OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

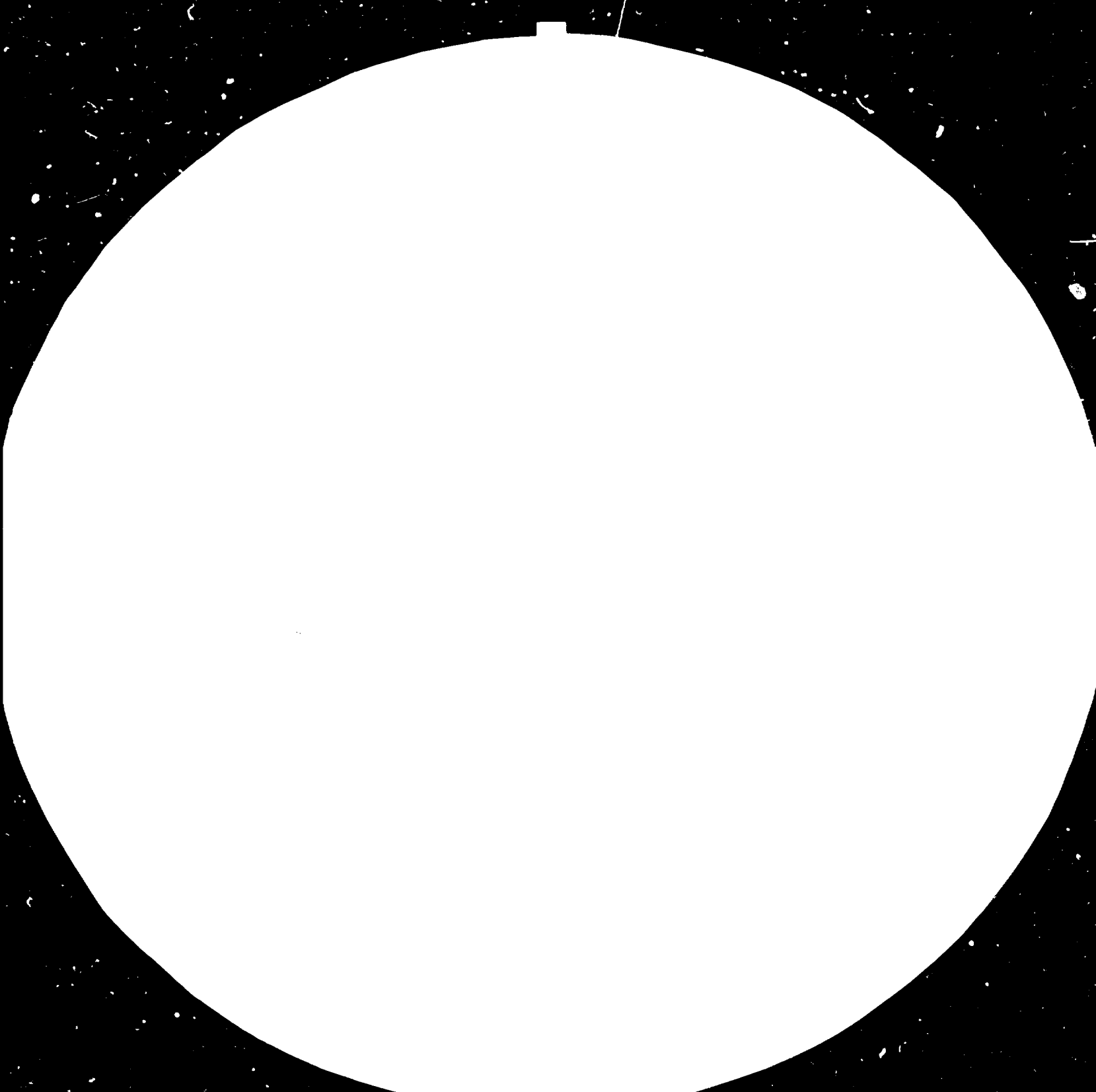
FAIR USE POLICY

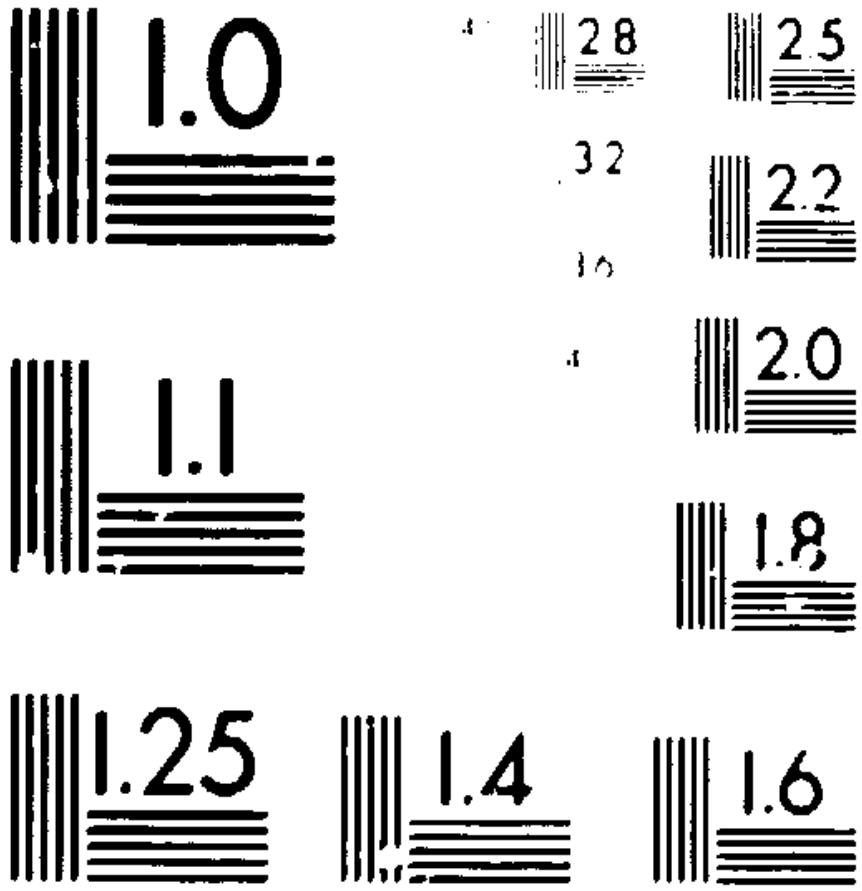
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org





LKT-TGM

Laboratorium für Kunststofftechnik am TGM
INSTITUT ZUM AUSBILDEN PRÜFEN UND FORSCHEN
Wexstraße 19-23, A-1200 Wien, Tel.: 35 35 11, 35 21 06, Telex: 131824

13524

Final Report

1803

14 th UNIDO In-Plant Group Training Programme in the Field of Plastics Technology AUSTRIA 1983

US/INT/83/070

LKT-TGM

Laboratorium für Kunststofftechnik am TGM
INSTITUT ZUM AUSBILDEN PRÜFEN UND FORSCHEN
Wexstraße 19-23, A-1200 Wien, Tel.: 35 35 11, 35 21 06, Telex: 131824

Fourteenth UNIDO Austria Group Training Programme in Plastics Technology

Organized by the United Nations Industrial Development Organization (UNIDO) in co-operation with the Government of Austria

to be held

from 11 October to 19 November 1983 in Vienna, Austria

Final Report

by
H.HUBENY
Programme Director

Zl.ZT 158/Hu/Dö, 19 November 1983

TECHNOLOGISCHES GEWERBEMUSEUM

1. Aknowledgments:

The LKT-TGM is deeply indepted to the following institutions for organizing the seminar and for the excellent and successful cooperation.

