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Sixteenth UNIDO In-Plant Group Training Programme
in the Field of Plastics Technology

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

to be held

from 30 September to 8 November 1985 in Vienna, Austria

F i n a l R e p o r t

by
H.HUBENY
Programme Director

Z1.ZT 148/Hu/Dö, 8 November 1985

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TECHNOLOGISCHES GEWERBEMUSEUM

1. ACKNOWLEDGEMENT

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

UNIDO:

Ms. A. Tcheknavorian-Asenbauer
Mr. V. Bysyuk
Mr. N. Youssef
Ms. I. Lorenzo
Mr. A. Karamanoglu
Mr. S. Hand
Mr. M. Sato
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Austrian Federal Chancellery:

Mr. U. Stacher
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Austrian Federal Ministry of Foreign Affairs:

Mr. F. Schmid
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Austrian Federal Ministry of Education, Sport and Arts:

Mr. W. John
Mr. O. Tischler

Technologisches Gewerbemuseum:

Mr. F. Plöckinger
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Mr. W. Hajni
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Austrian Federal Chamber of Commerce: Mr. K. Haas, Mr. G. Tscherne

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Mr. H. Gruber (Volkstanzgruppe)

Mr. S. Ehrenreich

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

Photos: H. Schermann, W. Michel



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Background and Objectives

1. The programme in the field of plastics technology is one of a series of the United Nations Industrial Development Organization (UNIDO) activities on specific sectors of industry which is being organized for the developing countries through the Chemical Industries Branch. This "In-Plant Group Training Programme" has been implemented annually since 1970 through a special contribution of the Government of Austria to UNIDO. The implementation of the 1984 programme as well as the previous ones has been successfully conducted by the Laboratorium für Kunststofftechnik LKT-TGM (Laboratory for Plastics Technology).

2. The trend of training activities in the field of plastics technology is characterized by the increasing sophisticated nature of the programme requiring high level experts, consultants and specialized equipment for the workshop. There is also an increasing demand for visits to plants, companies and institutes which are advanced in their field of specialization. Group discussions to deal with specific technological problems in manufacturing and application is also an important feature of current training activities.

3. Plastics are already one of the world's main groups of industrial materials. World plastics consumption is now greater than that of all non-ferrous metals in terms of weight and of steel in terms of volume. The numerous uses and applications of plastics which are still increasing, have caused this industry generally to grow at a faster rate than most branches of manufacturing industries and to contribute in growing proportion to the economy.

4. Recently, a few new technologies for production of commodity plastics have been announced, for example, Union Carbide unveiled a new low-pressure process for producing low-density polyethylene by using a special catalyst. Another new technology that has been announced is the use of a new catalyst for polypropylene production and as a result investment costs are reduced. The demand for plastics materials is steadily growing at a very high rate and this situation is expected to continue in the future. Engineering plastics will find many new applications and replace traditional materials. Important factors in the research and development activities will be the drive to save energy and feedstocks. Plastics allow for a large potential of energy saving, partly by replacing traditional heavier materials and partly by reducing the use of energy in the various production processes.

5. Through the acquisition of technological know-how and skills in the field of mould design and mould making, the plastics industry could achieve further development. The lack of experienced personnel in this field in the developing countries and the need to acquire and exchange experience, are the main reasons for the organization of this programme. Its aim is also to bring together a group of selected persons whose work is expected to benefit from a concentrated training programme which otherwise could require a long period of training, research and development work. This assistance to the developing countries in the development of their plastics industry and the development of manpower is in accordance with items i, ii and k of Article 58 of the Lima Declaration and Plan of Action as well as in line with the New Delhi Declaration and Plan of Action and the Fourth General Conference of UNIDO on development of human resources.

6. The programme is designed as a group training course covering the whole field of modern plastics technology at an industrial - not academic - level including

- theoretical introduction (plenary session)
- discussion of special topics (plenary session)
- practical work (small group work)
- group discussion on special topics (group sessions)
- practical experiments on special topics (small group work).

7. The programme has received the support of the Austrian Federal Ministry for Foreign Affairs, the Austrian Federal Ministry of Education and Fine Arts, the Austrian Federal Economic Chamber and Association of Austrian Industrialists. The Laboratorium für Kunststofftechnik LKT-TGM (Laboratory for Plastics Technology), a leading technological institute, will conduct, utilizing its facilities, the theoretical and practical training in plastics technology. The institute has a staff of highly qualified specialists.

Since 1970 LKT-TGM held sixteen programmes with a total of 286 participants from 70 countries.

The regional distribution was the following:

Far East (FP)	93	33 %
Middle East/ North Africa (ME)	67	23 %
Latin America (LA)	63	22 %
Africa (AF)	40	14 %
Europe (EU)	23	8 %

64 % of the participants came from companies, 36 % from institutes and government organizations.

