



**COURSES FOR COPERION CUSTOMERS ON DESIGN AND OPERATION OF ZSK TWIN-SCREW EXTRUDER SYSTEM INTENSIVE PROGRAMS INCLUDE HANDS-ON TRAINING**

At Coperion, we strive to be responsive to the needs of our customers. To make sure users of ZSK twin-screw extruders thoroughly understand the technology and are kept abreast of the latest technical advances, Coperion has developed in-house courses specifically for the ZSK Twin-Screw Extruder System. The objective of these courses is to provide process engineers, operations supervisors and operators with an understanding of the fundamental and practical aspects of the design and operation of the ZSK.

**ZSK 101, now in its twenty-eighth year, continues to be our most popular class** with many new attendees registering based on co-worker feedback. ZSK 101 is a 2.5 day course which takes an in-depth look at twin screw extrusion process design. It includes sections on process unit operations (feeding, melting, mixing, etc.) scale-up, compounding, modeling and materials of construction. A full course outline is shown attached.

**ZSK 102**, in response to requests for hands-on training, Coperion expanded its classes in 1997 to include ZSK 102. This 1 day course provides classroom instruction on the basic ZSK building blocks, barrels and screw bushings; a maintenance overview and a review of control systems and safety interlocks. Additionally, participants will spend a significant portion of each day in the lab learning how to efficiently assemble and disassemble machine components as well as basic operation of the ZSK. A sample course outline is shown below. ZSK 102 is designed for operators, technicians and anyone responsible for the safe, efficient running of a ZSK extruder.

Session registration is limited to approximately 15 people - in order to assure that individual participant needs can be accommodated. Multiple company participation is probable. However, single company, or even single company location sessions can be organized.

The registration fee for the 2.5 day ZSK 101 course is \$975 per person, and \$775 per person for the 1 day ZSK 102. Discounts are given for multiple registrations from an individual company. The fee includes notebook, program material, break refreshments and lunches. Lodging and other meals are not included.



The **2019** schedule is shown below:

ZSK 101	Start Date	End Date
Session 1	3/5/2019	3/7/2019
Session 2	6/11/2019	6/13/2019
Session 3	9/10/2019	9/12/2019
Session 4	12/3/2019	12/5/2019

ZSK 102	Start Date	End Date
Session 1	6/13/2019	6/14/2019
Session 2	12/5/2019	12/6/2019

ZSK 101 & 102 Schedule	ZSK 101 Day 1	ZSK 101 Day 2	ZSK 101 Day 3	ZSK 102 Day 1	ZSK 102 Day 2
	8:15 a.m. – 5:00 p.m.	8:30 a.m. – 5:00 p.m.	8:30 a.m. – 12:00 p.m.	1:00 p.m. – 5:00 p.m.	8:30 a.m. – 12:00 p.m.

All classes listed above are hosted in our new lab and training facility in Pitman, NJ.

In addition to the regularly scheduled classes listed above, both ZSK 101 and ZSK 102 can be presented at your company. The basic cost for ZSK 101 is \$7,750 for up to 10 attendees and ZSK 102 is \$4,750 for up to 8. Additional attendees will be charged at a per person rate depending on the total number of attendees. These courses can be modified to fit your needs. Under those circumstances we will be happy to discuss your needs and provide you with a customized pricing schedule.

The above pricing for on-site classes does not include travel expenses for two instructors.

For additional information on either the regularly scheduled classes or the on-site program, or to register for a course, please contact:

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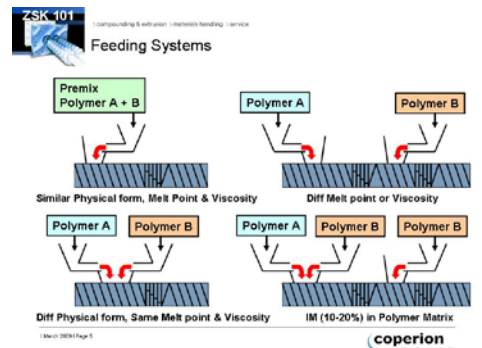
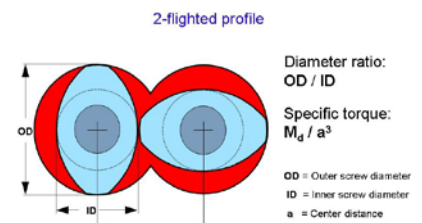


## ZSK 101 COURSE OUTLINE

### ZSK TWIN SCREW EXTRUSION COMPOUNDING SYSTEM

#### DAY 1:

- I. INTRODUCTION
- II. ZSK DESIGN CHARACTERISTICS
  - A. Historical Background
    1. Applications of Twin Screw
    2. Different ZSK Generations
  - B. Definitions
    1. Outer & Inner Diameter
    2. Torque
    3. Shear Rates
    4. Free Volume
  - C. Basic Machine Components
    1. Screw Bushings
    2. Kneading Blocks
    3. Special Elements
      - a. SK/SF
      - b. Distributive Mixing Elements
      - c. 3-lobe KB
    4. Barrels
    5. Vents
  - D. Pelletizer Options
- III. FEEDERS AND FEED HANDLING SYSTEMS
- IV. UNIT OPERATIONS Part 1
  - A. Feed Handling/Preparation
  - B. Feeding
    1. Upstream Feeding
    2. Downstream Feeding
      - a. Solids
      - b. Liquids
  - C. Plastification
    1. Conductive/Convective
    2. Shear Dissipation