UNIDO:

Mrs.I.Lorenzo
Mr.R.Gumen
Mr.Sato
Dr.D.Gardellin
Mrs.A.Uchida
Dr.H.May
Mr.H.Pichler
Mr.N.Youssef
Mrs.U.Vasudeva
Mr.E.C.Bull
Mr.K.Sepic

Austrian Federal Chancellery:

Mr.U.Stacher
Mrs.B.Dekrout

Austrian Federal Ministry of Foreign Affairs:

Mr.F.Schmid
Mr.H.Miltner

Austrian Federal Ministry of Education and Arts:

Mr.W.John
Mr.O.Tischler
Mr.D.Uyka
Mr.F.Plank

Technologisches Gewerbemuseum TGM:

Mr.F.Plöckinger
Mr.F.Gregori
Mr.A.Hollnsteiner

Austrian Federal Chamber of Commerce:

Mr.K.Haas
Mr.F.Hlawati
Mme.S.Zemek

Austrian Society for Polymer Engineering (GFKT):

Mr.A.Herrman
Mr.H.Margarétha
Mr.E.Papst
Mr.P.Roos
Mr.G.Schwarz
Mr.L.Katzmayer

The Community of Tauplitz:

Mr.Raimund Geyer
Mr.Sepp Lösch

Hochfellner Hausmusik

We have of course, also appreciated any contribution towards the programme, in form of free materials, lectures, invitations and visits presented to us by companies and individual persons in Austria and abroad.

2. History of the UNIDO/AUSTRIA Training Programme in Plastics Technology

Group Training Programmes for engineers and advanced technical personnel from developing countries are organized by UNIDO in co-operation with the Governments and Industries of countries having the specialized know-how and experience in the field in which the training is carried out. It is being increasingly recognized that intensive, systematic and closely controlled training in a suitable industrial environment is one of the most effective ways of acquiring industrial experience in a relatively short time. Through these programmes a means has been found of providing an experience that might not otherwise we possible in developing countries.

The programmes help to bridge the gap between the specific requirements of industry and the theoretical knowledge the participants have acquired through their studies. They also provide an opportunity for an exchange of ideas and experience both among senior personnel of industry and research institutes in industrialized and developing countries and among those from the developing countries themselves.

Austria and LKT-TGM are responsible in the field of plastics technology since 1970.

Since 1970 LKT-TGM held fourteen programmes with a total of 243 participants from 66 countries.

The regional distribution was the following:

Far East (FE)	78	32 %
Middle/East North Africa (ME)	61	25 %
Latin America (LA)	50	21 %
Africa (AF)	32	13 %
Europe (EU)	22	9 %

60 % of the participants came from companies, 40 % from institutes and government organizations.

Place	Region	Programme 1.- 10.	11.	12.	13.	14.	Total
Afghanistan	ME	-	-	1	-	-	1
Algeria	ME	2	-	-	-	-	2
Argentina	LA	2	1	-	1	-	4
Bangladesh	FE	3	-	-	2	-	5
Bolivia	LA	3	-	1	-	1	5
Bulgaria	EU	1	-	-	-	-	1
Brazil	LA	3	-	-	-	-	3
Burma	FE	1	-	-	-	-	1
Chile	LA	2	-	-	-	1	3
China	FE	5	1	5	-	1	12
Colombia	LA	4	-	-	-	-	4
Costa Rica	LA	3	-	-	-	-	3
Cuba	LA	4	-	-	-	-	4
Cyprus	EU	3	-	-	-	-	3
Dominicanian Republic	LA	-	-	-	1	1	2
Ecuador	LA	-	-	-	-	1	1
Egypt	ME	8	-	4	2	-	14
El Salvador	LA	2	-	-	-	-	2
Ethiopia	AF	-	-	1	1	-	2
Ghana	AF	3	-	-	-	1	4
Guatemala	LA	1	-	-	-	1	2
Guyana	LA	1	-	-	-	-	1
Honduras	LA	1	-	-	-	-	1
Hongkong	FE	1	-	-	-	-	1
Hungary	EU	3	-	-	-	-	3
India	FE	6	-	-	2	4	12
Indonesia	FE	6	2	1	-	-	9
Iran	ME	18	-	-	-	-	18
Iraq	ME	8	-	-	-	1	9
Israel	ME	3	-	-	-	-	3
Jamaica	LA	1	-	-	1	-	2
Jordan	ME	1	-	1	-	-	2
Korea (South)	FE	1	-	-	-	-	1
Korea (North)	FE	-	-	-	-	1	1

Lebanon	ME	1	1	-	-	-	2
Madagascar	AF	1	-	-	-	-	1
Malawi	AF	-	1	-	1	1	3
Malaysia	FE	1	-	1	-	-	2
Malta	EU	-	-	-	1	1	2
Mauritius	AF	-	-	-	1	1	2
Mozambique	AF	-	-	-	1	-	1
Nepal	FE	-	-	-	1	-	1
Nicaragua	LA	1	-	-	-	-	1
Nigeria	AF	4	-	-	-	-	4
Pakistan	FE	6	-	-	-	-	6
Paraguay	LA	2	-	-	-	-	2
Peru	LA	3	1	1	-	1	6
Philippines	FE	3	-	1	-	-	4
Poland	EU	6	-	-	-	-	6
Romania	EU	2	-	-	-	-	2
Senegal	AF	-	-	-	1	-	1
Singapore	FE	3	-	1	-	2	6
Somalia	AF	1	-	1	1	-	3
Sri Lanka	FE	1	-	1	1	2	5
Sudan	AF	2	-	-	-	1	3
Syria	ME	5	-	1	-	-	6
Taiwan	FE	2	-	-	-	-	2
Tanzania	AF	4	1	-	1	-	6
Thailand	FE	6	-	-	-	1	7
Trinidad Tobago	LA	1	-	-	-	-	1
Turkey	EU	4	-	-	-	-	4
Uruguay	LA	6	-	-	-	-	6
Vietnam	FE	-	1	-	-	1	2
Yemen (Aden)	ME	-	-	1	-	2	3
Yugoslavia	EU	2	-	-	-	-	2
Zambia	AF	-	-	-	1	-	1
		(66) 166	9	22	20	26	243

3. Background and Objectives

The programme, organized by the United Nations Industrial Development Organization (UNIDO), in co-operation with the Government of Austria, is one of the series of UNIDO training programmes on specific sectors of industry for engineers from developing countries. The programme will be carried out by the Laboratorium für Kunststofftechnik (LKT-TGM). This programme, the fourteenth in succession, has been implemented annually since 1970.

