

Training Programs for Rubber Industries

Rubber Compound Formulation Design

11-12 October 2010, Impiana KLCC Hotel, Kuala Lumpur

Extrusion of Rubber

13 October 2010, Impiana KLCC Hotel, Kuala Lumpur

Rubber Injection Molding

14 October 2010, Impiana KLCC Hotel, Kuala Lumpur

Adhesion of Rubber

15 October 2010, Impiana KLCC Hotel, Kuala Lumpur

Instructor

Dr. Hans-Joachim Graf
Rubber Industry Consultant, Germany

Organizer

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Rubber Compound Formulation (Recipe) – Design

11-12 October 2010, Impiana KLCC Hotel, Kuala Lumpur

The participant gets an overview of the construction of the recipe in rubber development and processing. All ingredients used have their influence on each other, undergo changes during mixing and effect processing. All these effects have to be under control at the same time in a kind of 360° view. After introduction of the recipe basics you learn about polymer selection under consideration of specification and processes. When compounded with reinforcing materials and plastizisers you will learn simple and useful selection criteria. The influence of Crosslinking and accelerator systems is *discussed* and their optimization due to the selected rubber as well as its influence on the properties during processing and service life of the rubber part. Nevertheless there are even more ingredients in the rubber recipe, like process aids, resins, weathering agents and more, which are of influence on the behaviour and property of the compound. All the ingredients show interaction if introduced in the recipe and changes due to reaction as well, when processed in the mixer and forming machines. Finally these multiple parameters have to be governed to achieve maximum quality at minimum cost, which is the goal of all the effort. To elucidate all parameters of influence will be discussed from an industrial production point of view. For a deeper understanding examples out of the industrial practice will be given. What is learned will be strengthened with some simple exercises.

Who should attend: This two-day training program is for people involved in actual compounding operations, who want to learn about modern and efficient compounding procedures. People involved in rubber processing, who like to understand the boundaries of compounding and the impact on their processes will benefit from this course

Program Language: ENGLISH; **Program Agenda :** 09.00 -17.00 (each day)

Program Outline

1. Introduction

- What is a Recipe (Formulation)?
- Design Principles

2. Formulation (Recipe) Development

- Methodology and Approach
- Importance of the Recipe for the Process Chain
- Interaction of Raw Materials in the Recipe and with the Processes
- Design Guide for the Recipe

3. Raw Rubber

- Types of Rubber and Rubber Selection Tree
- Influence of Rubber on Rubber Product Properties
- Rubber architecture and interaction with forming processes
- Rubber Properties and Flow
- Miscibility of Rubber
- Rubber Blends in compounding

4. Ingredients in Rubber Compounding

- Filler System (Reinforcing filler / Semi and non-reinforcing fillers / Plastizisers)
- Protectants (Antioxidants / Antiozonants / Inhibitors/promoters)
- Process Aids (Mixing Aids / Molding Aids)
- Cure System (Vulcanizing Agents / Activators / Accelerators / Scorch Retarders)

5. Carbon Black

- Basics on reinforcement
- The Carbon black and oil pair and influence on physical properties

6. Silica-filled Rubber Compounding

- Silica Dispersion
- Coupling Agents
- Considerations and Limitations

7. Whitings

- Structure of Whitings
- Whiting Oil Pair and influence on physical properties
- Interaction of the structure of whitings with the forming process

8. Process Oil

- Solubility as criteria for selection of oil in a Rubber
- Simple Selection method
- Influence of Oil on crosslink density
- Compounding for constant crosslink density

9. Sulfur crosslinking and acceleration

- Sulfur accelerator ratio and sulphur bridge structure
- Solubility of sulfur, accelerators
- Reversion in Diene Rubbers
- Basic accelerator designs

10. Crosslinking without Sulfur

- Peroxide Cure
- Role of Coagent in Peroxide Cure
- Interaction of ingredients with peroxide
- Metaloxide, Resin and other crosslinking methods

11. Process Aids

- Selection of process aids due to objective and structure
- Function of process Aids
- Resins as compatibilizers and tackifiers

12. Recipe Development Methods

- Simple two Factor Designs
- Multiple Factor Designs (DOE)
- Databank Analysis with Multiple Linear Regression

13. Reverse Engineering for Developing Compound Formulation

- Principal Physical, Chemical and Analytical Methods
- Rubber Identification
- % Carbon Black Calculation
- Volatile Separation
- Formulation Reconstruction

14. Case Studies of Rubber Compound Formulation

- Footwear
- Tyres
- O-Ring
- Conveyor Belt
- Automotive Rubber Parts

15. Reducing Compound Cost

- Compound Cost Calculation
- Replacement of Ingredients
- Compounding for Cost Reduction

