Packaging materials are many and varied. A number of properties of these materials can be studied. However, all properties may not be significant for one or other application. As outlined in (3.7) selection of test or property will depand on end use application of the material. The packaging materials were classified into eighteen main groups and the important properties of these materials were identified. These properties have important significance. The details of the packaging material

groups and relevant properties are given in Annexure - XIII. This would also give an idea of the additional testing facility to be built-up in the laboratories. A few were attempted and new tests for V.P.I., soxhlet extraction, delamination of substrates in laminates and identification of plastics films were introduced.

3.10 REFERENCE STANDARDGUIDE:

Standards followed in different countries particularly for testing of packaging materials were discussed. A comprehensive guide of reference standards for testing of properties of packaging materials was drawn-up. Details at Annexure - XIV. This would help for cross reference and for comparison of equipment and procedures outlined in other standards. This would also be helpful to prepare for regional and international meetings on standardisation. Wherever national standards are not available the reference guide could be used for identifying the other commonly used ones and the information therein could form the basis for preparation of national standards.

3.11 TECHNICAL PAPERS AND WRITE UPS:

For the benefit of the counterpart staff and the laboratory technical materials compiled on packaging and more relevant to testing were given. These are listed in Annexure - XV.

Also, the tabar stiffness tester was checked and put into operation. Few paperboard samples were tested and method of calculation shown.

The other new tests covered are Raw edge absorption and Z-direction tensile strength.

4. RECOMMENDATIONS

4.1 The few industrial visits conducted and the discussions held indicated that more interest could be generated among the industries and their need specifically in the area of testing of materials identified. Personal and indepth discussion also would be possible on various technical aspects through which areas of assistance required to be provided to the industries established. This would form the basis on which the facilities in the laboratories expanded and services intensified. Towards this industrial visits should be undertaken on a regular and continual basis.

4.2 It is suggested to conduct more technical seminars on various aspects of packaging covering material testing, package testing, quality control, package development, packaging materials etc. to attract participants from manufacturing, converting and user industries. The interaction of such group would help to clarify many points for the benefit of the industry and also would make them aware of the facilities available at KDPC. Simultaneously the packaging centre would be able to identify, establish and extend the additional facilities. This should also increase the clientale.

The above would also help the packaging personnel to come across, study and solve problems faced by the industries in the field of packaging.

4.3 The equipment for studying the cushioning characteristics were tested and put into operation and some experiments conducted. The studies should be continued and data generated for indigenously produced cushioning materials.

4.4 Whereas the laboratories are well equipped for testing of properties of different packaging materials, there is scope for expansion of this area by introducing new tests for other packaging materials like metals, glass, printing ink etc.

4.5 Presently the testing facilities available concentrate mainly on physical, mechemical and optical properties. Quite a few chemical tests could be added, based on the work done and suggestions made.

4.6 Few basic tests for identification and delamination of plastics and laminates respectively were introduced. This could be expanded further to cover broader areas, as plastics form one of the major groups of packaging materials.

Facilities required for migration and compatibility studies of plastics materials, additives, lacquers and coatings should also be built-up. This aspect is more important for food, pharmaceutical and chemicals packaging.

4.7 A few laboratory equipment based research projects were planned and conducted. Some more project areas were identified. Such projects should be taken up on a regular basis to generate technical data on properties of materials produced and used by the industries. Subsequently a data bank could be established which would be very useful in day to day work, technical discussions and consultancy services. This would also involve utilisation of quite a few equipment which are otherwise not regularly used.

4.8 Calibration and maintenance of equipment are extremely important. Necessary calibration charts, ancillaries and materials should be procured. The equipment should be calibrated at regular intervals of time. A register should be maintained to record the calibration and maintenance work carried out in respect of each equipment.

Similarly an utilisation register in respect of each equipment should also be maintained. The date and duration of utilisation of the equipment should be entered.

4.9 The testing facilities available at the laboratories could probably be broadened on a national scale for issuance of quality assurance certificate and quality marking system.

4.10 Packaging requirements particularly for dangerous goods vary differently from others. The requirements for exports by sea and air are also governed by regulations like IMCO code and IATA regulations. In the context of substantial exports facilities for carrying out tests in conformity to these international codes should be considered.

4.11 To the existing package testing facilities, static stack load test could be added. This test would help to study the stackload performance of package during storage. Being quick and easy to perform and assess, this would be useful.

4.12 It is suggested to equip the library with more literature and books on packaging. A list of important reference books and journals is drawn-up and given. The centre should also subscribe to obtain atleast a few useful technical magazines and journals.

ANNEXURE - I

JOB DESCRIPTION

ACTIVITIES

1. General discussion on the set-up and introducation to personnel

2. Visits to industries-packaging material manufacturers and user industries and to hold technical discussion

3. To conduct technical sessions for counterpart staff on:

   a) Principles and techniques of packaging
   b) Barrier materials and methods for water and water-vapour proofing
   c) Anti-corrosion techniques
   d) Study on charecteristies of packaging materials VIZ:

      d-i) Cushioning
      d-ii) Paper, paperboard and plastics,
      d-iii) Gas permeability
      d-iv) Others

4. To prepare a note on significance of tests in relation to the application

5. To prepare a reference chart of standards on materials' testing.

6. To prepare the report.

ANNEXURE - II

FACTORY VISITS' - BRIEFS

SL No.	FACTORY VISITED (DATE)	PERSONNEL MET
1	KDPC Corrugated board/box factory 50, Garibong-dong, Guro-ku, Seoul (14 Sept.1981)	M/S SoonKyoung Kim (Business Director) SungHan Kwon (Factory Manager)
2	Kukje Group Paper Co., Ltd. 81-3, Cheng-dong, Dobong-ku, Seoul (28 Sept.1981)	Mr. Yang Sung Rim
3	Lotte Aluminum Co.,Ltd. 516-2, Docksan-dong, Guro-ku, Seoul (2 Oct. 1981)	Mr. Sun Pyo Hong (Exeuctive Director) Mr. Hyung Soon Chang (Chief, R&D Dept.) Mr. Rhee Hyuk (Mgr. Printing Dept.)

GIST OF DISCUSSIONS HELD

Discussions were held with regard to types and quality of liners and corrugating medium used & selection of basic papers for a given end use application. Adhesive used and preparation of adhesives and requirement of preservatives. Economies of box particularly in the light of limited liner and corrugating medium (gsm) used. Advantages and disadvantages of different types of paper used. Production level and costing pattern. Tests adopted for raw materials and finished goods.

The visit was very brief and no discussions could be held. The factory manufactures paper for liner and corrugating medium in different grammages and white backed (Mainla) and millboard backed paper boards. They adopt some basic Q.C. measures.

Some samples collected for laboratory project work.

It is the largest plant of its mature in Korea, with an installed capacity of 9,000 M.T (annual), employing 550 peoples. In addition to rolling of aluminium foil, the plant has a number of laminating and printing units. They produce as many as 67 varieties of laminated/printed flexible materials which are used by food, pharmaceutical, chemical, engineering,electric and electronic and many other industries.

SL NO.	FACTORY VISITED (DATE)	PERSONNEL MET
4	Lotte Confectionery Co.,Ltd. 20,4-ka, Yang-pyong- dong, Youngdeungpo-ku, Seoul (5 Oct.1981)	Mr. Ik Boo Kwon (Director, R & D) Mr. Chun Hee Lee Mr. Sang Dae Lim & Others

LIST OF DISCUSSIONS HELD

Detailed discussions were held on recent developments, end use applications, specification, testing and quality control etc.

This industry avails the various testing facilities available in KDPC. Possible other areas whereby the services of the KDPC development and testing laboratories could be used, are also discussed.

Established in 1967, the company presently has a strength of 5,200 employees. The capital cost is of the order of US$6 million. During 1980 the sales turnover was US$200million.

The company has 7 product lines and the product mix consists of as many as 110 products.Of these 20 products are exported and the export earning during 1980 was of the order of US$ 7 million.

The company has a full fledged quality control and R & D laboratory. They make use of the testing facilities available at KDPC.

Detailed discussions were held on material specifications, shelf life determination and cost reduction aspects with specific reference to market life of the product and approach to assessing and selection of material. Mechanical design of cartons particularly for aesthetics and effect on strength

SL NO.	FACTORY VISITED (DATE)	PERSONNEL MET	GIST OF DISCUSSION HELD
			properties was also discussed. The other major aspect discussed was on graphics importance of brand name, colour scheme, product identity, house colour, and logo. Some specific existing packs were taken as examples for the discussion.
5	SAM HWA Can Making Co., Ltd. (16 Oct.1981)	Mr. C.M.KIM (Chairman)	This visit was undertaken alongwith APF Members (as a group) and there fore no specific discussions could be possible. The company manufactures round tinplate containers of various standard sizes. They have a well equpped Q.C. laboratory for testing of rawmaterials, inprocess Q.C., and testing of finished goods as well as product-package compatibility studies.
6.	Korea Heavy Industries & Construction Co., Ltd. Masan (3 Nov. 1981)	Mr. Gun-Myong Lee (Acting Manager) Mr. Shin-Il Lee (Section Chief) Packing & Shipping Department	The company is engaged in the manufacture of heavy engineering products like cranes, front end loaders, fork lift trucks, equipment for power stations, nucleur stations, and defence requirements. Discussions were held on basic requrements for packaging of such equipment and reference standards were provided for construction of packages for those items. The other point touched upon was with regard to waterproofing.
7	Tae Kwang Industrial Co., Ltd. Busan	Mr. K.L. Jung (Mill Manager) Mr. S.S. Jang Asstt.Manager)	This is one of the four companies of the group and produce cotton, polyester and acrylic yarn and fabric. About 8 percent of the production is exported. The packaging system adopted

SL NO.	FACTORY VISITED (DATE)	PERSONNEL MET	GIST OF DISCUSSIONS HELD
			could be broadly divided as bales for export, CFB boxes for exports and CEB boxes for local distribution. Various suggestions were made during the studies. These refer to style of box, shrink packaging of cops and cones, method of waterproofing, use of HDPE instead of LDPE for inner lining, use of dunnage for stacking, Interlocking portitions, flute direction of board, compression strength of CFB boxes, reuseable boxes for inter-factory movement of goods, and adoption of modular system.
8	Dae Woo Ind. Co., Ltd. Busan	Mr. Jae-Ki Choi (Manager, Production Management Dept.)	Dae Woo Ind.Co., Ltd. is essentially an export oriented company. They manufacture Textile and leather garments, other leather goods, tents etc. They export to over 1,000 countries, and the export during last year was worth 171 M.dollars. Of these 37 percent was to USA and 27 percent to Asian region. The packaging system required for various items exported was discussed. Some salient points discussed were safty aspects of unit bags, types and quantity per intermediate packs, dimensions of bulk packs particularly to achieve highest space utilisation of pallets.
9	KDPC. CFB Box Factory Busan Branch	Mr. Joong Kuen Park (Manager)	This factory is only a conversion plant. It gets the boards from Seoul factory and prints and makes the boxes. They cater mainly to export requirements.

ANNEXURE - III

THE CONCEPTS OF PACKAGIN

THE CONCEPTS OF PACKAGING

PACKAGING	:	Is historical
	:	New developments to suit modern living but basis still remain same
	:	Is the link between production - distribution - marketing
	:	Is an index of the standard of living
PACKAGING ENTITIES	:	Preserve
	:	Protect
	:	Present
	:	Price
	:	Profit
PACKAGING STATUS	:	As a management function
		Related to all other management functions
		Starts at blue-print stage of product design
PACKAGING DEVELOPMENT FACTORS	:	Product properties
	:	Product sensitivity
	:	Packaging material availability
	:	Packaging material properties
	:	Product package compatibility
	:	Storage & handling facilities
	:	Transportation means
	:	Marketing practices & environment
	:	Company attitudes
Product properties	:	Physico-Mechanical
	:	Abiotic
	:	Biotic
Product sensitivity	:	To environmental conditions and changes
	:	Rate, degree and extent of degradation
	:	Causes of danger

Packaging material	:	Type
	:	Availability
	:	Cost
Product Package compatibility	:	Acceptability of the product with the package and the vice-a-versa
	:	No harmful effect eitherways
Packaging material properties	:	Physical
	:	Mechanical
	:	Machineability
	:	Barrier properties
	:	Anti microbial
Storage and Handling	:	Type of storage
	:	Environment of storage
	:	Maintenance of storage
	:	Surroundings of storage
	:	Manual handling
	:	Semi-automatic handling
	:	Automatic handling - low speed - medium speed - high speed
	:	Racks
	:	Pallets
Transportation	:	Road
	:	Rail
	:	Sea
	:	Air
	:	Combination mode (Transhipments)
	:	Containerisation
Hazards of S, H & T	:	Mechanical - Horizontal & Vertical impacts - Shocks & Vibrations - Stacking - Punctures, Tensions, Torsions - Abrasion, Rolling & Dragging - Pilfering

	:	Climate - Snow, liquid water & moisture
		- Sand & Dust
		- Salt spray
		- Gases
		- Microbials
		- Heat
Marketing practices	:	Type of marketing organisational set-up
	:	Marketing - Advertising policies
	:	Competitions
	:	Retail, chainstore, super market, or self service store - sales outlet.
Company attitudes	:	Company type & policies
	:	Customer orientation
PACKAGING TYPE	:	Unit
	:	Intermediate
	:	Bulk
Unit	:	To contain one shot or family requirement
	:	Provides desired market like
	:	Provides convenience factors
	:	Prints required information
	:	Provides aesthetic values and helps sales
Intermediate	:	Facilitates distribution - in the overall marketing system
Bulk	:	Bulk containment of products or product groups
	:	Facilitates inventory and bulk distribution
	:	Protects package product during enroute journey
PACKAGING MATERIAL CLASSIFICATION	:	Primary
	:	Ancillary
Primary	:	Paper, speciality papers and paper board
	:	Corrugated & solid boards
	:	Metals - Black plate
		- Tin plate
		- Aluminium
		- Lead