The rapid increase in the use and application of plastics in industry, agriculture and homes in recent years has places plastics among the leading basic materials used for economic development of the developing countries. Parallel to this increase in the demand for plastics products, the developing countries have embarked on the establishment and development of a plastics industry to meet their own demands and even export to other countries. However, besides the financial difficulties, they are also encountering technological difficulties in processing and in acquiring raw materials.

The principal objective of the programme is to bring together a group of selected persons whose work is expected to benefit from a concentrated programme in modern plastics technology which otherwise would require a long period of training, research and development work. The programme is designed mainly to emphasize plastics fabrication technology, including the use and selection of modern processing equipment, quality control and testing, as well as various applications of plastics.

The programme has received the support of the Austrian Federal Chancellery, the Austrian Federal Ministry of Foreign Affairs, the Austrian Federal Ministry of Education and Fine Arts and the Austrian Federal Chamber of Commerce.
The Laboratorium für Kunststofftechnik (LKT-TGM), a leading technological institute has promised full co-operation in running the theoretical and practical course in plastics technology in its premises, utilizing its laboratories and equipment for this purpose. The institute has a staff of highly qualified specialists.

The programme will consist of theoretical and laboratory training, study visits and an evaluation session.

The theoretical part of the training will cover a general introduction to the plastics industry, the chemical and mechanical technology of plastics, raw materials, utilization of plastics equipment and tools, etc.

The practical training will be implemented in laboratories of LKT-TGM in Austria. The participants will be assigned to small groups according to their field of specialization and training needs as much as possible.

4. The Training Programme

4.1. Subject List

Abbreviation	Subject	Plastics Technology Hours
TTD	Technology Transfer and Development	4
PCT	Plastics Chemical Technology	8
PPT	Plastics Physical Technology	14
MEM	Mechanical Engineering and Mould Design	18
PEN	Plastics Application Engineering	6
PPH	Polymer Physics	4
CEN	Control Engineering	4
TME	Training Methods	2
TAN	Trouble Analysis	4
	Subtotal Theory	64
CC	Compounding and Calendering	10
CE	Computation Engineering	4
CT	Control Techniques	12
EX	Extrusion	16
FI	Finishing	4
FO	Foaming	6
IC	Injection and Compression Moulding	18
MF	Machining and Forming	6
MM	Mould Making	2
PC	Polymer Chemical Analysis	4
PP	Polymer Physical Analysis	10
QC	Quality Control	8
RF	Reinforced Plastics	6
TS	Trouble Shooting	4
	Subtotal Practice	110
	Grand Total	174

4.2. Content of Lectures and Lecture Notes

4.2.1. Design of Lecture Notes

The lectures notes have been adapted and developed in accordance with UNIDO, with the participants and with the experience of eleven programmes since 1970.
To meet the general, practical and theoretical needs of the participants three levels of comprehensive information are offert in form of

- general lecture notes (880 pages)
- special lecture notes (270 pages) and
- research papers (60 pages).

For this programme the following lecture notes have been edited or revised:

Plastics Physical Technology (226 pages)
Plastics Application Engineering (46 pages)
Polymer Physical Analysis (24 pages)
Polymer Chemical Technology (6 pages)

4.2.2. General Lecture Notes (Theory)

TECHNOLOGY TRANSFER AND DEVELOPMENT (TTD)

H.Hubeny

The Global Situation (selected Indicators):

World Development Report - Population - Non-Renewable Resources - Energy - Education - Income

Principles of Development:

Historical Models - Development Analysis

Technology Transfer:

Assumptions - Definitions - Concepts - Cost of Technology Transfer - Characteristic Stimuli and Barriers - Effects

Documents:

Code of Conduct - OECD Classification - National Paper of Austria

Models of Execution:

Macro-Level Conditions - Micro-Level Conditions - Plastics Technology - Plastics Development Activities

Personal Questions:

References:

PLASTICS CHEMICAL TECHNOLOGY (PCT)

E.Wogrolly

Classification of plastic materials
Formation reactions
Functionality
Polymerization reactions: Addition polymerization (free radical mechanism - ionic mechanism) - Condensation polymerization - Copolymerization - Auxiliary materials for polymerization.

Physical Behavior of Plastics
Secondary Bonds: Dispersion Forces - Dipolar-orientation forces - Induction forces - Hydrogen bridges.

Transition States: Hard-elastic state - Setting or Softening range - Glass transition - Brittle Point - Elastomeric state.

Polyolefines - Polyethylene (PE)-Modified Polyethylene--Chlorinated Polyethylene (CPE)-Sulfochlorinated Polyethylene--Crosslinked-Copolymers with Ethylene-Ethylene/Vinylacetate (EVA)-Ethylene/Vinylalcohole (EVAL)-Ethylene/Ethylacrylate (EEA)-Ethylene/Butene or Hexene (see also LLDPE)-Degradation of Polyethylene-Polypropylene (PP)-Modified Polypropylene--Copolymers with Ethylene (EPM and EPDM)-Polybutene -1 (PB)--Polyisobutylene (PIB)-Poly-4-methylpentene -1 (PMP)--Unsaturated Polyolefines-1,2-1,4-Polybutadiene-Polypentenamer--Polyoctenamer-Ionomers-Other Polyolefines,Trends in research and development.

Polyvinylchloride (PVC) - Plasticized PVC-Modified PVC--Compounds (Blends) with CPE-Compounds with EVA and graft polymers of EVA with VC-Compounds with Acrylo/Polymers-Copolymers with Vinylidenechloride VDC/Acrylonitrile-Copolymers with Maleic-imide.

Polystyrene (PS) - Unipolymers-Copolymers-Copolymers with α-Methylstyrene-Copolymers with Acrylonitrile (SAN)-High impact Polystyrene-Styrene/Polybutadiene graft polymers--Styrene/Acrylonitrile-butadiene-Styrene/Maleic Anhydride (SMA)-Expanded polystyrene (EPS).

Acrylics - Polyacrylonitrile (barrier plastics)-Polyacrylates--Polymethylmethacrylates (PMMA)-Polymethacrylimides--Reclamation of MMA from Acrylic wastes.

N-Vinylpolymers

Polyethers - Polyoxymethylene (POM)-Polyethyleneoxide (PEO).

F-Polymers - Polytetrafluorethylene (PTFE)-Polytrifluorchlorpethylene (PCTFE)-Copolymers-Copolymers with Hexafluoropropylene-Polytetrafluorethylene-co-perfluormethylvinylether--Polyperfluoralkylvinylether (Teflon PFA)-Polyvinylfluoride (PVF)-Polyvinylidenefluoride (PVDF).

Silicones - Methylpolysiloxanes-Phenylpolysiloxanes (PSI).

Polyamides (PA) - Polyamide 6 and 6,6-Polyamide 4 and other aliphatic Polyamides-Aromatic Polyamides.

Polycarbonate (PC)

Polyterephthalates (PET, PBT)

Polyphenyleneoxide (PPO)

Polysulfone (PSU)

Polyphenylenesulfide (PPS)

Polyethersulfones (PES)

Phenol/Formaldehyde Resins (PF)

Urea/Formaldehyde Resins (UF)

Melamine/Formaldehyde Resins (MF)

Unsaturated Polyesters (UP) - UP-Resins-Crosslinking of UP--Chemistry of Peroxides-Alkyd Resins.