16. Exercises

- Participant will create a Formulation
- Discussion of the creation

Extrusion of Rubber

13 October 2010, Impiana KLCC Hotel, Kuala Lumpur

During this one-day course the participant will learn about the extrusion operation from the rubber material point of view. Best understanding of the extrusion process starts with a deep knowledge of the material / process dependency in extrusion. The introduction will cover the principle extruder techniques, die design and their effect on the compound and vice versa. The effect of different heating devices for vulcanisation with its relevance for the compound will be addressed. A simple process model results in a better understanding of the extrusion in the day to day business with its potential for optimization. Specific emphasis is made on compounding for extrusion to enable a deep understanding of material / process interactions. This understanding result in the ability to manage the process in terms of troubleshooting. Coating of profiles depends on the surface energy of the rubber. Its dependency of the rubber recipe and the profile surface treatment is discussed.

Who should attend : This one-day program is for people involved in actual extrusion operations like recipe development for profiles or process engineers, who like to understand material behaviour in the extrusion process.

Program Language: ENGLISH; **Program Agenda:** 09.00 -17.00

Program Outline

1. Extruder Techniques – Overview

- Principle
- Hot Feed / Cold Feed / Single Screw Extruder
- Pin-Barrel Single Screw Extruder
- Vented Extruders
- Screw Types
- Developments of Screws
- Comparison with Gear Pump
- Advantages / Disadvantages of Different Screws

2. Shaping of Rubber – Heads & Dies

- Principle of Heads and Dies

- Heads – Types and Design Criteria
- Dies – Types and Design Criteria
- Development from Disk to Die Stack
- Flow in Die
- Die Relief Strategies

3. Rubber Curing - Heating Devices

- Batch vs Continuous
- Autoclave
- Hot Air oven
- Microwave Hot Air oven
- Saltbath Oven

- Fluid Bed Oven
 - Comparison
- 4. Extrusion Process and Control**
- Process Factor in Extrusion
 - Process Model
 - Operating Practices
 - Optimizing Extrusion Process
 - Instrumentation & Monitoring Equipment
 - Maintenance Issues
- 5. Rubber Compounding for Extrusion**
- **Dense** – Compound Base and Accelerator Systems
 - **Sponge** – Compound Base and Accelerator Systems
 - Optimizing Cure
 - Wall Slippage of Rubber Compounds
 - Stick Slip Effect

- 6. Troubleshooting in Extrusion of Rubber**
- Low Output Rate
 - Poor Dimensional Stability of Extrudate
 - Excessive Heat Buildup in Compound
 - Rough Surface on Extrudate
 - Contamination
 - Porosity in Extrudate
 - Strip Difficult to Feed
 - Surging Output
 - Die Drool
 - Screw and Barrel Wear

- 7. Coating**
- Some Coating Aspects
 - Surface Preparation
 - Surface Energy and Coating Adhesion
 - Measurement of Surface Energy
 - Rubber Compound considerations for Coating

Rubber Injection Molding

14 October 2010, Impiana KLCC Hotel, Kuala Lumpur

Injection Molding of Rubber is a multi parameter process. Machine, Mold and Material interact and effect each other. This course will provide an understanding that the participant gets the ability to manage such a process. After an introduction of the injection molding machine, followed by a detailed description of the plastification units and their function and influence on the operation, a process model is provided. This model leads to experiments, which allow to construct an operating window, which is a tool to govern the process. Principles of mold layout and compound design with special regards to rheology is discussed. The participant will learn how this triangle can be understood and handled to achieve a stable manufacturing process. As a precondition, the molding machine must provide all necessary functions, therefore a guidance, how to access the molding machine is discussed. We all see still defects on molded rubber parts, which makes troubleshooting necessary. The course is completed with a discussion of some specific newer molding techniques and developments

Who should attend: This one-day training course is for people responsible in actual injection molding operation like process engineers. People responsible for the molding material will benefit via an understanding of machine and process.

Program Language: ENGLISH; **Program Agenda:** 09.00 -17.00 (each day)

Program Outline

- 1. Introduction to Molding of Rubber**
 - Rubber Parts and Applications
 - Molding Techniques - Compression, Transfer, Flashless and Injection Molding
 - Vertical vs Horizontal
 - Why Injection Molding?
- 2. Rubber Injection Molding Machine**
 - Components
 - Different Plastification and Injection Units
 - Mold Basics
- 3. Injection Molding Process**
 - Process Steps
 - Analysis of the Plastification Process
- 4. Injection Mold Design**
 - The Injection Process
 - Pressure Profiles, After Pressure and Holding Time
 - Operating Window
 - Simple Statistic Process Model and its Practical use for Process Set up
 - Basic Principles of Mold Design
 - Hot runner vs cold runner
 - Rheological Design of Runner and Gate (practical considerations)

