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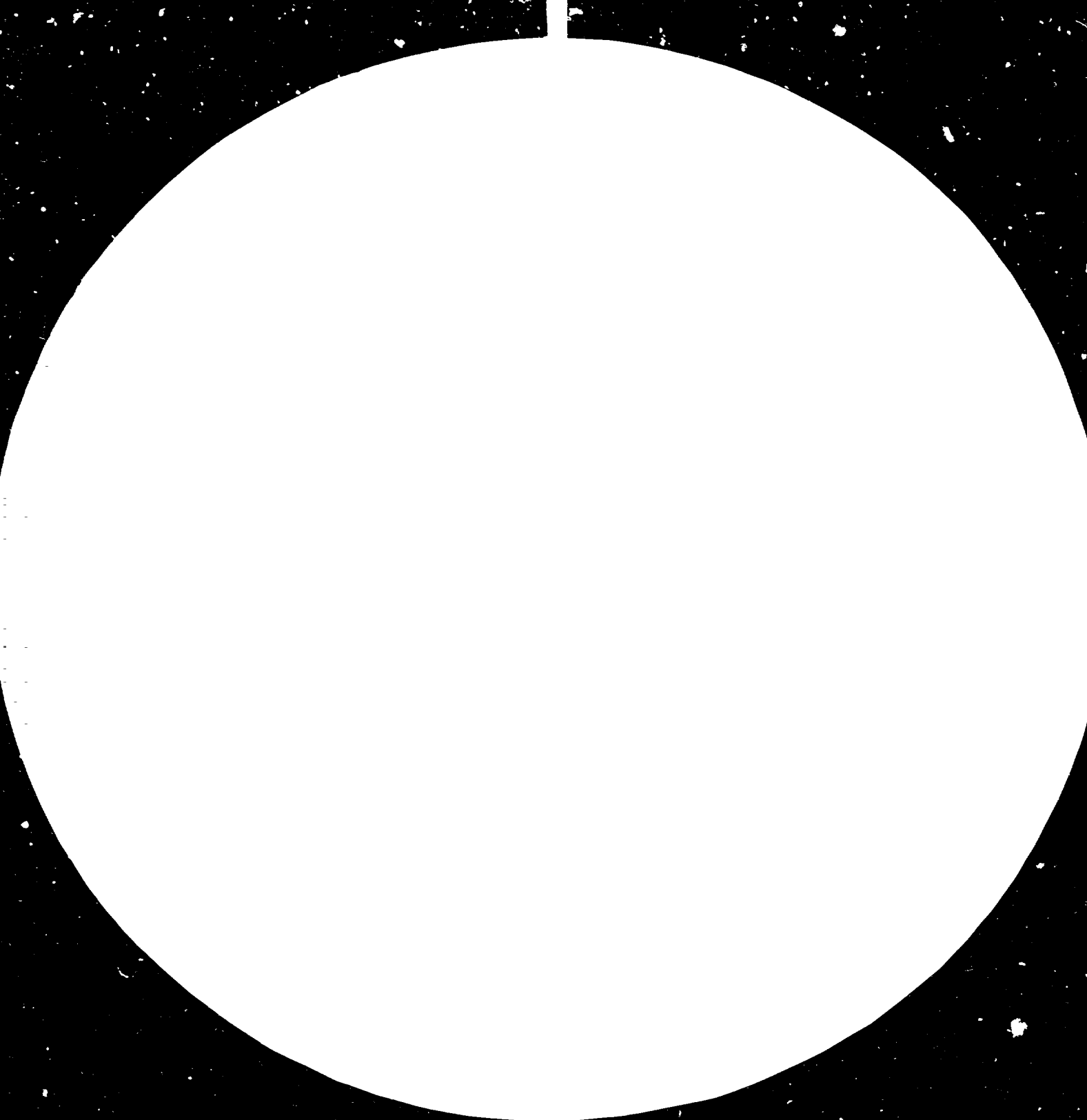
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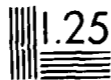
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Wexstraße 19-23, A-1200 Wien, Tel.: 35 95 11, 35 21 06, Telex: 131824