High Temperature Resistant Polymers - Polyimides (PI)-Polybenzimidazole-Polyimidazopyrolone (Pyron)-Polycyclobutadiene.

Polyepoxides (EP)

Polyurethanes (PUR) - Diisocyanates-PU Elastomers-Relation Between Structure and Properties of PUR-Manufacture and Properties of PUR-Foams.

Flame Retardancy of Polymeric Materials

Auxiliary Chemicals

Health Hazards and Toxicity

Degradation and Stabilization

Environmental Behaviour of Plastics Materials

Plastics Waste Management

Reclamation, Recycling and Reuse of Plastics Waste.

PLASTICS PHYSICAL TECHNOLOGY (PPT)

H.Hubeny

Plastics Technology
Introduction
Cycle Process
Model Matrix
Quality and Polymer Processing: Materials - Processes - characteristic functions

Technological States: Basic Material - Intermediate Material - Resin - Additives - Moulding Material - Moulded Material - Semi-finished Product - Finished Product - Waste.
Concersion Processes: Refining - Syntheses - Compounding - Fabrication - Machining and Forming - Finishing - Application - Recycling

Molecular Structure
Linear Macromolecules: Molecular Models - Molecular weight - Helical Conformation - Polarity
Crosslinked Macromolecules
Thermodynamics of Molecules: Potentials - Molecular Motion

Morphological Structure: Amorphous - Mesomorphous - Crystalline Structure

Additives: Stabilizers - Fillers and Reinforcement Materials - Plasticizers - Colorants - Flame Retardants - Antistatic Agents - Blowing Agents - Antimyotika (Biozides) - Lubricants - Activators - Nucleating Agents

Rheology
Elasticity: Crystalline Elasticity - Rubber Elasticity
Viscosity: Newtonian Fluids - Non - Newtonian Fluids - Flow Theory - Morphological Interpretation

Properties of Plastics
Classification: Oscillation Twisting Test - Definitions (Thermoplastics, Thermosets, Elastomers, Thermoelastics)
Abbreviations
Price

Statistical Data
Thermoplastics Moulding Materials
Bulk Polymers: Polyolefines (PE, PP, PB, PMP Ionomers) - Styrene Polymers (PS, BS, ABS, SAN) - Vinylchloride Polymers (PVC + Cop).
Engineering Thermoplastics: PA - PUR - PETP - PBTB - PC - Phenoxy - POM - PPO - PPS - Polysulfones - Polyarylsulfones.
General Thermoplastics: CA, CAB - Chlorinated Polyethers - Fusible Polyfluoro-carbons (PCTFE, PFEP, PVDF)

Thermosetting Moulding Materials:
PF - UF - MF - UP - EP - PUR

Thermoelastic Moulding Materials (PMMA)

High Temperature Resistant Moulding Materials:
PTFE - PI - PBI - PBT - Developing Products.

Compounding

Terms

Particle size reduction: Crushing - Grinding

Mixing: Operations - Dry solid mixers - Static and screw (auger) mixer - Mullers - Tumble mixers - Ribbon blenders - Orbiting screw mixers - Cylindrical mixers - Fluid mixer - Melt mixers - Internal kneader - Extruders - Motionless mixers - Liquid mixers.

Pelletizing

Compounding parameters: Homogeneity - Gross uniformity - Texture and local structure - Melt behaviour - Colour matching.

Continuous Processing

Classification

Continuous casting and laminating: Operations - Solvent film casting - Multicomponent liquid resin processes - Laminating - Slab stock foaming - Pultrusion - Continuous coating - Operation - Spread coating - Cast coating - Roll coating - Transfer coating.

Calendering: Operation - Calender types - Rheological calculations - Calender coating and laminating .

Extrusion: Operation - Classification of extruders - Single-screw extruder design - Function - Extruder size and L/D-ratio - Feed screws - Theory of plasticating single screw extruders - Feed section - Transition section - Metering section - Screw and die characteristics - Multiple screw design - Twin screw extruder design - Function - Calculations - Screw and die characteristics - Extrusion processes - Internal flow design - Basic rheological relations - Rheology applied to die design - Tubular extrusion - Sheet and film extrusion - Profile extrusion - Extrusion coating and laminating - Foam extrusion - Extrusion controls and instrumentation - Process parameter control - Thickness control - Supervisory control loops - Cooling stresses.

Discontinuous Processing (Moulding)

Classification

Liquid phase moulding: Operations - Casting processes - Rotational moulding - Monomer casting - Reacting injection moulding - Reinforced composites moulding - Hand lay-up moulding - Spray-up moulding - Bag moulding - Filament winding - Coating.

Compression moulding: Operations - Moulds - Flow and curing behaviour - Shrinkage behaviour - Preheating - Wet moulding - Controls.

Transfer moulding: Operations - Moulds.

Injection moulding: Operations - Plasticating unit - Moulds - Processing variables - Requirements - Pressure - Flow rate - Temperature - Cooling rate - Shrinkage - Frozen strains - Entropy-elastic strains (orientation) - Energy-elastic strains (cooling stresses) - Injection moulding processes - Injection moulding thermosets - Coinjection moulding - Structural foam moulding - Multistation rotary injection moulding - Injection moulding controls - Process control - Process monitoring - Microprocessors - Injection work.

Blow moulding: Extrusion blow moulding - Operations - Continuous extrusion - Intermittent extrusion - Coextrusion - Moulds - Programming - Injection blow moulding - Operations - Two-position system - Three-position system - Four-position system - Developing systems - Stretch-blow moulding - Blow moulding controls - Wall thickness - Finished weight - Microprocessors.

Fabricating of Semi-Finished Goods

Technical terms

Machining: Operations - Physical conditions.

Forming: Operations - Vacuum forming - Blow forming - Mechanical forming - Operations - Folding - Bending - Beading - Pressure forming - Stamping.

Assembly: Welding - Operations - Friction welding - Hot-Gas welding - Hot-Plate welding - Heated wedge welding - Hot-Bar welding - Impulse welding - High-Frequency welding - Magnetic heat welding - Ultrasonic welding - Bonding - Adhesive bonding - Electromagnetic bonding - Mechanical fastening.

Separating

Finishing

Painting

Printing: Operations - Flexography - Gravure - Lithography - Silk screens - Jet printing.

Metallizing: Operations - Electroplating - Vacuum metallizing - Sputtering.

Hot stamping

Embossing

Irradiation

Application

Systematic development of application

Standards

Waste

Recycling

Cutting mills

Reprocessing lines

Extruder screen changers

Incineration

Outlook

MECHANICAL ENGINEERING AND MOULD DESIGN (MEM)

R.Hillisch, H.Revesz

Extrusion
Extruder Plants and -Dies: Pipe Manufacturing - Blown Film - Flat Film - Sheet Extrusion - Lamination - Wire - Covering - Pelletizing Plants - Monofilaments - Profile Extrusion Plants.