5. **Compounds for Injection Molding**
 - Principles of compound Design
 - Influence of Compounds on Flow
 - Optimization of cure kinetic for Injection Moulding
6. **Assessment of an Injection Molding Machine**
 - Testing of the functions of a Machine
 - Testing of the reproducibility and capability of a Machine
7. **Troubleshooting in Rubber Injection Molding**
 - Shrinkage and Part Dimensions
 - Stickiness, Mold Fouling
 - Backrinding, Orange Peeling
 - Porosity / Blisters
8. **New Developments in Rubber Injection Molding**
 - Molding with LSR (Liquid Silicone Rubber)
 - 2K Molding
 - Micro Injection Molding

Adhesion of Rubber

15 October 2010, Impiana KLCC Hotel, Kuala Lumpur

Rubber with reinforcing elements is widely used in automotive and construction industry. The techniques of bonding rubber are fairly old but still seen as an empirical matter, even there are only a few scientific principles of rubber bonding. After an introduction into the topic the principles of rubber bonding will be discussed followed by rubber-to-metal bonding. The participant learns about metal preparation, the effect of primer and cement on bonding and compound design considerations. This part is completed with a discussion of testing bonded rubber and – in case of defect in operation – a troubleshooting guideline. The creation of bonds between rubber-rubber, rubber-TPE /TP and 2 K Molding follows often another mechanism and needs other conditions. An insight view on bonding before mentioned materials will be given. The course is completed with a discussion of other reinforcing elements in rubber bonding like steel cord and textile fabrics. This reinforcing elements are used mostly in other manufacturing techniques but have its similarities in short fiber reinforced rubber.

Who should attend : This one-day training course is for people responsible in actual manufacturing of reinforced parts operation like process engineers, project managers, part designers and people, responsible for the material. It will lead to a better understanding of the boundaries of rubber bonding and will enable to improve manufacturing processes in rubber bonding.

Program Language: *ENGLISH*; **Program Agenda:** *09.00 -17.00 (each day)*

Program Outline

1. **Introduction to Rubber Adhesion**
 - Application of Rubber Adhesion
 - Multi Components Automotive and Non-Automotive Parts
2. **Principles of Physics and Chemistry**
 - Cohesion – Adhesion
 - Physics of Adhesion
 - Chemistry of Bonding
 - Bond System Characteristics
 - Bonding Agents – Adhesion Promoters
 - Fusion Bonding
3. **Rubber to Metal Bonding and Manufacturing**
 - Preparation of Metal parts
 - Degreasing methods
 - Elimination of Oxide Layer
 - Phosphatisation
 - Primer, Cement
 - Handling Considerations in Moulding Operation
4. **Adhesion Testing and Troubleshooting**
 - Testing of Rubber to Metal Parts
 - Test Procedures
 - Bond Failures – Reasons and Prevention
 - Guidelines & Best Practices
5. **Rubber to Rubber Bonding**
 - Vulcanized & Unvulvanized Rubbers
 - Influencing Paramters
 - Adhesive/Bonding Agent Choice
 - Effective Bond Prepration
6. **Rubber to Plastics (TP,TPE) Bonding**
 - Plastics Substrate Prepration
 - Degreasing and Solvent Cleaning
 - Adhesive/Bonding Agent Choice
 - Surface Energy of Bonding Partners
 - Effective Bond Prepration

7. Manufacturing of Two K Parts

- Rubber / Rubber and Rubber / (TP/TPE) Parts in 2 K Moulding
- Corner Molding

8. Rubber to Fabric/Textile Bonding

- Applications & Mechanism of Adhesion
- Textile Substrate Preparation
- Adhesive/ Bonding Agent Choice
- Effective Bond Preparation.

Program Instructor – Dr. Hans-Joachim Graf, Germany



Hans-Joachim Graf has over thirty years experience in the rubber industry. He was first with manufacturing companies for pharmaceutical and technical rubber parts. He then joined DESMA a manufacturer of Rubber Injection molding and polyurethane shoe machines (DESMA) responsible for process development, followed by RheinChemie as senior manager of material developments for rubber industry. After Cooperstandard Automotive (CAN), division of profile extrusion, as a director of materials he is today with WOCO (GE), a manufacturer of injection molded parts in charge for material development and process design. Mr. Graf has authored over 60 publications and paper presentations and invented more than 15 patents. He has given a rubber technology course for graduates at University of Waterloo and is teaching courses in recipe design and industrial bonding

at University of Hannover (GE) continuing education department. He is a member of the American Chemical Society, Deutsche Chemische Gesellschaft and Deutsche Kautschuk Gesellschaft. He received his diploma degree from University of Mainz and his doctorate in polymer chemistry from University of Freiburg, both Germany.