12065

Final Report

**13th UNIDO In-Plant
Group Training Programme
in the Field of
Plastics Technology
AUSTRIA 1982**

3740

LKT-TGM



Laboratorium für Kunststofftechnik am TGM
INSTITUT ZUM AUSBILDEN PROFEN UND FORSCHEN
Wexstraße 19-23, A-1200 Wien, Tel.: 35 35 11, 352 0 , Telex: 131824

Thirteenth 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

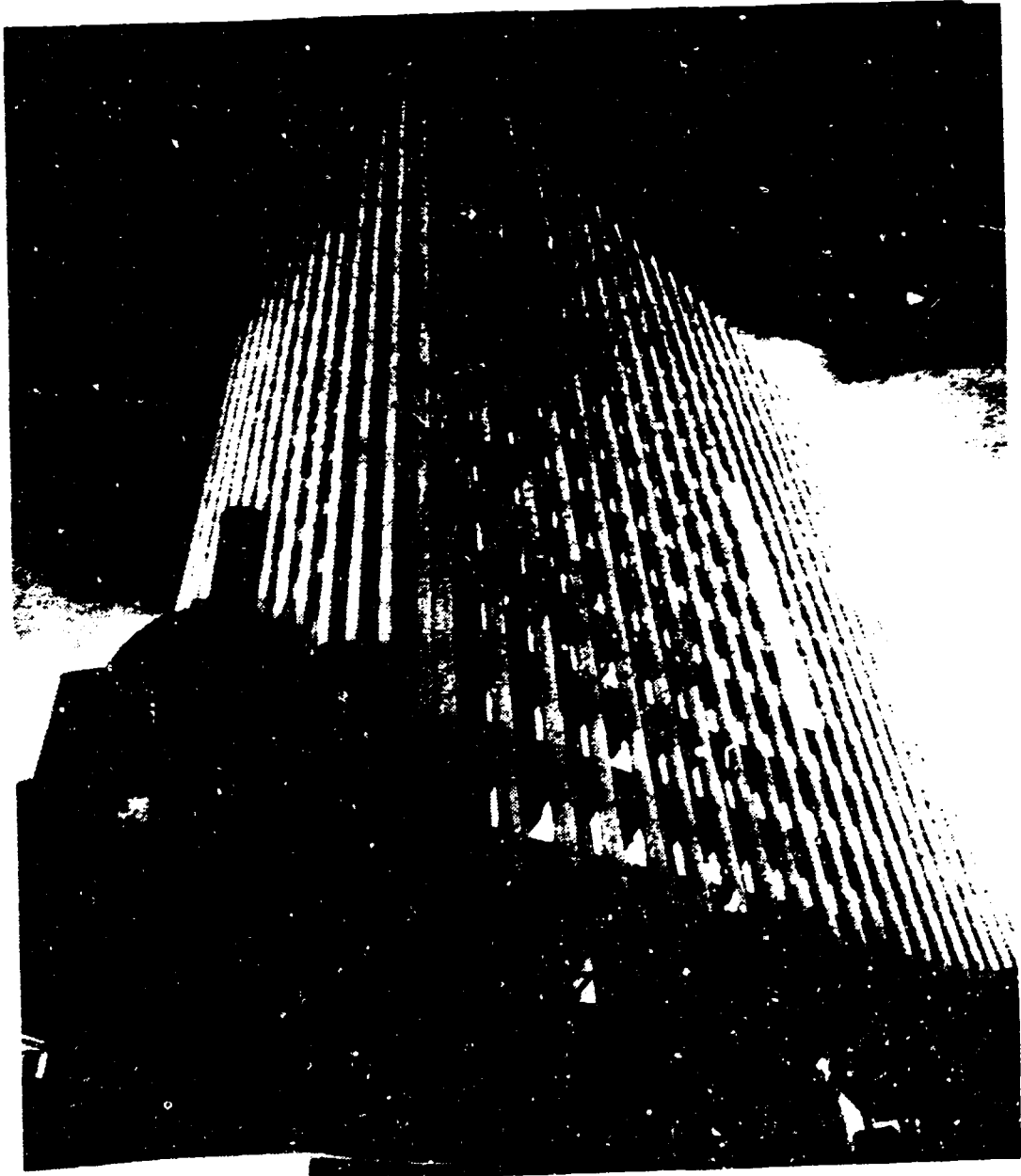
from 5 October to 15 November 1982 in Vienna, Austria