Pre-Set Elements: Silos - Transporting Systems - Compounding and Reworking Machines - Mixers - Kneaders - Mills - Pre-heating- and Drying Equipments - Vent Systems.

Elements of the Extruder: Classification - Function of Screws - Feeding - Designs of Barels and Screws - Drives - Bearings - Heating and Cooling - Temperature Control - Melt Pressure Gauges - Die Adapters.

Annexed Equipment: Sizing Dies - Cooling - Take off - Control Devices - Signators - Preliminary Treatment - Separating Equipment - Post Forming Equipment.

Principles of Extruder Die Design

Plants and Molds for Blow Molding
Accumulators - Tubing Dies - Orifices - Closing Units - Blowing Equipment - Severing Equipment - Ejection Equipment - Transporting - Blow Molds.

Molding of Thermosets.
Processing Techniques: Compression Molding - Transfer Molding - Injection Molding

Machines: Semi-automatic Presses - Automatic Presses - Mechanical - Hydraulic Presses - Compression- and Transfer Molding Machines - Plungers - Screw Plungers

Additional Equipment: Dosing - Preforming - Preheating - Finishing

Molds: Open Flash Mold - Positive Molds - Split Molds - Transfer Molds - Runners and Gates - Transfer Pot and Plunger Leaders - Ejector Pins - Mold Heating - Types of Steel - Special Machining Molds.

Design of Compression Molded Parts
Requirements - Draft of Surface - Wall-Thickness - Roundings and Ribs - Undercuts - Holes - Slots - Design of Threads - Metal Inserts.

Injection Molding
Techniques: Injection Molding - Injection Stamping - Flow Molding - Molding of Expanded Materials - Injection Blow Molding - Two Color Molding.

Machines: Classification - Technical Data - Injection Units - Screw Plunger - Nozzles - Closing Units - Safety Devices.

Additional Equipment: Material Storage - Transport - Preheating - Drying - Mixing - Dyeing - Cooling Equipments - Cutting Equipments.

Molds: Elements - Design of Sprue, Runner and Gate - Types of Molds: Single Cavity, Multiple Cavity, Three Plate, Four Plate, Split, Side Pull, Hot Runner, Calculation - Design of Molds.

PLASTICS APPLICATION ENGINEERING (PEN)

W.R.Jessenig

Plastics Survey

Shearmodulus temperature function

Plastics, materials for constructions
Thermoplastics
Thermosets
Composits
Hybridsystems

Long-time behaviour (static)

Stress-strain behaviour depending on temperature test speed and moisture

Economic aspects

Plastic points, tolerances

Construction of models and prototypes

Basic principles for mechanical calculation

Temporary variable deformations

Caracteristic dimensional funstions

POLYMER PHYSICS (PPH)

H.Dragaun, H.Muschik

Density Measurement

Measurement of Melt Viscosity

Measurement of K-Value

Measurement of Viscosity, Number and Determination of Intrinsic Viscosity

Optical Microscopy and Preparation

Electron Microscopy and Preparation

Thermal Analysis
DSC - Differential Scanning Calorimeter
TMS - 2 Thermomechanical Analyzer
TGS - 2 Thermogravimetric Analyzer

CONTROL ENGINEERING (CEN)

F.Gregori

Control Loop

Controlled System: Time-Behaviour - Heating-zone as Controlled System

Temperature Measurement
Resistance Thermometer: Cross-Coil Instrument - Moving Coil Instrument in Bridge Circuit (Deflection Method).

Thermocouples

Controllers
Continuous Controllers
Two-Position Controllers: Galvanometric Controller - Chopper bar Controller - Controller with inductive Pick-Up - Controller with Photoelectric Scanning - Electronic Controllers - Thermocouple as Detecting Element - Resistance Thermometer as Detecting Element.

Temperature Control
Hunting
Two Position Control with Feedback: PD-Control Behaviour - Thermal Feedback - Electronic Feedback - PID-Control Behaviour - Thermal Feedback - Electronic Feedback.

4.2.3. General Lecture Notes (Practice)

COMPOUNDING AND CALANDRING (CC)

H.Wolanek

The Production of PVC-Compounds by Heater-Mixing

Testing Methods for PVC-Compounds

COMPUTATION ENGINEERING (CE)

F.Mayer

General Facts
Structure of an Computer
Programming Operations
Connection with an EDV-Plant

Practical execution of a Programme at the Computer
Other Possibilities of Application in Plastics Engineering.

CONTROL TECHNIQUES (CT)

G.Minarovich

Open-Loop-Control
Voltage supply
Standardized connection diagrams and symbols
The Use of Instruments for measuring the Current, Voltage and Resistance

Functional Description of a Reversing Contactor Combination Automatic-Control

Definitions

Automatic Control System and Block Diagram

Transient Response of a Controlled Member

Temperature Behaviour of a Barrel Zone Controlled by Two-Step Action Controller without Feedback

Temperature Behaviour of a Controlling Member with Two-Step Action Controller and Feedback

Electrical Methods for Measuring the Temperature

EXTRUSION (EX)

H.Revesz

Production of Tubular (Blown) Films

Extrusion of Blown Double - Layer Films

Production of Sheets

Production of Rigid PVC-Pipes

Blow Moulding

Production of Polyethylene Pipes

FINISHING (FI)

J.Smelik

Electroplating

Materials

Part Design

Moulding Factors

Chemical Pretreatment

FOAMING (FO)

H.Hubeny

Classification of Plastic Foams: Material - Stiffness - Cell Morphology - Density - Density Distribution - Fabrication Process

Properties

Processing: Expandable Bead Methods - Reactive Foam Moulding (Low Pressure - High Pressure - Mould Carrier - Foaming Plant - Slab Stock Foaming) - Thermoplastic Foam Moulding - Foam Extrusion

Polyurethane Technology:

Polyurethanes (Isocyanates - Polyethers - Polyesters) - Mould Materials - Practical Exercises.

INJECTION AND COMPRESSION MOULDING (IC)

H.Graf, R.Hillisch

Introduction

Adjustment of Processing Parameters.

Influence of the Mass Temperature and Injection Pressure on Shrinkage and Machanical Strength of Polystyrene Test Bars.
Testing of Performance Properties of Standardized Panels made of Expanded Thermoplastics with a varied injections Speed.

The Principles of Process Control in Injection Moulding

Compression Moulding of Testing-Cups
Determination of Curing time (Stiffness)

MACHINING AND FORMING (MF)

E.Strohmayer

Machining: Cutting - Guillotine shears - Drilling - Screwing - Turning - Planing - Milling - Filing - Grinding - Polishing.

Welding: Press-Welding - Hear-Impulsive Welding - High Frequency Welding - Hot-Gas Welding.

Forming: Bending - Whirl-Sintering - Vacuum Forming.

Workshop - Drawings - Work Instructions.

TESTING (PC, PP, QC)

W.R.Jessenig, H.J.Fischer, H.Hubeny

Part I

Molecular Investigations
Viscometry - Viscosity number - Intrinsic viscosity - k-value - Distribution of Molecular Weight - Density and specific Volume.