Program Organizer - Rubber Industry Academy (TechnoBiz)

Rubber Industry Academy is a division of TechnoBiz Communications Co., Ltd., based in Bangkok. This academy provides services to the rubber industries in Asia. The academy organizes technical and market conferences, seminars and training programs related to rubber processing and technology. Following programs are also planned: Natural Rubber Markets Seminar (28 October 2010, Bangkok); Latex Tech Asia 2011 (1-2 March 2011, Bangkok). This academy also publishes and markets books related to rubber technology and processing. Please visit www.rubberindustry-academy.com for more information.

Note to Registered Delegates: Registered delegates are encouraged to prepare process problems and discuss with program instructor during the training program. Please also prepare necessary data and pictures related to your questions to get advice from the instructor.

You can send your questions by email to training@rubberindustry-academy.com so that this helps instructor to prepare in advance to address your process problems at the program.

Training Venue – Impiana KLCC Hotel, Kuala Lumpur: These programs will be held at Impiana KLCC Hotel, Kuala Lumpur. This hotel is located near to landmark building, Petronas Twin Towers. More information about this hotel can be found at www.impiana.com.

Rubber Industry Academy – Upcoming Events

- **Natural Rubber Markets** (28 October 2010, Bangkok) (*Seminar*)
- **Latex Tech 2011** (1-2 March 2011, Bangkok) (*Conference*)
- **Latex Products Manufacturing – Understanding & Troubleshooting** (3-4 March 2011, Bangkok) (*Training*)

Contact Address

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Contact : Khun Sirinthip, Program Coordinator

Registration Form

Instruction: Please fill all the information in English only

We confirm to register following events at Impiana KLCC Hotel, Kuala Lumpur

| | Event Name | Event Dates | Registration Fee/Person (US\$) |
|--------------------------|------------------------------------|--------------------|--------------------------------|
| <input type="checkbox"/> | Rubber Compound Formulation Design | 11-12 October 2010 | 750 US\$ |
| <input type="checkbox"/> | Extrusion of Rubber | 13 October 2010 | 550 US\$ |
| <input type="checkbox"/> | Rubber Injection Molding | 14 October 2010 | 550 US\$ |
| <input type="checkbox"/> | Adhesion of Rubber | 15 October 2010 | 550 US\$ |
| <input type="checkbox"/> | All Above Programs | 11-15 October 2010 | 2,000 US\$ |

Organization Name

Address

TelFax Email

Contact Person Tel Email

Participant Names :

Participant 1: Position Email

Participant 2: Position Email

Participant 3: Position Email

Participant 4: Position Email

Participant 5: Position Email

Payment is required with registration. **Group Discount:** 3 or more than 3 delegates from the same organization for the same event, 10% discount on the registration fee will be offered. If 5 delegates from the same organization for the same event, 6th person participation is FREE.

Payment Method

Bank Transfer to Bangkok Bank, Ratchada-Latphrao Road Branch, A/C No: 177-0-70727-9
A/C Name: TechnoBiz Communications Co., Ltd., Swift Code: BKKBTHBK
(Kindly make payment for all bank charges and fax /email bank slip to TechnoBiz)

Credit Card Visa Master Card (5% bank fee for credit card processing will be applied)

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Last 3 digits on signature panelCard Expiry Date

Signature of CardholderDate

Please send completed registration form to

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Website: www.rubberindustry-academy.com Contact Person: Khun Sirinthip, Program Coordinator W

Books for Rubber Industries – Order Form

Following books are available at special discount for the registered delegates of these training programs. Delegates will receive these books at the program only. Please select the books that you are interested to purchase. If you need more information on each book, kindly visit www.rubberindustry-academy.com to download the content. **DEADLINE FOR ORDERING BOOKS – 25 SEPT 2010**

| | Book Title | Book Price, US\$ | Delegate Price, US\$ |
|--------------------------|---|------------------|----------------------|
| <input type="checkbox"/> | China Rubber Industry Directory 2010 | 150 US\$ | 100 US\$ |
| <input type="checkbox"/> | Rubber Compounding Asia 2010- Proceedings | 150 US\$ | 75 US\$ |
| <input type="checkbox"/> | Rubber Processing – An Introduction | 100 US\$ | 75 US\$ |
| <input type="checkbox"/> | Fatigue, Stress and Strain of Rubber Components | 125 US\$ | 100 US\$ |
| <input type="checkbox"/> | Rubber Technology: Compounding and Testing for Performance | 185 US\$ | 150 US\$ |
| <input type="checkbox"/> | How to Improve Rubber Compounds | 185 US\$ | 150 US\$ |
| <input type="checkbox"/> | Thermoplastic and Rubber Compounds | 125 US\$ | 100 US\$ |
| <input type="checkbox"/> | Extrusion Dies for Plastics and Rubber | 125 US\$ | 100 US\$ |
| <input type="checkbox"/> | Engineered Rubber Products –Design, Manufacture and Testing | 125 US\$ | 100 US\$ |

Organization Name

Address

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TelFax Email

Contact Person Tel Email

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Signature of CardholderDate

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