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STRENGTHENING OF THE TECHNOLOGICAL CAPABILITY
OF THE THAI PACKAGING CENTRE
DP/THA/87/019
THE KINGDOM OF THAILAND

Technical report: Applied research and quality control
on plastic film and laminate packages*

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

Based on the work of J. Miltz,
expert in film and laminate packages

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Vienna

* This document has not been edited.

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Summary

This report summarizes the work performed by the expert during the first part of his mission to the Thai Packaging Centre (TPC) for the period of July - August 1991.

The main purpose of this mission was to strengthen the knowledge and understanding of TPC's Technical Personnel on Structure - Property - Application relationships of polymers in general and plastic films and laminates in particular and to train this personnel in laboratory testing and interpretation of results.

Fourteen lecture hours were given on the subject of Structure - Property - Application of Polymeric Packaging Materials and laboratory tests were presented to all TPC's technical personnel and many more tests were demonstrated and the results interpreted for the Testing Group.

In addition, advice and assistance was given to this group in conducting tests in the area of "Protective Packaging" for industrial firms in compliance with their request.

Assistance was given in designing an instrument to measure the coefficient of friction and in modifying an available Cushion Tester to enable determination of Cushion Curves.

Lists of recommended equipment and books in the areas of "Polymers and Packaging" to be acquired were prepared.

1. Introduction

1.1 General

This report summarizes the work performed during the first period (July - August 1991) of the split mission to the Thai Packaging Centre (TPC).

1.2 Job description

Upon arrival at the duty post, it was realized that the technical personnel at TPC do not have a sound background in the area of polymers and plastic packaging. As a result and after discussions and consultation with the director of TPC, Dr. Amornrat Swatditat, the job description was altered somewhat (compared to the original) to cover primarily the following subjects :

1. Lecturing on Structure - Property - Application relationship of polymeric packaging materials.
2. Advising and training the technical personnel in testing of plastic films and laminates and especially in the interpretation of results.
3. Assisting in industrial problems solving.
4. Visiting to industrial firms.
5. Submitting a one day seminar to industry, including a plenary session of questions and answers on "New Developments in Plastic Packaging."

In addition, as the author of this report is considered to

be also an expert in "Protective Packaging" (compression, shock, vibration) he was asked and complied with the request to advise and assist in tests in these areas being carried out for industrial firms. The author was also asked to assist in the area of one of his expertise : "Cushioning Properties of Plastic Foams."

1.3 Background

The Thai Packaging Centre (TPC) is part of the Thailand Institute of Scientific and Technological Research (TISTR) established, in the present form, in 1979. It is run under the Ministry of Science, Technology and Energy. TISTR is the only one of its kind in Thailand and contains Research Centers in almost all areas of Science, Engineering and Technology. TPC, established in 1984, is also the only Packaging Centre in the country. It contains three major fields of activities in alphabetic order :

- a) Promotion and Training
- b) Research and Development
- c) Testing and Consultancy

Each of the three activity groups has a group leader. The counterpart of the author of this report was the leader of the Testing Group, Mr. Sakkhee Sansupa. The Testing Lab is involved in different kinds of testing activities. It contains most of the equipment required to evaluate the properties and performance of packages and packaging materials. The list of available equipment is given in Appendix A. The equipment is of very good quality. Nevertheless, some instruments of very great importance for analysis and testing are missing and they will be mentioned in the recommendations. The technical personnel in the Testing Group is relatively young; although

very capable and eager to learn, their experience in "Packaging" in general and in "Plastic Packaging" in particular is limited. Although the majority of this group are engineers, none of them had formal, in depth, courses in "Polymer Engineering and Science" at the University level. Some of them were however exposed to short courses, seminars and/or training sessions. This was the reason behind the decision to initiate a series of lectures on structure - property - applications relationship of polymeric packaging materials to be outlined later in the report.