Structural Investigations
Oscillating twisting test - Thermoplastics - Elastomers - Thermosetting Materials - Glass Temperature - Dynamic Glass Transistion Temperature (according to DIN standards) - Melting Temperature - Decomposition Temperature - Melt Viscosity and Flow - Flow - Rheology - Therminology - Definitional Equations - Viscoelastic Behaviour - Measuring of viscosity in the capillary-tube rheometer.

Stability Behaviour
Permeation of Gases and Vapours - Mechanism of a Solution Diffusion - Gas Permeability.

Mechanical Behaviour
Short-Time Behaviour - Tensile Test - Measuring of Force with the Pendulum Force System - Electronic System for Measuring the Force - Electronic Force Measuring Head (Inductive) - Electric Force Measuring Sockets - Measuring of Elongation with the Mechanical Elongation Measuring - Electronic Elongation Measuring - Evaluation of the Tensile Test - Temperature Dependence - Dependence of characteristic values on strain rate in the Tensile Test - Compression Test - Bending Test - Impact Strength Test - Impact Tensile Test - Hardness Testing - Dropping Test - Friction and Wear, Burst Test - Internal Pressure Pipe Testing - Fundamental Principles - Wall Thickness Measuring - Conventional System - System DURAPIPE (ANGER) - Specimen End Fittings - Long-Time Behaviour - Creeping Test.

Optical Behaviour

Photoelasticity

Thermal Behaviour
Determination of characteristic physical values - Dimensional stability under heat - Dimensional stability under heat according to Martens - Vicat Softening Point VSP - Dimensional Stability under Heat according to ISO - Brittleness Temperature Tests according to DIN and according to ASTM - Shrinkage behaviour - Proof of Orientation in Moulded Parts - Classification of High Building Materials according to their Combustion Behaviour - General Facts - Executing of Test I - Evaluation - General Facts Test II - Execution of Test II - Evaluation.

Heat - and Sound Technology

Thermal Conductivity - Steam Permeability - Thermal Insulation - Step Sound Insulation - Air Sound Insulation - Degree of Accoustic Absorption - Dynamic Elasticity Modulus and Loss Factor.

Electrical Properties

Volume- and Surface Resistance - Tracking Resistance - Polarization and Dielectric Constant - The polarization of an insulating material - The dielectric constant is a criterion for the amount of polarization of an insulating material - Dielectric Loss Factor.

Part II

Hardness Testing by the Indentation Test

Dimensional Stability after Heat Storage (Shrinkage Test)

Testing of Homogeneity

Testing of Flammability

Compression Test

Tensile Test

Part IiI

Ultrasonics in Processing and Testing Materials

Ultrasonics in the Processing of Semi-Finished Goods
General Facts - Method - Sound Sources - Ultrasonic Rivetting - Ultrasonic Embedding.

REINFORCED PLASTICS (RF)

H.Hubacek, W.R.Jessenig

Technology

Reinforcing Materials

Types of Plastics

Practical Hints of Processing

4.2.4. Special Lecture Notes

The objective of the special lecture notes is to inform on new developments in processing, application, recycling and quality control of plastics technology at a higher comprehensive level.

DATA CONVERSION IN INJECTION MOULDING

H.Graf, F.Mayer

General Remarks
Measuring Pressure: Piezoelectric Transducer - Charge Amplifier.

Measuring Temperature: Fluctuation Compensation - Temperature Sensors - Preheatable Thermocouples - Plotter System

Measuring Front Flow

Measuring Distance: Inductive Measuring Sensors - Carrier Frequency Amplifier

Computerised Measuring: Digital Voltmeter - Interface - RS 232 Interface - System Computer

QUALITY CONTROL AND DAMAGE ANALYSIS BY MORPHOLOGICAL METHODS

H.Dragaun

Introduction: Definition of Quality - Increase in Quality - Technological Problem - Continuous melt viscosimetry - Polypropylene Pressure Pipes - Morphology

Morphological Methods: Optical Microscopy - Electron Microscopy - X-ray Diffraction - Wide-Angle X-ray Scattering (WAXS) - Small-Angle X-ray Scattering (SAXS) - Thermoanalytical Methods - Calorimetric Methods - Dilatometric Methods - Spectroscopy - Infrared Absorption (IR) - Electron Spin Resonance (ESR) - Nuclear Magnetic Resonance (NMR)

Practical Application in Damage Analysis:
Crack Formation in Polyethylene (PE)-Pipe - Irregular characteristics of Polyethylene (PE) sheets during finishing - Different Abrasion Characteristics of a Polypropylene (PP) Drive-Component - Differentation of Polyblends in various Polyethylene (PE) types - Different Fracture Behaviour of Polypropylen/Polyethylen Copolymer - Fracture in a Moulded Part (fitting) of Rigid Polyvinylchlorid (PVC).

QUALITY CONTROL OF GRP PIPES

W.R.Jessenig

Designation
Company Control: Resin Control (Purity - Viscosity - Solid Body Content - Gel-Time - Reactivity - Thermal Stability)
Textile-Glass Test (Fineness of Strand - Humidity - Rod Bending Test)
Filler Control (Resin Absorption - Sieve Analysis)
Reactant Control

Production Control: Regular Production Control - Choice of Specimens and Test Frequency - Requirements - Test Procedure - Gel-time - Wall thickness

Random Production Control

Acceptence Control

External Control: Test Volume - Recording - Designation - Condition at Delivery - Measurements - Pipe Stiffness - Longitudinal Tensile Force - Circular Tensile Force - Choice of Specimens - Expertise and Test Report.

NEW RURAL APPLICATIONS OF PLASTICS

H.Muschik

Introduction.
Protection of Plants by Nets.

Foils in Agriculture: Introduction - Flat Foils - "Mulch-Foils" - Plastic-Covered Tunnels - Foils for Sealing - Recycling of Foils - Greenhouses.

Containers for Plants.
Non Wovens for Mulch-Technique.

Irrigation: Introduction - Spray Tube - Sprinkler Irrigation Plants.

Waste Water and Drainage: Waste Water - Drainage.

Heating of Greenhauses.

Storage of Agricultural Products: Storage of Wood - Storage of Fruit and Vegetables in Foils - Storage of Fruits and Vegetables in Sacks - Storage of Liquids and Food.

Coating.
Technological Transfer.

ENVIRONMENTAL ASPECTS OF PLASTICS TECHNOLOGY

E.Wogrolly

Introduction.
UN-Activities in the Field of Environmental Protection.

The Environmental Impact of Plastics:
Air Pollution: The Properties and Effect of Pollutants - Ozone, its possible biological Effects and Reduction in the Atmosphere - MAK-Values

Formaldehyde Odor and Health Problems within Residences:
Toxicity of Formaldehyde.
The Vinyl Chloride Problem.
Waste Water Treatment.

Some Aspects of Waste Disposal: Plastics Wastes in the Solid Wastes Steam - Reclaim, Recycling and Reuse of Plastics - Recycling Mixtures of Plastics - Separation of Plastics from mixed Refuse - Biodegradation - The Technology of Biodegradable Fillers - The Competiveness of Plastics with traditional Materials after the 1973 Oil Crisis.

4.2.5. Research Papers

The objective of research papers is to offer information in the field of polymer science and technology of LKT-TGM at applied research level.