Final Report

by
H. HUBENY
Programme Director

Zl.ZT 128/Hu/Dö, 15 November 1982

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TECHNOLOGISCHES GEWIRBEMUSEUM WIEN



Practical work in reinforced Plastics
(Photo: E.Herbinger)



Practical work in Injection Moulding
(Photo: E.Herbinger)

1. Aknowledgments:

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

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Mr.G.Schrimpf
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The Community of Michaelerberg:

Mr.A.Berger

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 relative short time. Through these programmes a means has been found of providing an experience that might not otherwise be 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 thirteen programmes with a total of 217 participants from 63 countries.

The regional distribution was the following:

Far East (FE)	66	30 %
Middle/East		
North Africa (ME)	58	27 %
Latin America (LA)	44	20 %
Africa (AF)	28	13 %
Europe (EU)	21	10 %

57 % of the participants came from companies, 38 % from institutes and 5 % from government authorities.

Place	Region	Programme 1.-10.	11.	12.	13.	Total
Afghanistan	ME	-	-	1	-	1
Algeria	ME	2	-	-	-	2
Argentina	LA	2	1	-	1	4
Bangladesh	FE	3	-	-	2	5
Bolivia	LA	3	-	1	-	4
Bulgaria	EU	1	-	-	-	1
Brazil	LA	3	-	-	-	3
Burma	FE	1	-	-	-	1
Chile	LA	2	-	-	-	2
China	FE	5	1	5	-	11
Colombia	LA	4	-	-	-	4
Costa Rica	LA	3	-	-	-	3
Cuba	LA	4	-	-	-	4
Cyprus	EU	3	-	-	-	3
Dominican Republic	LA	-	-	-	1	1
Egypt	ME	8	-	4	2	14
El Salvador	LA	2	-	-	-	2
Ethiopia	AF	-	-	1	1	2
Ghana	AF	3	-	-	-	3
Guyana	LA	1	-	-	-	1
Honduras	LA	1	-	-	-	1
Hongkong	FE	1	-	-	-	1
Hungary	EU	3	-	-	-	3
India	FE	6	-	-	2	8
Indonesia	FE	6	2	1	-	9
Iran	ME	18	-	-	-	18
Iraq	ME	8	-	-	-	8
Israel	ME	3	-	-	-	3
Jamaica	LA	1	-	-	1	2
Jordan	ME	1	-	1	-	2
Korea	FE	1	-	-	-	1
Lebanon	ME	1	1	-	-	2
Madagascar	AF	1	-	-	-	1
Malawi	AF	-	1	-	1	2
Malaysia	FE	1	-	1	-	2
Malta	EU	-	-	-	1	1
Mauritius	AF	-	-	-	1	1
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	-	5
Philippines	FE	3	-	1	-	4
Poland	EU	6	-	-	-	6
Romania	EU	2	-	-	-	2
Senegal	AF	-	-	-	1	1
Singapore	FE	3	-	1	-	4
Somalia	AF	1	-	1	1	3
Sri Lanka	FE	1	-	1	1	3
Sudan	AF	2	-	-	-	2
Syria	ME	5	-	1	-	6
Taiwan	FE	2	-	-	-	2
Tanzania	AF	4	1	-	1	6
Thailand	FE	6	-	-	-	6
Trinidad Tobago	LA	1	-	-	-	1
Turkey	EU	4	-	-	-	4
Uruguay	LA	6	-	-	-	6
Vietnam	FE	-	1	-	-	1
Yemen P.D.R.	ME	-	-	1	-	1
Yugoslavia	EU	2	-	-	-	2
Zambia	AF	-	-	-	1	1
(63)		166	9	22	20	217