The Thai plastic industry is developing and expanding very rapidly. A list of major manufacturers of polymers, including quantities, is given in Appendix B. From this list it is evident that only the commodity polymers are currently manufactured in Thailand. The advanced polymers like the different nylons, polyethylene terephthalate (PET), crystallized PET (CPET), ethylene - vinyl alcohol copolymers (EVOH) and others are not manufactured in Thailand and the use of some of them (PET) is limited. However, with the current rate of expansion of the Thai polymer industry accompanied by new converting techniques and equipment, there is no question in the author's mind that this situation will change and in the future, advanced plastic materials, laminates and package will be available also in Thailand.

Upon arrival at the duty post, it was realized and conceived by the author of this report that although the technical personnel at the Center is familiar, to a certain extent, with the Thai plastic and food industry, strengthening of the ties between the Centre and major food and packages manufacturers would be beneficial to both parties. As a result he has recommended to arrange visits to industrial firms and received a very favourable response from the TPC management. The

list of visited companies and names of contact persons is given in Appendix C.

To strengthen the ties between TPC and industry, the expert has also offered to present a seminar to industry on the subject : "New Trends in Plastic Packaging for Food" and again received a very favourable response from TPC management.

To summarize, it is believed that the Thai Packaging Centre has the potential, in manpower and equipment, to become an excellent facility for helping the local industry in testing of raw materials and finished packages, for doing research and development work in packaging, for involvement in troubleshooting problems in industry and for assisting in preparation of specifications and standards.

2. Work Performed

2.1 Lectures

Upon arrival at the post station, it was realized that the technical personnel at TPC had a limited exposure and background in the area of polymer engineering and science. As a result, 14 hours of lectures were scheduled and given to all scientists at TPC on : " Structure - Property - Application" relationship of polymeric packaging materials, accompanied by some laboratory exercises. Many more exercises and testings were carried out with the Testing Group. The aim of these lectures was to improve the understanding of the effect of chemical and molecular structure on the properties of polymers used in packaging. Such an understanding is a must for proper selection of a polymer for a specific application and for prediction of product's shelf life. The topics covered in these lectures were :

Mechanical properties.

Thermal properties.

Flow (Rheological) properties.

Mass transfer (Permeation and Migration)

Optical properties.

Chemical properties.

Methods for Laminates manufacturing; advantages and disadvantages of the different methods.

The subject of Molecular Structure of polymers and relationship between Structure, Properties and Applications of polymeric packaging materials is scheduled to be given during the second part of the author's split mission.

2.2 Advising and Training of the Technical Personnel.

During the author's stay at TPC, most of the invited (from industry) tests were in the area of protective packaging. As this is one of author's expertise, he was asked to advise and assist in designing the tests. Thus, testing procedures were discussed and tests to evaluate the resistance of packages to compression, shock and vibration were designed and the amount of protection that these packages provide to the product were analyzed. These tests were carried out (in addition to tests on films and laminates) for various companies. In addition, different tests for in house training were designed and carried out and the significance outlined to the technical personnel.

2.3 Assisting in Industrial Problems Solving.

During the author's stay at TPC, one problem was brought up by an industrial firm : delamination of a flexible laminate. The problem was analysed and the possible causes for the delamination were discussed with the Testing Group. One test that was required for the analysis was the Melt Flow Index of the polymer. TPC does not possess a Melt Flow Indexer. Therefore, a trip to the Bang Poo laboratories (which have such an instrument) was made and the procedure of the test was explained and demonstrated to the Testing Group.

2.4 Visits to Industry

Following the author's previous experiences from UNIDO missions to developing countries, he has recommended upon arriving at TPC, to visit industrial firms. The main purposes of these visits was to establish closer ties between TPC and industry and to inform Food and Packaging companies that UNIDO experts are assisting TPC in developing a sound and reliable

R&D and Testing facility and that this center is the only one of its kind in Thailand and is at the disposal to the local industry for assistance in problems solving and upgrading Thai packages.

The companies visited, the contact persons and main products are summarized in Appendix C.

