RheoComp®
“Rheological Processing Companion”

Classic
Concerto
Symphony

Processing Wizard within ten square meters
State-of-the-art Technology in Processibility Evaluation

Polymer Processing, Rubber Processing
Food Material Processing, Pharmaceutical Material Processing
Nano Material Processing, Bio Material Processing

RheoComp® is the registered trade mark of MKE
Rheology is the study of deformation and flow of matter.
..................Bingham, 1920

Processing is defined as the “engineering activity concerned with operations carried out on materials or systems to increase their utility”
..................Bernhardt and McKelvy, 1956

The product of MKE is not just a device, but a solution for better products and shorter time to market, which are key success factors of new developed materials and final products.

“Fast and reliable measurement of material properties, Finding new test methods for quality control, Easy report generation for fast decision, and Close relationship with valuable customers”

Best Solution, Best Partner! Stand by valuable customer!

MKE supplies machines with experience in rheological processing solution !!!

..................These are business strategies of MKE.
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MKE's cutting-edge technology

MKE offers advanced processing solution for the four distinct material processing area:

- Nano-material processing
- Pharmaceutical material processing
- Plastics and rubber processing
- Food processing
- Cosmetics processing

- Easy processibility evaluation
- Easy producing final products
- Easy analysis

We suggest five lab stations and processing modules.

"HYPERIER**"—most astonishing technology in MMT nano-composites
Multiple lamellar-layered technology using one single screw extruder and die
Lab Stations for Advanced Material Processing

Lab Station: Revolutionary Modular Laboratory System

Including laboratory setup consulting

**Plastics lab station**
- Film
- Sheet
- Compounding / Mixing
- Pelletization

**Cosmetics lab station**
- Powder mixing
- Powder fluidity
- Slurry mixing

**Nano lab station**
- CNT mixing
- CB mixing
- MMT mixing

**Rheology lab station**
- Shear viscosity
- capillary rheometer
- Screw rheometer
- Elongational viscosity

**Pharmaceutical lab station**
- Hot melt extrusion
- Powder handling

<table>
<thead>
<tr>
<th>Material</th>
<th>Properties</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics</td>
<td>Rheology</td>
<td>Cosmetic Pharma</td>
</tr>
<tr>
<td>Rubber</td>
<td></td>
<td>Nano Bio</td>
</tr>
</tbody>
</table>

Based on Innovative idea for PPS* relationship !!!

*PPS relationship: Properties-Processing-Structure relationship

RheoComp® is the registered trade mark of MKE
RheoComp®
Symphony / Concerto
"Command station" is core of RheoComp** solution. Symphony and Concerto model offer most sophisticated process solutions:

Plug and play devices do measuring, recording and analysis.
- Viscosity
- Consistency
- Thermal stability
- Frictional property
- Procesesibility of various material tested

Plug and play devices are highly instrumented:
- Batch Internal Mixers
- Single Screw Extruder
- Co-/counter Twin Screw Extruder
- Screw Rheometer
- MK Mixer

Performance target allows "Fast and Easy"
- Product Development
- Quality Control
- Property measurement for equipment design

Command station additionally provides optional
- Vacuum trap and chillers
- Space for installing liquid injection pump, vacuum pump, and printer for reporting
- Three drawers for key component storage

We call this floor-space saving as "Processing wizard in ten square meters".

"Fully compatible with other major brand equipment"

Main feature
- Servo motor control
- Powered by National Instrument** DAQ device
- Sense of rotation, forward and backward
- User selective torque measurement range
- Up to eight Melt/metal temperature
- Up to eight Melt pressure
- Control type:
  - Computer and manual control of air cooled barrel temperature control
  - Computer controlled drive speed
  - Easy report generating capability for time saving
  - Upgradable water cooling system
  - External USB port and monitor port
RheoComp offers unique solution for user convenience and better expansion of downstream or auxiliary equipment.