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 thirteenth 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 placed 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 Engineering	6
PPH	Polymer Physics	4
CEN	Control Engineering	4
TME	Training Methods	2
TAN	Trouble Analysis	4
Subtotal Theory		64
CC	Compounding and Calandring	10
CE	Computation Engineering	4
CT	Control Techniques	12
EX	Extrusion	16
FI	Finishing	6
FO	Foaming	6
IC	Injection and Compression Moulding	18
MF	Machining and Forming	6
MM	Mould Making	2
PC	Polymer Chemical Analysis	4
FP	Polymer Physical Analysis	10
QC	Quality Control	6
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 offered in form of

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

Polymers: POM - PVAL - PVAC - PVC (Plasticizers, Stabilizers, Fillers, Lubricants, Pigments) - PVDC - PMMA - PS (Expanded, High Impact) - Polyvinyl - Carazol - Polyvinyl-Pyrrolidone - PE (LD, MD, HD) - PP - Fluoric Polymers - other Polymers.

Polycondensation and Polyaddition Products

Classic condensation reaction: Phenoplasts - Aminoplasts.

Thioplasts

Polymeric Esters and Ethers: CN - CA - CAB - Cellulose ethers.

Polyesters: UP - PETP - PC.

Polyamides: PA6 - PA66.

Polyimides

Epoxy Resins

Polyurethanes: Isocyanate manufacture - PUR Elastomers.-

Relation between structure and properties of PUR-

Manufacture and properties of flexible foam - Rigid foam -

Combustion properties - Health hazards of isocyanates.

Silicones: Oils - Resins - Rubbers.

Inorganic Polymers.

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.
 Conconversion 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 - Antimykotika (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:

PTPE - PI - PBI - PBT - Developing Products.

Selection of Materials

Compounding

Discontinuous Processing of Moulding Materials

Compression Moulding: Operations - Fluidity - Temperature - Time Preheating - Shrinkage.

Transfer Moulding: Pot-Type, Transfer Moulding, Plunger-Moulding, Operations, Comparison.

Injection Moulding: Operations - Pressure - Speed, Frozen Strains - Mould Design - Injection Stamping - Injection Blow Moulding - Flow Moulding - Reactive Moulding.

Casting: Hollow Moulds - Embedding - Dip Moulding - Filament Winding.

Continuous Processing of Moulding Materials

Extrusion: Classification - Single-Screw Extruder - Design and Theory - Twin Screw Extruder - Characteristic Lines - Working Diagrams - Quality Theory - Tube, Sheet, Film, Profile-Extrusion - Coating - Laminating - Blowing - Winding - Internal Stresses - Orientations.

Calendering

Drawing

Moulding Expanded Plastics

Fabrication of Semi-Finished Goods

Technical Therms - Machining - Vacuum Forming - Blow Moulding - Hot-Forming - Plug- and Ring Forming - Friction Welding - Hot-Gas Welding - Heated Tool Welding - HF-Welding - Ultrasonic Welding - Banding.

Finishing and Decorating

Printing - Metallizing - Stamping - Embossing - Irradiation.

Coating Methods

Quality Control

Molecular Tests - Structural Tests - Mechanical, Thermal, Acoustic, Optical, Electrical, Stability Behavior.

Fields of Application

Mechanical and Electrical Engineering - Transport - Apparatus Construction - Packaging Industry - Building and Architecture - Medicine - Electronics - Precision Mechanics and Optics - Agriculture - Household and Living - Recreation.

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 Barrels 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 ENGINEERING (PEN)

W.R. Jessenig

Survey on the mechano-thermal behaviour of plastics: Structure - Flow behaviour - melting point - glass transition point - dependence of properties on the temperature - definitions.

Mechanical short- and longtime behaviour: Creep - relaxation - temperature dependence.

Structure: crystallinity - microscopy - intrinsic viscosity.

Discussion: Interference to the practical work and to Chemistry, Plastics Chemical Technology and Plastics Mechanical Technology.