	:	Plastics - Thermoplastics
		- Thermosets
	:	Glass
	:	Wood & Plywood
	:	Jute and textiles
	:	Cellulosics
	:	Laminates
	:	Composites & fibre drums
Ancillary	:	Adhesives
	:	Cushioning materials
	:	Straps & clips & seals
	:	Nails, nuts & bolts
	:	Labels
	:	Inks
	:	Wadding materials
PACKAGING LAWS	:	Control of health & hygiene
	:	For consumer protection
	:	Quantity and quality control
	:	Labelling and marking regulation
Labelling	:	Information
	:	Instruction
	:	Identification
Marking	:	As a means of communication through pictorial representation
	:	For handling & storage
	:	For product identification and safety
PACKAGE DISPOSAL	:	Should be susceptible to easy disposal and avoid ecological problems
	:	Possible reuse and recyclability

PACKAGE STANDARDISATION	:	For industry & national standardisation
	:	For international trade
	:	For ease in developing modular systems
	:	For variety reduction
	:	For cost reduction
	:	For better quality maintenance and quality assurance
	:	For competitive trade
	:	For improved & increased choice for customer
PACKAGE - AS A	:	Aesthetic, presentation and impulse buying creation factors
	:	More emphasised in modern marketing for consumer and consumer durables
	Factors	: Colour
		Copy
		Trade & brand name
		Weight & measurements
		Lettering
		Representation
		Product identity
		Package stability and proportions

ANNEXURE - IV

MATERIAL TESTING

A. FACTORES TO BE CONSIDERED:

1. OBJECTIVE
2. TEST METHOD
3. SPECIFICATION
4. EQUIPMENT
5. TYPE OF TESTS
6. SAMPLING
7. CONDITIONING
8. RECORDING OF TEST DATA
9. REPORTING OF TEST DATA
10. UNITS

B. SIGNIFICANCE OF TEST RELATE TO:

1. TO MEET A SPECIFIC REQUIREMENT
2. TO CONFORM TO A GIVEN/LAID DOWN SPECIFICATION
3. TO HELP THE QUALITY CONTROL CONTROL OF INCOMING/OUTGOING/ FINISHED MATERIAL
4. TO HELP THE BUYER TO PROCESS ORDERS
5. TO HELP THE SUPPLIER TO EFFECT ORDERS
6. TO HELP THE MANUFACTURER TO MEET THE DEMAND AND CONTROL HIS PROCESSES
7. TO MAINTAIN ECONOMY LEVELS
8. TO ACHIEVE CONSUMER SATISFACTION

C. PURPOSE OF TESTING:

1. TO PREDICT PERFORMANCE
2. TO CONTROL QUALITY
3. TO OBTAIN INFORMATION FOR
   a) MODIFICATION
   b) IMPROVEMENT
   c) COST REDUCTION

ANNEXURE-V

CORROSION IN PACKAGING

AND

PREVENTIVE METHODS

1. INTRODUCTION

Corrosion is one of the major causes of destruction of materials and the losses due to this will be very enarmous. Effective packaging is one of the means of providing protection from corrosion.

All metals with the probable exception of gold, platinum and radio active elements are susceptible to corrosion in one form or another form. Even alloys also are susceptible to corrosion.

2. TYPES OF CORROSION:

From the packaging field view four basic types of corrosion can be discussed.

(a) Atmospheric moisture and oxygen:

Iron + Moisture + Oxygen → Iron oxide + Hydrogen

(b) Due to atmospheric gases:

This is caused by the presence of gases in the atmosphere such as sulfur-di-oxide, chlorine etc. This is more predominent in industrialised places. The effluent gases in the presence of moisutre in the atmosphere form acid which lead to corrosion of metals.

(c) Due to Salt Spray:

This type of corrosion is observed more in sea shore/dock areas or shipmentmoved by sea, where the atmosphere is saturated with salt. Salt in the presence of atmospheric moisture forms a hydrate and acid which cause corrosion.

(d) Bimetallic Corrosion:

This is caused when the article is made from two metals. Presence of moisture or water act as electrolyte resulting in the formation of a galvanic cell leading to transfer of ions.

3. FORMS OF CORROSION:

There are different forms of corrosion and these could be listed as:

3.1. Uniform corrosion

3.2. Pitting corrosion

3.3. Stress corrosion

3.4. Dezincification

3.5. Graphetization

3.6. Intergranular corrosion

3.7. Filliform corrosion

3.8. Erosion corrosion

4. FACTORS INFLUENCING CORROSION:

4.1. Rain, Wind, Heat ...

4.2. Temperature

4.3. Pollution

4.4. Humidity

5. CORROSION PERVENTIVE MEASURES:

The preventive meausres involve three main stages Viz;

5.1. Surface preparation (cleaning)

5.2. Drying

5.3. Application of preservative

5.1. Surface Preparation:

The primary and important stage in the process of preventive measures is to prepare or clean the surface of the article. It is obvious that application of a preventive on a surface which is unclean or already corroded would be a wasteful effort as underneth the coated surface the corrosion would continue. Therefore there is a need to clean the surface.

Cleaning is needed to remove the commonly experienced impurities which include:

Dust and dirt
Metallic residues
Oils and greases
Rust and corrosion products
Sweat residues
Moisture

5.1.1. Cleaning methods:

There are different cleaning methods. These could broadly be divided into two main groups, VIZ: (a) Degreasing methods, and

(b) Derusting methods.

The various cleaning techniques under each head are illustrated in Table -1. As could be seen there are a number of methods available. It may often be necessary to adopt more then one method depending on extent of cleaning required.

5.1.2. Selection of cleaning method:

The selection of cleaning method is governed by many factions and these could be listed as:

Type of impurity
Extent of impurity
Number of articles
Size of articles
Sensitivity of articles
Production speed
Cost consideration

5.2 D R Y I N G:

The articles after cleaning should be dried before application of preservative. There are various techniques adopted for drying. These are:

Dry compressed air (6.3 kgf/cm^2)
Oven drying (120-175^{o}C, with air circulation)
Dipping in hot water (90-100^{o}C)
Hot solvent drying
Immersion in water displacing liquid
Wiping with cloth

5.3 APPLICATION OF PRESERVATIVE

The preservative required to be applied mainly depend on end use requirement. A number of preservatives are developed and available. Qualitative and quantitative requirements should be determined before adopting a specific method and material.

5.3.1 Selection Criteria:

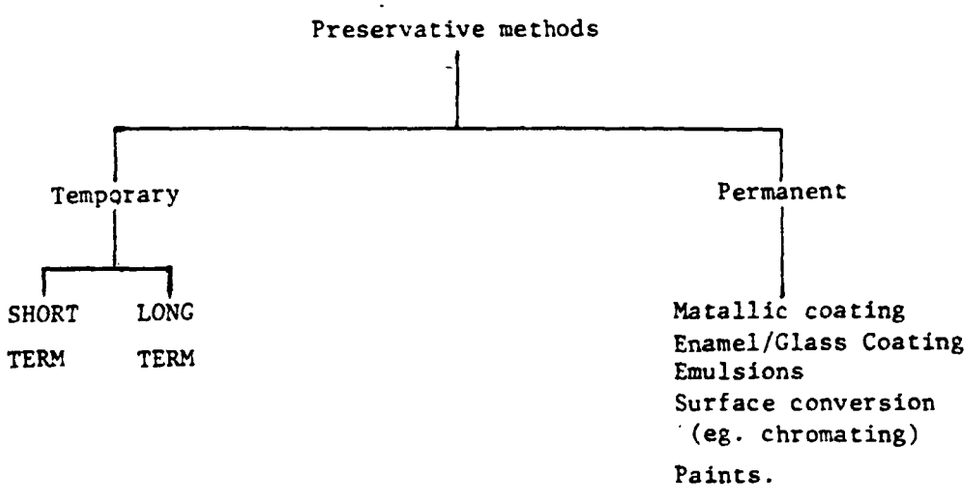
The factors that influence the selection of the type and application of preventive (preservative) are:

Storage and environmental conditions
Duration
Complexity of articles

Size and number of articles
Means of application
Cost considerations

5.3.2. Preservative methods:

The preservative measures could be broadly divided into two as temporary and permenent meausres. The terms temporary and permanent also connote the meaning of being easy to remove and difficult to remove. Temporary preventive measures could be short term as well as long term. There are a number of preservative measures. These could be summarised as:



5.3.3. Selection Criteria:

The selection of the preservative will depend on:

Acceptability and compatibility of article
Type, size, and number of articles
Method of application
Duration of protection required
Exposure conditions
Cost consideration

5.3.4. Application Methods:

The following mainly refer to application of temperary preventives.

Dipping
Spraying
Brush Coating
Flow Coating

5.3.5. Temporary Preventives

Types, examples and application methods:

(a) Short term:

Soft film :	Linolium, Hydrocarbons, Petrolatum, Bees wax)	: Hot and cold dipping
Hard film :	Plasticised resin and bitumen (in solvents carbon tetrachloride, Trichloroethylene Petrol, White spirit, Coal tar Naptha)	: "

Oils and grease :

Vapour phase Inhibitor :
(V.P.I.)

Desiccants.

(b) Long Term:

Strippable plasticoats:

These are based on ethyl cellulose, PVC. PS. They provide long term protection, transluscent in nature, hard and reuseable. But these are comparatively costlier than the short term preventives.

Strippable plasticoats are normally available in hard solid form and melted when required and articles coated by dip process.

6. DESICCANTS:

Desiccants are chemicals which are hygroscopic by nature. They absorb moisture from the atmosphere (within the package) and thus maintain

a low level of humidity. Because of the reduced level of moisutre availability, the articles do not get corroded.

6.1 Selection of desiccants:

6.1.1. Quality factors:

(a) Physical form
(b) Means of containing
(c) Reactivation
(d) Absorbancy capacity and rate
(e) Chemical action.

6.1.2. Factors for quantity determination:

(a) External atmosphere
(b) Type and area of barrier
(c) WVTR of barrier
(d) storage and transport period
(e) Type and quantity of dunnage used.

6.2 Basic desiccant:

Different desiccants have varying absorbancy and other qualities. Therefore in order to work out a formula of determining the quantity of desiccant some basis should be adopted. Towards this a basic desiccant is taken as a standard.

A basic desiccant is defined as a desiccant which will absorb 27 percent moisutre when exposed to 25°C and 50% R.H.

Based on the above a standard formula is arrived at for determing the quantity of basic desiccant required.

$$W = \frac{A\ R\ M}{120} + F \quad \text{(for tropical conditions)}$$

$$= \frac{A\ R\ M}{450} + F \quad \text{(for temperate conditions)}$$

Where : W = Weight in lbs. of basic desiccant
A = Area of barrier material
R = WVTR of barrier material
M = Storage period (months)

and $F = \frac{D}{5}$ timber above 14% moisutre

$= \frac{D}{8}$ Felt, CFB ...

$= \frac{D}{10}$ Timber/Phywood less than 14% moisture

D = Dunnage material used in lbs.

6.3 Common desiccants

The most commonly used desiccants are silica gel, activated alumina and fused calcium chloride.

7. VAPOUR PHASE (CORROSION) INHIBITOR V.P.I / V.C.I

Of the corrosion preventives, these are of recent development. VPI is available in powder form or coated form. The basic chemicals used are Dicyclohexyl ammonium nitrate, cyclohexyl ammonium carbonate and amine salts of acid radicals.

The article is mormally wrapped in the V.P.I. paper with the coated side in contact with the article. In the case of powder, after placing the article(s) in the pack, desired quantities of powder is put at different points. The principle involved is that the powder/coating slowly evaporates and forms a thin film around the article and acts as a barrier to moisutre and gases and thus prevents corrosion.

The recommended quantity is $36g/M^3$ when used as powder and $11g/M^2$ when used as coating.

TABLE - 1

CLEANING METHODS

DEGREASING METHODS

- (a) Trichloroethylene
  - Immersion
  - Vapour
  - Spray
- (b) Alkaline
  - Insitu
  - Immersion
- (c) Emulsion
  - Immersion
  - Spray
- (d) Solvent
  - Immersion
  - Spray
- (e) Steam - Jet (spray)

DERUSTING METHODS

MECHANICAL

- (a) Sand blasting
- (b) Shot blasting
- (c) Abrasion

CHEMICAL (ACID PICKLING)

- (a) Sulfuric acid
- (b) Hydrochloric acid
- (c) Phosphoric acid

ANNEXURE - VI

BELL JAR TEST

FOR

V. P. I. PAPER

CORROSION INHIBITION ABILITY TEST FOR VPI PAPER

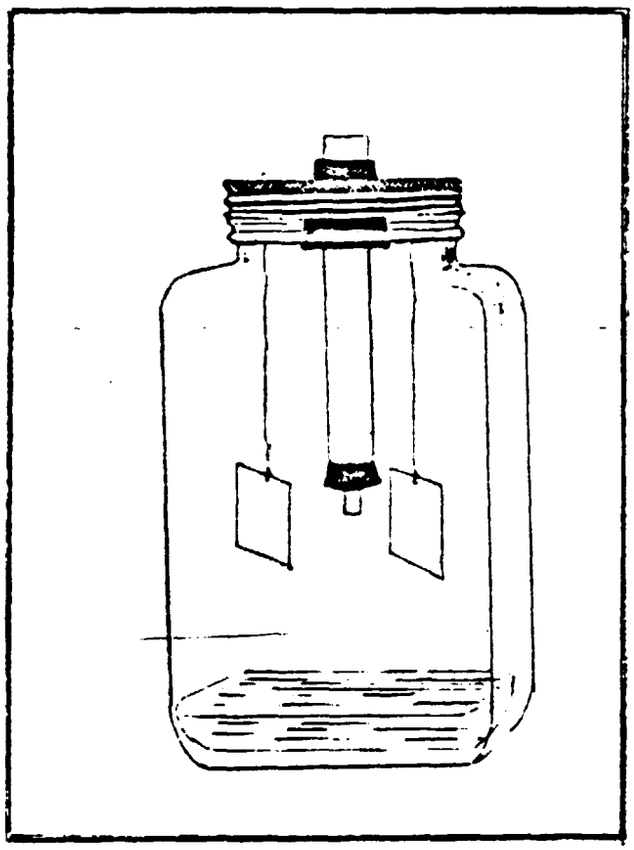
OBJECTIVE: The V.P.I. paper whould prevent corrosion of polished steel rods when tested by bell Jar test as detailed below.