Place	Region	Programme 1.-15.	Programme 16.	Total
Afghanistan	ME	1	-	1
Algeria	ME	2	-	2
Argentina	LA	5	-	5
Bangladesh	FE	6	1	7
Benin	AF	-	2	2
Bhutan	FE	2	1	3
Bolivia	LA	5	2	7
Bulgaria	EU	1	-	1
Brazil	LA	5	-	5
Burma	FE	2	1	3
Chile	LA	3	-	3
China	FE	12	-	12
Colombia	LA	4	-	4
Costa Rica	LA	4	-	4
Cuba	LA	4	-	4
Cyprus	EU	3	-	3
Dominican Republic	LA	2	-	2
Ecuador	LA	2	-	2
Egypt	ME	14	-	14
El Salvador	LA	2	-	2
Ethiopia	AF	3	-	3
Ghana	AF	4	-	4
Guatemala	LA	2	-	2
Guyana	LA	1	-	1
Honduras	LA	1	-	1
Hongkong	FE	1	-	1
Hungary	EU	3	-	3
India	FE	12	-	12
Indonesia	FE	10	-	10
Iran	ME	18	-	18
Iraq	ME	9	-	9
Israel	ME	3	-	3
Jamaica	LA	3	1	4
Jordan	ME	2	1	3
Korea	FE	1	-	1
Korea DPR	ME	2	1	3
Lebanon	ME	2	-	2
Madagascar	AF	1	-	1
Malawi	AF	3	-	3
Malaysia	FE	3	-	3
Malta	EU	2	-	2
Mauritius	AF	3	1	4
Mexico	LA	-	1	1
Morocco	ME	1	-	1
Mozambique	AF	1	-	1
Nepal	FE	1	-	1
Nicaragua	LA	1	-	1
Nigeria	AF	4	-	4
Pakistan	FE	6	-	6
Panama	LA	-	1	1
Paraguay	LA	2	-	2
Peru	LA	6	-	6
Philippines	FE	4	-	4
Poland	EU	6	-	6
Romania	EU	2	-	2
Saudi Arabia	ME	1	-	1
Senegal	AF	1	-	1
Singapore	FE	7	-	7
Somalia	AF	3	-	3
Sri Lanka	FE	5	-	5
Sudan	AF	4	-	4
Syria	ME	6	-	6
Taiwan	FE	2	-	2
Tanzania	AF	6	-	6
Thailand	FE	8	-	8
Trinidad Tobago	LA	1	1	2
Turkey	EU	4	-	4
Uruguay	LA	6	-	6
Vietnam	FE	3	1	4
Yemen PDR	ME	4	2	6
Yugoslavia	EU	2	-	2
Zambia	AF	2	-	2
Zimbabwe	AF	1	-	1
	73	268	18	286



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5. SUBJECT LIST

5.1. GENERAL PART

5.1.1. <u>Theoretical Introduction (Plenary Session)</u>	<u>Hours</u>
Technology Transfer and Development	2
Trends in Polymer Chemistry	6
Polymer Physics	8
New Aspects in Plastics Technology	12
Principles of Mould Design	12
Principles of Control Engineering	4
Plastics Application Engineering	6
Sub-total Introduction	<u>50</u>
5.1.2. <u>Discussion of Special Topics (Plenary Session)</u>	
Presentation of Special Topics by Participants	2
Quality Control	2
Mould Design	2
Injection Moulding	2
Extrusion	2
Sub-total discussion	<u>10</u>
5.1.3. <u>Practical Work (Small Group Work)</u>	
Compounding and Calandering	8
Computation	8
Control Techniques	8
Extrusion	12
Finishing	4
Foaming	6
Injection and Compression Moulding	12
Machining and Forming	8
Mould Making	4
Polymer Chemical Analysis	4
Polymer Physical Analysis	8
Quality Control	8
Reinforced Plastics	4
Trouble Shooting	4
Sub-total Practice	<u>98</u>
Total General Part	<u>158</u>

5.2. SPECIAL PART

5.2.1. Group Discussion on Special Topics (Group Sessions) 8 hours

Selection of ONE item in the following fields:
 Polymer Science
 Quality Control
 Injection Moulding
 Extrusion and Blow Moulding

5.2.2. Practical Experiments on Special Topics (Small Group Work) 8 hours

Selection of ONE item in the following fields:
 Polymer Science
 Quality Control
 Injection Moulding
 Extrusion and Compounding

Total Special Part 16

GRAND TOTAL 174 hours

6. LECTURE NOTES

6.1. DESIGN OF LECTURE NOTES

The lecture notes have been adapted and developed in accordance with UNIDO, with the participants and with the experience of fifteen programmes since 1970.

To meet the general, practical and theoretical needs of the participants three levels of comprehensive information are offered at 1263 pages in form of

- general lecture notes (1034 pages)
- special lecture notes (279 pages) and
- research papers (72 pages)

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

Plastics Physical Technology (Supplement, 56 pages)

Mould Design (Supplement, 50 pages)

Reinforced Plastics (60 pages)

Control Techniques (24 pages)

Compounding (49 pages)

Finishing (31 pages)

Data Conversion in Technology and Morphology
(Supplement, 12 pages)

The lecture notes on testing have been completely replaced.



6.2. GENERAL LECTURE NOTES (Theoretical Introduction)

TECHNOLOGY TRANSFER AND DEVELOPMENT

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

PLASTICS CHEMICAL TECHNOLOGY

E. Wogroly

Classification of Plastic Materials

Formation Reactions

Functionality

Polymerization Reactions:
Addition Polymerization (Free radical mechanism - Ionic mechanism) -
Condensation Polymerization - Copolymerization - Auxiliary Materials for
Polymerization

Physical Behaviour of Plastics

Secondary Bonds:
Dispersion Forces - Dipolar-orientation Forces - Glass Transition - Brittle
Point - Elastomeric State

Thermoplastics:
Polyolefines, Polyethylenes and Copolymers - Degradation of Polyethylene-Poly-
propylene (PP)-Modified Polypropylene-Copolymers with Ethylene (EPM and EPDM) -
Polybutene -1 (PB) - Polyisobutylene (PIB) - Poly -4-methylpentene -1 (PMP) -
Unsaturated Polyolefines - Trends in Research and Development

Polyvinylchloride (PVC) and Copolymers - Plasticized PVC - Modified PVC -
Compounds (Blends)

Polystyrene (PS) and Copolymers - Expanded Polystyrene (EPS)

Acrylics - Polyacrylonitrile (Barrier Plastics) - Polyacrylates - Poly-
methylmethacrylates (PMMA) - Polymethacrylimides

Polyethers - Polyoxymethylene (POM) - Polyethyleneoxide (PEO)

F-Polymers - Polytetrafluorethylene (PTFE) - Polytrifluorochloroethylene (PCTFE) -
Copolymers

Silicones - Methylpolysiloxanes-Phenylpolysiloxanes (PSI)

Polyamides (PA)
Polycarbonates (PC) - Polyterephthalates (PET, PBT) - Polyphenyleneoxides (PPO) -
Polysulfones (PSU) - Polyphenylenesulfides (PPS) - Polyethersulfones (PES)