2.5 Seminar to Industry

Upon arrival at TPC, the author offered to present a seminar to the local industry on the subject of "New Trends in Plastic Packaging for Food". The aim of this seminar was twofold:

a) to expose, once again, the TPC to the Thai Food and Packaging industry, and

b) to update the technical and managerial personnel in the industrial firms on the trends in the developed countries in plastic packaging and new technologies.

Thus, although many of these packages and technologies are not yet available in Thailand, the companies will be aware of their existence, advantages and disadvantages in case of the need or desire to expand into new directions. This seminar was held at TPC on August 22, 1991 and 60 representatives from different companies participated in it, in addition to the technical personnel of TPC. The number of participants was limited to 60 by TPC management because of space limitations. At the end of the seminar an open discussion session was held during which the participants were encouraged to ask questions and receive answers.

2.6 Miscellaneous

During the author's stay at TPC, he was asked to assist in using a Cushion Tester for cushion properties evaluation. Upon inspecting the available instrument and its performance, it was realized that the tester could not be used in the present form for cushion evaluation. The required modifications and additions were outlined to the Testing Group. These equipment modifications and the required additional parts were ordered. Cushion tests were designed to be carried out during the first or second part of the split mission. The author has also realized that TPC does not have an instrument for measuring the coefficient of friction of packaging materials. He has advised how to construct such a tester using the available Instron Tester. The parts were ordered and tests were designed to be carried out during the first or second part of the split mission.

Upon reviewing the equipment available at TPC it was realized that TPC is lacking several very important pieces of equipment that are a must in every advanced packaging laboratory. These instruments include:

a) A gas chromatograph (GC) with flame ionization and thermal conductivity detectors for gas and aroma permeability and for residual solvents and monomers studies.

b) A Melt Flow Indexer (MFI)

c) A melting temperature apparatus.

d) A double blade sample cutter.

A list of suppliers of these instruments was prepared and given to the Testing Group.

It was also discovered that the number of books available at TPC and/or in the Central Library in the field of polymers is very limited. A preliminary list of books to be acquired was prepared (given in Appendix D). A more complete list will be delivered upon the author's return to his base station.

2.7 Recommendations

a) It is highly recommended that a gas chromatograph with flame ionization and thermal conductivity detectors and a Melt Flow Indexer are acquired as soon as possible and that the Technical Personnel (at least the Testing Group) are trained in their operation and use.

b) It is also recommended that the cheaper Melting Temperature Apparatus and Double Blade Sample Cutter are purchased and used.

c) It is recommended that more visits are carried out to local Food and Packaging firms to further strengthen the ties between TPC and the Thai industry.

d) It is recommended that some books on Polymers (according to the list in Appendix D) are purchased and used as reference books.

e) It is recommended that the Technical Personnel of the Testing Group carefully reviews the material covered in the lectures during the first part of the expert's mission in July-August 1991, including the methods of analyzing results. These methods should be used in analyzing and reporting results of tests carried out for industrial firms.

f) It is also recommended that the TPC Technical Personnel becomes familiar with the subject of Molecular Structure of Polymers and with Structure-Property-Application relationships. These subjects will be covered during the second part of the expert's split mission scheduled for February 1992.

g) TPC Technical Personnel should be familiarized well with the important subject of residual solvent and monomers in flexible packaging. This subject will also be covered during the second part of the expert's split mission.

The expert also recommends that during the interval of the split mission, namely during the period of September 1991 and January 1992, some additional work would be carried out by the Testing Group.

h) Three different flexible films for packaging of Instant Noodles should be chosen as this is an "Export Product". These materials could include: a laminate of polypropylene with polyethylene, of a metallized polypropylene with polyethylene and of nylon with polyethylene.