APPARATUS: It consists of a wide mouthed jar(mouth diameter about 10cm and height about 30cm) closed with a rubber gasket lined or compound lined metal cap which is lacquered to prevent corrosion during use. The cap is drilled in the centre to fit a rubber stapper which in turn is drilled to hold an aluminium tube. A 0.012 - 0.013cm thick hollow aluminium tube of 16.5cm length and 2.5cm diameter is fitted to the rubber stapper of the cap such that when the cap is screwed on to the jar, 15.5cm length of the tube remains inside the bottle and rest outside. A rubber stapper with a perforation in the centre which would hold a polished steel rod of about 1cm diameter and 1.5cm length,is fitted to the bottom end of the tube.
The jar consists of a solution of potassium nitrate to give a relative humidity of 90%. (The salt may change depending on environmental temperature).
Two small perforations are made in line with the centre of the cap each at 3.5cm distance from the centre, to hold the vapour phase inhibitor (VPI) test samples by means of thread.
The test is done in triplicate and a fourth jar is used in the same way but without VPI paper in it. This acts as control.

METHOD : Carefully polish the steel rod so that it is totally free of any rust spots. Holding the rod by means of a clean muslin cloth, fix it to the rubber stopper so that 1.5cm length of the rod remains exposed. The distance between

the tip of the rod and the potassium nitrate solution is about 12cm. Tie two 5cm x 5cm VPI paper samples each to a thread. Fix the threads to each of the two perforations of the cap by means of a cellotape so that the coated side of the papers face the rod and the samples are in line horizontally with the rod. Close the cap tightly over the jar and place the assembly at 75°F for 20 hours.
Pour chilled water into the aluminium tube so as to induce moisutre condensation on the face of the steel specimen. After 3 hours open the assemblies and examine the rods for rust spots.

INTERPRETATION: The steel specimen must be free of rust is order to pass the test. If one specimen has slight rust on it, the test is repeated. All the three specimens must be free from rust.



BELL JAR TEST

APPARATUS

A N N E X U R E - VII

CUSHIONING SYSTEM AND MATERIALS

CUSHIONING SYSTEM & MATERIALS

Object of Cushion: is to mitigate shock
- by absorption
- by localisation
- by distribution

Functions of CM : Shock absorption
: Protection from abrasion
: Protection to protruded parts
: Protection to barriers
: To fill void
: To absorb liquid
: As insulation

Selection of C.M.

Storage period	Product	Properties of CM
Type of storage	Size	Quantity required
handling	Shape	Cost
Transport system	Nature	
Period	Material	
transhipment		
Outer package used		
Environmental conditions		

PROPERTIES OF CUSHIONING MATERIALS

1. Resilience
2. Rate of recovery
3. Creep
4. Compression set
5. Cushion factor
6. Damping-periodic oscillation
7. Corrosion
8. Hygroscopicity
9. Microbiological properties
10. Dusting
11. Abrasive properties
12. Effect of temperature high & low
13. Density
14. Flammability
15. Liquid absorbancy
16. Health hazard
17. Dynamic performance
18. Effect of repeated impact
19. Load bearing capacity

Classification of C.M.

(1) Based on forms: granular, bulk fibres and strips, matted fabrics, cellular structures, moulded, foamed, springs, shock mounts.

(2) Based on uses/properties:

(a) Space fillers: to fill void, prevent reorientation, absorb liquids, prevent-broken parts moving.

(b) Resilient materials: prevent damage due to repeated impacts - gp-1 Linear, gp-2 tangent and gp-3 Anomalous.

(c) Non-resilient (rigid) materials: protection from single shocks-surface/structure collapses.

(3) Based on properties: gp-1 substantially elastic materials, gp-2 relatively elastic materials, gp-3 loose space fillers (floats) gp-4 load spreaders.

CUSHIONING MATERIALS

Space fillers	Resilient C.M.	Non-resilient C.M.
Ground Cork	Rubberised Coir	Moulded pulp containers
Saw dust	Rubberised hair	Rigid polyurethene foam
Coir pith	Expanded rubber	Rigid polystyrene foam
Kieselguhr	Polyurethene foam	PVC foam
Paddy straw	Expanded polyethylene	Paper Honeycomb
Dry Grass	Expanded polystyrene	
Wood wool	Felts	
Paper shaving	Springs & shock mounts	
Creeped cellulose waddings	Cotton	
Extruded/Shreaded plastic foams		
CFB pieces		

TESTS FOR CUSHIONING MATERIAS

1. Water absorbancy
2. Porosity
3. Load Compression Charecteristics
4. Creep and Compression Set
5. Flammability
6. Mould growth
7. Density

ANNEXURE - VIII

DELAMINATION OF SUBSTRATES IN LAMINATES

DELAMINATION OF SUBSTRATES IN LAMINATES

Paper, speciality papers, films and foil are the most commonly used flexible packaging materials. The combinations of two or more of these similar or dissimilar materials are called as laminates which also belong to the family of flexible packaging materials. Among the flexible packaging materials, the laminates constitute a major share for the packaging of a variety of products due to the advantage of the combined properties of different materials.

It often becomes necessary to make quantitative and qualitative determination of the individual materials (substrates) in the laminates. In order to do this, each substrate has to be separated from the laminate. The following outlines some of the simple methods for delamination of the substrates.

To adopt the easier and quicker method it is desirable first to identify the laminate.

1. GENERAL:

Edges peel back while burning/heating on a metal back at 65-75°C. Skid a rubber covered glass rod over the surface. Samples (substrates) laminated by thermoplastics adhesive usually separate.

2. PAPER/POLYETHYLENE:

Polyethylene can be dissolved by soxhlet extration. Alternatively paper can be treated with a moderately concentrated $NaOH/NaNo_2$ solution and warmed if necessary for oxidising the paper. Paper when rubbed after washing will leave back polyethylene.

3. CELLOPHANE/POLYETHYLENE:

The method described for paper/polyethylene is applicable for cello/poly also.

4. PAPER/ALUMINIUM FOIL/POLYETHYLENE:

Method two can be followd; or

Treat the laminate with 0.5 N Hcl to dissolve foil. Paper may also get disintegrated in the process leaving polyethylene free. However, conc. Hcl if used could make the polyethylene to shrink, the reaction also being exothermic.

5. PVC/PAPER

PVC will dissolve in cyclohexanone

6. PVC/POLYETHYLENE

PVC will dissolve in cyclohexanone.

7. ALUMINIUM FOIL/POLYETHYLENE:

Laminate with PVA based adhesive should separate out when boiled with hot water or treated with amylacetate.

8. ALUMINIUM FOIL/PAPER

If PVA based adhesive is used, the substrates should separate out when boiled with hot water or treated with amylacetate.

9. LAMINATES WITH WAX AS BONDING AEDIUM:

When treated with CCl_4 (carbon tetra chloride), the wax should dissolve, and thus the substrates separate out.

10. POLYESTER/POLYETHYLENE:

Polyethylene can be dissolved in toluene or benzene by soxhlet extration.

11. NYLON/POLYETHYLENE:

Treatment with 40% H_2SO_4 will dissolve nylon. Or treatment with toluene will separate PE.

12. COATED FILM:

Most of them separate out by heating in water bath.

13. ALUMINIUM FOIL/HOT MELT/TISSUE:

On heating over a hot plate the substrate will peel back, as hot melt will soften.

Alternatively on rinsing with $NaOH/NaNo_2$ solution tissue will soften. Dry and remove tissue.

14. CELLOPHANE/POLYETHYLENE/ALUMINIUM FOIL/POLY ETHYLENE:

Treatment with NaOH - warm, wash and dry will remove cellophene.

Treatment with warm toluene will separate polyethylene. If polyethlene is found difficult to separate then this can be dissolved by soxhlet extraction.

15. POLYESTER/ALUMINIUM FOIL/NYLON/POLYETHYLENE:

Treatment with hot water/Toluene will separate polyester/foil from Nylon/polyethylene. Further treatment with toluene of Nylon/poly, poly will separate or dissolve. Similarly treatment of polyester/foil further with hot toluene separate the layers. Alternatively foil can be dissolved in hydrochloric acid.

16. OPP OR POLYESTER/ALUMINIUM FOIL/POLYETHYLENE:

Warming over hot plate will peal back upper layer. Polyethlene can be separated from foil by treatment with toluene or toluene extraction.

17. GLASSINE/POLYETHYLENE/ALUMINIUM FOIL/POLY ETHYLENE/GLASSINE:

Glassine can be removed by treatment with $NaOH/NaNo_2$. Treatment with toluene will separate polyethene and aluminium foil layers. Polyethylene can also be removed by toluene soxhlet extraction.

18. CELLOPHANE/POLYETHYLENE/PAPER/POLYETHYLENE/ALUMINIUM FOIL/POLYETHYLENE

Remove cellophane with NaOH treatment. Treatment with toluene or toluene soxhlet extraction will remove/dissolve polyethylene layers. Paper aluminium foil will be free.

19. METALLISED POLYESTER:

The metallised foil can be removed by treating and if necessary by very gently scrubbing, with 0.5N Hcl or mild aquaregia.

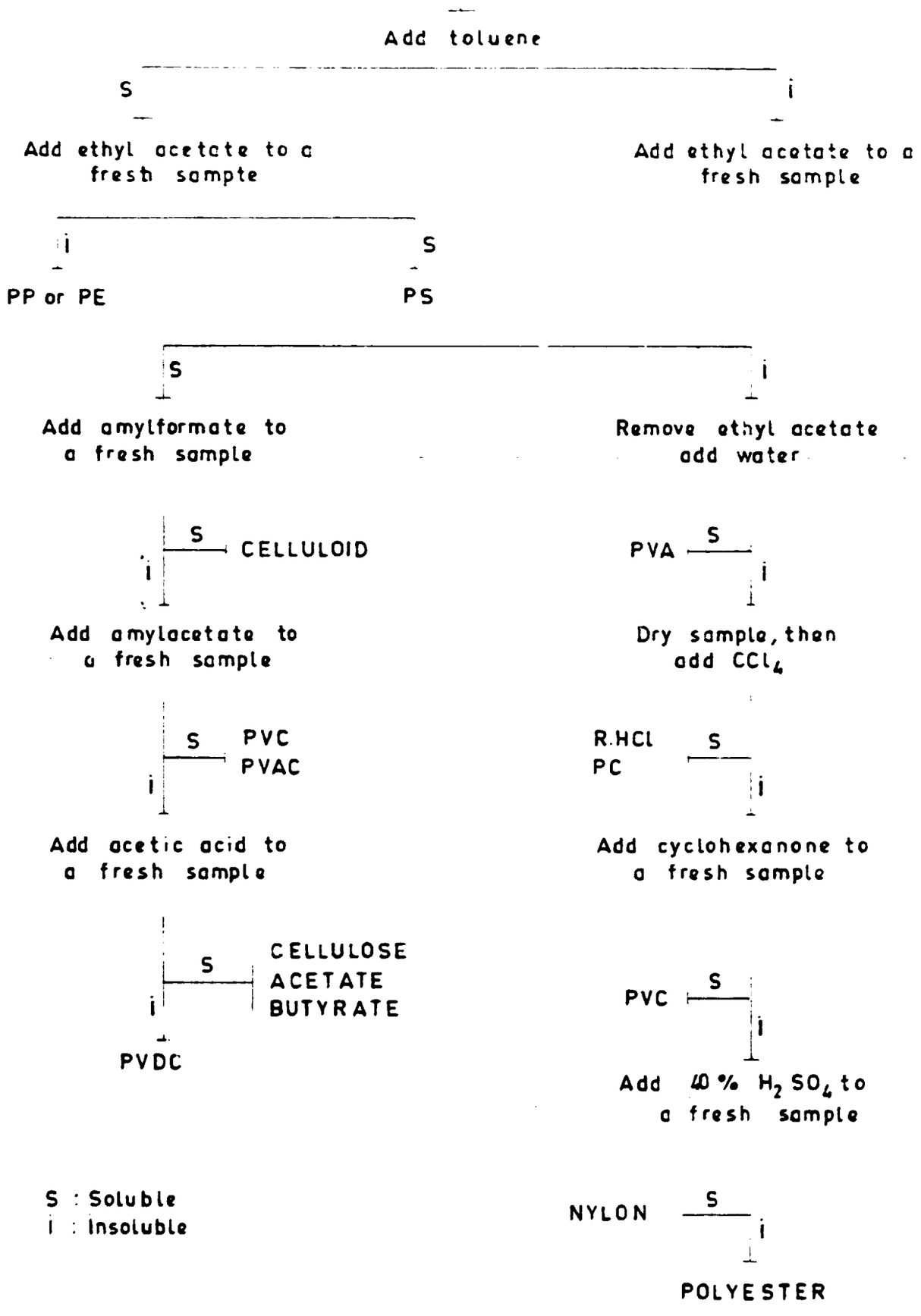
20. POLYPROPYLENE/POLYETHYLENE:

The substrates will separate out on treatment with toluene (if necessary warm).