Thermosets:

Phenol/Formaldehyde Resins (PF) - Urea/Formaldehyde Resins (UF) - Melamine/
Formaldehyde Resins (MF) - Unsaturated Polyesters (UP)

Polyepoxides (EP)

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

High Temperature Resistant Polymers:

Polyimides (PI) - Polybenzimidazole - Polyimidazopyrrolone (Pyron) - Poly-
cyclobutadiene

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

H.Hubeny

Plastics Technology:

Polymers - Cycle Process - Model Matrix - Quality - Technological States -
Conversion Processes

Molecular Structure:

Description - Linear Macromolecules - Cross-linked Macromolecules -
Thermodynamics of Molecules - Degradation of Molecules

Supramolecular Structure:

Molecular Arrangement - Amorphous Structure - Mesomorphous Structure -
Crystalline Structure

Rheology:

Definition - Elasticity - Viscosity - Viscoelasticity

Polymers:

Classification - Designation - Survey - Standard Thermoplastics -
Engineering Thermoplastics - Specialty Thermoplastics - Thermoelastics -
Thermosets - High Temperature resistant Polymers

Additives:

Compatibility and Efficiency - Antioxidants - Light Stabilizers - Heat
Stabilizers - Enhancers - Colorants - Flame Retardants - Antistatic
Agents - Biostabilizers - Blowing Agents - Nucleating Agents - Activators -
Plasticizers - Lubricants

Compounding:

Terms - Particle Size Reduction - Mixing - Pelletizing - Compounding Para-
meters

Continuous Processing:

Classification - Continuous Casting and Laminating - Calendering -
Extrusion

Discontinuous Processing (Moulding):

Classification - Liquid Phase Moulding - Compression Moulding - Transfer
Moulding - Injection Moulding - Blow Moulding

Fabricating of Semi-Finished Goods:

Technical Terms - Machining - Forming - Assembly - Separating

Finishing:

Painting - Printing - Metallizing - Hot Stamping - Embossing - Irradiation

Application:

Systematic Development of Application - Standards

Waste

Recycling:

Equipment - Cutting mills - Reprocessing Lines - Extruder Screen Changers - Incineration - Outlook

PLASTICS MECHANICAL ENGINEERING

R.Hillisch, H.Revesz

Extrusion:

Extruder Plants and -Dies - Pre-set Elements - Elements of the Extruder - Annexed Equipments - Principles of Extruder Die Design - Plants and Moulds for Blow Moulding

Moulding of Thermosets:

Processing Techniques - Machines - Additional Equipment - Moulds - Design of Compression Moulded Parts

Injection Moulding:

Techniques - Machines - Additional Equipments - Moulds

MOULD DESIGN

R.Hillisch

General:

Injection Mould - Classification of Injection Moulds - Methodical Mould Design - Size of Mould - Flow Path/Wall Thickness Rate - Number of Cavities - Arrangement of Cavities

Feeding:

Sprue Design - Runner Design - Gating - Pin Gate - Edge Gate - Sprue Gate - Film Gate - Diaphragm Gate - Ring Gate - Tunnel Gate - Sprue Puller Pin Gate - Ante-Chamber Type Pin Gate - Sprueless Moulding - Insulated Runner - Hot Runner

POLYMER PHYSICS

H.Dragaun, H.Muschik

Morphological Structure:

Structure and Morphology - Models of Crystalline Structure - Expressions of Crystallinity - Experimental Methods

Differential Thermal Analysis:

Introduction - Application of DTA - Principles of DTA
Evaluation of DTA Curves - Caloric Informations - Thermometric Information
Applications - Physical Transitions - Chemical Reactions
Concluding Remarks

PLASTICS APPLICATION ENGINEERING

W.R.Jessenig

Plastics Survey

Shear modulus Temperature Function:

Plastics, Materials for Constructions - Thermoplastics - Thermosets -
Composites - Hybrid systems

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 - Characteristic Dimensional Functions

Reactive Resin Systems

Design of Constructional Parts:

Friction and Wear - Snap-fit Joints - Press-fit Joints

Ultrasonic Plastic Assembly

Outsert Technik

Screw-fit Joints

Plastic Screws

Adhesive Joints

CONTROL ENGINEERING

F.Gregori

Control Loop

Controlled System:

Time Behaviour - Heating Zone as Controlled System

Temperature Measurement:

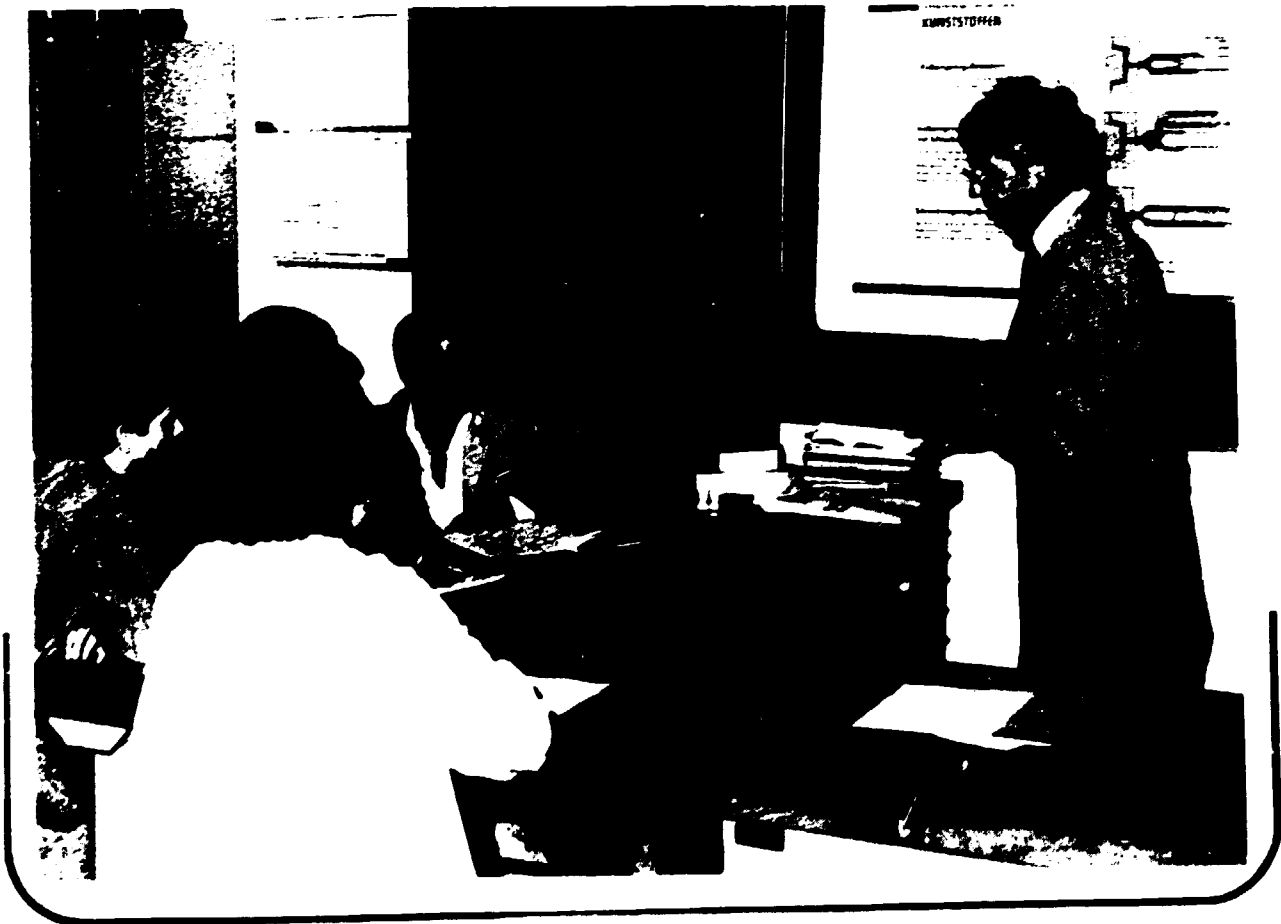
Resistance Thermometer - Thermocouples

Controllers:

Continuous Controllers - Two-Position Controllers - Galvanometric
Controller - Electronic Controllers

Temperature Control:

Control Oscillation - Two-Position Control with Feedback - PD-Control
Behaviour - PID-Control Behaviour



6.3. GENERAL LECTURE NOTES (Practical Introduction)

COMPOUNDING

H.Wolanek

Compounding Methods

Additives and Formulations:

PVC Stabilizers - Action of Heat Stabilizers - Groups of PVC Stabilizers -
Lubricants - Processing Aids - Impact Modifiers - Fillers

Compounding Machinery

Mixing Procedure:

Sintering of PVC - Agglomerating of PE-chips - Coloration - Drying

Test Methods:

Bulk Density - Heat Stability Tests - Static Tests - Dynamic Tests -
Plastograph - Mixing Rolls - Rheometer

COMPRESSION MOULDING

R.Hillisch

Toggle Lever Press

Up-Stroke Press:

Tabletting - Preheating

100 ton-Laboratory-Press:

Compression Mould for Testing-Cups - Determination of Closing-Time (Closing
Force) - Determination of Curing Time (Stiffness)

160 ton Down-Stroke Press:

Boiling Test

COMPUTATION

F.Mayer, P.Freisler

General Facts

Structure of a Computer

Programming Operations

How the Computer Counts

Description of the Z80 Microprocessor System:

Memory Allocation - Floppy Diskettes - Data Files - System Start-up -
Warm Start and Drive Selection - Directory

The Programming Language BASIC:

Introduction - Operators - Important Instructions and Commands

Example:

The Problem - Flowchart - Solution of the Problem

CONTROL TECHNIQUES

G.Minarovich

Open-Loop-Control

Voltage Supply:

Supply for Power Unit - Supply for Control Unit

Standardized Connection Diagrams and Symbols:

Connection Diagrams - Wiring Symbols

The use of Instruments for Measuring the Current, Voltage and Resistance:

Test Lamp - Multimeter

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 and Feedback:

Feedback - Optimization of the Feedback

Electrical Methods for Measuring the Temperature:

Measuring by Means of a Thermocouple - Resistance Thermometer

EXTRUSION

H.Revesz

Production of Tubular (Blown) Films

Extrusion of Blown Double-Layer Films

Production of Flooring

Blow Moulding

Production of Rigid PVC Pipes

Production of Pipes

FINISHING

W.Mähr

In-mold Metal Coating

Vacuum Metallizing:

Base Coating - Vacuum Metallizing - Top Coating - Test-methods

Electroplating:

Molding - Part Design - Preliminary Treatment - Cleaning - Sensitizing -
Nucleiation- Electroless Plating - Initial Electroplating - Final Electro-
plating - Applications - Test Methods

Appendix:

Process Sequence for Plating ABS-Plastics - Formulations

FOAMING

H. Hubery

Classification of Plastic Foams:

Material - Stiffness - Cell Morphology - Density - Density Distribution -
Fabrication Process

Properties

Processing:

Expandable Bead Methods - Reactive Foam Moulding - Thermoplastic Foam
Moulding - Foam Extrusion

Polyurethane Technology:

Polyurethanes - Mould Materials - Practical Exercises

INJECTION MOULDING

H. Graf

Adjustment of Processing Parameters:

Box Mould - Processing Temperature-Mould Temperature - Adjustment of Pressure -
Internal Pressure-Clamping Pressure - Loss Factor - Cooling Time - Machine
Protocol

Orientation - Mechanical Properties:

Test Bars - Injection Moulding Machine - Processing Conditions - Interpretation
of Test Results

Foamed Thermoplastics:

Introduction - Production of Mixtures - Test Panels - Physical Properties -
Possibilities in Design of Machine and Equipment - Production of Panels -
Machine Protocol

The Principles of Process Control in Injection Moulding:

General - Internal Pressure - Influences on Internal Pressure - Influences of
Internal Pressure on the Quality of Products - Computerprogramme for the
Calculation of cooling Time - Location of the Pressure sensors in the Testbar -
PVT-Diagram for Polystyrene - Machine Protocol - Surveyor's Protocol

Simulating Diagram

MACHINING AND FORMING

E. Strohmayer

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

POLYMER PHYSICAL ANALYSIS

H.Dragaun, H.Muschik, M.Radax, H.Braunsteiner

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

QUALITY CONTROL

M.Radax

Statistical Evaluation - Preparation of Specimen - Tensile Test -
Determination of the E-Modulus - Flexural Test - Modulus of Elasticity
(Flexural Test) - Tensile Impact Test - Impact Flexural Test - Hardness -
Shore Hardness - Vicat Softening Temperature - ISO / R 75 - Martens
Temperature - Oscillating Twisting Test - Environmental Stress Cracking -
Pipe Testing

REINFORCED PLASTICS

W.R.Jessenig

Theory

Resins

Reinforcements:

Fibrous and Wire Reinforcements - Fibre Constructions - Nonwove Constructions

Fillers:

Filler to Resin Bonding

Manufacturing Processes:

Contact Moulding (Hand Lay-up, Spray-up) - Bag Moulding - Vacuum Bag -
Pressure Bag - Autoclave Moulding - Resin Injection System - Matched Die
Moulding, Compression Moulding - Centrifugal Casting Process - Continuous-
Pultrusion Process - Continuous-Laminating Process - Filament Winding Process
(cont.and discont.) - Injection Moulding

Aspects to Practical Processing:

Surfacing - Gelcoat - Topcoat - Models - Moulds - Release Agents

Transportation and Handling

Prepreg and Sheet Moulding Compounds

Precautions and First Aid

Dimensional Fundamentals

Constructional Fundamentals

Economic Aspects and Future Outlook

6.4. SPECIAL LECTURE NOTES

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 OF GRP-PIPES

W.R.Jessenig

Designation

Company Control:

Control of Goods Received - Resin Control - Textile-Glass Rest - Filler
Control - Reactant Control - Production Control - Regular Production Control -
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.

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) - Thermo-
analytical 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 Poly-
propylene/Polyethylene Copolymer - Fracture in a Moulded Part (Fitting) of
Rigid Polyvinylchlorid (PVC)

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

6.5. RESEARCH PAPERS

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 β -form Crystallization in Isotactic Polypropylene - Determination of the Avrami Exponent of Partially crystallized Polymers by DSC-(DTA)-Analysis - Qualitative Analysis of Molecular Structure of Polypropylene Fibres on the Basis of X-ray Diffraction Patterns

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 Foams

RECYCLING

The Behaviour of Household Refuse containing PVC in Incinerators



7. PLANT VISITS

To the special interest of the participants 13 plant visits during the six-week course in Austria has been organized by LKT-TGM.

The selection of the plants according to the interest of the participants gives a regional and technical survey on the Austrian plastic industry:

ACTUAL Kunststoff Ges.m.b.H. u.Co.KG
Actual Straße 31
4053 Haid/Linz
Tel. 07229/88401
Telex: 02/1093

Extrusion down stream
equipment, PVC window
manufacturer, tools for
profile extrusion

CHEMIE LINZ AG
St.Peter Straße 25
4021 Linz
Tel. 997/591-0
Telex: 21324

PE, PP-Compounds, stretched
fibres, films, plastics
application

CINCINNATI MILACRON AUSTRIA
Laxenburger Straße 276
1232 Wien
Tel. 222/67 76 11 - 0
Telex: 131518

Twin screw extruders, single
screw extruders, dies,
down-stream-equipment,
injection moulding machines

LUDWIG ENGEL KG
4311 Schwertberg
Tel. 07262/62 17 10
Telex: 2174521

Fully automatic in-line
injection moulding machines,
two-colour systems, mould
making, roboter systems

EREMA
Stummerstraße 4
4060 Leonding/Linz
Tel. 0732/52 175

Recycling plants for the
plastics industry

FEPLA-HIRSCH
Wiener Straße 113
2700 Wr.Neustadt
Tel. 02622/45 41, 57 76
Telex: 16629

PE, PP film blowing, finishing,
welding

GABRIEL CHEMIE
Stipcakgasse 6
1234 Wien
Tel. 222/67 46 23-0
Telex: 131376

Thermoplastic masterbatches,
coloration, formulations

IFW Manfred Otte KG
Pyhrnstraße 73
4563 Micheldorf
Tel. 07582/2556

Mould making

ERICH PERNER Kunststoffwerk
Muhldorf 235
4644 Scharnstein
Tel. 07616/305
Telex: 24463

Injection moulding,
thermoforming, welding

PETROCHEMIE DANUBIA Ges.m.b.H.
Danubiastraße 23-25
2320 Schwechat
Tel. 222/77 66 01
Telex: 2875

PE and PP production

POLOPLAST
Poloplaststraße 1
4060 Leonding
Tel. 0732/80621
Telex: 21131

Pipe extrusion, injection
moulding, pipe and fitting
systems

SALEN
Symalenstraße 2-6
3500 Krems
Tel. 901/5501
Telex: 71111

Pipe extrusion, injection
moulding, pipe and fitting
systems, drip irrigation
systems, containers