All the mechanical properties, namely Stress - Strain curves, seal and peel (if possible) strength, tear (in both directions) and impact resistance and coefficient of friction should be evaluated (this will also allow the people to be trained in coefficient of friction measurements) according to the given lectures. All data including WVTR and oxygen permeability and thicknesses should be measured and recorded. Data Sheets of these materials and costs should be obtained. The results will then be analyzed during the second part of the expert's split mission in February 1992.

i) It is recommended that noodles are packed in pouches made of these materials and some shelf life studies (according to lectures outlined by Prof. Varsany) be carried out by the R&D Group. The parameters to be evaluated could be:

- Water uptake
- Oxydation
- Texture (shear, for instance)

j) The equipment for cushion testing should be finalized (including the trigger) and pretested.

Acknowledgements

The expert would like to express his gratitude to all TPC's technical and administrative staff and especially to TPC's Director, Dr. Amornrat Swatditat and to his counterpart Mr. Sakkhee Sansupa for their close and fruitful cooperation and for the excellent atmosphere which prevailed during all his mission and that made his task easier and enjoyable.

Many thanks are also extended to UNIDO country director, Mr. Nils Ramm - Ericson and his assistant Mr. Johan Nelis and to Ms. Natiyar for their cooperation and assistance.

APPENDIX A

Equipment available at the Thai Packaging Centre

1. Instron Universal Testing Machine model 1123
2. Mullen Tester Model A-H, B.F Perkins Co.
3. Puncture Tester, Tmi Co.
4. Hinde & Dauch Crush Tester, Tmi
5. Cobb Sizing Tester
6. Micrometer Model 549 ME, Tmi
7. Pira Crease Stiffness Tester, H.L Messmer LTD.
8. Taber Stiffness Tester, Teledyne
9. Elmendorf Tearing Tester, Tmi
10. Abraser Tester Model 5130, Tmi
11. Rub Proofness, Wallace
12. Bendtsen Smoothness Tester Model 6, Tmi
13. Analytical Balance, Santer
14. Analytical Balance, Sartorius
15. Viscometer, Brookfield
16. Waco Seam Projector and Seam Saw MK 200
17. Patra Humidity Cabinet, Laboratory Thermal Equipment
18. Dart Drop Impact Tester, Local Made
19. Vibration Table, Local Made
20. Incline Impact Tester, Local Made
21. Head space analyzer Model 307, Instrumentation Laboratory
22. Gas Transmission Rate Tester Model Lyssy L 100, Lyssy GPM 200, Lyssy LTD.
23. Water Vapour Transmission Rate Model Lyssy L 80, L 90, Lyssy LTD.
24. Compression Tester, Tarno Grocki
25. Drop Table, Local Made
26. Walk-In Conditioning Chamber, Weiss Technix (0-60 yC, 5-100 %RH)
27. Cold-heat Conditioning chamber, Weiss Technix (-20 to 100^o C, 1-100%RH)
28. Vibration Test system Model MTS 840
29. Shock machine Model MTS 846

APPENDIX B

*

Polymers Manufactured in Thailand

| Polymer and Manufacturer | Quantity (ton/year) |
|-------------------------------|---------------------|
| 1. POLYETHYLENE | 442,000 |
| - THAI POLYETHYLENE | 152,000 |
| - THAI PETROCHEMICAL INDUSTRY | 150,000 |
| - BANGKOK POLYETHYLENE | 140,000 |
| 2. POLYPROPYLENE | 300,000 |
| - HMC POLYMER | 100,000 |
| - THAI PETROCHEMICAL INDUSTRY | 100,000 |
| - THAI POLYPROPYLENE | 100,000 |
| 3. POLYVINYL CHLORIDE | 275,000 |
| - THAI PLASTIC & CHEMICAL | 140,000 |
| - VINYTHAI (C.P + SOLVAY) | 135,000 |
| 4. POLYSTYRENE | 120,500 |
| - PACIFIC PLASTIC | 22,500 |
| - ETERNAL RESIN | 30,000 |
| - SRITHEPHTHAI PLASCHEM | 14,000 |
| - HUNTSMAN | 25,000 |
| - THAI PETROCHEMICAL INDUSTRY | 29,000 |
| 5. ABS | 25,200 |
| - THAI PETROCHEMICAL INDUSTRY | 18,000 |
| - ETERNAL RESIN | 7,200 |