ANNEXURE - IX

IDENTIFICATION OF PLASTICS
SOLUBILITY AND FLAME TESTS

SAMPLE



S : Soluble
i : Insoluble

PLASTIC FILMS SOLUBILITY CHART

FILM MATERIAL	SOLVENTS									
	Water	Hot Toluene	Methyl Alcohol	Ether	Acetone	Tetrachloro ethane	Ethyl acetate	Amyl Acetate	Acetic Acid	Cyclo hexanone
Cellulose acetate	I	I	SS	I	S	S	S	I	S	S-PS
Cellulose acetate butyrate	I	I	SS	SS	S	-	S	I	S	-
Cellulose nitrate	I	I	SS	SS	S	I	-	-	S	S
Ethyl cellulose	I	S	S	SS	S	I	-	-	S	S-PS
Gelatine	S	I	I	I	I	-	-	-	-	-
Methyl cellulose	S	I	I	I	I	S	I	-	-	-
Nylon	I	I	-	-	-	I	I	-	I	I
Polycarbonate	I	I	-	-	-	I	-	-	-	-
Polyethylene	I	S	I	I	I	S	I	I	I	I
Polymethyl methacrylate	I	S	I	I	S	-	I	I	I	PS
Polytereph-thalate	I	-	-	-	-	-	-	I	-	I
Polyvinyl alcohol	Softens (S)	I	I	I	I	I to SS	I	S -PS	-	-
Polyvinyl chloride	I	S	I	I	I	I	I	I	I	S
Polyvinyl chloride acetate (co-polymer)	I	I	I	I	S	-	-	-	I	S
Polystyrene	I	S	I	S	Softens	I	S	I	I	I
Regenerated cellulose	I	I	I	I	I	-	-	-	-	-
Rubber hydrochloride	I	S	I	I	I	S	I	-	I	-

I : INSOLUBLE S : SOLUBLE SS : SLIGHTLY SOLUBLE

FLAME TEST - FOR IDENTIFICATION OF PLASTIC FILMS

TEST : Hold a strip of the film in a forcep to the edge of a small non-luminous bunsen flame.

OBSERVE : Rate of burning; continuity of burning after withdrawing from flame, immediate color of flame, and odor of the smoke.

	FILM MATERIAL	ODOR	RATE OF BURNING	REMARKS
1-	Cellulose acetate	Mixture of acetic and burning paper.	Will continue to burn slowly when withdrawn from flame. Breaking or spluttering sound.	Edges of flame yellow green. Sample melts to brown drops.
2-	Cellulose acetate butyrate	Odour of rancid butter.	Continues to burn, melts and drips.	Dark yellow flame with blue edge.
3-	Cellulose nitrate	Nearly camphor	Very quick burning	Intense white flame.
4-	Ethyl cellulose	Sweet smell	Fairly rapid	Yellow-green to orange edges to flame. Melts to brown drops which on dropping into cold water forms round platelets.
5-	Gelatine	Odor of burning hair	Extinguishes but chars.	Fumes give transient smell on hardening with formaldehyde.
6-	Methyl cellulose	Burning paper	Extinguishes on removal from flame but continues to smoulder.	
7-	Nylon	Burning hair smell	Self extinguishing, melts and drips.	Blue flame with green edge
8-	Poly carbonates	Vigorous but pleasent odour	Self extinguishes	Yellow orange flame with black smoke.
9-	Polyethylene	Waxy	Burns fairly rapidly	Melts and give clear bead drops.

10-	Polymethyl methacrylate	Fruity odour
11-	Poly-terephthalates (Polyesters)	Vigorous odour
12-	Polyvinyl alcohol	Soapy odour (Pungent odour)
13-	Polyvinyl chloride	Acrid
14-	Polyvinyl chloride-acetate (Co-polymer)	Odour of acrid PVC and acetic combined
15-	Polyvinylidene chloride	Acrid
16-	Polystyrene	Characteristic smell of merigolds
17-	Regenerated Cellulose	burning paper
18-	Rubber hydrochloride	Rubbery

Burns slowly with splutting sound	Very luminous flame, with blue flame at lower region.
Burns steadily and gets softened	Yellow flame with black smoke.
Moderate burning, extinguishes slowly	Yellow flame and slightly smoky (grey smoke)
Self extinguishing	Greenish tinge - white at flame. Darkens rapidly, softens and decomposes.
Generally self extinguishing; If strongly ignited will continue to burn.	Greenish tinge - while at flame.
Self extinguishing	Greenish tinge - while at flame.
Burns fairly rapidly	Yellow white, smoky, luminous flame.
Burns fairly rapidly and smoulders on extinguishing	Yellow orange colored flame.
Self extinguishing	Green flame at edges to begin with and then yellow.

Annexure - X

SIGNIFICANCE OF TESTS/PROPERTIES

Sl. NO.	TEST	DESCRIPTION	UNIT
1.	Thickness	Thickness refers to the caliper of paper, film, boards, laminates etc. This is related to the grammage and bulk density of the material and has on influence on the physical properties of the material.	mm gauge micron
2.	Basis weight	This is also referred to as grammage or ream weight. This represents the weight of the paper or board of a given unit arealike weight per square metre or weight of a ream of board of 480/500 sheets of a particular dimension.	grams per metre square (g/M^2)
3.	Bursting strength	It is a physical property of paper, boards, corrugated and solid boards. It gives an idea of the strength of the material and therefore easily adopted as a quality control test. Bursting strength gives the ability of the material to with stand gradual increase in pressure applied either hydraulicly or pneumatically. Bursting strength is dependent on the basic material, formation, and construction. Increased lavels of moisture content in the material decreases the burst value. Bursting strength is also sometimes represented as burst factor - which is the ratio of bursting strength to grammage.	kg/cm^2
4.	Puncture Resistance	This is also an important physical property of boards including corrugated and solid boards. Unlike bursting strength, puncture gives the strength of the material to withstand quick and instantanious	kg-cm

SL NO.	TEST	DESCRIPTION	UNIT
		shock or application of force. The puncture values also are dependent on the basic material, and its construction. Puncture values also give an idea of the overall performance of the boxes.	
5.	Stiffness	Stiffness is the ability of the packaging materials - particularly paper and boards to resist bending forces. This property is related to thickness, grammage and bulk density of the material. Normally a higher caliper gives a higher stiffness value. Stiffness of the board is correlated to the ultimate compression strength of the converted carton or box. Moisture content in the board has a direct influence on the stiffness charecteristic.	grams force or kgf.
6.	Tensile strength and Elongation	Tesnile and elongation properties are generally tested for paper, plastics sheets and films, textile and synthetic yarn and fabric etc. Tensile property varies with the thickness of the material and elongation is influenced by the elasticity of the material. Test conditions also influence the values. Tensile and elongation properties are used for quality control and specification of materials. Tensile property is considered as a basic engineering property required in many application. This property is also influenced by the moisture content and formation.	kgf for cm width kgf/cm^2 Elongation in percentage

SL NO.	TEST	DESCRIPTION	UNIT
7.	Folding Endurance	This test is mainly used for paper and thin boards, and sometimes for flexible materials. The folding endurance gives the number of double folds that the material would give before repture. The importance of the property is in the conversion industry (bag and carton making)and wherever paperbased materials are used for multiple and long term use -eg- document paper, stamp paper, currency notes etc.	Number of double folds
8.	Friction (Static and dynamic)	This property is more commonly known as coefficient of friction or slip. Slip is the ability of two pieces of same film(similar material) to slide over one another or a piece of film(one material) to slide over a metal surface. The slip value is the reciprocal of co-efficient of friction. This is one of the properties used to predict film/laminates machineability. A deficiency of this property leads to sticking.	Co-efficient of friction in mumerical value.
9.	Tear	There are two aspects - namely (Tear initiation and tear propogation) and Tear propogation. Tear initiation and propogation is the force required to initiate tearing a die cut sample placed in the grips of a tensile tester (Instron) and the grips(jaws) separated at a fixed rate. The specimen is cut in such a manner that the concentration is produced in the region at right angles and tear initiates at that point. The maximum stress recorded is the tear initiation strength.	grams force or kgf

SL NO.	TEST	DESCRIPTION	UNIT
		Tear propogation (Elmendorf) is the force required to propogate a tear through a fixed distance of film/paper/board after the tear has already been initiated.	
10.	Flat Crush	Flat crush is a property associated to flute charecteristics of single face and single wall (2-ply and 3-ply) corrugated fibre boards. It is the measure of the resistance of the flutes to a force applied in perpendicular when the board is placed flat. Thus it gives indirectly the resiliency or cushioning effect. The board material components, and air humidity will influence the property.	kg
11	Edge Crush	This is also an important property of corrugated boards. A specimen of predetermined length and height with flutes running vertical is placed between the platens and force required to crush the column is determined. This gives the measure of the board resistance to vertical force. Thus the value can be correlated to the compression strength of the box and its stack performance.	kg (per test specimen length and column height)
12	Ring Crush	This is similar to edge crush but the test is carried out for the liner and corrugating medium. The sample is placed in the form of a ring between the platens and the force required to crush is measured. Ring crush is related to stiffness of the material. Variations in the experimental set-up and moisture content in the specimen will affect the values.	grams force or kg force

SL NO.	TEST	DESCRIPTION	UNIT
13.	Opacity	Opacity is the degree of imperviousness of the material to light. This has a direct significance on end use application of the material. Products requiring light protection should be packed in more opaque materials. Opacity is normally measured in terms of contrast ratio or transmittance. In the case of paper and board opacity is dependant on degree of bleaching, fillers and coatings used, etc. In the case of films it will be dependent on virginity of the material, additives, coatings etc.	In Percentage Value
14.	Haze	The basic method is used for measurement of light transmitting and light scattering properties of transparent plastics. Haze is the ratio of diffuse transmittance to total transmittance and is expressed in percentage. Luminous transmittance is the ratio of transmitted to incident light. Haze values help to identify the heterogenous surface and internal defects which influence the diffusion or deviation of light. This test/property is useful for quality control purposes and research as this can be related to fundamental properties.	In Percentage Value

SL NO.	TEST	DESCRIPTION	UNIT
15	Gloss	Gloss is a surface and overall property. The gloss of a surface can be affected due to environmental conditions, scuffing and abrasion and development of haze. Glass values could be used to merit material in their order of resistance to mar. Gloss also is a measure of the shing appearance of films and surfaces. Gloss can be affected by variation in surface smoothness and flatness	In percentage value
16	Dart Impact	The falling dart impact test is a standard test for polyethylene and other plastics films. The weight that will result in the failure of 50% of the samples tested is determined. This would give an idea of resistance of the film to impact forces. The gauge, uniformity, defects etc in the film influence the test result.	groms
17	Abrasion or scuff Resistance	Many packaging materials like paper & board and printed surfaces are sensitive to surface abrasion. This leads to spoilage of the print and surface properties. Abrasion can be due to continuous contact & movement of similar surfaces or dissimilar surfaces. Due to surface abrasion surface print or fibres could be removed. The test normally helps to assess the loss in weight and visual observations like print marring.	Loss in weight in mg/sq. M. (for given number of revolutions)
18	Impact Resistance	This property is a measure of the ability of the material to absorb energy in a very short time and is usually regarded as closely related to toughness.	