**Special features : “RheoComp® Concerto, Symphony”**

- Built-in three in one cooling and vacuum system
- Built in power socket for further expansion of downstream and auxiliary equipments

“Vacuum trap”
“chiller”
“Extensive cooling for injector”
Fully supported by i-RheoComp OS

one extension power of 380V, 20A
Two extension power of 220V, 10A

- Manual and computer control do temperature Settings
- Melt pressure and temperature sensors are available for extensive process monitoring
- Up-to eight ports for pressure and temperature measurement make further differentiation of R&D possible.
- Making video clip for the visual comparison

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RheoComp® is the registered trade mark of MKE
MKE proudly announced the wider selection guide for the RheoComp® system from the technical and economical point of view.

<table>
<thead>
<tr>
<th>Specification</th>
<th>RheoComp® Classic</th>
<th>RheoComp® Concerto</th>
<th>RheoComp® Symphony</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive power</td>
<td>3.5 KW</td>
<td>7.5 KW</td>
<td>7.5 KW</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>200 rpm</td>
<td>200 rpm</td>
<td>200 rpm / 100 rpm</td>
</tr>
<tr>
<td>Max. Torque</td>
<td>500 Nm</td>
<td>250 Nm / 500 Nm Select</td>
<td>200 rpm / 100 rpm</td>
</tr>
<tr>
<td>Max. barrel temperature</td>
<td>350°C</td>
<td>350°C*</td>
<td>350°C*</td>
</tr>
<tr>
<td>Temperature Control zone</td>
<td>3 zone Two zone Air Control</td>
<td>6 zone 3 zone Air control Optional with water cooling</td>
<td>6 zone exchangeable Control with PID, Air or water cooling</td>
</tr>
<tr>
<td>Computer Control</td>
<td>Optional External computer system**</td>
<td>Built in Computer system</td>
<td>Built in Computer system</td>
</tr>
<tr>
<td>Application Area</td>
<td>Plastics, Rubber</td>
<td>Plastics, Rubber</td>
<td>Plastics, Rubber, Food, Pharmaceutical</td>
</tr>
</tbody>
</table>

* Maximum temperature can be changed up to 450°C upon customer request
** Limited i-RheoComp feature
*** Patent pending technology
The combination of “i-RheoComp®” and “Command station” makes your experiments “fast and easy”.

“i-RheoComp®” is a brain for command station” and “plug and play modules” as a torque rheometer and a processing solution provider.

“i-RheoComp®” powered by National Instruments® data acquisition system and Windows® 7 platform. It provide most reliable data gathering and handling in any harsh environmental condition of installation.

“i-RheoComp®” Provides
• Precise control of motor and barrel temperatures
• Easy selection of data type – rpm, torque, barrel temperature, melt temperature water flow rate, and melt pressure
• Easy selection of Plug-and-Play module
• Imbedded processibility calculation scheme
• Viscosity calculation for screw rheometer
• Overlay view with process chart and viewfinder
• Report generator based on hand on experience of engineer
• Easy handling of experiment database
• Spreadsheet and CVS file export for further analysis
• Built in movie maker for BIM and PBIM mixer Find “torque rheometer” in YouTube
Main Feature

• Various mixer capacity selection
• Variety blade type for different application
• Visible internal volume
• Very sensitive melt temperature and torque measurement
Measurable Batch Internal Mixer

- “RheoComp BIM series” offers cost effective solution for wide range of applications.
- BIM-150 is proven testing device comprises with ISO and ASTM.
- BIM-150 is an ideal device as a dependable, cost effective module for
  - Sample preparation
  - Color Matching of Production
  - Small scale Compounding
  - Pelletizing Materials (with Compression Molding Machine)
- RheoComp® offers multi-scaled batch mixer with same operation principles.