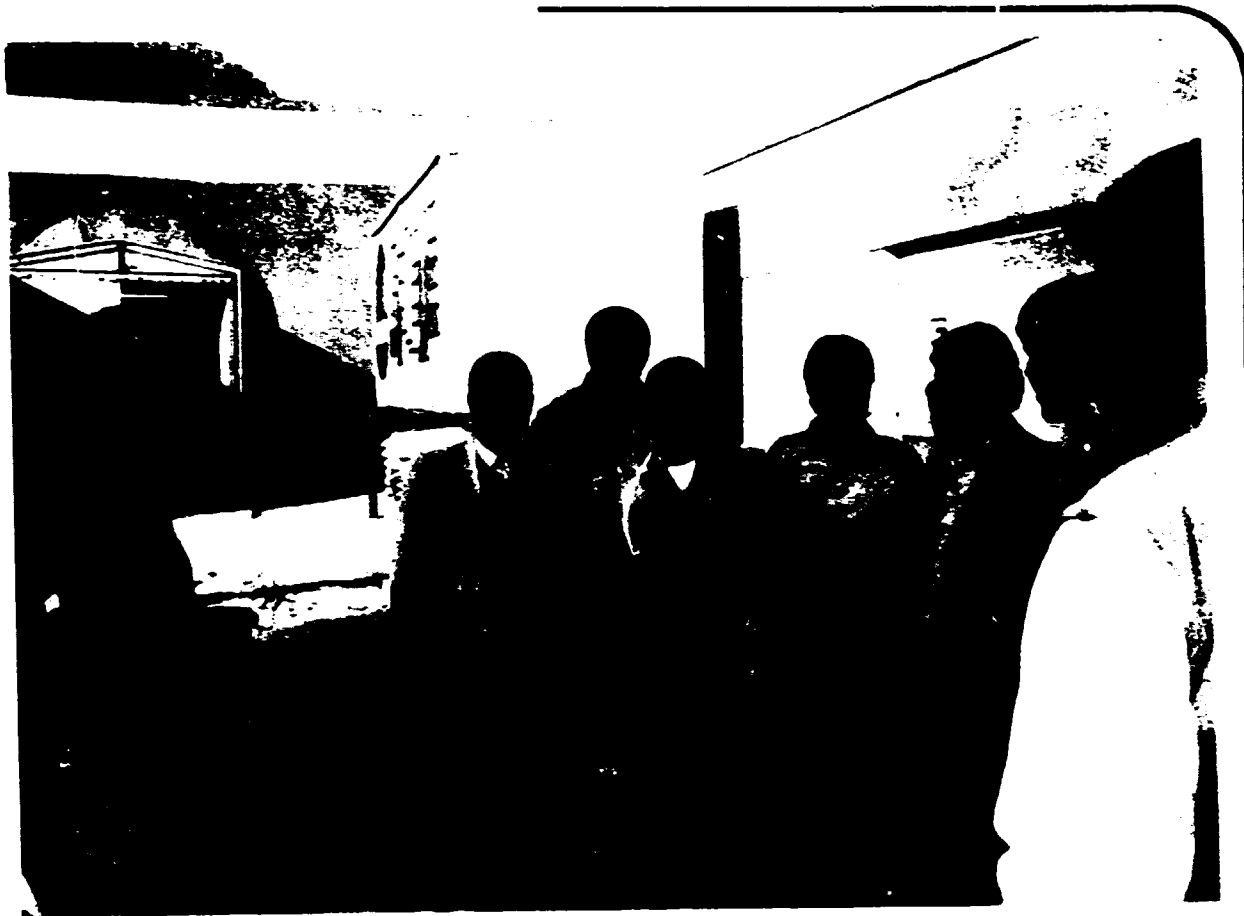
KARL WESS OHG
Wiener Straße 54-56
2640 Gloggnitz
Tel. 02662/2291

Mould- and die-making

GUEST LECTURES:

XORELLA Ges.m.b.H.
Pyrkergasse 38
1190 Wien
Tel. 222/36 46 77
Telex: 115593

Welding machines



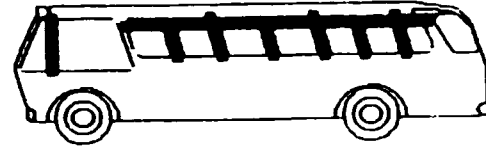
8. SPECIAL EQUIPMENT FOR THE TRAINING PROGRAMME

ALPINE, BRD; Extruders
AVL, Graz; Electronic Control Systems
BATTENFELD, BRD; Injection Moulding and Blow Moulding Machines
BATTENFELD-FISCHER, BRD; Blow Moulding
BATTENFELD Kunststoffmaschinen GmbH., Kottlingbrunn:
Injection Moulding Machines
BAUER, Schweiz; Measuring Instruments
BECKMANN, USA; IR-Equipment
BIZERBA, Vienna; Silo-Installation
BRANSON, USA; Ultrasonic Welding
BROSA, BRD; Control Instruments
BUCHER-GUYER, Schweiz; Presses
CEAST, Italy; Testing Equipment
CHURCHILL, England; Water and Oil Circulating Controllers
CINCINNATI MILACRON, Vienna; Extruders, Injection Moulding Machines
COUDENHOVE Poly-Spray, Vienna; Spray-Up Machines
DEMES, BRD; Pre-Treatment Instruments
ENGEL, Schwertberg; Injection Moulding Machines
ERBA, Italy; Gaschromatography
FRANK, BRD; Testing Equipment
FUCHS, Vienna; Mills
GOERZ Electro, Vienna; Instruments
GÖTTFERT, BRD; Rheological Equipment
HAACK, Vienna; Laboratory Equipment
HAGEDORN & BAILLY, BRD; Water and Oil Circulating Controllers
HARTMANN & BRAUN, BRD; Control Systems
HASCO, Vienna; Moulds
HENSCHEL, BRD; Mixers
HONEYWELL Bull, Vienna; Time Sharing
HOTTINGER, Vienna; Torque Measurement Equipment
JOEL, Japan; Electron Microscopic 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, BRD; Foaming, Extrusion, Recycling
K-TRON SODER, Schweiz; Metering-Computer
LÖDIGE, BRD; Mixer
MEDEK & SCHÖRNER, Vienna; Signator (Marker)
METRAWATT, BRD; Control Systems
METTLER, Schweiz; Analytical Instruments
MIKETRONIX, Pulkau; Electronic Equipment and Computer
NETSTAL, Schweiz; Injection Moulding Machines
PERKIN-ELMER, USA; Analytical Instruments
PHILIPS, Vienna; Control Systems and Recorders
PVL, Waldbreitbach (Austria); Electronic Equipment
REICHERT-JONG, Vienna; Microscopic Equipment
SARTORIUS, BRD; Analytical Instruments
SCHLUMBERGER, Vienna; Electronic Equipments
SINGLE, BRD; Water and Oil Circulating Controllers
STAIGER & MOHILO, BRD; Instruments
STOUGAARD, Dänemark; Instruments
TIEDEMANN, BRD; Optical Instruments
TROESTER, BRD; Calanders, Roll Mills
UNILABOR, Vienna; Electronic Equipment
VIKING, UK; PUR-Foaming Machines
WITHOF, BRD; Control Systems
ZWICK, BRD; Testing Equipment