SL NO.	TEST	DESCRIPTION	UNIT
19	Moisture Content	Although most of the plastics materials are not very sensitive to moisture, cellulosics like paper, wood etc behave differently. They absorb or desorb moisture according to the temperature and relative humidity of the atmosphere. It is one of the significant properties and can grately influence other charecteristics. Neither high moisture level nor very dry condition are desirable. Strength properties like tensile, fold, tear, burst etc either increase or decrease due to varying moisture conditions. Other properties like permeability, scuff, also are influenced by variations in moisture level. For smooth conversion, optimum moisture level is to be maintained. Moisture in wood can affect the nailing and nail holding power. Moisture or water content in wood is a direct input and therefere is related to tare weight. Higher moisture/water level also attract micro organisms. All samples should be conditioned at standard temperature and humidity levels, to obtain reproduceable results and for comparison purposes among different materials.	
20	pH	The term pH is used to designate the acidity or alkalinity level. In packaging, it has more significance w.r.t paper, board, adhesives, labels, glass etc. and to a lesser degree w.r.t plastics. Rigid	

SL NO.	TEST	DESCRIPTION	UNIT
		control of acidity is required for paper used for permanent use such as documents and bond papers. The glass vials used for injections should be neutral as alkalinity of glass will deteriorate the injectible.	
21	Oil penetration	The test helps to determine the time required for a standard oil to penetrate from one side to the other side of the substrate or time required for a uniform spread of the oil on the surface. Oil penetration values give the printing quality of the paper and board. A quick penetration will offect the second side of the sheet and a show absorbancy rate can result in the lift of print and spoiling the next adjacent layer. The test can also be used to study the sensitivity of coated surfaces, plastics films etc.	
22	Water Penetration (Cobb)	In this a known area of the sample is brought in contact with water for a specified interval of time, and the quantity of water absorbed per square mater is taken as an index of penetration. The value is expressed as cobb value. Test is done for paper, sized papers, treated and coated papers & boards, and waterproof paper. The property should be checked for both sides of the material.	grams/M^2 cobb (- mintues)

SL. NO.	TEST	DESCRIPTION	UNIT
23.	Viscosity	Viscosity is the fludity of the material and is represented as coeffecient of viscosity. Viscosity and fluidty are inverse in charecter. This is tested for adhesives, inks, coating compounds, varnishes, etc. Optimum viscosity needs to be used to abtain better tack & adhesion, uniform coating, better print, and maximum yield (coverage).	co-effcient of viscosity centipoise or time of flow in seconds.
24.	Air Permeability	Air permeability represents the ability to permit flow of air from one side to the other under a pressure difference. This property is related to porosity or surface charecteristics but the latter cannot be a measure of air permeability. The surface properties, pore size, number, shape and pattern of distribution, however, have an influence on air permeability. Air permeability gives an idea of the compactness and uniformity of paper and board materials. It also helps to know the spread and penetration of inks, adhesives, etc.	expressed in time secs for given volume of air to pass through
25.	GTR (Gas Transmission Rate) or Gas Permeability)	GTR is defined as the volume of gas that passes through a sample of unit area under unit pressure differential at specified humidity and temperature and for specified thickness. The permeability co-efficient is a more fundamental property and is independent of the geometry of the sample since it is defined in terms of	CCs for given thickness of material

SL NO.	TEST	DESCRIPTION	UNIT
		unit thickness. It is the product of the solubility of the gas in the film and the diffusion rate of the gas through the film. The GTR property is important for packaging products that are sensitive to specific gases like oxygen leading to oxidative rancidity and deterioration	
26.	WVTR Water vapour transmission	WVTR is defined as the quantity of water vapour that passes through a sample of unit area at specified humidity and temperature, for every 24hrs. The basic material & its composition and uniformity will influence the WVTk cherecteristics. This is a very important property and useful both as a Q.C. index and in the selection and development of package for many products, particularly those which are moisture sensitive. Conventionally a dish method is used which is still popular and more commonly used. Now more sophisticated instruments are developed for determination of W.V.T.R. porperty	g/M^2. 24hrs at $38^{o}C$, 90% RH
27.	Refractive Index	This is the measurement of index of refraction of transparent organic plastics materials. The refractive Index represents a fundamental property which is useful for control of purity and composition. Thus the test (property) can be used for identification purposes and for optical parts design.	

ANNEXURE - XI

EQUIPMENT UTILISATION

SL NO.	EQUIPMENT	USE
0	Constant Humidity & Temperature Room	This is part of the packaging laboratory where the temperature and relative humidity are maintained constant. The conditions are in conformity to national standards VIZ 20°C and 65% R.H. some of the important equipment are placed here. The samples before testing are conditioned in this atmosphere. This is necessary for comparative evaluation and reproducebility of tests.
1	Instron	This is a universal testing machine used for testing of paper, board, plastic, yarn, fabric and other materials. Various tests like tensile, elongation, tear, slip, crush, compression etc. can be done with Instron. This model has a maximum load capacity of 10,000kg. Different load cells areused depending on test requirements. the Instron has an automatic chart recording system. The speed of grip separation and chart can be varied to conform to specific test requirements/procedure.
2-3	Bursting Strength Tester	There are two bursting strength testers. One with test capacity of 6kg/cm^2 and the other 45kg/cm^2. The testers can be connected to digital peak hold metre to get more accurate peak burst values. These are used to test the burst strength property of paper, boards, corrugated and solid boards, films, fabric etc. Busting strength is a useful quality control test for packaging materials. This is normally expressed in kg/cm^2. Both the testers are operated hydraulically, and the pressure is applied through a diaphragm on to the sample clamped above.
4	Poroscope (Pin hole tester)	This equipment is used for testing the number of pores(pinholes) in the test sample. The poroscope is generally used for testing non conductive and protective coatings on electically conductive materials.

SL NO.	EQUIPMENT	USE
		In the packaging laboratory it is mainly used for plastics films. After setting-up the equipment, the voltage adjuster is set as per the sample and the electrode is brought in contact with the test sample. Each pore causes a visible spark discherge and is automatically counted and recorded in the counter. A higher counter indicates more number of pores and vice-a-versa.
5	Folding Endurance Tester	This is a schopper type tester. The tester is used for testing the folding cherecteristics of packaging materials like paper, board and film. The sample is fixed between two grips through a folding head. The knife head moves the sample forword and backward through its middle line. Each forward and backward motion together is counted as one double fold. The counter automatically stops when the sample snaps(fails). The number of double fold is recorded as the test value.
6	Elmendorf Tear Tester	This equipment is used for testing the tear propogation of packaging materials like paper and boards. The sample is loaded between the sample holders and an initial cut is made in the sample with the help of the knife, placed at the rear of the sample holder. The pendulam is then released and its swing is influenced by the resistance offered by the same to tear propogation. The force required to tear is recorded from the pendulam indicator needle and is expressed in grams. The equipment is levelled, zero adjusted and calibrated before sample testing.

SL NO.	EQUIPMENT	U S E
7	Gurley Densometer	Densometer is used to measure the air permeability of a packaging material. The sample is mounted on base head and the cylinder is raised. The cylinder is marked with volume levels. The time taken for a particular volume of air to pass through the sample is recorded. A longer interval of time would indicate a lower permeability. The surface property, pore size, number, shape and pattern of distribution influence air permeability.
8.	Compression Tester Ring Crush Flat Crush and Edge Crush	This tester is used to study the property of ring crush of corrugating medium, and flat crush of 2-ply and 3-ply corrugated boards and edge crush (vertical columm crush) of corrugated boards(3-ply, 5-ply, 7-ply). According to the material to be tested and test requirement the sample is cut and placed over the lower platen of the tester. The upper platen is then lowered at constant speed and force applied on to the sample. Force required to compress or crush the sample is measured (recorded). A better ring crush value is an indication of the stiffness and therefore goodness of the medium. A high flat crush value of board indicates good flute formation and cushion properties. Edge or column crush gives an idea of the performance of the box in terms of compression strength.
9	Dial Gauge (Thickness Tester)	Dial gauge is used to measure the thickness of paper, board, films and laminates. Dial gauge both manually operated and electrically operated are available. The sample is inserted between the base head and sensing head and the thickness(caliper) is

SL NO.	EQUIPMENT	U S E
		directly read off from the dial gauge. Normally about 10 reading are taken at different places of the sample and average taken. Thickness or caliper is expressed in mm, gauge or micron.
10	Thermo Hygro meter	This is used for measurement of temperature and relatvie humidity of the atmosphere. The sensitive heads fluctuate as per changes in the atmosphere and recording pens continuosly mark on the graph fed into the recorder. This helps to confirm the conditions maintained or adjust the conditioning equipment as required.
11	Aspiration Psychrometer	Aspiration psychrometer helps to determine exactly the temperature and humidity of air. The basic principle of wet and dry thermometer and vapour pressure are adopted and form the basic principle of the working of the instrument.
12	Wood Moisture Meter	The quantity of moisture present in wood is determined using wood moisturementer. The principle of conductivity is used in designing the equipment. The probe head is inserted into the wood sample and voltage of current generated is dependant on the moisture level. The dial indicator is calibrated in terms of moisture percentage and therefore the percentage moisture is directly read off. Several observations at differt spots of the sample are made and average moisture level percentage calculated.
13	Paper Moisture Meter	The principle of working is the same as that of wood moisturemeter. Here the probe(electrode) is placed on the surface of the paper sample and the moisture content percentage is read off directly from the dial.

SL NO.	EQUIPMENT	USE
14	Paper Curl Tester	This equipment helps to study the curling charecterestics of paper, particularly when the surface is wet. The average value and the range of maximum curvature or the range of time to reach maximum curvature is reported.
15	Williams Oil Penetration Tester	The test helps to determine the time required for a standard oil to penetrate from one side to the other side of the material or time required for a uniform spread of the oil on the surface. In the test the sample specimen is cut to orifice size and placed below the glass plate. The temperature of oil is preset and the equipment tilted downword in the forward direction and the time required for oil penetration recorded. This has relevance to printing and other packaging applications.
16	Single pen Balance	The capacity of this balance is 1200g. Generally it is used for determination of basis weight of paper material. Samples of convenient sizes are cut and weighed. Then weight per square metre calculated which gives the basis weight.
17	Stiffness Tester (Taber)	The resistance to bending force offered by paper & board is measured by the stiffness tester. Thus the bending force or resistance value is a measure of the stiffness of the material. The sample is fixed between two(top and bottom) points and by movement of the lower head is bent to the desired degree(angle). Normally the angle of bend is 15^{o}. The force required to bend the sample in either directions is found and average taken. In addition to finding the stiffness,

SL NO.	EQUIPMENT	U S E
		physical observations on the behaviour of the material during and when bent are also made. These include cracks, splits etc.
18	Tensile Tester (Shopper type)	The capacity (load range) is 30kg. This shopper type tensile tester is used for finding the tensile strength property of paper. The smaple is cut in required dimensions - in the form a long strip - and fixed between the upper and lower jaw. The sample is slowly and steadily (at a constant speed) is pulled down by lowering or downword movement of the lower jaw. The movement of the jaw and the Tensile force of the material influences the pendulam movement which stops when the sample snaps (fails). The T.S. is read off directly from the scale. A number of specimen from the sample are tested and average (sometimes maximum and minimum) value determined.
19	Tensile Tester (Shopper type)	This tensile tester has a capacity of kg. and is more commonly used for plastics straps, and bands. The principle of operation, and working is same as that of paper tensile tester, as above.
20	Haze Meter	Haze meter is used for measurement of light transmitting and light scattering properties of plastics films (transparent plastics). The equipment is first calibrated & against a standard meterial values of light transmittence is taken. Similarly values taken for the test sample. Haze is the ratio of diffuse transmittence to total transmittence. Haze property is useful to study the surface nature and internal defects in the material. These defects influence the diffusion or deviation of light.

SL NO.	EQUIPMENT	U S E
21.	Gloss Meter	Gloss is a surface and overall property of the material and can be affected by surface charecteristics, neze and mechenical damage to the surface. It often is referred to the shine of the surface. Thus the optical properties are affected by these factors. Light reflection properties of the test sample is measured against standard sample values and the percentage is recorded as gloss value.
22	Abrasion Tester	This is also called as rub resistence or scuff resistance tester. This helps to study the effect of mechenical abrasion on the material. The property can be studied for abrasion between similar and dissimilar properties. The sample is cut as per dimensional requirement and placed on the Round lead surface and abrading or moving heads. These are preweighed. The surfaces are kept in contact and moving head allowed to abrade. Normally 2000 revolutions are made. A weight (754g) is also placed over the moving head. The material removed during abrasion is taken out by vacuum. The sample is reweighed at the end of the test and loss in weight in mg per square metre calculated. At the end of the test, the effects of abrasion on the surface of the material can also be observed. Such as print lift, print spread, fibre lift etc.
23	Oscilloscope	Oscilloscope is a multipurpose unit and can be used for checking, calibration, and measurement. The oscilloscope can be connected to various testing equipment. The unit is first calibrated and standardised according to input requirement. The horizontal time & vertical scale are suitably adjusted to get the best curve.

SL NO.	EQUIPMENT	U S E
24.	G T R Tester	GTR tester is used for studying the gas transmission characteristics of various packaging materials like speciality and coated papers, cellulosic and plastics films and foil, and laminates. The GTR tester essentially consists of GTR cells, manometers, vacuum pump and vacuum gauge, and required gas cylinders. A recorder can also be connected. The principle involves vacuumising the lower head of the cell and system as such, mounting of sample in the cell, and passing the gas from one side through the sample, at a steady rate and pressure. Depending upon the transmission of gas through the sample a pressure differtial is built-up on the other side and accordingly the mercury level changes. The test is continued for different time intervals - say 1,2,3,4 ... hrs. and the change in mercury levels noted. From these values the GTR can be calculated applying the formula.
25.	TAPE Pressure Tester	Bonding charecteristics and bond pressure of tapes are studied through this tester.
26.	Constant Temperature and Humidity Oven	The constant temperature and humidity oven is meant for exposure of samples at different humidity and temperature conditions. The conditions are set by preadjusting the dry and wet thermometers, to build-up the humidity required. The renge is 40°C and 90% R.H. Temperature level up to environmental level can be maintained and humidities adjusted as requred. This cabinet is most commonly used for WVTR studies. The conditions maintained are 38-40°C and 90% R.H. The aluminium dishes with samples sealed with wax, also containing anhydrous $CaCl_2$ are exposed.