<table>
<thead>
<tr>
<th>Model</th>
<th>Space volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM-150</td>
<td>150 cc</td>
</tr>
<tr>
<td>BIM-350</td>
<td>350 cc</td>
</tr>
<tr>
<td>BIM-650</td>
<td>650 cc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roller blade</td>
<td>Plastics</td>
</tr>
<tr>
<td>Banbury blade</td>
<td>Plastics / Rubber</td>
</tr>
<tr>
<td>Cam blade</td>
<td>Rubber/Food/Pharmaceutics</td>
</tr>
<tr>
<td>Sigma blade</td>
<td>Food/Powder/Pharmaceutics</td>
</tr>
</tbody>
</table>
i-RheoComp® used in BIM-150

Improved melt temperature sensitivity / Sensitive torque measurement.

Test Experiments
Density of solid pp : 0.90 g/cc
Density of molten pp : 0.76 g/cc

<table>
<thead>
<tr>
<th>Charging amount (g)</th>
<th>Fill Factor Solid</th>
<th>Fill Factor Melt</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>72</td>
<td>85.8</td>
</tr>
<tr>
<td>46</td>
<td>74</td>
<td>87.7</td>
</tr>
<tr>
<td>47</td>
<td>76</td>
<td>89.6</td>
</tr>
<tr>
<td>48</td>
<td>78</td>
<td>91.5</td>
</tr>
</tbody>
</table>

User defined report generation

Easy comparison with six relevant experiments
Four axis types with same time domain
Company logo applied on demand
Traceable processing parameters
  • melt temperature
  • torque
  • Barrel temperatures
  • Cumulative torque
Powder Batch Internal Mixer

Compatible with major mixer torque rheometer

Three different volume size available
- ½ size chamber
- Full size chamber
- Double size chamber

Mixer function
- Mixer for particulates
  - Powder, Granule
- Mixer for complex fluid
  - Creams, slurries

i-RheoComp® Compatible
Measure, record, and compare
- Rotation speed of primary blade
- Number of rotation and torque
- Product temperature
- Video clipping during mixing
Single Screw Extruder (standard)

- Barrel diameter 19 mm, 25 L/D no vent extruder
- Four zone high temperature casting heater, max 450 °C
- Air cooling system
- Possible to use water cooling system for barrel
- J-Type Thermocouple
  three zone extruder temperature control zone for three air or air/water control zone
  two additional control zone for adaptor and die
  Including single strand die

Standard Single Full Flight Screw

- Diameter 19 mm, 25 L/D single full flight screw
- Compression ratio
  possible to suggest for material interested
  Standard compression Ratio: 3

<table>
<thead>
<tr>
<th>SSE Model</th>
<th>Barrel Diameter</th>
<th>Vent option</th>
<th>Effective Screw Length- xxD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSE 19S/xxD</td>
<td>19 mm</td>
<td>No</td>
<td>17D to 28D</td>
</tr>
<tr>
<td>SSE 19V/xxD</td>
<td>19 mm</td>
<td>Yes</td>
<td>32D to 36D</td>
</tr>
</tbody>
</table>
RheoComp® Rubber Extruder SSRE19

Highly Effective Solution for Rubber Processing Research

- Small size extruder 19mm, 10 L/D
- Stable roller feeding system
- Monitoring feeding temperature
- Measuring adaptor for output melt temperature and pressure
- Starand die and Garvey die
MKE MiniJect
Mini-injection molding device
Simplified plastication and injection molding sequence
Single cycle for one time plastication
and one-time injection molding

Mold type
- Standard type
  : tensile(1), flexural(1), impact(1) specimen
    compatible with ISO standard
- Falling dart, abrasion test specimen, etc.
  : ISO or ASTM compatible

RheoComp® MiniCompounder
Concurrent Technology for Developing Advanced Material
Device Solution for High-throughput Compounding and Rheology

MKE MicroCompounder
Test sample amount: ~ 15 g
Maximum temperature: 400 °C
Maximum rotor speed: 400 rpm
Available die: Strand / Slit die
Co-rotating twin shaft
Using Dissipative Mix Melting Mode
Why is melting and mixing mode so important?
Unit Operation of Melting and Major Mixing in Co-TSE

Major melting mode FED
**Powder Melting in Co-TSE**

Major melting mode PED
**Plastic Pellet Melting in Co-TSE**

“Most of Mixing take place in the melting region of Compounding equipment…. The order of domain size reduced from mm size to micrometer size in that region.

