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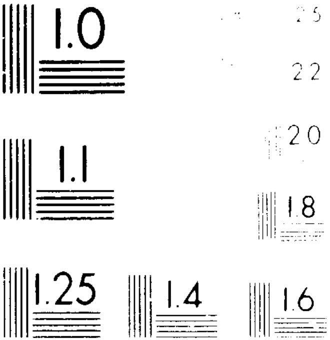
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org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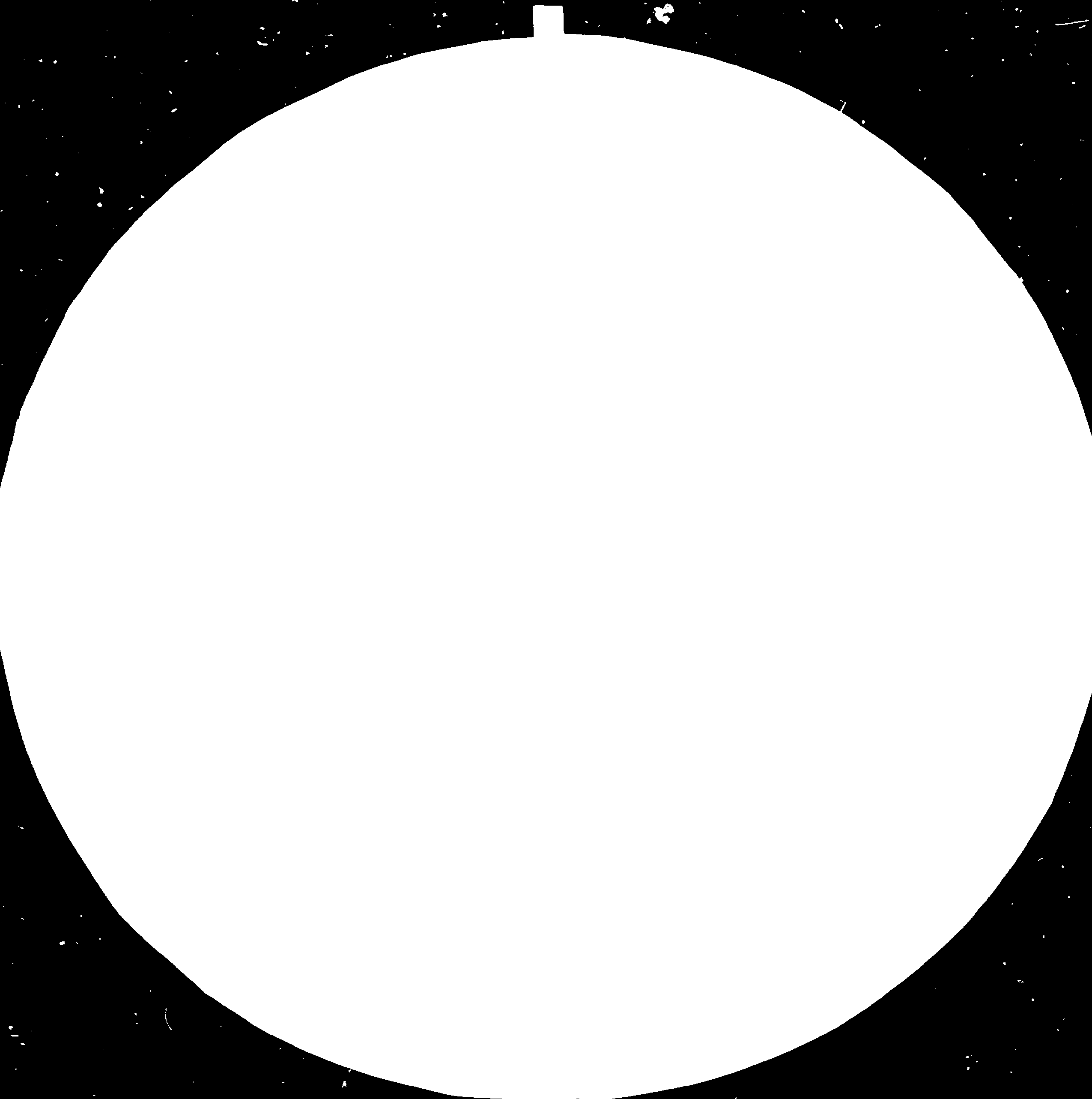