SL NO.	EQUIPMENT	U S E
27.	Dart Impact Tester	The dart impact test is a standard test for polyethylene and other plastics films. The weight that will result in the failure of the 50% of the samples tested is determined. The sample is mounted on a base. The dart is fitted to the moveable dart head to the desired height. The dart is dropped on to the film and failure or otherwise noted. The dart weight or the dart height can be varied to create different impact force. This test gives an idea of the resistance of the film to impact forces.
28.	Flute Tester	This tester is used for making the corrugated medium flutes (fluted paper or medium). By changing the flute roller, A,B,C,D or E flutes can be made. The equipment is set-up and temperature adjusted. A strip of the paper or medium passed through the roller to get the fluted paper. This is then tested for its ringcrush or flat crush value in the compression tester.
29	Scoring Strength Tester	This tester is used to study the creasing(scoring) charecteristics of paper boards. The equipment has a top and bottom platen and different scoring rules (2,3,4 points etc) with male and female contours can be fitted. The sample is fed and creasing properties studied. The creasing properties depend on thickness and density of the material. Moisture content also influence the property. Normally a higher caliper board requires a wide point scoring rule.
30	SLIP Tester	The slip characteristics of various materials can be studied using a slip tester. Slip is mainly a surface phenomenon. Packaging materials like plastics

SL NO.	EQUIPMENT	U S E
		films, paper, textile fabric can be tested. The underside of the sled and slide plate are stuck with the sample. The load required to cause slip is determined. From this value the dynamic and static slip are calculated. The equipment is provided with a chart recorder which gives the force of resistance against the slip.
31	Melt Indexer	The melt index is an useful guide for the plastic industries for their manufacturing process. This is measured in relation to the flow rate of heat-versatile materials. The principle involves in determining the weight of the material in grams that flows through the orifice for tenminutes at a given temperature and load (100°C and 21...). The flow rate and density of the polymer can also be calculated.
32	Polari-meter	Polarimeter works on optical principles and is used to measure the degree of optical activity. The degree of optical activity when the solution is exposed to sodium light is measured. The density of the solution or conversely the specific degree of optical activity can be calculated.
33	Heat Sealer	The heat sealing (heat seal closure) of the plastics films, laminates and coated materials are governed by three factors VIZ-Temperature, pressure and dwall time. The heat sealer is provided with these three control parameters. By variations of these, the best heat seal conditions could be ascertained. The seal strength is normally deatermined on a tensile tester.

SL NO.	EQUIPMENT	U S E
34	pH Meter	pH meter is normally used to measure the acidity or alkalinity of a solution. This property has wide application in the field of packaging. This is commonly used for testing of pH of paper, board, adhesives, inks etc. The pH meter is first standardised with a buffer solution, which then is replaced by the test solution. The pH is directly read off from the indicator gauge.
35.	Autoclave	The autoctave is an electrically heated type and steam generated from the built in generator is supplied to the top of the chamber. The pressure working range is 0.35 to 2.25 kgf/cm^2. A timer is installed which starts when the predetermined pressure is achieved and cuts off after the time duration for heating is complete. One of the most common use is in food processing and microbiological studies. Also used for sterilisation purpose.
36.	Distilled Water Equipment	This is used for making distilled water required for many laboratory testing. The distilled water has a pH nearly 7, Viz neutral.
37	Smoothness Tester	This equipment is used for measuring the smoothness of surfaces of various packaging materials. A predetermined volume of air is passed between the specimen and a smooth table surface, under a pressure of 380mm of Hg. The time required for the volume of air (normally 10ml) is determined, which corresponds to 20mm Hg pressure difference. The smoothness is expressed in terms of this time factor.

SL NO.	EQUIPMENT	U S E
38.	Tack Tester	Tack is an important property of adhesives and this tester is used for determining such property. The adhesive tape specimen is stuck between a crosshead and top of the probe. To the probe it is fixed by the weight. The specimen is torn off from the probe and the force required for the same is measured which gives an indication of the tack property.
39.	Oxygen Indicator	This is a portable instrument used for determination of oxygen content in a confined space like pouch, bag, carton etc. This is very useful particularly where oxygen sensitive products are packed.
40.	Tinto Meter	The lovibond tintometer is used for colour measuring purposes and the results are normally expressed in lovibond scale. The tint of the test specimen is compared in the light of three primary colours Viz Red, yellow and blue, and colour combinations such as orange, green and violet. The sample is described as dull or bright. This method is very helpful for colour matching and is widely accepted.
41.	Water Bath	Water bath is basically used for heating purposes. The container containing sample to be heated is placed in the water bath(container with water) and heated. This is more useful when slow heating is desired and direct flame heating is not desired.
42.	Repellancy Tester	Repellancy tester is used for qualitative evaluation of repellancy property of leather garment materials to water. A wrinkleless specific area of the test sample is placed and 250ml of water sprayed. The sample is tapped once each along 180°C and the wetted surface is compared to a standard chart and the qualitative rating is made.

SL NO.	EQUIPMENT	U S E
43.	Viscometer	This particular model is used for measurement of viscous resistence torque of liquids. In other words it is used to determine the viscosity. Viscosity is an important property for many applications in packaging such as adhesives, coating compounds, lacquers, inks, rest preventives etc.
44.	Refracto-meter (ABBE's)	This equipment is used for measurement of Refractive Index. This is an optical property. Briefly the ray constituting the critical angle, on emerging from the prism, fall on mirror where they are reflected into the field telescope. Position of coincidence of borderline(reflected) to crosswire gives the refractive index. Samples of liquids, solids, thin films etc can be suitably positioned on the prism and R.I. found.
45.	Corrosion Catalyser Tester	This is nothing but a humity/temperature controlled cabinet. It is generally used to study the rust preventive properties of oils, greases etc against ligh humidity. The tester is adjusted to ligh temperature & ligh humidity conditions of 50°C & 80% R.H. The sample prepared is exposed to the above conditions to the desired time and withdrown and the rust spots (square) counted and graded.
46.	Shock Recorder	These are accelerometers which are sensitive to shocks and impacts and are used for studying the shock absorbing or cushioning properties. Normally known as accelerometers and used in conjection with a drop impact tester, amplifier and recording systems. The other group is impact-o-graphs which are used to study the journey hazards. The impact-o-graphs are different types one way, two way and three way -

SL NO.	EQUIPMENT	U S E
		they can measure & record the impacts experienced by the packaging during handling and transportation from one, two or three directions. The results are useful to plan and schedule the intensity of testing required in the laboratory to simulate actual field conditions.
47.	Cobb Tester	This is a simple method to study the water penetration properties. The water penetration or cobb value is tested for paper, board, coated & treated paper & board, waterproof paper etc. The sample of particular area is exposed to a water level and after a desired time the increase in weight is determined. The water absorbed per sq.M. is calculated and expressed as cobb value (mentioning exposure time).
48.	Chemical Balance	This is a single pan, sauter model balance, used for accurate weighing purposes. The range is upto 200g, with an accurancy of $\pm$ 0.1 mg.
49.	Furnace	The muffle furnace has a heating range of 1100^{o}C. It is suitably insulated, with a pyrometer/thermostet control. It is used for high temperature drying, determination of ash content etc.
50.	Shelf Life Cabin	This is basically a room with controlled atmospheric temperature. It is provided with shelves and a sensitive balance. A series of desiccators are placed inside and each desiccator contains saturated solutions of different chemical salts which correspond to different relative humidity conditions, within the desiccator, at the temperature maintained.

SL NO.	EQUIPMENT	U S E
		This set of conditions are mainly used for determining the shelf life of various products in different packages. These could also be used to study the influence of different humidities on packaging materials and their properties. The salts used should be pure and water distilled. The solution should be saturated.
51.	Salt Spray Tester	Salt spray tester is used to study the corrosion resistance of materials and the usefulness of coatings, paintings, plating, and application of preventives. It is provided with a tank to hold salt water at desired concentrotion and pressure and temperature are maintained at constant level. The test sample is exposed to the salt atmosphere for desired period of time and withdrawn to study the effects. The evaluation is done according to the surface conditions and appearance of rust spots or degree of rust.
52.	Immersion Corrosion Tester	Corrosion resistence of coatings on metal surfaces is tested using Immersion corrosion tester. The sample is immersed in the corrosive liquid, removed and exposed to air, and dried by hot air. The operation(cycle) is repeated a number of time. The duration of immersion and cycle will be dependent on the final conditions required, type & extent of corrosion expected, type of coating etc. The temperature, immersion, exposure and drying cycle duration can be controlled automatically.
53.	Vacuum Oven	The oven is mainly used for vacuum drying of products (drying under vacuum conditions). The Instrument is designed with a maximum pressure range of 2.5 psi and 300^{o}C temperature. This facilitates quick drying.

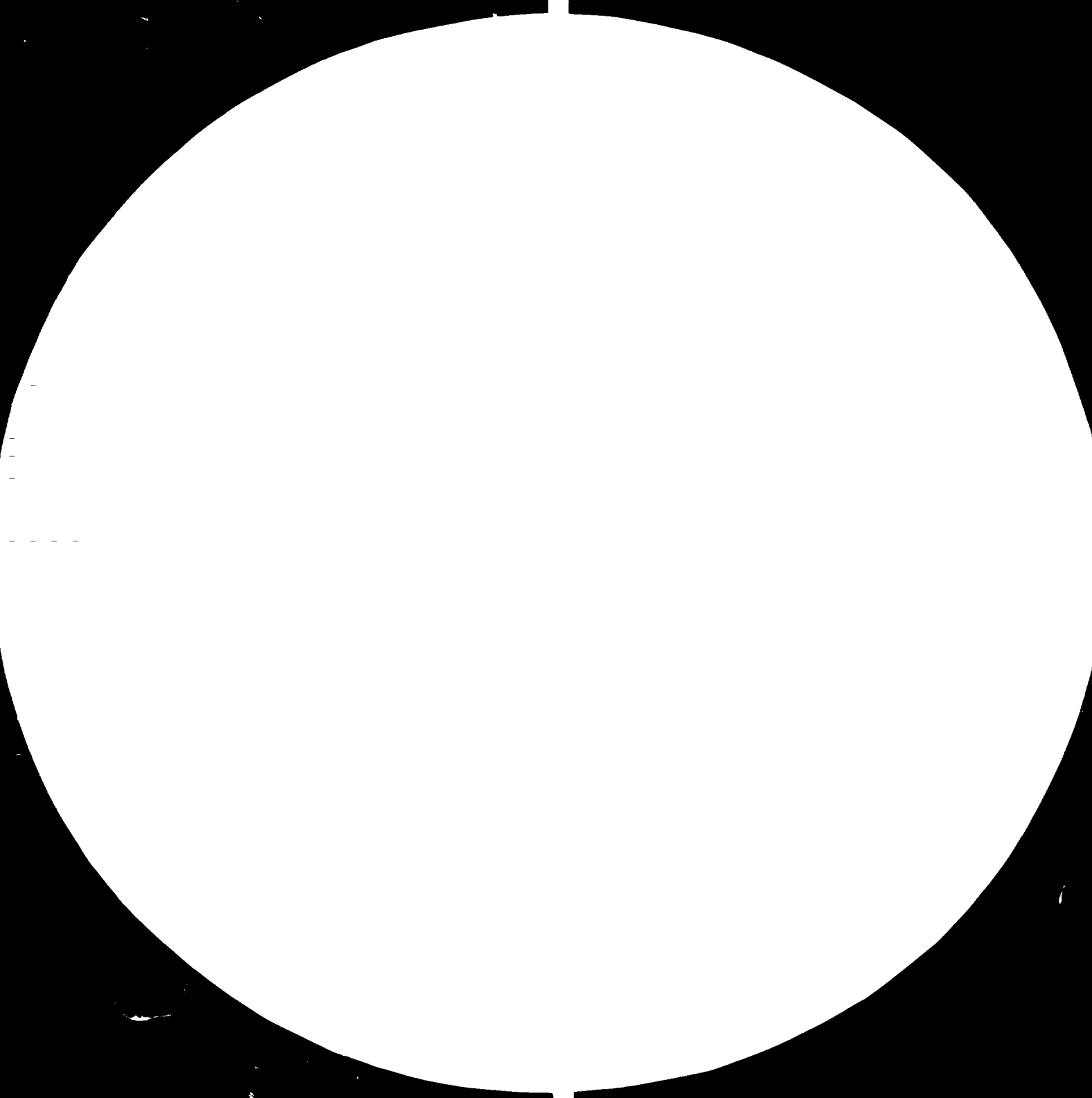
SL NO.	EQUIPMENT	U S E
54.	Hardness Tester (Rockwell)	Rockwell hardness tester is the most commonly used tester for studying the hardness property of materials like metals, plastics and rubber. Circular sample piece is subjected to load applied by a deadweight lever loading. The load is selected depending on the test specimen. The measurement depends on the incentation made by the penetrator. Diamond cone penetrator or steel ball penetrator are used. The hardness is normally expressed as Rockwell number.
55.	Drop Tester Single Arm Tester &, Sling and Quick Release tester	These are used for drop testing of packages and to study the performance of packages and components against drop hazard. The package is placed on the arm - which is previouly raised to the desired height and the arm released to allow the packages to fall on to a steel platform or concrete ground. The test is repeated on corners, edges & faces of the package, in a sequential manner. The principle is the same in sling & quickrelease tester also. This type is found to be more convenient for packages other than square/ rectongular, such as drums, sacks, bags etc.
56.	Humidity Cabinet	This is used to study the effect of climatic conditions on packaging and packaging material. Desired conditions, within the range, are obtained by adjusting the wet and dry thermometer scales. The packages or materials after exposure to the condition are taken out and observed and or subjected to the test schedule drawn-up,
57.	Water Spray Tester (Shower Tester)	Effect of liquid water or rain on the package is assessed through this tester. The package is placed on a pallet and water sprayed from top and sides, simulating a rain or shower conditions. The duration