1999 / C. G. Gogos, Z. Tadmor, M.H. Kim

Compounding Research Tools in Macromolecular Engineering

<table>
<thead>
<tr>
<th>Device &amp; Equipment</th>
<th>Micro-Compounder</th>
<th>Mini-Compounder</th>
<th>Co-TSE 19mm</th>
<th>Co-TSE 40mm</th>
<th>Co-TSE Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation</td>
<td>Batch Mode</td>
<td>Continuous Mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Usage</td>
<td>Material Development</td>
<td>Scale-up Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melting Mode</td>
<td>DMM$^3$ Mode</td>
<td>PED$^4$ FED$^5$ Melting Mode</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Co-TSE: Co-rotating twin screw extruder
3. DMM: Dissipative mix melting
4. PED: Plastic energy dissipation
5. FED: Frictional energy dissipation
**MKE V-Feeder**
High Accuracy & Economical Choice

*Key factors in intelligent compounding*
- Accurate feeding
- Cascade feeding
- Separate feeding
- Multiple feeding

Feeder capacity: 0.5~5 kg/hr (8~80 g/min)*
Adopt screw feeder (Launching 2017)
Upgradable to ‘Loss-in-weight feeder’

* Varying with the bulk density of feeding materials
* Feedability follows typical theory of solid particulate handling

**MKE Blending/Compounding Hardware Platform**
Effective BCRND Solution

<table>
<thead>
<tr>
<th>Sample Amount</th>
<th>Weight</th>
<th>Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro amount sample</td>
<td>~10 g</td>
<td>MicroCompounder</td>
</tr>
<tr>
<td>Small amount sample</td>
<td>~50 g</td>
<td>BIM-150</td>
</tr>
<tr>
<td>Medium amount sample</td>
<td>~250 g</td>
<td>BIM-350</td>
</tr>
<tr>
<td>Medium amount sample</td>
<td>80~250 g</td>
<td>Mini-Compounder</td>
</tr>
<tr>
<td>Large amount sample</td>
<td>~ kg</td>
<td>Co-TSE 25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System</th>
<th>Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water bath &amp; pelletizing system</td>
<td>Smart Pelletizing System</td>
</tr>
<tr>
<td>Specimen injection molding</td>
<td>MiniJect</td>
</tr>
</tbody>
</table>
Pilot Film Casting Line

Most advanced state-of-the-art technology incorporated in

Special feature

- Powered by RheoComp® Command station
  - Symphony and Concerto
- Extremely good temperature uniformity in cooling roll
- Maximum film width up to 200 mm
- Dual contact position of cooling roll
- Best performance offer in film width to machine size ratio
- High temperature cooling water available in cooling water
  - Advanced ~180 °C
- Separate Computer control
- Measuring system for film running

General information

- Including constant take-up unit
  - Maximum speed 21 m/min
- Including film wind-up unit
- High temperature cooling water available in cooling water
  - Basic ~ 80 °C
  - Standard ~120 °C
  - Advanced ~180 °C
  - Manual control for roller speed

Further upgrade and options

- Machine directional orientation module
- Automatic gel counter for resin quality control
- Trimming unit
MKE Screw Rheometer
Screw Rheometer

- New standard for the measuring polymer melt viscosity
- High throughput rheometry
  - 32 measurements in 9 hours of working time
- Good reproducibility and repeatability

- Batch-wise operation of short-length single screw extruder like machine
  - Need small amount of material, less than 100g of materials including cleaning
  - Self plasticating and less degradation
  - Self deaeration
  - Less viscous energy dissipation during measuring
  - Five degree C differentiable temperature setting
  - Possible to change shear rate range using selected screw
    - Normal range: 0.2 to 400 1/sec
    - Maximum range: 50 to 4,000 1/sec