* Taken from the report of Mayuree Paklamjeak

"General Packaging Status in Thailand" January 1991

APPENDIX C

Visited companies and contact persons.

| <u>Company and address</u> | <u>Contact persons</u> | <u>Main products</u> |
|--|---|--|
| 1. South East Paper Industry 17/9 Petkaseam 81 Nongkham, Bangkok Tel : 4201454,1705 4202883-7 | Mr.Viroon Ounhakittinaut Managing Director Mr. Somkid Visesmit Factory Manager Mr. Boonmee Lertviriyavanich Sales Office Manager | Flexible films and laminates |
| 2. Thai President Foods CO.,LTD. 2154/1 TF Bldg. New Petchburi Rd. Bangkok Tel : 318-0059 | Mr. Krid Siraprapasin Managing Director Mr. Suchai Ratanajajaroen Vice President | Instant noodles, cookies, wafers |
| 3. TAI OFFSET CO.,LTD. 1741 Trock Chand Rd. Bangkok Tel : 286-2031 | Mr. Suthee Limatibut One of the Owners and Manager | Flexible films and laminates |
| 4. Best Pack Co.,Ltd. 66 Chittaram Bldg. Krungthonburi Rd. Klongsan Bangkok 10800 Tel : 4370354 | Mr. Prasit Pornpaitoonsakul Managing Director | PVC films, sheets and trays; coextruded nylon with polyolefin films; coextruded PP and PS sheets. |

APPENDIX D

Preliminary list of books on polymers and packaging to be acquired.

1. Billmeyer, W.Jr.
Textbook of Polymer Science
2nd (or later) edition, Wiley - Interscience

2. Nielsen E.
Mechanical Properties of Polymers and Composites
Vol 1 & 2 Marcell Dekker (1974)

3. Compton, T.R.
The Analysis of Plastics
Pergamon Press, Oxford (1987)

4. Bakker, M. & Eckroth, D.
The Wiley Encyclopedia of Packaging
Wiley Publ. Co. (1986)

5. Cairns, J.A., Oswin, C.R. and Paine. F.A.
Packaging for the Climatic Protection
Newnes - Butterworths, London (1974)

6. Gray, J.I., Harte, B.R. and Miltz, J.
Food Product - Package Compatibility
Technomic Publ. Co. (1987)

7. Hotchkiss, J.H.
Chemical Interactions Between Food and Food Packaging
ACS Symposium Series No. 365

8. Koros, W.J.
Barrier Materials and Structures
ASC Symposium Series. (1989)
9. ASTM Vol. 15.09 - Packaging
10. Heldman, D. and Lund, D.
To appear at the end of 1991

Comments

1. According to the original job description the mission would be mainly concerned to laboratory applied research and development on flexible packaging for specific products. However, taking into consideration the need of previous acquaintance of the counterparts concerned with the fundamentals of plastic films and laminates technology, related training was programmed and provided to both the counterparts at the Thai Packaging Centre and technicians invited from the industry.
2. Although the Thai Packaging Centre is relatively well equipped for testing of packaging materials and packages, at least in comparison to most of the other countries in the Asia region, a few important testing instruments, namely a gas chromatograph, a melt flow indexer, a melting temperature apparatus and a sample cutter, are missing at its laboratory. The expert's recommendation regarding acquisition of this equipment is particularly supported by the backstopping officer.
3. Purchase of the additional books recommended by the expert is also supported. In fact, regular purchase of new books and technical documents, well selected among the up-to-date technical literature, is always advisable at institutions responsible for technology support of the national industries concerned.
4. The institutional policy recommended by the expert, namely with regard to visits of technicians from the Thai Packaging Centre to industries, is very pertinent. On the one hand, the industries will learn more about the capabilities of the Centre and benefit from on-the-spot advice during the visits; on the other hand, the visiting technicians will have contact with the priority subjects of technical interest to the industries, therefore, the programmes of activities of the institution may be actually adapted to real needs of the national industry.