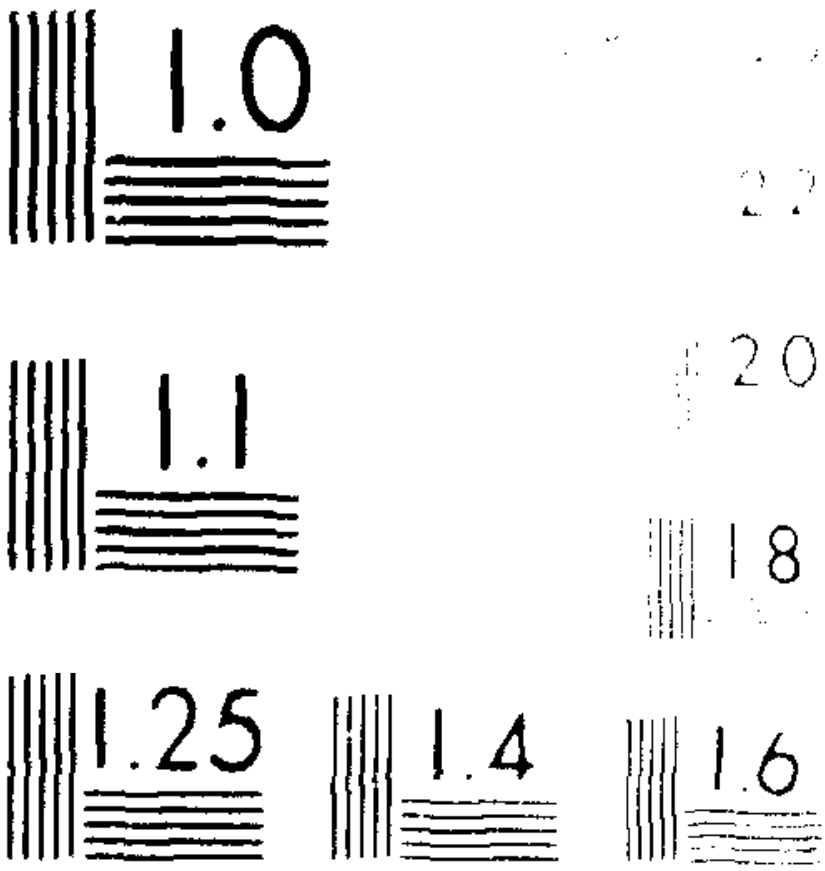
SL NO.	EQUIPMENT	U S E
		of test and quantity and force of spray vary depending on specific package and test conditions. The package is weighed before and after the test to assess quantity of water absorbed and penetrated through. Packages are opened after the test to observe the interal conditions. The test results give an idea of the effectiveness of waterproofing.
58.	Universal Box Compression Test	Universal tester is used to study the compression strength charecteristics of corrugated fibre board boxes and others. This is also used for evaluation of compression strength of fibre drums. The compression strength value can be related to stack performance. In this, the box is placed between a top and bottom platen and pressure applied. The force at the point of failure is recorded alongwith deflection. The maximum load capacity is 5000kg & platen dimension (useable) 1000mm x 1000mm. Maximum box dimensions should be limited to 1000 x 1000 x 1000mm.
59.	Vibration Tester	This package testing equipment is adopted to study the effect of vibrations on the package and components. Vibrations of different intensities are created during transportation and this also vary depending on mode of transportation and speed. The equipment is designed to have an amplitude of 2.54cm and the vibrations could be adjusted upto 300 cpm. The equipment is also provided with the timer which could be preset to desired duration at the end of which the equipment is automatically cut off. The test is performed either under load or without load.
60.	Incline Impact Tester	This is also a package testing machine. This helps to simulate horizontal impacts on packages

SL NO.	EQUIPMENT	U S E
		normolly experienced in railway shunting. The effect of horizontal impacts are studied. The machine essentially consists of a baffle (wooden platform), a moveable trolly fixed on two rails along the incline. The pack is placed on the trolley which is moved along the rail to the desired length depending upon desired impact velocity and released. The pack travel and impacts against the baffle. Test is repeated so as to give impacts on different sides of the pack and observations taken.
61	Drop Impact Tester (Guided)	This is mainly used for studying the cushioning charecteristics of various materials. This is used alongwith a peak - G or suitable recording unit, accelerometer and amplifier. The cushionsample is pleased at the base and the drop hammer released from the desired height. The accelerometer feels the impact decelerations is carried through the amplifier to the recorder. Each set of experiment is repeated several times to generate adequate cushion data of different materials.
62.	Puncture Tester	Puncture resistence is an important property of boards and corrugated & solid boards. This property is evaluated with puncture tester. Puncture resistence is the ability of the board to withstand puncturing. In the test the sample is placed between two plates and a puncture head(pendulam) is quickly released. The release mechanism is exactly at 180° to the test sample and the prism puncture head at 90°. The resistence offered by the board to the piercing of the puncture head is measured and is expressed in kg cm.

ANNEXURE - XII

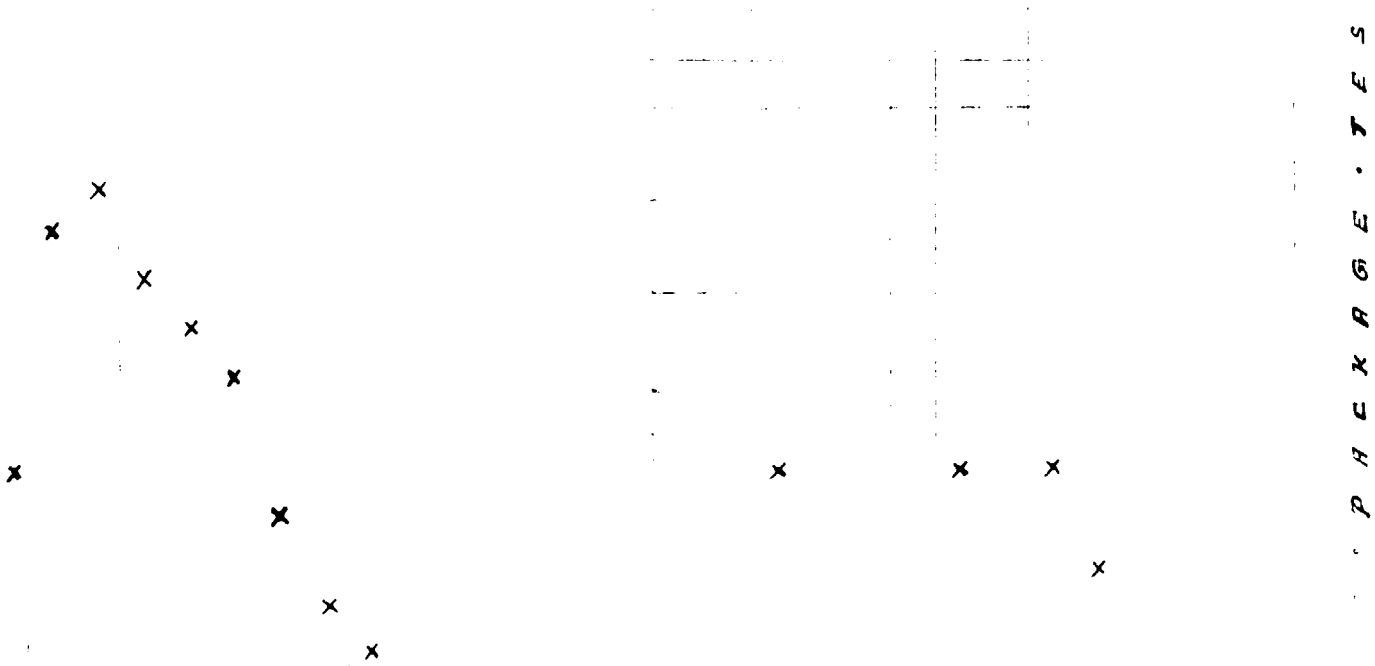
EQUIPMENT UTILISATION




1.0
1.1
1.25
1.4
1.6
18
20
22

PROPERTIES / EQUIPMENT

PROPERTIES / EQUIPMENT	ABRASION	AIR PERMEABILITY	ASH	BASIS WEIGHT	BOND STRENGTH	BURSTING STRENGTH	COLOUR	COMPRESSION	COATING	CORROSION RESISTANCE	CREASIBILITY	CURL	DART IMPACT	DENSITY	EDGE CRUSH	ELONGATION	FLAT CRUSH	FLUTING	FOLDING ENDURANCE	FRICTION	GAS PERMEABILITY	GLOSS	HARDNESS	HAZE	HEAT SEAL PROGRAM	HEAT SEAL	MOISTURE
ABRASION TESTER	×																									
BALANCE		×																								
BURST TESTERS			×																							
COBB TESTER				×																						
COMPRESSION TESTER					×																					
CORROSION CATHALISER						×																				
CURL TESTER							×																			
DART IMPACT TESTER								×																		
DENSOMETER									×																	
FLUTE MAKER										×																
FOLDING ENDURANCE TESTER											×															
FURNACE												×														
GLOSS METER													×													
GTR TESTER														×												
HARDNESS TESTER															×											
HAZE METER																×										
HEAT SEALER																	×									
IMMERSION CORROSION TESTER																		×								
INSTRON																			×							
MELT INDEXER																				×						
MICROMETER																					×					
MOISTURE METER																						×				
OIL PENETRATION TESTER																							×			
OSCILLOSCOPE																								×		



SECTION 2

FRICTION	
GAS PERMEABILITY	
GLOSS	
HARDNESS	
HAZE	
HEAT SEAL PROPERTY	
MELT FLOW	
MOISTURE	
OIL PENETRATION	
OPACITY	
OPTICAL ACTIVITY	
OXYGEN CONTENT	
pH	
POROSITY - PINHOLES	
PUNCTURE RESISTANCE	
RECORDING + CALIBRATION	
REFRACTIVE INDEX	
RING CRUSH	X
SMOOTHNESS	
STIFFNESS	
TACK	
TEAR	
TEMPERATURE - HUMIDITY	
TENSILE STRENGTH	
THICKNESS	
VISCOSITY	
WATER ABSORPTION	X
WATER REPELLENCY	
WATER VAPOR PERMEABILITY	

T I N G

- CLIMATIC C
- DROP TABLE
- INCLINED I
- SHOCK RECOR
- SHOWER SPRAY T
- UNIVERSAL COMP
- VIBRATION TES

- Climatic Chamber
- Drop Table
- Inclined Impact Tester
- Shock Recorders
- Shower Spray Tester
- Universal Compression Tester
- Vibration Table

PACKAGE TESTING

SECTION 3

REPELLENCY TESTER

SALT SPRAY TESTER

SCORING TESTER

SLIP TESTER

SMOOTHNESS TESTER

STIFFNESS TESTER

TACK TESTER

TAPE PRESSURE TESTER

TEAR TESTER

TENSILE TESTERS

THERMOHYGROMETER

TINTOMETER

VACUUM OVEN

VISCOMETER

WVTR TESTER

EQUIPMENT / PROPERTIES
OXYGEN INDICATOR
OVEN TEMPERATURE UNIFORMITY
PH METER
PLANOLA TESTER
POLARIMETER
PSICHROMETER
PUNCTURE TESTER
RUBICOADE
REFRACTOMETER

ABRASION	
AIR PERMEABILITY	
ASH	
BASIS WEIGHT	
BOND STRENGTH	
BURSTING STRENGTH	
COLOUR	
COMPRESSION	
CONDITIONING	×
CORROSION RESISTANCE	
CRENSIBILITY	
CURL	
DIRT IMPACT	
DRYING	
EDGE CRUSH	
ELONGATION	
FLAT CRUSH	
FLUTING	
FOLDING ENDURANCE	
FRICTION	
GAS PERMEABILITY	
GLOSS	
HARDNESS	
HAZE	
HEAT SEAL PROPERTY	
MELT FLOW	

SECTION 2

PACKAGE TESTING

- DRYING
- EDGE CRUSH
- ELONGATION
- FLAT CRUSH
- FLUTING
- FOLDING ENDURANCE
- FRICTION
- GAS PERMEABILITY
- GLOSS
- HARDNESS
- HAZE
- HEAT SEAL PROPERTY
- MELT FLOW
- MOISTURE
- OIL PENETRATION
- OPACITY
- OPTICAL ACTIVITY
- OXYGEN CONTENT
- pH
- POROSITY- PINHOLES
- PUNCTURE- RESISTANCE
- RECORDING & CALIBRATION
- REFRACTIVE INDEX
- RING CRUSH
- SMOOTHNESS
- STIFFNESS
- TACK
- T[illegible]
- T[illegible]
- T[illegible]
- THICKNESS
- VISCOSITY
- WATER ABSORPTION
- WATER REPELLENCY
- WATER VAPOUR PERMEABILITY

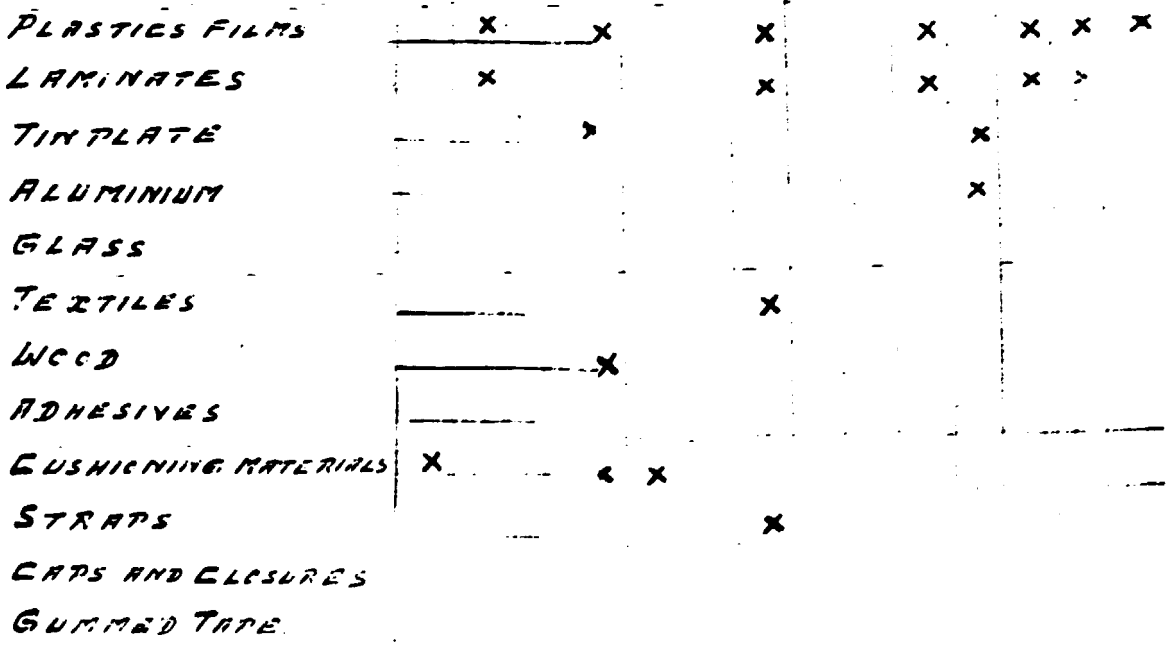
PACKAGE TESTING

SECTION 3

ANNEXURE - XIII

PACKAGING MATERIALS AND PROPERTIES

Materials / Properties	Abrasion	Air Permeability	Ash	Density	Dusting	Edge Crush	Elongation	Fiber Analysis	Flat Crush	Folding Endurance	Formability	Friction (Slip)	Gas Permeability	Gloss
Paper - Kraft		X	X	X			X	X		X				
Corrugating Medium		X		X			X	X		X				
Specialty Papers	X	X	X				X			X				
Paper Boards	X			X										X
Corrugated Board						X			X					
Cellulosic Films										X		X	X	X