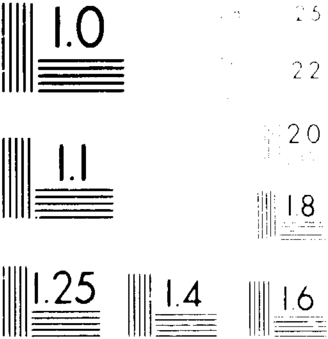
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13th December 1983

English

Romania

PRODUCTION OF THERMOPLASTICS COMPOUNDS

SI/ROM/82/(71)801/11-51/32.1.H

ROMANIA

SI/ROM/82/801

Terminal Report (Split Mission One Month)

Based on the work of Mr. ISHWAR SINGH BHARDWAJ, UNIDO EXPERT

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

Abstract

The objective of the project 'Production of thermoplastics Compounds, SI/ROM/82/(71)801/11-51/32.1.H, was to assist the Romanian enterprise Masse Plastic so that the company's know-how is at a level and an indigenous production of polymer compounds can be attempted. This is a split mission of 3 m/m and the first part of the mission for one month has been completed.

The company has good experience of processing various grades of thermoplastics and other materials. This is also backed by competent quality control methodology and other technical support. The availability of different grades of thermoplastics and their handling experience, which is a prerequisite for such work is not a constraint. Moreover, local additives and auxiliaries are available and only a few will have to be imported. The equipment for such purpose is already commissioned and is handled by persons having good job knowledge. The concerned persons have a feel for the markets available for such products and are conversant with technical service problems and do appreciate the relationship of price & performance of such materials which will have to be produced at a scale which may not be competitive in the firms of other foreign countries in the business. However, this is an 'import substitution' attempt and the persons concerned are serious and competent to attempt diversification for the production items of this company.

A team of persons in the different backgrounds like technological, processing and maintenance, control methods and applications have good interaction which is the most important to make the work successful. Based on this familiarisatim mission, the recommendations are that each concerned and identified person may like to brush up the present status of art in this area

Introduction

Engineering plastics can be divided into 3 groups :

A. Plastics without additional components like B & C.

B. Plastics with additional polymeric components (alloys)

C. Plastics in the additional inorganic (mineral) or organic components (reinforcing agents and fillers)

These three types of plastics are produced and prepared by the following methods:

A.1 Polymerisation of a monomer into a homopolymer.

A.2 Polymerisation of several monomers into copolymers.

B.1 Alloying of a polymer with a second polymer.

C.1 Incorporation of fillers and reinforcing agents into polymers.

Plastics of group A have most of the properties required for certain applications after synthesis. They are made ready for further use by subsequent process steps, ie stabilising, colouring or devolatilizing of small amounts of volatiles and pelletizing.

For group B & C, however, the required material properties are obtained by modifying the basic polymer characteristics through special compounding processes.

In order to produce materials (filled thermoplastics) for various applications; the following are desired in the compounding equipments.

(1) The closely intermeshing, self-cleaning screws ensure uniform material feed, constant melt conveying and consistently high levels of product quality.

(2) Special design feed intake for non-free-flowing materials. Problem-free conveying of poor-flowing powders, sticky materials and fillers.

(3) Good dispersion and homogenisation.

(4) Definable narrow residence time distribution and uniform product treatment.

(5) Possibility to vent, also under high vacuum if required.

(6) Exact control of temperatures.

(7) Short turn-around for colour & formulation charges.

(8) Reproducible product quality.

After compouding, the products are pelletized :

(1) by the strand-cutting method or

(2) by the hot face-cutting method with rotor pelletizer or water ring pelletizer.

A. Plastic without additional components:

These materials are converted into a usable form by processes such as the incorporation of stabilizers, pigments, lubricants, flame retardants etc , venting of volatiles and pelletizing.

Examples of materials

Polyamides-Nylon-6

Polycarbonate (PC)

ABS-terpolymers.

The polymers can be coloured with free pigment or pigment concentrate (master batch). A nitrogen blanket be introduced in the feed one to prevent the entry of oxygen. An innovative method of introducing nitrogen in Buss-kneader has been suggested to the engineer concerned.

B. Plastics with additional polymeric components (alloys):

The properties and processability of plastics can be very much improved by alloying e.g. their strength, impact resistance and rigidity can be increased. In addition, long term behaviour characteristics can be improved even at high temperatures- as well as specific properties such as flow behaviour, fire resistance and resistance to environmental influences.

Polymer alloys are blends of different polymers, or the same polymers with different viscosities, which are homogeneously intermixed in the melt phase.

The difficulties of producing alloys increase the more the viscosities of the initial product differ, the less compatible the polymeric materials are and the more the quantities of the ingredients vary.