UNIDO & LKT at TAMSWEG

AGENDA



Fri. 18.Oct.'85 ca 7.00 p.m. Arrival at Tamsweg

Move into Pension Kandolf (Marktplatz)

8.00 p.m. Supper at Gambswirt (two minutes from the hotel)

Sat. 19.Oct.'85 7.30 to 8.30 Breakfast

9.00 Walk through Tamsweg and to the famous Church of St. Leonhard
(guided by Miss Gill Prieler)

There we'll have a drink with the Mayor of Tamsweg

12.00 Dinner at Gellnwirt (beside the Hotel)

1.00 p.m. Tour through the Lungau, guided by Mr. Kurt Melchard

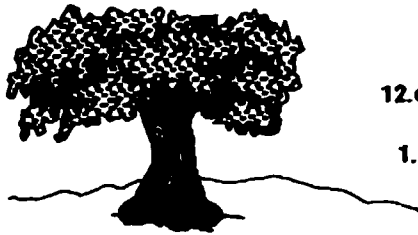
We visit Mauterndorf village and the old Castle of Moosham

6.00 p.m. Back from the journey

6.30 p.m. Departure to Sauerfeld

Supper and "Heimatabend" at Gasthof Gruber

(Austrian Folkmusic and Folkdances)



Sun. 20. Oct.'85 8.30 to 9.30 Breakfast

Please, put the luggage into the bus

10.00 Tour to the Prebersee (a little lake in the mountains)

12.00 Dinner at Gasthof Sallerer in Wölling

(a little village near Tamsweg)

14.00 Departure to Vienna





Tamsweg 



 **Salzburger
Land**



LKT-TGM international

Austrian Laboratory for Plastics Technology

SID-Programme

Wexstrasse 19-23 · A-1200 Wien · Tel (0222) 35 21 06-0 · Telex 131824

Special Industrial Development Programme in Polymer Engineering and Plastics Technology

Top Level A

Description:

The SID programme A is an individually arranged top-level programme for experienced candidates to help them solve their specific problems in plastics technology. It is designed as an individual tuition course through project work in a specific field of polymer processing, engineering, application and recycling including theoretical introduction, practical work, plant visits, individual contact with national and international organizations, companies and other institutions, educational training methods, computer-aided skills, publications, and membership to the Austrian Society for Polymer Engineering (GFKT).

Content:

The project work is selected from the following fields of study:
Plastics processing and control engineering, injection moulding, extrusion, blow moulding, foaming, compounding, machining, forming, welding, bonding, finishing, mould design — application engineering, mechanical engineering, electrical engineering, electronics, agriculture and fishery, ecotechnology, bio-medical application, energy conversion, pipe- and fitting systems, transport and packaging — quality control, polymer physics (X-ray diffraction, electron microscopy, thermal analysis), polymer chemistry (analysis, IR spectroscopy, chromatography), testing (mechanical, thermal, optical, electrical behaviour, ageing, stability and flammability) — environmental technology, industrial air contaminants control, toxicology, waste management (collection, transportation, disposal, composting, combustion, refuse derived fuel), reclamation (secondary usage and recycling of polymeric materials), hazardous waste — automation and computation, programming, microprocessors, roboters — control engineering.

Services:

Permanent individual tuition by senior lecturers — individual lectures — daily planning, review and evaluation of project work — permanent assistance — operators services — seminars with senior lecturers and guest lecturers — preparation and use of equipment and materials — computer-aided literature and patent services — documentation — individual administrative facilities — individual contacts with industry including transport in Austria.

Organization:

Austrian Laboratory for Plastics Technology LKT-TGM, (Laboratorium für Kunststofftechnik), Wexstrasse 19 — 23, A-1200 Vienna, Austria, Tel (0) 222 35 21 06 · 0 and (0) 222 35 35 11 · 478, Telex 13 18 24 in co-operation with UNIDO Headquarters, Chemical Industries Branch, Division of Industrial Operations, Vienna International Centre, P O Box 300, A-1400 Vienna, Telephone (0) 222 26 31 · 0, Telex 13 56 12.

Qualifications:

Graduation and research experience

Language:

English, German, French, Spanish (interpreters for other languages can be arranged by request)

Institution Fees:

US \$ 5400 per man-month.



Austrian Laboratory for Plastics Technology

SID-Programme B

Wexstrasse 19-23 · A-1200 Wien · Tel. (0222) 35 21 06-0 · Telex 131824

Special Industrial Development Programme in Polymer Engineering and Plastics Technology

High Level B

Description:

The SID-programme B is an individually arranged high level programme for candidates to help them solve their problems in polymer engineering and plastics technology. It is designed as an individual training course through project work in the field of plastics technology including theoretical introduction, practical work and plant visits.