POLYMER PHYSICS (PPH)

Morphological Structure

H. Dragaun

Structure and Morphology

Models of Crystalline Structure: Fringed - Micelle Model - Folded - Chain Model

Expressions of Crystallinity: X-ray Crystallinity - Mass Crystallinity - Calorimetric Crystallinity

Experimental Methods: Optical Microscopy - Electron Microscopy - X-ray Diffraction - Density Measurement - DTA

Differential Thermal Analysis

H.Muschik

Introduction

Application of DTA

Principles of DTA

Evaluation of DTA Curves

Caloric Informations

Thermometric Informations

Applications

Physical Transition: Crystallinity - Melting - Glass -
Transition - Pretreatment

Chemical Reactions: Crosslinking - Vulcanization -
radiation

Concluding Remarks

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 Con-
trollers - 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 Hester-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 Mechanical 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. Strohmayr

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

Welding: Press-Welding - Heat-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 Transition Temperature (according to DIN standards) -
 Melting Temperature - Decomposition Temperature - Melt
 Viscosity and Flow - Flow - Rheology - Terminology -
 Definitional Equations - Viscoelastic Behaviour - Measur-
 ing 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 - Differentiation of Polyblends in various Polyethylene (PE) types - Different Fracture Behaviour of Polypropylene/Polyethylene 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

Acceptance 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 Greenhouses.

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 Stream - 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 PapersThe 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 Polypropylene Pressure Pipes - Microfibrils in
Brittle-Fracture-Surfaces on Isotactic Polypropylene at
4.2 K - Shear-Induced B-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.



Practical Work in Testing and Quality Control
(Photo: E.Herbinger)

4.3. Special Lectures

- 5.October 1982: Univ.Prof.Dr.Dr.h.c.mult.H.F.Mark
Polytechnic Institute of New York,
New York 11201, USA:
Development of Polymer Engineering
- 5.October 1982: Dipl.-Ing.D.N.Shroff,President,UNIDO Expert
The Silk and Art Silk Mills Research
Association,Bombay,India:
Activities and Experiences of SASMIRA
- 14.October 1982: Dipl.-Ing.J.C.Garnaud,General Secretary,
UNIDO Expert
International Committee for Plastics in
Agriculture,Paris,France:
Plastics in Agriculture and Water Management
- 19.October 1982: Univ.Prof.Dipl.-Ing.Dr.E.Fitzer,UNIDO Expert,
FRG:
Fibre Reinforced Composites
- 27.October 1982: Dkfm.W.Mayerhofer,
UNIDO Investment Promotion Vienna Office,
Vienna:
Industrial Co-operation and Technology Transfer
between Developing Countries and Austria.
- 2.November 1982: Prof.Dipl.-Ing.Dr.H.Muschik,
LKT-TGM, Vienna:
New Rural Applications of Plastics
- 4.November 1982: Dkfm.G.A.Rubitschka,
International Patent Documentation,Vienna:
Transfer of Technology with the Help of the
International Patent Documentation
- 8.November 1982: Prof.Dr.-Ing.K.Schaden,
National Authorized Testing Institute for
Building Materials, TGM, Vienna:
Plastics in Civil Engineering
- 11.November 1982: Mme.Dipl.-Ing.Jiang Jieyi,
Plastics Processing and Application Centre,
Beijing, China:
Foundation and Activities of the Research
Centre

5. ParticipantsARGENTINA:

Carlos E. AGUILAR
Development Manager

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1053 Buenos Aires

BANGLADESH:

Muhammad CHOWDHURY

Rahman HABIBUR
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Karim Rubber Industries
Po:-Fatulla
Dacca

DOMINICAN REPUBLIC:

Manuel R. BROS

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Lilongwe 3

MALTA:

George BALDACCHINO
Works Manager

Plastics Processing Co.
Ltd.