Product examples:

PE + PA

PP + EPDM

To achieve a qualitatively perfect end product, the compounding machine must fulfil the following requirements during the alloying process:

(1) Good feed and conveying.

(2) Separate facilities for feeding ingredients at one or more points.

(3) Thorough plastification of the ingredients avoiding thermal & mechanical overwork.
(4) Minimum specific energy input.
(5) Homogeneous mixing of all components and additives.
(6) Effective devolatilizing of the melt.
(7) Exact temperature control & uniform product treatment with narrow residence time spectrum.
(8) Filtering of the melt to remove impurities.
(9) Production of uniform pellets.
(10) Easy cleaning of the machine.

C. Plastics with additional inorganic (mineral) components (reinforcing agents and fillers)

Incorporation of reinforcing agents into thermoplastics:

Reinforcing agents improve mechanical properties by increasing resistance to heat distortion and decreasing the longitudinal expansion co-efficient and deformation under load.

Example of products:

Plastics	: PA, PP, ABS, PC, PS, HDPE.
Reinforcing agent	: Glass fibres (rovings or chopped strand), short glass fibres.

Factors influencing quality:

Influential in determining the characteristics of the reinforced thermoplastic (compared to the non-reinforced polymer) are the proportions of reinforcing agents and their resistance to tension and flexing, as well as the efficiency of the sizing of the fibres. Above all, however, the compounding process has the most decisive influence on the properties of the final product.

The compounding process must therefore fulfil the following requirements :

(1) The fibres must not be excessively broken down in size and should have a narrow length distribution band.
(2) The fibres must be distributed homogeneously and thoroughly wetted by the plastic melt.
(3) Reliable venting of volatiles.
(4) The final pelletizing process must produce cleanly cut uniform pellets.

Incorporation of fillers in thermoplastics

In addition to making a more economical material, fillers often serve to improve certain properties of the polymer. Generally, they increase its resistance to heat distortion.

Examples of product:

Plastic	: PP, HDPE, PA
Filler	: Talc, Chalk,Kaolin, etc.

Factors influencing quality:

The effectiveness of a filler depends on its shape, type, surface treatment and proportion.

The final properties of the compound are however also influenced considerably by the compounding process. A condition for perfect product quality is that the process should fulfil the following requirements :

(1) Gentle but thorough plastification of the polymer.
(2) Minimum specific energy input.
(3) Homogeneous distribution of the filler particles in the polymer.
(4) Good adhesion between filler and polymer.
(5) No air or gas entrapped in the product.

In addition, the compounding machine must have a good intake and conveying action and the final pelletizer produce uniform pellets.

Similarly the Banbury mixer is used in rubber industry for the plasticizing, mixing, and compounding of rubber stocks. Using the internal mixing principle, the Banbury does the work formerly done on mills, but far more efficiently. In many cases, mixing time is reduced by as much as 100% and with increased safety. This versatile mixer is used for the production compounding of new products including natural and synthetic rubber and plastic materials. It also has other advantages.

(1) It forces a uniform dispersion of small quantities of materials throughout a relatively large batch mix.

(2) Its operating conditions, such as speed, temperature, and pressure are readily chargeable for mixing a wide range of materials.

(3) Since mixing action is not dependent upon fine mechanical tolerances, less maintenance time is required than for other methods.

Plan of Work

During the first part of the mission (1 month) the expert was required to:

1. Acquaint himself with the existing units of the plastics development centre, Bucharest with two technological lines recently set up; mixers (Henschel & Bridge-Banbury type) and granulator.

2. To establish the necessary raw materials, auxiliaries and control equipment jointly with the Centre staff.

3. Establish a detailed work programme for the second part of the mission.

1.1 I studied the various equipments mentioned in the job description with the help of Engr. Parlog Michail who has been trained in Switzerland in the operation and maintenance of various machines. We went through the data sheets provided by the Principals and digested the capabilities of each machine in terms of mixing, extrusion and processing methodologies which is essential to appreciate the parameters to be used for different materials to be made in the second mission. The engineering plastics are all polymers which in one form or another are used as structural or load bearing materials in the wide field of technology. They include both plastics which have the necessary properties for certain applications after synthesis & polymers which are suitably modified later (e.g. by alloying, reinforcing or filling). Existing polymers are modified to obtain the desired properties for particular applications.