PLASTICS FILMS
LAMINATES
TINPLATE
ALUMINIUM
GLASS
TEXTILES
WOOD
ADHESIVES
CUSHIONING MATERIALS
STRAPS
CAPS AND CLOSURES
GUMMED TAPE

PLASTICS FILMS	X	X	X		X							X
LAMINATES		X	X		X							X
TINPLATE	—	—	—	—	—							
ALUMINIUM	—	—	—	—	—							
GLASS				X			X					
TEXTILES					X				X			
WOOD												
ADHESIVES	—	—	—					X				
CUSHIONING MATERIALS	—	—	—	—	—					X		
STRAPS	—	—	—	—	—		X					
CAPS AND CLOSURES	—	—	—	—	—	X		X				
GUMMED TAPE	—	—	—	—	—							

PROPERTIES / MATERIALS	GRAIN DIRECTION	GREASEPROOFNESS	HAZE	TEARING	TENSILE STRENGTH	TORQUE	VERTICALITY	VISCOSITY	WATER AND VAPOR	WATER REPELLENCY (SIZE)	WATER VAPOUR PERMEANCE
PAPER - KRAFT	×				×					×	
CORRUGATING MEDIUM	×				×					×	
SPECIALITY PAPERS	×	×	×		×						×
PAPER BOARDS	×										
CORRUGATED BOARDS											
CELLULOSIC FILMS		×	×								×

ANNEXURE - XIV

REFERENCE STANDARD GUIDE

TEST/PROPERTIES	REFERENCE STANDARD				
	I.S.O.	ASTM	TAPPI	BS	TNO
1	2	3	4	5	6
Abrasion loss of paper & paper board			T476m	BS3110-1959	
Acid soluble Iron in paper	ISO/R779-1968E		T434m	BS4897	
Acidity or Alkalinity, water soluble		D548	T428m		
Adhesive performance (Gummed paper tape)		D773	T463m		
Adhesiveness of seals and closures for packages			T805sm		
Adhesion strength of adhesives				BS 647	
Adhesion strength of pressure sensitive cellulose tape				BS3887	
Air resistence	ISO3687		T460	BS2925-1958 (part II)	
Alkalinity of glass					
Alkali staining number					
Alpha cellulose content (B & R)		D588	T429m		

1	2	3
Anchorage of adhesive in pressure sensitive cellotape		
Ash content	ISO/R-1962-D586 1970E ISO2144-1974	
Bacteriological test		
Basis weight	ISO/R 60-1958 E	D6464
Bending test		
Bitumen content		
Bleeding resistance for asphalted papers		D917
Blocking resistance		D918
Breaking length		
Bulking thickness	ISO/R438-1965	D527
Bursting strength(and factor) 53141	ISO2758 ISO2759 ISO3689	D774

4	5	6
	BS1133-21	
T413m	BS3631	
T449m		
T410 os	BS3432	IvV1.1,1966
T474m		
T475m		
T477m		
T426m	BS3983	
T403m	BS31371959	IvV2.2, 1966 IvV2.1, 1966 IvV2.3, 1966

1		2
Caliper (thickness)	53111	ISO TC6 ISO3034
Chloride content		
Conditioning & Weathering		
Conditioning for testing	53102	ISO/R-187 1961E
Conditioning of paperboard & fibreboard for testing		
Copper number		
Crack resistence of blow moulded plastic containers		
Crease retention of wrapping papers		
Creasing paper for permeability test		
Curl and sizing		
Chromo coating of paper & board		
Creasing quality-carton board		

3	4	5	6
D645	T411m	BS4817	1vV1.3,1966
D1161			
E41 (35,41)			
D685	T402m	BS3431	1vV0.3,1966
D641	T402m		1vV0.3,1966
D9	T430m		
D2561 (36)			
D920 (Discontinued)	T446m		
D1027	T465sm		
D826	T466m		
		BS4818	

1		2
Density		
Determination of stability of pressure sensitive tapes		
Dimensional change in paper/film		ISO5635 ISO5637
Dimension of carton/box/paper		
Edge crush (for CFB)		
Effectiveness of temporary corrosion preventive		
Efficiency of closure wads		
Exudation test(for bitumenised paper)		
Fastness to light	5338871	ISO/R-877, 878,879-1968E
Fibre analysis		
Fillers - Microscopical Identification		
Flamability of treated paper board and film		
Flat crush resistance		ISO 3035

3	4	5	6
		BS4818	
D1042-51 (35)			
D2658-68			
D2561		1679-1965	
		BS2732-540A	
		4618	
		4618	
D1030	T401m		
	T488sm		
D777	T461m		
D1225	T808	BS4686	1vV2.10-1966

1		2
Flexural properties of rigid, semi-rigid plastics	53452	ISO178-1972E
Flute height		
Friction test-dynamic static		
Friction-Coefft.of,plastic film		
Folding endurance		ISO5626
Fungus resistance		
Gas transmission rate		
Grammage of paper of 3 ply of 5 ply of 7 ply of others		ISO536 1976 ISO3039 ISO5638
Gloss contrast at 57.5 deg.		
Gloss specular at 75 deg.		
Gloss of waxed paper at 20 deg.		
Grease resistance (Turpentine test)		
H A Z E		

3	4	5	6
D790-91		BS2782/3	
	T 815		
	T 815		
D1894			
D643	T423m	BS4419	
D2020	T487m		
D1434-63		BS2782-514A	
D646	T410as	BS3432	
D1222	T424m		
D1223	T480m		
D1834	T653ts		
D722	T454m		IvV3.4,1968
	T454ts		
D1003	T480		

1	2	
Heat seal strength(Fin & lap seal)		
Heat shrinkage of plastics films	53468 53467	ISO60,61
Humidity-relative, method of determination		
Hydrogen ion concentration of paper extracts (pH)		
Hydrostatic pressure test for glass/plastic bottles		
Impact strength		
Ink absorption of blotting papers		
Insect resistance		
Leak in heat seal flexible pouches		
Machine/cross direction of paper & paper board		
Mildew(fungus)resistance		
Mineral coating(quantitative determination)		

3	4	5	6
F88(21)			
D1204(35)		BS2782/6	
E337			
D778	T453m	BS2924	
D1709		BS2782 306F	
	T431m	BS4574	
	T478m		
D3078			
D528	T409s		
D2020	T487m		
D687	T407m		

1		2
Mineral filler and Mineral coating (qualitative)		
Mineral filler (qualitative analysis)		
Modulas of elasticity(for thin plastic sheets)		
Moisture	53103	ISO287-1978
Moisture by toluene distillation		
Nitrogen in paper & paper board		
Odour of packaging materials		
Oil penetration(proofness)		
Opacity		ISO2471 1977 2469 2470
Package cushioning materials Dynamic properties		
Package cushioning materials testing		
Pallet(non expendable) testing		

3	4	5	6
D686	T421 s		
D686	T421m		
D882(35)			
D644	T421m T412os	BS3433-1961	lvV3.7,1967
	T484m		
D982	T418os	BS4497	
	T483sm	BS3755-1964	
D202			lvV3.4,1968
D589	T425m	BS4432	
D1596		BS1133-12	
D1372		BS1133-12	
D1872(22)			

1	2
Paraffin	
Paraffin wax absorptiveness	
T-peel test for gummed paper/ adhesives	
Peeling resistance	
Peel test for gummed paper/ other packaging materials	
pH of acqueous solutions- determination of	
Pinholes in glassine & grease proof papers etc.	
Ply adhesion (pin adhesion test-CFB)	ISO3038
Ply separation of combined container board	
Porter/shots(ends/picks) of hessian	
Presence of impurities in paper board	
Qualitative analysis	
Quantitative analysis	
Printing ink permeation (Castor oil test)	

3	4	5	6
D590			
D983			
D1876(22)			
D1029			
D903(49) (22)			
E 70	T435	BS2924	
D1221	T485m		IvV3.6, 1968
D825	RC269		IvV2.9, 1967
D1028			
		BS1820-1961	
		BS1820-1961	
D780	T462m		

1		2
Puncture & stiffness test	53142	ISO3036
Reflectance		
Ream weight		
Resistance to acetic acid (for tinplate container)		
Resistance to sulfur staining (for tinplate container)		
Rigidity, stiffness		
Ring crush		
Rosin		
Sampling	53101	ISO/R186 1968E
Scuffproofness		
Seamstrength-fabrics & other properties		
Sizing properties(qualitative test)		

3	4	5	6
D781	T803m	BS4816	1vV2.5,1966 1vV2.6,1966
D985 E97 D726	T452m		
D747	T451m		
D1164	T472m		
D549	T408os		
D585	T400m	BS3430	1vV0.1-1966
		BS3110-1959	

1	2	3
Smoothness of paper	ISO2494	
Smoothness of printing paper		
Sodium Benzoate in paper		
Softener content in films/paper		
Staining of paper by alkali		D723
Starch		D591
Stiffness	ISO2493	
Stretch		D987
Sulfur, reducible		D984
Surface strength		
Surface Wettability		D724
Sulphate content		D1099
Tear strength & Tear factor	ISO/R1974-1971E	D689 D1922
Tenacity of fabrics 53455	ISO/R527 rigid	

4	5	6
T490m	BS4420	
T479sm		
	BP1973	
	BS1820-1961	
T440m		
T419m		
T489m	BS3748 BS2782/3	lvV2.6,1966
T457m		
T406m		
T459m		
T458m		
T468m		
T414m	BS4468	lvV2.7, 1966

1		2	3
Tensile strength-Dry	53112 53455	ISO/R1184- films 1970E	D828 D882
Wet		ISO/R1924- 1971E	D829
of straps, fabrics		ISO3781	
Thickness		ISO TC6 ISO/R534 1967	D645
Tincoating in tinplate			
Tincontent(percentage) of soft solder			
Titamium di oxide content			D921
Total solids in adhesives			
Verticality test (for glass bottles)			
Water absorbancy			
Water absorption of plastics	53495	ISO/R62- 1958E	D570 (35)
Waterproofness-cobb test	53132	ISO535-1976	
Water immersion of paper board			

4	5	6
T404os	BS4415 BS2782/3 (plastics)	1vV2.8,1966
T456m		
T411m	BS4817(cfb)	
T441m T492sm	BS2916	
	BS2782	
T441m	BS1133- Section 7	1vV3.1-1966
T491sm		

1	2	3
Water resistance(Dry indicator method)		D779
Water resistance of glue bond by immersion		
Water soluble matter		D1162
Water vapour transmission rate	ISO/TC 53122 61-656E ISO2528	E96
Wax absorptiveness		
Wax content(Ether extraction method)		
Weight of suface wax on waxed paper		D2423
Wax coverage		
Wax pick number(Dennison wax number)		
Weight of hessain		
Wire and felt side		D725
Yield tolerance		

4	5	6
T433m		IvV3.5-1966
T464m	BS3177-1959	IvV3 2-1965
T464-448	BS2782,513-A-D	
	BS4685	
T455m		

ABBREVATIONS USED:

I. S. O.	:	International Standards Organisation.
A.S.T.M.	:	American Society for Testing and Materials (Figures in brackets indicate ASTM Part number, wherever no figure is indicated, it refers to ASTM Part 20)
TAPPI	:	Technical Association of the Pulp and Paper Industry.
B. S.	:	British Standards
BP	:	British Pharmacapea.
T. N. O.	:	Inst. TNO for Packaging Research
D I N	:	Figures immediate to property/test indicate DIN (FRG - German Standard) number.

ANNEXURE - XV

TECHNICAL MATERIALS GIVEN

1. Some historical events in the development of packaging
2. The concepts of packaging
3. Packaging a total concept
4. Scientific packaging and loss prevention
5. Flexible packaging material properties - chart
6. WVTR values of some important flexible materials
7. S. I. UNITS Chart
8. The measurement of W.V.P - various methods & merits
9. The measurement of G.P - various methods & merits
10. Test methods of corrugated fibreboard - illustrations
11. Booklet on table of conversion
12. A B.S.(British Standard) note on tests - standards - units & - conversion
13. A PIRA slide for identification of flutes and no/height of flute
14. Pictorial views of testing of CFB
15. Water vapour Transmission tester - an assessment
16. Gas permeability apparatus for films and sheets
17. Coulometric celldetermination of WVTR
18. Notes on cushion