MAURITIUS:

Lee R.P.J. PIN HARRY
Prod. & Techn. Manager

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Quay Road
Port Louis

MOZAMBIQUE:

Jaime PINTO REGO
Mechanical Engineer

Plastics Direction Unity
Ministry of Industry and
Energy
P.O. Box 2006
Maputo

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Nepal Polyethene and Plastics
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Kathmandu

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Papa DIAGNE
Coordinator in the Ministry
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Ministère du développement
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Rubber Technology Section
C.I.S.I.R.
P.O. Box 787
Colombo 7

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Rajabu K.MLEMBE
Production Manager

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P.C.Box 9202
Dar-es-Salaam

ZAMBIA:

Alouysius Y. MUNDIA
Industrial Chemist

City Radio Ltd.
P.O.Box 30619
Lusaka



6. Staff for the Training Programme

Principal of TGM: Hofrat Dir.Dipl.Ing.Dr.techn.F.Plöckinger
 Director of LKT-TGM: Senator h.c.Reg.Rat Prof.Dipl.Chem.E.Schmitz
 Programme Director: Prof.Dipl.-Ing.Dr.techn.H.Hubeny
 Deputy Programme
 Director: Ing.R.Hillisch, Ing.W.Michel
Organisation Committee:

Prof.Dipl.-Ing.Dr.techn.H.Hubeny
 Prof.Dipl.-Ing.Dr.techn.E.Wogrollly
 Ing.R.Hillisch
 Ing.W.Michel
 Ass.Ch.Armann
 B.Dörr
 H.Braunsteiner

Lectures:

FOL F.Beran
 Prof.Dipl.-Ing.Dr.techn.H.Dragaun
 Prof.Ing.Dkfm.H.Graf
 Ing.R.Hillisch
 Prof.Dipl.-Ing.Dr.techn.H.Hubeny
 Prof.Dipl.-Ing.Dr.techn.W.R.Jessenig
 StR.Ing.R.Jirsa
 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
 Prof.Dipl.-Ing.Dr.techn.J.Smelik
 FOL Ing.E.Strohmayer
 Ing.E.Weiß
 Prof.Dipl.-Ing.Dr.techn.E.Wogrollly
 VL Ing.Mag.H.Wolanek

Assistance and Preparation:

Ass.Ch.Armann
 FOL H.Bitschnauer
 FOL K.Blazek
 H.Braunsteiner
 B.Dörr
 Ass.P.Freisler
 FL C.Freyer
 W.Fussenegger
 FL E.Jahn
 Wiss.Ass.Ing.E.Herbinger
 H.Lahner
 F.Lorenz
 Ing.F.Mennerstorfer
 Ing.W.Michel
 Ch.Neustifter
 Th.Parzer
 Ass.M.Radax
 Ass.A.Revesz
 Ing.H.Schermann
 FL H.Seifert

7. Plant visits

To the special interest of the participants 15 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:

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

LUDWIG ENGEL KG

4311 Schwertberg

Injection Moulding
Machines, Mould Making

FEPLA-HIRSCH

Wiener Straße 113
2700 Wr.Neustadt

Film blowing

GABRIEL CHEMIE

Stipcakgasse 6
1234 Wien

Additives for processing
of plastic materials,
Colour Concentrates,
Thermoplastic Rubber-Comp.