Content:

The project work is selected from the following fields of study:
Mould design — compounding and recycling — plastics processing (injection moulding, extrusion, blow moulding, foaming, machining, forming, finishing) — application engineering — testing methods — statistical evaluation — automation and computation — control engineering — trouble shooting — planning of maintenance

Services:

Introduction and evaluation by senior lecturers — instruction — weekly planning, review and evaluation of project work — limited operators services on request — preparation and use of equipment and materials — documentation — administrative facilities — contacts with industry

Organization:

Austrian Laboratory for Plastics Technology LKT-TGM, (Laboratorium für Kunststofftechnik), Wexstrasse 19 — 23, A-1200 Vienna, Austria, Tel. (0)222 35 21 06 · 0 and (0) · 222 35 35 11 · 478, Telex 13 18 24 in co-operation with UNIDO Headquarters, Chemical Industries Branch, Division of Industrial Operations, Vienna International Centre, P.O. Box 300, A-1400 Vienna, Telefon (0)222 26 31 · 0, Telex 13 56 12

Qualifications:

Graduation and experience in industry

Language:

English, German (interpreters for other languages can be arranged by request)

Institution Fees:

US \$ 2200 per man-month

LKT-TGM international

Austrian Laboratory for Plastics Technology

SID-Programme

Wexstrasse 19-23 · A-1200 Wien · Tel. (0222) 35 21 06 - 0 · Telex 131824

Special Industrial Development Programme in Polymer Engineering and Plastics Technology

Basic Level C

Description:

The SID-programme C is an individually arranged basic level programme for candidates to be trained in plastics technology. It is designed as an individual training course through project work in the field of plastics technology including introduction, practical work and plant visits.

Content:

The project work is selected from the following fields of study:
Mould making — compounding — plastics processing — testing methods and sample preparation — plastics application — controlling — trouble shooting — maintenance

Services:

Introduction, review and evaluation of project work by senior lecturers — instruction — preparation and use of equipment and materials — administrative facilities — contacts with industry

Organization:

Austrian Laboratory for Plastics Technology LKT-TGM, (Laboratorium für Kunststofftechnik), Wexstrasse 19 — 23, A-1200 Vienna, Austria, Tel. (0)-222 35 21 06 - 0 and (0) - 222 35 35 11 - 478, Telex 13 18 24 in co-operation with UNIDO Headquarters, Chemical Industries Branch, Division of Industrial Operations, Vienna International Centre, P.O. Box 300, A-1400 Vienna, Telefon (0)-222 26 31 - 0, Telex 13 56 12

Qualifications:

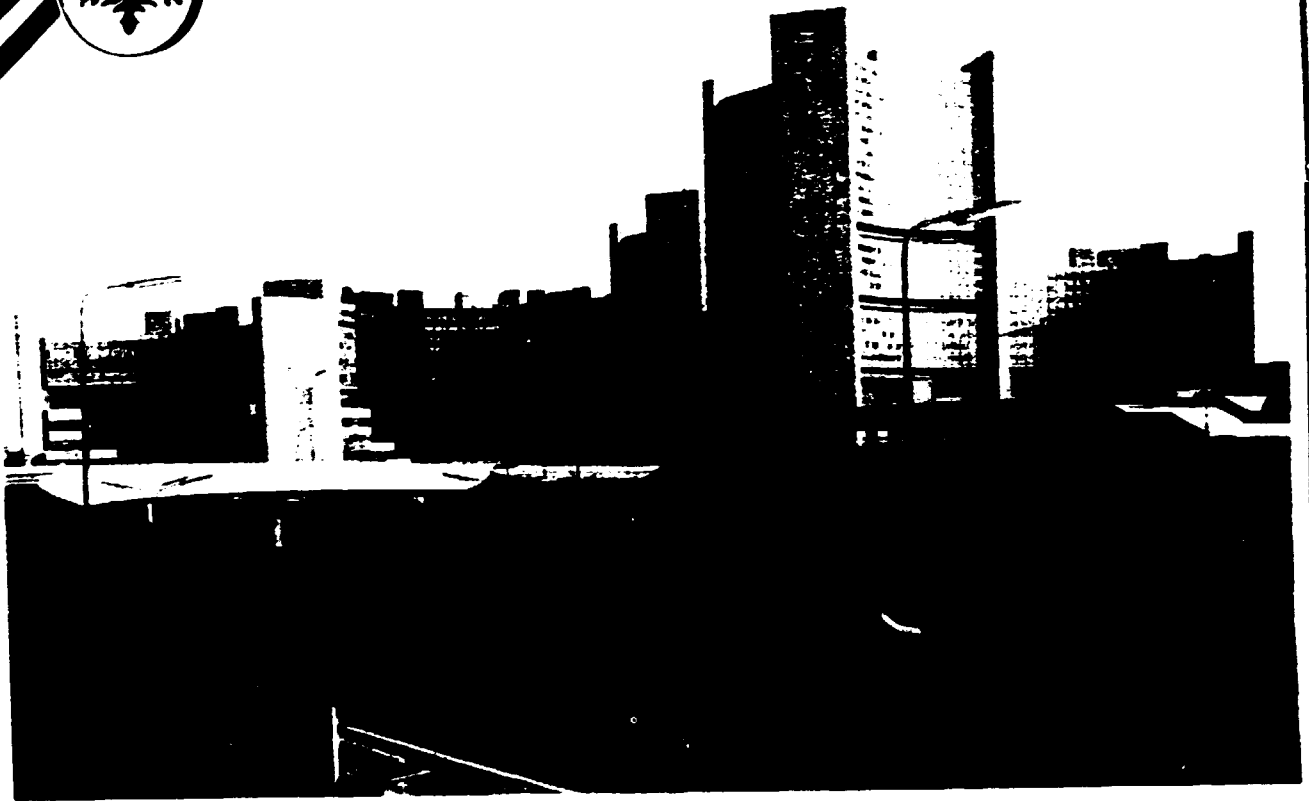
Experience in industry after completion of a technical school or equivalent

Language:

English, German (interpreters for other languages can be arranged by request)

Institution Fees:

US \$ 1500 per man-month



Vienna International Centre (UNO-City)