“No need for melt feeding and pellet packing”

<table>
<thead>
<tr>
<th>Device</th>
<th>Drying</th>
<th>Sample preparation</th>
<th>Testing</th>
<th>Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-2 hr</td>
<td>~10‘ packing</td>
<td>~40‘</td>
<td>~5‘</td>
</tr>
<tr>
<td></td>
<td>1-2 hr</td>
<td>30‘ Compression</td>
<td>~30‘</td>
<td>~30‘</td>
</tr>
<tr>
<td></td>
<td>1-2 hr</td>
<td>~5‘ No packing</td>
<td>~5‘</td>
<td>~5‘</td>
</tr>
</tbody>
</table>

ISO standard development

Main feature

- Full computer controlled automation of barrel temperature settings and screw speed
- Preset screw speed protocol
- Computerized analysis and reporting
- Easy viscosity comparison with previously measured values
Compression Molding Machine

**EzComp™**
Basic necessary device for material development and testing

**Main Feature**

- Two zone temperature control
  - Top and bottom plate
- Temperature range: 50°C to 350°C
- Rapid cooling with tap water
- Adopt air evacuation system
- Maximum Plate size: 150mm by 150mm
- Compression method: Manual driven hydraulic pump
- Maximum tonnage: Cylinder pressure: 1,000kgf/cm²

* Electric heating and water quenching systems enable researchers to mold the materials very fast.
MKE Product Lineup
See most advanced technology incorporated

RheoComp™ Symphony / Concerto / Classic

RheoComp™ Modules
  Batch Internal Mixer (BIM series)
  Powder Batch Internal Mixer (PBIM series)
  Single Screw Extruder
  Single Screw Rubber Extruder
  Vented Single Screw Extruder
  Co-rotating Twin Screw Extruder
  Counter-rotating Twin Screw Extruder
  Continuous Kneader
  Mini-Compounder
  Micro-Compounder
  Slurry Screw Rheometer (Module Type)
  EL-Vis (Elongational Viscosity)

Stand-Alone Equipments & Devices
  MKE EzMixer
  MKE EzCast (Lab Film Casting Line)
  MKE EzBlown (Blown Film Line)
  MKE Screw Rheometer (Stand-alone Type)
  MKE Smart Pelletizer
  MKE MicroJect (Injection Molding)
  MKE EzComp (Compression Molding)
  MKE RheoStation
  MKE EL-Vis (Elongational Viscosity)
  MKE EzTense (Melt Strength)
  MKE FREEDAQ (Data Acquisition System)

* MKE Rheology Solutions
  Viscosity Function, Elongational Viscosity
  PVT, Melt Density, Bulk Density

About technology holder

Myung-Ho Kim, Ph.D.

Development of nanobarrier compound “HYPERIER”™
Primary inventor of more than two hundred international patents
Coining father of PED – Plastic Energy Dissipation
Commercialization of the Screw Rheometer – ISO standard under developing
Many technical papers and book chapters for the polymer processing area
Customer Opinion

Please check the equipment, which are most closely related to your research and development.

**Rheology**

- Shear viscosity measurement
- Elongational viscosity measurement
- Normal stress measurement
- Temperature dependency of viscosities
- MI, MFR measurement
- Viscosity of Polyamide and Polyester
- Viscosity of super engineering plastics

**Processing**

- Small size compounding equipment
- Reactive extrusion device
- Oil absorption tester
- Planetary mixer
- Film processing machine
- Multi-layer film
- Micro-layer film
- Particulate fluidity
- Bulk density measurement
- Dynamic friction coefficient measurement
- Inter-particle friction coefficient
- Melt density measurement
- Plastic Energy Dissipation measurement

Please send us your opinion to mke0401@hanmail.net or www.rheocomp.com
MKE Virtual Lab.