GREINER KG Schaumstoffwerk

Greiner-Str. 70
4550 Kremsmünster

PUR-Foaming

GREINER C.A. & Söhne GmbH

Postfach 6
4550 Kremsmünster

Injection Moulding,
Vacuumforming

HASENCLEVER

Industriestraße 21
2353 Neu Guntramsdorf

Standard Moulds

INTERPLASTIC GmbH

Franz Fritschstraße 11
4600 Wels

Calandering, Films

LUTZKYPLAST GmbH

Kremsegger Straße 15
4550 Kremsmünster

Blow moulding

MÜLLHYGIENISIERUNGSANLAGE

8940 Liezen

Recycling

ÖSWAG-Österr.Schiffswerften AG

Derfflingerstraße 15
4027 Linz

Processing Equipment,
Extruders, Down-Stream
Equipment, Recycling

POLOPLAST

Poloplaststraße 1
4060 Leonding

Pipe Extrusion,
Injection Moulding,
Pipe and Fittings Systems

KARL WESS OHG

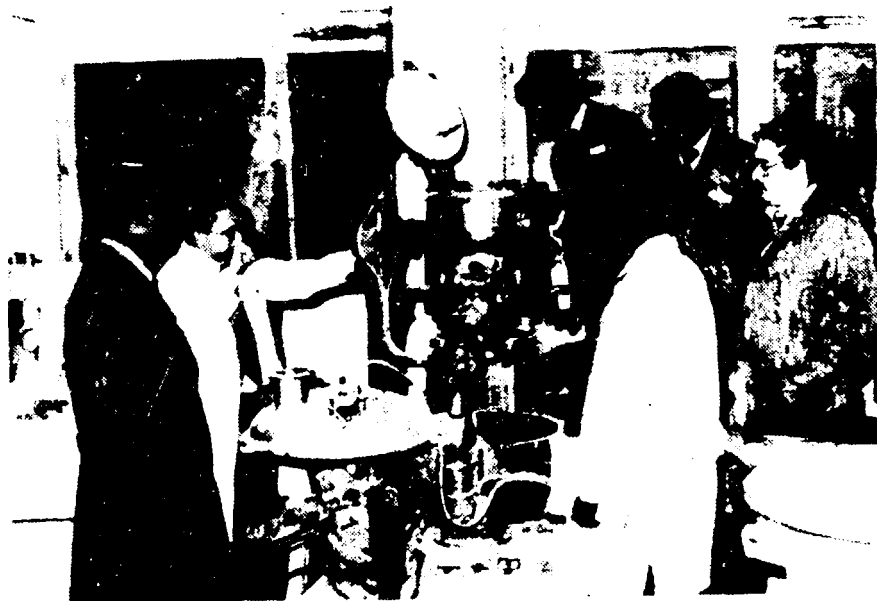
Wiener Straße 54-56
2640 Gloggnitz

Mould- and Die-Making

Plant visit in the CSSR, organized by UNIDO

Petrochemický Slovnaft
Bratislava, CSSR

Polypropylene
high-pressure
Polyethylene



Practical Work in Compounding and Calendering
(Photo:E.Herbinger)



Hellbrunn 1982



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
 HENSCHER, 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., Kottlingbrunn;
 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 & MOHILLO, 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
 WITHOP, BRD; Control Systems
 ZWICK, BRD; Testing Equipment

9. Applied R & D Programme in Plastics Technology

9.1. Objectives

To increase the efficiency of the 13th Training Programme it will be useful to continue the contacts between participants, institutions, companies and authorities. One facility besides contracts between institutions is a tailor-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 the German language, especially for students from various institutions in Austria. We are now interested in extending this experience to include post-graduate research programmes conducted in the English and French language for foreign students. The success of the first tentative arrangements encourage us to take on more research students on a similar basis together with UNIDO.

The programme is planned as an academic-practical (professional) tuition in a 12 week-course by applied research 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 (GPKT).

9.2. Research Programme in Brief

Subject: Industrial Post-Graduate Research Programme
in Plastics Technology

Detailed fields

of study 170 Applied Research Projects in Procedur Engineering and Control Engineering (Injection Moulding, Extrusion, Foaming, Compounding, Forming, Casting)

Plastics Application (Mechanical Engineering, Electrical Engineering, Agriculture, Eco-technology, 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: M.Sc. or PhD. or equivalent in a scientific faculty and research experience

Language: English, German (French, Spanish partly)

Location: Vienna

Tuition fee: UNIDO

Commencing date: January, April, July, October

Duration: 12 weeks

Deadline for enrolment: September, December, March, June

This Industrial Post-Graduate Research Programme is organized by Laboratorium für Kunststofftechnik LKT-TGM of the Association for the Promotion of Plastics Technology (GPKT) in co-operation with the United Nations Industrial Development Organization (UNIDO), the Federal Government of Austria, Federal Chamber of Commerce and Verband Österreichischer Industrieller (VÖI).