The Banbury is a high shear internal mixer consisting of a chamber within which two helical rotors revolve in opposite directions; a high powered driving motor; a hopper for feeding the materials; and a dumping door. The rotors are cored during manufacture to create channels through which steam or water may be circulated for control of temperature. Chamber walls are also fitted for heating and cooling.

The mixing action in a Banbury is more than just blending. Atleast four interacting operations occur simultaneously. These may be termed kneading, smearing, longitudinal cutback; and lateral overlap.

The mixer (Henschel type) is a simple piece of equipment fitted with a mixing blade. During mixing at various speeds, the temperature is increased due to friction. It is useful for making masterbatches for PVC and its compounding.

2.1 Depending on the modification required, the chemicals and other materials required were identified and their specifications, source of supply etc., were indicated. e.g. for improving the impact properties and other characteristics of polymers in general and polypropylene in particular the following information is very relevant.

Type of elastomeric material required:

- Polyisobutene
- Ethylene-Propylene copolymer
  Mooney viscocity 35-45
- Ethylene propylene copolymer
  Mooney viscocity 65-75

The analysis of Industrial Talc & Fossil meal may be the following :

Particle size				%
	d	40	micron	0.2
40	d	20	"	24.8
20	d	10	"	40.0
10	d	5	"	20.0
5	d	2	"	15.0
Silica				01.9
Al_2O_3				3.3
Fe_2O_3				1.2
P_2O_5				0.2
TiO_2				0.2
CaO				0.5
MgO				0.5
H_2O				0.1

Glass Fiber (chopped strands/or Rovings)

Coupling agents - Silane type or Titanates

Antioxidants - BHT, Irganox 1076, 1010

UV Stabilizers - 2,4-dihydroxybenzophenone or Triazins like Tinuvin or Nickel-chelates.

Antiblocking agent - Silica (0.8 /U size)

Slip agent - Fatty acid amide oleamide.

Lubricants - GMS (Glyceryl mono stearate); calcium stearate and metal deactivators.

Miscellaneous chemicals

1. Dioctyl phthalate
2. Chlorinated parafin wax
3. Inamol (Expoxidised oil)
4. Barium stearate
5. Calcium & Cadmum stearate; stearic acid.
6. Dibasic lead stearate
7. Tribasic lead stearate
8. Cetyl alcohol
9. Tin mercaptide

The control equipments with Masse Plastics were also studied and it was found that it will be enough for the next mission. However, the determination of following properties whic are given below for record will have to be determined. The concerned persons have been requested to brush up & have a practice of testing raw materials (Polymers of various grades) and chemicals including sample preparation so that the results in future are comparable and relÉiable. The test methods depend on the particular application for a specific material under investigation.

1. Mlet index
2. Specific gravity
3. Tensile strength
4. Elastic modulus
5. Vicat softening temperature
6. Rockwell hardness
7. Izod impact strength
8. Moud shrinkage

3.1 A detailed work programme for the second part of the mission has been described and on the basis of 2nd part of the job description a copy of the protocol is attached. Moreover, the following documents were given to Masse Plastic Engineers for study and preparing themselves for the next mission.

1. Colouring of Polypropylene, -methods, recipes and samples.
2. Continuous compounding of Engineering plastics.
3. Details for production of compounds and filled polypropylene.
4. Write up on Banbury mixer.
5. Guide to continuous melt compounding machinery.
6. Continuous melt compounding.
7. Fibre reinforced plastic for automobile industry.

Conclusions & Recommendations

I like to observe that the Chief Engineer (Mr. Peter) of the company along with his engineer namely Messers Busegeanu, Chivulescu, Parlog and Davidescu showed a keen interest in investigating the area of 'thermoplastic' compounds. They have the proper equipment to take up the jobs and a special laboratory size extruder is being provided by UNIDO. I will remain in contact to provide the technical information required in some areas of interest. I appreciate the interest and guidance of Mr. Ion Marinescu for this project. I like to put on record my gratefulness to Mr. Raymond Rabenold, RR, and his administrative assistant, for advice and help. I also express my indebtedness to Mr. Gumen - Backstopping Officer for good briefing which has helped me to make the job a success and pleasant one.

The recommendation is that the company should attempt a few grades of Polymer Compounds, considering various aspects of technology, quality control, applications, waste utilisation etc. so that import substitution is possible. This is an area of commercial production activity and the proposed products have to stand the test of cost/benefit exercise; production methodology parameters, marketing possibilities and scale up of production which is always long but necessary before a product development work can be implemented..

Finally, I express my appreciation to UNIDO to have given me a chance to serve as an Expert and satisfy my desire to serve people in my small way.