DATA CONVERSION IN TECHNOLOGY AND MORPHOLOGY

Extrusion:

New Possibilities of a Cascade Control of Extruders by Means of a Torsion-Sensitive Screw Tip - Continuous Measurement and Control of Viscosity throughout the Extrusion Process - Novel Systems for Viscosimetry of Polymer Melts and Solutions.

Injection Moulding:

The Principles of Process Control in Injection Moulding - Degassing of Plastics Materials on Injection Moulding Machines.

Morphology:

A Comparison of Critical Elongation as Determined by the Ball Indentation Method and by Creep Test on Injection Moulded Rigid PVC Test Specimens - The Technology and Morphology of Polypropyle Pressure Pipes - Microfibrils in Brittle-Fracture-Surfaces on Isotactic Polypropylene at 4.2 K - Shear-Induced ß-form Crystallization in Isotactic Polypropylene.

POLYURETHAN STRUCTURAL FOAMS

Non-Destructive Determination of the Density Profile in Polyurethane Structural Foams - Measuring and Influencing of the Density Distribution in Polyurethane Structural Foams - Statistic Examination of Cell Size Distribution in Polyurethane Structural Doams.

RECYCLING

The Behaviour of Household Refuse containing PVC in Incinerators.

4.3. Special Lectures

20 October 1983: Mr.Kaminski
Chemische Werke München,Otto Bärlocher Ges.m.b.H.
Stabilizers for PVC-extrusion and injection moulding processing

31 October 1983: Dr.O.Abu Zaid
Director General of PDC-Alexandria Egypt Plastic Development Centre
Plastics in agriculture

8 November 1983: Mr.A.Schätzschock
Elwas Company
Manufacturing of Elwas-file and application

18 November 1983: Prof.Dr.Hermann F.Mark
Progress in Polymer Science and Technology

5. Participants

BOLIVIA	
Justiniano CANEDO	Plasmar S.A. Av.6 de Agosto,P.O.B.4818 La Paz
CHILE	
Gonzalo DULANTO	Duratec Panamericana Norte 1615
CHINA	
Hang Min JI	Heilongojiang Province Plastics Industry Co. No.255 Fendou Street Mangang Harbin
DOMINICANIAN REPUBLIC	
Cesar ARJONA	Pegoro Industrial, C.A. Km15. Carretera Duarte, Sto.Dqo.R.D.
ECUADOR	
Gaston BURGAENTZLE	Plastex S.A. Pan.S.Km 5 1/2, Aptdo 2485, Quito
GHANA	
Albert Aidoo HAGAN	Gihog Electronics Co.Ltd. Akasanomah, P.O.Box 577, Tema Ghana
GUATEMALA	
Angel MARTINEZ	Plasticos Estructurales 3a.Ave.39-61, zona 8,Guatemala
INDIA	
S.Mohamed NAINAR	Central Institute of Plastics Eng.& Tools, CIPET, Guidy, Madras-32
P.POOMALAI	ditto
K.P.GOVINDAN	ditto
Rampal SINGH	ditto

IRAQ	
Afaf M.D.AL-AZZAWI	Specialized Institute for Engineering Industries, S.I.E.I., Iraq-Baghdad-Doura
KOREA	
Yong Son PAK	Febrary & Vinaton Complex, Hamhung City, DPRK
MALAWI	
Keegan M.W.MUWERO	Plastic Products Ltd., P.O.B.907, Blantyre, Malawi
MALTA	
Joseph FARRUGIA	Toly Products, Bulebel Industrial Zejtun,Malta
MAURITIUS	
Georges SHENG CHUN	Paris Shoes Ltd., Coromandel Industrial Estate
PERU	
Felix VENTURA PEREYRA	Plasticos Nacionales S.A., Av.Los Talleres 4898, Elnaranjal, Lima 31
SINGAPORE	
Khee Sio YEO	Techplas Industries Pte, Ltd., Block 994, Benedemeer Road, 01-05/07, Singapore 1233
Li Chin CHUI-LIU	Singapore Institute of Standards & Industrial Research, 179 River Valley Road, Singapore 0617
SRI LANKA	
Sriyani WARUSAVITHANA	Bureau of Ceylon Standards, No.53, Dharmapala Mawatha,Colombo-3, Sri Lanka
Upendra PERERA	ditto

SUDAN	
Hassan Gaafar MOHAMED	Nahda Plastic Com.,P.O.Box 993, Omdurman
THAILAND	
Payona PADANUPONG	Business, Organization of Teachers Institute, Suksapan Panit, Rajdamnern Ave Bangkok, Thailand
VIETNAM	
Han TRAN	Institute of Industrial Chemistry, 2 Phamngulao Hanoi
YEMEN	
Hasson Mahmood A.REHMAN	Algundi Plastic Factory, P.O.Box 4206, Aden, P.D.R.Y.
Nasser Hussein ALALA	ditto

6. Staff for the Training Programme

Principal of TGM: Hofrat Dir.Dipl.Ing.Dr.techn.F.Plöckinger

Director of LKT-TGM: AV Dipl.Ing.Dr.techn.H.Hubeny

Deputy Programme Director: Ing.R.Hillisch, Ing.W.Michel

Organisation Committee:

AV Dipl.-Ing.Dr.techn.H.Hubeny
Prof.Dipl.-Ing.Dr.techn.E.Wogrolly
Ing.R.Hillisch
Ing.W.Michel
Ass.Ch.Fabiankowitsch
B.Dörr
H.Braunsteiner

Lectures:

FOL F.Beran
Prof.Dipl.-Ing.Dr.techn.H.Dragaun
Prof.Ing.Dkfm.H.Graf
Ing.R.Hillisch
AV Dipl.-Ing.Dr.techn.H.Hubeny
Prof.Dipl.-Ing.Dr.techn.W.R.Jessenig
StR.Ing.R.Jirsa
Prof.Dipl.-Ing.W.Mähr
Prof.Dipl.-Ing.Dr.techn.F.Mayer
Prof.Dipl.-Ing.Dr.techn.H.Muschik
FOL Ing.G.Minarovich
Prof.Dipl.-Ing.Dr.techn.H.Revesz
FOL Ing.E.Strohmayer
FL Ing.E.Weiß
Prof.Dipl.-Ing.Dr.techn.E.Wogrolly
Prof.Ing.Mag.H.Wolanek

Assistance and Preparation:

FOL H.Bitschnauer
FOL K.Blazek
H.Braunsteiner
St.Büchinger
B.Dörr
Ass.Ch.Fabiankowitsch
Ass.Ing.Mag.P.Freisler
FL G.Freyer
A.Imre
FL E.Jahn
B.Jarosch
Wiss.Ass.Ing.E.Herbinger
H.Lahner
P.Liptak
F.Lorenz
FL Ing.F.Mennerstorfer
Ing.W.Michel
Ass.Ch.Neustifter
Ass.Ing.M.Radax
Ass.A.Revesz
Ing.H.Schermann
FL H.Seifert

7. Plant visits

To the special interest of the participants 13 plant visits during the six-week course in Austria were organized by LKT-TGM. The selection of the plant according to the interest of the participants gave a regional and technical survey on the Austria plastics industry:

BATTENFELD Kunststoffmaschinen Ges.m.b.H. Wr.Neustädter-Straße 81 2542 Kottingbrunn	Injection moulding equipment, blow moulding machines
CHEMIE LINZ AG St.Peter-Straße 25 4021 Linz	PE, PP-Compounds, Staple Fibres, Films, Plastics-Processings
CINCINNATI MILACRON AUSTRIA Laxenburger Straße 276 1232 Wien	Twin Screw Extruder, Dies, Down-Stream-Equipment
COUDENHOVE Ges.m.b.H. Gorskigasse 15 1230 Wien	Reaction injection moulding of GUP
LUDWIG ENGEL KG 4311 Schwertberg	Injection Moulding Machines, Mould Making
FEPLA-HIRSCH Wiener Straße 113 2700 Wr.Neustadt	PE, PP film blowing, finishing, welding
GABRIEL CHEMIE Stipcakgasse 6 1234 Wien	Thermoplastic masterbatches, coloration, formulations
HALVIC 5400 Hallein	PVC raw material production

IFW-Manfred Otte Pyhrnstraße 73 4563 Micheldorf	Moulds, dies
INTERNORM Ges.m.b.H. Ganglgutstraße 131 4091 Oedt	PVC window profiles, windows
NAUE & NAUE 8974 Mandling	Moulded foam, slabstock foam, special purpose machines
POLOPLAST Poloplaststraße 1 4060 Leonding	Pipe Extrusion, Injection Moulding, Pipe and Fittings Systems
KARL WESS OHG Wiener Straße 54-56 2640 Gloggnitz	Mould- and Die-Making

Individual plant visits have been arranged to

OSWAG-Osterr.Schiffswerfte AG Derfflingerstraße 15 4027 Linz	Extruders, down stream equimpent
CHEMIEFASER LENZING AG 4860 Lenzing	Strech film equipment
REICHHOLD CHEMIE AG Breitenleerstraße 97-99 1220 Wien	Microscops
PARA-CHEMIE Hauptstraße 53 2440 Gramatneusiedl	PMMA casted sheets

8. Equipment for the Training Programme

ALPINE, BRD; Extruders
AVL, Graz; Electronic Control Systems
BATTENFELD, BRD; Injection Moulding and Blow Moulding Machines
BATTENFELD-KUHNE, BRD; Extruders (actually: Kuhne GmbH,BRD)
BAUER, Schweiz; Measuring Instruments
BOY, BRD; Injection Moulding Machines
BRABENDER, BRD; Plastograph
BRENSON, USA; Ultrasonic Welding
BROSA, BRD; Control Instruments
BRUELL & KJAER; Acoustical Instruments
BUCHER-GUYER, Schweiz; Presses
CHURCHILL, England; Water and Oil Circulating Controllers
CINCINNATI MILACRON, Wien; Extruders
COUDENHOVE Poly-Spray, Wien; Spray-Up Machines
DEMES, BRD; Pre-Treatment Instruments
ENGEL, Schwertberg; Injection Molding Machines
FRANK, BRD; Testing Equipment
FUCHS, Wien; Mills
GOERZ Electro, Wien; Instruments
HAGEDORN & BAILLY,BRD;Water and Oil Circulating Controllers
HARTMANN & BRAUN, BRD; Control Systems
HASCO, Wien; Moulds
HENSCHEL, BRD; Mixers
HONEYWELL Bull, Wien; Time Sharing
HOTTINGER, Wien; Torque Measurement Equipment
JOENS, BRD; Control Systems and Recorders
JUMO, M.K.Juchheim, BRD; Control Instruments
ILLIG, BRD; Vacuum Forming Machines
KIEFEL, BRD; Film-Extruder
KRAUSS-MAFFEI, Injection Moulding, Foaming, Extrusion, Recycling
LÖDIGE, BRD; Mixer
BATTENFELD Kunststoffmaschinen GmbH., Kottingbrunn; Injection Molding
MEDEK & SCHÖRNER, Wien; Signator (Marker)
METRAWATT, BRD; Control Systems
NETSTAL, Schweiz; Injection Molding Machines
PERKIN-ELMER, USA; Analytical Instruments
PHILIPS, Wien; Control Systems and Recorders
POLYROLL, BRD; Foaming Machines
PVL, Waldbreitbach (Austria); Electronic Equipment
PWF, DDR; Presses
SCHLUMBERGER, Wien; Electronic Equipments
STAIGER & MOHILO, BRD; Instruments
STOUGAARD, Dänemark; Instruments
TIEDEMANN, BRD; Optical Instruments
TROESTER, BRD; Calanders, Roll Mills
UNILABOR, Wien; Electronic Equipment
VEB Werkstoffprüfmaschinen, DDR; Testing Equipment
VIKING, UK; PUR-Foaming Machines
WITHOF, BRD; Control Systems
ZWICK, BRD; Testing Equipment

9. Special Industrial Development (SID) Programme in Plastics Technology

9.1. Objectives

To increase the efficiency of the 14th Training Programme it will be useful to continue the contacts between participants, institutions, companies and authorities. One facility besides contracts between institutions is a taylor-made research programme for candidates to help them solve their problems in plastics technology.

LKT-TGM have had considerable experience in conducting post-graduate research programmes in German language, especially for participants from various institutions in Austria. We are now interested in extending this experience to include post-graduate SID-programmes conducted in the English and French language for foreign participants. The success of the first arrangements encourage us to take on more participants on a similar basis together with UNIDO.

The programme is planned as a professional tuition by development work in a specific field of plastics technology including theoretical introduction, project work, plant visits, individual contacts with national and international organizations, companies and other institutes, educational training, publications, membership of the Austrian Association for the Promotion of Plastics Technology (GFKT).

9.2. SID-Programme in Brief

Detailed fields of study	180 Projects in Procedure Engineering and Control Engineering (Injection Moulding, Extrusion, Foaming, Conpounding, Forming, Casting), Plastics Application (Mechanical Engineering, Electrical Engineering, Agriculture, Ecotechnology, Marine Technology, Transformation and Storage of Energy,

	Biomedical Application), Testing (Quality Control), Polymer Physics (I-Ray diffraction, Electron Microscopy, DSC), Polymer Chemistry (Analysis), Environmental Technology (Recycling, Re-use of Waste and Litter, Combustion, Protection), Training Technology, Research Management.
Conducted by:	Laboratorium für Kunststofftechnik LKT-TGM Vienna
Address:	A-1200 Vienna, Wexstraße 19-23, Austria
Admissions requirements:	B.Sc. or equivalent in a scientific faculty and research experience
Language:	English, German (French, Spanish partly)
Location:	Vienna
Tuition fee:	UNIDO
Commencing date:	to be arranged
Duration:	to be arranged
Deadline for enrolment:	two months in advance

This SID-Programme is organized by Laboratorium für Kunststofftechnik LKT-TGM of the Association for the Promotion of Plastics Technology (GFKT) in co-operation with the United Nations Industrial Development Organization (UNIDO).

Hochfellner Hausmusik