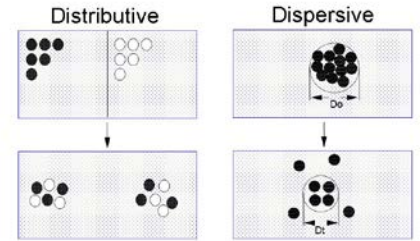




## ZSK 101 COURSE OUTLINE

### DAY 2:

- V. UNIT OPERATIONS Part 2
  - D. Mixing
  - E. Devolatilization/Degassing
  - F. Metering/Pressure Generation
  - G. Discharge
    - 1. Pelletizing Train
    - 2. Direct Extrusion
  
- VI. PROCESS CONTROLS & INTERLOCKS
  - A. System Scope
  - B. Design
  - C. Safety Interlock System
  
- VII. EXAMPLES OF PROCESS SYSTEMS
  - A. Compounding
    - 1. Dispersive
    - 2. Distributive
  - B. Devolatilization
  
- VIII. SCALE-UP FACTORS FOR ZSK MACHINES
  - A. Machine Series Geometry Difference
  - B. Basis for Scale-up Method Selection
  - C. Volumetric Scale-up - Degree of Fill
  - D. Alternate Method to Scale Throughput:  
Specific Mechanical Energy
  - E. Scaling Shear Rate for ZSK Extruders
  - F. Scale-up for Heat Transfer
  
- IX. LABORATORY, ASSEMBLY & OPERATION



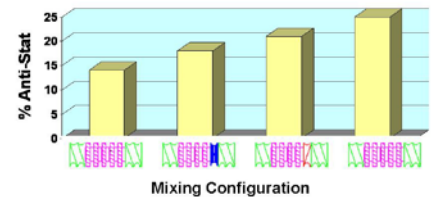
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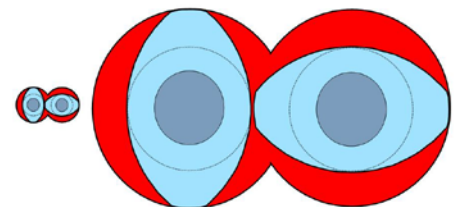
Percent Anti-Stat as a Function of Mixing Configuration



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Relative X-Sectional Area: ZSK 58 vs. ZSK 320



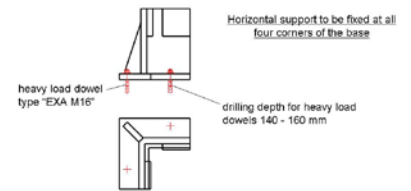
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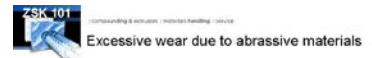
## ZSK 101 COURSE OUTLINE

### DAY 3:

- X. TROUBLE SHOOTING THE PROCESS
- XI. MAINTENANCE OVERVIEW
  - A. Maintenance Manuals
  - B. Spare Parts
- XII. EXTRUDER WEAR/MATERIAL OF CONSTRUCTION
  - A. Types of Wear
  - B. Wear Reduction/Process Related Minimization
  - C. Wear Reduction/Special Materials of Construction



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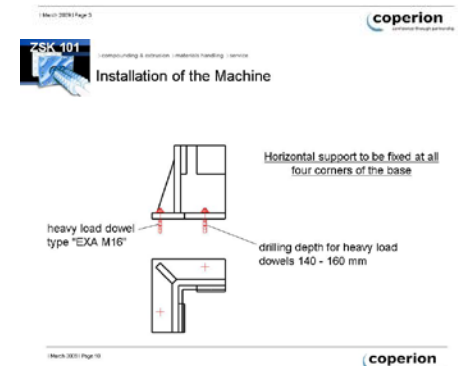
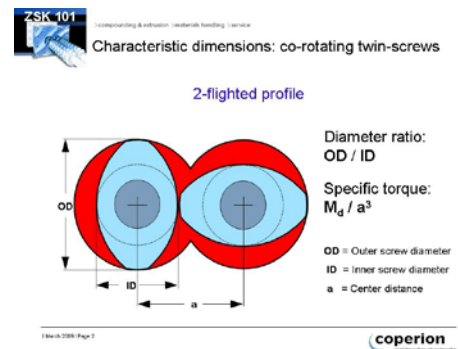


## ZSK 102 COURSE OUTLINE

### ZSK TWIN SCREW EXTRUSION WORKSHOP

#### DAY 1:

- I. INTRODUCTION
  
- II. ZSK DESIGN CHARACTERISTICS
  - A. Historical Background
    1. Applications of Twin Screw
    2. Different ZSK Generations
  - B. Definitions
    1. Outer & Inner Diameter
    2. Torque
    3. Free Volume
  - C. Basic Machine Components
    1. Screw Bushings
    2. Kneading Blocks
    3. Special Elements
      - a. SK/SF
      - b. Distributive Mixing Elements
      - c. 3-lobe K.B.
    4. Barrels
    5. Vents
  - D. Pelletizer Options
  
- III. LABORATORY - Screw Assembly
  
- IV. MAINTENANCE OVERVIEW
  - A. Maintenance Manuals
  - B. Spare Parts







## ZSK 102 COURSE OUTLINE

### ZSK TWIN SCREW EXTRUSION WORKSHOP

#### DAY 2:

- V. PROCESS CONTROLS & INTERLOCKS
  - A. System Scope
  - B. Design
  - C. Safety Interlock System
  
- VI. LABORATORY - Barrel Assembly, Screw Installation
  
- VII. EXTRUDER WEAR/MATERIAL OF CONSTRUCTION
  - A. Types of Wear
  - B. Wear Reduction/Process Related Minimization
  - C. Wear Reduction/Special Materials of Construction

